RESOURCES for FREEDOM

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A Report to the President by

THE PRESIDENT'S MATERIALS POLICY COMMISSION

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Background Information

Chapter 22 Projection of 1975 Materials Demand*

Part I. U. S. Materials Demand

As THE POPULATION of the United States grows and as the productivity of labor increases, the United States will produce an increasing flow of goods and services and in doing so will use up increasing quantities of materials. Any policy designed to guide us in the future must recognize this fact.

But policies must depend not only on recognition of such growth but also on its prospective magnitude. Will the Nation's needs for steel, or copper, or oil increase by 50 percent in the next generation or by 250 percent? Will mineral reserves, at prospective rates of consumption and discovery, last for 25 or for 100 years? Clearly, different policies may be appropriate for different rates of growth.

The choice of policy depends, however, on the broad order of magnitude of the prospective growth rather than on the precise amount. For few if any of the materials under review would the appropriate policy be different if the materials demand of a generation hence should be 100 percent larger rather than 50 percent larger than at present. For example, if our resources would last 29 years at the lower of these two growth rates, they would last but 25 years at the higher rate; if they would last 11 years at the lower rate, they would last 10 years at the higher rate.

Indeed, serious difficulties would arise if much more precision than this were vital to correct policy judgment. The forces that govern economic growth and development are themselves not regular enough to enable us to allege that a 60-percent growth is likely while a 75-percent growth is not. Accordingly, the projections of materials requirements presented below do not purport to be predictions but only indicators of the size of the problems the United States is likely to face.

WORKING POPULATION AND PRODUCTIVITY

The continued operation of the traditional free-market economy of the United States at high levels of employment is assumed for the long-term future—both because it is an avowed objective of national policy and because, even in the absence of such a policy objective, we would want to provide a flow of materials certain to be great enough to support economic growth. A defense program continuously adequate to meet any external threat is taken into account. It is also assumed that no all-out war will occur during the next generation, not because all-out war is unlikely but because the nature and extent of the materials problems following in the wake of such a conflict cannot be foreseen. Needs are accordingly projected on the basis of peace and prosperity in the constant shadow of war.

THE LABOR FORCE IN 1975

The Bureau of the Census estimates that in 1975 there might be about 146 million people 14 years of age and over in the United States. Some reduction of birth rates from recent peaks is assumed, but, owing to the small proportion in the total 1975 labor force of people as yet unborn, the estimate would not be changed by more than 10 percent even if very high birth rates were to continue. Historically, the labor force, except for wartime emergencies, has constituted a remarkably stable fraction of around 56 percent of the population 14 years of age and over. Applying this percentage to the Census estimate, the 1975 labor force would be 82 million persons. Of this total we assume that 4 million will be in the armed forces, 7½ million employed in agriculture, and 2½ milion (about 3 percent) unemployed.

THE GROSS NATIONAL PRODUCT

The number of hours per worker is expected to be reduced by about 15 percent, while product per man-hour is expected to rise at about 2½ percent per year. The assumed rise in man-hour productivity is somewhat in excess of the historical average rate of increase of 2.1 percent per year, but continued high employment, together with a rate of increase of capital per worker somewhat in excess of that which prevailed in the past quarter century, should make such growth feasible. Much of the increase of output of the past 25 years was actually achieved in the 15 years 1935–50 in spite of the fact that the needs of the greatest war in history were in competition with the demand for producers' equipment.

The joint result of the projected changes in the working

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to produce them, or how much they will add to the future demand for any material. They may even, by substituting for old products, reduce the drains on some materials, but again there is no basis for determining which materials will be thus affected nor by how much.

ALLOWANCE FOR TECHNOLOGIC CHANGES

Wherever possible, allowance has been made for technological changes that are likely to be effected under recent price relationships. If, as with sulfur used for petroleum refining, the plants currently being built use less of a material than the average of plants now in operation, it is assumed that the plants to be built over the next 25 years will also use less. Likewise, where the virtual elimination of a material from one of its current uses appears to be clearly in progress (as in the case of tin for collapsible tubes), the future requirement arising out of that use is either eliminated or reduced.

PROJECTING MAJOR AGGREGATES AND END-USES

If no changes were envisaged in the composition of the goods and services that together make up the gross national product, the projected increase of 100 percent in gross national product would imply an increase of 100 percent in all materials requirements. However, the composition of gross national product will surely change in the next 25 years. The long-term tendencies of growth and development are: (*a*) to increase the incidence of services in the expenditures of consumers, and (*b*) to increase the extent of fabrication that materials undergo before they find their way into final products. The first of these tendencies is somewhat obscured in available statistics, which show a decline in the ratio of expenditure for services to total consumer expenditures, from about 38 percent in 1925 to about 31 percent in 1950. The 1950 figures have been widely recognized as being low because of the influence of rent control in keeping the allowance for housing services below the prewar proportion. In addition, the definition of services used in compiling the statistics does not include the service components in food and other expenditures; these components have expanded in the past relative to total consumer expenditures and will probably continue to expand in the future.

These tendencies toward increased fabrication and increased expenditures for services lead to the presumption that the need for materials will increase somewhat less than in proportion to gross national product. An additional and more forceful argument can be presented with respect to those materials, particularly metals, that are used largely in the making of durable goods. Demand for these materials may be expected to move substantially in proportion to the durable goods components of the gross national product. These particular components were at unusually high levels in 1950, but 1975 (which, to repeat, should be considered as a typical year in its decade) cannot be expected to be influenced by features peculiar to the 1950 postwar period.

The arguments supporting this proposition, on which are based many of the projections in this study, are given in the following pages first in general terms and then are expanded and illustrated by specific examples. Over the 25-year period that began in 1925, durable goods as a whole (gross private domestic investment plus personal consumption expenditures on durable goods) averaged 18 percent of the gross national product; in 1950 these components constituted 27 percent of the gross national product.* Thus an increase of only a third in the absolute amounts of these components would succeed in restoring the average past ratio if, as we have assumed, gross national product is to double between 1950 and 1975.

PLANT AND EQUIPMENT EXPENDITURES

The components that most directly and strongly influence the growth of gross national product are producers' expenditures on plant and durable equipment. These items provide the capital base on which industrial production may expand. Depending on whether the war years are included or excluded, the producers' durables part of this base averaged, in the quarter century prior to 1950, between 5.6 and 6.3 percent of the gross national product. In 1950 it was 9.5 percent of gross national product. An increase of less than a third above the 1950 level of these components, together with the projected doubling of gross national product, would restore by 1975 the same relationship between producers' durables expenditures and gross national product as helped to double gross national product in the past generation.

Because the labor force is not expected to increase quite as rapidly in the next 25 years as it did in the past, somewhat more rapid growth of cooperating capital must be allowed in order to yield the same percentage increase in the total product. The producers' durables component is therefore projected as constituting about 7 percent of gross national product in 1975, as opposed to its somewhat lower past average figure. The projected rise in this component from 1950 to 1975 is thus about 50 percent.

