

CONSEIL DE L'ATLANTIQUE NORD  
NORTH ATLANTIC COUNCIL

EXEMPLAIRE N°  
COPY

423

N A T O C O N F I D E N T I A L

ORIGINAL: ENGLISH  
17th March, 1971

DOCUMENT  
C-M(71)5

See corr. 18-3-1971

SOVIET ENERGY POLICY

Report by the Economic Committee to the Council

MAIN FINDINGS

The following main findings can be drawn from the attached report on the energy policy of the USSR.

1. The Soviet Union remains wedded to the principle of self sufficiency as regards its energy requirements. Its policy is based on its possession of abundant energy from a wide variety of sources: uranium, water power, coal, natural gas and crude oil.

2. However, whereas four-fifths of the total demand for energy is concentrated West of the Urals, at least as high a proportion of the exploitable energy resources lies to the East of them. As the main producing areas which are now in European Russia and the Urals have already been extensively worked, the exploitation efforts, notably for coal, oil and natural gas are now being shifted to the Eastern territories and to the Far North. This trend will be accelerated during the second half of the Seventies. However, the 1971-1975 Plan calls for very considerable exploration efforts to be continued in European USSR in order to maintain oil and gas production in this area at present levels.

3. The USSR has been for some time faced with the problem of transferring energy from areas of surplus to areas of deficit. In the Seventies this problem will become greater as the Siberian resources are developed; perma-frost and other geological and climatic difficulties complicate drilling and laying of pipelines. It will be necessary to extend existing railways, pipelines and long distance electric power transmission lines. Given the difficult conditions in the Eastern regions, the relatively poor Soviet drilling equipment and technology, and the acute shortage of wide diameter pipe (likely to persist over the present decade) the Soviet Union, to achieve the level of energy production envisaged in this report, may well have to

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rely to a not insignificant extent on imports of oil drilling, automated producing, refining and transport equipment (in particular pumps, compressors, large diameter pipe and valves) from its COMECON partners and from the West.

4. Despite an apparently disappointing performance in coal production over the last few years, a sharp reduction in annual targets for natural gas, and a decline in growth rates of crude oil production, it is likely that in the Seventies the Soviet Union will be able to develop its total energy resources sufficiently to meet domestic demand, to provide for a very substantial share of COMECON and other Communist countries' imports of energy and to produce some surplus for export to non-Communist countries.

5. The present small export of natural gas to hard currency markets will grow in the Seventies following the deals concluded with Italy and Germany. Should talks currently held with other West European countries and Japan end in agreements, by the late 1970s total exports to the Free World might reach 10 milliard cu.m. annually. It is not expected that coal exports to non-Communist countries will vary much in the future. However, should the present shortage of coking coal in a number of Western countries continue, the Soviets might find some additional outlets there.

6. During the last Five-Year Plan period, crude oil production in the USSR rose from 243 million tons in 1965 to 353 million tons in 1970, in which year production exceeded the Plan target by 3 million tons. There is a consensus that in 1975 Soviet production of crude oil within the range of 450-480 million tons will be adequate to provide for all domestic needs, to satisfy most of East European and other Communist countries' demand for Soviet oil and still leave substantial quantities for export to the Free World. Nevertheless the USSR, in view of agreements already concluded with some petroleum producing countries, may be procuring a small volume of oil from these sources, probably for sale to third countries.

7. Looking as far ahead as 1980, although the range of probabilities is wider, it is the opinion of the majority of the Committee that the USSR with a production of some 600 million tons will continue to have an exportable oil surplus for sale to the Free World, and that the maintenance of this surplus is an integral part of Soviet Planning. The United States, however, takes the view that production will only reach about 500 million tons and that, while Soviet output would be more than adequate to cover internal demand, exports from domestic resources would be greatly reduced. Therefore, if the USSR continued to provide most of the oil required by Eastern Europe and maintained other exports near present levels, it might have to procure sizable quantities from Free World sources.

8. The Committee is agreed that in view of the Soviet principle of self sufficiency and the evidence available, it is clear that the USSR has no intention of becoming dependent on non-Communist oil for its own needs, and any imports will be for the purpose of developing trade and political relations, as far as possible, with the oil producing countries. The USSR also appears reluctant to let the East European countries become too dependent on non-Communist countries' oil, and will continue to provide the bulk of their requirements at least for the next decade. In this regard the widely publicised assertion that by 1980 the Soviet Union, or indeed the Soviet Bloc, will become a large net importer of oil is probably incorrect. The Soviet Bloc has not and is unlikely to provide in the foreseeable future a meaningful alternative market for the oil producing countries of the Middle East and North Africa.

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SOVIET ENERGY POLICY

I. SUMMARY

1. The policy of the Soviet Union towards the utilisation of its energy resources must be inferred from a wide variety of sources. From the available miscellany of statements and statistics of aspirations and achievements, however, some major points of principle emerge which are at the roots of the official attitude towards the problem of energy production and utilisation. The main principle is that of self-sufficiency. This is fundamental to Russian policy as much for strategic and military reasons as for anything else. It is a credible policy because it is possible for the planners to have complete confidence in the physical availability of sufficient reserves of all the major forms of energy. Within this general policy, there is a historical emphasis, still maintained, on the rôle of electrification, and an emphasis on oil and gas as the modern fuel rather than coal. Within the framework of total supplies, there is an emphasis on adequate regional planning and on the provision of a surplus of energy for export. There is at present no particular emphasis on a growing rôle for atomic energy.

2. All the evidence on the extent of Soviet fuel and power resources is of Soviet origin and none of it can be independently verified. In terms of ultimate potential, however, there is no obvious reason to doubt that reserves are likely to be more than adequate. Indeed, it must be taken as an axiom of Soviet energy policy that the total reserves of coal, oil, natural gas and water power are so large that there is no foreseeable prospect of their exhaustion. Shortages of energy reserves are only of regional or local importance, to be made good by the discovery and development of new resources, by bringing in supplies from other regions or a combination of both.

3. The existence of such reserves enabled the USSR to adopt from its foundation a policy of depending entirely on its own natural resources rather than relying on imports. Imports meant a risk of blackmail in peace and starvation in war in a world dominated by Powers believed to be hostile and antipathetic to Soviet interests. There has been no departure from this determined policy of self-sufficiency and such imports of fuel as have taken, or now take, place have been justified by special circumstances. In the aftermath of war and its dislocation of production, some coal and oil were imported as war reparations. Poland still sends coal and Rumania oil to their former territories now occupied by the Soviet Union. Some oil and coal are purchased on Soviet account but shipped to third countries. In calorific terms, and measured against Soviet production and consumption, these imports are no challenge to the policy of self-sufficiency in energy and are unlikely ever to become one.

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4. Given this policy of depending on domestic sources of fuel, the Soviet Union faces the task of efficiently distributing energy to all the various regional consumers. The central problems of energy distribution within the Soviet Union are:

- (a) Whereas four-fifths of the total demand for energy is concentrated west of the Urals, at least as high a proportion of the exploitable energy resources lies to the east of it. Thus the area of greatest demand, including the Moscow and Leningrad industrial complexes, is amongst the poorest in energy resources.
- (b) All the centres of advanced industry, whatever their total demand for energy, require a mix of forms of energy - coal, oil products, gas and electricity. The scope for interchange of fuels is not unlimited. But regions producing a surplus of energy are commonly deficient in one or more of the main major fuels and this must often be brought in from long distances. Thus the Urals with a large surplus of oil draws gas from Uzbekistan and north-west Siberia and coal from the Kuzbass, whilst Siberia, with a large coal surplus, until recently produced no oil at all and brought it in from the Urals.
- (c) There is constant debate and research on the best way of transferring energy from areas of surplus to areas of deficit - should coal be transported by rail or converted into electric power and the power transferred by transmission lines; should gas be piped or similarly converted to electric power for transmission; should crude oil be transported or refineries be built on the oilfields?

5. Lenin's own dictum that "the Soviets plus electrification equals Socialism" expresses the significance which the Soviet Union, from its inception, has attached to electricity as a form of energy. No other country with so comprehensive a fuel base has laid such emphasis on electricity, and the electric power industry is the only branch of energy application in which the range and quality of the Soviet achievement is equal to that of Western Europe. Thermal power stations account for 80 per cent of power capacity, the rest being almost entirely hydro-electric. Coal, which in 1968 accounted for over 50 per cent of all fuel consumed in the power stations, is still the main fuel although in recent years it has lost ground to oil (14 per cent) and gas (20 per cent). This trend should be reversed in the early 1980s when some of the very large new power stations in Kazakhstan and central Siberia, designed to use the cheap coal

of these areas, come into operation. Although the Soviet Union is among the world leaders in hydro-electric power stations, the share of hydro-electric power in total production has been falling rather than rising in recent years. The full exploitation of the vast, isolated areas with untapped resources may, in fact, have to wait for an effective solution to the technical problem of long-distance transmission of electric power.

6. The Soviet programme of industrialisation, with its strong emphasis on heavy industry, was based from the outset on abundant and easily exploitable coal. The last two decades, however, have seen the premier position of coal as a source of energy eroded as more resources were turned to the exploitation of oil and gas. So the share of coal in total energy production fell from 66 per cent in 1950 to 38 per cent in 1968, while the shares of oil and natural gas in the same period rose, respectively, from 17 to 39 per cent and from 2 to 18 per cent. It was Khrushchev, among the Soviet leaders, who most strongly urged the change to hydrocarbon fuels; his inspiration seems to have been his association of the technological supremacy of the United States with a high rate of exploitation of oil and natural gas. The change of emphasis was written into the Soviet long-term plans from 1959 onwards. Even so, coal production consistently failed to reach its target, the gas plans were usually written down before they were achieved, whilst the oil producers were able to reach the planned targets throughout. There are indications that the reconstruction of the fuel structure will be complete by 1975. Then coal should stabilise at 30-35 per cent of total fuel produced, with oil and natural gas making up most of the remainder. The other minor solid fuels at 3-4 per cent and the share of hydro-electric and nuclear power total energy supplies will together contribute far less than any one of the three main fuels. Total installed capacity at nuclear stations is roughly 1 per cent of total Soviet electric power capacity. This share is unlikely to increase substantially over the next decade at least.

7. In Western countries energy policy is determined largely through a consideration of relative costs. No such criteria could have been applied in the past in the Soviet Union where prices gave no indication of actual costs or relative scarcity of resources. There was, therefore, no price structure in a sense that is meaningful in the West. Decisions and the promotion of one type of energy or another were taken by the planners on criteria such as material availability, technical competence and overall political, economic and social priorities. What is uncertain is how far this situation has been affected by the 1967 price reforms and subsequent price changes and the growing emphasis on financial measures within

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the Soviet Union. It is likely that relative prices and cost, expressed in financial terms, are beginning to influence planning decisions; certainly, it is intended that they should have an increasingly important rôle. It cannot be said, though, how important these factors have yet become.

8. Although there has been no public announcement of a Soviet policy on energy exports, one of the features of the Soviet energy policy over the past 20 years has been the provision of an export surplus. The Soviet Union emerged as a net exporter of fuel in the mid-1950s and exports have continued to increase each year since, although the rate of increase has slowed down considerably in recent years. The official figures on imports and exports of energy are expressed in terms of standard fuel with no distinction between one fuel and another, but from trade data it is clear that oil is by far the most important energy export, contributing over 85 per cent to total energy exports. The net exports of fuel in 1968 were 133 million tons of standard fuel (143 million tons exports, 10 million tons imports).

9. Soviet energy exports are divided between three groups of markets - the other Communist states, the developed Western countries (including Japan) and the less developed countries. For nearly 25 years, the USSR has been the only country able to supply oil to fuel-deficient Communist countries without requiring payment in hard currency. Often such supplies, e.g. to China and Cuba, were made in the face of transport and other difficulties. The main Communist market for energy, however, was Eastern Europe with gross fuel imports of some 60 million tons of coal equivalent rising by perhaps 8-10 per cent a year, practically all of it from the USSR. Exports to the industrial West include a few million tons of coal and a little gas but consist overwhelmingly of oil. The West imported some 43 million tons of Soviet oil in 1969, compared with about 48 million tons imported by Communist countries. This trade in oil to the West constitute's Russia's largest single source of convertible currency earnings. Soviet energy exports directed to small scattered markets in the less developed countries are confined to oil and oil products, amounting to some 4.0 million tons in 1969.

10. It seems likely that up to 1975 both gross and net exports of fuel will continue to grow, the former faster than the latter and both at a slow pace. The exports of coal may not rise, but the Soviet exports of natural gas to Eastern Europe are gathering momentum, exports to Austria have begun and agreements have been signed for the supply of natural gas to Italy and Germany, whilst negotiations are in hand with France and Japan. The small export of electric power should



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also increase. The USSR also seems assured of supplies of oil for export for some years to come and oil will almost certainly continue to dominate the Soviet Union's fuel exports for the foreseeable future. Up to and maybe beyond 1975 she will be able to meet all the oil requirements of other Communist countries and at least maintain the level of her exports to the Free World.

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II. INTRODUCTION

1. The evidence on the nature and scope of Soviet policy on energy, as on all but a few secret sectors of Soviet economic activity, consists almost entirely of information released by the central and regional authorities; where it appears in books or signed articles, the author is nearly always a Minister or senior official in the Ministry concerned or an economist prominent in one or more of the State institutes. This material abounds in statistical information - except in respect of such sensitive topics as the future consumption and export of oil - but for the rest is little more than propaganda. The figures seem trustworthy enough, though those dealing with regional output of the various forms of primary energy almost invariably celebrate success in the fulfilment of regional plans; a regional failure is hardly ever expressed in statistical form. Thus the various regions announcing their annual plan results for an individual fuel will claim to have exceeded their plan goal by a considerably greater average margin than that by which the USSR as a whole has exceeded the All-Union plan goal, and the reader will search in vain to discover which regions, by failure to reach their target, have depressed the All-Union production total to the published figure. The body of the text is mainly devoted to praise, blame, exhortation and expression of awe at the limitless prospect for the future. Critical appraisal and reasoned statements of policy are unimpressive and rare. Policy must then be inferred from the facts and forecasts of performance, and from numerous official exhortations and declarations, notably the speeches announcing annual and long-term plans.

III. THE BASIC ELEMENTS

2. The chief elements which go to form Soviet energy policy are as follows:

- (a) confidence in extent of reserves;
- (b) self-sufficiency;
- (c) effective regional distribution;
- (d) electrification;
- (e) emphasis on oil and gas at the expense of coal;
- (f) provision of surplus energy, notably oil, for export.

The first two of these may be treated as the root principles in terms of which action is taken to implement the other four. The following paragraphs briefly discuss each of these main elements.

(a) Reserves of primary energy

3. If the whole territory of the Soviet Union is considered as one, the volume and variety of its primary energy resources must provoke the envy of the rest of the world. The total reserves of coal, oil, natural gas and hydro-electric power, when compared with the requirements of the Soviet peoples for as far ahead as its rulers have at any time foreseen, are so large as to inspire complete confidence in all concerned and to defer the prospect of their ultimate exhaustion beyond the scope of serious debate. It is, however the level of proved reserves(1) that determines the maximum permissible rate of extraction, and the efforts of the Soviet drilling teams engaged in adding to the proved reserves of oil and gas are often and sharply criticised. During the 1960s for example, proved reserves of oil increased only 51% whereas crude oil production more than doubled. Like much else in the Soviet fuel industries, their average standard of performance is generally rated, both at home and abroad, well below that of their Western counterparts, but though it has probably cost the Russians more time and labour than Western technicians - with Western equipment - would have needed to expand proved reserves to their present level, their shortcomings have never been a serious limiting factor in production or cast doubt on the abundance of the oil, gas and coal in the ground. All the evidence on the extent of Soviet fuel and power resources is of Soviet origin and none of it can be independently verified, but in terms of ultimate potential there is no obvious reason to distrust it or the confidence it seems to inspire. This confidence may be treated as an axiom of Soviet energy policy as devised and executed by the central authorities. Shortage or exhaustion of energy reserves, when relevant at all, are only of regional or local importance to be made good either by the discovery and development of new resources, by supplies from more favoured regions or by a combination of both. Given this faith in the extent of their resources, the basic question for Gosplan is not "how much energy can we produce?" but "how much do we need to produce by any given date?". In recent years, the answer seems to have been "slightly less than we had planned".

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(1) Caution must be exercised when considering Soviet figures of proved reserves, in particular those of petroleum and natural gas. Soviet geologists have indicated that perhaps only two-thirds to three-fourths of their estimated "proved" reserves can be considered as confirmed by drilling, and hence roughly comparable to Western definition. Consequently, Soviet claims of oil and natural gas reserves apply to probable and/or possible resources rather than to "proved" reserves, upon which firm long-term plans for future production can be made.

