Chapter 15
Energy and Plastics: Toward a Fossil Land of Milk and Honey

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Contents

Abstract Two energy transitions characterised the period 1910–1970: the rise and fall of a national mining industry and the shift from coal to oil and natural gas. Domestic coal made the Netherlands less dependent on foreign supplies. World wars and economic crises long inspired a lifestyle based on low energy consumption.

An energy-intensive lifestyle emerged after the 1960s with the import of cheap oil and the discovery of natural gas in Groningen. The discovery also led to the attraction of energy-intensive industries, to the massive use of natural gas in greenhouse farming and to a national gas grid for households.

Oil and gas also laid the basis for the production, processing and use of plastics. These became the symbol of modernity and of the rise of the consumer society. As packaging material and raw material for cheap consumer goods they also initiated the waste society and formed the iconic example of the linear economy. The products of this linear economy ended up *en masse* on the rapidly growing waste heaps.

Increasing energy consumption in industry and households caused local air pollution. The first investigations of and policy measures in the area of air pollution

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were initiated from the viewpoint of public health. Pollution mobilised local resistance against the excesses of modernisation. Local environmental groups were the cradle of a broad societal concern about the environment, ecology and climate change in the following decades (see Chaps. 17, 18, 19, 20 and 21).

Keywords Energy supply · Coal · Oil · Natural gas · Plastics · Waste · Linear economy · Air pollution · Environmental movement

15.1 Working on a National Energy Supply

15.1.1 Vulnerable Energy Supplies and Public Welfare

'A country that does not know how to use its natural sources of wealth proves that it does not deserve them,' according to the second-chamber parliamentarian from the province of Limburg, W.H. Nolens, speaking in December 1897.

> We all know that societal income, the material component of national well-being, comes into being through the combination of natural givens with labour, capital and entrepreneurial ambition, that the size of this income will depend on the quantity of each component and from the more or less correct proportions with which they are brought into contact with one another...[1]

At the end of the nineteenth century, subsoil core samples had demonstrated mineable layers of coal under significant portions of South Limburg. Despite various requests for mining concessions and the construction of a railway line to the south, a flourishing coal-mining industry remained a distant vision. Nolens characterised coal mining as vital to:

> the national interest...the economic independence of our country...A measure by the German Government to temporarily prohibit the export of coal would be disastrous for our country, even now.[2]

[1] W.H. Nolens in Handelingen Tweede Kamer, 35ste vergadering, 22-12-1897, 675, italics in original.

[2] W.H. Nolens in Handelingen Tweede Kamer, 35ste vergadering, 22-12-1897, 675, italics in original, Nolens referred to an article entitled ´Een Nationaal Belang,´ *De Ingenieur* 4(1889), no. 25. Nolens' remarks suggest that policy makers above all feared the Netherland's dependency on Germany. Around the turn of the century German coal increased its market share in the Netherlands and the latter became ever more dependent on the Ruhr region. But public opinion also referred to other suppliers. See, for example, H.C. van der Houven van Oordt and G. Vissering, *Economische beteekenis van afsluiting en drooglegging der Zuiderzee*, (Leiden 1901), 250: 'Should war with England ever break out again, then the State Mines will be of decisive importance.' The Boer Wars in South Africa made such a conflict conceivable. An even greater threat was perceived in 'that huge spider' the United States.

But it must be noted that the Netherlands also had some advantages. Because of British competition the Rhineland-Westphalian coal syndicate kept prices on the Dutch market lower than in their home market.

His call to modify the Mining Laws were heard by the government, that subsequently made efforts to promote the development of domestic mining.

From the perspective of well-being, Nolens' argument was telling. First of all, he made an explicit connection between national well-being and the exploitation of natural capital. In the nineteenth century, in imitation of England, the Netherlands had invested in steam engines and railways. This was accompanied by a transition in energy supply. Coal increasingly supplemented Dutch demands for energy. In 1870 the Dutch energy supply still consisted for 62% of classic sources: turf and wood, wind and water and the muscle power of humans and animals. Around 1900 this share had declined to 34%.[3]

The gradual energy transition to coal made the Netherlands completely dependent on foreign supplies, which made the country vulnerable. This was Nolen's second point. He regarded the development of a domestic coal supply as the necessary precondition for a stable and sustainable development of the economy and of well-being.

The theme of foreign dependency recurred regularly throughout the twentieth century. Between 1870 and 1970 the Netherlands passed through two energy transitions. The first was the transition from traditional forms of energy to coal (1870–1910), the second the transition to oil and natural gas (1950–1970). The first transition was already anticipated by the end of the nineteenth century, but almost no one could imagine that after a bit more than 50 years domestic coal production would be traded in for oil and natural gas. From a present-day perspective the energetic values of coal, oil and natural gas and an increasing energy consumption seem almost autonomous drivers for this transformation process.[4] The truth lay elsewhere.

The new fuels that shaped the modernisation of society were scarce goods throughout most of the twentieth century. The two world wars and their aftermaths led to rationing. Foreign conflicts meant fluctuations in price and delivery. This absolute and relative scarcity was a continuous spur to improvements in energy consumption. In this chapter we shall first of all consider the energy question. How dependent was the Netherlands and how did the country develop in the twentieth century? From being a net importer of energy around 1900, by 1970 the Netherlands had changed into a net exporter of energy, thanks to the discovery of natural gas in the Groningen subsoil. What effects did this have on the Dutch economy and energy consumption?

Coal, oil and natural gas varied in composition. The raw materials had in many cases to be processed before they could be used. The purification and refining of fossil assets were the basis for the development of chemical complexes. These com-

[3] H.N.M. Hölsgens, *Energy transition in the Netherlands: Sustainable challenges in a historical and comparative perspective* (Groningen 2016), 20.

[4] The energetic or combustion values are expressed in units of produced energy (joule) per kilogram. For methane - the major fraction of natural gas - this is between 50–55 MJ/kg, for petrol (gasoline) this is 44–47 MJ/kg, for diesel this is about 45 MJ/kg, anthracite coal is 27 MJ/kg, lignite coal about 15 MJ/kg, and wood and dry turf also about 15 MJ/kg.

plexes produced not only fuels, but other products as well. After the Second World War, plastics became an important sector with companies like DSM and Shell deploying a great deal of innovative prowess. We discuss this sector in the second part of the chapter.

We conclude with the ecological downsides of the fossil transition. What effects did production and consumption have on air, water and soil? How did these negative effects gradually find their way onto the political agenda? How did these evolve into the origins of the present-day sustainability challenges? We focus in particular on air pollution.

