Fueling the Third Reich

ARNOLD KRAMMER

"The Kingdom of Heaven runs on righteousness," declared Ernest Bevin during a heated argument in the British Parliament over a distasteful decision in the Middle East, "but the Kingdom of Earth runs on OIL!" If these words were a political reality to Britain in 1948, they would have been embraced with religious fervor by Germany during the period of the Third Reich. Without oil, and the fuel and lubricants which are produced from oil, every form of mechanized transportation, heating, and military defense is paralyzed. Any nation in that position becomes utterly dependent upon foreign sources for its life's blood and, in effect, surrenders its sovereignty. For Germany, between 1919 and 1945, the question of oil—its production, importation, synthesization, stockpiling, allocation, and consumption—occupied a status which was second only to the survival of the political state. History proved that these priorities were not, in fact, in error, for with the destruction of the fuel industry, the collapse of the state was virtually assured. Germany's preoccupation with fuel, however, and its crucial relationship to the state, became a reality as a result of the First World War.

Synthetic Fuels

Germany went into World War I poor in oil resources; this, in addition to her calamitous military blunders, was one of the prime causes of her defeat. While it would be useless to speculate on the outcome of the war if Berlin had had sufficient fuel reserves, the German military establishment resolved never again to be dependent upon the outside world for petroleum and fuel. Germany may not have had large oil deposits within her own boundries, but she did have abundant reserves of soft brown coal (*Braunkohle* or lignite), hard brown coal (*Glanzkohle* or anthracite), and noncoking coal (*Fettkohle* or bituminous). The primary goal of German scientists at the

DR. KRAMMER is associate professor of history at Texas A&M University. He is the author of numerous works on modern Germany and is a principal investigator of a major project to reevaluate German technology on synthetic petrochemicals for potential current application.

 0040-165X/78/1903-0003$02.25

end of the war, therefore, was to find a way to convert this coal into gasoline.[1]

The chemical groundwork had been started during the First World War when the process of synthesizing ammonia was developed by two German scientists, Haber and Bosch, of the Badische Anilin & Soda Fabrik (which later merged into the chemical octopus known as I. G. Farbenindustrie). This breakthrough in synthetic ammonia led to three important developments in the search for synthetic petrochemicals: it perfected the production methods to produce large quantities of hydrogen from coal at low cost, it taught the Germans the technique of industrial operations at high pressures, and, perhaps most important, it made them familiar with catalysis. As a result of this earlier work, German postwar experiments on the production of

[1]There are astonishingly few publications dealing with the fuel situation in Germany during the period from 1918 to 1945, despite the substantial technological accomplishments in the field of coal gasification and liquefaction. However, with the recent energy crisis, precipitated by the 1973 Arab oil embargo, a host of investigations was launched to study alternative fuels. One of the central avenues of investigation concerns the conversion of lignite into petrochemicals, an area in which modern Germany was particularly successful. This study, initiated by Texas A&M University's Center for Energy and Mineral Resources, represents the first historical investigation into an area which would have continued to remain untouched but for technology's need to look to the past for answers. A vast source of information on the German oil industry can be found in the superb collection of 208 (European Theater) reports which form the *United States Strategic Bombing Survey,* mimeographed and printed (Washington, D.C., 1945) (hereafter cited as *USSBS*). These reports are further supported by a large collection of documents and exhibits which comprise Record Group 243 in the Modern Military Records Division, National Archives, Washington, D.C. Of equal importance are 2,720 separate reports, which were prepared by teams of industrial and technical experts who were attached to the invading British and American armies in 1945. From April 1945 to June 1947, these teams investigated every facet of German industry and produced their findings in reports known as BIOS (British Intelligence Objectives Sub-Committee), its American counterpart FIAT (Field Information Agency, Technical), and the combined Anglo-American Agency, CIOS (Combined Intelligence Objectives Sub-Committee). These reports may be found in the Modern Military Records Division, National Archives, Washington, D.C.; the Federal Documents Repository, Suitland, Maryland; the U.S. Bureau of Mines, Research and Development Division, Pittsburgh, and in the Imperial War Museum, London. The raw data from which these reports were drawn are contained in 306 reels of microfilm called the Technical Oil Mission documents, the three known copies of which are held by the Library of Congress, the Department of Energy Station in Morgantown, West Virginia, and Texas A&M University. We have also recently located a collection of twenty-five reels of Allied intelligence reports on German synthetic fuel, located at the Albert F. Simpson Historical Research Center at Maxwell Air Force Base. A final source of information on the development of synthetic oil production in the Third Reich is the original records of the *Reichsministerium für Rüstung und Kriegsproduktion* (Reich Ministry for Armament and War Production), which are on deposit in the Imperial War Museum, London.

gasoline from coal moved forward rapidly, and within three short years after the end of the war, in 1921, they had it. Friedrich Bergius, who was to win the Nobel Prize in 1931, discovered the technique known as hydrogenation. This process converts coals, tars, and other solid or liquid carbonaceous substances into high-grade liquid fuels by adding huge quantities of hydrogen under 200–700 atmospheres pressure, and at high temperatures (between 400° and 600° C), in the presence of such catalysts as tin oxalate–ammonium chloride, or tungsten sulphide and nickel sulphide on activated Terrana catalyst. The hydrogenation process was particularly suitable for the production of high-grade motor and, after some additional processing, aviation fuel as well. In order to produce aviation gasoline by this process, German industry ran its hydrogenation plants to ordinary gasoline, with an Octane rating of 72, and subsequently treated it with the so-called DHD *(Dehydrierung Hochdruck)* process, or its variant H.F. (Hydroforming). Both the DHD and the H. F. processes produced a high-grade aviation base stock (A-3, 80 ON; B-4, 89 ON; and C-3, 950N) with a high aromatic content[2] (see fig. 1).

Another variation of the hydrogenation process by which I. G. Farbenindustrie, in particular, converted coal into motor fuel was by methanol synthesis. In this process a mixture of carbon monoxide and hydrogen was made to react at high pressures (about 200–300 atmospheres) and high temperatures (about 450°–500° C) over a catalyst to produce methanol. Methanol itself was never a success as a motor fuel component, but a variant of the process, the isobutyl process, became quite important. In this variant of the methanol process, an alkalized catalyst was used to produce not only methanol but about 14 percent isobutyl alcohol. The isobutyl alcohol was in turn separated and dehydrated to isobutylene, from which the important aviation gasoline blending agent, isooctane, was produced by polymerization and subsequent simple hydrogenation.

A second process was discovered in 1923 by two German chemists, Franz Fischer and Hans Tropsch, in which the coal molecules were

[2]For technical information on these processes, see "The Fischer-Tropsch Process," CIOS report, item 20, file VI-22, X-18 and 22, XV-5; "Medium Pressure Synthesis with Iron Fixed-Bed Catalyst: Interrogation of Dr. H. Kolbel," BIOS final report no. 1712, item 12; "Gelsenberg Hydrogenation Plant," CIOS report, item 30, file XXX-105; "Synthetic Oil Production in Germany: Interrogation of Dr. Butefisch," BIOS final report no. 1697, item 30; and H. H. Storch, N. Golumbic, and R. B. Anderson, *The Fischer-Tropsch and Related Syntheses* (New York, 1951); U.S. Bureau of Mines, *Synthetic Liquid Fuels Program,* Report of Investigations No. 5506, 1944–1955 (Washington, D.C., 1956); Neal P. Cochran, "Oil and Gas from Coal," *Scientific American* 234, no. 5 (May 1976): 24–29; and Warren F. Faragher, "Germans Made High Aromatic Aviation Gasoline by Coal Hydrogenation," *Refinery Management and Petroleum Chemical Technology* 37, no. 45 (November 7, 1945): (R) 851–55.

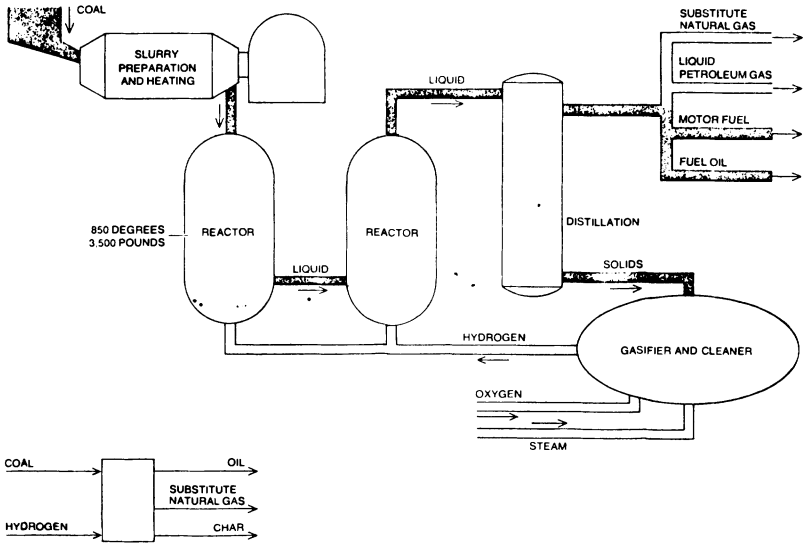

FIG. 1—Direct hydrogenation. In this process coal in the form of a slurry is fed into a reactor where it reacts with hydrogen at high pressure. The reactor usually contains a catalyst, such as cobalt molybdenum, that facilitates the process. After hydrogenation the liquid yielded by the reaction is distilled to remove solids, which are gasified to provide hydrogen for the operation. In this process, as in others, water in the form of steam is the source of the hydrogen that must be added to the coal to convert it into oil and gas. (From "Oil and Gas from Coal," by Neal P. Cochran. Copyright © May 1976 by Scientific American Inc. All rights reserved.)

broken up by steam and the resulting mixture of carbon monoxide and hydrogen was made to react at up to 20 atmospheres pressure, over a catalyst, and at well-controlled temperatures of about 200° C, to produce a synthetic crude oil (see fig. 2). The product of the Fischer-Tropsch process yielded a motor gasoline of low octane, a high-grade diesel oil, and some wax; despite the support of Ruhrchemie, the Fischer-Tropsch process never reached great importance for the liquid-fuel supply of Germany.