(b) Self-sufficiency

4. From the October Revolution onwards, the Soviet Government has shown its determination to develop its own natural resources - notably those of fuel and power - rather than rely on imports of material already to hand. In Tsarist days it was found cheaper and more convenient to supply St. Petersburg with coal from Tyneside rather than the Donets Basin, but even had this been possible in the early days of the Revolution it would not have been contemplated. Nor was it necessary. Whatever else the Soviets needed and procured from beyond the cordon sanitaire of those days, they knew that they need never lack coal and petroleum from their own territory, and they proceeded to exploit these resources on a steadily increasing scale. To do so even under a capitalist régime would probably have been expedient not least on strategic grounds; to do otherwise after Stalin's slogan "Socialism in one country" was unthinkable. With some variation of emphasis, and a severe setback during the Second World War, the drive to maximise domestic fuel supplies and to maintain complete self-reliance in essential fuels has persisted ever since. For this reason the USSR is now the world's largest producer of coal and the second largest of oil and gas. Though the long-term goals are now smaller than those declared by Khrushchev there is no sign of a change in this tendency. However, as explained in the following paragraph, this principle of self-sufficiency does not exclude a certain volume of purchases of energy by the USSR; and imports of oil and gas which are now limited, may well grow - while still remaining marginal to total production - over the next ten years.

5. There have been some imports of coal and oil into the Soviet Union even since 1945 and though these may well diminish, those of gas, which have barely started, will increase. In each case they are justified by special circumstances. Despite vigorous development of new coal and oil resources to compensate for those overrun or threatened by the Germans, Soviet production of both fuels in 1945 was far less than in 1940 and for a time fell short of rapidly increasing demand. Some coal and oil was, therefore, imported, partly as war reparations, partly under normal trade arrangements. According to her published trade returns, the USSR remained a net importer of oil until 1954 and of coal until two years later. Secondly, some of Russia's western neighbours still send fuel to what is now Soviet but was formerly their own territory; thus some Polish coal goes to the former Eastern Poland and some Rumanian oil products to the former Bessarabia. Thirdly, some border areas of the pre-war Soviet Union have for a long time been short of local supplies of one or more of the major fuels, and it has been

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convenient - though never imperative - to make good some part of the deficiency by drawing on appropriate surpluses in neighbouring states. (This often suits the neighbours, who can thus pay for Soviet goods and services.) Under this heading come Polish coal for Belorussia and the Baltic States and Afghan gas for Soviet Central Asia, later to be followed by Iranian gas for Transcaucasia and beyond. Lastly, there are the oil and coal supplies which, though included in the Soviet trade returns with the genuine imports, were never physically imported at all. Of the imports shown, an unknown but significant proportion was distributed direct from the exporting countries to third parties on Russian account, thus also figuring in Soviet export returns. This category would cover Polish coal and Austrian oil, nominally imported by the Soviet Union but in fact - or so we believe - parcelled out in Eastern Europe, and Rumanian and Albanian oil despatched at various times to Western Europe, Eastern Europe or China. It is almost certain that the oil which Algeria and the UAR are supplying or due to supply to Russia under recent trade agreements will be similarly disposed of. Taken together and measured against the scale of Soviet economic activity, these imports are very small. In calorific terms they amount to no more than a tenth of Soviet fuel exports and a hundredth of her consumption. Neither they nor the more recent imports of natural gas offer any sort of challenge to her self-sufficiency in the sphere of energy and are unlikely ever to do so.

(c) Optimum distribution

6. Like all governments throughout the world, regardless of whether they produce their own energy or import it, the Soviets wish to make the most efficient use of available fuel and power resources.

7. From the beginning of the régime in 1917, military strategy largely determined economic policy, in respect of energy as much as in any other sphere. Convinced that sooner or later their country must face invasion, the authorities knew that survival would depend on armaments, and armaments on the volume and diversity of a heavy industry whose bases were coal and steel. They had then to see that this industry, or as much of it as possible, remained beyond the reach of invaders and to face the fact that existing industry and population were chiefly concentrated in the Moscow and Donets Basins. Had they not foreseen the threat of invasion, they, like their predecessors, might have chosen to maintain the industrial ascendancy of these two regions and confined the eastern lands to a purely extractive rôle. But the threat was

taken seriously, for both industrial regions were vulnerable (a third had already been lost to Poland). For this and other reasons there were two developments. First, the Soviet High Command adopted - and at least in theory has ever since maintained - a defence strategy designed to ensure that any fighting with potential invaders should take place outside rather than inside Soviet territory. Secondly, the eastern lands were to develop heavy industry of their own to supplement that of the threatened areas. Their coal and ores were to be mined and developed as fast as possible, but the near monopoly of their supplies by the existing main centres of demand in European Russia was to cease. In the event, the increase the output of raw materials, notably fuels, has been so great in Asiatic Russia regions that there has been a steadily increasing flow in the more western regions, even though local industry enjoys first call on local resources.

8. Since their production consists mainly of steel in one form or another, the new centres of industry are usually located near coalfields and iron ore deposits. The Urals region (including the neighbouring area of North-West Kazakhstan) is rich in iron and other metals and is also the Union's second largest producer of oil; the Kuzbas has massive reserves of coking coal and had some iron ore, although the ore has now proved uneconomic to work. In all cases, the emphasis on developing metallurgical industries as near as possible to their source, rather than transporting them in raw or semi-processed form to existing centres of demand, was in part strategically inspired. In World War II, when the Donbass was wholly overrun and the Moscow region partly seized and partly neutralised, the policy was amply justified though it is arguable that in the changed context of nuclear warfare the strategic *raison d'être* has largely disappeared. It has also saved much in transportation. This has, however, imposed some distortion on the Soviet ecology. The exploitation of these resources has depended on bribery, coercion and other expensive procedures to procure or maintain a sufficient number of workers, most of whom would never have wished to work there and many of whom return westwards as soon as they have achieved their financial goals. But in so far as they stay, and the industries which employ them prosper, they ease a little of the problem of distribution - of energy or of other resources - by shifting the focus of demand to the source of supply.

9. However important all this has been - and perhaps may still be - to the strategy and regional development of the USSR, the central problems of energy distribution remain. They may be stated as follows:

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- (i) Four-fifths of the total demand for energy is concentrated west of the Volga; at least as high a proportion of the exploitable resources lie to the east, and most of the remaining part is in the Ukraine and the Caucasus/Caspian area. More specifically, the area of greatest demand including the Moscow-Leningrad industrial complexes is among the poorest in local energy resources. (In spite of the recent increases in population, industry and energy consumption east of the Urals, the Soviet Authorities appear to accept this situation as permanent and seek to modify it only in detail.)
- (ii) Whatever their total demand for energy, all centres of advanced industry require specific minimum quantities of coal, oil products, gas and electricity during any given period of time. Only those regions where industry is little developed or confined to such fields as mineral extraction can accept dependence on a single fuel. It is one of the principal tasks of Gosplan using, it is claimed, a system of mathematical models, to draw up a so-called "material balance" of energy for each region and eventually for the whole Union, estimating demands for each individual fuel and providing for its supply. These minimum figures account for the great bulk of consumption during the period; the rest must come from stocks or from the substitution of one fuel for another. In terms of current demand, the scope for interchange of fuel is limited (no amount of coal, for example, will compensate for the absence of gasoline), though in forward planning it can be much greater. However, even regions producing a surplus of energy are commonly deficient in one or more of the major fuels and this must often be brought in over great distances. Thus the Urals, with a large surplus in the form of oil, draws gas from Uzbekistan and North-Western Siberia; Siberia, with a large coal surplus, until recently produced no oil at all and obtained it from the Urals.
- (iii) There is much debate and some research on the best means of transferring energy from areas of surplus to those of deficit: whether and to what extent coal should be carried direct by rail to consuming centres or burnt at source in power stations which would transmit the resulting electrical energy through power lines; whether gas should be piped direct or similarly burnt in power stations; whether centres

of oil consumption should import their oil products or build their own refineries using local or imported crude; whether the lake to be impounded behind a projected hydro-electric dam complex should or should not be allowed to submerge a potential oilfield; or indeed, as we saw above, whether to build up industry from scratch on remote coalfields and absorb part of their surplus on the spot. (See Appendix G for regional surpluses and deficiencies of energy.)

(d) Electrification

"Socialism equals the Soviets plus Electrification" - V.I. Lenin

10. It is understandable that the early Bolsheviks, headed by Lenin, should have had a special weakness for electricity. It was clear that the coal-fired steam engine - at least for many purposes - was already tending to decline; the petrol engine had then made very little impact on Russian life and virtually none on Russian industry, and was tainted by its association with privately-owned motor cars. Electricity seemed to be the ideal and uniquely flexible means of exploiting the country's huge resources in solid fuels (and also in water power) and of dispensing and manipulating energy wherever and in whatever form or quantity might be required. It also seemed to offer relatively little scope for misuse by individuals and to be peculiarly amenable to Socialist control. The dynamo has ever since held a special place in Soviet imagery.

11. No other country with so comprehensive a fuel base has laid so strong or so continuous an emphasis on this branch of energetics - at the expense of others - since the supremacy of coal was first challenged at the turn of the century. It is the only mode of energy application in which the range and quality of the Soviet achievement stands up to that of Western Europe. But not apparently to that of the United States. A recent American study comparing Soviet and American technological prowess and industrial performance and covering a wide field in considerable detail concedes the Soviet Union's primacy in hydro-electric power and also in high-voltage, long-distance transmission, but rates their thermal-electric effort as at least five years behind the American, both in size of generating unit and in other technology.

12. Electric power generation now absorbs about a fifth of all primary energy consumed in the Soviet Union as compared with the 1966 figures of 25 per cent in the United Kingdom and 24 per cent in the United States. (In Italy and Sweden, which are poor in domestic fuel resources but relatively rich in water power, dependence on electricity is greater but its



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share of fuel expenditure is less.) In spite of the Soviet drive to electrify the economy, the approaching dominance of electric traction on the railways, and the weakness of competition from motor transport, the Soviet level of electrification is slightly below that of advanced capitalist countries. Here it is worth recalling that in electrification, as in so much else, the Russians made a late start. In 1917, they succeeded to an almost negligible generating capacity at a time when electrification in America and Great Britain was already well under way. Nevertheless, by 1957 their power stations were absorbing 21.8 per cent of total energy consumption, a figure not reached in Great Britain until two years later. Two points arise here. First, in 1957 the USSR used very little natural gas and Great Britain none at all. In the next few years, electrification proceeded in both countries but relatively faster in Great Britain, largely because by 1966 the Russians had sharply increased their natural gas supply and fed most of it direct to industry - rather than to power stations - whereas Great Britain still produced none of her own and had barely begun to import it. Secondly, private and other non-industrial demand for electricity is lively and fast growing in Great Britain but severely restricted in the Soviet Union. (In the latter in 1960 it covered 13.4 per cent of total consumption, but only 12.3 per cent in 1966.)

13. One might have supposed that with the increasing share of oil and gas in Soviet fuel consumption - and these two fuels contribute only a small percentage of fuel for power stations - the expansion of electric power at the expense of other means of energy used might now be approaching its limit. Indeed, in October 1967 Baybakov, head of Gosplan, indicated that for the three remaining years of the 1966-70 Five Year Plan certain target figures, including those for coal and electric power, were now somewhat lower than those quoted in the original plan directive. This adjustment was occasioned by less than anticipated growth in effective demand. Baybakov is also acknowledging the persistently slow rates of progress in bringing new power capacity into production and obtaining the coal which it needs - without prejudice to faster progress later. Year by year, the unit consumption of fuel in thermal power stations continues to fall and the output of power (which in practice means the consumption of power, since power exports are relatively insignificant) continues to increase faster than the output of fuel. It is clearly intended to prolong these trends and in the course of the 1970s the advance of electric power should pick up speed. The latest Soviet estimate predicts that the extraction of fuel will rise by 5.3 to 5.4 per cent per year over the years 1966 to 1970 and by 5.2 to 5.4 per cent over the decade 1971 to 1980, but

that figures for electric power output will be 8.0 to 8.5 per cent and 8.5 to 9.1 per cent respectively - and this despite the near certainty that a far higher proportion of fuel than of power will be exported. This would indicate that in 1971-80 electric power consumption will rise considerably faster than that of fuel as a whole. The years after 1975 are generally beyond the range of current planning, but we may infer that, along with three chief fuels, electricity is expected to play a major part in making up for the limited energy resources of the Soviet north-west. At present, it is probably an open question how much of this power will eventually come from nuclear stations to be built in the deficient regions - not much, it appears, before 1980 - and how much from conventional stations in the Siberian and Kazakh coalfields. The answer will presumably depend on financial and technical factors now under study, such as the cost of power from local fast reactor stations as against the flexibility of long-distance DC transmission at very high voltages.

14. In 1968 thermal power stations accounted for about 80 per cent of total power capacity and 83 per cent of power output, the rest being almost entirely hydro-electric. Coal is still the main fuel for these plants but in recent years has lost ground to fuel oil and gas. The following table showing the percentage share of the various fuels in the total fuel consumption of thermal stations illustrates this trend:

USSR FUEL CONSUMPTION IN THERMAL POWER STATIONS

	1966	1968	1970 (plan)
Coal	55.1	53.0	51.9
Fuel Oil	11.9	15.2	14.3
Gas	23.2	22.1	24.8
Peat	4.5	4.1	4.3
Shale, wood, etc.	5.2	5.6	4.7
	100.0	100.0	100.0

This tendency of gas and oil to encroach on coal as fuel for power stations is not destined to last much longer. Development of the oil and gas reserves in Tyumen Oblast will call for new plants, most of which will use these fuels; but in the early 1980s, when some of the much larger new power stations intended for Kazakhstan and Central Siberia are ready to absorb the cheap coal of these regions, the share of coal will once more rise. Part of the gas goes to dual-fired stations which use it in the summer when heating demand falls off, and revert to coal in winter. There is, however, a tendency to deprecate the burning of gas for this purpose as wasteful (unless, as in much of Central Asia, there is nothing else within reach); nor is oil much favoured unless a nearby refinery has a convenient surplus of fuel oil. The preponderance of coal as a power fuel should, therefore, increase. This increase will probably make up for the reduction in its share of other sectors of energy consumption.

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15. Although hydro-electric power is a field in which the Russians are among the world leaders, hydro-electric stations on the whole seem to have fared badly in the long debate in which their case was urged against that of thermal stations. Their share of total installed capacity rose from 11.3 per cent in 1945 to a peak of 22.6 per cent in 1962 but had dropped to 18.8 per cent in 1967. During the past decade, their share in output has been consistently lower than in capacity, but has followed much the same pattern. Rising from 11.2 per cent in 1945 to 19.5 per cent in 1962, it fell to 15.1 per cent in 1967. However low the operating costs of hydro stations, and however cheap their power when once it flows, their drawbacks include: length of time spent in design with frequent modification, heavy capital outlay in construction, equipment tied up for excessively long periods, difficulties in assessment and control of water resources and - in the case of the larger and remoter sites where grids are little developed or as yet non-existent - the absence of accessible power markets with attendant problems of transmission. There are still very large untapped reserves of hydro-electric power in Siberia, and in some regions the rivers offer the best if not the only source of energy yet discovered, but the planners seem doubtful as to when, if ever, they would be worth exploiting in full.

(e) Oil and gas versus coal

16. The dominance of coal in the Soviet fuel pattern has only just ceased; the following table shows how solid fuels have lost ground to oil and gas.

USSR PRIMARY ENERGY PRODUCTION

<u>Year</u>	<u>Total</u>	<u>Crude Oil</u>	<u>Natural Gas</u>	<u>Coal</u>	<u>Peat</u>	<u>Shale</u>	<u>Firewood</u>
<u>Million tons standard fuel</u>							
1950	311.2	54.2	7.3	205.7	14.8	1.3	27.9
1955	479.9	101.2	11.4	310.8	20.8	3.3	32.4
1960	692.8	211.4	54.4	373.1	20.4	4.8	28.7
1965	966.6	346.4	149.8	412.5	17.0	7.4	33.5
1968	1,122.6	442.1	201.2	428.7	18.3	7.6	24.7
1969	1,177.3	469.5	215.5	439.6	16.7	8.0	28.0
1970	n.a.	504.8	238.0	448.0	n.a.	n.a.	n.a.

Percentage of total

1950	100	17.4	2.3	66.1	4.8	0.4	9.0
1955	100	21.1	2.4	64.8	4.3	0.7	6.7
1960	100	30.5	7.9	53.9	2.9	0.7	4.1
1965	100	35.8	15.5	42.7	1.7	0.8	3.5
1968	100	39.2	17.9	38.0	1.6	0.7	2.6
1969	100	39.9	18.3	37.3	1.4	0.7	2.4

Source: Statistical Year Book for 1969, Moscow 1970.  
For 1970 data based on Soviet statements of results

The table does not include hydro-electric power which, converted to standard fuel, amounted to 1.6 million tons in 1950, 6.3 million tons in 1960, 10.0 million tons in 1965 and 12.8 million tons in 1968.