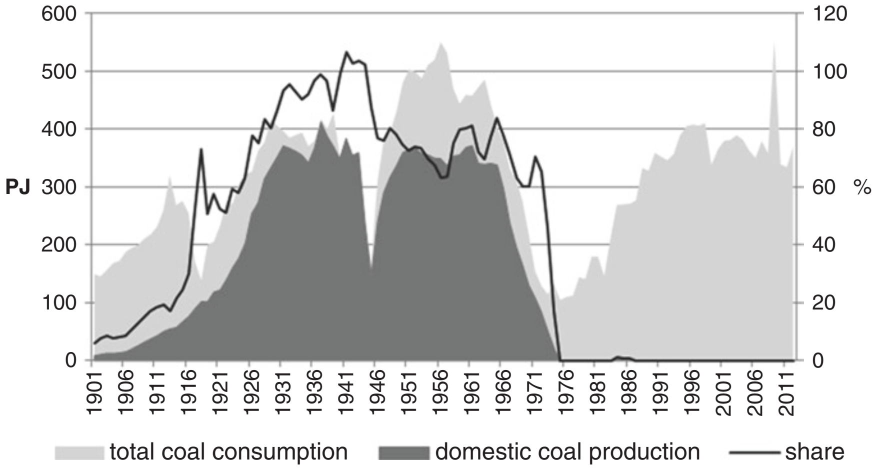
15.1.2 Domestic Coal Production

Parliamentarian Nolens' declamations have to be viewed in the light of the slow and difficult development of coal mining in the Netherlands. On the eve of the twentieth century coal was mined in only two small mines, the Domaniale and the Neuprick Mines in Kerkrade. From 1850 on, geological explorations confirmed the presence of coal over a larger area in South Limburg. Around 1860 and especially after 1876, 15 concessions were granted on the basis of French mining laws dating from 1810. In this period of liberal dominance, many entrepreneurs succeeded in staking a claim. These concessions were above all a matter of speculation and the creation of reserves by foreign mining companies. In 1891 the Minister of Public Works, Trade and Industry put a stop to this by recalling the concessions and granting the Company for the Exploitation of Limburg Coal Mines a concession for the Oranje-Nassau Mine. From the very beginning – with the digging of the shafts – the enterprise struggled with technical problems and accidents. Policy makers became increasingly irritated with the delay. In 1898 new concessions were granted for the exploitation of the Willem, Sophia and Laura en Vereeniging mines.

In early 1901 Minister Lely proposed establishing state-owned mines in Limburg. Instead of a limited area, the government reserved the entire territory known to contain coal in its subsoil at that point in time. This was, internationally speaking, a unique move. In addition to economic and nationalist motivations, social considerations played a role. A state enterprise, according to the Catholic parties, could prevent labour conflicts and the disruption of traditional society. The debate about the State Mines took place during the 'coal crisis.' The price of German coal had risen steeply. Subsequently Great Britain imposed duties on its coal exports. Given these circumstances the public and parliament concurred in Lely's proposition.

In 1903 construction was started on the Wilhelmina State Mine and in 1906 the Emma State Mine opened its gates, followed by the Hendrik State Mine in 1911. At the same time various private mines started producing: Oranje Nassau (1899, with a second mine in 1904), Willem Sophia (1902) and Laura (1907).[5] In barely a decade

[5] Ad Knotter (eds.), *Limburg Kolenland, over de Geschiedenis van de Limburgse Kolenmijnbouw* (Zwolle 2015), 66–67.



Graph 15.1 Consumption and domestic production of coal in petajoules (left scale) and share of domestic production in total consumption in percent (right scale)
Source: B. Gales and H. Hölsgens in: H.N.M. Hölsgens, Energy transition in the Netherlands: Sustainable challenges in a historical and comparative perspective (Groningen 2016), 207–217

a serious mining industry had come into existence thanks to much hard work both by private parties and the state.

The domestic production of coal increased steadily after 1910. Nonetheless the spectre of foreign dependency came to haunt the country during the First World War. Coal shortages followed on the abrupt cessation of foreign imports. Only after difficult negotiations and in exchange for other important 'war commodities' like food, was the Netherlands again able to import very modest quantities of coal. In the final years of the war this led to rationing and the closing of factories.

It took until the mid-1920s before coal consumption again reached pre-war levels. In the meantime, however, domestic production was meeting 60% of the demand. In 1937 the Dutch mines even supplied about 90% of the domestic demand. In the first years of the Second World War, coal production remained stable, but after 1942 war circumstances began to play a role and production declined. After the war the ideal of self-sufficiency was quietly laid to rest.[6] Imports met an increasingly large part of the demand for coal and this caused no worries. Up to the announcement of the Limburg mine closures in the mid-1960s, the state mines were responsible for delivering 60–80% of the domestic demand for coal (Graph 15.1).[7]

Self-sufficiency and foreign dependence became increasingly unimportant factors. But the preoccupation with a responsible use of subsoil resources remained undiminished. Policy makers feared that the mining companies, in pursuit of quick profits, would first concentrate on the richer layers and thereby make the extraction

[6] H.N.M. Hölsgens, 'Resource vulnerability and energy transitions in the Netherlands since the mid-nineteenth century' in *Energy Policy*, Forthcoming.

[7] Hölsgens, *Energy transition in the Netherlands*, 42–43.

of other layers impossible. By also taking on the thinner layers from the outset, costs would rise by 10–15% but in the end the entire supply would be utilized. This became an important point in the debate on the nationalisation of the private mines that took place after 1946. In the event, nationalisation was not pursued but a 'thin layers policy' became the norm. A less than optimal level of productivity became the price for less waste.[8] The tradition of responsible use was continued in the 1970s in decisions to first tackle the smaller natural gas fields and to keep the big field at Slochteren partly in reserve.

15.1.3 The End of Domestic Coal

Coal still played an important role in the post-war energy supply and thus occupied a central place in Dutch society. The decision, in 1952, to open a new State Mine (Beatrix) in Vlodrop attested to that. The previous year, the Netherlands had become part of the European Coal and Steel Community (ECSC), a cooperative trade and production agreement signed by France, Germany, Italy, Belgium, Luxembourg, and the Netherlands. This cooperative venture had developed along the transnational cartels of the powerful iron and steel industries of especially France, Germany, Belgium and Luxembourg. From a Dutch perspective, the emergence of West-European cooperation in the ECSC was a complex juxtaposition of national interests aimed at the rapid recovery of export markets, at monetary integration at the behest of the USA and of opening up markets for coal and steel that were important for reconstruction and industrialisation.[9]

With this European cooperation, domestic mining activities found themselves in a new international playing field. The Suez crisis of 1956, and particularly the blockage of the canal, moved energy to the top of the European agenda. Reports by the ECSC high authority demonstrated that West European energy demands could not be met with coal mining. Increasing demand would have to be met by importing coal and oil. Nuclear power also offered hope. In 1958, with the founding of the European Economic Community (EEC), cooperation on the European market inten-

[8] Staatscommissie ingesteld bij Koninklijk Besluit van 26 November 1946 No. 1, Den Haag 1948, 25–26, 33.