The final methods utilized in the conversion of coal to liquid fuel involved by-products of Germany's coking industry. Approximately 400,000 metric tons of *Benzol* were produced yearly (after 1935) to be used as motor fuel, an aviation fuel component, a solvent, and raw material for explosives. Germany's coking industry also produced about 1,750,000 metric tons of high temperature (H.T.) tar yearly from 1938, which was used as a feed stock to hydrogenation plants, or distilled into diesel oil, low-grade lubricating oils, pitch, road oils, and briquetting oils. The last such by-product was low temperature carbonization (LTC) tar (about 308,000 metric tons produced yearly from 1938), which could be distilled into low-grade motor gasoline,

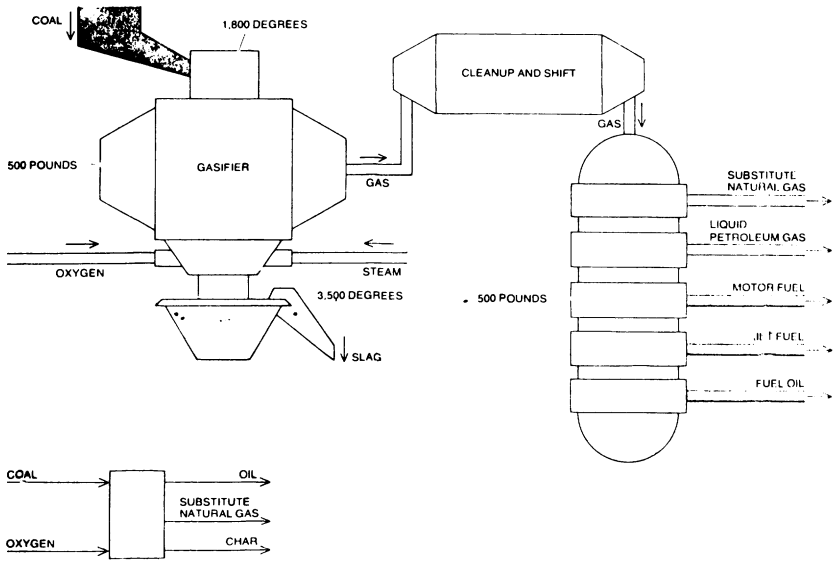

FIG. 2—Fischer-Tropsch process. Here coal goes into a gasifier where it is burned in the presence of oxygen and steam. The combustion generates a gas consisting mainly of carbon monoxide and hydrogen. In a cleanup-and-shift stage the gas is purified. It then passes over a catalyst, producing not only substitute natural gas of pipeline quality but also a variety of liquid products. (From "Oil and Gas from Coal," by Neal P. Cochran. Copyright © May 1976 by Scientific American, Inc. All rights reserved.)

and low-grade diesel and fuel oil. Its normal utilization, however, was as an excellent feeder stock for hydrogenation plants. As a result of these processes (hydrogenation, Fischer-Tropsch, and coking by-products), Germany could now obtain gasoline out of a coal mine, but more important politically, it could now operate a mechanized army of tanks, bombers, and fighter planes with a minimum of natural petroleum.

The next decade saw the development of a number of variations on the Bergius-hydrogenation and Fischer-Tropsch processes, depending upon the different qualities of local coal (sulphur content, moisture, ash, availability of water, etc.), and the different catalysts employed (nickel-thoria on kieselguhr, cobalt catalyst, chrome oxide and molybdic oxide on Florida earth, etc.). Names like Linde-Karawat, Koppers, Lurgi-Drawe, Pintsch-Hillebrand, Bubiad-Didier, Winkler, and Schmalfeldt came to represent the majority of the variations of these two synthetic methods.[3]

Regardless of the differences in these processes, production of synthetic fuel required acres of pipes, ovens, conveyor belts, presses,

[3]*USSBS*, "Methods for Preparation of Synthesisgas," mimeographed, Record Group 243, file 110, document B 18.

compressors capable of building from between 3,000 and 10,500 lbs per square inch, laboratories, and storage facilities. This was no operation for small independent factories, since the initial capitalization could easily run into the tens of millions of Reichsmarks. Such operations required the facilities of the major German chemical combines, like Ruhrchemie which bought the patent rights to the basic Fischer-Tropsch process and built the first commerical plant of this type in its nitgrogen works at Holten. I. G. Farbenindustrie in turn bought the Bergius patent and built the first hydrogenation plant at Leuna. Dozens of lesser industrial giants—companies like Deutsche Erdöl A.G., H. Koppers G.m.b.H., A. G. Sächsische Werke, Lurgi Gesellschaft für Warmetechnik and Krupp Treibstoffe Werke G.m.b.H.—bought or developed variations of these synthetic processes.[4] Each company continued to pursue the variations of coal gasification and liquefaction, while in the political arena the crumbling Weimar Republic finally gave way to the cataclysm of the Nazis. The great industries were gratified to learn that the new regime's interest in synthetic petrochemicals surpassed even their own.

Oil and the Nazi Government

When the Nazis came to power in 1933 they were fully aware of Germany's dependency on overseas imports for crude oil. "Our dependence on foreign trade," declared Hitler in 1934, "would condemn us eternally to the position of a politically dependent nation."[5] Although it later became clear that his solution involved not greater industrialization but the conquest of eastern Europe, the new regime began taking immediate steps toward autarchy in oil products by harnessing the great industries to the future goals of German militarism. The coal and chemistry industries, no less than steel, textiles, shipping, and construction, received massive government support—though it was legislative rather than financial and not always welcome. Armed with unlimited arbitrary powers, the Ministry of Economics gradually agglomerated private corporations into industrial monopolies, restructured the corporate system to create a rapid increase in undistributed profits, forced corporate boards of directors to accept new political "appointees," and all but disenfranchised the stockholders. Moreover, the government offered numerous concessions to those companies who complied with their benefactors, and generally included access to inexpensive land, flexible railroad

[4]For a close investigation of these companies, see CIOS reports, item 30, file XXX-13; item 30, file XXV-25; item 30, XXVII-69; item 30, file XXXII-91; item 30, file XXVIII-23; and item 30, file XXXII-3.

[5]Quoted in Hermann Rauschning, *Gespräche mit Hitler* (Zürich, 1940), p. 116; see also Arthur Schweitzer, *Big Business in the Third Reich* (Indiana, 1964), pp. 440–45.

schedules, adequate labor, and the not-insignificant removal of bureaucratic obstacles. All of which led to nearly unlimited industrial expansion.

The regime moved decisively in three general areas to increase the production of petroleum. First, in an effort to encourage domestic production or to discourage Germany's continued dependence on foreign fuel, a stiff tariff barrier was erected against imported gasoline. The duty on gasoline with a specific gravity of less than 0.750, for instance, was increased yearly until, by December 1936, the duty reached 270.90 Reichsmarks per ton or 30.1¢ per U.S. gallon. At the same time, motor fuel produced by foreign companies using German raw materials was subjected to an excise duty (called *Inlandsabgabe*) of 60 Reichsmarks per ton or 6.7¢ per U.S. gallon.[6]

Second, the government encouraged its most enthusiastic industrial partner and the largest chemical industry in the world, I. G. Farbenindustrie, to increase the exploitation of its secret agreements with Standard Oil of New Jersey. The curious history of this corporate marriage goes back to 1927 when a formal agreement was signed through a jointly owned company, International Hydro-Patents Company, by which Farben agreed to supply Standard Oil with complete details of the hydrogenation process in return for the construction of a complete hydrogenation plant plus $30 million worth of Standard Oil stocks. By November of 1929, I. G. Farben and Standard Oil had completed four additional agreements which effectively achieved price fixing through patent royalties, the division of markets through International Hydro-Patents Company, and, finally, Farben's agreement to stay out of the oil business while Standard deferred to Farben in the chemical field. The next several years saw the creation of a tangle of interlocking agreements and joint corporations, such as the American I. G. Chemical Company, I. G. Chemie, and Jasco Incorporated, in a relationship which continued long after the Nazis came to power.[7]

[6]*USSBS,* "German Oil Industry, Ministerial Report" team 78, sec. 1.07, mimeographed (September 5, 1945), p. 18 (hereafter cited as "German Oil Industry").

