CHAPTER 7

The Prospects for Energy Conservation in the U.S.S.R.

CONTENTS

LIST OF TABLES

FIGURE

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Most of the attention devoted to Soviet energy in Western literature of the last several years has focused on production, especially the prospects for Soviet oil and gas and the potential role of Western technology in petroleum output. Production, however, is only half of the energy picture: the prospects for Soviet energy consumption are equally important. If the U.S.S.R. could slow its rate of growth of energy demand, the consequences of any decline in production would be correspondingly less critical. Moreover, Soviet plans to substitute among different sources of energy supply (more abundant for scarcer, nearer for farther, more efficient for less) will involve corresponding shifts in the structure of consumption. Measures aimed at controlling or modifying consumption, therefore, are not simply alternatives or complements to a "supply--side' energy strategy; the two are inseparably dependent on one another.

This chapter briefly examines the current structure of Soviet energy consumption and recent trends in Soviet energy use; describes the evolution of Soviet official policy on energy conservation and the major conservation options available to Soviet planners; reviews recent performance in achieving energy savings; and discusses the implications for Western policy of Soviet conservation strategies.

Energy conservation is not a new issue for Soviet policy makers, but an aspect of a general concern with the availability and use of all raw materials. The increasing scarcity of attractively located and high-yield natural resources is a constraint on Soviet prospects for economic growth. Nevertheless, Soviet experience in conservation has been mixed. For all the official exhortation over the years, there are only a few cases in which more than token gains have been recorded. This is not for want of opportunities. In 1975, the Soviet Union used nearly as much energy as the United States in industry, but Soviet industrial output was only three-fourths that of the United States. Similarly, in the agricultural sector in the same year, the U.S.S.R. used appreciably more energy to achieve 80 to 85 percent of America's output. [1]

Impressive Soviet conservation efforts have taken place in the energy field itself, particularly through steady improvement in the efficiency of electrical power generation and the use of cogeneration for centralized urban heat supply.[2] Unfortunately, now that these gains have been realized, further progress may be slow. The reasons, as this chapter demonstrates, stem from basic features of the Soviet command economy: the system of prices and incentives, the mechanisms for investment and technological innovation, and the distribution of power. In addition, Soviet decisionmakers are disposed to think of output performance before efficiency. This makes individual enterprises disinclined to support actions that might threaten the former in support of the latter, and planners reluctant to stake the success of their energy policy on conservation measures that they may know from previous experience are unlikely to work. In short, the future of Soviet efforts to conserve energy can be regarded as one part of a larger problem–the struggle of the Soviet system to overcome the inherited habits of Stalinist-style industrialization.

[1]Robert W. Campbell, "Energy Prices and Decisions on Energy Use in the U.S.S.R.," discussion paper, Department of Economics, Indiana University, February 1981, p. 1.

[2]See Leslie Dienes and Theodore Shabad, *The Soviet Energy System* (New York: John Wiley & Sons, 1979), pp. 187-194.

STRUCTURE AND TRENDS IN SOVIET ENERGY CONSUMPTION

The most striking feature of Soviet energy consumption compared to that of any major Western industrialized country is the dominance of the industrial and the comparatively small shares of the transportation and residential sectors in energy use. Table 49 shows how Soviet primary energy supply is allocated among various uses—including own use and losses in the energy industries, nonfuel uses, and various sectors of the economy—both with electric power stations shown as consumers and with consumption shown by final user (i.e., after consumption in power stations has been reallocated among the sectors that use their output). Industry has consistently accounted for by far the largest share of Soviet domestic energy consumption over the past 20 years. This is largely due to the small stock of private automobiles and the low share of trucks in the overall transport mix, and the fact that a large proportion of Soviet buildings are heated through centralized systems using the heat cogenerated during the production of electrical power.

Another striking characteristic of Soviet energy consumption is the large share used by the energy-producing sector itself. Own-use by the gas industry, for example, is about 10 percent of total output, mostly to power pipeline compressors.[4] Much of the energy consumed by the energy industries is simply due to the circumstances under which they must operate: long transit distances to points of consumption (40 percent of all Soviet rail traffic is devoted to shipment of fuels), inhospitable environments in the producing regions, the need to work with low-grade fuels, and some energy-intensive extractive methods. For example, waterflooding has turned the Ministry of the Oil Industry into a major consumer of electricity. The industry consumed 48 billion kilowatt-hours (kWh) in 1979, and the rate is rising by 11 to 13 percent a year.[5] These factors are becoming even more important over time, as transportation distances increase and the accessibility of fuel declines. In fact,

[3] For a review of recent data on this subject, see Leslie Dienes and Nikos Economou, "CMEA Energy Demand in the 1980's: A Sector-al Analysis," paper presented at the 1981 Colloquium of the NATO Economics Directorate, Brussels, April 19H 1.

Table 49.—Soviet Energy Consumption (million tons of oil equivalent)

	1960	1965	1970	1975	1980
Total primary energy supply (corrected for foreign trade) . . .	438.9	579.5	737.4	922.0	1,086.2
Consumed in:					
Own needs and losses.	56.4	67.8	79.8	115.7	119.2
Industry.	132.0	169.9	2099	253.4	306.4
Electric power stations	1119	164.0	2253	3028	367.4
Household and municipal	463	65.3	79.5	98.0	80.5
Agriculture	21.3	29.3	42,6	43.4	543
Transportation . .	517	57.1	57.0	529	85.9
Construction	73	82	14,2	16.0	27.0
Nonfuel	12.0	17.9	29.1	39.8	45.5
After reallocation of *electric power and cogenerated heat:*					
Own needs and losses.	123.4	1575	1957	271.8	304.6
Industry	165.8	2275	292.9	360.0	438.9
Household and municipal	54.7	773	98.7	1267	114,4
Agriculture	21,8	302	44.5	47.5	60.2
Transportation . .	53.1	599	612	58.6	93.5
Construction	8.0	91	15,3	17,6	29.1
Nonfuel	12.0	179	29,1	39.8	45.5

SOURCE Robert W Campbell

[4] A. A. Makarov and L. A. Melentev, "Problems and Directions of Energy Development in the U. S. S.R.," *Ekonomika i organizatsiya promyshlennogo proizvodstva (Ekon.)*, No. 3, 1981, p. 28.

[5] V. D. Kudinov, "Rational [Utilization of Fuel and Power Resources in the Oil Industry," *Neftyanoye khozyaystvo*, No. 9, 1980, pp. 6-9. According to Kudinov, the ministry also consumed 9.3 mtoe in liquid fuels and gas in 1979, one-quarter of which was used for gas-lift operations. Total own-use by the Ministry of the Petroleum Industry in 1979, according to another source, was 14.7 mtoe. See I. Grekhov, et al., "Use Fuel and Energy Resources Economically and Efficiently," *Neftyanik*, No. 10, 1980, p. 12, in JPRS No. 77154, Jan. 12, 1981, p. 8.

there is overall an upward trend in own-use by the energy sector.[6]

Prospects for Soviet energy conservation and substitution, therefore, turn heavily on developments in industry, and especially in the energy industries. This is in contrast to conservation prospects in the West, where major savings have recently been realized in residential and transportation uses. Analysts in both the U.S.S.R. and the West have argued that Soviet industrial consumption tends to be less flexible than that of other sectors, and potential energy savings will consequently be harder and slower to realize than were gains in the past. ' This is not to say, however, that opportunities for most such savings have been exhausted. In any case, the shares of residential and municipal consumption, relative to industrial, are unlikely to alter much without a sharp shift in the political priorities of the Soviet leadership. There is no evidence that such a change is imminent.

The inevitable rise in the energy sector's consumption may alter the regional distribution of demand, yet the traditional concentration of demand in the European part of the U.S.S.R. is reinforced by the tendency of industrial ministries to locate where infrastructure and labor are readily available. Further, as table 49 demonstrates, a large share of Soviet energy is consumed in the form of electricity. This is due to the nature of the technological processes employed in industry. (The transportation and residential sectors directly consume greater proportions of liquid, solid, or gaseous fuel.) Gradual technological modernization of Soviet industry and the rise of sophisticated manufacturing specialities should lead to a continuation of this trend.