[9] The cooperation among France, Germany, Italy, Belgium, Luxembourg and the Netherlands in the ECSC had diverse origins. Important roots were the formation of economic cooperation between Belgium and Luxembourg in the 1920s, the economic cooperation in the framework of the Benelux since 1944, as well as post-war international cooperative arrangements like the United Nations Economic Commission for Europe (UNECE) and the Organisation for European Economic Cooperation (OEEC). More on this in W. Kaiser and J. Schot, *Writing the rules for Europe: Experts, cartels and international organisations*, (London 2014), 212–16. Concerning the national and macro-economic considerations of the Dutch government in the realisation of the ECSC, see: J. Luiten van Zanden and R.T. Griffith, *Economische geschiedenis van Nederland in de 20e eeuw*, (Utrecht 1989), 247–54.

sified. At the same time Euratom started a program to satisfy increasing energy demands with nuclear energy.

These developments turned Dutch coal mining into a plaything in a world of covert national subsidy programs in the surrounding countries.[10] Moreover, oil began to compete with coal. Mounting imports of foreign coal and oil eroded profitability. Process improvements in the steel industry meant a much lower demand for cokes, leading to overproduction. To add insult to injury, the discovery of natural gas in Groningen cast an entirely new light on the national importance of coal mining.

Mining engineers pointed out that Dutch coal mines were among the most modern in Western Europe. But the government had doubts about the size of the reserves and the profitability of mining. They placed these doubts over against the alternative of national exploitation of natural gas and a choice for the latter became inevitable. In 1962 the first decisions for the gradual phasing out of the mines were taken. In 1965 the Minister of Economic Affairs, Joop den Uyl, announced the definitive closing of the mines in a speech in the municipal theatre in Heerlen, headquarters of the State Mines. Nine years later, colliers employed by the Oranje Nassau mine brought op the last of the Dutch coal.[11]

In 1958 more than half the energy consumption was still provided by coal, while the share of oil was about 40%. By 1964 the figures were the inverse.[12] Statistics on energy consumption show the fuel transitions in the 1960s across different sectors (Table 15.1). About half of the energy was consumed by electricity production and industrial applications (both 24%). These sectors consumed mainly oil and coal. In industry, coal demand declined only gradually, but its consumption was dwarfed by the growing use of oil and natural gas from the late 1960s onward. Transportation was largely oil-driven and accounted for about 10% of the energy demand. Households and small businesses were the main consumers of coal (41% in 1962). In the late 1960s these small-scale users also transferred to oil.

With this shift in energy consumption, dependency on foreign sources again increased. And, as a result of the increasing use of oil and the founding of OPEC in 1960 – the cartel of oil-exporting countries – Dutch energy supplies became even more vulnerable.[13] Just as at the outset of the twentieth century, the Netherlands was now also in large measure dependent on foreign suppliers. But now too it had the option of partially compensating its dependency. By the mid-1960s the enormous

[10] On the development of mining and the national subsidy programs of the participants in the ECSC see B. Breij, *De mijnen gingen open, de mijnen gingen dicht* (Alphen aan den Rijn 1991). 125–128 and 147–165.

[11] The history of the mine closures is more complicated than can be described here. How the situation evolved and which arguments were used by different groups of engineers and politicians is described in detail in B. Gales, ‘Delfstoffen.’ in J.W. Schot et al. (eds.) *Techniek in Nederland in de twintigste eeuw - Delfstoffen, energie, chemie* (Zutphen 2000), 61–65. and C.E.P.M. Raedts, *De opkomst, de ontwikkeling en de neergang van de steenkolenmijnbouw in Limburg* (Assen 1974), 198–201.

[12] Hölsgens, *Energy transition in the Netherlands,* 31–32.

[13] Calculations concerning the vulnerability of the Netherlands with respect to energy supplies and different energy sources can be found in Hölsgens, *Energy transition in the Netherlands*, 19–59.

Table 15.1 Energy consumption by fuel and sector 1958–1974 (in PJ)

		1958	1962	1964	1966	1968	1970	1972	1974
Electricty production	Coal	152	145	137	131	133	73	34	32
	Oil		117	230	303	202	514	243	170
	Gas		7	9	13	40	133	245	312
Industry	Coal		110	105	92	95	81	76	80
	Oil		161	182	198	234	168	293	353
	Gas		5	7	42	132	266	434	499
Transport	Coal		2						
	Oil		118			185		250	252
	Gas					2		3	3
Other (Incl. Households)	Coal	309	238	202	130	93	46	19	9
	Oil		219	363	440	318	574	348	214
	Gas		10	20	63	166	306	518	607
All	Coal	460	495	444	353	322	201	129	121
	Oil		614	775	941	939	1255	1135	989
	Gas		22	36	117	340	706	1200	1420
Grand Totals		460	1131	1255	1412	1601	2162	2464	2531
Electicity production		152	268	376	447	375	721	522	515
Industry			277	294	332	461	515	803	932
Transport			120			188		253	255
Other (incl. houseoulds)		309	466	585	634	577	925	886	829
Total		460	1131	1255	1412	1601	2162	2464	2531

Sources: CBS Statistical Yearbooks 1967, 1971, 1973, 1975

gas field in Groningen had turned the Netherlands into a net exporter of energy. Worries about scarcity, at least for the coming decades, were a thing of the past.

15.1.4 A Warm House

Concerns about energy scarcity, foreign dependency and costs had governed the use of fossil resources up to the end of the 1960s. Frugality was woven deeply into the fabric of Dutch society, and extended to the use of fuels. In firms, innovations for energy-saving and for increased production often went hand in hand. For example, the brick and glass processing industries introduced new ovens so that progressively less fuel would be needed per unit product.[14] The effects of such investments could be seen in the relationship between energy consumption and investments in machines and apparatus. Over the long term these figures exhibit a continual decline, with the exception of short periods before and after the First World War and at the end of the 1960s.[15]

[14] G.B. Janssen, *Baksteenfabrikage in Nederland, 1850–1920* (Zutphen 1987), 276–78.; E.J.G van Royen and H. Buiter, *Grofkeramische industrie* (Zeist 1994).; B.A. van Veen, *Glas- en glasbewerkingsindustrie* (Zeist 1994).