Private nonresidential construction averaged, over the past 25 years, between 2.2 and 2.5 percent of gross national product, measured in constant prices. In 1950 it constituted almost 3 percent of gross national product. An increase of from one-half to two-thirds over the 1950 level would be sufficient to restore the average past relationship to the doubled gross national product projected for 1975. This component of the gross national product is projected as increasing by 50 percent in the next 25 years, the projection being based on the predominance of producers' plant construction in this category, and on the relation between the number of workers and plant space needed. Although the ratio of plant space to workers employed need not remain constant as techniques of production change, there is considerable stability in these techniques. The projection takes into account the fact that space is also required by the machines and tools, the numbers of which are expected to grow more rapidly than the labor force.

RESIDENTIAL CONSTRUCTION

Residential construction is most closely related to the number of individual households. For 1975, 62½ million individual households are estimated, and it is assumed that there will be a dwelling unit for each household. Of these dwelling units an estimated 500,000 to 600,000 will have to be replaced in 1975,

*Except as otherwise noted figures for gross national product and its components are taken from the *Economic Report of the President*, July 1951.

consumer expenditures and durable goods expenditures imply that 11.8 percent of the money that consumers spend will go to buy durables. This is only a little above the average that consumers allocated to durable goods over the past 25 years, so that they need only retain the average past pattern of expenditure on other things in order to yield sufficient demand for the total of goods and services that we believe may be produced in 1975.

Of course, there may be reallocations within the nondurable categories, with services possibly gaining at the expense of food and clothing. But it is well to recall here that expenditures for food and clothing are not as unresponsive to changes in income as one might suppose. It is true that the amount of food and clothing consumed is determined largely by the total population and does not increase much as the average man gets richer. But it is wrong to move from this belief to the assertion that as the average man gets richer he spends no more money than before on food and clothing. What is more likely to occur is a shift from lower quality to higher quality food and clothing, as indicated by the fact that the percentage of consumer spending allocated to food and clothing actually increased in the last generation.

Readers must interpret with care the picture that emerges from the above analysis of an increase in aggregate durable goods requirements of 50 percent or less in the coming generation. In particular, the conclusion should not be drawn that there is a basic, long-term tendency for durable goods demand to increase at only half the rate at which the gross national product expands. The main reasons why there is expected to be a relatively slow growth in durable goods demand between 1950 and 1975 are to be found much more in the peculiarities of 1950 than in any such long-term tendency.

THE ABNORMAL DURABLE-GOODS PRODUCTION OF 1950

The fundamental economic function of durable-goods production is twofold: to replace worn-out items and to expand the total stock in a fashion consistent with the pattern of growth of the over-all economy. In 1950, and in fact in all postwar years, durable goods production performed even more. Since the war there has been a race on the part of durable goods production to meet the needs that it perforce failed to meet during the war years and to help the stock of durable goods to catch up with the wartime and postwar growth of the economy as a whole. Automobiles constitute the most striking example. If merely the fundamental long-term function of automobile production had been fulfilled, say in 1949 and 1950, the increase in the stock of cars would have been largely dependent upon the increases in population and disposable income. Yet more cars were added in 1949 and 1950 (over 7 million) than people were added to the population, and for this net increase there was probably spent more than the 15 billion dollars (at 1950 prices) by which disposable income, in 1949 and 1950 together, exceeded the annual rate of 188.6 billion dollars that prevailed in 1948.

Two further examples may be offered. If residential construction were to increase along with gross national product, there would be produced between 1950 and 1975 almost 50 million dwelling units, and there would be added in 1975 a new unit not for every 25-year-old married couple but for 80 percent of all 25-year-old persons. If the output of television sets were in increase in proportion to gross national product, and if television sets, like radios, were to last for 10 years or more, the 1975 stock would be so large that two sets could be placed in every household. The implausibility of these examples reflects the unusual incidence of the growth factor in 1950. Once stocks of durable goods have attained their normal relationships to population, gross national product, and other aggregates, there would first be a falling off of the demand for new products and thereafter a rate of increase either about as great as that of gross national product, or slightly higher than the rate of growth of population, depending on what are the relevant determinants of the stock of the goods in question. Because the timing of this transition from postwar to normal relationships is not known, nor whether it will be smooth or precipitous, the path by which the projected levels are likely to be attained cannot be predicted. Nor, indeed, can it be alleged that 1975 will not be another "special" year. The requirements with which this study is concerned are not those engendered by the fortuitous transfer of long-term needs from one year to another, but those reflecting the underlying necessities and consequences of over-all economic growth and development.

OTHER END-USE AGGREGATES

Aside from end-uses already projected, there are a number of others that are especially important in estimating future materials needs, as discussed in the following paragraphs.

TELEPHONE INDUSTRY

The telephone industry is projected to require no more materials in 1975 than it used in 1950. At the beginning of 1950 some 40.7 million telephones were in use in the United States, and during the year a net addition was made of some 2.3 million. Since the life of a telephone is reckoned at 15 years, the number of replacements in 1950 were about the average number of telephones installed in the years around 1935, or about 2 to 2.5 million. Maintenance of an installation rate of 4 to 5 million new and replacement telephones per year would permit between 60 and 75 million telephones in use by 1975. It is difficult to see how the projected economy would be willing to pay for more. Similiar conclusions are indicated by an analysis of the wire needs of the telephone industry, for in 1950 the Bell System made a net addition of 9.4 million miles to the initial stock of 147 million miles of wire.

FARM MACHINERY

Output of new farm equipment constituted almost 2 percent of the gross national product in 1950, as opposed to a past average of less than 1 percent. Thus no increase at all in the absolute level of output of such equipment would provide in 1975 a ratio between investment in farm equipment and gross national product greater than that which prevailed in the past. Farm-type tractors are a good example. Mere maintenance of 1950 output of over 500,000 such tractors would be more than adequate, with a normal life of well over 10 years, to provide a tractor for every man on the farm in 1975.

THE PROJECTION OF SCRAP SUPPLIES

Many of the issues of materials policy in the metals field relate to the problem of obtaining sufficient supplies of new metal or ore. The demand estimates relevant to these problems are therefore estimates of probable future needs for new material, not for the total of new material plus material recovered from scrap. If somehow future requirements could be fully and indefinitely met from scrap, there would be no policy problem.

Demand for new material cannot be estimated directly, since for all the metals treated here there are numerous and quantitatively important uses that can be met equally well from scrap or from new material. A large percentage of consumers are indifferent as to which they use. To determine the demand for new metal, it is necessary first to estimate total demand and then to subtract from it the probable amount of scrap that will be returned for reuse.

Supplies of scrap may change considerably from year to year, since large stocks are typically held by junkyards, automobile graveyards, and the like. Underlying the supply of scrap, however, there is a fundamental long-term regularity, rooted in the fact that of each year's production of a metal the amount ultimately recoverable and the average length of time that must elapse before recovery are both reasonably well determined. The ratio of scrap to total supply will vary with the percentage recoverable, with the rate of growth of the total requirement, and with the time lag in recovery. Furthermore, as the rate of increase in total consumption gets smaller, the significance of the time lag decreases.