[7]The largest German cartels were, of course, closely linked with many of America's largest petroleum and chemical industries (see Gabriel Kolko's "American Business and Germany, 1930–1941," *Western Political Quarterly* 15 [December 1962]: 713–28). The fact that this technical cooperation continued to the very outbreak of the war was the source of some bitter resentment in the United States (see "Standard Oil and I. G. Farben," *New Republic* [August 4, 1941], pp. 147–49; Richard Sasuly, *I. G. Farben* [New York, 1947]; and Howard Watson Ambruster, *Treason's Peace* [New York, 1947]). To complicate matters, the documents reveal that much of this combined knowledge was later passed to Germany's wartime ally, Japan (see "Technical Assistance on Synthetic Oils Rendered the Japanese by the I. G. Farben-industrie A.G.," CIOS Report, item 30, file XXX-34).

As a result of the new regime's effort to make Germany self-sufficient in petroleum products, however, I. G. Farben began to exploit the relationship. For example, after Standard Oil assigned Farben control of its steam process for ammonia synthesis—a superior method for making explosives—in 1933, Farben refused to issue licenses to American firms to utilize the identical process. A similar exploitation concerned a host of lesser products, such as acetylene, in which process both parties had previously shared. In 1938 the half-owned subsidiary of Standard Oil, Deutsche-Amerikanische Petroleum A.G., built a 100-octane aviation-fuel plant in Germany with a capacity of 150,000 metric tons per year, while at the same time I. G. Farben refused to allow Standard Oil to produce the identical aviation fuel for the United States Army.[8] So successful was this one-sided industrial relationship to Germany's fuel position that, in 1944, I. G. Farben was able to boast that "since the beginning of the war, we have been in a position to produce lead tetraethyl solely because a short time before the outbreak of the war, the Americans had established plants for us, ready for production, and supplied us with all available experience."[9]

Even before the Nazis came to power, I. G. Farben had negotiated with the Schleicher government for guarantees against losses in future expansion of synthetic petroleum installations. These negotiations culminated in the major *Benzinverträg* agreement with the Nazis in 1934. In exchange for government-guaranteed prices and markets for the duration of this ten-year contract, Farben agreed to increase annual production of 350,000 metric tons by December 1935, Risks removed, it seemed that I. G. Farben would profit handsomely, despite a minor clause stipulating that substantial excess profits would be returned to government coffers. It quickly learned, however, that the rebate clause was meant to be enforced.[10]

The government's third major effort to stimulate domestic fuel production saw the consolidation of petroleum-producing monopolies under central control. In September 1934, the Ministry of Economics moved swiftly to force all major brown-coal interests into a semipublic compulsory combine, known as BRABAG (Braunkohlen-Benzin A.G.), to coordinate the construction and operation of several new synthetic fuel plants, all costs for which were to be borne

[8]Kolko, pp. 722–23; and Wendell Berge, *Cartels: Challenge to the Free World* (Washington, D.C, 1944), p. 23.

[9]Kolko, p. 725; *New York Times* (October 19, 1945); *Trials of War Criminals before the Nuremberg Military Tribunal under Control Council Law No. 10* (Washington, D.C., 1951–52), 8:1279.

[10]Wolfgang Birkenfeld, *Der synthetische Treibstoff 1933–1945: Ein Beitrag zur nationalsoziallstischen Wirtschafts- und Rüstungspolitik* (Göttingen, 1964), pp. 26–34.

by the brown-coal companies. The same year, a wide strata of chemical, coal, steel, and construction corporations were forced to underwrite yet another organization, this with the misleading name "Economic Research Association" (Wirtschaftliche Forschungsgesellschaft) commonly known as Wifo. From its inception, it was clear that Wifo, a completely government-controlled company, was merely a facade to mask the war preparations of the Wehrmacht and the Luftwaffe. Apart from the construction of several nitric acid and toluene plants for use by the armed forces, the chief function of Wifo was to build underground storage space and to accumulate synthetic fuel as a military war reserve. By the start of the war, in fact, Wifo had under its direct control more than 6 million barrels of storage space, though it had succeeded in accumulating only 4 million barrels of fuel.[11] The major problem by 1936, however, was that there were altogether too many independent and semi-independent agencies and producers dealing with oil, with no real effective coordination. That, declared a number of Hitler's ambitious associates, was about to change.

In March 1936, after much interparty rivalry, Luftwaffe leader Hermann Göring secured Hitler's support to become Germany's "Fuel Commissar" with broad powers to implement a massive Four-Year Plan. With much fanfare, this new plan was announced as the means by which Germany was to become "100% independent of foreign sources" in fuel—totally self-sufficient—in the astonishingly short time of eighteen months! With regard to synthetic fuels in particular, the plan called for a considerably greater expansion of hydrogenation plants rather than Fischer-Tropsch plants, for several reasons. The principal reason was that hydrogenation could produce large quantities of high-quality aviation gasoline (for Göring's Luftwaffe), while the Fischer process produces none. Moreover, the motor gasoline produced by hydrogenation is superior in quality to that from the Fischer process, and the hydrogenation process is better adapted than the Fischer process to the utilization of the vast amounts of brown coal. Finally, and of no small significance, the expansion of hydrogenation plants at the expense of Fischer-Tropsch plants was strongly influenced by the powerful I. G. Farbenindustrie, which happened to be the owner of the hydrogenation process. In any case, the Four-Year Plan launched the construction of ten hydrogenation synthetic fuel plants at a total cost of 1,150 million Reichsmarks, and Fuel Commissar Hermann Göring predicted a scheduled yearly increase in fuel production (synthetic as well as crude) from 1.4 million metric tons in 1936 to 4.3 million metric tons by 1940.

[11]"Reich Ministry of Armaments and War Production," CIOS Report, item 28, file XXVI-12; "German Oil Industry," sec. 1.07 and 1.08; *Technical Oil Mission*, reels 32 and 73.

It quickly became evident that these goals were unrealistically optimistic. Bottlenecks in the plan appeared in the required supply of steel, iron, and manpower, not to mention the increasingly unavailable private capital (574 million Reichsmarks) which the plan demanded from industry.[12] Foreign imports, several times less expensive than synthetic petroleum, continued to rise dramatically, and it became necessary for the Government Office for Economic Expansion (Reichsamt für Wirtschaftsausbau), to revise downward the original goals for the Four-Year Plan. Finally, in July 1938, it was decided to introduce a new plan—the Karin Hall Plan—which readjusted the original Four-Year Plan toward war production and which contained a sensible 15 percent reduction in Göring's fuel expectations. By the target date of 1940, even the reduced goal of the Karin Hall Plan of 1938 fell about 5 percent short of expectations.[13]

Yet, despite the difficulties, fuel production under the Nazis increased substantially. From 1936 to 1939, in fact, synthetic oil production nearly doubled, and when the war broke out on September 1, 1939, Germany had a total of fourteen hydrogenation and Fischer-Tropsch plants operating at full capacity, with an additional six new plants under construction. Although no new domestic oil fields had been discovered, Germany's annexation of Austria in March 1938 provided access to additional producing areas, and the subsequent discovery of the Prinzendorf field in the Vienna Basin enabled Austria to contribute crude at a rate of nearly 900,000 metric tons per year. Thus on September 1, 1939, at the moment when the German legions poured across the frontier into Poland, the fuel situation (in metric tons per year) was as follows: (*a*) Synthetic fuel by hydrogenation, 1,227,000, by Fischer-Tropsch, 240,000; (*b*) domestic crude plus

[12]The 574 million Reichsmarks are financed by private interests as follows:

Private Interest	Million Reichsmarks	%
Participating companies' own funds	98	17.1
Bank credits	98	17.1
Issue of new capital stock	155	27.0
Issue of bonds	211	36.7
Government credits	12	2.1
Total	574	100

SOURCE.—"German Oil Industry," sec. 1.07, p. 23. See also Dieter Petzina, Autarkiepolitik im Dritten Reich: Der nationalsozialistische Vierjahresplan (Stuttgart, 1968), pp. 83, 97, 169–88.

[13]Berenice A. Carroll, *Design for Total War: Arms and Economics in the Third Reich* (The Hague, 1968), pp. 123–37; and "Letter from Hjalmar Schacht to Hermann Göring, 2 April, 1937, Subject: The Four-Year Plan," *Nazi Conspiracy and Aggression* (Office of United States Chief of Counsel for Prosecution of Axis Criminality), vol. 7, document EC-286, pp. 384–85.

imports, 1,454,000; and (*c*) Austrian crude, 900,000; for a total of 3,821,000.[14] This petroleum, in turn, produced the following quantities (in metric tons per year) of oil products: gasoline, 1,769,000; diesel oil, 781,000; heating oil, 728,000; and lubricants, 462,000; for a total of 3,750,000.[15] Moreover, Germany had accumulated about 4 million additional metric tons of fuel, mostly imported petroleum, in Wifo storage centers across the country. Germany's fuel situation represented an impressive leap forward from its status in 1933, though it was substantially less than the military offensives required (see figs. 3 and 4).

Germany's entire oil position, in fact, was wholly inadequate for an extended and mechanized war. In comparison, her future enemy, Great Britain, a country with a much smaller population, imported 12 million metric tons of fuel during that same year, and the United States and Russia produced 164 and 29 million tons per year, respectively. On the basis of production versus consumption required to sustain both the military and civilian economy, even the most optimistic German estimate showed that the available motor fuel would sustain the nation for 5.2 months, and diesel fuel, only 3.2 months. The German government, therefore, responded by moving in three areas simultaneously. First, the entire German oil-producing combine was brought under tight government control; second, resources of newly conquered territories in eastern Europe were savagely exploited. Finally, civilian and military consumption was sharply curtailed by means of rationing.