But the balance among Soviet energy sources must change. Soviet planners have understood for some time that the share of oil must be cut and other fuels substituted. At the center of their effort has been a policy of investing in nuclear and hydropower for electricity generation, and of mobilizing the abundant resources of lignite and subbituminous coal from Siberia and Kazakhstan. Now, a growing emphasis on gas has emerged. Much of what is presently used as fuel oil will be converted to lighter fractions, requiring a major expansion of refinery capacity in the next decade. There have been recurring differences of opinion among Soviet leaders and planners, however, over the relative priority to accord these plans (see below and ch. 8).

[6]For example, in the first 4 years of the Tenth FYP, the energy required to produce and transport 1 ton of crude oil by pipeline increased by 12 and 26 percent respectively. Ibid., p. 14.

[7]Makarov and Melentev, op. cit.

ENERGY CONSUMPTION AND ECONOMIC GROWTH

The key point at issue is whether the Soviet Union can "decouple" increases in energy consumption from overall economic growth by the end of the century. There are important areas in the Soviet economy where certain energy intensities have fallen—largely accomplished through substituting gas and oil for less efficient coal; electrifying key sectors of the economy, including half of all railroad haulage; and controlling conversion losses through improvements in the heat rate and extensive use of cogeneration. But in general, once the Soviet index for gross national product (GNP) growth *is* corrected (downward) to make it conform more closely to Western definitions, it is apparent that Soviet energy use is growing faster than Soviet GNP.

Analysis of Soviet energy/GNP elasticities shows a progressive deterioration since the early 1970's. Soviet economists continue to claim an elasticity of less than 1, perhaps because they use an exaggerated measure for growth rate of aggregate output, but the Soviet data in table 50 nonetheless reflect the recent rise in GNP elasticity of energy use. It must be noted, however,

Table 50.—Relationship of Economic Growth to Energy Use, 1961-78
(increments expressed in average annual percentages)

	Gross energy consumption	National Income	Coefficient of elasticity
1961-65,	6.6	6.5	1.02
1966-70,	4.8	7.8	0,62
1971 -75...,	5.1	5.7	0.89
1976 -78....,	4,8	5.1	0.94

SOURCE S N Yatrov Fuel-Energy Complexes *Ekonomieheskaya gazeta,* No. 10, March 1980, P 10

that this trend appears to rest more on a decline in GNP than on growth in gross energy consumption.

The most authoritative Western estimates of energy/GNP coefficients are given in table 51. These are based on different data than the Soviet estimates, and consequently show significantly higher coefficients. Nevertheless, they reflect the same trend. Both Soviet and Western calculations, therefore, carry the same long-term implications. If one assumes an average annual Soviet growth rate of 2.5 percent and an energy/GNP elasticity of 1.0, gross energy consumption would rise from under 1,556 million tons of oil equivalent (mtoe) in 1980 to 1,615 mtoe a year by the year 2000.[8] Some forecasts for total Soviet primary energy production in that year come to very little more, leaving nothing for energy exports. This is a crude calculation, but it serves to highlight the importance of conservation in the Soviet economy.

The aggregate energy intensity of the Soviet economy can decline only if energy efficiency continues to improve as it did before 1970; or if the overall structure of the Soviet economy evolves in the direction of sectors that are less energy- and material-intensive. The degree to which either of these conditions can be met is, at best, debatable. Several factors work against the prospect of declining energy intensity.

[8]Robert W. Campbell, "Energy in the U.S.S.R. to the Year 2000," unpublished paper prepared for the Conference on the Soviet Economy, Oct. 23-25, 1980, Airlie House, Va.

Table 51.—Relationship of Economic Growth to Energy Use, 1960-80
(increments expressed in average annual percentages)

	Gross energy consumption	GNP	Coefficient of elasticity
1965-60, ...,	5.9	4.9	1.20
1970-65 ., .,	4.9	5.3	0.92
1975-70, .,	4.0	4.1	0,97
1980-75,	4.0	3.0	1.33

SOURCE Robert W Campbell Energy in the U S S R to the Year 2000 unpublished paper prepared for the Conference on the Soviet Economy Oct 23-25 1980 Airlie I-louse, Va

First, opportunities that made it possible for Soviet managers to reduce the energy input per unit of output in many processes in the 1950's and 1960's—shifts to cheaper fuel, rapid improvements in the heat rate of powerplants, etc.–dwindled in the 1970's and are vanishing in the 1980's. Extraction and transportation costs for all energy sources are climbing; the quality of coal and oil is deteriorating; and progress in lowering the heat rate in the best powerplants has nearly reached its limits. Furthermore, any structural shifts in the Soviet economy toward reemphasis of energy- and material-intensive sectors may be offset by equally strong trends in the opposite direction, i.e., toward sectors like agriculture that are highly energy-intensive. In addition, the energy-producing sector itself is growing rapidly in importance.

The prospects for improvement in either the net energy intensity or the efficiency of major conversion processes are, in short, uncertain. If present trends continue, a deterioration in the aggregate energy intensity of the Soviet economy over the next two decades is possible. It is in this context that Soviet energy conservation policy must be evaluated.

EVOLUTION OF SOVIET CONSERVATION POLICY

High-level interest in energy conservation has been evident in the U.S.S.R. since the early 1970's. Such concern is probably less attributable to specific anxiety about future Soviet oil production (Siberian supergiants were still being discovered until 1973) than to a general deterioration in the economics of energy supply caused by the rapidly growing extraction and transmission costs connected

with the decline of European energy deposits and the development of Siberian resources. In 1973, the Central Committee of the Communist Party and the U.S.S.R, Council of Ministers issued a joint decree on energy conservation, "On Steps to Improve Efficiency in Using Fuel-Energy Resources in the National Economy." This decree, frequently cited as the starting point of the present conservation policy,' was primarily concerned with recovery of "secondary energy resources," mainly high-temperature process heat that could be profitably reused before being released and lost.

By now a number of official decrees have appeared on the subject of energy conservation, gradually broadening the scope of the policy. This policy now encompasses a wide range of investment and housekeeping measures, aimed not merely at capturing secondary heat resources but at monitoring energy use, establishing criteria of efficiency for major industries and processes, improving insulation, etc. The decrees have also created an administrative apparatus for the implementation of the conservation effort, and have attempted to increase the involvement of the party in conservation. As a result, conservation is now a prominent part of official energy policy.

Soviet decrees evince a tension between two broad conservation strategies. The first, a "high-investment strategy," is aimed at improving the efficiency of Soviet energy use through technological innovation and replacement of obsolete plant. The second, a "low-investment"' or "housekeeping" approach to conservation, is aimed at saving energy through better monitoring and better production practices, but largely within the confines of existing technology and plant. For example, in the case of automotive transportation, the first strategy might aim at developing more efficient engines, perhaps through widespread adoption of diesels; the second approach would call for better maintenance of the existing stock and for measures to curtail the thriving black market in oil and gasoline.

In principle, the investment and housekeeping strategies are complementary, The former seeks to substitute capital for energy, the latter labor for energy, including labor in the form of innovation and more stringent management. In a market economy, their precise mix is determined in principle by the relative marginal return from each, and the conservation strategy employed at any time will be a combination of investment and housekeeping, with no clear disjunction between them. In the Soviet Union, in contrast, there is a clear difference between the investment and housekeeping strategies. The first is handled through the central planning system. The second is regarded as an enforcement and monitoring problem, and is handled through so-called "public organizations," largely at the local or enterprise level. Coordination of these two strategies is a difficult process in a command economy.

THE HIGH-INVESTMENT STRATEGY

Restructuring Demand

The most urgent task of Soviet planners in the next decade is to lessen the share of oil in the overall energy balance. This involves both producing fuel substitutes and adjusting the capital stock on the demand side to accommodate them. Problems exist on both counts. Nuclear power development and electrical power construction have fallen behind schedule; and coal output has seriously lagged plan targets. The combination of these problems has caused a virtual eclipse of the ambitious program adopted at the 25th Party Congress in 1976, which relied heavily on conversion to coal-fired powerplants. Although ambitious gas targets have been adopted, it is still possible that diversification of supply will not proceed fast enough to avoid domestic oil shortages in the mid to late 1980's. These might necessitate fuel rationing or mandatory cutbacks (see below).