Relevant data are lacking for precise estimates of future scrap ratios, particularly those relating to the length of lag in recovery from specified end-uses. The necessary tools are present, however, for making intelligent statements regarding them. Thus, barring wide changes in the end-use pattern, if the projected rate of increase of total demand is about the same as that of the past, the same scrap ratio can be used for 1975 as is now prevalent. If the projected rate of increase is greater than that of the past, a lower scrap ratio must be projected, and vice versa. It is also possible to determine, from common knowledge, whether the lag in scrap recovery from particular end-uses is relatively long or relatively short, and on this basis, knowing the approximate percentage of recovery, to estimate the approximate average future scrap ratio. For example, one may be confident that the steel in automobiles will not return to the steel mills until well after 10 years, while it is equally certain that the lead in batteries will return for reuse after something less than 5 years.

NEW SCRAP NOT INCLUDED

The scrap referred to above is only that known as "old scrap," i. e., material that has been part of a final product. "New scrap," which is usable waste material generated in the process of manufacture, returns for reuse after a negligibly short lag and does not enter directly into the projection of demand for new materials.

The rationale behind this special treatment of new scrap can be seen most clearly by dividing the economic process into three parts: raw materials production, the manufacturing process, and the consumption (or purchase) of final products. The need for materials, seen from the consumption level, is determined by the purchases of final products. It includes the materials actually embodied in the final products plus whatever materials were rendered useless in the process of manufacture (true waste). It does not include circular flows of materials, such as "new scrap," that are not lost in the process of manufacture.

ALLOWANCE FOR EXPORTS

The method used to project the 1975 levels of consumption of such end-products as automobiles, railroad equipment, and the like, makes no allowance for exports. Hence the projected levels of materials consumption derived from these end-use projections will not fully reflect anticipated 1975 consumption in United States industry. Furthermore, 1975 levels of such broad aggregates as producers' durables and appliances have been projected on the basis of the expected needs of the domestic economy. The unusually intensive domestic consumption of durables in 1950 led to the durable aggregates being projected at somewhat lower rates than would have been used if 1950 were a more "normal" year. In the rest of the free world in 1950, the consumption of durable products was not so abnormally high as in the United States; hence foreign consumption of these products will probably grow faster than our own. When, however, the expected growth rate of United States purchases of new appliances is applied to the 1950 use of steel in the production of these appliances, exports of appliances are implicitly projected to grow at the same rate as domestic purchases. Additional allowance must therefore be made in order to reflect the expectation that exports of appliances will grow more rapidly.

In order to take into account potential exports of materials in finished-product form, and to allow for the somewhat more rapid expansion of exports than of domestic purchases, an adjustment factor labeled "allowance for exports" has been introduced into the 1975 projection where appropriate. This figure, except in the case of coal, does not include any allowance for exports of the material in raw form.

The allowances for exports are rough and essentially arbitrary. They are based on a general appraisal of the proportion of manufactured exports to the total output of manufacturing industries in the United States, on the incidence of exportable commodities in end-use patterns, and on an estimate of the probable rate of increase of exports. They are clearly subject to a much larger percentage error than are the projections of specific end-uses of particular materials, and should therefore be used only to round out the total consumption figure. They have too wide a margin of error to be used as a measure of projected export developments in any case in which primary interest lies in exports.

No allowance for exports is made where the projected demand for a material is not directly connected with end-product projections, as in the cases of aluminum and the additive metals. In these instances the projections must be interpreted only as broad indicators of the expected change in demand. Since plausible allowances for exports would not change the general order of magnitude of the projections, it was felt that the making of such allowances would give an unwarranted impression of precision in the original projected figures.

data, however. Future over-all military needs depend more on the nature, scale, and location of a possible war than on economic aggregates rigidly defined, and there is little basis on which to project these factors. Furthermore, the technology of warfare changes so rapidly that the raw materials needed for future defense cannot be predicted. The defensive strength of the United States can be expected to grow as its productive power grows, but the commodity composition of the growth cannot be foreseen. The token projections of military end-uses should therefore be accepted as invitations to the sophisticated reader to make such allowances as appear necessary with respect to specific military problems.

RANGE OF ERROR

The aim in making the projections has not been to draw a detailed picture of the future—an impossible task—but to help policy makers to decide among alternative courses of action. For this purpose a broad picture of likely future trends suffices. For many materials there is a wide range of possible rates of growth of demand that are small enough that no positive action is necessary, and another wide range of conceivable growth rates so large that in the absence of policy action serious problems would confront the Nation. In many cases it may be highly useful to know that demand is not likely to more than double in the next generation; in others, it may be equally important to ascertain that even under the most favorable of prospective technological developments, requirements at recent prices are unlikely to be reduced to parity with the foreseeable supplies. Above all, these projections are highly useful for estimating how rapidly this Nation is likely to be drawing upon its mineral reserves. For the most critical materials—those whose commercial reserves are closest to running out—the precise rate of growth is the least important; ranges of error as high as 25 or 50 percent can often be easily tolerated without altering the appropriate policy conclusions. With respect to these particular materials, the reader can be most confident in using the projections. Where a very high degree of discrimination is required of the projections, they had best be left unused.

By the use of intelligent analysis, it is possible to trace the broad outlines of the shape of things to come. But a wide range of uncertainty remains as the inevitable attribute of the future. We can do no more than recognize this uncertainty and provide as best we can, within the limits of what we are able to foresee, for the contingencies that lie ahead.

COPPER

Total United States consumption of copper in 1950 was about 1.73 million short tons. The estimate of the American Bureau of Metal Statistics is 1.37 million tons, but this includes only that portion (0.12 million tons) of the scrap supply that passed through the hands of primary smelters and refiners. The total scrap used, as estimated by the Bureau of Mines, was 0.48 million tons. There is added, therefore, 0.36 million tons (for uncounted scrap) to the A. B. M. S. figure, yielding a total of 1.73 million tons. The end-use breakdown provided by the Copper and Brass Research Association allocates about 0.15 million tons to exports of copper in semimanufactured form. This is carried in the tables under the heading "Allowance for copper content of exports," but this 1950 figure does not include copper content of exports of automobiles, electric equipment, and the like. Such exports are, for 1950, included in the copper consumption allocated to these end uses in the table.

The 1.73 million tons was allocated to end-uses approximately as shown in table IV, which also shows the consumption projected for 1975 on the basis of these end-uses.