Tightening Government Control

Government control over the coal, crude oil, and synthetic petroleum industries had been growing stronger and stronger through the 1930s. Within the loose traditional confederation of industry representatives, originally called the Reichskohlenrat (Reich Coal Council), and replaced in 1939 by the Reichsvereinigung Kohle (Reich Coal Union) and Reichsstelle für Kohle (Reich Coal Board), a new series of wartime controls were brought to bear. The industry as a whole was divided into four industry associations called Arbeitsgemeinschaften, each of which was responsible for the production and allocation of the products under its control. These associations were: (*a*) Arbeitsgemeinschaft Erdölgewinnung und Verarbeitung (AEV) (Association for Crude Oil Production and Refining), (*b*) Ar-

[14]Table in *USSBS, Oil Division Report,* p. 18, fig. 5 (hereafter cited as *Oil Division Report*).

[15]Table in Burton H. Klein, *Germany's Economic Preparations for War* (Cambridge, Mass., 1959), p. 40.

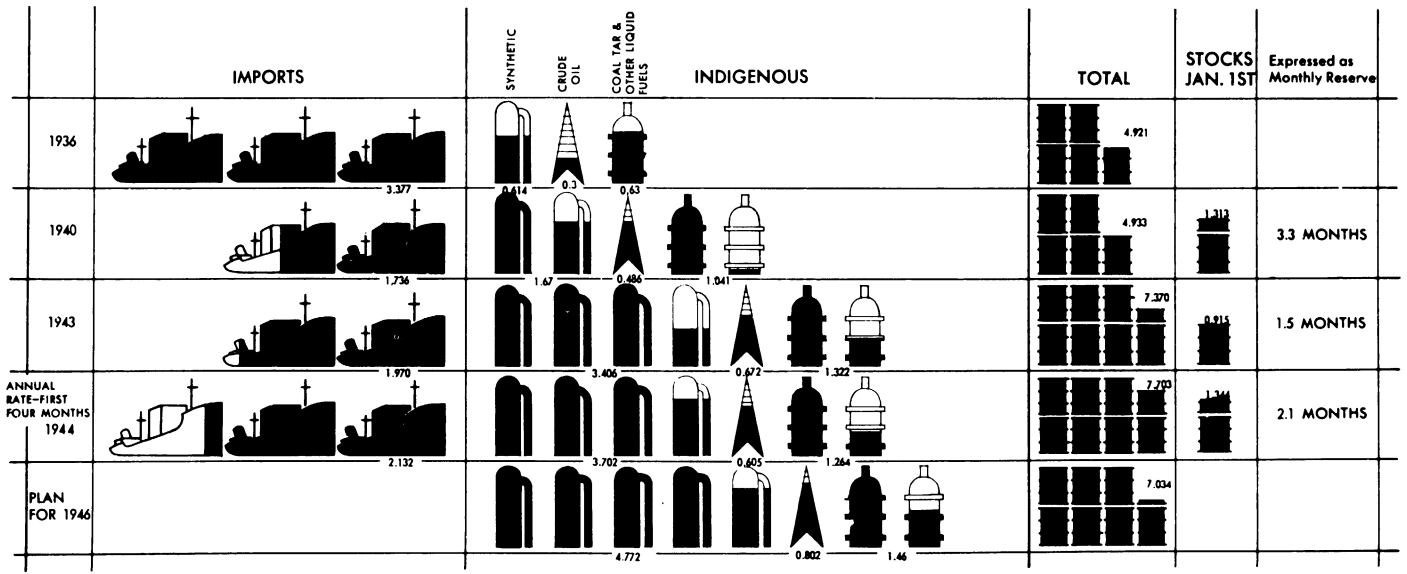

FIG. 3—German liquid fuel position (figures in millions of metric tons). (From *USSBS*, "Oil Division Final Report" [Washington, D.C., August 25, 1945], fig. 1, p. 1.)

	Capacity as of September, 1939	Capacity as of May, 1940	Ultimate Capacity: Plants Designed Prior to War	Ultimate Capacity: All Plants
Western Germany				
Hydrogenation	246	386	1,014	1,065
Fischer-Tropsch	144	270	365	365
TOTAL	390	656	1,379	1,430
Central Germany				
Hydrogenation	981	1,018	1,488	1,491
Fischer-Tropsch	96	138	182	182
TOTAL	1,077	1,156	1,670	1,673
Eastern Germany				
Hydrogenation	—	36	640	1,495
Fischer-Tropsch	—	6	40	40
TOTAL	—	42	680	1,535
Total				
Hydrogenation	1,227	1,440	3,142	4,051
Fischer-Tropsch	240	414	587	587
TOTAL	1,467	1,854	3,729	4,638

FIG. 4—German synthetic oil capacity in operation or under construction at outbreak of war (thousands of metric tons per year). (From *USSBS*, "Oil Division Final Report" [Washington, D.C., August 25, 1945], table 5, p. 18.)

beitsgemeinschaft Hydrierung, Synthese und Schwelung (ARSYN) (Association for Hydrogenation, Synthesis and Low Temperature Carbonization), (*c*) Arbeitsgemeinschaft deutscher Benzolerzeuger (ARBO) (Association of German Benzol Producers), and *(d)* Arbeitsgemeinschaft Verteilung deutscher Steinkohlenteererzeugnisse (AVS) (Association for Allocation of German Bituminous Coal Tar Products). These four associations of producers were harnessed upward in turn to an association of distributors. Acting under a direct charge from the German government in September 1939, all the companies concerned with handling petroleum products—taking in seventeen large concerns and over 300 jobbers—were banded into an "Association of Mineral Oil Distributors" (Arbeitsgemeinschaft Mineralölverteilung or AMV). Direct government control over the association was exerted through a subsidiary of the AMV, called the Zentralbüro für Mineralöl G.m.b.H. (Central Bureau for Mineral Oil, Ltd., or ZB). All dealings with the government, then, were handled by the ZB, which was charged with the procurement and distribution of

all motor gasoline and diesel fuel produced in the Greater Third Reich (i.e., Germany, Austria, Alsace-Lorraine, Luxemburg, and part of Poland).[16] Within the government itself, a number of agencies were created to bring the petroleum-producing industries under further control. The Ministry of Economics (Reichs Wirtschaftsministerium) was in overall control, although, like every other agency dealing with Germany's industries during the war, it too was totally responsible to Albert Speer's Reich Ministry of Armaments and War Production (Reichsministerium für Rüstung und Kriegsproduktion), and ultimately to the German High Command (Oberkommando Wehrmacht).[17] From the Ministry of Economics downward, the keystone in the structure of governmental control over the German oil economy was the Reichsstelle für Mineralöl (Reich Board for Mineral Oil). Further down, government power passed to the Rohstoffamt Amtsgruppe Mineralöl (Office of Raw Material Oil), which, in turn, passed control to its subdivision Wirtschaftsgruppe Kraftstoffindustrie (Economic Group for Liquid Fuels). It was at this point that the agencies of the government met the agencies of the petroleum industry.

A general picture of this wartime circuit, then, saw (*a*) producing plants (refineries of crude oil and synthetic plants) under tight governmental control manufacturing basic fuel stock at an unprecedented rate for the war effort. These plants had inadequate storage facilities, and as the fuel was produced it was shipped almost immediately to (*b*) one of a number of ZB centers across Germany. The main ZB depots acted as blending stations, tailoring the fuel for its intended function, and, when necessary, adding tetraethyl lead to the gasoline. The finished products were then shipped in bulk by tank car or tank truck to (*c*) the depots of the armed forces, or Wifo. Additional blending would also be made at these depots. Throughout the war, all aviation fuel destined for the Luftwaffe, as well as drums and jerricans of motor fuel destined for the Wehrmacht, was processed at Wifo depots. The finished products were then shipped in bulk to the specified depots of the armed forces, to other Wifo depots, or to jobbers for use by the civilian economy.

[16]"German Oil Industry," sec. 1.07, p. 19.

[17]"Reich Ministry of Armaments and War Production," CIOS report, item 28, file XXVI-12; Petzina, p. 60. For a fascinating examination of Speer's bureaucracy, see Ethan A. Singer and Leland M. Wooton, "The Triumph and Failure of Albert Speer's Administrative Genius: Implications for Current Management Theory and Practice," *Journal of Applied Behavioral Science* 12, no. 1 (1976): 79–103. A more detailed investigation may be found in Wolfgang Becker, "The Basis of the German War Economy under Albert Speer, 1942–1944" (Doctoral diss., Stanford University, 1971).

Expansion through Conquest

The German government's second remedy to their decision to enter the war with only a few months' supply of fuel was to drain the newly conquered territories of Poland, Rumania, and southern Russia. With the conquest of Poland in 1939 came the crude production and refining capacity of Galicia: 320,000 metric tons of paraffins, 60,000 metric tons of asphaltic crude oil, and a refining capacity of 390,000 metric tons per year.[18] In addition, Germany captured new modern plants still under construction at Jaslo and Drogobych with the capacity to process all the crude oil produced in that area. It was a substantial amount of petroleum and almost immediately replaced the oil reserves which Germany had expended to take Poland.