Standard fuel equivalent (SFE) = 7,000 kilo/calories per kilogram. The USSR standard conversion factors for individual fuels are as follows: 1 ton of coal = 0.718 tons SFE; 1 ton crude oil = 1.430 tons SFE; 1,000 mw natural gas = 1.190 tons SFE; 1 ton shale = 0.353 tons SFE; 1 ton peat = 0.400 tons SFE; 1 ton firewood = 0.249 tons SFE and 1,000 kwh of electric power = 0.12 tons SFE.

In terms of coal equivalent, oil in 1945 accounted for 15 per cent of total Soviet fuel extraction (fractionally less than firewood) and gas for only 2.3 per cent, whereas the share of coal was 62.2 per cent and for some years continued to rise still higher. In 1950 and again in 1952 it reached 66.1 per cent and remained well over 60 per cent until 1957, the year of decision to scrap the sixth Five Year Plan. Since then, it has yielded to the steady increase of oil and the relatively faster increase of gas. 1967 was the last year in which coal's share, by however tiny a margin, exceeded that of any other single fuel. By then, however, the combined share of oil and gas had risen to 55 per cent.

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17. Among the Soviet leaders it was Khrushchev who most strongly urged the change to hydrocarbon fuels. His inspiration seems to have been the technological prowess of America, which he linked not only with her massive and many-sided exploitation of oil but also with what was then her unique position as an exploiter of natural gas. The tempo of the desired change was laid down in the directive for the Seven Year Plan (1959-65) which in actual volume - for in energy content the figure differed in detail - prescribed an increase in coal production of some 22 per cent, but a 2.4-fold increase in oil and a five-fold increase in natural gas.

18. The 1965 results illustrate Gosplan's bias in favour of gross production to the relative neglect of fuel distribution factors and - in the case of coal other than coking coal - to the progress of demand. To some extent this indifference continues. As explained above, the long distance transference of energy, rather than the ultimate quantity available, is the critical problem and each of the three main fuels have widely different transport characteristics. Long-distance bulk transport of coal by land depends overwhelmingly on the railways (which haul more tons of coal than anything else), and that of gas on pipelines, whereas oil can go by rail - much to the distaste of the railway managers - though pipelines are better for most crudes and for some refined products. These contrasting transport characteristics probably had much to do with the fuel plan results. In terms of tonnage extracted - and these were the terms in which the Seven Year Plan target was announced - the original coal plan was largely ignored and the increase in production over the plan period was some 25 per cent less than expected. Even so, rail haulage of coal increased more slowly than coal production, and though we have no firm evidence of shortage among consumers we think it probable that the difficulty of distributing the planned supplies in full tended to restrict demand, and hence production, in favour of the other fuels.

19. Having drilled the wells and ensured a suitable pressure régime, the "extraction" of natural gas merely consists in letting it blow out of the ground. But it cannot be put to effective use without a complete chain of installations extending from well-head to blast furnace or gas cooker. The Seven Year Plan provided for a rather shorter total length of trunk pipeline to be laid for gas than for oil, but Glavgaz, which had overall charge of both programmes, made sure that gas lines received priority. Twice as much gas pipeline as oil pipeline was duly laid. It was not only the lack of trunk pipelines nor the much criticised efforts of the drillers which from time to time caused some anxiety about the level of proved gas reserves that precluded the fulfilment of the gas plan; it was the lack of local distribution facilities,

user equipment and to some extent compressor power on the long-distance lines that curtailed consumption. Since only a small part of the gas produced could be stored, this meant curtailing production to avoid waste. The gas production plan was, therefore, cut by about an eighth and the reduced 1965 target slightly exceeded, though waste still occurred on a large scale.

20. Production of crude oil largely escaped these limitations. The oil pipeline network, though growing more slowly than that of gas, carried a steadily increasing share of the crude from fields to refineries and latterly a considerable share of the rising crude exports. In the absence of product pipelines, however, the railways took most of the strain of distributing oil products from refineries, and railborne oil traffic, though still smaller than that of coal, increased much faster. The oil producers were thus able to maintain their uniform success in annual plan achievement throughout the seven-year period.

21. Throughout the 1966-70 Five Year Plan, the three main fuels reproduced with curious precision their performance during its predecessor. By 1968 it was clear that in tonnage, though probably not to the same degree in energy content, anything approaching the original 1970 target for coal was out of reach. In gas the annual plan goals have been more or less successfully achieved, but only after being sharply reduced to conform with the transport available and with effective demand. (Only in Azerbaijan, among significant regional producers, has gas extraction been allowed to fall appreciably - perhaps in anticipation of large gas imports from Iran.) Oil still maintains its unbroken record of annual plan fulfilment. Some uncertainty attends the production forecasts for the next few years mainly because most of the planned increase must come, for the first time in two decades, from remote new fields still in the early stages of exploitation and doubt persists as to the speed at which their yield will develop. More than usual depends on the hitherto indifferent performance of the drillers. Future output of oil and gas is a function of installed producing capacity (number of wells drilled and properly equipped) rather than the level of proved reserves. Meanwhile, the share of oil and gas in the energy content of total fuel output reached 58 per cent in 1969 and is still increasing.

22. A Soviet expert foresees that the so-called reconstruction of the fuel structure will be more or less complete by 1975. In quoting this date he may have assumed that coal production, for a change, would keep to its long-term schedule; should it fail to do so, as is now habitual, the balance may be struck somewhat sooner. Whatever the date, coal should stabilise at a 30 to 35 per cent share in the

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total energy content of all fuel produced, and the minor solid fuels(1) (peat, shale and firewood) might at best hang on with 3 or 4 per cent. Oil and gas would provide all the rest, with oil predominating. Finally, there would be further supplies of energy from hydro-electric and nuclear power stations, but, as explained elsewhere in this paper, their joint share of total energy supplies in the foreseeable future seems likely to be far less than that of any one of the three major fuels.

23. In Western countries energy policy is determined largely through a consideration of relative costs. No such criteria could have been applied in the past in the Soviet Union where prices gave no indication of actual costs or relative scarcity of resources. There was, therefore, no price structure in a sense that is meaningful in the West. Decisions and the promotion of one type of energy or another were taken by the planners on criteria such as material availability, technical competence and overall political, economic and social priorities. What is uncertain is how far this situation has been affected by the 1967 price reforms and subsequent price changes and the growing emphasis on financial measures within the Soviet Union. It is likely that relative prices and costs, expressed in financial terms, are beginning to influence planning decisions; certainly it is intended that they should have an increasingly important rôle. It cannot be said, though, how important these factors have yet become.

(f) Provision of export surplus

24. The Soviet Union emerged as a net exporter of energy in the mid-1950s and from year to year the increase in the export surplus, if not uniform, has been unbroken ever since. It now amounts to well over 140 million tons of coal equivalent, and nearly an eighth of total energy production. In 1968 over 90 per cent of this surplus consisted of oil and oil products. Since 1955 the Soviet fuel industries, mainly because of shortfalls in coal and gas, have produced rather less energy than successive plans have prescribed, but by a somewhat greater margin the Soviet economy has consumed less than Gosplan had expected and hence the surplus has continued to grow. The only available Soviet forecast for the total surplus in 1965 to be published in advance of that year placed it at 74.4 million tons of coal equivalent; the actual total was 107.6 million tons, the figure for oil being nearly twice that predicted.

25. So far as is known, Soviet policy on energy exports has never been the subject of a comprehensive and intelligible public announcement; it can only be inferred from recent practice. Here the contrast between the progress of crude oil

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(1) Minor fuels are discussed in Appendix D

output and that of domestic refinery capacity raises an obvious question. Crude oil output as already noted has developed according to plan, nearly always with a little to spare, whereas refinery capacity, in terms of absolute throughput, has fallen further and further behind it. Barring the storage factor, crude oil must be either refined or exported in the crude state, and it has been argued that crude oil now accounts for more than half the total energy export because the unrefinable surplus has to be disposed of somehow. The corollary might then be that as soon as refinery capacity had closed the gap, the USSR would refine all the crude she produced and crude exports would cease. On the abstract level, this argument is favoured by some Soviet economists; they often point out in general terms that the export of engineering goods offers a far better return on outlay than that of raw materials. But this argument is hardly relevant to the facts of Soviet oil and Soviet technology. The oil surplus may or may not have been intended from the outset - the date of the decision, if indeed there was a decision, to develop it as a leading export is unknown - but its advantages, political and strategic as well as economic, must soon have been clear and the promotion of its growth seems long since to have become a part of Soviet policy.

26. The official Soviet figures for exports and imports of energy, which nowadays appear annually, are expressed in terms of standard fuel and make no distinction between one form of energy and another, though it has long been clear from trade data that most, and latterly nearly all, of these exports have consisted of oil and oil products. The latest gross figures for exports and imports are shown below as published, together with those of net exports: in each case, the share of oil is given as a percentage to illustrate the heavy and increasing predominance of oil.

IMPORTS AND EXPORTS OF PRIMARY ENERGY\*

(Million tons of standard fuel)

	<u>1960</u>	<u>1965</u>	<u>1966</u>	<u>1967</u>	<u>1968</u>	<u>1969</u>
Gross exports	59.8	116.7	129.2	137.5	147.6	159.8
Percentage of crude oil and oil products	70	79	80	81	84	84
Gross imports	10.7	9.1	8.9	9.5	11.2	14.5
Percentage of crude oil and oil products	65	29	26	20	15	12
Net exports	49.1	107.6	120.3	128.0	136.4	145.3
Percentage of crude oil and oil products	82	83	85	85	89	91

\* Details of individual fuel imports and exports are given in paragraph 31 et seq.

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The slow-up in the growth of energy exports since 1966 will be noted. This is largely due to the slower growth of oil exports: not entirely so, however, for apart from the continued fall in net exports of coal and coke the small export of gas was in 1968 almost balanced by imports from Afghanistan.

27. Soviet energy exports are divided between three groups of markets - the Communist states, the industrialised West and Japan, and the developing countries. In regard to the Communist states, for nearly 25 years the Soviet Union has been the only country able to provide the fuel-deficient Communist countries with oil and, where necessary, coking coal and natural gas without requiring payment in hard currency. Deliveries were often made in the face of considerable transport and other difficulties. For example, in 1959 China was the world's second largest customer for Soviet oil, mostly in the form of refined products; all but a fraction of this export, which amounted in total to about 2½ million tons, was carried by the Trans-Siberian Railway. Italy took just over 3 million tons, and together they accounted for 24 per cent of the total Soviet oil export. In the following year when Italy took 4.7 million tons, China's tonnage took a very slight fall, but in the summer exports to Cuba - a long and complicated haul for Volga crude - began on a scale hardly less than those to Italy. For political reasons, Cuba was from the outset a priority customer and at first her demand occasioned some strain. There is evidence that in the early days of this trade some oil intended for Eastern Europe was sent instead to Cuba, which for a time left the East European refineries seriously short of crude. Soon afterwards it was rumoured that the Russians would be happy to see Cuba once more supplied from Venezuela and that the question of dollar payments alone precluded such arrangements.

28. In the past few years, China's imports of Soviet energy have almost vanished; those of North Korea, Outer Mongolia and North Vietnam - though critical to the economy of these countries - have remained very small, and those of Cuba have remained almost static. In each case, the supplies have consisted almost entirely of oil and oil products; in each case, apart from a very small Rumanian contribution, the USSR has been the sole supplier, and in each case political motives seem to have been predominant. Inside the Communist world, it is Eastern Europe which offers the main market. The fuel resources of Eastern Europe are very unevenly distributed, and trade in fuel between these countries has remained at a very low level. Poland and Rumania have consistently preferred to divide the bulk of their respective surpluses of hard coal and oil products between Western Europe and, to a lesser extent, the Western territories of the USSR, and except for a small supply of Rumanian gas to Hungary there is no inter-satellite trade in natural gas. Eastern Europe as a whole exports some

8 million tons of oil products (11 million tons of coal equivalent) to Western Europe - most of it Rumanian and the rest largely refined from Soviet crude - and Poland ships 10-12 million tons of coal in the same direction, but the gross fuel imports of this group of countries are now running at an annual rate of over 60 million tons of coal equivalent and rising by perhaps 8-10 per cent per year. Practically all this fuel comes from the Soviet Union - mostly as crude oil from the Volga-Urals region since the growth of East Europe's refinery capacity, though it also includes two-thirds of the much smaller Soviet coal exports and relatively small, though increasing, supplies of natural gas.

29. Exports of fuel to the industrialised West and to Japan include a few million tons of coal, a little methane (supplies of which to Austria have now begun) and occasional shipments of LPG(1) to France, but consist overwhelmingly of oil. Most of this once again is Volga crude and nearly all the rest is fuel oil. These oil exports, which in 1968 amounted to 44 million tons, as compared with 42 million tons shipped to Communist countries, constitute about 5 per cent of the world's international oil trade in these markets. In a few instances they account for a very large share of the customer's total oil import (1967 figures show Finland as 81 per cent, Iceland as 83 per cent, Greece as 24 per cent and Sweden as 18 per cent), but since the threat to stop supplies procured the resignation of the Finnish Government in 1958, there has been no evidence of Soviet efforts to manipulate oil trade with non-Communist Europe for political purposes. In Italy, which has been the world's largest importer of Soviet oil since 1960, the figure is 13 per cent. The trade in oil constitutes Russia's largest single source of convertible currency earnings.

30. There remain the small scattered markets in less developed countries. Soviet energy exports to these countries are confined to oil and oil products, which in 1968 amounted to some 4.5 million tons, about 5.5 per cent of Russia's total oil exports for that year. Some less developed countries, such as Ceylon and Syria, have ceased to import Soviet oil(2). The trade, never large, had begun to decline by 1967 and was partially disrupted by the closure of the Suez Canal. The

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(1) Liquefied petroleum gas (mainly propanes and butanes)

(2) The same would already have happened in the UAR, which is now a significant net exporter of oil, had not the closure of the Suez Canal cut off her surviving refinery at Alexandria from her leading oilfield in the Gulf of Suez. As it is, she imports some Soviet oil via Alexandria and exports the whole yield from the Gulf of Suez, including some to Cuba on Soviet account.

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Soviet Authorities show less interest in maintaining it than in helping to develop the domestic oil potential of the countries concerned. Two other features of Soviet oil relations with less developed countries should be noted. In the past decade, the Soviets have several times offered and delivered oil to countries in dispute with their normal suppliers, the international oil companies. This happened in Cuba and Ceylon, although, as already noted, supplies to Ceylon have ceased. They have had no recent occasion to perform these good offices, but, given the right opportunity, they might well do so again. Secondly, they have begun to accept small supplies of oil from such producers as the UAR, Syria and Algeria in payment for their services to these countries' oil and other enterprises. So far as we know, little of this oil ever reaches a Soviet port, but is shipped direct to existing Soviet customers on Soviet account. This practice will probably continue and even grow, but is unlikely to account for much of the Soviet oil trade in the next few years.

31. Our present opinion is that until 1975 both gross and net exports of energy will continue to grow, the former faster than the latter, but both at a slow pace. We base this opinion partly on recent Soviet performance and partly on the fact that all we know of Soviet intentions in the energy sector of the 1971-75 Five Year Plan indicates that the increase maintained since 1955 will be continued rather than halted or reversed. As at present, exports will consist chiefly of oil, but will also include coal and coke, natural gas and electric power. It will be convenient to deal first with the three minor components and finally with oil.

32. Coal. Both gross and net exports of coal (including coke) reached their peak in 1964, when the gross and net totals were 27.3 and 21.5 million tons respectively. Four years later the total had fallen to 25.1 and 17.5 million tons. Eastern Europe, the main market area, will certainly continue to need some Soviet coal, but whether the same applies to Western Europe or Japan is problematical. As regards the Soviet surplus, it is worth noting that the erratic performance in coal extraction has in recent years borne no close relation to the trend in exports. One Soviet analyst predicts exports of 34 million tons in 1980, and we may take it as certain that any reasonable increase in the export surplus could be achieved, though perhaps none too promptly, if the planners thought it worth while.

33. Gas. Soviet exports of natural gas to Eastern Europe are now beginning to gather momentum and exports to Austria have begun. Agreements have been signed between the Soviet Union and Italy and West Germany whereby the Western countries will supply pipes for the construction of pipelines, in exchange for Soviet exports of gas to them, and negotiations

are under way with Sweden, Finland, Denmark, France and Japan to sell them gas on a long-term basis. The Russians appear convinced that if the prices suit them they can fairly rapidly increase their gas exports, but it is not at all clear whether they anticipate a net import or a net export of gas in the next few years. Present imports from Afghanistan should now roughly equal, and may already exceed, the current westward exports, and by 1975 the combined imports of Afghan and Iranian gas could well reach 23 milliard cubic metres. There is no evidence of prospective imports from any other source. The advantage to the Soviet Union in this trade is that she sells gas to hard currency areas and buys gas from countries which are prepared to take Soviet goods and services in exchange.