Copper is no longer essential to most electrical uses, and indeed there are strong indications that it will be displaced by aluminum in many of them. Already aluminum has been substituted for copper in long-distance transmission lines, and the bare beginnings of a similar shift away from copper have been witnessed for distribution lines. The projection of no more than a 50-percent increase for light and power uses is based on the assumption that copper's importance for these uses will continue

TABLE IV.—*Projected United States demand for copper*

End-use	Projected as moving with—	1950 consumption (thousand short tons)	Percentage increase projected	Projected consumption about 1975 (thousand short tons)
Electrical equipment	(*)	303	60	485
Telephone and telegraph	Demand for telephone equipment	87	0	87
Light and power	(*)	100	50	150
Appliances	Demand for new appliances	106	50	159
Ammunition	(*)	70	50	105
Automobiles	Demand for new automobiles and trucks	145	33⅓	193
Building	Construction	135	30	175
Railroads	Demand for new railroad equipment	25	100	50
Ships	Shipbuilding	22	0	22
Other uses of new copper	(*)	227	50	340
Other uses of old scrap	(*)	360	25	450
Allowance for copper content of exports		150		284
Total United States demand for copper		1,730	45	2,500
Less scrap		−475		−700
Total United States demand for new copper		1,255	43	1,800

*Explained in paragraphs under "Copper."

ings indicates a substantial substitution, so that there is projected a 50 percent reduction in the consumption of lead for cable coverings.

Continued substitution of titanium in pigments is anticipated; hence the use of lead in paints is projected to rise by a smaller percentage than that projected for paints as a whole.

The use of lead in gasoline is projected to expand more rapidly than gasoline itself, since it is expected that a greater proportion of future engines will require antiknock fuel.

The use of lead in construction is expected to increase at a slower rate than construction generally, owing to the anticipated substitution of other metals for lead in some applications.

A rapid growth in use of lead in insecticides is indicated by studies showing the profitability of greatly intensified pest control activity, but, owing to the development of chemical insecticides not containing lead, the projected increase in lead consumption in insecticides is lower than the projected rate of growth for insecticides as a group. (See projection of fast-growing uses.)

The use of lead for foil is not expected to expand, since aluminum foil and new packaging methods will restrict lead foil to highly specialized purposes. In ceramics, use of lead is expected to grow at the same rate as gross national product.

In the absence of substitutions, the demand for solder would be expected to rise 65 percent, i. e., the weighted average of the percentages by which its major uses are expected to expand. Electrical uses, which in 1950 took about 15 percent of the solder used, are expected to triple by 1975; autos and trucks, which took 40 percent in 1950, are projected to increase by a third. Other durable goods and construction uses took 25 percent in 1950 and are expected to grow 50 percent by 1975; miscellaneous uses took 15 percent in 1950 and are expected to double in the next generation. Anticipated substitutions in some uses (automobile radiators, cans) reduce the projected rise to 50 percent.

Appliances and producers' durables other than trucks and railroad equipment are believed to account for the bulk of the unspecified uses. These uses are therefore projected to expand by 50 percent in the next 25 years.

Over the past 25 years the scrap return has averaged about a third of total consumption. We expect this ratio to rise in the long-term future, largely because the major source of scrap (storage batteries) is projected to expand more rapidly than lead demand as a whole. From this source alone between 550,000 and 600,000 tons of scrap may be expected in an average year in the 1970's, since approximately 90 percent of the lead which goes into storage batteries returns in the form of scrap, after a lag which averages around 2 years. Other scrap-producing uses (printing, automobiles, railroads, cable, and construction) probably will provide close to 200,000 additional tons.

Owing to the projected increase in the scrap ratio, the demand for new lead is projected to rise by about 53 percent. This compares with a projected increase of 78 percent in the demand for new lead in the rest of the free world.

ZINC

United States zinc consumption in 1950 was about 1,156,000 short tons. This figure (from Bureau of Mines data) represents the sum of the figures on slab zinc consumption (947,000 short tons), return of old scrap (75,000 short tons), and zinc used in pigments (132,000 short tons) and salts (2,500 short tons) made direct from ore. It could not be subdivided according to consuming industries, but a breakdown (based on Bureau of Mines data in table VI and allocating old scrap into brass and bronze uses) has been attempted.

Rolled zinc is used largely for dry cell batteries and engraving plates. In both these uses substantial substitution of magnesium for zinc is anticipated.

Numerous parts of appliances, automobiles, and small utensils are die-cast from zinc-base alloys, and these together account for most of such alloy material. The use of zinc-base alloys has increased more than tenfold in the past generation, but for the purposes of projection it is assumed that by 1950 the potential new uses of such alloys has been substantially exhausted. Furthermore, a substantial substitution of aluminum for zinc in die-casting appears to be in process. Prior to the Second World War, some 60 percent of all die-castings were made from zinc-base alloys, but by 1951 only a third were so made. The projection assumes total die-castings to rise approximately in proportion to the demand for appliances, with some further substitution of aluminum for zinc as the basic metal.

TABLE VI.—*Projected United States demand for zinc*

End-use	Projected as moving with—	1950 consumption (thousand short tons)	Percentage increase projected	Projected consumption about 1975 (thousand short tons)
Galvanizing	Producers' durables nonresidential construction.	434	50	651
Brass and bronze	See copper projection	211	25	264
Rolled zinc	(*)	68	−25	51
Die castings	(*)	281	25	351
Pigments	See lead projection	132	50	198
Other	Gross national product	30	100	60
Allowance for export of fabricated zinc				25
Total		1,156	38	1,600
Less scrap	(*)	−75		−100
New zinc		1,081	39	1,500

*Explained in paragraphs under "Zinc."

TABLE VIII.—*Projected United States demand for antimony*

End-use	Projected as moving with—	1950 consumption (short tons)	Percentage increase projected	Projected consumption about 1975 (short tons)
Metal products:				
Antimonial lead and battery metal	See lead projection	*26,774	70	45,516
Bearing metal and bearings	(†)	3,256	(†)	4,135
Type metal	Printing and publishing	766	75	1,340
Sheet and pipe	Gross private domestic investment; demand for consumers' durables.	300	40	420
Solder	See lead projection	162	50	243
Other metal products	(†)	230	50	345
Total metal products		31,488		51,999
Nonmetal products:				
Frits and ceramic enamels	(†)	1,462	0	1,462
Glass and pottery	(†)	579	100	1,158
Plastics	Fast-growing uses	737	400	3,685
Paints and lacquers	(†)	269	0	269
Flame-proofed textiles	(†)	369	300	1,476
Other nonmetal products		2,452	100	4,904
Total nonmetal products		5,868		12,954
Allowance for export				1,047
Total United States demand for antimony		37,356	76	66,000
Less scrap		—21,862		—38,000
United States demand for new antimony		15,494	81	28,000

* Storage batteries are almost the sole end-product for which scrap antimony is used. In the absence of an end-use breakdown for scrap antimony in 1950, the total scrap consumed in 1950 is assumed to have gone into the production of storage batteries.

† Explained in paragraphs under "Antimony."