'E. I. Vertel, in *Vestnik mashinostroyeniya*, No. 3, 1980, pp. 3-7, and V. Varavka, "Gas Heats the Sky," *Ekonomicheskaya gazeta*, No. 17, April 1980, p. 16.

Altering the structure of energy demand in the Soviet Union raises some of the same problems as in any other industrialized country. Consumption patterns are the outcome of many past policies. Changing these patterns requires making adjustments to the country's basic infrastructure, a slow and expensive process, despite the fact that aging capital stock must eventually be replaced. In the Soviet Union such replacement has taken place much more slowly than in the West, and there is a large stock of inefficient and obsolete equipment. Given the present shortage of capital, alleviation of this problem in the near term is unlikely.

The existing capital stock strongly inhibits Soviet ability to shift the energy consumption mix. For example, there are about 250,000 small boiler plants in the U. S. S. R., the majority of which operate on coal. Half of the Soviets' larger nonnuclear powerplants use gas and fuel oil. Sound policy, according to Soviet fuel experts, would be to convert the small boilers to gas and the larger ones to coal.") But such a conversion would require a massive expansion of local gas lines and of gas storage facilities, a project that seems out of the question for a gas ministry that will be totally absorbed in the next few years in expanding gas production and bulk carriage.[11]

Coal presents other obstacles. It is unattractive to users, and its quality is rapidly declining. Enrichment facilities, treatment to remove moisture and ash, and the utilization of new boiler types that can deal with poorer grades of coal have all been slow to achieve widespread application. Coal's declining heat content also makes larger shipments necessary. The Moscow power system, for example, requires 20,000 more coal cars than formerly just to offset the poorer quality. The presence of impurities adds to downtime and maintenance costs, and shortens the lifetime of boilers.[12] Moreover, conversion of large powerplants to coal is expensive and time-consuming, taking powerplants out of operation for long periods. The latter is a particularly serious consideration in view of existing concern over power supplies to the European U. S. S. R., where generating capacities are strained by demanding output targets.

The result of these problems has been a tendency to convert oil-fired powerplants to gas, but even that process has been lagging.[13] In short, there is reason to believe that Soviet planners will find it difficult to restructure demand. Success will depend to a great extent on replacing an older, inefficient plant, and on planning an energy-saving investment.

Replacing Inefficient Plant

Modernizing or replacing existing stock with more energy-efficient equipment requires both capital and the active commitment of industrial planners and designers. In the U.S.S.R., technological innovation and diffusion have traditionally been hampered by a dysfunctional incentive system and problems of coordination across administrative boundaries.[14] The country has been slow in modernizing its inefficient plant, and this situation is unlikely to readily change.

An illustration of Soviet problems in this area may be found in the electrical-power sector. The Ministry of Power and Electrification is assigned an annual plan for the replacement of obsolete boiler equipment, particularly equipment operating at pressures of less than 90 atmospheres. The Power Ministry's planners nevertheless continue to include the less efficient equipment in their own specifications, because they know it has a better chance of being pro-

[11] S N. Yatrov, "Energy Resources: Ways to f+; conomize," *Sotsialisticheskaya industriya*, May 19, 1980, in JPRS No. 76261, Aug. 20, 1980, p. 9.

"S N, Yatrov and A. Pyatkin, "Effectiveness of Utilization of Fuel and Power Resources," *Planovoye khozyaystvo*, No. 2, 19'79, p. 12.

[12] N. Kovalev, N. Tikhodeyev, and I. Y. Ershov, "How To Draw Reserves," *Pravda*, Nov. 20, 1980.

"kl. A. Styrikovich, "The Main Link," *Izvestiya*, June 1, 1980.

[13] See Paul M. Cocks, "Science Policy in the Soviet Union," in [National Science Foundation, *Science Policy USA/U. S. S. R.*, vol. 2 (Washington, D. C.: U.S. Government Printing Office, 19801.

duced in sufficient quantities to meet plan targets. No incentive exists for the enterprises that manufacture boilers to undertake difficult and time-consuming change-over operations that would inevitably affect planned output fulfillment for some time. The Ministry of Power Machine Building, which builds boilers for the Ministry of Power, claims to be indignant about the lack of progress and has raised the issue before planning authorities. Yet large numbers of small and energy-inefficient boilers continue to be produced.[15]

Because Soviet industry has problems with technological innovation in general, it of course does not necessarily follow that improved energy efficiency in particular is impossible. Energy efficiency in the Soviet iron and steel industry, for example, has long been increasing. These improvements in ferrous metallurgy can be seen in dramatic declines in the average fuel rate in Soviet open hearth furnaces over the past 40 years, declines that are likely to continue in the present decade.[16] Similar improvements have occurred in thermal power generational' and a number of other energy-intensive industrial sectors—construction materials and chemicals for example—might well cut their energy use sharply with the introduction of modern equipment.

The potential for significant energy savings through the high-investment strategy should, therefore, not be lightly written off. The key to the rate and degree of success in this area lies in the Soviet economic system itself. One major inhibitor of innovation in the U.S.S.R. is the fact that ready measures of "good' innovation are lacking—a seller's market prevails in the producer-goods sector, and users must accept what they get, regardless of whether changes actually constitute improvements. Energy efficiency is an exception. It can be based on a criterion that is readily measurable, both by users and by outside monitors. With such a criterion, Soviet industry has in the past been able to produce useful change, *once it was given the incentive to do so.* Restructuring incentives may, therefore, be the key in determining the response of Soviet industry to a high-investment conservation strategy.

Planning Mechanisms

Energy conservation cannot be built into new industrial technology simply by decree from above; it must originate within the industrial ministries themselves and be built into basic technologies and designs. Consequently, a high-investment approach to energy conservation requires more than just the cooperation of industrial ministries and research and design institutes. Enterprises must also be given the appropriate instructions and incentives to incorporate energy-saving schemes into proposals for new plant and machinery. In the absence of such cooperation and incentives, official exhortation will have little practical effect.

There is little evidence of the necessary mechanisms for progress in this area. In 1979, a deputy chief of Gosplan's energy division criticized the industrial ministries for failing to incorporate energy conservation into their planning systems. In the most important areas of fuel substitution—nuclear power, hydropower, and waste heat recovery—the necessary procedures had been "partially" implemented. But the article was especially critical of the failure to plan for greater efficiency in low-parameter use of heat resources.[18] Similarly, a high-level survey done in the same year revealed that only 2 of 67 enterprises of the Ministry of the Automobile Industry had adopted 5-year energy conservation plans, and that matters were no better in other industries.[19]

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[15] *Pravda*, Oct. 28, 1980.

[16] See William J. Kelly, Hugh L. Shaffer, and Timothy P. Spengler, "Trends in the Energy Efficiency of Open-Hearth Furnaces in the Soviet Union," paper presented at the Midwest Economics Association, Louisville, Ky., April 1981.

[17] William J. Kelly, "Industrial Energy Conservation in the Soviet Union: Thermal Power Generation," paper presented at the Southern Economic Association, Washington, D.C., November 1978.

[18] \. Troitskiy, *Planovoye khozyaystvo*, No. 2, 1979, p. 24.

[19] S. Veselov, "Rational Expenditure of Fuel and Power Re- ~ourL'('\,"' I'I(III()I ovek II():\'(11 stvo, No. 2, 1979, p. 33.

Such results are hardly surprising given the past cheapness and abundance of energy resources and the relative novelty of Soviet recognition of "energy problems." No evidence has yet appeared in the West of any adaptation of industrial ministries' policy-making systems to these emerging problems. Perhaps the relative lack of official attention to this issue reflects a shift of focus away from a centralized-investment approach to energy conservation, since during the same period there has been no lack of coverage of the ministries' mechanisms for oversight and enforcement. It would appear that for now this aspect of conservation policy is still fluid.