34. Electric power. The Ukraine has for some time been connected with the Eastern European power grid, whose control centre is in Prague, and its net power export is increasing. It will soon assume the new task of supplying Bulgaria by a new line to go direct across part of Rumania. In terms of energy, however, these power supplies will continue to make up a very small fraction of the total Soviet export.

35. Oil. Each year since 1953, Soviet trade statistics show increases of Soviet exports of oil and oil products. In 1969 there was an export of 90.8 million tons and an import of about 2 million tons(1). Both totals include a few hundred thousand tons of non-Soviet oil shipped to third parties on Soviet account, but apart from this the official Soviet figures seem substantially correct. Failing a radical change in oil policy, the USSR seems assured of a surplus of oil for export at least for some years to come and it is likely to continue as the Soviet Union's principal energy export.

36. Although there are many difficulties, estimates of future Soviet exports can be made by comparing forecasts of production and assessments of future domestic consumption.

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(1) The oil exports in 1969, as given in the Soviet foreign trade journal probably contains - perhaps unintentionally - double counting. In recent swap deals with the international oil companies and Middle East countries, the USSR delivers its oil to certain markets in Western Europe in exchange for deliveries of Persian Gulf oil to Soviet markets east of the Suez Canal, especially to Japan. The export figures in the Soviet foreign trade journal include both sides of these swap deals, thus inflating actual exports by more than 1 million tons. Also, the USSR includes in its exports the crude oil obtained from Egypt and Algeria and re-exported to other countries on Soviet account; the total involved is 1½ million tons.

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The majority of the Committee is agreed that forecasts of production may be taken as 480 million tons in 1975(1) and 600 million tons in 1980(2)(3). Consumption estimates may be made by applying the relationship between past rates of oil consumption and increases in national industrial production to estimated future industrial growth. There is a good deal of uncertainty about the latter, so fairly wide ranges have had to be used with the result that the range of net exports could be 124-151 million tons in 1975 and 102-172 million tons in 1980(4). The very size of these ranges in relation to total Soviet output shows how difficult it is to make firm forecasts. If the forecasts of growth in gross industrial production (those assumed in making these estimates are 6-8 per cent a year to 1980) prove too high - and the plan for 1970 was only 6.3 per cent - then the oil surplus available for export will be in the upper end of the range. A similar effect might follow the consumption trends in boiler fuel, discussed in Appendix B. Increases in oil production will depend on the exploitation of the new fields in Western Siberia, where conditions are very difficult and investment costs high.

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- (1) Recent information about the 1971-1975 Soviet Plan indicates that oil production in 1975 is expected to be 480-500 million tons. It is likely that this will be reached, at least, at its minimum level.
  - (2) In view of the raised targets for 1975, it seems likely that the Russians will now be aiming at something like 630 million tons production in 1980. If so, they will have to take the necessary steps in advance to ensure this higher production.
  - (3) The United States Authorities do not share the majority view and they consider that in 1975 Soviet production may be 450 million tons, reaching 500 million tons in 1980. The rationale for these alternative estimates and their implications are discussed in Appendix B.
  - (4) In view of their lower estimate of production and also of slightly different domestic consumption forecasts, the United States considers that net exports could be 90-110 million tons in 1975 and 10-60 million tons with, a best estimate of 50 million tons, in 1980.

37. However, whatever the difficulties of making quantitative estimates, it seems clear that by 1975 the Soviet output will be adequate to provide for all domestic needs, to satisfy most of East European demand for oil and still leave substantial quantities for export to other Communist countries and to the Free World. All that need be added is that the Soviet Union has undertaken to increase supplies to Eastern Europe, but that for a small margin of their growing requirements these countries must look elsewhere; that she may be expected to continue and slowly increase her small exports to North Korea, North Vietnam and Outer Mongolia while further replanning the supply of her own oil to Cuba by deliveries of non-Soviet oil on Soviet account; that she is in process of replacing some of her own exports of oil by similar small acquisitions from Arab producing countries and apparently intends to do so on a slowly increasing scale; and, finally, as oil is her largest single earner of foreign exchange, she has good reason to continue to export as much of it as she can to hard currency markets.

BALANCE OF FUEL-ENERGY RESOURCES, 1960-69

(Million tons of standard fuel)

	<u>1960</u>	<u>1965</u>	<u>1966</u>	<u>1967</u>	<u>1968</u>	<u>1969</u>
<u>Total resources</u>	836.5	1,121.5	1,195.1	1,259.4	1,311.5	1,358.2
Fuel production	692.8	966.6	1,033.1	1,088.4	1,126.6	1,177.3
Hydro-electric power	6.3	10.0	11.3	10.9	12.8	14.2
Imports	10.7	9.1	8.9	9.5	11.2	14.5
(Of which oil as percentage)	(65)	(29)	(26)	(20)	(15)	(12)
Other resources*	32.7	35.5	34.8	35.8	36.1	37.0
Stocks at beginning of year	94.0	100.3	107.0	114.8	124.8	115.2
<u>Total distribution</u>	836.5	1,121.5	1,195.1	1,259.4	1,311.5	1,358.2
Consumption (including transport and storage losses)	678.0	897.8	951.1	998.1	1,048.7	1,098.4
Exports	59.8	116.7	129.2	137.5	147.6	159.8
(Of which oil as percentage)	(70)	(79)	(80)	(81)	(84)	(84)
Stocks at end of year	98.7	107.0	114.8	123.8	115.2	100.0

Source: 1969 Year Book

\* Not defined. Believed to consist of various forms of secondary energy such as coke, oven gas, furnace gas, etc. May also include natural gas liquids, synthetic fuel and shale oil.

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38. If we accept that total oil exports will be about the middle of the range of 124-151 million tons given for 1975, and further assume that imports and exports of natural gas will roughly balance each other and that those of coal will continue more or less as at present, gross exports of fuel, in terms of coal equivalent, should be about 225-245 million tons and net exports about 205-215 million tons. (In these terms the exports of electric power, gross or net, will be very small.) The gross and net exports would constitute roughly the same proportion of total energy output as at present. Neither total is as high as expected before the scaling down of Khrushchev's long-term production forecasts, or indeed as the Soviets would probably have wished. This is presumably due to Soviet caution in predicting development rates for the new oilfields, for these will largely determine the oil surplus which will in turn dominate that of energy in general.

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THE SOVIET COAL INDUSTRY - PERFORMANCE AND PROSPECTS

1. The Soviet Union's coal reserves are so large that their precise volume is a purely academic question. There is no reason to doubt the statement of one of her experts that they are enough to last a thousand years and since the late 1950s she has been the largest gross coal producer in the world. This, however, is only true in terms of actual tonnage extracted. In fact just over 20% of coal produced is brown coal which has a low calorific value. In terms of energy content of total coal production, the United States comes first(1). The Soviet coal industry progressed towards this position during the Stalin era when the ascendancy of coal as the main source of energy went unquestioned - as late as 1955 it accounted for 64.8 per cent of total fuel output and for 58.8 per cent at the start of the Seven Year Plan - but during the past decade its faltering progress has afforded so much perplexity that some observers have doubted whether a coal plan existed at all.

2. In 1958 the USSR produced 493 million tons of coal, of which about a quarter was brown coal of low calorific value. Starting from this figure, the Seven Year Plan prescribed 600-612 million tons as the goal for 1965, but no sooner was this announced than Khrushchev, preoccupied with oil and gas, seems to have lost interest in its achievement. From the outset there was no discernible relationship between the terminal plan target which soon ceased to be maintained and the much more modest annual plan targets, and out of the required seven-year increase of about 115 million tons no more than 24 million had been achieved during the first four years.

3. Production then picked up speed, and in the last two years of the plan period achieved a rate of progress which, had it been maintained from the outset, would have carried the industry beyond the original 1965 target; as it was,

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(1) For instance, in 1967 the USSR produced a total of 595 million tons, of which 451 million was classed as hard coal and 144 million as brown coal. Together these gave a total of 429 million tons of coal equivalent. In the same year, the United States produced 507 million tons of hard coal of higher average energy content than the Russians, but only 4 million tons of lignite. The total United States tonnage extracted was thus 84 million tons less than the Russian but at least 75 million more in terms of energy content.



however, the 1965 result was 578 million tons(1). There is no firm evidence that the economy as a whole suffered much from this performance, though private consumers - as usual at the end of the queue - seem to have gone short on occasion, and there were the usual complaints that particular grades and qualities of coal were in short supply. In this connection difficulties are made worse by the inadequacies of the Soviet transport system, which delay deliveries from the production centres to the consumers(2). Exports of coal and coke, both gross and net, continued to mount until 1964, when both exceeded 20 million tons, and declined only slightly in 1965. The annual All-Union plan results were greeted with approval, criticism being reserved almost exclusively for local or regional failures, or for technical shortcomings. The fact that production over the Seven Year Plan as a whole had fallen tens of millions of tons short of the plan figures, and 22-34 million tons short in the terminal year, received little or no public comment.

4. Much the same happened during 1966-70 as in the Seven Year Plan period. The plan for 1970 called for the coal output to reach 665-675 million tons, some 90-100 million tons above production in 1965. In 1966 and 1967, however, the actual increases were 7.9 million tons and 9.6 million tons respectively, although in each year the annual plan was claimed as slightly overfulfilled; in 1968 and in 1969, for perhaps the first time in Soviet history for any major commodity, the plans called for reductions in output - for 1 million and 5 million tons respectively. In the event, 1968 output did fall as planned (594 million tons), but the falling stocks and shortages that resulted caused a tactical change of policy in 1969, and output, in fact, rose by 14 million tons (608 million tons), 18 million tons above plan. Actual output in 1970, however, was only 624 million tons, only about 46 million tons more than in 1965. Although this was some 50 million tons less than originally planned, it is possible that the domestic and export markets could not have absorbed more.

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- (1) The total production of coal in 1965 refers to gross raw tonnage, without deducting losses from preparation and mechanical cleaning. On the basis of recent information from a Soviet handbook, it is estimated that about 30-35 40-45 million tons of the gross production was waste and reject, and about 545 million tons of coal was available for use in 1965.
  - (2) In August 1970, as a result of the shortage of railway trucks (used to transport perishable products from the crop) one million tons of hard coal were left at the mine head.

It should be added that coal's erratic performance in the last two plan periods looks worse in terms of tonnage extracted - to which all the above figures refer - than in terms of energy content. This, as explained, below, is due to the much higher calorific value of hard coal, whose output has increased without a break since World War II, than of brown coal which reached a peak in 1965 and has since slipped back for the second time in ten years.

5. This situation seems to be the result of several conflicting trends, each of which represented a departure from plan. In the first place, the Donbass failed to reach its 1965 plan target and hence to deliver the required quantities of hard coal (including the vital coking grade) to the rest of European Russia, where closures of uneconomic brown coal pits had already begun. The deficiency was made good from the more distant Kuzbass and Karaganda basins. Secondly, the Urals received considerably less Kuzbass hard coal than expected - presumably because of increased demand further west - and responded by above-plan production from its own hard (though mostly rather low-grade) deposits. Thirdly, the exploitation of opencast resources - notably of brown coal in the east - proceeded much more slowly than the long-term planners appear to have foreseen. Annual production plans look far more realistic and are regularly exceeded. An ambitious goal to be achieved in five years' time might well seem plausible, whereas a correspondingly ambitious annual goal could easily be recognised as absurd. The short-term planners, presumably, could well see that the power plants and heating installations for which the low-grade coal was destined would not be built in time to burn it. Thus in 1967 the output of brown coal was 1.8 per cent below that of the previous year in spite of exceeding the plan total by 2.2 per cent. In most cases, and in particular in the east, rail transport has acted as a limiting factor in both plan and result, for it was not worth producing what could not be moved, and in some regions the difficulties of long-distance coal transport may well have helped to maintain the output and consumption of peat and firewood above expected levels.

6. The prospects of coal in the USSR, at least as foreseen by the coal industry and the long-term planning authority, contrasts sharply with those of the United Kingdom and United States. In the United Kingdom, where the coal industry faces an absolute decline in production and consumption,

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electric power is the only consuming sector still clearly on the increase. In the United States both production and consumption are still rising, but this, it appears, is almost entirely due to power station demand. In the USSR the latest available forecast for the period up to 1980 ascribes the largest increase in consumption to electric power. Other consumer factors will take much smaller, if any, extra quantities of coal. The future share of coal in the Soviet energy pattern over the next ten years will depend on the rate of development and construction of new mine capacity in the Eastern region from where the bulk of the coal will be extracted; another important consideration will be the progress achieved in producing more natural gas and crude oil, in particular after 1975. Recently announced plans call for coal production to reach 685-695 million tons in 1975, a realistic goal that would require an annual growth in output of about 13 million tons. Although a preliminary goal of 950 million tons for 1980 was announced in 1969, recent statements by Coal Ministry officials indicate an output of 775 million tons is more likely in 1980. Estimates so far ahead as 1980 must of necessity be considered only as broad indications of future developments.

7. The increase in coking coal will come largely from the Donbass, with smaller contributions from the Kuzbass, Karaganda and Pechora deposits. The miscellaneous coals used for a wide variety of heating, as at present, seem likely to be burnt as close as possible to the centres of consumption. The increase in power station coals, for which by far the largest increase is projected, will come largely from Kahsk-Achinsk and Ekibastuz Basin, and to a lesser extent from the Kuzbass and Donbass. The remoteness of the new coal mines from the consumer centres poses serious problems to the Soviet planners who are considering the building of high voltage transmission lines and of extra railway lines specialising in the transportation of coal. This question is further examined in Appendix G. The following table illustrates the position of the main producing regions in 1965, the latest year for which data are available.

COAL EXTRACTION

(Million tons)

	<u>1965</u>
Donets Basin	206.2
Moscow Basin	40.8
Pechora Basin	18.0
Chelyabinsk Basin	23.7
Sverdlovsk Basin	21.2
South Ural Basin	6.7
Total for European Russia and the Urals	<u>350.0</u>
Kuznetsk Basin	96.0
Kansk-Achinsk Basin	13.9
Ekibastuz and Maikuben Basins	14.3
Other coalfields of East Siberia	32.5
Other coalfields of Kazakhstan and Central Asia	40.2
Coal deposits of Far East	29.1
Total for Eastern Regions (1)	<u>227.1</u>
Grand total USSR (1)	<u>577.7</u>

8. It is chiefly the long delay in developing the Siberian and Kazakh reserves of opencast coal which accounts for the failure to adhere to the Seven Year Plan and its successor. Progress here awaits that of the design and building of very large power stations, generator sets and transmission lines. When these are ready, coal production should resume its advance.

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(1) Statistical Yearbook 1969. Data on production in the basins mentioned do not add up to totals.

THE SOVIET OIL INDUSTRY - PERFORMANCE AND PROSPECTS

General

1. During the Seven Year Plan period 1959-65, crude oil was the only form of primary energy to meet and exceed the targets planned for it in the medium-term plans, and the only one whose annual plan for 1970 was in accordance with the Five Year Plan 1966-70. Over the last decade or so crude oil production has risen from 98 million tons in 1957 to 353 million in 1970, and the achievement of planned targets, usually with an annual bonus of 1 million or 2 million above targets, has been a consistent feature of the Soviet oil industry(1).

TABLE 1. SOVIET OIL: PRODUCTION, CONSUMPTION AND TRADE  
(in million tons\*)

	<u>1955</u>	<u>1960</u>	<u>1965</u>	<u>1966</u>	<u>1967</u>	<u>1968</u>	<u>1969</u>	<u>1970</u>	<u>Plan</u>
Production	71	148	243	265	288	309	329	353	(350)
Apparent consumption	67	119	181	193	210	224	237		
Exports: Total	8	33	64	74	79	86	91		
of which									
Communist countries	4	15	29	32	35	42	48		
Free World	4	18	36	41	43	44	43		
Imports	4	4	2	2	1	1	2		

\* Totals may not always agree because of rounding

Recently announced goals for 1975 call for crude oil production to reach 480-500 million tons, an ambitious plan. The net export of crude oil and refined product grew from 4 million tons in 1955 (the first post-war year of surplus) to nearly 90 million in 1969.

(1) Recent information obtained from Soviet Handbooks and technical journals reveals that the output of natural gas liquids has been included in crude oil production during the past decade, accounting for some of the reported over fulfillment. In 1970 the production of natural gas liquids amounted to about 2 million tons of the total reported output of 353 million tons of "crude oil".