ALUMINUM

Aluminum has not yet found its "normal" relative place in the materials demand of the American economy. In almost all its uses it is in the process of winning markets away from competing materials, as already cited in the discussions of the other nonferrous metals. But markets gained from the nonferrous metals are unlikely to be quantitatively the most important causes of aluminum's future expansion, for substitutions even far in excess of those anticipated could be effected by less than a million tons of aluminum. They may, of course, be highly valuable substitutions because of the specialized uses served by the nonferrous metals. In contrast, the possibilities of substituting aluminum for steel and wood are almost unlimited. Aluminum window frames and furniture, and aluminum in construction could by themselves account for a four- or five-fold expansion of United States aluminum demand from its present level of 983,000 short tons. This fact frustrates any attempt at precision in the estimate of aluminum demand. If there were no substitutions at all in favor of aluminum, its demand would probably expand by 1975 to 2 or 2½ times its 1950 level. Readers may verify this statement by comparing the percentage breakdown of the 1949 output of the three major United States producers, shown in table IX, with the expected growth of the economic aggregates listed.

The projected substitutions of aluminum for other nonferrous metals would add another 500,000 tons. To the resulting figure of 2½ to 3 million tons must be added an arbitrary allowance for the probable amount of aluminum that will substitute for steel and wood.

We have chosen to project the 1975 United States demand for aluminum at 4.5 million (between 4 and times the 1950 consumption) as indicating a plausible rate of growth. A figure much less than this would imply almost no incursions of aluminum into fields now held by other materials. A figure much greater, say 10 times the 1950 output, would be possible if aluminum were assumed to take over more than a small part of the functions now performed by wood and steel. The policy implications of a ten-fold increase should therefore be considered.

TABLE IX.—*Output of aluminum in 1949 by categories*

	Percent
Power	8.74
Aircraft	8.95
Water and coal	1.55
Automotive	7.35
Building	22.26
Utensils	5.90
Appliances	6.63
Machinery	3.77
Other	34.85
Total	100.00

The scrap ratio of aluminum has averaged less than 10 percent in the United States in recent years. Since the projected rate of growth is considerably slower than that of the past, this ratio is expected to increase in the future. In Europe, where the growth of aluminum consumption from 1935–38 to 1948–49 was at about the rate projected for the United States, recent scrap ratios have been around 30 percent, but these ratios were influenced by the presence of war scrap on the European market. An intermediate figure of around 20 percent is not implausible for the United States in 1975. This would make the projected United States demand for new aluminum around 3.6 million tons, an increase of about 300 percent over the 1950 consumption of 920,000 short tons of new metal.

put of finished ferrous products in the years around 1955. The defense goal of 120 million tons is accepted as the estimated 1955 output of crude steel. This amount of crude steel would produce about 90 million tons of finished steel and steel castings. To this must be added 15 million tons or more for iron castings to be produced around 1955, yielding a total supply of finished ferrous products of around 105 million tons. The estimated 1975 scrap supply is 30 percent of this latter figure.

The demand for iron ore may be derived from the demand for pig iron. In 1950 the United States used the equivalent of 130 million short tons of iron ore of 50 percent recoverable iron content. For the projected pig iron consumption of 100 million tons the equivalent of some 200 million tons of 50 percent recoverable content ore would be needed.

ADDITIVE METALS

Projection of demand for the additive metals is particularly difficult, because many of them are close substitutes for one another and because data on the end-uses of alloy steels are not separately available. It is anticipated, however, that as the American economy develops further, its machines and equipment will require relatively greater quantities of special-use steels. Hence the demand for the additive metals as a group will probably expand at a more rapid rate than the demand for steel. Use of the alloys of more generalized usefulness, chromium and nickel, is projected to double, with the demand for chromite (chromium ore) increasing from about 875,000 to about 1,750,000 long tons, and that for nickel rising from 100,000 to 200,000 short tons.

Consumption of the more specialized alloys is expected to increase more than that of nickel and chromium, with that of tungsten and molybdenum growing about 150 and 170 percent, respectively, and that of cobalt expanding by almost 350 percent. The especially high increase for cobalt stems from its use in rockets, guided missiles, and atomic energy developments. Molybdenum consumption was about 26 million pounds in 1950 and is expected to increase to around 70 by 1975. Cobalt consumption, which was about 9 million pounds in 1950, is expected to rise to about 40 million pounds by 1975. For tungsten the 1950 figure is 6 million pounds, but consumption in the latter part of that year was restrained by failing supplies. Allowance for this has therefore been made in projecting demand to rise to about 15 million pounds by 1975.

These projections represent little more than the quantification of broad qualitative judgments. They are somewhat supported by past trends, however. Consumption of tungsten had risen by 1948 to almost double its 1936 level; consumption of molybdenum in 1950 was some 50 percent larger than in 1936, and that of cobalt was over 4 times its prewar level. Nickel consumption in 1950 was somewhat less than double and chromium consumption somewhat more than double their respective averages in the immediate prewar years.

The demand for the ferro-alloys is furthermore vulnerable to changes in military requirements, and might be more than doubled if a state of full mobilization were approached.

MANGANESE

The use of manganese in steel making is technically determined; it requires about 13 pounds of manganese to make a ton of crude steel. The projected average level of ingot steel production of 150 million tons would thus require about 975,000 tons of contained manganese. The average grade of the manganese ore currently consumed is about 46 percent, but almost 16 percent of the manganese content of the ore is lost in converting the ore to ferromanganese, the alloy actually used in the steel-making process. Hence about 2.5 million tons of manganese ore of 46 percent average grade would be needed to produce the projected 1975 steel output. An allowance of some 200,000 tons of ore has been made for other uses, which have typically accounted for a very small share of our consumption of manganese. Thus the total projected consumption of manganese ore of 46 percent average content is about 2.7 million tons, as compared with some 1.8 million tons in 1950.

FLUORSPAR

United States consumption of fluorspar of all industrial grades in 1950 was about 426,000 short tons. Presented in table XI is an approximate list by end-uses for the years 1950 and 1975. In order to expedite a comparison with reserves, the consumption figures are converted to short tons of pure fluorspar (100 percent CaF_2). On this basis the 1950 consumption was 369,000 short tons.

The use of fluorspar in the manufacture of aluminum is projected to increase in two ways: first, through expansion of production of new aluminum; and second, through an increase in

TABLE XI.—*Projected United States demand for fluorspar*

End-use	Projected as moving with—	1950 consumption (thousand short tons CaF_2)	Percentage increase projected	Projected consumption about 1975 (thousand short tons CaF_2)
Steel	Crude steel*	191	55	296
Aluminum	(**)	43	518	265
Glass	See antimony projection	32	100	64
Enamel	Paints	9	50	13
Iron foundry and ferro-alloys	(**)	8	100	16
Other hydrofluoric acid	(**)	78	400	390
Miscellaneous	Gross national product	8	100	16
Total		369		1,060

*See steel projection.
**Explained in paragraphs under "Fluorspar."

TABLE XII.—*Projected United States demand for sulfur*

End-use	Projected as moving with—	1950 consumption (thousand long tons)	Percentage increase projected	Projected consumption about 1975 (thousand long tons)
Acid uses:				
Superphosphate fertilizers	(*)	1, 145	130	2, 634
Chemicals	(*)	780	200	2, 340
Ammonium sulfate	(*)	407	200	1, 221
Paints and pigments		390	50	585
Iron and steel	(*)	320	40	448
Petroleum refining	(*)	310	50	465
Rayon and films	(*)	220	100	440
Miscellaneous	Gross national product	163	100	326
Total in acids		3, 735		8, 459
Nonacid uses:				
Pulp and paper	(*)	420	20	504
Rayon	(*)	180	100	360
Pesticides	(*)	150	0	150
Rubber	(*)	65	100	130
Chemical and miscellaneous	Gross national product	256	100	512
Total in nonacid uses		1, 071		1, 656
Total sulfur		4, 806	110	10, 115

*Explained in paragraph under "Sulfur."