[15] Hölsgens, *Energy transition in the Netherlands*, 81–83.

In the household, frugal use of fuels was encouraged by the building codes. The national government was able to influence the construction of public housing via various guidelines. These so-called 'suggestions' were inspired by the ideology of simplicity and sobriety. Guidelines in the area of heating dated from the 1920s and assumed a stove in the kitchen and a hearth in the living room. These had to provide warmth for the entire home. Compared to surrounding countries Dutch heating facilities were extremely frugal. From time to time Netherlanders suffered from cold *en masse.*[16]

During the Second World War, architects developed new concepts in housing construction. Among other things this included heating the home by means of central heating or block heating, which were held to improve the comfort of the home as well as its compatibility with the future.[17] But these ideas were at loggerheads with the stringent post-war restrictions imposed by the government on scarce materials and means. The government was able to control the production of materials via its system of distribution and to control the specification of housing standards via its systems of financing. It was even able to regulate the configuration of neighbourhoods by means of its ground-price policy.[18]

Given the limited financial means, the government tried to augment housing production by implementing a radical standardisation of floor plans for dwellings. In this way the government consciously or unconsciously also shaped the level of comfort and heating of the home. These politics had a favourable effect on the low expenditures for domestic fuels and on the energy rationing around and during the Second World War. The fear of future energy shortages caused these measures to remain in force until well into the 1950s.

It seemed that the occupants themselves were not overly concerned about the cold in the house. Dissatisfaction seemed limited to experts, who kept insisting on structural improvements to facilities in the home. But households plotted their own course in improving domestic comfort. Supplementary heating by means of mobile electric or petroleum stoves supplied the desired comfort. A survey conducted in Utrecht in 1948 revealed that more than 20% of the households kept the cold at bay in this fashion. A nationwide survey in 1957 revealed that 27% of the Dutch households used an electric and 6% a petroleum stove as supplementary heating. In 1964, 61% of the households owned an electric stove and only 24% of the households had no form of supplementary heating.[19]

The guided heating policy seemed to be effective on the supply side. Modest heating facilities limited the demand for domestic solid fuels. But portable stoves compensated the lack of comfort in the homes. From a financial point of view this

[16] B. Gales, 'Gemütlich Am Ofen?', *Zentrum Für Niederlande-Studien - Jahrbuch*, 2009, 91–112.

[17] Gales, 'Gemütlich Am Ofen?', 100.

[18] K. Schuyt and E. Taverne, *1950: Welvaart in zwart wit* (Den Haag 2000), 204–5.

[19] P. van Overbeeke, *Kachels, geisers en fornuizen: Keuzeprocessen en energieverbruik in Nederlandse huishoudens, 1920–1975* (Hilversum 2001), 179.

Table 15.2 Different types of heating in percent, 1947–1998

	1947	1957	1966	1968	1970	1972	1974	1978	1981	1998
Coal stove/hearth	97	84	58	} 61	43	26	17	1	0	0
Oil Stove	0	8	19					2	1	0
Gas stove/hearth	0	3	11	21	31	39	42	40	34	11
Individual central heating	} 3	5	8	11	16	24	30	47	55	78
Block/neighborhood/district heating			4	7	10	11	11	10	10	11

Source: Peter van Overbeeke, *Kachels, Geisers en Fornuizen*, (Eindhoven 2001)272

did not seem to be the ideal solution. Electric stoves cost 200 cents per 100 megajoules (about 28 kwh) of heat.[20] The detour of using electricity to produce warmth also entailed extra energy costs. The energetic efficiency of coal-fired electricity plants in the Netherlands in the late 1950s hovered around 28%.[21] In exchange for comfort and ease, households were prepared to suffer higher energy consumption and higher costs.

In comparison with surrounding countries stoves long remained commonplace. In Sweden, by 1961, 99% of the new residences had central heating. With only 5%, the Netherlands struck a discordant note among other West European nations.[22] Around 1960, architects and societal organisations became ever more insistent in addressing the question of heating. 'Good Living' (*Goed Wonen*), a foundation for promoting a modern lifestyle, typified the bedroom as a polar region. In its view it was necessary to put an immediate end to this dire situation.[23] The transition to natural gas marked the turning point. From the early 1960s on the number of new housing units in which central heating was installed grew explosively. After 1965 almost all new flats were equipped with central heating; around 1970 this was also the case for one-family homes. In that year only 26% of the dwellings in the Netherlands had central heating; by the early 1980s this was about 50% and only around the turn of the millennium had homes without central or collective heating become an exception (see Table 15.2). The guided energy policy reverberated long after its inception.

[20] Other options were bottled gas (180 cents), municipal gas (105 cents) and petroleum (55 cents) for the same quantity of heat. See van Overbeeke, *Kachels, geisers en fornuizen,* 180.

[21] This meant that most of the energy in coal was lost in friction, heat and transformation losses. J.H. de Boer, 'Primaire en secundaire energiebronnen,' in *Bevolkingsgroei en energie-Verbruik* (symposium at the University of Amsterdam held in the summer of 1957, Assen: Van Gorcum & Comp NV, 1958), 76. Internationally in the 1950s and 60s the efficiency varied between 30–40%. See V. Smil, *Energy in world history* (Oxford 1994), 171–75.

[22] Central heating in homes in West European countries in 1961: Switzerland (90%), Denmark (76%), Belgium (70%), France (44%) and West Germany (24%). Van Overbeeke, *Kachels, geisers en fornuizen*, 165.

[23] Gales, 'Gemütlich Am Ofen?', 107.

15.1.5 Natural Gas to Spare

The first drilling for natural gas was in 1959, but it took more than 4 years before the different parties were able to reach agreement on an acceptable way to exploit this new natural resource. Since the interbellum, exploration for and exploitation of oil and gas had been the monopoly of the Dutch Petroleum Oil Company (*Nederlandse Aardolie Maatschappij, NAM*). The NAM was a joint venture of the oil companies Shell and Esso. Earlier gas finds had been entirely financed and distributed by the State Gas Company (SGB).