Planning Prices[20]

Another factor inhibiting the high-investment strategy relates to the price system employed by planners in making major investment decisions. Soviet "planning prices'" are intended to convey the national economic cost of various fuels in the major economic regions. Planning prices are calculated through a complex system which takes account of aggregate demand for boiler and furnace fuel in each region; capacity levels for these fuels and for certain transport links; the capital and operating costs of producing the fuels; and the capital and operating costs of transporting them.

These planning prices, however, tend to understate the real costs of producing and delivering the energy, which rose steeply in the 1970's as the centers of oil, gas, and coal production moved eastward. In addition, planning price calculations take only domestic demand into account. World market prices for energy have been rising rapidly, however, and the real opportunity cost of, for example, Soviet oil is the world market price. This is substantially higher than its planning price. The absence of a system which takes account of the true opportunity costs of exportable oil and gas makes it difficult to construct optimum production mixes and to decide on rational fuel substitution policies. The high-investment conservation strategy is, therefore, seriously hampered because the prices used as a basis for investment decisions do not sufficiently encourage the substitution of capital for energy or of one energy source for another.

THE LOW-INVESTMENT STRATEGY

Transaction Prices

Prices play a second role in Soviet energy conservation. Beside the planning price used to make investment decisions is a separate system of transaction prices. These are the prices at which energy is actually bought and sold. Because they directly affect the consumer, transaction prices figure prominently in the low-investment or housekeeping strategy, and here too prices have proved an obstacle to energy conservation.

Soviet energy transaction prices for both industrial and residential consumers are far below actual energy costs. The fuel bills of even large enterprises can be too low even to be recorded. At the large Gorky Automobile Factory, for instance, natural gas constitutes less than 2 or 3 percent of total production costs.[21] One plan to control industrial over-consumption of gas during periods of intense cold by charging punitive rates (as much as five times above normal) for consumption above established limits had to be abandoned when planners concluded that gas prices were so low that such surcharges would have no effect if charged to an enterprise's direct production costs.[22] It is hard to imagine how a surcharge system could be applied to residential customers. Most homes are charged only a flat subscription fee for gas.[23]

Underpricing of energy was part of earlier policies designed to encourage consumption. In 1968, prices for centrally supplied heat and electricity were set low to encourage

[20] This section is based on Campbell, "14;nerglr Prices .." op. (it.

[21] Varavka, op cit., p. 16.
[22] N. Fedorov, "Economic Flame," *Pravda*, Feb. 2, 1981.
[23] \'aratk:i, op. cit.

users to switch to the central sources. The rates have not changed since. As a result, most power systems lose money-70 million rubles a year at the Moscow system alone. Demand for electrical power has recently been growing faster than capacity, but authorities have added to this demand by establishing a new system of preferential rates to agricultural users.[24]

Soviet planners are well aware that energy prices are too low. On January 1, 1982, transaction prices of coal, petroleum, natural gas, fuel oil, electric power, and thermal energy will be increased. According to the State Committee on Prices, the new prices will provide a better stimulus to conservation because they will make the more remote consumer and the consumer of higher quality fuels pay more. Early indications are that this price rise will be on the order of a 2.3-fold increase. If this is indeed the case, it should help to alleviate the problem-assuming that all other prices are not increased in tandem. But although a major criterion for this reform appears to have been the increasing cost of energy extraction, Western experts believe that it is still unlikely that the 1982 prices will reflect the real opportunity costs of energy.[25]

Nor is there necessarily a strong correlation between higher prices and lower energy consumption. There is some evidence that the 1967 price reform—which greatly increased the prices of oil products, natural gas, and coal–resulted in substantial energy savings.[26] However, the mechanisms which brought about that result are not well-understood and may not still be operative. Because of numerous institutional barriers in the Soviet economy, higher prices do not guarantee significantly lowered consumption.

In sum, it is far from axiomatic that higher prices will lead to large energy savings. The Soviet system is one in which the role of markets is deliberate} restricted and the impact of prices therefore limited. Within the existing incentive system, factory directors who cut their energy bills are likely to be rewarded with a cut in future energy allocations. Moreover, some energy-related commodities have "no value' because no markets exist for them. Designers of petrochemical plants typically fail to provide uses for byproducts, which can amount to two-thirds of the original feedstock. The usual practice is simply to burn them-using fuel oil.[27] Finally, the numerous administrative barriers that separate producers from users may make decisionmakers remote from the costs they impose.

Measurement of Energy Consumption

The difficulties of employing a price mechanism are compounded by problems in measuring the amount of energy actually consumed. The Soviet press frequently alludes to the widespread lack of apparatus to measure all energy sources, at every stage from extraction to final use. From the oilfields of Tyumen to the gas heaters in Moscow homes, energy is produced and delivered "na glazok," as the Russians say, "by eye alone."" The situation is apparently less serious for electricity than for gas,[29] and less serious in the cities than in the countryside,[30] but the problem remains pervasive.

'Kovalev, et al., op cit.

Ekonomika neftyanoy promyshlennosti, August 1980, p. 2; Campbell, "Energy Prices," op. cit., pp. 230-43.

William J. Kelly, "Effects of the Soviet Price Reform of 1967 on Energy Consumption," *Soviet Studies*, vol. XXX, No. 3, July 1978, pp. 394-402; Albert L. Danielson and Charles D. DeLorme, Jr., "An Alternative Analysis of the Effects of Energy Prices on Energy Consumption in the Soviet Union," *Soviet Studies*, vol. XXXI, No. 4, October 1979, pp. 581-584. Danielson and DeLorme employed different econometric specifications, but confirmed Kelly's thesis that energy prices and energy consumption in the Soviet economy are inversely related.

'P. V. Fedorin, "An Important Source of Savings of Fuel and Power," *Ekonomicheskaya gazeta*, No. 5, January 1981, p. 10; "It Does Not Appear in the Signs," *Pravda*, Mar. 5, 1980, in JPRS No. 75687, May 13, 1980, pp. 1-6.

"For comment on Tyumen, see V. P. Rosliakov, "Reserves of the Economy of Energy Resources in Western Siberian Industries," *Neftyanoye khozyaystvo*, No. 9, 1980, p. 30; on household use see Varavka, op. cit.

'Orudzhev, op. cit.

"The Price of a Kilowatt-hour," *Pravda*, Mar. 7, 1981. Electricity charges in most collective and state farms are established according to the capacity of the electrical equipment in operation in the farm, regardless of actual level of

Lack of measurement apparatus causes both short- and long-term problems. In periods of intense cold, for instance, there is no way to control or even evaluate surges in demand for gas.[31] Serious long-term consequences are the impossibility of setting and enforcing rational consumption standards, and the difficulty of setting meaningful energy prices, particularly for individual or small consumers.

Minpribor, the ministry in charge of instruments, automation, and control systems, is often blamed for the lack of meters and other energy-measuring devices. Gas and electricity meters are low-cost items, and therefore unprofitable for Minpribor to manufacture. (Ironically, Minpribor was one of the first ministries to undergo "economic reform" putting it on a profit-oriented, cost-accounting basis. Its failure exemplifies the difficulties of economic reform in a command system.) But the blame does not lie with Minpribor alone. Soviet energy has been literally "too cheap to meter, and it is doubtful that the forthcoming price reforms are radical enough to change this situation.

Consumption Norms

In the absence of a realistic price system or market mechanism, Soviet planners provide industries and enterprises with energy-consumption norms or indices to set optimum levels for energy use. These are detailed specifications for the amount of energy that may be employed in any process. Consumption indices are rigid and often arbitrary, and there is ample evidence that norm-setting is a process fraught with bargaining and controversy.