Although the projected demand for iron and steel products is about 60 percent above 1950 production, the use of sulfuric acid in the iron and steel industry is expected to expand by only 40 percent because of foreseeable savings in its use.

Economies already instituted in some oil refineries are likely to save about 25 percent of the acid use that would be projected on the basis of no change from current practices. Thus, this use of sulfur is projected to expand by 50 percent rather than to double along with the output of petroleum products.

The use of rayon and films is expected to about double in the next generation. Films are anticipated to proceed with gross national product, while rayon, though continuing to grow more rapidly than textiles as a group, is not thought likely to more than double. Rayon, which requires both sulfuric acid and carbon bisulfide, already accounts for about 10 percent of cloth production. Its ultimate growth at the expense of other fibers is limited both by its unsuitability for the bulk of cotton's present uses and by the fact that it is itself subject to incursions from newer synthetic fibers.

Pulp and paper uses of sulfur are expected to increase by 20 percent. Although the total consumption of paper (including paper for wrappings and containers) may double in the next 25 years, sulfate and semichemical papers, which are relatively low sulfur consumers, are expected to account for most of the increase.

The use of pesticides of all kinds in 1975 is likely to be at several times the 1950 rate, but the continued substitution of acid-using chemical applications for elemental sulfur will probably keep the nonacid use no larger than at present.

THE ENERGY FUELS

Projections of demand for the energy fuels (coal, oil, and natural gas) are subject to particularly wide margin of error because they can so readily be substituted for one another in certain major uses. Clearly, natural gas and petroleum are more convenient than coal for residential heating, and petroleum is coming to monopolize the market for transportation fuel. Nevertheless, important quantities of all three fuels are currently consumed in industrial and power-generating uses—uses in which a small change in the relative prices and availabilities of coal, oil, and natural gas could cause very substantial substitutions.

Athough it is recognized that the demand for the three fuels is highly sensitive to price, it is assumed that their relative prices remain unchanged. Hence, the relative shares in those uses in which they compete closely also are assumed to remain unchanged. Readers should, however, be aware of the vulnerability to even small price changes of the projected levels of demand for any of these fuels in such uses.

ELECTRIC ENERGY*

Electric power production in the United States has approximately doubled every 10 years since 1900. The principal elements that have contributed to the rapid growth of this form of energy are as follows:

a) A 100 percent increase in population.

b) A 660 percent increase in the number of ultimate consumers.

c) Approximately a 130 percent increase in real income per capita.

d) The mechanization of industrial plants, farms, and homes.

e) The electrification of mechanical processes in industrial plants, on farms, and in homes.

f) The growth of electroprocess industries.

The extension of electric service, which has accounted for much of the past growth, has been nearly completed. Popula-

*By Herschel Jones.

tion of industrial electric energy requirements will be supplied by utility systems, the losses involved in supplying industrial electric requirements will also be greater. Technical improvements in electric transmission and distribution equipment, however, will reduce the losses of energy incident to utility system operations. Such reductions in losses are estimated to about offset the gain in losses expected from the increased utility service to industrial plants.

Like the other projections in this report, the projected requirements for electric energy represent only broad expectations regarding the future. A deviation of 10 percent on any end-use or on the total is likely even if all assumptions regarding population, income, production, and the like are realized.

Petroleum

Petroleum consumption in the United States in 1950 was 2,375 million barrels. This total was divided among end-products approximately as shown in table XIV, which also shows the projected quantity of each end-product for 1975.

Table XIV.—*Projected United States demand for petroleum*

End-product	1950 consumption (millions of bbl.)	Percentage increase projected	Projected consumption about 1975 (millions of bbl.)
Motor fuel	994	110	2,085
Kerosene and distillates	513	130	1,180
Residual oil	554	100	1,110
Lubricants	39	100	75
Other products	275	100	550
Total	2,375	110	5,000

Motor fuel

The projected increase in motor fuels assumes that the average fuel consumption per car, truck, and bus remains constant. Sixty percent of the motor fuel used in 1950 was consumed in passenger cars; it is projected as increasing by 75 percent. Trucks and buses used 25 percent of our 1950 motor fuel consumption and are expected to use 2½ times that amount in 1975. Aircraft used 4 percent and are projected as using 5 times that amount in 1975. Other uses (including industrial naphtha) accounted for about 11 percent of the 1950 consumption and are projected as doubling. If each of these uses is increased by the indicated percentages, total motor fuel consumption will increase by about 110 percent.

Kerosene and distillates

Forty-five percent of the fuel in the category "Kerosene and Distillates" goes into house heating. This use of oil products is projected as expanding by 150 percent. Projections of heating requirements for particular fuels are naturally subject to wide ranges of error, since coal, oil, and gas substitute readily for one another. It is assumed that most consumers will continue to prefer oil and gas to coal, and that the major heating uses of coal will be in apartment houses, hotels, and other places where the convenience advantages of gas and oil carry less weight. As between gas and oil, it is assumed that gas will be the predominant heating fuel, both because it has a moderate convenience advantage over oil and because of the lower installation cost of the heating unit. Thus, as many as half the total number of dwelling units may be heated by gas in 1975. Dwelling units heated by oil are likely to be most common in areas not supplied with natural gas, which will probably be those in which the density of population does not warrant the building of a pipeline. It is easily conceivable that 30 or 40 percent of the total number of dwelling units may, in 1975, be in such areas, which would include many rural and small urban areas in States whose metropolitan areas were served by natural gas. It is thus not unreasonable to assume that 10 to 12 million oil burners will be in operation in 1975, as opposed to some 4.8 million in 1950.

Also in the "Kerosene and Distillates" category are range oil, which took 18 percent of the 1950 total and is not expected to expand; jet fuel, which took 1.5 percent in 1950 and is projected to increase tenfold; and railroad diesel fuel, which took 9 percent in 1950 and is anticipated to rise to three times that amount by 1975. The great rise in diesel fuel consumption is projected on the assumption of a continuing trend toward diesel as the major fuel of railway transport. This trend may be expected to continue, since diesel power is far more economical than steam. Diesel locomotives, which constituted about one-fourth of the locomotives in use in 1950, accounted for about half of the work done. If heavy freight traffic increases between 50 and 100 percent between 1950 and 1975, and if substantially all hauling in 1975 is done by diesel engines, 3 or 4 times as much diesel fuel will be required. The 1975 requirement for diesel fuel is therefore projected as 3½ times that of 1950. The equipment to use other fuels will be of negligible importance, since nearly all locomotives built before 1945 will have gone out of service.