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2. Although full details are usually published by the Russians of their estimates of natural gas reserves, such information on oil reserves is apparently regarded as a state secret, so that exact figures cannot be quoted. Estimates of proved reserves range between 4,500 million tons and 5,700 million tons(1). During the past few years Soviet technical journals and books have revealed the concern of geologists and technical experts about the adequacy of proved reserves of crude oil, expressing doubts about the criteria used to evaluate them and the validity of the figures used. Thus it has been reported that at least 25%-35% of the reserves in categories A and B, regarded hitherto as proved, have had to be written off and that about 40% of category C.I reserves (probable reserves) had to be written off too. From Soviet claims for individual deposits it appears that proven reserves are probably at least adequate to meet the goals of the USSR, and from the fact that two-thirds of the country is sedimentary that potential reserves are enormous. The two main obstacles to the development of these reserves are the low level of Soviet technology and the remoteness and adverse climatic conditions of so many of the newly found reserves.

3. The Russians have shown themselves, when comparisons were possible, to be less successful in surveying and locating deposits than the international oil companies, probably as a result of poor quality instrumentation. Extraction practices are not always sound as evidenced by many articles in Soviet journals criticizing improper waterflooding and overproduction of best wells as well as wasteful flaring of associated gas. In drilling, both for exploration and for production, they are frequently handicapped by the preponderance of turbo-drills over rotary drills, itself necessitated by the shortage of high strength steel for drilling tubes; turbo-drills are advantageous in some media, but in most cases they suffer from very high wear and are very inefficient at great depths. If to this is added the fact that, for exploratory drilling, premia are earned by the drillers according to the footage drilled and not according to results, the drillers naturally place their equipment where they can achieve their norm rather than where they are likely to achieve a strike. To all this must be added the great weight of the equipment, which is typical of Soviet engineering, and the consistent failure of the oil equipment industry every year to achieve its planned output. An additional hurdle is the transportation problem which in particular plagues production in the West Siberian

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(1) Soviet estimate made in December 1970

region. There is inadequate planning for the construction of roads, railroads and pipelines(1). Domestic supplies of large diameter pipe are not adequate to meet the needs of both the oil and gas industries; imports of such pipe will continue to be required from Western and Eastern Europe to fulfill construction goals(2). It is not, therefore, surprising that there is considerable criticism of the industry's failure to expand proven oil reserves at the required rate. The fact that this has been so for many years, and yet oil output plans have equally consistently been achieved, is a further indication of the probable abundance of Soviet reserves.

Changes in the regional pattern of crude production

4. The Russians have repeatedly stated that at least until 1975 the Volga-Urals area - in the wide sense in which they commonly use the term - will continue to produce most of the country's crude oil. In the past few years, this has meant that Tataria, Bashkiria and Kuybyshev Oblast have produced nearly 60 per cent of the USSR's total crude output. Progress in these three, however, has now slowed to a crawl and in Bashkiria output is actually falling. It has evidently faltered somewhat earlier than expected - above all before the new producers in Western Siberia have had time to make any great contribution, but this faltering has to some extent been compensated for by the development of new reserves to the north-west and south-west of the area. It

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- (1) For the laying of the pipes in those areas of the USSR, where the soil is permanently frozen, the steel has to meet very high requirements of resistance, corrosion resistance, stability and notch impact strength. Since these requirements cannot yet be fully met, the Soviet metallurgical plants are compelled to manufacture pipes with thicker walls than those of western make, a fact which has a negative influence on the quality and especially on the flexibility of the pipes. Plans for the production of pipes with thinner walls and a sufficiently high degree of precision by thermal treatment exist, but test results are not yet satisfactory and the capacity of the thermal treatment facilities is insufficient.
- (2) Plans for pipeline construction, even for 1975, seem to be very optimistic and will require great effort to achieve. The goal for 1975 calls for the construction of 57,000 kilometres of oil and gas pipelines, almost 20,000 kilometres more than accomplished during 1966-1970. This programme will call for a supply of at least 16 million tons of large diameter pipe: which is at least 6 million tons more than the USSR can produce or has planned to import during 1971-75.

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seems likely, however, that for the first time in a quarter of a century the Soviet oil industry must rely on a completely new and only partly explored area, rather than well-known and established fields, for the greater part of the expected increase above the current level of production during the next 15-20 years.

5. The Soviet response to the premature flagging of the three main producers in the Volga-Urals is now revealing itself in three changes of emphasis. Firstly, an increasing share of the future output is now expected to come from the smaller producers in the area - such as Orenberg, Perm and Saratov Oblasts and the Komi and Udmurt ASSRs - whose relatively small-scale efforts until lately received little attention in the Soviet Press. This however, will not be enough to offset declines in output from other areas. Meanwhile, it is apparently intended to give greater prominence to outlying and largely unexploited reserves inside the big producers themselves; this may partly entail the development of small fields hitherto neglected as not worth exploiting, and partly the exploitation of oil which, until this situation arose, appeared to be of too low quality. All this is aimed at maintaining an acceptable rate of growth in the Volga-Urals as a whole, perhaps until 1975. Secondly, we now hear more of the prospects of smaller producers to the west and south and hence nearer to the main centre of production demand, notably Chernigov and Poltava Oblasts in the Ukraine and in Belorussia. Most of the regions cited in the Press have been producing on a small scale for many years, but a few such as Belorussia and Daghestan in the Caucasus are newcomers. Only once, according to our information, has it been publicly argued that "Europe" rather than the Volga-Urals or the eastern region should take precedence in short-term development but it is fairly clear that, taken as a whole, these smaller and less remote producers (or in some cases potential producers, such as the Baltic littoral) already count for rather more in terms of effort and output than during the Seven Year Plan period. Lastly, the main new producers which carry the chief hope for the future seem to be pressing well ahead of plan. Thus, Tyumen Oblast, for which the original 1970 target was 15-20 million tons, produced 25 million in that year and is expected to produce 80-100 million in 1975; the adjoining Tomsk Oblast, which in 1966 received no separate mention as a producer, yielded over 5 million tons in 1970 and is expected to yield 20 million tons in 1975, and the Mangyshlak Peninsula in Western Kazakhstan raised its 1970 target from 12 million to 14 million tons and to 25-30 million in 1975. All this should go far to compensate for the loss of momentum in what are still the chief producing regions.



Production Prospects

6. Because efforts to increase reserves and production in the old-established fields of Azerbaijan and the Volga-Urals region have faltered(1), the Soviet Union must rely on new and only partly explored deposits further east for the greater part of the increase above the current level of production. The most important of these new deposits are in Western Siberia, where climatic conditions are harsh and transport and housing facilities limited(2). In these circumstances, the rate of exploitation of the new fields depends on the Soviet decisions regarding the allocation of resources; for initial investment costs are high and new techniques have to be developed and adapted on a large scale(3). A Party and Government decree of January 1970 shows that the Soviet Union is preparing to invest heavily in this area and by 1975 it is to supply 100-120 million tons of crude oil and by 1980 output is planned to reach 230-260 million tons. Many pipelines are to be built; a new rail link and airport is to be constructed; and housing accommodation is to be extended. These signs of a more intensive development of Western Siberia suggest that the exploitation of the new field is going ahead regardless of the natural and technological problems involved and at a pace which should enable the long-term targets to be reached. It is, however, difficult to try to forecast the Soviet attitude to increase oil production by applying normal Western economic criteria or rationale.

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(1) Much of the increase in Soviet crude oil production during the past 15 years came from the Urals-Volga region, primarily from the very large Romashkino field in the Tatar ASSR. Output from this field alone accounted for about one-fourth of total national output of crude oil in 1969. In recent years, however, improper water flooding and over-production of high yield-wells have accelerated depletion and greatly increased the amount of water in total fluid production to about 50%. Lifting costs will increase significantly from now on as the total volume of fluid increases and larger pumps are required to maintain crude oil production.

(2) There will have to be a sharp improvement in the quality of Soviet steel or considerable pipe imports, if the future production goals are to be achieved.

(3) Soviet planners have admitted the need to import Western equipment and technology to develop oil and gas production in West Siberia, where they intend to double drilling to a total of 6-7 million metres during 1971-1975. This appears to be an ambitious task.

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7. Judging by precedent it seems likely to the majority of the members of the Committee that production in 1975 will reach 480 million tons, which is the lower figure of the range set for that year by the recently published 1971-1975 Plan (480-500 million tons). However, the United States Authorities consider that the technological and transport problems with which the Soviet oil producers are faced, as well as the rapidly declining yields in a number of oil fields currently worked will probably make it difficult to reach this level, and their best estimate is that in 1975 Soviet production will be 450 million tons.

8. As regards the production levels in 1980, the Soviet forecasts, which 3 years ago ranged between 550 and 600 million tons, have gradually risen. Last year the figures quoted by high Soviet officials were 600-620 million tons, and early in 1971 the forecast was 625-645 million tons. Most members of the Committee agreed with the United Kingdom forecast that production at the end of the present decade would be about 600 million tons, but it cannot be excluded that the Russians, in view of the raised targets for 1975, might subsequently step up their production with the aim of reaching something like 630 million tons in 1980. If so, they will have to take the necessary steps in advance to ensure this higher production. The United States Authorities, on the other hand, feel that the problems confronting the Soviet petroleum industry will be even more aggravated in the second half of the decade and could be overcome only by the allocation of sufficient resources to provide needed technology and equipment, probably at the expense of other industrial programmes. Therefore the United States best estimate is that Soviet production in 1980 may be 500 million tons. The table at the end of this Appendix shows the United Kingdom and United States best estimates of Soviet production and consumption and their implications for Soviet oil trade.

#### Consumption and Export Prospects

9. There are many problems in the way of arriving at quantitative estimates of Soviet oil consumption and hence a surplus available for export. The statistics used as the basis of consumption forecasts are subject to such a margin of error, that only a wide range of probabilities can be given. Future Soviet consumption has been estimated by assuming firstly that the relations between it and gross industrial production would continue as over the past few years, and secondly that gross industrial production would grow by 6-8% a year up to 1980(1). On these assumptions future Soviet consumption may be estimated at 329-356 million tons in 1975 and 428-498 million tons in 1980(2). The difference

- (1) Percent based on official Soviet statistics and estimates.  
(2) The OECD have produced an estimate of total consumption in 1980 which is higher than that taken here. But the OECD estimate is a rough one based on an assumed per caput consumption.

between these figures and those of Soviet oil production accepted by the majority of the Committee (see paragraphs 7 and 8 above) indicates the range of likely future Soviet exports in 1975 and 1980, which would be 124-151 million tons and 102-172 million tons respectively (1).

10. The conclusions which emerge are as follows:

- (a) In spite of the statistical difficulties, it is reasonably certain that in the course of the next decade the Soviet Union will be able to supply all its domestic requirements and still have a surplus for export. It is possible, on some assumptions that, by say 1975, the surplus available for export to the Free World, if the Soviets met all the requirements of the other Communist countries, as well as their own, would be 44 million tons; on other assumptions it might be 86 million tons. The median figure of 65 million tons compares with exports to the Free World in 1969 of 43 million tons. The range of probabilities is greater by 1980, when the corresponding estimated median is somewhat lower. The United States holds a different view on the situation likely to develop in 1975 and in 1980. Their best estimate of Soviet oil available in 1975 for export to the Free World is 30 million tons. As regards 1980 a Soviet production of 500 million tons while sufficient to meet domestic demands, would not leave much for export. Therefore, if the Soviets were to meet all the requirements of the other Communist countries they would have to procure a certain volume of oil from Free World sources. This would be much larger if the USSR decided to maintain her exports to the Free World at about present levels
- (b) In this situation, we believe Soviet policy on oil in the 1970s will be guided by two main principles.

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- (1) On the basis of their best estimates of future Soviet production and their forecasts of the range of domestic demand (see AC/127-D/321/1), the United States have arrived at different figures of Soviet oil available for export, i.e. 90 to 110 million tons in 1975 and 10 to 60 million tons (best estimate 50 million tons) in 1980.

First, she will not import oil to such an extent that she builds up internal distribution facilities dependent on imported oil. Secondly, she will not wish the Soviet bloc as a whole to become too dependent on foreign supplies of oil. Subject to these overriding considerations, the USSR has a keen interest in promoting the export of oil to the Free World so as to maximise the earnings of convertible currency.

- (c) With these considerations in mind, and on the assumption that present forecasts of production in 1975 and 1980 are realised, the Soviet Union will continue to supply the bulk of the oil requirements of the other Communist countries, but she has already informed some of the East European countries that they must obtain a proportion of their increased requirements of oil from elsewhere. The amounts involved will be relatively modest, in the order of 5-20 million ton range in 1975; even this may be reduced by the preference of some of the countries, notably Czechoslovakia, for investment in the Soviet oil industry in exchange for increased deliveries, in view of the problems of transport from the Middle East. The Soviet Union might also obtain some oil probably in small quantities on behalf of the Eastern Europe countries and other Communist markets from Middle East and North African countries in return for economic and military aid. Such a course would also ease the burden of the Eastern Europe countries on the domestic Soviet oil supplies.
- (d) This possible economic interest of the Soviet Union in the Middle East and North Africa oil will be reinforced by her ability to use such oil as a means of earning foreign exchange, for she can be expected to extend the practice, already conducted on a small scale, of disposing of Middle East oil obtained in return for aid, to third parties. It is unlikely, however, that the Soviet Union could assume the rôle of a broker on a large scale. In view of the links already existing between them, it would hardly suit either the oil-producing and exporting countries or most of the Free World consumers to use the Russians as intermediaries. Most of the Soviet exports to the Free World will, therefore, continue to come from domestic production.

- (e) Finally, it is clear that the Soviet Union and Eastern Europe will become more involved in the world oil trade but in absolute terms their trade will be a very small fraction of the total. By 1980, it may well reach 2 per cent of the total production of the Middle East and North Africa(1), but it is unlikely to exceed 7 per cent in the worst possible case. Such involvement in future will rest not only on political motives which have dominated the past, but to an increasing extent on economic interests.

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(1) It has been assumed that between 1.1.1971 and 31.12.1980, oil production in these two areas will be growing at an annual average rate of 7 per cent. Total production in 1970 has been estimated at 912 million tons; production in 1980 could well be 1,800-1,825 million tons.

UNITED KINGDOM AND UNITED STATES  
ESTIMATES OF FUTURE SOVIET TRADE IN OIL

(Million metric tons of crude oil equivalent)

	<u>1975</u>		<u>1980</u>	
	Best estimate		Best estimate	
	U.K.	U.S.A.	U.K.	U.S.A.
I. <u>PRODUCTION</u>	480	450	600	500
<u>Demand for Soviet Oil:</u>				
Domestic (a)	343	350	463	450
Eastern Europe (b)	60	60	80	80
Other Communist countries	<u>6</u>	<u>10</u>	<u>6</u>	<u>10</u>
II. <u>TOTAL COMMUNIST COUNTRIES' DEMANDS</u>	409	420	549	540
III. <u>AVAILABLE FOR EXPORT TO NON-COMMUNIST COUNTRIES</u>	71	30	51	-40
IV. <u>HYPOTHETICAL SOVIET EXPORTS TO FREE WORLD ASSUMED TO CONTINUE AT ABOUT PRESENT LEVELS</u>	40	40	40	40
Net position (I-(II + IV)) (c)	+31	-10	+11	-80

- (a) Median figure of a range of possible domestic demands which includes losses, storage and bunkers.
- (b) Excluding Rumania (which does not import oil from the USSR). Eastern Europe will be importing, in addition to Soviet oil, a certain volume of petroleum from some Free World countries in exchange for sales of technical equipment and manufactured goods.
- (c) Should, by and large, the above estimates of Soviet production and Communist countries' demand for oil prove accurate, the United Kingdom view is that the USSR would dispose of a surplus for export to the Free World larger than the average quantities sold to it over the last few years. On the other hand, the United States consider that to keep sales to the Free World at their present level the USSR would have to import a small volume of oil in 1975, and that in 1980 these imports would have to be substantially increased if the Russians wanted, concurrently, to meet their commitments to their Communist partners and to continue to sell the same amount of oil, as hitherto, to the Free World.

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THE SOVIET NATURAL GAS INDUSTRY - PERFORMANCE AND PROSPECTS

1. In very small quantities, natural gas was used as a fuel in Russia even in pre-revolutionary days, but its present position as a major source of the country's primary energy is due to the discovery of vast new deposits and the gas industry's very fast development during the past 20 years. In 1950, natural gas represented only 2.3 per cent of the USSR's primary energy production (less than peat, shale or firewood); by the end of 1968, it had reached the proportion of 18 per cent and is due to reach 27 per cent by 1980. Russian natural gas shares one factor in common with oil and coal in that 70 per cent of its deposits are east of the Urals, far from the heavily consuming industrial and more densely populated areas of the USSR. However, gas more than any other type of fuel requires specialised transport and also adaptation of domestic and industrial plant to enable it to be used. The development of the natural gas industry has, therefore, been more dependent on factors beyond its control than any other primary energy source. (Oil in large quantities can, in the absence of pipelines, be carried by road, rail or waterways. Because of the large quantities and long distances involved in the USSR in taking gas to its consumers, pipeline is the only viable means of transport. Moreover, the comparatively slow development in compressor technology has meant that the large diameter pipelines for both gas and oil operate in practice at far below their theoretical capacity.)