The following year, in 1940, Germany's lightning sweep into France and the Low Countries provided dividends of a different sort. The invading Wehrmacht took control of several large and up-to-date oil refineries, but since Germany lacked the crude oil to begin with, she was never able to utilize these refineries to full advantage. Later in the war, these installations were cannibalized for special equipment needed by the German plant at Lobau and to repair Rumanian and German refineries damaged by Allied air raids. One prize of the French campaign was particularly valuable to the German war machine: the oils fields of Pechelbronn, in Alsace, which, from July 1941 on, contributed 60,000–65,000 metric tons of crude oil per year to the Third Reich.[19]

The most important acquisitions of raw materials and refining facilities, however, came through "alliances" with Rumania and Hungary. Although prior to its alliance with Germany in November 1940 Hungary's crude oil production was hardly sufficient to meet its own domestic needs, German demands and expertise quickly changed that. In 1936, for example, four years before Hungary threw its lot in with Germany, Hungarian crude oil production was a scanty 450 metric tons; by 1940 it had reached 231,000 tons and under German control had soared to 809,000 metric tons by 1944.[20] The real prize, however, was Rumania. As early as 1938 the Office of Economic Expansion (Reichsstelle für Wirtschaftsausbau) had counted on Ruma-

[18]Robert L. Baker, *Oil, Blood and Sand* (New York, 1942), pp. 16–22; "German Oil Industry," sec. 2.05; and *Technical Oil Mission,* reels 24, 48, 50, and 97.

[19]"German Oil Industry," sec. 2.06; "Synthetic Lubrication Oil Production in France," CIOS report, item 30, file XVIII-5; "Chemical Industries in Belgium and France during German Occupation," CIOS report, items 2 and 22, file V-30 and XII-18.

[20]"German Oil Industry," sec. 2.06; and *Technical Oil Mission,* reel 10.

nian oil for Germany's military machine, and, in fact, Berlin had been importing Rumanian crude oil for years to augment its own reserves. But after Rumania joined the Axis in November 1940, exports were considerably increased, and the massive Ploesti oil fields of Rumania contributed approximately 3 million metric tons of refined petroleum products to Germany each year.[21]

An unexpected dividend came in the conquest of Estonia in 1941. The Estonians had developed a modest but relatively sophisticated shale oil industry, which had yearly produced 120,000 metric tons of crude shale oil until the retreating Russian forces had largely destroyed their refineries. The incoming Germans swiftly repaired the damaged industry, and by 1943 production had reached 107,000 metric tons.[22]

In 1941, the total oil production of Axis Europe was approximately 12 million metric tons. Of this amount the Germans produced 4.1 million metric tons of synthetic oil products and 1.6 million metric tons of crude oil. Rumania contributed 5.5 million metric tons of crude oil, and Hungary, Poland, Estonia, and even Albania, together, contributed an additional 0.9 million metric tons. Without question, 6.6 million tons of crude and refined petroleum would easily have satisfied any and all domestic projects upon which the Third Reich might choose to embark, were she only able to curb her obsession for additional conquest. This she was unable to do, and on June 22, 1941, Germany declared war on the Soviet Union. The very success of the Russian campaign hinged on the availability of a vast supply of additional petroleum, since it was required to fuel the continuation of the campaign, and the massive oil resources of the Caucasus became Germany's major goal. The Baku oil fields, in particular, produced fully two-thirds of Russia's crude oil supply and two and a half times as much as all of Axis Europe. With the Wehrmacht's colossal defeat before Stalingrad, the Nazis' only hope of obtaining adequate oil resources to sustain this new campaign, and therefore the entire war, was shattered. The Maikop fields, with only a tenth of the output of Baku, were captured by the Germans in August 1942, but were retaken by Soviet forces before any substantial output was obtained. It was the beginning of the end, although that end was still several years in the future.

[21]*Mineralöl Sicherungsplan: Stand 15, 9, 1944* [Fuel Situation as of September 15, 1944]; Reichsministerium für Rüstung und Kriegsproduktion, F.D. 3043/49, Sc. 367, folder 1, p. 10, Imperial War Museum; Frederick Phillip Hellin, "Russia's Oil and Hitler's Need," *Atlantic Monthly* (June 1942), pp. 675–82.

[22]*Technical Oil Mission,* reels 65, 70, and 86; "German Oil Industry," sec. 2.05, no. 4, p. 45.

Reducing Wartime Consumption

The third and final effort by the German government to adjust to Germany's initial fuel situation, complicated by her unexpected decision to begin the war nearly a year before all projections deemed reasonable, was the government's attempt to reduce fuel consumption by both military and civilian sectors. The most vital consumer during wartime, of course, was the military, and its consumption varied widely with the course of the war. The opening attack of the war against Poland in 1939, resulted in a relatively small drain on Germany's fuel reserves. But the assault on France and the Low Countries (and the bombing of Britain) the following year saw the use of fuel rise sharply to an average of 100,000 metric tons per month. Then came Russia. When the German legions crossed into Russia on June 22, 1941, no fewer than 800,000 Wehrmacht vehicles were consuming petroleum products. In fact, the all-time high of German military consumption was reached in the first month of the invasion of Russia (June 1941), consumption reaching an astonishing 268,000 metric tons of motor gasoline alone. The consumption of diesel fuel, during the same month, peaked at 86,000 metric tons, and by the spring of 1943 the Luftwaffe was projecting the awesome drain of up to 250,000 tons of aviation fuel per month.[23] When consumption finally did begin to drop during the end of 1943 and the early weeks of 1944, the massive Allied bombing raids on the centers of German industry, coupled with the Normandy invasion in June, spelled the end.

To curtail this enormous consumption of fuel, the Wehrmacht High Command initiated a series of economy measures. Horses were utilized whenever possible, and tens of thousands were shipped to the eastern front to replace fuel-driven vehicles. In cases where horses were not applicable, and yet the need for petroleum fuel not mandatory, the army turned to wood and coal-burning generators. So impressed was the government by the potential savings offered by these generators that at the end of 1944 the German government, through the Rüstungskontor (Armament Office), bought a 50 percent partnership in the private company, Generator A.G., which manufactured these devices.

The most common type of vehicle generator, called the Imbert down-draught model (see fig. 5), consisted of a heavy metal cylinder with a fuel hopper above and a fire grate in the lower portion. The

[23]"German Oil Industry," sec. 5.03; *Oberkommando der Wehrmacht,* Zusammenstellung über die personnelle und materielle Rüstungslage der Wehrmacht, Oberkommando der Wehrmacht [OKW; Army High Command], Abteilung Landesverteidigung, March 1943.

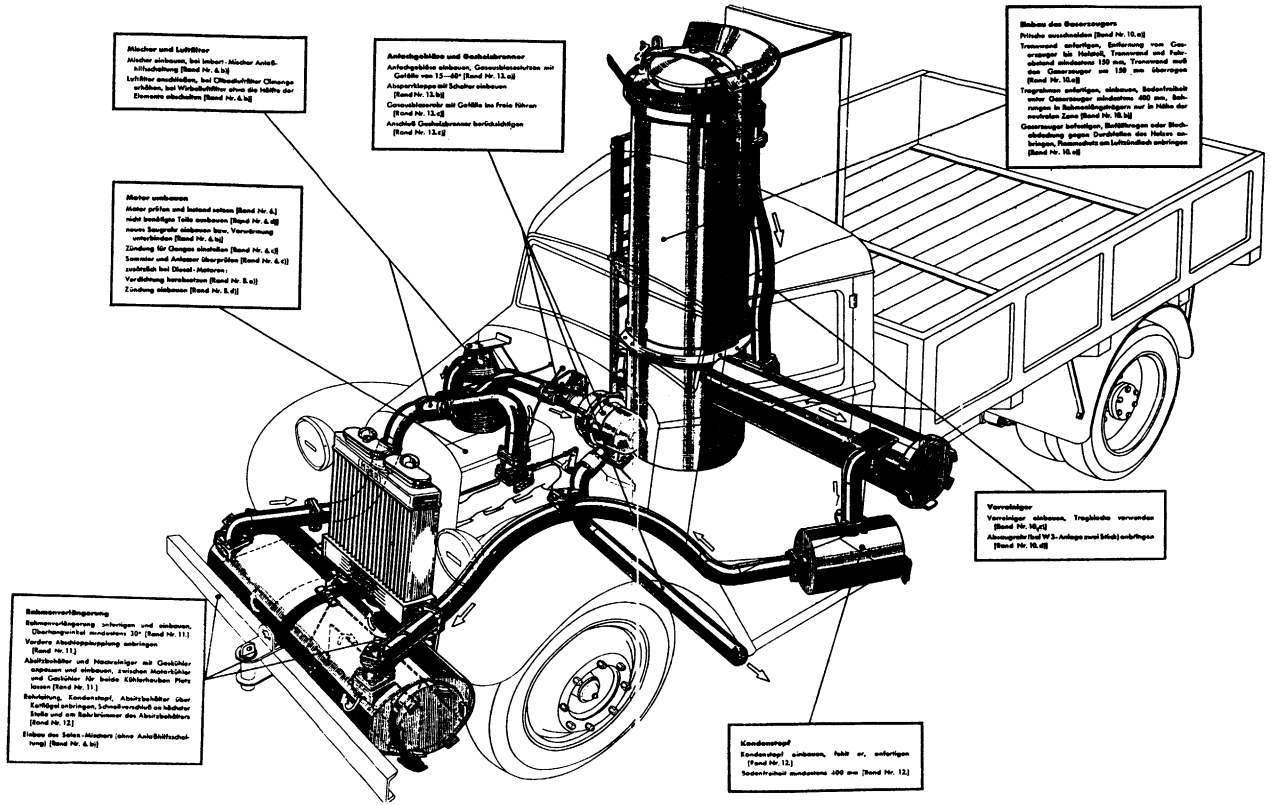

FIG. 5—Imbert down-draught wood and coal-burning generator (from Oberkommando der Wehrmacht [OKW; Army High Command], "Gaserzeugeranlage Imbert im Verschiedenen LKW," D696/35 [December 18, 1944], pp. 84–85.)