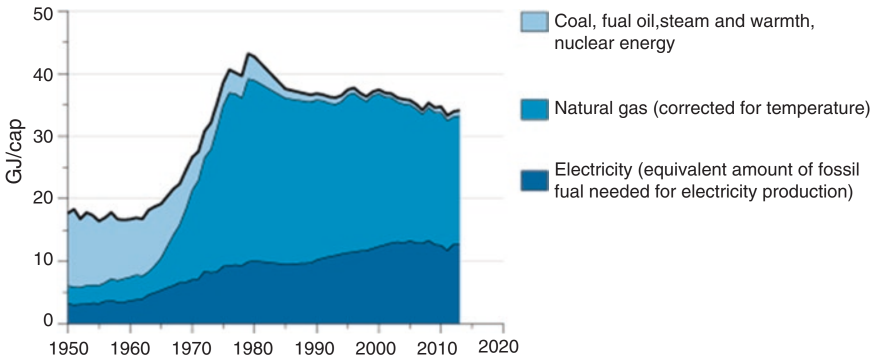
But given the gigantic size of the Groningen gas field, this construction became untenable. Against this background, negotiations commenced, about building an infrastructure of pipelines, the sale of gas domestically and abroad, and the division of the income. The role of the government was a complicating factor for Shell and Esso. Foreign governments of oil-producing countries demanded a big cut in sales incomes from the oil companies. Were the Dutch government to make similar demands with respect to the Groningen gas, this would compromise Shell's and Esso's negotiating position elsewhere. The Minister of Economic Affairs, J.W. de Pous, had to weigh the considerable investments of these companies in the Netherlands, like the oil refineries in Rotterdam's Botlek area, against the possibility of extraction via a state enterprise.

In the course of the negotiations, the government proposed that its other energy enterprise, the State Mines (nowadays DSM) become a partner in the extraction and distribution of the Groningen natural gas. In 1962, after nationalistic sentiments within the government had been quelled, the minister presented a 'Memorandum regarding the Natural Gas'. This led to the founding of the Gas Union (*Gasunie*) in 1963, a joint venture in which DSM participated for 40%, Shell for 25%, Esso for 25% and the state for 10%. Thanks to this division of shares as well as corporate taxes, about 70% of the income accrued to the state.[24]

In the course of the negotiations, Esso and Shell developed plans for selling natural gas to households and small businesses. The oil companies calculated that this could be the most profitable market. The gas could be coupled to existing municipal gas networks by means of a national distribution network, which would make it immediately competitive with coals and fuel oil. Households were to utilize the gas for space heating, cooking and warm water. Additionally, plans were made to develop a so-called premium market for applications in the chemical, metal and ceramic industries. Private users and firms consuming large quantities of gas could bargain for significant discounts.[25]

[24] G.P.J. Verbong, 'Energie,' in J.W. Schot et al. (eds.), *Techniek in Nederland in de twintigste eeuw - Delfstoffen, energie, chemie*, (Zutphen 2000), 206–10., W. Kielich, *Ondergronds rijk: 25 jaar gasunie en aardgas* (Groningen 1988), 41–45., A. Correlje, *Hollands welvaren: De geschiedenis van een Nederlandse bodemschat* (Hilversum 1998), 27.

[25] Correlje, *Hollands welvaren*, 21–32.



Graph 15.2 Domestic energy consumption per inhabitant 1950–2012
Source: CBS/okt14, www.clo.nl/nl003617

In 1963 the Gasunie laid down the first high-pressure pipelines that were to deliver the gas from Slochteren to the municipal gas companies. Within 5 years almost all onshore Dutch municipalities were connected to the natural gas network. In the cities and towns gas companies were busy modifying and installing new heating and cooking appliances. In the early 1970s households became one of the largest consumers of natural gas (see Table 15.1 and Graph 15.2).

By the mid-sixties expectations about nuclear energy were driving the sale of gas to new heights. It was self-evident that nuclear energy was destined to become the energy source of the future and to replace fossil fuels. That would be the end of natural gas profits. After 1966 natural gas was increasingly used to fuel conventional electric power plants. Low gas prices were employed to seduce industries with large energy requirements into investing in the Netherlands. In this way a consortium consisting of the Billiton Company, Alusuisse and Hoogovens founded an aluminium smelting facility, Aluminium Delfzijl (Aldel), in the province of Groningen. The government agreed to a consignment of 13 billion cubic metres of natural gas, enough to produce 60,000 tons of aluminium in 40 years. The aluminium ore was provided by the Billiton Company and came from bauxite mines in Surinam.[26]

Other energy-intensive sectors also profited from the declining energy prices due to the availability of natural gas. Natural gas, for example, utterly transformed the greenhouse farming industry. Greenhouses were heated with natural gas and also supplied with carbon dioxide (CO_2). The cultivation of vegetables in commercial gardening under glass increased between 1960 and 1970 from 4200 to 5300 hectares, the cultivation of cut flowers from 500 to 1700 hectares. In addition there was a yield increase thanks to the addition of CO_2. The yield of tomatoes, for example, increased from 10 to 15 kilograms per square meter.[27] Along such devious paths,

[26] H. Beukema, *Lichtmetaal op zware grond: 40 jaar Aldel* (Delfzijl 2006).

[27] J. Bieleman, *Boeren in Nederland: Geschiedenis van de landbouw, 1500–2000* (Amsterdam 2008), 553–560.

Groningen's natural gas had fundamental consequences for energy use and the industrial structure of the Netherlands.

Natural gas, oil and coal were not only used to make fuels. They were also raw materials for countless chemical products and materials. A new type of material was the synthetic materials, especially plastics.[28] Prior to the Second World War there had been a number of basic inventions in this area, especially in Germany and the United States. After the war, plastics technology created a revolution. A 1949 a Dutch treatise on the state of the art in plastics opened with these sentences:

> Next to atomic physics and radar there is probably no domain that has so exercised the public imagination as that of plastics. Throughout the world new materials have come into use and new applications for these materials have been found, thanks to which new industries have come into being or existing industries have expanded beyond recognition...[29]

In the post-war Netherlands, plastics were the fastest growing industrial sector. At the same time it very quickly won the heart of the welfare society. It offered the masses ease, comfort and pleasure. At the same time, plastics were from the very first controversial materials. They were associated with poor quality, consumerism and environmental problems. The history of plastics is a sublime illustration of the tension between well-being and sustainability. As a part of the fossil material flows, plastics will get special attention in the next section and in the next part.[30]

15.2 Wellfare with Plastics

15.2.1 The Netherlands as Leader

Plastics are built up from long chains of mostly carbon atoms, with molecules that are 1000 to 100,000 times bigger than molecules of substances like water and sugar. During manufacture they can be moulded or are fluid and at the final stage they assume a more or less permanent form. In the course of moulding or casting, i.e. plastic shaping, these synthetic materials acquire their material function.

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[28] In the past, elaborate factory complexes had developed around fossil subsoil resources. An early example was the rise of the synthetic dye industry in Germany after 1870, an entirely new branch of industry that settled among other places in the neighbourhood of coal basins. In the Netherlands, small-scale chemical industry flourished around the production of city-gas in municipal gasworks. In Limburg a large-scale chemical complex developed under the control of the State Mines once coal deposits there began to be exploited.