Because energy consumption varies widely with the age of the plant and type of technology, each industry exhibits a considerable range between the consumption of the leading enterprises and the industry average. In 1976, for example, the leading enterprise in the production of forgings and stampings in machine-building consumed 288 kg of standard fuel for every ton of metal it used. The industry average was 342 kg/ton. Similarly, the leading iron casting enterprise consumed nearly 100 kg/ton less of standard fuel than the industry average.[32]

An optimum system would not only require separate indices for every enterprise, but for every major process within each enterprise. Even then, the system would be flawed because energy inputs are usually measured only for the enterprise as a whole, not for individual processes. In practice, little information is available to advise on the effectiveness of indices.[33]

Therefore, the most common system of norm-setting is simply to set a consumption ceiling for an enterprise as a whole. This practice entails a large measure of guesswork, and encourages bargaining by interested ministries or local regions. Ministries can assign their enterprises inflated consumption norms that allow output targets to be met without energy constraints. If an enterprise exceeds its norm, the ministry can raise it after the fact. The enterprise can then claim paper energy savings which are credited to its conservation performance.[34]

In principle, the main consumption norms are steadily lowered each year according to an official plan specifying the amount of the decline. But ministries do not always abide by these plans. One recent article charged that the Ministry of Power failed to carry out its 1979 plan for lowering the heat-rate norm in thermal powerplants, and was thereby responsible for wasting over 0.622 mtoe.[35] Moreover, some norms are exempt from the

Continued from p. 235.

use, This fact, combined with preferential rates for electrical power (part of a massive program of rural electrification that received high priority during the 1970's), means that there are no disincentives attached to overconsumption.

[31] Fedorov, op. cit.

[32] Yu. Sibikin, "The Efficiency of Utilization of Fuel-Energy Resources in Machine Building, " *Planovoye khozyaystvo*, No. 12, 1979, p. 49.

[33] V. A. Zhmurko, "Economics of Electric Energy—A Common Concern, " *Ekonomicheskaya gazeta*, No. 4, 1981, p. 9.

[34] "Fuel and Energy—Strict Accountability," *Pravda Ukrainy*, Dec. 7, 1979; S. Bogatko, "The Working Kilowatt, " *Pravda*, Jan. 8, 1980; see also Zhmurko, op. cit.

[35] Dolgikh, "To Increase the Level ..., op. cit., p. 23.

annual change. The Ministry of Power has been blamed for failing to insulate power stations and streamlines. As a result, 24 million gigacalories of thermal energy are purportedly lost each year. But the norms governing insulation have not changed since 1959.[36]

The combination of a consumption system with no meters, prices too low to encourage strenuous conservation efforts, and meaningless norms produces a vicious circle which has been very difficult to break. The deficiencies of the price system make the norms necessary, but the lack of measurement apparatus makes them easy to virtually ignore. So long as this situation persists, there is little incentive to obtain meters or to pressure Minpribor, which at present cannot be induced to produce them. The root of the problem is the fact that energy has in the past been so cheap in the true economic sense that careful monitoring was unnecessary. Now that this is no longer the case, the task of the Soviet system will be to adjust to the new circumstances. It may be expected, however, that the rigidities and dysfunctional side-effects of the command economy will make change slow, especially if the political leadership is less than fully committed to conservation.

Monitoring and Enforcement of Conservation

The Soviet leadership's commitment to housekeeping strategies might be measured by the effort put into creating effective machinery for monitoring and enforcement. In the last year, enforcement offices with modest functions have been upgraded and given greater powers; the scale of monitoring activity and enforcement has increased; and the official publicity given to the effort has grown. Officials of the monitoring agencies themselves, however, are among the most outspoken in charging that their efforts have been almost totally ineffective.

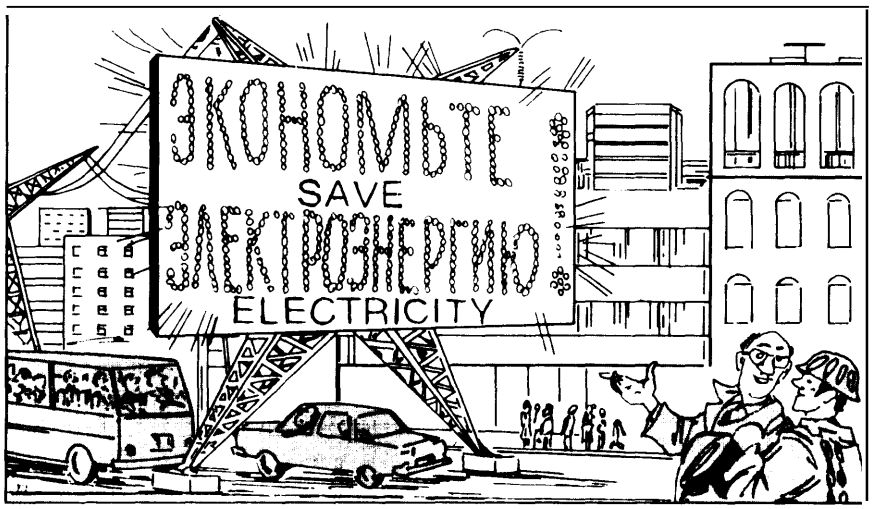
The two most visible enforcement offices, the State Power Inspectorate of the Ministry of Power and Electrification and the State Gas Inspectorate of the Ministry of the Gas Industry, are well-established bodies. Originally charged with oversight of the supply of gas and electricity in their respective ministries, their jurisdiction has been expanded to include a wide range of other industrial ministries. In theory, the State Gas Inspectorate can recommend administrative fines of up to *100* rubles, and it has the power to cut off an offender's gas supply. In practice, however, such powers are weak. The likelihood of a cutoff is very small, and even the imposition of a fine must be assessed by the apparatus of the local Soviets. The "recommendations" of the inspectorates have been widely ignored by enterprises.

The energy inspectorates are useful, however, in conducting investigations which have publicized the extent of inefficient energy use throughout Soviet industry. Such publicity in itself will do little if anything to influence the incentive structure which regulates the behavior of Soviet enterprise officials, but it may be a first step to potentially more drastic actions.

Another way of publicizing official Soviet policy is through public mobilization campaigns. Common devices in the conservation campaign include ''commissions and ''staffs" located in factories to perform public inspections; "raids and contests for energy conservation; ''socialist pledges" and "personal creative plans" to save energy.

These groups lack power and are usually regarded as a symptom of low priority and inaction. This appears to be true of the conservation campaign; in fact, many enterprises are not even going through the motions. In 1978, the State Power Inspectorate found that 21 of 48 enterprises surveyed in the Ministry of Ferrous Metallurgy had made no move to apply a recent statute establishing bonuses for workers and engineers for saving energy, and about a third of the enterprises had adopted no energy-

[36] "Don't Let Heat Be Lost," *Materialno-tekhnicheskoye snabzheniye*, No. 6, 1979, pp. 124-128; and "[illegible]," *Ekonomicheskaya gazeta*, No. 22, 1980, pp. 16-19.



Now no one will reproach us that we are devoting little attention to saving electrlc power

A Soviet cartoon that appeared in *Pravda* in March 1978

saving program at all.[37] According to one account, the much-vaunted public groups are "activated only when the corresponding directives come down from above and gradually dwindle down to nothing as soon as the campaign is over. "[38]

The result is widespread cheating. According to critics in the energy inspectorates, industrial enterprises have become adept at saving awe-inspiring amounts of energy—on paper. For example, in 1978 the Uzbek Ministry of Municipal Services claimed to have saved 410 tons of gasoline, 2 percent of its annual consumption. An official inspection discovered that the ministry's drivers did not log gas consumption in their trip reports, routinely exaggerated the length of their trips, and sold quantities of gasoline on the black market.[39] Such accounts have lately become common in the Soviet press.

The enforcement system is now being expanded. A recent official decree on energy conservation instructs all ministries, state agencies, and republic-level Councils of Ministers to develop conservation offices. '() In 1980, a decree of the U.S.S.R. Council of Ministers upgraded the official rank and powers of the conservation inspectorates of the Ministries of Gas and Power.[41] The responsibilities of the Gas Inspectorate now include gas consumption throughout the economy—a change which has increased its jurisdiction from 22,000 enterprises to 150,000.[4'] In addition, the Gas Inspectorate is now responsible for forwarding recommendations to the State planning apparatus on whether natural gas should be used in proposed new enterprises; passing on all proposals to install new gas-using equipment; demanding the removal from service of old and inefficient gas-burning devices; and

'Veselov, op cit., p 34.

[38] I u. Kopytov, "W'hat 1)oes t he Analysis Say?" *Sot sialisticheskayaindustriya*, July 5, 1979; see alsoIlinskiy, op. cit

[39] Ilinskiy, op. cit.