resulting producer gas was then fed into an expansion box or centrifugal dust separator to prevent solid particles from entering the engine, then through a simple cooling unit, and finally through a scrubber or filtering device, usually a container filled with dry or water-moistened coke, wood wool, or cork. The unit only required an additional throttle device on the car's engine, piping, and a fan to induce air flow for starting or when the vehicle was stationary. The engine itself required a minimum of conversion—little more than the planing of metal from the cylinder heads to increase the compression ratio. The Imbert model was modified and produced by a number of automobile manufacturers, notably Auto-Union A.G. and Daimler-Benz A.G., at weights of 35 and 70 kg, respectively, and it consumed wood at the rate of about 1.5 lb per mile. Charcoal was also used effectively, as was anthracite.[24] Despite the obvious disadvantages of such generators (i.e., bulky fuel requirements, decreased auto efficiency, and the presence, in producer gas, of up to 30 percent carbon monoxide) Germany's fuel shortage necessitated their utilization for more than three years after the end of the war.

In noncombative areas, especially in the occupied territories of France and the Low Countries, strict instructions were issued that, with the exception of the "Technische Truppe," all military and, if possible, civilian, vehicles were to be equipped with generators. By 1944, at least fifty Tiger Tanks were generator driven.[25] The severity of these fuel cutbacks, combined with the lack of military-offensive activity during the spring of 1943, did indeed lead to a substantial recovery. Consumption had been greatly reduced, and even Germany's reserves were making an amazing recovery. At the end of 1941, for example, Germany's reserves had dropped dangerously low, below 800,000 metric tons of fuel, representing less than two-months' supply at the average consumption rate of 1941. By April 1944, German stocks of aviation and motor gasoline and diesel fuel had skyrocketed to 1,372,000 tons. The accomplishment of this rather spectacular recovery, however, was less a tribute to the restrictions

[24]Committee of Operations Analysis, British War Cabinet Technical Sub-Committee on Axis Oils, "A Review of the Substitute Fuel Position in Continental Europe," L211a/1/Z (January 6, 1944), pp. 1–28. Roll A-1004, reference 118,04Q-10. Albert F. Simpson Historical Research Center, Maxwell Air Force Base. A complete description of the gas generator, including blueprints and experimental data, may be found in the Wehrmacht pamphlets "Kraftfahrzeuge verschiedener Typen mit Gaserzeuger Imbert," D696/2 (October 13, 1943); and "Gaserzeugeramlage Imbert in verschiedenen LKW," D696/35 (December 18, 1944), Record Group 242/1032, Modern Military Records Division, National Archives, Washington, D.C.

[25]"German Oil Industry" sec. 5.04, p. 73; "Oil Division Report," p. 27.

placed on the military than to the enormous sacrifices made by the civilian sector.

From the very beginning in January 1933, the National Socialist regime was caught in a conflict of interests. On one hand, the government was deeply concerned with the conservation and stockpiling of fuel, and on the other, it was Germany's policy, since the advent of the Nazis, to build up a large automobile industry and to provide a steady flow of consumer goods. Thus, the purchase of automobiles and motorcycles was encouraged by advertisements and tax reductions, and any such item purchased after March 25, 1933, became exempt from any registration and license taxes. Again, during the summer of 1936, only months after the inauguration of the great Four-Year Plan, the government issued a decree allowing a 33⅓ percent tax reduction on the purchase of new trucks, provided they met specifications such as: 3½-liter engines of 66 h.p.; five speeds; 190 × 20-cm tires; and so on. Two years later, as the Karin Hall Plan was being introduced to reduce the goals of the original Four-Year Plan, the Nazi government trumpeted the opening of the Volkswagen plant with its consumer-oriented installment payment plan. Prior to 1939, therefore, the average German citizen may have found himself restricted in his consumption of numerous commodities and foodstuffs, but petroleum was not among them.[26]

Thus when the war began, German civilians were consuming about 200,000 metric tons of motor gasoline a month. In fact, prior to 1939, German civilians had been the fourth largest consumers of oil products in the world, a status which was simply not compatible with a massive two-front war. In a tug-of-war between the proverbial guns and butter,[27] there was little doubt as to the outcome. Civilians were informed within four months of the beginning of the war that drastic reductions in civilian consumption of fuel and petroleum products were to be expected. By the spring of 1940 those expected limitations had arrived, and Germany patriotically endured a drastic cut to 71,000 metric tons a month, followed quickly by still greater cuts. The

[26]Richard Grunberger, *The 12-Year Reich: A Social History of Nazi Germany* (New York, 1971), pp. 222–39.

[27]Even butter was eventually synthesized as well. During the war years, a synthetic butter was manufactured by Deutsche Fettsäure Werke in Witten. The process involved the manufacture of straight chain aliphatic acids of C_{11} and C_{12} and their esterification with glycerin. The resulting ester mixture was refined and purified and sold largely to hospitals and the German army. Production averaged 11,000 lb. per day, was competitive with margarine, and could have been sold with profit at 60 percent of the price of natural butter (see CIOS report 22/459, item 22, file XXXI-79; and *Technical Oil Mission,* reel 199).

civilian consumption of motor gasoline rapidly decreased from 53,300 metric tons per month through 1941, to 28,750 tons per month in 1942, to 24,800 metric tons during 1943, and finally, to a bare 23,750 metric tons during the months of 1944.[28] These tremendous cuts were in large measure compensated by the replacement of wood-burning generators similar to those being issued to German vehicles in occupied France. Inexpensive generators were manufactured by the government-controlled Generator A.G. and sold by the hundreds of thousands.

By early summer of 1944 the number of vehicles in Germany which had been converted to generator use was estimated to be about 86,000, 70 percent of which ran on wood or peat.

Even more significant as a substitute for standard motor gasoline was the adaptation of bottled gas. A mixture of liquefied butane and propane, which the Germans called *Treibgas,* this fuel was used to some extent before the war but came into its own as the first substitute for motor gasoline to appear in appreciable amounts after 1939. Actually, *Treibgas* was not a substitute fuel in the true sense of the word, since it was produced as a by-product of the manufacture of aviation and motor gasolines and was produced mainly in the hydrogenation plants. Nonetheless, the production of *Treibgas* reached a peak of 388,000 metric tons in 1943, constituting about 30 percent of the total substitute automotive fuel used by civilians.[29] With the devastating Allied bombing raids in 1944, however, the production of *Treibgas* slipped rapidly to only 210,000 metric tons during that year, since hydrogenation plants were among the main Allied targets. In addition to *Treibgas,* German civilians were offered several other fuel substitutes. A type of compressed gas called *Permagas* was sold to fuel-starved civilians at an equivalent gasoline tonnage of 30,000 metric tons in 1944, while the sale of an additional methane gas substitute skyrocketed to 12,050 metric tons in the same year. In the final analysis, slightly more than 50 percent of the fuel used by German civilians during the war consisted of such substitutes as *Treibgas, Permagas,* and bottled methane.

Diesel fuel was another story. Since diesel oil was used largely in agriculture, transportation, and other essential work, civilian usage could not be arbitrarily tampered with. Civilian consumption of this fuel was cut drastically, to be sure, but each reduction of allocation was weighed at the highest level as to its possible effects on the domestic war effort. Nevertheless, civilian consumption of diesel oil declined

[28]"German Oil Industry," sec. 5.03, pp. 70–72.
[29]Birkenfeld, übersicht 5, 6, pp. 219–22.

from a prewar average of 130,000 metric tons per month to an average of 80,000 tons per month in 1941, and continued to decline.[30] In 1942 and 1943, between 40 and 50 percent of all diesel fuel went to the military, chiefly the navy; over 20 percent was inexplicably exported; and the remainder—about one third—went to agriculture and the civilian economy. By 1944, the "essential" sectors of the civilian economy were allowed to consume no more than 33,750 tons of diesel oil per month, approximately one-fourth of the monthly prewar consumption. In short, Germany's fuel position by the spring of 1944 was tenuous indeed. Tanks were being converted to wood-burning generators, the Wehrmacht's motor gasoline and diesel oil needs were met only by ruthlessly stripping the civilian economy, even the pampered Luftwaffe was not getting enough aviation fuel to meet its minimum needs, and Germany's fuel reserves contained no more than approximately three months' supply. In retrospect, it was a tribute to the German organization of its production and consumption of fuel that the economy had not yet buckled under the pressures of military reversals and severe domestic shortages, especially in light of the fact that one level of the government was utilizing desperately needed transportation for the ruthless relocation and eventual extermination of whole segments of the population.