[29] R. van de Kasteele, *Het kunststoffengebied: Chemie, grondstoffen en toepassingen* (Amsterdam 1949), 13.

[30] See for the following: H.W. Lintsen, M. Hollestelle and R. Hölsgens, *The Plastics Revolution. How the Netherlands became a global player in plastics* (Eindhoven 2017), the prologue and part I. Furthermore: E.M.L. Bervoets en F.C.A. Veraart, 'Bezinning, ordening en afstemming 1940–1970', in: J.W. Schot et al., *Techniek in Nederland in de twintigste eeuw* (Zutphen 2003) Part VI, 214–239.

Bakelite – invented around 1907 by the Belgian Leo Baekeland – was the first synthetic material derived from a fossil raw material and substances derived therefrom (in this case coal and its derivatives).[31] The three plastics that as bulk products would dominate the market after the Second World War had been developed in the 1920s and 1930s in large foreign chemical enterprises: polystyrene at the American Dow Chemical Company and the German IG Farben, polyvinyl chloride (PVC) at IG Farben, and polyethylene at the British ICI. The most important plastic fibre, nylon, was invented at the American chemical firm DuPont.

Prior to the Second World War, Dutch firms played next to no role in plastics technology. In 1923 Philips became one of the companies that produced and processed Bakelite. It was used to make speakers, radio cabinets and insulating base plates for x-ray apparatus, but also for lightbulb fittings, plugs and switches. A few firms specialized in Bakelite moulding.[32] After the war the Netherlands lagged far behind the USA, England and Germany. Despite this, within 20 years it would succeed in becoming one of the front-runners in plastics technology.

An important reason was the presence of raw materials for plastics production. DSM was perched on top of the coal in the Limburg subsoil. Shell had access to oil and refineries in Pernis. Pernis and Europoort developed into the largest storage and trans-shipment location for crude oil in Europe. That attracted foreign firms. The plastics industry thus represented a classically Dutch type of industry, namely the *trafiek*, a processing and value-adding industry based on flows of trade.

A second reason was that the Netherlands was able to appropriate plastics technology very quickly. Shell, DSM and AKU (General Artificial Silk Union) invested large sums in research and development and built world-class competencies in the production and processing of plastics. TNO, the largest public research organisation

[31] As early as the mid-nineteenth century, materials that could be molded were the object of extensive experimentation. Various materials like paper-maché (based on paper and glue) and vulcanised natural rubber (based on natural rubber and sulphur) were not (and are not) counted as synthetic materials. Parkesine, named after its inventor Alexander Parkes (1813–1890), was the first substance that later acquired that predicate, albeit somewhat half-heartedly. Some speak of a half-synthetic substance because cotton was the basic material. The cotton was treated with a mixture of nitric and sulphuric acid and subsequently mixed with vegetable oil and organic solvents. This produced a kneadable dough that could be cast, formed, cut and painted to produce a variety of products like medallions, billiard balls, buttons and letter openers. But the material was brittle, breakable and flammable. An important improvement was the addition of camphor, that made the material strong and flexible. The American John Wesley Hyatt (1837–1920) succeeded at the end of the nineteenth century in producing this material (that now is called celluloid) and its derivative products at an industrial scale.

[32] With a bit of good will we can also count the artificial horn and artificial silk industry as part of the plastics sector. But these were in fact half-synthetic plastics (to speak in contemporary terms) because the artificial horn was prepared from casein, a by-product of the dairy industry and the artificial silk from cellulose derived from wood and cotton. The International Artificial Horn Industry (IKI) for example, belonged to the plastics sector. ENKA (the First Netherlands Artificial Silk Factory in Arnhem, founded in 1912) was the first producer of artificial silk in the Netherlands. Other artificial silk factories followed. In 1928 the ENKA took over one of those firms, the Holland Artificial Silk Industry and merged in 1929 with the German *Vereinigte Glanzstoff Fabriken AG* to form the Algemene Kunstzijde Unie NV (AKU).

in the Netherlands, founded the Plastics Institute TNO, that developed into the national centre of expertise in plastics.

In the 1960s the sector grew at an extraordinary rate. The Netherlands expanded its plastics production capacity so quickly that by the mid-1970s it ranked among the top producers worldwide.[33] Domestic consumption rose from 1.7 kg per inhabitant in 1950, to 9.1 kg in 1960, to 35 kg in 1971.[34] The most important market for plastics in the 1970s was construction (30%). Products included water conduits, gutters, rain pipes, bathroom fixtures, and sinks. A second big category was packaging (23%) such as bags, bottles, crates and shrink-wraps. Then there were several smaller market segments among which were transport (6%) especially applications in cars; households (5%) with utilitarian objects, decorations and toys. In addition there were numerous other markets and application domains, like electronics, machine-building, furniture, paints and medicines.

15.2.2 The Plastics Revolution

The career of plastics after the Second World War can justifiably be characterised as a revolution. Where plastics were still marginal materials just before the Second World War, only 30 years later they had become one of the most prominent materials in the Netherlands. The revolution was caused by, among other things, the extremely low oil prices at the time, a raw materials cost-factor that immediately made plastics price-competitive with classical materials like wood, metal, cotton and wool. Another important factor was the great variety of plastics – each with its own functionality.[35] What also made plastics so attractive was the promise of

[33] Production of plastics per capita in various countries in 1963 and 1975 (kg).

	Production (kg/cap) 1963	Estimated production (kg/cap) 1975
West-Germany	24.3	78
United States	20.6	45
England	13.7	?
Italy	12.4	?
Netherlands	11.2	106
France	10.5	41

[34] Initially this was significantly less than the average American, the largest user of plastics. The difference between America and the Netherlands (and other Western European countries) diminished in the course of the 1950s. Around 1970 Germany would become the largest user with 62 kg per year per capita.

[35] F. Van der Most, F.V. Homburg, E. Hooghoff and A. Van Selm, 'Nieuwe synthetische producten: plastics en wasmiddelen na de Tweede Wereldoorlog', in J.W. Schot, H.W. Lintsen, A. Rip and A.A. Albert de la Bruhèze (eds.), *Techniek in Nederland in de Twintigste Eeuw – deel II* (Zutphen 2000), 364.

mass-production, the possibility of imitation and the allure of modernity. Growing welfare did the rest.