[40] "I'() 1 mprove the Economics of Fuels," op. cit.

[41] "1'hr' official text appears in *Sobraniye postanovleniy pravitelstvaSSSR*, No. 14, 1 9X(), pp. 339-348. A statement by TASS appeared in *Sotsialisticheskayaindustriya* on June 22, 1980. See also "The Kilowatt Must 11(' Put to Work, " *Pravda*, 1 Dec. 1 5, 1980; and A.S. Voytenko, ' "To I mprove t he Cont rol of (as Ut ilizat ion in t he Nat ional Economy," *Gazovaya promyshlennost*, No. 8, 1980, pp. 20-22. The change is part ly a matter of nomenclat ure: t he Sta te (as I nspect orate has been upgraded from t he rank of *upravleniye* (administ rat ion) t o *glavnoye upravleniye* (chief administration), w hile t he St ate Power I nspect orate has been promoted from t he ( )ff ice of Power Supply and Ov ersight of Use to St ate Power Inspectorate and Sales ( )f f ice t he change of order presumably reflect ing a cha nge in emphasis in the agency's officia 1 d u t ies.

[42] 1'()~rtcrlko, op. cit.

screening recommendations for mass manufacture of new devices. Inspectorate representatives have also been made official members of so-called "acceptance commissions," the bodies charged with commissioning new completed buildings and plants which are about to be transferred to the user. Membership on these commissions gives the State Gas Inspectorate the power to veto the commissioning of new plants with gas-consumption systems not up to official regulations.

It will be some time before the impact of the Gas Inspectorate's new powers can be measured. On paper they resemble those technically available to similar enforcement offices, notably water-quality inspectorates, whose actual influence is known to be modest.[43] But analogous groups have made impressive claims. In *1980,* the Power Inspectorate reportedly made over 60,000 plant inspections, imposed over 100 million rubles in fines, and saved 1.5 billion kWh of electricity. It is difficult to evaluate the accuracy and practical effect of these assertions, but an important inference can be drawn from the evolution of their tone over time. Power Inspectorate officials who now boast of housekeeping savings were recently writing derisively of the local energy-saving efforts, stressing instead the importance of central investment measures as the only way to meaningfully conserve energy.[44]

This change in attitude, together with the general evolution of official policy, suggests that emphasis in the conservation campaign as a whole has shifted from high- to low-investment. The stress of such a **strategy** would be on the small innovations that enterprises can implement without central investment—substituting stamping for cutting in the manufacture of small metal parts, for example. If a locally oriented conservation strategy has in fact been accorded priority, and if Soviet leaders are serious about energy conservation, there should now be evidence of more prominent participation in these campaigns by the apparatus of the Communist Party. References to such involvement by the Party have hitherto been rare.[45]

OTHER CONSERVATION STRATEGIES

The preceding discussion has suggested that the U.S.S.R. lacks the capital to implement a major high-investment conservation strategy and will encounter difficulties in monitoring and enforcing low-investment measures. These do not exhaust the leadership alternatives. It can also impose calculated fuel and power cutoffs. Such tactics would obviously be reserved for emergencies, but they would not necessarily impose unprecedented hardships on industrial or residential consumers-or seriously increase threats to economic growth. The European portion of the Soviet Union has historically experienced chronic shortages of power and fuel. Difficulties during the 1980's might, therefore, be viewed as a return to a traditional state of affairs that was interrupted by a brief period of energy abundance in the 1960's and 1970's.

One would expect Soviet authorities to be experienced in allocating shortages and cutoffs so as to preserve economic growth, and to be prepared to force unable or unwilling Soviet industry to conserve energy. There is no sign of coordinated implementation of such measures, however. The allocation of electrical power, for example, resembles a tug-of-war in which Gosplan and the industrial ministries are pitted against the Ministry of Power. The quotas assigned by the Ministry of Power to its regional power authorities are smaller than the quotas as-

[43] See Thane Gustafson, "Environmental Policy Under Brezhnev: Do the Soviets Really Mean Business?" in Donald R. Kelley (ed.), *Soviet Politics in the Brezhnev Era* (New York: Praeger Publishers, 1980), pp. 129-149.

[44] Kopytov, op. cit.

[45] One of the few references to an active role by the Party is in "The Price of a Kilowatt-hour," *Pravda,* Mar. 7, 1981. In the city of Ural'sk the local party forced the local power station to switch rapidly from fuel oil to gas, presumably using its influence to ensure allocation to the city of the necessary gas supplies.

signed by State planners to each of the consuming industries (based on the industries' own statements of their power needs). The result is power cutoffs. Those who are unable to pad their requirements so as to ensure a healthy margin of safety are those who suffer.[46]

Moreover, chronic problems in fuel supply to powerplants frequently cause the unified power grid that serves the European part of the country, the Urals, and the Transcaucasus to operate at reduced power, Shortages are not apportioned according to a system of political or economic priorities, but are spread equally among all unified grid customers in "universal brown-outs. " Those users whose production depends on small electric motors, which slow or stop altogether when the power drops, are most seriously affected. Similarly, lack of sufficient capacity to cover daily peak demand forces network operators **to** resort to load-shedding, sometimes blacking-out entire areas. There is no sign of priority setting to determine who shall bear the costs, and indeed, there is evidence that these costs have never been systematically studied. As a result, undersupply of kilowatt-hours that cost 2 or 3 kopecks to generate cause losses of production on the order of 1 or 2 rubles." These examples support the generalization that rationing and cutbacks, although increasingly frequent, are not well planned. Nor are they a particularly promising route for enforced energy savings in the economy.

[46] A. Fedosyuk, "Protect Energy" *Pravda*, Dec. 7, 1980.

[47] Styrikovich, op. cit.

OFFICIAL SOVIET CONSERVATION TARGETS

The preceding sections have described Soviet conservation strategies and the opportunities and constraints appropriate to them. The true test of any set of conservation measures is the extent of energy savings. These are particularly difficult to identify in the U. S. S. R., both because consumption data are scarce and difficult to interpret, and because of the manner in which energy savings are counted.

Energy savings in the U.S.S.R. are computed on the basis of the last year of the Five Year Plan (FYP) to which they apply. In other words, if **a** "savings rate" of 100 mtoe is claimed, this means that by the last year of the plan actual energy consumption was lower by 100 mtoe than it would have been at the input norms experienced at the beginning of the plan period. The results are noncumulative, and the reduced consumption rates achieved by the end of one plan become the norm for the following one.

The U.S.S.R. claims that in the Ninth FYP rates were reduced enough to save 81 mtoe and in the Tenth, 62 to 78 mtoe, The latter was considerably below the plan target which called for savings of 100 mtoe.[48] The savings target for 1985 is 100 to 106 mtoe, roughly 10 percent of 1980 domestic energy consumption.[49] Table 52 shows the way in which the savings target for 1980 was broken down in the original plan. It demonstrates how conservation is defined in the

[48] *Eko*, No. 9, 1980, p. 124 and No. 3, 1981, p. 30. *Eko* gives a 1980 figure of 62 mtoe; the 78 mtoe is from A. Lalayants, *Planovoye khozyaystvo*, No. 1, 1981, p. 35.

[49] *Pravda*, Dec. 2, 1980.

Table 52.–Tenth FYP (1976-80) Planned Energy Savings

27 mtoe	Decline--in consumption of fuel per unit of output.
24 mtoe	Increase in output of electricity from nuclear power and hydropower.
22 mtoe	Decline in consumption of electricity and heat per unit of output.
12 mtoe	Better use of secondary heat resources.
9 mtoe	Efficiency gains in consumption of light fractions.
4 mtoe	Cuts in losses from storage and transportation.

SOURCE Eko, September 1980 p 124

U. S. S. R., and the areas in which major energy savings are anticipated. These figures include net additions to nuclear and hydropower capacity, items which would not be considered "savings" in the West.

The most noteworthy feature of the targets for both the Tenth and Eleventh FYPs is their modesty, particularly if they represent the outer bounds of official optimism. The original 1980 goal of saving 100 mtoe amounted to conserving about 10 percent of the total primary energy planned for distribution in that year. If the figures are adjusted to subtract net additions of nuclear and hydropower capacity, actual planned savings were about 7.5 percent of total primary energy. The 1985 goal is even less ambitious. Although the total primary energy available for distribution is projected to grow by over 20 percent, the total amount to be saved remains unchanged from the previous plan.