2. Now discoveries of natural gas deposits during the early 1950s prompted ambitious goals for the industry and the Seven Year Plan made provisions for an increase in production from 28 milliard cu.m in 1958 to 148 milliard cu.m in 1965. (These figures include recovery gas from oilfields.) This was probably a case of enthusiasm for the "new" fuel obscuring the attendant difficulties of distribution and utilisation. During the first three years of the Seven Year Plan, the targets were not achieved but a reduction of the terminal year's goal from 148 milliard to 126.6(1) milliard cu.m, and, therefore, presumably of the annual targets for the remainder of the plan period, produced a record of overfulfilment by 1-4 milliard cu.m a year. The first four years of the 1966-70 Five Year Plan have seen underfulfilment of the annual gas targets by 3 milliard cu.m in 1966 and 1967, by 2 milliard cu.m in 1968 and by 3 milliard cu.m in 1969; this at a time when

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(1) These figures exclude a small quantity of gas produced from coal and shale; in the gas target figures for 1970 and subsequent years, these gases are probably included. They could not, however, cover more than about 1 per cent of the total

more new pipeline than ever before was completed. (The average completion rate for the gas pipeline system from 1959-65 was 4,200 km a year; in 1966 and 1967 5,600 km and 5,200 km were added.) In spite of the failure to keep to the Seven Year Plan targets, the industry during this period did, in fact, show steady progress, the annual increase in output rising by fairly regular stages from 7.3 milliard cu.m in 1959 to 19 milliard cu.m in 1965. In the 1966 to 1969 period, the rate of growth slowed down to about 12 milliard cu.m a year, however in 1970 the increase in output was 17 milliard cu.m. The 1966-70 Five Year Plan directive called for a production of 225-240 milliard cu.m in 1970, but this was later reduced to 215 milliard cu.m. In 1969, this figure was in turn abandoned and the annual plan target was quoted as 196 milliard cu.m. In fact production in 1970 reached 200 milliard cu.m. Successive forecasts for 1975 production were reduced from an original 380-400 milliard cu.m to 360-380 milliard cu.m and according to the draft 1971-75 Plan stand at 300-320 milliard cu.m; it is, however, quite possible that even this production goal may not be achieved. In a recent statement, Shashin, Minister of the Oil Extracting Industry, quoted a production figure of 620 milliard cu.m for 1980; but there is obviously no certainty - on present performance - that this target will be achieved. There is, however, no lack of gas to be extracted and the Soviet equivalent of proven reserves has increased rapidly from 2,202 milliard cu.m in 1960 to 9,000 milliard cu.m in 1968. About 25 per cent of these deposits lie in the Tyumen region, where output is already rising fast. The uncertainty lies in the rate at which it can be transported and effectively used as the difficulties of the past decade - lack of producing and consuming equipment, shortages of large diameter pipeline (up to (2,500 mm) with matching valves and compressors, lack of storage - may well continue during the seventies.

3. Russian activity in foreign trade with natural gas is still at an early and modest stage.. For some years, gas has been exported to Poland. Between 1965 and 1967 deliveries increased rapidly and reached in the latter year 1 milliard cu.m. Since then they have remained at about that level and will probably continue to do so through 1975, despite increases in Polish indigenous production. More significant is the construction of the "Brotherhood" pipeline, completed in 1967, which made possible the export of gas to Czechoslovakia and, in 1963, to Austria.



USSR: EXPORTS OF NATURAL GAS

	Total quantity (Milliard cu.m)	Starting date of delivery	Initial annual rate (Milliard cu.m)	Standard annual rate (Milliard cu.m)
<u>East Europe</u>				
Poland	n.a.	*	1.0 (current)	1.0
Czecho- slovakia	n.a.	1967	3.0 (current)	5.0
Bulgaria	n.a.	1972	n.a.	5.0
East Germany	n.a.	1972	n.a.	n.a.
Hungary	n.a.	? 1975	n.a.	2.0
<u>Free World</u>				
Austria	32	1968	0.3	1.5
West Germany	55	1973	0.5	3.0
Italy	120	1973	4.0	6.0

\*Poland was the sole importer of Soviet gas between 1946 and 1966. Some of this would have been natural gas, particularly in the later years.

4. In addition to the countries shown in the table, talks have been held, but no agreements yet reached, with Japan, France, Sweden, Denmark and Finland on possible Soviet gas exports. Imports from Afghanistan (already running at roughly 2 milliard cu.m) and Iran, which began in the autumn of 1970, should by 1974 reach some 13-14 milliard cu.m. If plans for delivery of Soviet gas to both Eastern and Western Europe were achieved, the USSR could be a net exporter of some 5-6 milliard cu.m of gas in 1975. However, if the recent Soviet proposal to double imports of Iranian gas by 1975 is accepted, the USSR may well be a net importer of a small volume of gas in that year. By the late 1970s, total exports might reach 25 milliard cu.m, of which perhaps 10 milliard cu.m would be earning hard currency in Free World markets.

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5. Although the need for trunk pipelines to carry the gas from the producing to the consuming areas doubtless determined the level of production in the first stages of exploitation, a further limiting factor in recent years has been the local distribution facilities and the availability of suitable equipment to use the fuel. In 1957, power stations, which could take gas in relatively large quantities at comparatively few installations, accounted for 32.5 per cent of the gas produced. There were complaints that this was not the most sensible use of gas and this proportion declined to 25.3 per cent in 1967. Metallurgy, which has much to gain from the use of gas for some processes, consumed 1.2 per cent in 1957, rising to 11.2 per cent in 1960, and by 1968 was taking 16 per cent of all the gas produced in the USSR. This is expected to level out in the next two years and to stabilise at about 13 per cent. The share of domestic and municipal consumption in which a large number of installations each uses a fairly small amount of gas has for ten years remained static around 12 per cent. For these consumers, gas is as convenient as electricity and does not have the latter's disadvantage of needing the conversion of one form of energy into another; it is here that some expansion at the expense of other sectors of the economy might be expected. That its progress is slow may be attributed to shortcomings in local distribution of the gas and in industries manufacturing the apparatus to burn it. Indeed, it is probably here that the explanation for the disappointing output of the gas industry during the past few years is mainly to be found.

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SOVIET MINOR FUELS - PERFORMANCE AND PROSPECTS

1. This category includes peat, shale, firewood and - at least in theory - such small quantities of geothermal, tidal and even solar energy as may be consumed in isolated electric power plants. No statistics for the last three are available. In the All-Union pattern of energy production, their combined output is negligible and likely to remain so. It is ignored in published energy tables, though in such cases as the single sizeable power station known to operate on tidal power, the output is presumably included in the relevant data on electric power. Peat (other than that used in agriculture), shale and firewood (the latter excluding wood cut under private arrangements) together accounted for 11.7 per cent of total fuel production in 1955 but their aggregate share had fallen to 7.7 per cent in 1960 and was only about 5.6 per cent in 1967. There was, in fact, some increase in the production of peat and shale; the fall in percentage of the total is mainly due to the far larger absolute increase in output of oil, gas and coal. Forecasts for the future production of peat and shale are rare and unreliable, although in both cases the absolute increase is apparently intended to continue, their share in primary energy output should continue to fall. Firewood, which in 1913 supplied over 20 per cent of Russia's primary energy, has in recent years maintained a surprisingly steady output of some 30 million tons of standard fuel. Its survival as a fuel for small-scale power plants and heating installations in rural areas is due to delay in the supply of more advanced forms of energy such as electricity from long-distance power lines, heating oils and bottled gas. When enough of these are available, firewood will presumably disappear from public, as opposed to private, use.

SOVIET ELECTRIC POWER: PERFORMANCE AND PROSPECTS

General

1. Since less than a sixth of the electric power produced in the Soviet Union comes from hydro-electric stations and thus counts as primary energy, the rest figuring as a medium for the delivery and use of energy derived from fuel, this appendix offers no detailed treatment of electric power as a whole. A few points on this subject should, however, be mentioned before dealing briefly with the hydro-electric sector.

Growth

2. The drive towards electrification which has lasted longer and enjoyed more prestige than any other effort in the field of Soviet energy, ensured throughout the 15 years ending in 1965 a much faster growth of electric generating capacity and power output than those of the total production - let alone consumption - of primary energy, and has stayed even further ahead of the growth of total industrial production. In 1970, total capacity reached about 166,000 MW and output totalled 740 milliard kWh. Although the Russians still complain that the thermal efficiency of their power stations is lower than in some Western countries, electrification is still the most efficient means of large-scale energy application and its growth has ensured that an increasing part of the energy supplied to industry is put to relatively efficient use. This is the one redeeming feature in the otherwise depressing Soviet record of fuel waste.

3. The table below shows the rise in capacity and output since 1950:

USSR: ELECTRIC POWER CAPACITY AND OUTPUT

<u>Year</u>	<u>Thermal stations</u>		<u>Hydro stations</u>		<u>Total</u>	
	<u>Capacity</u> ( <u>'000 kW</u> )	<u>Output</u> ( <u>Million kWh</u> )	<u>Capacity</u> ( <u>'000 kW</u> )	<u>Output</u> ( <u>Million kWh</u> )	<u>Capacity</u> ( <u>'000 kW</u> )	<u>Output</u> ( <u>Million kWh</u> )
1950	16,396	78,535	3,218	12,692	19,614	91,226
1960	51,940	241,361	14,781	50,913	66,721	292,274
1965	92,789	425,238	22,244	81,434	115,033	506,672
1966	99,930	452,743	23,077	91,823	123,007	544,566
1967	106,914	499,128	24,813	88,571	131,727	587,699
1968	115,069	534,621	27,035	104,040	142,504	638,661
1969	124,145	573,869	29,645	115,181	153,790	689,050
1970	135,000	620,000	31,000	170,000	166,000	740,000

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During the Five-Year Plan just completed, the Russians reduced the 1970 target for electric power production, from 830-850 milliard kWh to 740 milliard. The goal for installed power capacity also was reduced from an original level of 170-180 million kW to 166 million kW. In 1969 and 1970 12 million kW of new capacity were installed each year, the highest annual amount attained so far, but lower than originally planned. The new Five-Year Plan provides for the installation of 65-67 million kW by the end of 1975, or just under 14 million kW annually. This is much less than the aggregate capacity of 80 million kW, which according to an announcement made one year ago by Neporozhny, the Minister for Power and Electrification, was to be installed by the end of 1975.

Possible reasons for plan reduction

4. The reasons for the failure to keep to schedule since 1965 are not fully clear, but the following are suggested. Firstly, there is no concrete evidence of a shortage of electricity in terms of effective demand. If, as occasionally happens, the Press describe a district as short of electricity, it seems to mean that sooner or later it should be further electrified rather than that it suffers from power cuts or that current is harshly rationed. It may, therefore, be that the economy at large, however reprehensibly, is in no position to use much more power than in fact it does, and will only do so when it has produced and installed more equipment for doing so. This possible explanation is backed by the following additional reasons: failure of manufacturing plants to produce and deliver the necessary equipment and machinery on schedule; and the poor quality of some major items of equipment produced, some being rejected when received at the site and some breaking down after being installed and put into operation. There is also need to perfect the design, simplify the construction and speed up the installation of the larger and larger generators on which the Soviets are increasingly concentrating. The first set of 200 MW only appeared in 1959, but by the end of 1970 there were 83 sets of 200 MW and 70 sets of 300 MW capacity in operation representing 30% of total capacity installed in thermal powerplants. The number of 300 and 500 MW sets installed is steadily growing (10 of 500 MW are on load at the Kransnoyarsk hydro-station alone) and it is hoped during the next ten years to standardise the new large regional thermal stations (GRES) on 500-800 MW sets with a total capacity of 3,000-4,000 MW per station(1). One set of 800 MW has been installed to date, the second such set will be installed in 1971 at the Slovyansk GRES. The Minister has

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(1) We do not suggest that the Russians are alone in preferring such large sets. West Burton in Nottinghamshire has had four 500 MW for more than two years; though all have recently suffered from boiler trouble. They are, however, still uncommon

mentioned 1,200 MW sets as the next step and designing of these is said to be in progress, but by recent showing none is likely to be installed for some years. Long delays are also experienced in the building of the big stations destined to house the generators - partly owing to frequent design changes and partly to the notorious dilatoriness and indecision characteristic of large-scale Soviet construction work. Such projects as the Novodreprovka thermal station (designed for 3,600 MW from three 800 MW and four 300 MW sets), another thermal plant of 4,400 MW to be built on the Syr Darza River, and the Shustenskaya hydro-station of 6,400 MW from ten sets appear likely victims of these delays.

5. Lastly, the elimination of very numerous small and uneconomical stations which the demand for power, regardless of unit costs, had kept on load long after the end of their economically useful life now seems to have begun in earnest. Of the published total of 213,000 power stations of all types in 1965 more than half were of this class. The time they spend on load was less than a quarter of the overall average and together they produced just over 1 per cent of the total power output. Their progressive closure has slowed the growth of capacity and also, fractionally, that of output. Although these trends have slowed the growth of installed capacity and power output, it cannot be shown that they have had any seriously adverse effect on the Soviet economy.

#### Combined heat and power stations

6. This type of station (toploelektricheskaya tsentralnaya stantsiya or TETS) which distributes more energy in the form of steam or hot water than of electricity, is more prominent in the USSR than anywhere else in the world. The electric power capacity of TETS accounts for about a third of the All-Union total for all types of station and nearly 40 per cent of all thermal stations. In addition, they provide a third of all heat energy delivered to all sectors of the economy in the form of steam or hot water, mostly for industry but also the heating of public premises and homes. In 1967, their heat transmission totalled 550 million Gcal and in 1970 reached 730 million Gcal; in terms of coal equivalent the figures respectively amount to 79 million and 104 million tons of fuel. Although much smaller than the largest class of normal condensing thermal stations, none apparently exceeding 600 MW capacity or incorporating sets of more than 100 MW, their efficiency in terms of consumption per unit of electric power produced is well above the average for all thermal

stations, and further TETS are expected to reach 1,000-1,200 MW or half the rated capacity of the largest class of thermal station yet in use. Such district heating schemes are not unknown elsewhere, but it seems possible that only an economy which can dictate the form of heating and the scale of power supply and also the shape and volume of economic activity to match it would greatly favour them. In the USSR, which is proud of them, they will continue to play an important part.

Prospects and priorities

7. The Soviet Ministry of Power and Electrification is now proposing a long-term development plan to extend until 1980. The first stages of this programme will form part of the 1971-75 Five Year Plan, the draft of which has been published, and the later stages will figure in its successor. According to the long-term power plan (see also paragraph 3), progress in output and capacity would appear to be as follows:

<u>Year</u>	<u>Capacity</u> (Million kw)	<u>Estimated output</u> (Thousand million kWh)
1968	142	639
1969	154	689
1970	167	740
1975	232	1,030-1,070
1980	343	1,500-1,600

It will be noted that the output figure for 1975 or any close approach to it would require faster growth rates than those expected of coal or oil. This may call into question the realism of the forecasts, but success in the 1971-75 Five Year Plan period should help to ease the pressure on demand for these two fuels in the economy as a whole.

	<u>1970</u>	<u>1975</u>	<u>Percent increase</u>
Coal (million tons)	624	685-695	10% - 11%
Oil (million tons)	353	480-500	36% - 42%
Power output (milliard kWh)	740	1030-1070	39% - 45%

8. The three main projects which together would account for more than three-quarters of the planned increases in All-Union capacity and output are apparently to be:

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- (a) A group of thermal stations on the Ekibastuz coal basin in north-eastern Kazakhstan using opencast coal. Much of the power output is destined for the Urals and eventually the Moscow region. The coal here is of higher average calorific value than in (b) below and the transmission distances, though formidable, would be less than in (b) or (c). This project, the smallest of the three, is taking precedence over the others. No forecasts of capacity or output are available, but coal data suggest that the capacity might be 15-20 million kW, producing up to about 100,000 million kWh per year by 1980.
- (b) A group of thermal stations in the Kansk-Achinsk brown coal basin in Central Siberia, where extraction costs at the opencast workings are thought to be the cheapest in the whole chain. Capacity here is forecast at 70 million kW, producing some 350,000 million kWh per year. Much of this power is also scheduled for westward transmission, but the distances and technical problems are greater, and development has apparently been postponed until the end of the decade.
- (c) A chain of new hydro stations on the Yenisey and Angara rivers, to include some of 7,000 MW capacity. Including those already complete or under construction, this project provides for 16 stations with a total capacity of 50 million kW to produce an annual 250,000-265,000 million kWh of power, of which two-thirds are to come from plants not yet begun. These plants will eventually be linked to the All-Union grid which will incorporate all existing systems, but to judge from the Press and radio the scheme, unlike (a) and (b) above, is primarily intended to foster the development of Siberia itself rather than to meet the power needs of the Urals and the west. This is the most conjectural of the three main projects and development is unlikely to be seriously under way by 1980 even if this is seriously intended.