Crockery, statues, medals, chains, dolls and a cornucopia of consumer articles could be produced cheaply and *en masse.* These kinds of products were formerly made of wood, leather, glass, earthenware, metal or ivory. And components of durable products like cupboards, tables and chairs could be made of plastic or treated with synthetic paints. Dresses, shirts, socks and other clothing made of tricot weaves could also be fabricated with synthetic fibres. Many products had formerly only been affordable for the middle and upper class. Now they came within the reach of the working class. And with plastics, modern design also entered the home. Middle and upper-class consumers could flaunt their good taste with radio cases of satiny black laminates in streamlined forms, elegant tables with shiny plastic surfaces and a chrome-plated frame or cast plastic clocks of eccentric design.

Originally, plastic had a bad reputation: a plastic product was cheap junk and of poor quality. This improved in the course of time. In the 1960s a plastic product stood for 'strong, hygienic, washable, lightweight, attractively coloured and...a pleasant design.'[36] Plastic played an essential role in the rise and the shaping of consumer society.

15.2.3 Symbol of the Linear Economy

Low production costs also made plastics eminently suitable as packaging material. The light weight, the cheap raw materials and the ease with which it could be shaped, increasingly caused plastics to be seen as the ideal material for disposable packaging.[37] This, together with the rise of the self-service store, resulted in increasing use of pre-packaged food products and beverages. Experts in the packaging industry stated in 1957: 'The most important development in cast plastics insofar as it relates to packaging is the acceptance of the idea that packaging is made to be thrown away.'[38]

Recycling of rags, rubber, glass and paper declined and more and more material was disposed of as waste or burned. In earlier times the Netherlander was careful of his possessions and was constantly refurbishing and re-using them. Now there were goods that one threw away after using them briefly and only once. The first disposable packaging was made of paper, glass or tinned steel, materials that were increas-

[36] G. Staal, 'Het wonder, het wantrouwen en de weerstand', in M. Boot, A. Von Graevenitz, H. Overduin and G. Staal (eds.), *De eerste plastic eeuw: Kunststoffen in het dagelijks leven* (Den Haag 1981), 22.

[37] G. Hawkins, 'Made to be wasted: PET and topologies of disposability', in J. Gabrys, G. Hawkins and M. Michael (eds.), *Accumulation: The material politics of plastic* (London 2013), 49–67; J.L. Meikle, 'Materia Nova: Plastics and Design in the U.S., 1925–1935', in S. Mossman and T. Morris (eds.), *The development of plastics* (Cambridge 1994).

[38] In Hawkins 'Made to be Wasted', 5 cited in Lintsen, Hollestelle and Hölsgens, *The Plastics Revolution,* part I.

Table 15.3 Household waste in the Netherlands in 1972

	Veg.Fruit & Garden (GFT)	Paper	Plastics	Glass	Ferro	Textile
Specific gravity: kg/m^3	300	120	50	300	400	250
in million kg	1,534	800	156	348	100	66
in million m^3	5.1	6.7	3.1	1.2	0.2	0.3
per household						
in kg	116	60	12	26	7	5
in liters	385	503	234	87	19	20

Processed data of CBS – Composition of Household Waste, 1940–2011

ingly replaced by plastic. The consumer society also became a waste society. That was a new phenomenon and plastic waste became its symbol.

Until the early 1970s, the debate on plastic waste remained restricted to those processing the waste. Between 1950 and 1970 the volume of household waste per inhabitant doubled. In 1972 the four main waste categories in weight and volume were vegetable, fruit and garden waste (GFT), paper, glass and plastics. Despite their as yet brief presence in Dutch households, in 1972 about 12 kg of plastic was thrown out per household. That amounted to a volume of about 234 litres (see Table 15.3).

It became more and more difficult to turn the garbage into compost. The increasing glut of materials like glass, paper and plastics that decomposed only with difficulty, if at all, forced waste processors to switch to new methods. The new composition of municipal wastes increased their caloric value, causing many municipalities to consider investments in waste incinerators.[39] This appeared to solve the spatial aspect of the growing waste burden. The problem went up in smoke, at least partly. A fine solution, so it seemed, but certainly one that fits in with a linear production and consumption chain. With the advent of plastics the circular economy became ever more distant.

15.3 Dark Clouds Gather Above Well-being and the Human Environment

15.3.1 The 'Super Pipe'

On September 26, 1965, the under-minister of social affairs and public health ceremonially rammed the first of 196 piles into the ground that would serve as a foundation for the 'Super Pipe,' a 213 meter-high smokestack at the Shell refinery complex at Pernis. The smokestack was completed in 1968 and was part of the fight against air pollution. Twenty-five processing units were connected to the smokestack that

[39] W. van Dieren, *Een grondige zaak: 50 jaar vuilafvoermaatschappij VAM, 1929–1979* (Amsterdam 1979), 131–36.

could dispose of 1000 m^3 of waste gasses per second. Not without a touch of pride, Shell refinery engineers announced in 1969 that since the smokestack had come on line,

> it has become necessary to install more sensitive apparatus in the Shell monitoring stations in order to measure sulphur dioxide concentrations [...] We have tried to follow the cloud with a mobile laboratory. Despite all our efforts it has proved impossible to define the location where the cloud touches the ground. Nothing remains of the sulphur-dioxide concentrations after the cloud has travelled several kilometres in the higher air layers.[40]

Air pollution problems seemed to have dissolved, literally and figuratively. It might have seemed surprising that an under-minister of public health should have performed the start-up ceremony at the Shell refinery. From a present-day perspective the ‘Super Pipe’ is certainly in no way a solution for air pollution. The presence of the under-minister shows that at that time air pollution was seen as a public health issue.

Urban liveability and environmental problems belonged to the most important political and societal topics at the end of the 1960s and the beginning of the 1970s. Local groups of experts called attention to the issue. They mobilised local residents and journalists. New political currents politicised the environmental issues.[41]

This was the context in which environmental legislation around surface water (1970) and air pollution (1972) was passed. This raises various questions. How serious was air pollution? How did different groups throughout the twentieth century look upon air pollution and what conclusions and interventions followed? We shall attempt to answer these questions in the following section. We start with the last question.

[40] Reports on the ‘Super Pipe’ in: ´Tegen de luchtvervuiling: Reuzentoren voor Shell in Pernis´ in *De Telegraaf* 28 februari 1964; ´Eerste paal voor Superpijp van Shell´ in *Gereformeerd Gezinsblad* 27 september 1965 and citation from Henk Thonen ‘Vuilstort’der Staatmiijnen ook nog onder raffinaderij wolken´ in *Limburgs Dagblad,* 11 oktober 1969. Furthermore F.V. Homburg, A. Selm, and P.F.G. Vincken, ‘Industrialisatie en industrie-complexen: De chemische industrie tussen overheid, technologie en markt’, in J.W. Schot, H.W. Lintsen, A. Rip and A.A. Albert de la Bruhèze (eds.), *Techniek in Nederland in de twintigste eeuw – deel II* (Zutphen 2000),. 376–401.