Based on past performance, however, the prospects for achieving even this are uncertain. Although Soviet energy consumption nearly doubled between 1965 and 1980, the "annual savings rate" declined from 16.1 to 5.6 percent over the same period.[50] A careful examination of Soviet predictions for the period beyond 1985 shows that experts expect this downward trend to continue, albeit at a more moderate rate, to the end of the century. One prediction is for a savings of only 49.8 mtoe by 2000,[51] a forecast predicated on the assumption that major technological advances will be achieved, i.e., that high-investment conservation strategy will be successfully implemented. Although the electric power and ferrous metallurgy sectors have continued to improve their energy efficiency, Soviet difficulties with assimilating technological innovation, and the extreme shortage of capital for investment, make the prospects for wholesale achievements across a number of industrial sectors unlikely. Without evidence of fundamental changes in investment and conservation strategies, and without basic reforms of incentive, price, and monitoring systems, there is little reason to expect more than modest energy savings in the Soviet Union over the next 10 years.

[50] Makarov and Melentev, op. cit., p. 30
[51] Campbell, op. cit., p. 31.

PROSPECTS FOR CONSERVATION

The picture that emerges is of a level of technology and a structure of energy consumption that provide ample opportunities for energy conservation, and an economic system which impedes the implementation of promising conservation measures. Some idea of the potential for and difficulties to be encountered in conservation in the U.S.S.R. can be gleaned from an examination of several areas in which energy savings might be most easily achievable.

Perhaps the most promising target for Soviet energy savings is in boiler uses, i.e., the use of fuel for the production of electricity, steam, and hot water. Energy consumption in boiler uses is increasing rapidly. In 1970, they accounted for 54 percent of the total primary consumption; by 1980 the share had risen to 59 percent.[52] This trend is expected to continue. One Soviet source estimates that by 2000 half of all Soviet energy consumed will be in the form of electricity.[53] Boiler uses are potentially the most flexible means of energy consumption, and they give the U.S.S.R. a measure of flexibility in its efforts to substitute coal and gas for fuel oil.

Efficiency gains in the production of electricity and heat have been the chief source of energy savings in the past two decades, but an upper limit has nearly been reached. Even the most optimistic Soviet forecasts see sav-

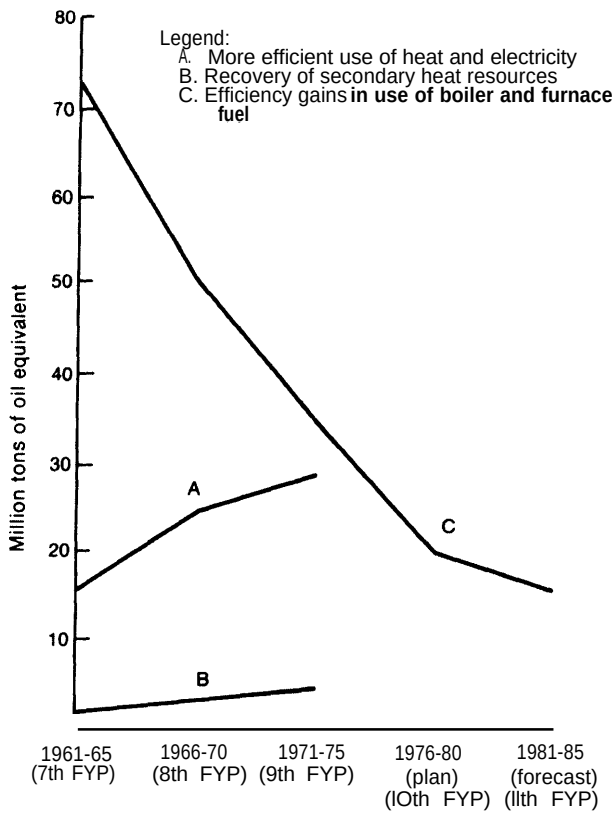
[52] Nekrasov and Troitskiy, op. cit.
[53] Makarov and Melentev, op. cit., p. 29

ing no more than about 16 mtoe in this area by 1990,[54] a small fraction of the roughly 249 mtoe in conversion losses the Soviet economy will be experiencing by that time. Figure 21 shows the striking pattern of decline in efficiency gains over the last decade. The trend suggests the possibility that by 2000, efficiency in electricity and heat generation may actually be declining. Nevertheless, replacement of small furnaces and the displacement of the direct use of fuel in them should lead to continued, if small, overall gains in energy efficiency .55 Soviet planners are aware that future progress will depend more on efficiency gains in the *use* of electricity and heat, rather than in their *production*.

[54] Troitskiy, op. cit., p. 25.

[55] There are over 280,000 small furnaces and boilers scattered throughout the country. These produce 1.5 billion of a nation's total of 3.2 gigacalories of heat annually. Their efficiency is low: they require an average of 200 to 220 kg of standard fuel to produce 1 gigacalorie of heat, whereas the larger boilers require only 173 to 175 kg. See Lalayants, op. cit., p. 40.

Figure 21 .—Where Energy Savings Come From
(1961-85)



SOURCE **Vestnik** *rnashinostroyeniya No* 3 1980 p 5

Further insight into energy conservation prospects may be gained from analysis of individual consumption sectors. Agriculture, whose share of total energy use has grown substantially in the last two decades, is particularly interesting. A large part of the considerable agricultural investment under the present Soviet leadership has consisted of mechanization of farm and off-farm operations and food processing. Table 49 recorded the result. The amount of energy used by the agricultural sector doubled between 1965 and 1980, from 30.2 to 60.5 mtoe. The horsepower available per worker in Soviet agriculture increased from 7.7 in 1965 to 22.9 in 1979, and continues to rise rapidly .5'

This growth in energy consumption has largely consisted of electricity, a reflection of an active rural electrification policy. Total agriculture-related use of electricity rose about fivefold between 1965 and 1979, from 21 billion to 102.3 billion kWh.[57] In 1965 most of the fuel consumed in the agricultural sector was diesel fuel and gasoline, but by 1979 electricity accounted for more than 10 percent of total agricultural energy consumption. This proportion is growing.[58]

Agriculture is an important sector for overall energy conservation policy because it may be one of the few sectors of the economy in which more or less arbitrary cuts could be made in case of emergency. Agriculture's share of total energy—just as its share of capital investment—depends on whether it continues to enjoy the high priority accorded it under the present leadership. There is at present no evidence that Soviet leaders are considering any major curtailments. Prime Minister Tikhonov's report to the 26th Party Congress called for a 50-percent increase in the horsepower available per agricultural

[57] *Sel'skoye khozyaystvo*, 1979, p. 1 '20.
[58] Ibid., p. 125.
[59] Campbell, op. cit.

worker during the Eleventh FYP.[59] Still, eventual successors to Premier Brezhnev may cut back the massive flow of inputs to the countryside, and it is possible that agriculture could be held considerably short of the roughly 156 to 187 mtoe it might have expected to receive by the end of the century.

Such a change in priorities would allow the Soviet economy to save some of the light-fraction petroleum products which make up a substantial portion of agricultural consumption. To the extent that agricultural energy consumption continues to shift toward electricity, the demand for light-fractions is lightened further. On the other hand, increasing electricity consumption compounds Soviet problems in shifting away from fuel-oil in electricity generation. Opportunities to ration agricultural electricity supply, therefore, will presumably be welcome.