9. There will also be various smaller additions to capacity in regions of acute demand, notably in the Moscow region where new coalmines will feed them, some development of nuclear power (discussed in Appendix F).



Transmission of future power supplies from east to west

10. The general problem of conveying energy from the eastern region of surplus to the energy-deficient regions of the west and the part to be played by coal in solving this problem have already been mentioned. The electrical task is to deliver power, by 1980, at an annual rate commonly quoted at 225 milliard kWh. For this purpose, the largest possible size of generator is favoured, and here the Soviet designers have set no limit to the economy of scale at which they aim. The two 800 MW sets, one installed and the other to be in 1971, may lead them to adopt this size, at least for the first of the projected stations, although one of 1,000 MW is already in course of design and mention has been made of the first 1,200 MW site as due to come into operation at some unspecified time during the next decade. The main problem, however, is not the optimum size of generating sets but long-distance transmission, for existing 500 kV AC lines have been ruled out as inadequate for carrying such loads from the Siberian and Kazakh coalfields to the main European grid. The experts are now collecting data from experimental lines of higher voltage - one of 750 kV AC from Konakovo to Kashira and one of 800 kV DC from Volgograd to the Donbass, the latter now being adopted and under construction to supply Ekibustuz power to the Moscow region. Some of the TESTS seem to be based on a requirement of 2,500 km and 1,500 kV (DC), though as early as 1966 a 3,000 km line capable of carrying 6,000 kW per single string was advocated as the best means of bringing Siberian power to Central Russia. The writer added that the "Energeset proyekt" Institute had "already evolved all the data for such a project" and went on to anticipate voltages as high as 2,000-2,200 kV for this purpose in the more distant future. Another expert suggests 2,400 kV as the minimum requirement for integrating the remoter power sources into an All-Union grid. Construction of the power stations and development of the already chosen coalfields await the success of these researches. The greater part of the output of the projected thermal stations - though perhaps not of the hydro-electric - would then flow westwards, but plenty would remain for consumption nearer at hand.

Hydro-electric power

11. Hydro-electric stations produced 120 milliard kWh of power in 1970 or 16.2 per cent of total electric power output. In terms of coal equivalent, this was only about 1 per cent of the total production of primary energy. At the end of that year, hydro-electric capacity stood at 31 million kW or about 19 per cent of the total. An article published in August 1968 stated that 35 hydro stations

aggregating 31 million kW were under construction. The enormous hydro stations latterly built or partly built in the Soviet Union, however, take even longer to complete than the thermal stations, and much of the projected new capacity will be uncompleted in five years' time. The Russians apparently intend the share of hydro-electric power, both in output and capacity, to remain much the same in 1975 as in 1969. In view of the remoteness of the main reserves of water power, however, even this seems unlikely to be attainable.

12. The Russians have estimated their total resources of hydro-electric power as follows:

<u>Area</u>	<u>Technological potential</u> (Milliard kWh)	<u>Percentage utilised</u> <u>in 1967</u>
European USSR (including Urals)	354.9	14.9
of which Centre	64.6	32.4
North-West	54.9	19.7
North Caucasus	53.4	4.1
Trans-Caucasus	92.5	5.1
Other (largely Ukraine and Urals)*	89.5	16.0
Eastern Region	1,751.2	2.1
of which Siberia	756.5	3.4
Central Asia	248.7	2.2
Other (mainly Soviet Far East)*	746.0	0.8
Total USSR	2,106.1	4.2**

\* These "Other" figures are omitted from the Soviet table, and are residuals.

\*\* The utilisation figure of 4.2 per cent in 1967, when applied to the total potential, agrees with the published figure of 88,571 milliard kWh of hydro-electric power produced in that year.

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13. The table shows that utilisation is much higher in the west (except for the Caucasus) than in the east, and the Russians have indicated that in the present and immediately foreseeable state of technology - notably that of large low pressure water turbines - hydro-electric development in European Russia proper is approaching its limit. Nevertheless a number of pump-storage hydro power plants are being planned in this area to meet peak periods of power demands. Prospects in the east are more obscure. Siberia already has in Krasnoyarsk (5,000 MW) and Bratsk (4,100 MW) the largest hydro stations in the world. Capacities at Krasnoyarsk, Sayan and Ust Ilim, when complete, have been indicated as 6,000, 6,500 and 4,320 MW respectively; each will include sets of 500 MW or more (Krasnoyarsk has ten of this size in operation). All three have been under construction for many years and may take several more to complete. The building of a chain of 5,000-7,000 MW stations on the middle and lower Yenisey has for long been mooted and now figures in power plans extending up to 1980, the existing large Siberian stations are in general somewhat under-utilised and short of power outlets; the future growth of Siberian power demand, though possibly rapid, may never justify the huge scheme; and the only known projects for transmitting power from Siberia to the Urals and Europe are confined to coal-based stations. The utilisation rate for the vast Siberian potential will probably remain very low for many years and possibly for ever.

14. In the Soviet Far East, which in proportion to its area is apparently credited with greater hydro resources than Siberia, development has hardly begun. These resources are mainly centred on the Amur and its tributaries. Previous hopes for their exploitation have depended on wide-ranging economic agreements with China or Japan which have not yet materialised; whether the Russians will proceed alone with major hydro-electric schemes in this little-developed and thinly-populated region remains uncertain. Neither here nor in Central Asia is there any talk of projects comparable with those of Siberia or Soviet Europe, or of major power deliveries to the rest of the USSR.

SOVIET NUCLEAR ENERGY - PERFORMANCE AND PROSPECTS(1)

1. With her vast reserves of conventional fuels and her extensive hydro-electric potential, there has been no compelling need for the Soviet Union to concentrate on the rapid development of nuclear-fuelled power stations. The latter are able to compete economically with the conventionally fuelled stations only for the largest power stations, and for the present and immediate future it is the intention of the Soviet Ministry of Power to build nuclear power stations only in those areas of the country where there is a serious energy shortage, i.e. the area west of the Urals loosely termed "European" Russia, and in parts of the Arctic north and other relatively inaccessible areas, where nuclear power has a built-in advantage because of the difficulties in transporting conventional fuels.

2. Throughout the USSR there are ten nuclear reactors and associated generating plants of 50 MW(e), or over, in actual operation. There are 4 separate power stations with capacities of this magnitude. Power reactors located in Siberia are all at the same location and are referred to by the Soviets as one nuclear power station. These were built primarily to produce plutonium and their electricity output is secondary to this function. Recent information on plans indicates that installed capacity at nuclear power stations is to increase from the present level of 2,000 MW(e) to about 2,640 MW(e) in 1972. This would include the addition of 440 MW at Novocronezh, 150 MW at Shevchenko and 48 MW at Bilibine. During 1971-75, 6-8 million KW of capacity are to be put into operation at nuclear power stations. It is not expected that the proportion of nuclear capacity of the total supply of energy in the decade 1970-80 will substantially increase.

3. From 1980 onwards, the Russians expect nuclear power to play an increasingly important part in the Soviet economy with the development of the fast breeder reactor. A small experimental station based on this type of reactor went into operation at the end of December 1968, and two larger prototypes are under construction. If the design lives up to its promise, the fast breeder station should generate electricity demonstrably cheaper than a conventionally powered station in most areas of the USSR, and this would undoubtedly provide the breakthrough which could stimulate a widespread construction programme from 1980, or even somewhat earlier, onwards.

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(1) This Appendix discusses nuclear energy largely in the context of electric power stations, the area in which the "peaceful uses" of atomic energy have been most developed.

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4. So far, the development in the Soviet Union of the peaceful uses of nuclear energy has been largely directed towards the production of electric power. Work has gone beyond the experimental stage in two further applications - radio-isotopes and ship propulsion. In the latter case, however, nuclear energy is too expensive for general commercial use, and is still confined to almost wholly military application in the submarine and to ice-breakers. One of the two prototype fast breeder reactors, at Shevchenko on the Caspian coast, will also provide heat for a number of experimental water desalination equipments. Finally, in the same manner as the conventional Soviet TETS, a nuclear station can be designed to distribute heat as well as electricity, and this aspect has not been neglected by the Russians.

SOVIET UNION: SUPPLY OF ENERGY FROM AREAS OF  
SURPLUS TO AREAS OF DEFICIENCY

1. The transfer of energy from regions of surplus to those of deficit is one of the main elements in Soviet energy policy. In this Appendix we examine the transfers now in progress and those planned up to 1980. The programme is primarily designed to supply the northern two-thirds of European Russia, which accounts for most of the whole country's demand, and secondarily the Urals, the former of which is short of all three of the major fuels and the latter of coking coal and gas

2. The Ukraine and the Northern Caucasus still make good most of the deficiency of the European north and west. The Donbass (including Rostov Oblast) produces some 200 million tons of coal, about a third of the All-Union total; the Eastern Ukraine - notably the Shebelinka field - together with Krasnodar Kray and Stavropol Oblast, produces more than half of the total for gas. Much of the coal goes northwards by rail and water. The gas is piped largely to the ring pipeline encircling Moscow but also to Belorussia and the Baltic republics. The multiple line running from Rostov and Shebelinka to the Moscow Ring includes the earliest long-distance high-capacity gas pipeline laid anywhere outside the United States, and much of the first 40-inch pipe laid anywhere in the world forms part of the system. There is already a fairly well-developed gas grid covering most Soviet territory west of the Urals and the first lines connecting it with the gas deposits of Central Asia have now been laid. As regards oil, the Ukraine, though it now produces about as much as Rumania and hopes for 40 million tons in 1980, is itself a deficit area, whereas the regions producing oil and gas to the north and south of the Caucasus have little coal. This pattern leaves ample supplies of coal and gas for despatch to northern and western Russia but hardly any oil. The northward flow of coal will continue, though whether by 1980 its total volume will be more or less than at present is not clear. Since the Donbass should then be providing half the supply of the coking grades for the whole country, which should then be 65 per cent above the 1968 level, the despatches of coking coal will increase and will continue to cover most of the demand in the deficient northern region. Presumably those of other European coals will fall in response to competition from other fuels. The arrangements for gas are well on the way to completion and no great expansion of the flow from south to north is likely in the next few years.

3. The Volga and Urals region together account for two-thirds of the Soviet oil output; the volume of production is still, though rather slowly, increasing, but its share of the total has begun to fall and this will continue. These two provide nearly all the oil consumed in western and north-western Russia (mostly piped in as crude) and the Pechora Basin (on the Arctic immediately north of the Urals) provides a little of the coking coal. The eventual flow of oil from Volga-Urals to the centre and north-west will continue and should increase, but here again no rapid development is expected. The same applies on a much smaller scale to Pechora coal. Apart from oil, however, the economy of the Urals is coming to rely on energy resources lying further south and east.

4. Soviet writers claim that the eastern regions, by which they mean all territory to the east of the Urals as well as Central Asia and Kazakhstan, contain nine-tenths of their country's energy reserves. It is impossible to verify this generalisation in detail, but many of the claims made for individual deposits (such as the allegedly vast unexploited coalfields of Yakutia) suggest that they may not overstate the truth. For many years the westward flow of energy from these regions consisted almost entirely of coal - mostly coking coal from the Kuznetsk Basin - but it also included a very little oil from Kazakh and Turkmenian fields. It now includes a large and fast increasing volume of gas. In 1963 the first of two 40-inch pipelines began delivering Uzbek gas to the Urals, a second followed two years later and a third, running due south to link with the first two, brought gas from north-western Siberia. These three lines are now supplying the Urals with gas at somewhere near their optimum rate of 25-30 milliard cubic metres a year. Early in 1967 plans for a new two-branch system incorporating much larger pipe were published - the number of lines depending on the size used - for delivering gas from other and somewhat remoter fields in north-west Siberia to the southern Urals and also to European Russia. Work on the first string of the so-called Urals branch was begun, according to the plan, this branch should in 1980 feed in another 45 milliard cubic metres. However, it is not fully clear that the Urals will need to bring in so much gas as this from a distance, for the Russians have announced the discovery of a large gas deposit in Orenburg Oblast, which is itself in the southern Urals. If this is exploited for local use, the increased deliveries expected in this region from Siberia may perhaps be retarded, diverted or curtailed.

5. By 1966, significant production in the new oilfields of Tyumen Oblast in north-western Siberia and the Mangyshlak Peninsula on the Caspian coast of Kazakhstan had begun. The Tyumen fields have already made a start towards relieving Siberia of its hitherto complete dependence on Urals oil, and Mangyshlak has begun to do the same for the huge territory of Kazakhstan; both, however, are expected, and are preparing, to send much of their output to European Russia. The flow of crude oil and oil products from Bashkiria eastwards along the existing multiple pipeline system - and also by the railway - across Siberia should soon be halted and by 1980 reversed. A large pipeline to take Mangyshlak crude northward to Guryev and thence to Kuybishev and beyond is now completed and another one is to be laid. Work on a far larger scheme to pipe Tyumen oil across the northern Urals to the European north-west, with a westerly extension to parallel the existing Friendship pipeline to serve Eastern Europe, is due to start in 1971. (As mentioned above, much of the original Friendship system is now being duplicated.) One other giant oil pipeline project is under study, and may take shape during the 1970s; this appears to consist of one or more 40 or 48-inch lines, again from the Tyumen fields, to run south-eastwards across Siberia - probably collecting more oil from the still unexploited deposits of the upper Lena - to reach the Pacific at Nakhodka. We do not yet know whether this project will be incorporated in the coming Five Year Plan for it looks hard to justify unless Japan were to accept several times her current import of Soviet crude, and this in turn might involve increasing the total export supplies. With Japanese help, this could probably be done if the terms were sufficiently attractive, but we doubt whether the Russians will decide on this scheme before 1975. In the meantime, Siberia's oil surplus will flow to the west.

6. European Russia has also begun to receive gas from the east, as yet only from Uzbekistan. Apart from the slow extension of piped supplies within this republic, to its neighbours in Soviet Central Asia and to the Urals, two very large gas lines from the Uzbek fields are being laid on a north-westerly track. One of these already connects with the gas grid of European Russia, and soon after 1970 both should reach Moscow and later extend still further north and west. Larger parallel lines will be added during the 1970s to take up to 80 milliard cubic metres a year; this would amount to nearly 100 million tons of coal equivalent, or nearly three times the optimum delivery rate of the pair now carrying Uzbek gas to the Urals. But there remains the largest of all these



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gas schemes, once again based on north-west Siberia. This is the larger, or Northern Lights "branch", of the double project already mentioned whose smaller component will serve the southern Urals. Its tracé will extend from the great gas deposits of northern Tyumen Oblast and pass north of Moscow to the northern and western parts of European Russia where it will link with those already delivering gas from the Ukraine. Work on the middle stretches of one 48-inch line is now proceeding but there seems to be some doubt as to the number and diameter of its future parallels, each partly depending on the other. In the final stage, intended to be complete by 1980, it is hoped to use pipe of 2.5 metres (96-inch) diameter and trial production of this size has now started.

(Presumably this huge pipe will operate at low pressure and contribute to storage besides delivery.) Planned yearly deliveries by way of this system to Europe (excluding the Urals) are quoted as 85 milliard cubic metres by 1980. If all the capacity of the lines intended to be laid by 1980 from the eastern to the western regions were used at optimum rates, gas would account for more than half the total east-west transfer of energy envisaged for that year. In spite of the very healthy state of proved gas reserves in the USSR, there may well be some overlapping in the plans for these projects and some lag in their execution, but in any event the share of gas should not be less than a third.

7. Meanwhile, the westward despatch of coal from the Kuzbass continues. The Russians expect coal output east of the Urals to rise from 277 million tons in 1965 to 580 million in 1980, but coking coal will comprise less than 100 million tons of the latter figure, and, though some of this will almost certainly travel westward, the volume will be much less than that going north from the Donbass. Much will be consumed by eastern industry and little, if any, coal of other grades would be worth the cost in long-distance rail transport. (This question is further discussed in the following paragraphs.) Finally, no coal of any kind from the relatively small and scattered deposits is very likely to leave these regions except for small exports from the nearest Far Eastern fields to Japan. We need, therefore, expect no great increase, and very possibly a decrease, in the westward transport of coal from the eastern regions.