Remaining uses in the "Kerosene and Distillates" category, which include nonrailway uses of diesel fuel, are projected as doubling. They accounted in 1950 for about 27 percent of the total. These projections, when combined, result in a growth of about 130 percent for the category as a whole.

Residual oil

Residual fuels were used for heating (12 percent), railroad transportation (11 percent), public utility power generation (17 percent), marine transportation (18 percent), industrial power generation (37 percent), and other uses (6 percent). Heating uses are projected to expand by the percentages indicated in the discussion of the "Kerosene and Distillates" category, while railroad use of residual oil is expected to yield place to diesel. Public utility uses are projected as trebling, on the assumption that the percentage of electrical generating capacity fueled by petroleum remains substantially constant. Marine uses are expected to double, with part of the increase coming from substitution of oil for coal as bunker fuel. Industrial and other uses are also projected as doubling. These anticipated increases yield a growth of about 100 percent in the residual oil category.

Lubricants and other products are projected as doubling along with gross national product. The projected growth for lubricants is thus substantially the same as that for motor fuels.

Part II. Materials Demand in Other Free Nations

Just as the prospective growth of the United States economy will entail increasing consumption of materials, so increases in output and living standards abroad will result in growing drains on the free world's resources. And since it is in the national interest of the United States that the free nations of the world should be strong and prosperous, United States materials policy should be aimed not only at meeting its own prospective needs, but also at facilitating the growth and prosperity of other free countries.

The foreign economic policy of the United States is based on the belief that the ingenuity and know-how that lie behind the great growth of the American economy are not American monopolies. Many other countries have already shown their potentiality for growth, and this Commission believes that still others should be able to expand their productivity and raise their levels of living at rates comparable to those attained in the United States. Other countries, some of them only recently awakened to the idea of economic growth, can do much by their own efforts to break down the barriers that impeded growth in the past. Once these barriers are down, their own ingenuity too, can be relied upon to bring about rapid advances. These countries have, furthermore, an asset of great worth in the fund of processes and techniques discovered, applied, and perfected through long years of experiment and experience in the developed economies of the world.

With all these factors leading to a reasonable expectation of rapid growth abroad, and in the light of a policy that has this growth as one of its fundamental aims, the materials needs of the future must include ample allowance for economic expansion abroad.

It is assumed that in Europe, the United Kingdom, Canada, Australia, New Zealand, and Japan, productivity per man-hour may expand as rapidly as in the United States. In Canada, Australia, and New Zealand, where living standards are presently comparable to those in the United States, it is assumed that the number of hours worked by the average member of the labor force would fall by the same percentage as projected for the United States. (See Part I.) For the European countries, where present levels of consumption are significantly lower than in the United States, a somewhat smaller percentage reduction in the average hours worked is assumed. In Japan, productivity per man-hour is expected to rise more rapidly than in other developed countries, owing to the under-utilization of productive capacity in 1950; average hours worked are not expected to fall since they are already low. Japanese workers have much to gain before they attain a consumption level equal to that prevailing in other industrial countries. Labor forces have been estimated from population projections provided by the Department of State, by assuming that the labor force in each country remained at a constant percentage of the total population between the ages of 15 and 65. These projections are summarized in table XVII.

Limitations of both time and data have prevented as detailed an analysis for the rest of the free world as was made for the United States. The projections for the rest of the free world are accordingly even rougher approximations than those for the United States.

For aluminum, the additive metals, fluorspar, antimony, manganese, rubber, and sulfur, consumption is projected, for the rest of the free world as a whole, with no attempt at a geographical breakdown. For copper, lead, zinc, tin, iron, and steel the projected demand for the rest of the free world is subdivided among areas.

TABLE XVII.—*Projections for free countries*

	1950	1975
FREE EUROPE*		
Population of age 15–64 (millions)	165	187
Labor force index	100	114
Index of average hours worked	100	90
Index of productivity per man-hour	100	185
Index of gross national product	100	190
UNITED KINGDOM		
Total population (millions)	50. 6	50. 9
Population of age 15–64 (millions)	33. 9	32. 9
Labor force index	100	97
Index of average hours worked	100	90
Index of productivity per man-hour	100	185
Index of gross national product	100	162
CANADA		
Total population (millions)	13. 8	17. 9
Population of age 15–64 (millions)	8. 8	11. 4
Index of labor force	100	130
Index of average hours worked	100	85
Index of productivity per man-hour	100	185
Index of gross national product	100	204
AUSTRALIA AND NEW ZEALAND		
Total population (millions)	11. 5	18. 1
Population of age 15–64 (millions)	7. 6	12. 4
Index of labor force	100	164
Index of average hours worked	100	85
Index of productivity per man-hour	100	185
Index of gross national product	100	258
JAPAN		
Total population (millions)	83. 2	111
Population of age 15–64 (millions)	50	72
Index of labor force	100	145
Index of average hours worked	100	100
Index of productivity per man-hour	100	221
Index of gross national product	100	320

*Includes France, Western Germany, Italy, Finland, Sweden, Norway, Denmark, Belgium, The Netherlands, Luxembourg, Portugal, Spain, Switzerland, Austria, Greece, and Yugoslavia.

Only the method used to estimate the demand of the industrial countries is discussed at this place, the nonindustrial areas being discussed separately below. Since patterns of consumption in the industrial countries are similar to these in the United States and probably will become increasingly so, the growth of their materials consumption relative to gross national products will presumably be broadly similar to that in the United States, with one important exception. Since the special characteristics of an abnormal proportion of durable goods in the United States consumption-investment pattern

percent for every 100 percent increase in gross national product. This compares with a 43 percent increase as projected for the United States demand for new copper and includes an allowance for probable increases in scrap ratios in other countries.

TABLE XIX.—*Projected demand for copper in rest of the free world**

Area	1950 consumption (thousand short tons of new copper)	Projected consumption about 1975 (thousand short tons of new copper)	Percentage increase
Canada	100	152	52
Australia and New Zealand	45	81	79
United Kingdom	374	490	31
Free Europe	627	909	45
Japan	42	88	110
Others	155	345	123
Total	1,343	2,065	[1] 54

*Based on 1950 data from the International Materials Conference.
[1] Average.

LEAD

In 1950 the rest of the free world consumed about 840,000 short tons of new lead, distributed geographically and projected to increase as shown in table XX. The projections are based on an assumed increase in lead demand of 65 percent for every 100 percent increase in gross national product. This compares with a 61 percent increase projected for the United States and includes an allowance for probable increases in scrap ratios abroad.

TABLE XX.—*Projected demand for lead in rest of free world**

Area	1950 consumption (thousand short tons of new lead)	Projected consumption about 1975 (thousand short tons of new lead)	Percentage increase
Canada	56	94	68
Australia and New Zealand	42	85	103
United Kingdom	181	253	40
Free Europe	451	713	58
Japan	13	32	143
Others	101	323	220
Total	844	1,500	[1] 78

*Based on 1950 data from the International Materials Conference.
[1] Average.