Another promising candidate for conservation efforts is the energy producing sector itself. The importance of conservation here is magnified by the fact that own-use by energy producers is bound to increase. The refining and petrochemicals industry, for example, in 1979 consumed 7 percent of the country's total output of refined oil. As the Soviet Union increases the volume and depth of refining, this share will grow, even if efficiency is improved.[60]

Important savings could be gleaned here by reducing losses, which are currently estimated at 3 mtoe/yr in the gas industry alone. In the coal industry 6.2 to 9.3 mtoe are lost annually through faulty transportation and storage. In the oil industry in 1980, 13.5 out of a total of 47 billion cubic meters of associated gas were lost in 1979.[61] Newspaper accounts claim that 30 million tons of crude oil (i. e., 5 percent of total Soviet output) are lost annually by producing organizations, i.e., before the crude oil is shipped.[62] Further sizable losses occur in transportation, because of the poor state of repair of tank cars and wasteful methods of transferring oil and oil products from one vessel to another in transit.[63] Finally, losses of electricity in transmission networks are substantial. In 1978, these amounted to more than 9 percent of the total generated (95 billion kWh), and the share will increase as transmission distances rise.[64]

[59] *Pravda*, Feb 28, 1 98 1

[60] G. M Yermolov , "Conservation of Fuel and Energy Resources in the Oil Refining and Petrochemical Industry" *Khimiya i tekhnologiya topliv i masel*, No 11. 1 980, pp 1 :1-1 6, in JPRS No J. 9482, Jan 12, 198 1, p 17

[61] A. M. Lalayants, "Problems of the Economics of Fuel-Energy Resources in the National Economy," *Planovoye khozyaystvo*, No. 1, 1980, pp. 34-44.

[62] V. V. Kuleshov and V. M. Sokolov, "The Economics of Fuel: Possibilities and Reality," *Eko*, No. 9, 1980, pp. 114-122. It is claimed that this is an improvement. Since the 1960's, the loss rate per ton extracted has declined by one quarter. P. Kozlov, "Lose Not, But Save!" *Pravda*, June 26, 1979.

[63] "Transfer losses account for a further 2 million tons of crude annually (Kuleshov and Sokolov, op. cit.). The poor condition of railroad tankcars is discussed in N. Valitov, "Containers for Fuel," *Sotsialisticheskaya industriya*, Dec. 24, 1980. The problem is substantial because 46 percent of Soviet oil is shipped by rail (Valitov, op. cit.). Doubling the ton-mileage of oil shipped by rail between 1965 and 1978 has severely overloaded the railroad network, which may account for much of the poor condition of the cars. K. B. Leikina, *The Lowering of Losses in the National Economy* (Moscow: "Nauka," 1980), p. 108.

[64] "Directions for the Economics of Fuel and Energy in the National Economy," *Planovoye khozyaystvo*, No. 2, 1979, p. 6. Seventy percent of those losses occurred in transmission lines operating at voltages of 110 kV or lower. Total line losses, including the transmission lines of the user enterprises, amounted to about 250 billion kWh (51.6 mtoe) in 1979. See V. Vladimirov and I. Tarikuliyev, "Without Losses in Transmission," *Sotsialisticheskaya industriya*, Sept. 14, 1980.

THE POTENTIAL ROLE OF THE WEST IN SOVIET ENERGY CONSERVATION

Western energy technology might play a role in either a high- or low-investment conservation strategy. If Soviet planners implement centralized, high-investment methods, logic would dictate that it consist primarily of new plant and processes in the most energy- and capital-intensive industries—metallurgy, oil refining and petrochemicals, chemistry—and that investment be aimed at reducing own-use within the energy-producing sector itself. Promising areas for industrial conservation include the following:[65]

- *Chemicals:* improvements in the energy-efficiency of production of yellow phosphorus, chlorine, caustic soda, ethylene, acids of phosphorus and nitrogen, divinyl monomers. Investment in these processes could produce reductions of 5 to 25 percent in energy use below current levels. One example frequently mentioned in Soviet sources is process changes in the production of ammonia, which could considerably cut unit electricity consumption.
- *Computers:* institution of microprocessor and minicomputer-based process control systems in such energy-intensive processes as oil refining.
- *Metallurgy:* improvements in aluminum-refining, continuous steel-casting, combined-blast systems for blast furnaces, autogenic processes in nonferrous metallurgy.
- *Materials:* production of cement by the dry method, which consumes half as much energy as the wet method.

With the exception of computer process control, none of these require particularly advanced technologies, and if Soviet policymakers decided to import the required capacity, they would likely find manufacturers throughout the West who could meet their needs. In fact, implementation of a high-investment conservation strategy is tantamount to industrial modernization. There is no reason to believe that the same constraints that have inhibited wholesale purchase and implementation of Western industrial technology in general–including shortages of hard currency and difficulty in absorbing and diffusing imported technology-will not continue to operate.

A serious, high-priority, low-technology approach to conservation might lead to considerable demand for Western equipment to bolster the inadequate output of Soviet industry in insulating materials, metering equipment, small boilers and furnaces, jets and burners, static condensor batteries, etc. In the past, however, Soviet ministries and foreign-trade organizations have been unwilling to expend scarce hard currency on small items of this type, partly because they are less attractive than high technology items and partly because the need for them is scattered across many separate organizations.

An important complement to conservation is the *restructuring* of energy consumption to allow substitution among primary energy sources. Here major investment is needed soon in expansion of gas pipeline capacity, particularly expansion of local feeder networks; improvement of capacity for cleaning and enriching coal; peak-coverage technology to make up for the rigidities of nuclear power in the European zone of the country; acceleration of nuclear powerplant construction and transmission lines; and development of refinery capacity. These tasks should not be postponed, yet the evidence from Soviet literature is that planners are experiencing severe delays in all of them.

[65] These examples are drawn from a series of articles published in *Planovoye khozyaystvo,* No. 2, 1979, Similar "shopping lists" of opportunities for energy savings through centralized investment are common in the Soviet literature, See also I u. Sibikin, "The Efficiency of Utilization of Fuel-Energy Resources in Machine Building," *Planovoye k* / 10.?Jf(l)'.YI1'(), No.12,1 979, pp.48-54.

Soviet decisionmakers might resort to Western technology to eliminate the most crucial of these bottlenecks. If they do so in a manner consistent with behavior of the past two decades, Western technology will be sought to gain a degree of flexibility that compensates for the sluggishness of domestic industry. The list of sectors in which the Soviets have made the greatest use of imported technology reveals an interesting pattern. In the chemical and agrochemical industries, in the automotive and trucking industries, and in machine tools, much of the Soviet import activity has been clearly aimed at accelerating new policy initiatives. Restructuring Soviet energy demand to allow an indispensable substitution among primary sources of supply might fall into the same urgent category.

Perhaps the most important connection between conservation and technology transfer, however, lies in possible displacement effects. To the extent that conservation is tantamount to modernization, a vigorous and successful conservation program could result either in an overall reduction of the need for Western technology or in a displacement of imports toward smaller, lower technology equipment. But, since the main thrust of Soviet energy policy appears to be directed toward energy production rather than conservation, it is possible that Soviet need for large, high-technology Western items will be correspondingly greater. Production-related imports are more likely to be concentrated in a few industries and firms than are imports targeted at energy consumption.

SUMMARY AND CONCLUSIONS

The structure of Soviet energy consumption, particularly the high percentage of energy consumed by industry, presents many opportunities for conservation. This could well be accomplished both through a centralized, high-investment strategy and a local, low-investment strategy, the latter aimed at improving the efficiency of operation of equipment already in place. Conservation should be an extremely promising policy for the U.S.S.R. Effort invested in saving energy could yield a greater payoff at the margin than investment in new production, and the difference would grow as in time production costs rise.

The emphasis of the Soviet energy policy has hitherto been on production rather than conservation. As in the West, the perception of a pressing need to conserve expensive energy resources is relatively recent and serious conservation campaigns are relatively new. Stress has lately been on a local, low-investment rather than a centralized high-investment approach. Significant savings could be achieved through a low-investment strategy, but it is unlikely to produce major results very quickly because of weaknesses in the price structure and the prevailing incentives, the enforcement mechanism, the system of norms, and monitoring of measurement.

There is little reason to expect that Western nations will have significant impact on Soviet energy conservation. Short of contributing to a long-term program of extensive industrial modernization, the most that the West could provide is a variety of “low-technology” conservation equipment, on which the U.S.S.R. is unlikely to expend precious hard currency. In sum, while major opportunities for energy savings exist and indeed have brought results, rigidities in the political and economic structure could still prevent Soviet policymakers from taking full advantage of them.