Labor

As if the already-critical fuel situation needed complication, the greatest problems appeared in two areas Germany had failed to foresee. The first area concerned the question of the manpower required to produce a sufficient supply of petroleum products. The Third Reich was caught in a basic manpower crunch, not unique to the Axis. Since the armed forces had priority in conscripting the most able-bodied men, domestic industry, equally hard-pressed for labor, had to settle for the best it could get. Moreover, protracted warfare demands more and more men as the fighting continues, and these new recruits can be taken from only one place: the labor force. The German oil industry began to feel the pinch almost immediately after the start of the war, and instead of the nearly 100,000 men required, the actual number of workers dropped from 71,000 in the summer of 1941 to 65,000 in the fall. Berlin decided to relieve the strain by the use of foreign workers, prisoners of war, Jewish civilians, and eventually slave labor. The original idea was to lure "voluntary" foreign workers who would be brought to Germany by offering seemingly attractive terms to induce them to sign up for long periods of time.

[30] *Mineralölplanung Sicherungsplan: Stand 14, 8, 1944*, F.D. 3042/49, Sc. 367, folder 1.

Berlin soon learned, however, that even with the many pressures—none very subtle—brought to bear on these foreign workers, it was difficult to keep them on the job, and the turnover was considerable. In fact, at the 20th Conference of the Zentrale Planung (Central Planning) in October 1942 it was revealed that even within the past six months fully half of the oil industry's 110,000 workers had left and had to be replaced.

The solution reached at the conference was to turn to *Ostarbeiters* (workers from the East), workers "who could not run away,"[31] and the program of slave labor was born. By September of 1944, the total number of slave laborers in the fuel industry reached 34,000, approximately 13 percent of whom were women. The utilization of slave labor in the fuel industry accounted for at least 30 percent of the total number of workers in the industry. An entire segment of the economy relying for nearly one-third of its labor on slaves, Berlin learned, is extremely vulnerable. All the more so if the war effort hinges on the product.

Despite the relative inefficiency of slave labor—in that, unlike free workers, slaves must be fed, clothed, given medical treatment, and seldom include skilled workers—the petroleum industry at least had a steady supply of workers.[32] Polish "volunteers" were shipped to Germany first, and after the Soviet invasion Russian slave laborers were brought in by the thousands. The number of foreign workers, voluntary and slave, in the oil industry reached its peak in April 1943, comprising 38,000 workers out of the total 136,800 people required in crude refining (14,500), synthetic production (89,200), coal distillation (13,100), and crude oil production (20,000).[33] With the Wehrmacht's continued military reversals on the eastern front after the summer of 1943, however, the number of Russian workers steadily decreased, and although Berlin turned to the importation of more laborers from France, Belgium, Holland, and Italy, it was only a temporary solution. The Normandy invasion in June 1944, followed by the steady Allied advances toward the German heartland, completely closed off the last source of foreign labor. The fluctuating status of

[31]"Die von uns nicht weglaufen können," quoted in "German Oil Industry," sec. 2.03, p. 38.

[32]With maddening objectivity, the managers of the Krupp Locomotive Factory in Essen, the I. G. Farben Plant at Auschwitz, and the Farben-owned Luranil and Wilhelm Beck Construction Companies, later enumerated to a Nuremberg courtroom the problems of maintaining full production with only starved and tubercular foreign workers, who escaped at every opportunity (see *Trials of War Criminals,* VIII, pp. 392–93, 400, 405, 419–20, 450, 463 [see n. 9 above]).

[33]"German Oil Industry," sec. 1.07, p. 23, table 9; Jürgen Kuczynski, *Germany: Economic and Labour Conditions under Fascism* (New York, 1968), p. 192.

labor was, in short, of critical importance to the fuel industry, and its final collapse was a problem which Berlin could have neither foreseen nor altered.

The Effects of Bombing

The last of these unforeseeable or unalterable issues upon which Germany's petroleum situation hinged concerned the Allied bombing missions.[34] The first significant bombing raids affecting Germany's oil production came in a series of spectacular, low-level attacks on the Rumanian oil refineries at Ploesti on August 1, 1943. The damage was temporary and, as a matter of fact, Rumanian deliveries to Germany actually increased. The following April, however, raids on the Rumanian refineries and the mining of the Danube River substantially cut down the flow of oil to Germany and set the stage for the all-out Allied raids on the synthetic oil plants in Germany proper which began in May 1944. The first attacks were against the hydrogenation plants at Leuna, Gelsenberg, and Böhlen on May 12, followed by raids at Zeitz, Lützkendorf, Leuna, Magdeburg, and Pölitz on May 28 and 29. Germany was in deep trouble, and knew it. Reichsminister Albert Speer initiated a host of countermeasures. By a special decree of May 30, the successful director of the munitions industry, Edmund Geilenberg, was appointed Commissioner General for Emergency Measures (Generalbevollmächtigter für Sofortmassnahmen) with almost unlimited powers to requisition labor or materials from other industries to rebuild the petroleum sector.[35] Geilenberg utilized every imaginable means to protect the remaining oil plants, from the construction of decoy plants, smoke screens, underground plants, camouflage, air-raid shelters, and balloons, to fighter planes and antiaircraft guns.

However, it was too late. Bombing missions by the Eighth and Fifteenth U.S. Air Forces, as well as the RAF, dropped as much as 35,023 tons of bombs on the oil industry in a single month (in this case, November 1944), cutting deeply into Germany's ability to continue fueling the war machine. Ironically, the Allied bombing missions did not actually destroy Germany's ability to produce fuel—indeed, post-

[34]Aside from the authoritative *Strategic Bombing Survey,* the reader interested in the various aspects of the Allied bombing raids on Germany's industries is directed to the *USSBS, The Effects of Strategic Bombing on the German War Economy* (Washington, D.C., 1945), (hereafter cited as *Effects of Strategic Bombing);* C. Webster and N. Frankland, *The Strategic Air Offensive against Germany 1939–1945* (London, 1961); Deutsches Institut für Wirtschaftstorschungs and Rolf Wagenfürt, *Die deutsche Industrie im Krieg, 1939–45* (Berlin, 1954); Alan S. Milward, "The End of the Blitzkrieg," *Economic History Review* 16, no. 3 (April 1964): 499–501.

[35]Albert Speer, *Inside the Third Reich* (New York, 1970), pp. 350–51.

war estimates by both Allied officials and representatives of German industry indicate a loss of only 13 percent of productive capacity. The bombing raids destroyed the German fuel network not by crippling production but by causing a complete breakdown of transportation. Ultimately, there was simply no way to get the fuel from the refineries and storage depots to the front lines. When production *was* seriously curtailed, however, it was most often in the area of high-octane aviation gasoline.[36] Thus, the Luftwaffe, which could not exist without aviation fuel, found itself operating on one-tenth of the minimum required gasoline, resulting in a fatal cycle. Without fighter planes to protect the oil plants, Allied raids could penetrate their defenses in greater number, thereby further reducing the production of aviation fuel for the Luftwaffe (see figs. 6–8).

The fuel situation was no more encouraging for Germany's land forces. With the loss of Rumanian crude oil, and the Allied bombing concentration on Germany's major hydrogenation and Fischer-Tropsch plants, reserve stocks were rapidly depleted, and the losses were quickly felt at the front lines. At the end of October 1944, for example, while viewing the Tenth German Army, Speer recalls his shock at encountering "a column of a hundred and fifty trucks, each of which had four oxen hitched to it; others were being pulled by tanks and tractors."[37] By the end of October, the deteriorating fuel situation led to the publication of a general order by Field-Marshal von Runstedt which banned the use of gasoline-powered vehicles for any reason, save actual combat. By a further order, on November 15, 1944, no gasoline-powered vehicle was to move in the western theater of operations unless it bore a special trip label signed personally by the area commanding general. To emphasize the seriousness of the crisis, the November order closed with the ominous warning that "anyone using fuel for purposes other than the immediate conduct of operations will be considered a saboteur and court-martialled without mercy."[38] It was clearly Germany's eleventh hour. The following month, Germany's final, desperate counteroffensive in the west, the Battle of the Bulge, ended in failure when many of the Panzer units simply ran out of gasoline. The German military machine had all but collapsed.

Germany's nightmare had materialized. It had become an industrial giant—one whose scientists had developed synthetic fuels, whose

[36]*USSBS*, "German Oil Industry," "Effectiveness of Various Bombs and Methods of Attack," sec. 4.05, pp. 65–67 and *Effects of Strategic Bombing*.

[37]Speer, p. 406.

[38]*USSBS*, Supporting Document No. 10.A1, Record Group 243, Modern Military Record Division, National Archives, Washington, D.C.