ZINC

In 1950 the rest of the free world consumed about a million tons of new zinc, distributed geographically and projected to increase as shown in table XX. The projections are based on an assumed increase in zinc demand of 48 percent for every 100 percent increase in gross national product. This compares with an increase of 38 percent projected to the 1975 period for total zinc demand in the United States and assumes substantial constancy in the rate of scrap return in other nations of the free world.

TABLE XXI.—*Projected demand for zinc in rest of free world**

Area	1950 consumption (thousand short tons of new zinc)	Projected consumption about 1975 (thousand short tons of new zinc)	Projected percentage by 1975
Canada	58	88	50
Australia and New Zealand	57	100	76
United Kingdom	265	344	30
Free Europe	534	764	43
Japan	57	117	106
Others	89	291	228
Total	1,061	1,705	[1] 61

*Based on 1950 data from the International Materials Conference.
[1] Average.

TIN

The method used for the other major metals has been used for tin only with respect to tin not used for tin plate. The use of tin for tin plate in countries other than the United States was about 24,100 long tons in 1950 and is projected as remaining substantially constant. The electrolytic process, already in operation in the United States, will eventually be adopted in the rest of the world and will permit large expansions in the amount of tin plate produced with this same amount of tin. The introduction of the process may be delayed by an apparent preference on the part of foreign canners to use thick platings as a precaution against long storage of canned products, but as present tin-plating facilities wear out, they are likely to be replaced by machines using the newer technique.

TABLE XXII.—*Projected demand for tin in rest of free world**

Area	1950 consumption (thousand long tons of new tin)	Projected consumption about 1975 (thousand long tons of new tin)	Percentage increase
Canada:			
Tin plate	3.4	3.4	0
Other uses	1.0	1.5	52
Australia and New Zealand:			
Tin plate	0	2.0	0
Other uses	2.4	4.3	79
United Kingdom:			
Tin plate	9.8	9.8	0
Other uses	13.5	.6	31
Free Europe:			
Tin plate	7.7	7.7	0
Other uses	18.3	26.5	45
Japan:			
Tin plate	1.1	1.1	0
Other uses	1.6	3.4	110
Others:			
Tin plate	2.0	.....	.....
Other	11.8	31.3	127
Total	72.6	108.6	[1] 50

*Based on 1950 data from International Tin Study Group, *Statistical Bulletin*, January 1952, pp. 27–31.
†Based on 1951 consumption of tin in tin plate production.
[1] Average.

Table XXII shows the geographical distribution of the free world's 1950 consumption, with projected figures for 1975. The projections for non-tin-plate uses are based on an assumed increase of 50 percent in the tin demand arising out of these uses for every 100 percent increase in gross national

TABLE XXV.—*Rest of free world demand for the additive metals*

New material	Consumption 1950	Projected consumption about 1975	Projected percent of increase
Nickel (thousand short tons)	32	64	100
Chromite (thousand long tons)	600	1,100	100
Molybdenum (million lb.)	10	27	170
Tungsten (million lb.)	22	55	150
Cobalt (million lb.)	6	26	340

*Estimated.
SOURCE: U. S. Bureau of Mines.

MANGANESE ORE

Inasmuch as the production of a metric ton of crude steel requires about 14.3 pounds of manganese, the manganese metal required for steel making in the rest of the free world is projected at about 800,000 short tons. Allowance being made for a loss in converting the crude ore to a usable product (ferromanganese or speigeleisen); this is the equivalent of about 2.1 million tons of ore containing 46 percent of manganese. An additional allowance of 200,000 tons of ore has been made for nonsteelmaking uses, giving a projected 1975 demand for 2.3 million tons of 46 percent ore. This compares with a 1950 consumption of some 1.4 million short tons.

FLUORSPAR

In 1950 the free world outside the United States used the equivalent of about 159,000 short tons of pure fluorspar (100 percent CaF_2), mainly in the production of aluminum and steel. While the use of fluorspar per ton of aluminum was about the same in other free countries as it was in the United States, their consumption of fluorspar in steel making was considerably lower than here. This is because considerable quantities of foreign steel were produced by the Bessemer process, which uses negligible quantities of fluorspar. Assuming that in 1975 the Bessemer process will account for the same proportion it does today, the demand for fluorspar arising out of the production of steel and aluminum is estimated to be the equivalent of 400,000 short tons of pure (100 percent) material. Even though other uses of fluorspar were negligible in the rest of the free world in 1950, their association with such rapidly growing products as plastics and refrigerants makes it unlikely that these other uses will remain small. An arbitrary allowance of some 170,000 short tons of pure fluorspar is made for these uses in foreign countries in 1975. Thus, the rest of the free world is projected to demand the equivalent of about 570,000 tons of pure fluorspar (or 640,000 tons of all grades) in 1975.

RUBBER

Even if productivity in other free countries were not to grow significantly in the next 25 years, the number of motor vehicles in use in those countries would undoubtedly expand considerably. Hence the demand for rubber in the rest of the free world cannot be projected in direct relation to gross national products. It is feasible, however, to compare the present stage of development of automotive transportation in the rest of the free world with that attained in the United States in the late twenties. If, during the next 25 years, automotive transportation abroad grows at about the same rate as it did in the United States in the past quarter century, and if other uses of rubber also expand rapidly by 1975, the rest of the free world will be demanding more than three times the amount of rubber it is currently using. Its demand for new rubber may, under such circumstances, easily increase from the 1950 figure of 825,000 long tons to a 1975 level of around 2,500,000 long tons.

SULFUR

During the next 25 years the demand for sulfur in the rest of the free world is expected to rise by about the same percentage (110 percent) that is projected for United States sulfur demand. The projected 1975 sulfur consumption of other free countries is thus 14.1 million long tons, as opposed to their 1950 consumption of 6.7 million tons.

The projected rise of 110 percent in foreign demand for sulfur is based on the assumption that a rate of increase of fertilizer demand lower than that projected for the United States will be counterbalanced by a rate of increase in the use of sulfur for rubber, iron and steel, and petroleum products higher than projected for the United States. The lower projected rate for fertilizer demand abroad stems from the fact that European farmers are already heavy users of fertilizer. They could not economically use much more fertilizer than they do now, while American agriculture can profitably use 2½ times its current volume.

REFERENCES ELSEWHERE IN THIS REPORT

This volume:
- The Additive Metals.
- Aluminum.
- Antimony.
- Chemicals.
- Copper.
- Fluorspar.
- Iron and Steel.
- Lead.
- Manganese.
- Production and Consumption Measures.
- Reserves and Potential Resources.
- Rubber.
- Tin.
- Zinc.

Vol. III: THE OUTLOOK FOR ENERGY SOURCES.
- Coal.
- Electric Energy.
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Vol. IV: THE PROMISE OF TECHNOLOGY.
- Coal Products and Chemicals.
- Forecasts for Petroleum Chemicals.
- Oil and Gas as Industrial Raw Materials.
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- The Technology of the Building Industry.
- The Technology of Iron Ore.
- The Technology of Iron and Steel.
- The Technology of Manganese.
- The Technology of Tin.

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