8. A Soviet expert has estimated that oil and gas would cover about 70 per cent of the future increase in fuel consumption in the European part of the USSR (here he seems to include the Urals) and it is clear from this and much other material that most of the balance is expected to come from coal, mainly by way of coal-fired power stations. All available studies agree that opencast brown coal from the Kansk-Achinsk Basin in Central Siberia and the Ekibastuz Basin in northern Kazakhstan have by to the lowest extraction costs and that they should be used for fuel thermal power stations sited on or near coalfields themselves. This would involve DC

transmission at voltages and over distances not yet approached anywhere in the world. So far as is known the research carried out on experimental power lines, though promising, has not yet conclusively proved the feasibility of the project. Sensibly enough, however, the Russians seem here as elsewhere to be planning well ahead of current technical capability, for to do otherwise would court the risk of stultifying technical progress. We have little doubt that within the next ten years or so, these remote coalfields - remoter than any other among the leading coalfields in the country - will be contributing a substantial amount of power to the Urals if not beyond.

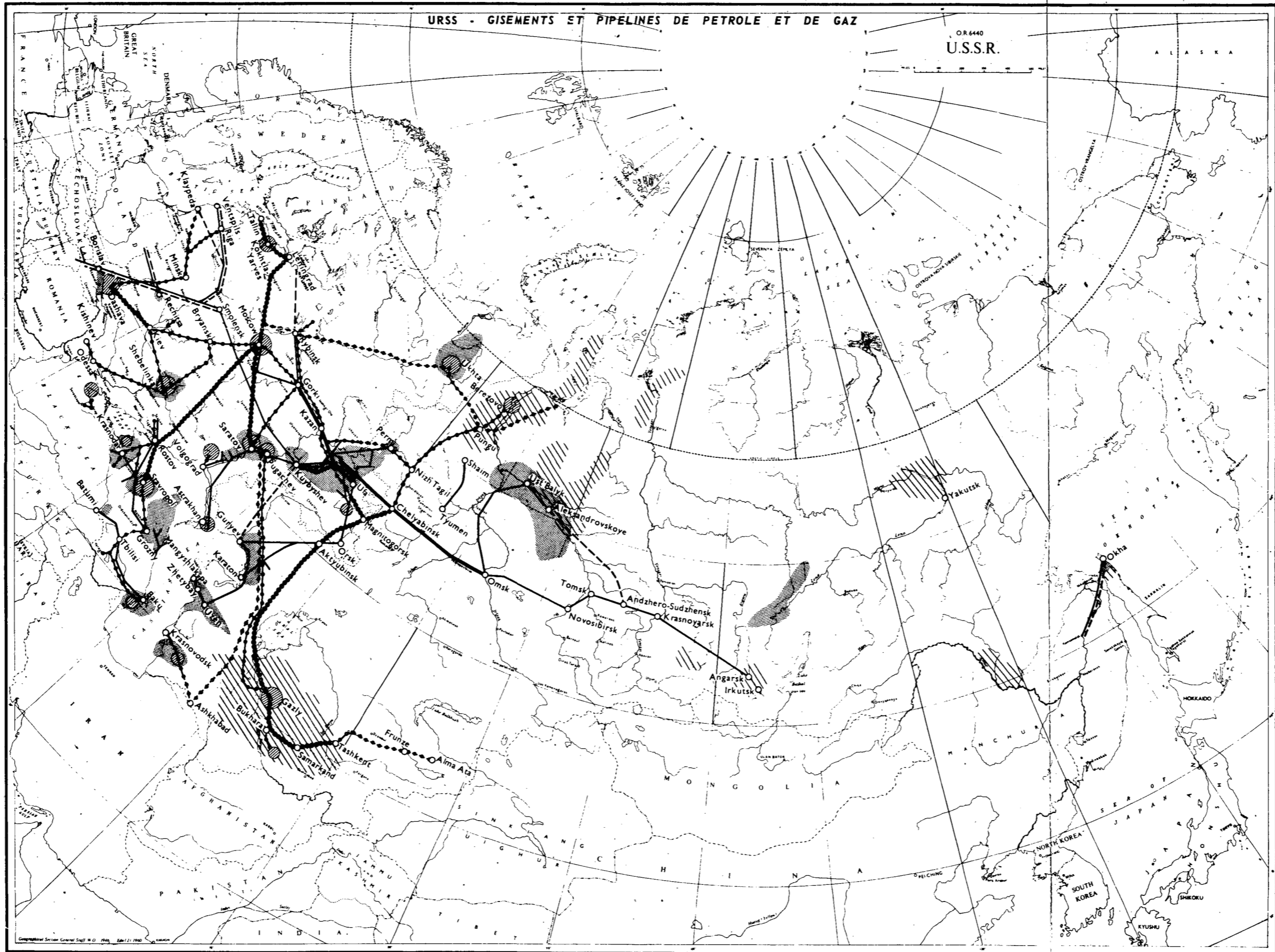
9. More doubt rests on the scale of these future power transmissions than on their ultimate feasibility. As indicated above under "Coal", their scale will appreciably affect not only the volume of future coal output but also the degree of future dependence on other fuels and hence, probably, the volume of oil and gas available for export. One Soviet study assumes a power delivery of 225.2 milliard kWh per year to the deficiency areas; this might amount to 15 per cent of All-Union power output in 1975 and 10 per cent in 1980; we estimate that this power would absorb about four-fifths of the output forecast for 1980 from the Kansk-Achinsk and Ekibastuz Basins which are the favoured sources of coal. This seems reasonable, but it does suggest that if the transmission problems are mastered the coal output from these basins might be still further increased. It is, however, unlikely that a firm target has yet been fixed. Much here will depend on the success of the long-distance transmission experiments and on the speed at which such transmission is achieved. Only in the event of failure or undue delay are the Russians likely to turn to alternative patterns for the distribution of coal or to give much greater emphasis to nuclear power.

10. In 1965, according to a recent Soviet estimate, the westward export of energy from the eastern region to European Russia and the Urals amounted to 70 million tons of coal equivalent - still mainly coal but with a rapidly rising proportion of gas. (The net flow was, however, far smaller, for at that time no oil was produced between the Urals and Sakhalin, and the whole of Siberia, though not Central Asia or Kazakhstan, was still dependent on Urals oil.) The writer, Academician Melnikov, goes on to recommend that the total energy to be transferred should rise to 117 million tons of coal equivalent in 1970, 330 million tons in 1975 and up to 470 million tons in 1980. Melnikov's is the only available text which gives overall figures for a process on the necessity of which all the Soviet experts appear to agree. As early as 1964, Kosygin warned the nation of an impending energy shortage in the main consuming areas unless active steps were taken. The measures discussed above should go far to avert this danger.

# U.S.S.R. — OIL AND GAS DEPOSITS AND PIPELINES

URSS - GISEMENTS ET PIPELINES DE PETROLE ET DE GAZ

OR 6440  
U.S.S.R.



CRUDE OIL  
PIPELINES  
PIPELINES DE  
PETROLE BRUT

Multiple - Multiple  
Single - Simple  
Under construction  
or planned  
En construction  
ou en projet

NATURAL  
GAS  
PIPELINES  
PIPELINES DE  
GAZ NATUREL

Multiple - Multiple  
Single - Simple  
Under construction  
or planned  
En construction  
ou en projet

GASFIELDS  
GISEMENTS  
DE GAZ

ACTIVE - EN ACTIVITE  
PARTLY PROSPECTED  
DEPOSITS  
PARTIELLEMENT  
PROSPECTES

OIL DEPOSITS  
GISEMENTS  
DE PETROLE

Compiled and Drawn by D.I.S. June 1970

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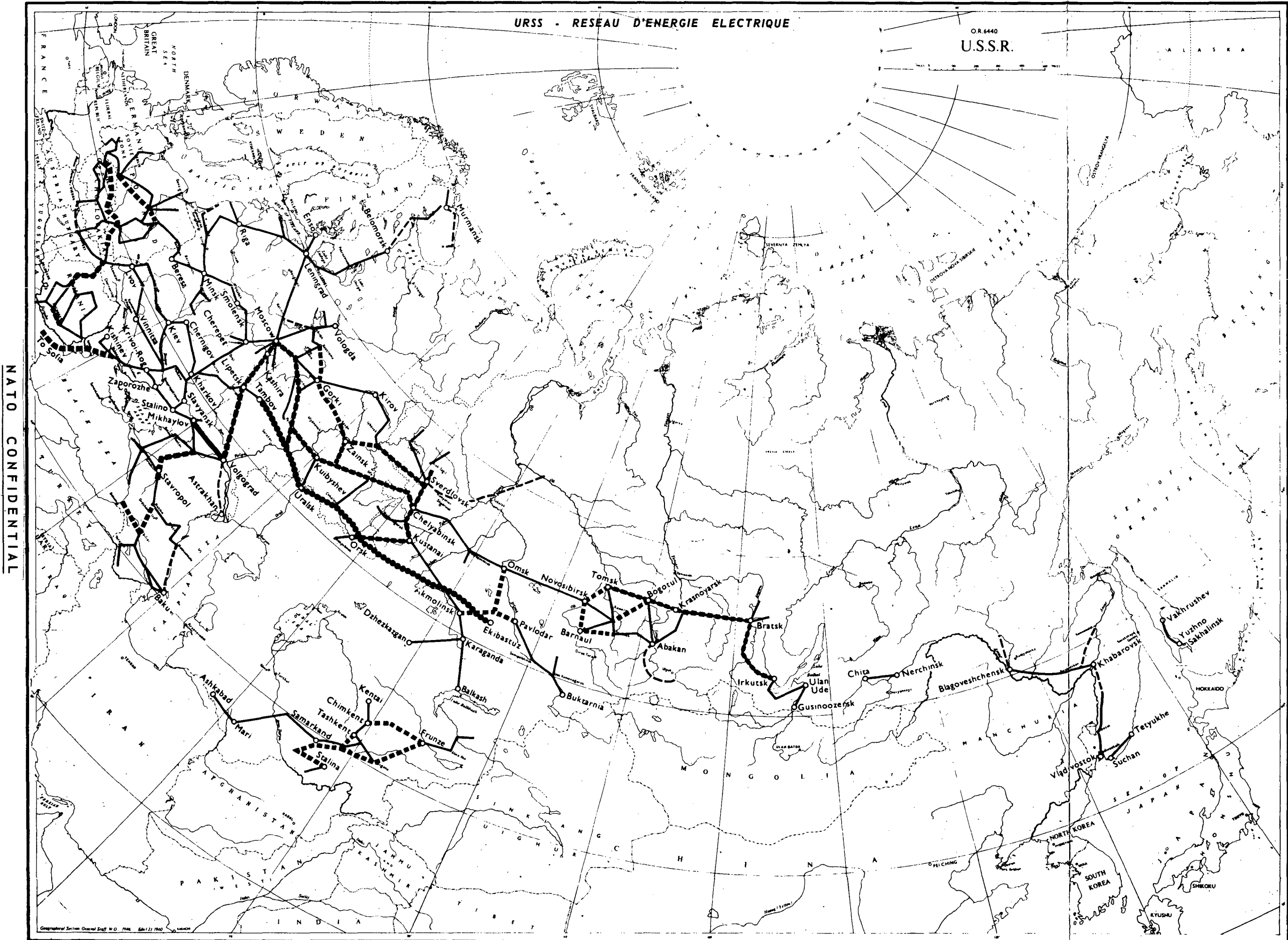
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Attachment 1 to  
CM(71)5

# U.S.S.R. - ELECTRIC POWER GRID

URSS - RESEAU D'ENERGIE ELECTRIQUE

OR 6440  
U.S.S.R.



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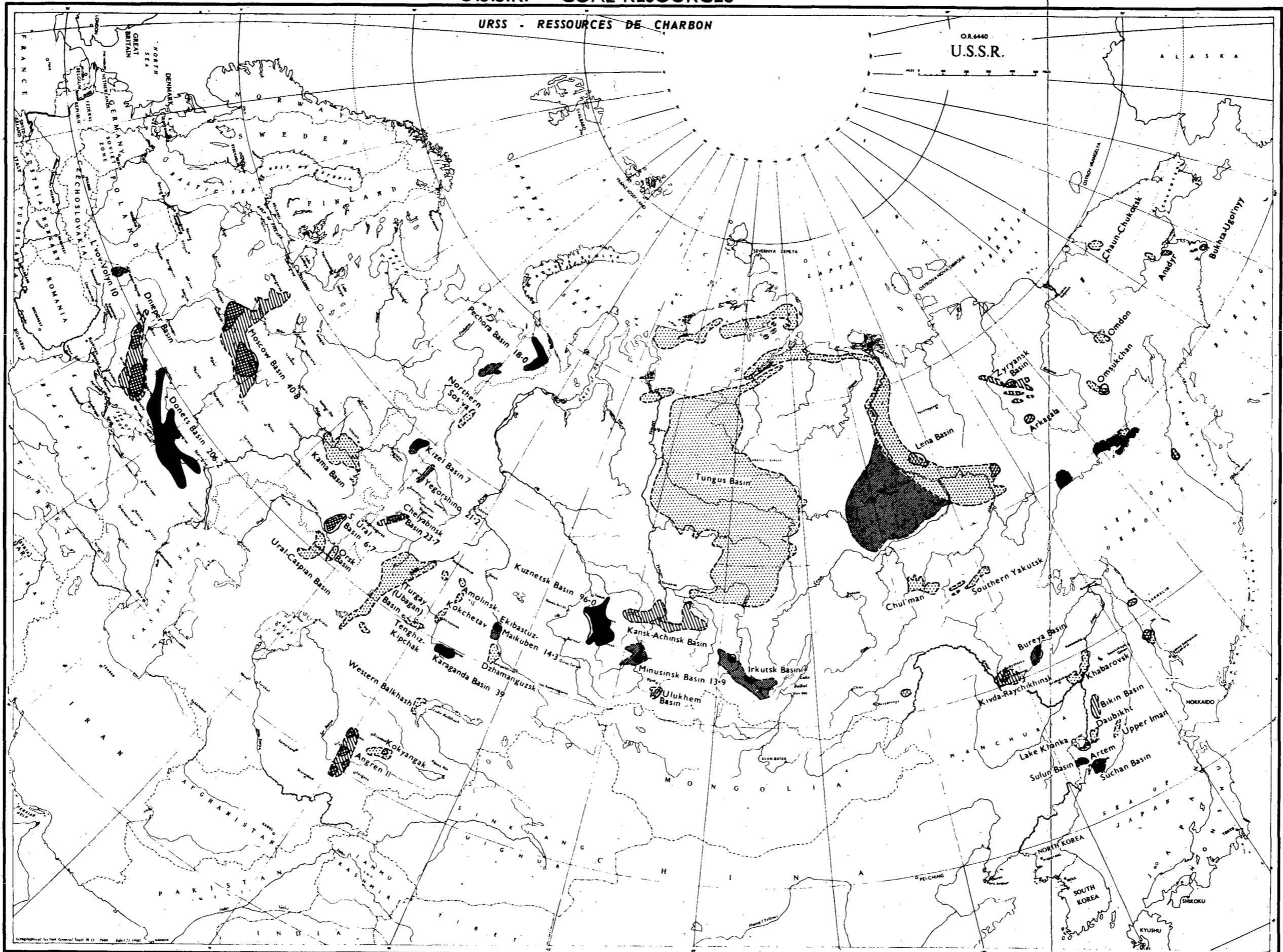
Compiled and Drawn by D.I.S. June 1970

- |                                                                     |                                                                     |                                                                     |
|---------------------------------------------------------------------|---------------------------------------------------------------------|---------------------------------------------------------------------|
| <b>220-330 kV lines - Lignes de 220-330 kV</b>                      | <b>400-500 kV lines - Lignes de 400-500 kV</b>                      | <b>800-1500 kV lines - Lignes de 800-1500 kV</b>                    |
| — Completed - Achevées                                              | — Completed - Achevées                                              | — Completed - Achevées                                              |
| - - - Under construction or planned<br>En construction ou en projet | ■ ■ ■ Under construction or planned<br>En construction ou en projet | ● ● ● Under construction or planned<br>En construction ou en projet |

# U.S.S.R. — COAL RESOURCES

URSS - RESSOURCES DE CHARBON

O.R. 6440  
U.S.S.R.



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**BASINS - BASSINS**

- Predominantly hard coal (anthracite or bituminous)  
*Surtout houille (anthracite et charbons bitumineux)*
- Predominantly lignite - *Surtout lignite*
- Hard coal and/or lignite - *Houille et/ou lignite*

**Producing area**

- Zone de production

Figures give 1965 production in million tons.

Other East Siberian fields: 32.5  
Other Kazakhstan and Central Asia fields: 40.2  
Far East fields: 25.8

*Chiffres de la production de 1965 en millions de tonnes.*

*Autres charbonnages de Sibérie orientale : 32,5*  
*Autres charbonnages du Kazakhstan et d'Asie centrale : 40,2*  
*Charbonnages d'Extrême-Orient : 25,8*