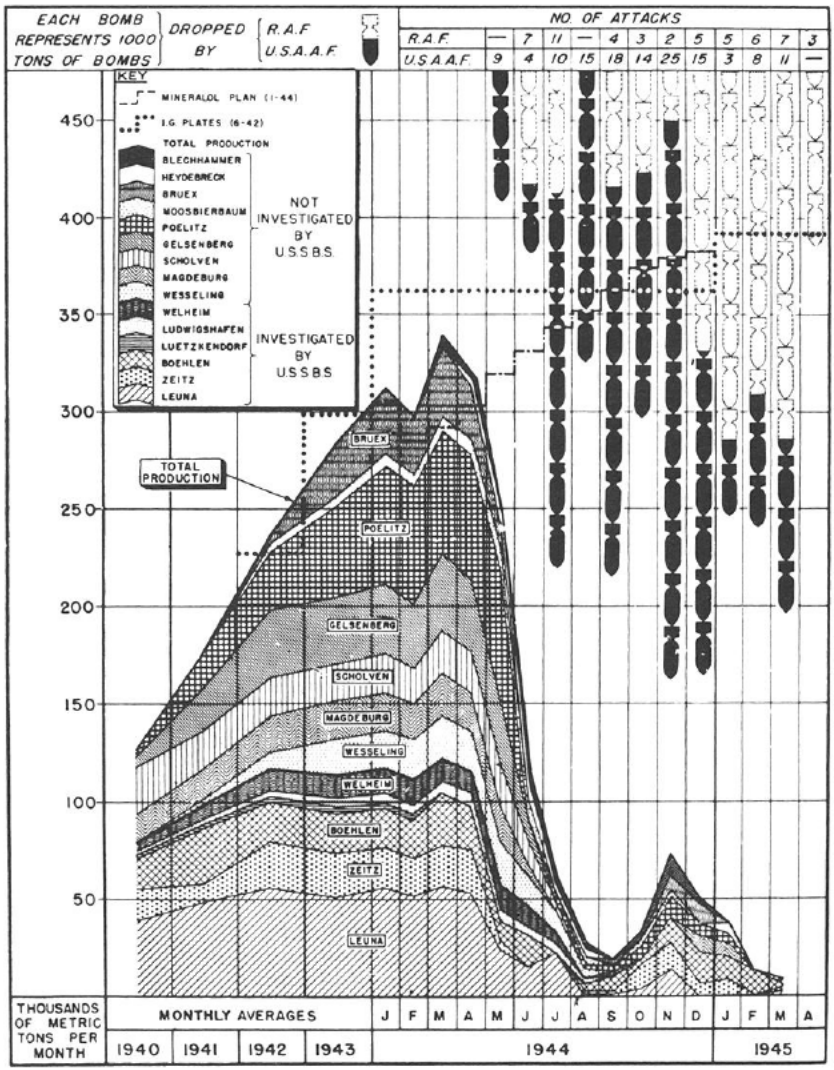

FIG. 6—Oil production from hydrogenation (plants within greater Germany and tonnage of bombs dropped). (From *USSBS*, "Oil Division Final Report" [Washington, D.C., August 25, 1945], fig. 97, p. 88.)

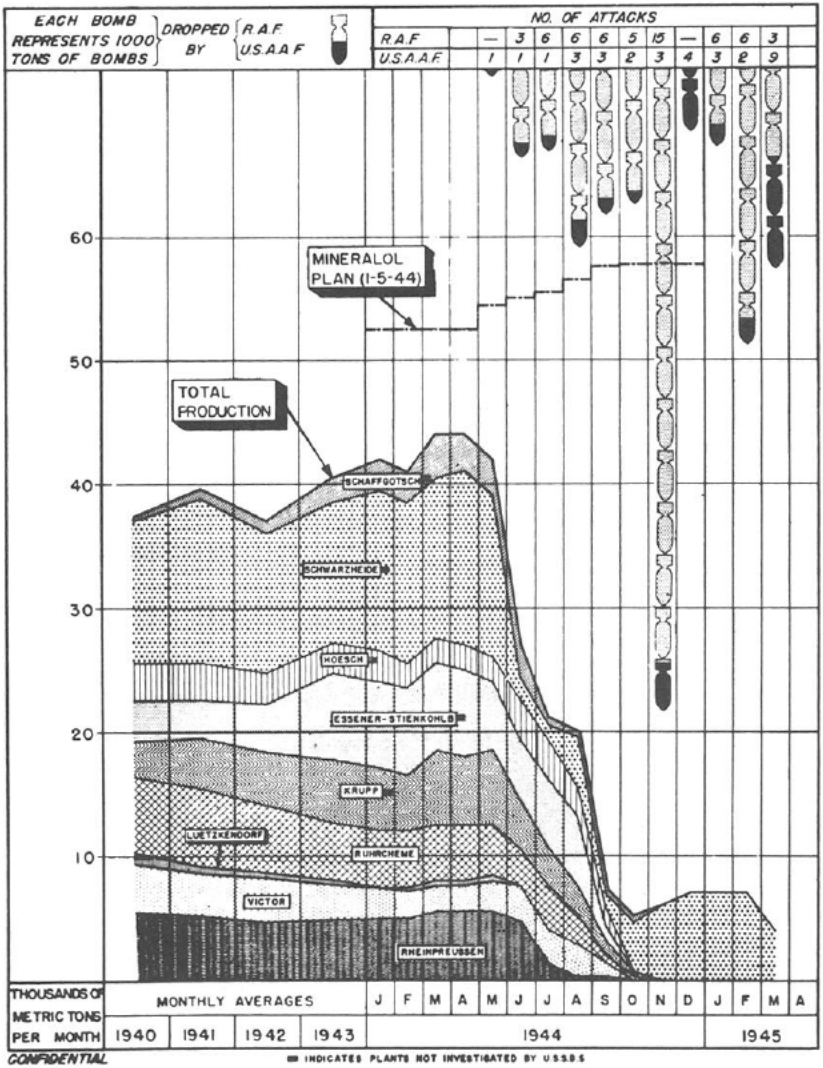

FIG. 7—Oil production from Fischer-Tropsch (plants within Germany and tonnage of bombs dropped). (From *USSBS*, "Oil Division Final Report" [Washington, D.C., August 25, 1945], fig. 96, p. 86.)

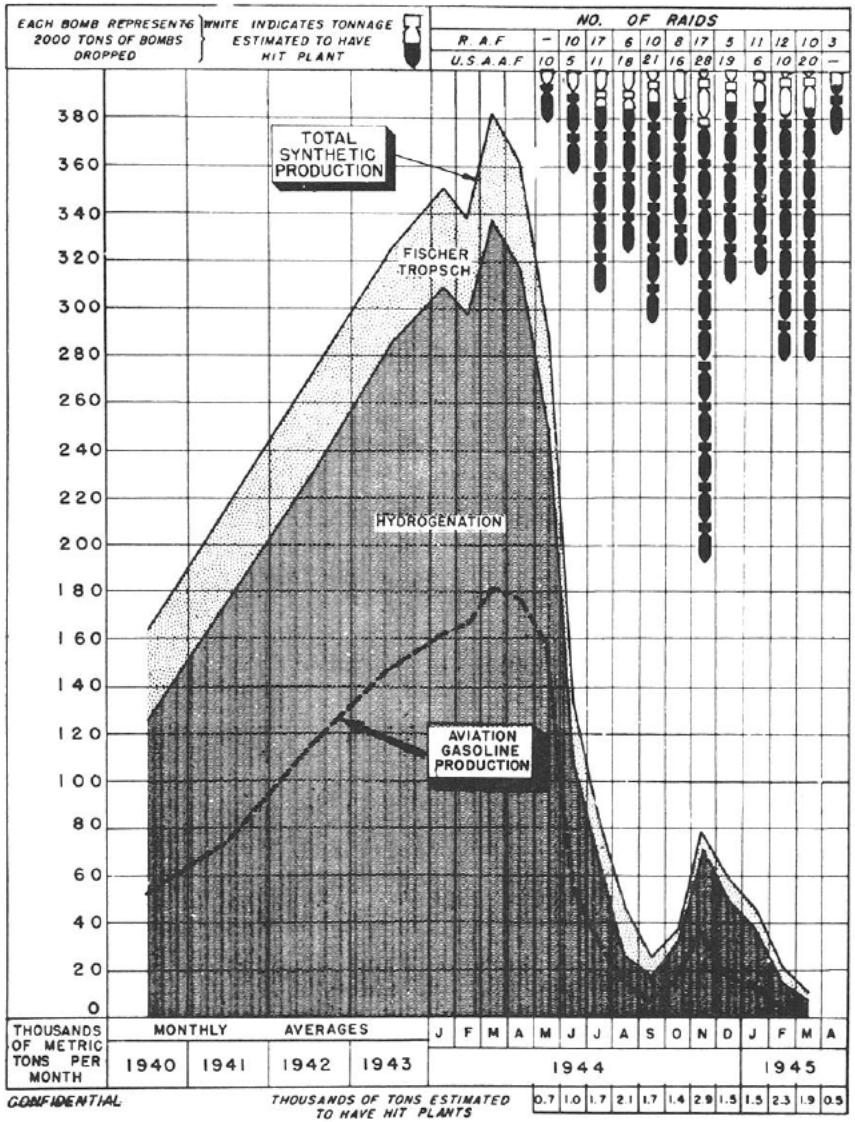

FIG. 8—Total synthetic fuel production by process (aviation gasoline production and tonnage of bombs dropped on synthetic facilities). (From *USSBS*, "Oil Division Final Report" [Washington, D.C., August 25, 1945], fig. 20, p. 24.)

government had encouraged and cajoled private industry to produce and stockpile it, whose civilian population had conserved it, and whose military forces had utilized it for territorial aggrandizement—but a giant without fuel. Between January 1945 and April, the Germans crumbled to total defeat. The death blows dealt by the Allied bombing raids to Germany's fuel network sealed the fate of its war machine and forever closed the chapter on the Third Reich.