[41] Top 5 problems according to survey of Dutch voters

	1967	1971	1972	1977
Unemployment	**29**	3	11	**57**
Housing shortage	21	**28**	15	6
Environment	1	22	**18**	4
Political Problems	11	4	12	3
Income and Prices	8	7	15	7

From Aarts 1989 Cited in H.T. Siraa, A.J. van der Valk, and W.L. Wissink, *Met het oog op de omgeving: Het Ministerie van Volkshuisvesting, Ruimtelijke Ordening en Milieubeheer, 1965–1995* (Den Haag, 1995), 234.

15.3.2 Polluted Air as a Nuisance

For centuries local authorities issued regulations to limit water and air pollution seen as a nuisance and a threat to health. These rules were aimed at perceptible pollution, i.e. pollution that you could see and smell. In 1896, the various regulations were nationally integrated into the form of the Nuisance Law. This law was intended to prevent nuisance and dangers caused by industrial activities, for example explosions, poisoning of water and polluted air.[42] Stench, smoke, soot and ash were the directly perceptible components of air pollution. The measures prescribed in the Nuisance Law aimed at these components, such as zoning for smelly enterprises like slaughterhouses, tanneries and steam-powered factories.

In 1905, the minister of Agriculture, Industry and Trade contacted the executive board of the Society for Industry (*Maatschappij van Nijverheid*) in order to discuss possible new articles in the Nuisance Law 'against smoking factory chimneys.' Inspired by German and British examples, the industrialists advocated the promotion of 'economic steam production,' whereby thanks to total combustion less soot was produced. The consultation led neither to the subsidized stokers' courses advocated by the industrialists nor to new rules. On the minister's advice the Society for Industry founded the Association for the Promotion of Smoke-free Stoking. This 'in order to combat smoke formation by factory chimneys on our own power.'[43] In 1910 the association counted 54 members responsible for 244 boilers. In that year the association merged with the Netherlands Association against Water Pollution to form the Netherlands Association against Water, Soil and Air Pollution. The members of the association included industrialists, but also public health inspectors and representatives of public works and municipal utilities. The association emphasized that it was not 'hostile' or 'less sympathetic' to the interests of agriculture and industry. The universal interest in clean air, water and soil had to be achieved by mutual consultation and enlightenment.[44]

Water pollution was the dominant topic in the association's journal, *Water, Soil, Air*. The sporadic articles on air pollution were largely accounts of British and German research into the effects of coal combustion. Smoke was seen as a danger to health chiefly in closed spaces and in cases of direct inhalation of soot clouds. Municipal health services investigated the effluents of specific factories after complaints by nearby residents. Incidental investigations were carried on in cooperation with research institutes like agricultural experimental stations and the Central

[42] T. J. Dijkstra, Het bezwaar: De beleving van leefomgevingshinder in de periode 1870–2000 in de Friese havenstad Harlingen (Groningen 2006), 54–58.; E.M.T. Beenakkers, *Aandacht van de overheid voor bodembescherming: Sinds wanneer?* (Den Haag 1991), 7–15.; Siraa, van der Valk, and Wissink, *Met het oog op de omgeving,* 230–233.

[43] J. de Kuijser, 'Mededeelingen betreffende de vereeniging tot bevordering van rookvrij stoken' in *Water Bodem, Lucht*, vol 1. 1910–1911, p. 7–10

[44] Redactie, 'De Oprichting Der Vereeniging´ in *Water, Bodem Lucht*, 1(1910–1911), 19–20; see also H. van der Windt, 'De Totstandkoming van ´de Natuurbescherming´ in Nederland,' *Tijdschrift Voor Geschiedenis* 107(3) (1994): 485–507.

Laboratory for Public Health, founded in 1909. The solution was found in optimizing the combustion of coal and diluting the smoke concentration. Given the right chimney-height the latter could be achieved and this, most critics agreed, solved the problems.[45]

15.3.3 A National Monitoring Network for Air Pollution

In December 1930 sixty-three people died in a deadly fog in the Meuse Valley town of Engis in Wallonia (Belgium). Immediately after the disaster, it was speculated that poisonous chemicals were to blame. Subsequent investigation showed the disaster was the result of serious air pollution. This conclusion caused hardly a ripple in the Netherlands, despite the participation of the Leiden physician, Willem Storm van Leeuwen, in the investigation. Air pollution – as the reports of the Association against Water, Soil and Air Pollution attest – was a foreign problem especially in the industrialised areas of Germany, England and Belgium. In those regions, for the time being, no measures were being taken to curb pollution.[46]

In medical circles there was, however, concern about air pollution and consequences for labour and public health. In the Netherlands, the inspector of public health, M.J.N. Schuursma, spoke out about the dangers of air pollution.

> Air pollution due to smoke, exhaust gases and condensation nuclei are prevalent where there are large concentrations of industry and can produce irritation and danger. As industrialisation increases it is desirable to pay attention to this matter.'[47]

In 1948, the city of Rotterdam established a commission for Soil, Water and Air. In the 1950s this body investigated excessive quantities of fluoride and sulphur-dioxide in the region's atmosphere caused by artificial fertiliser factories, electrical power plants and oil refineries. On the basis of data from 18 air-quality measurement stations, the commission was able for the first time in the Netherlands to chart the geographical dispersion of pollution.

London's 'Great Smog' of December 1952 gave an extra impulse to the public health aspects and encouraged a more integral approach to pollution. Medical research concluded that about 4000 people died as a result of the smog. In Great Britain the event led to the making of new laws on air pollution that came into force in 1956. The legislation focused not only on industry, but also on the use of coal in domestic stoves and cooking stoves. In the Netherlands too, investigations focused

[45] Redactie, 'Luchtverontreininging door eene loodaschbranderij' in *Water Bodem, Lucht*, 5(1915), 89–91; J. De Kuijser, 'Luchtverontreininging en hinderwet aangelegenheden', in *Water Bodem, Lucht*, 6(1916), 45–56 and E. Buijsman, *Er zij een meetnet...: Een geillustreerde geschiedenis van het luchtmeetnet van het RIV(M)* (Bilthoven 2003), 18–19.

[46] B. Nemery, P.H.M. Hoet, A. Nemmar, 'The Muese Valley fog of 1930: an air pollution disaster', in *The Lancet*, Vol. 357, (2001); Redactie, 'Mist in het Maasdal' in *Water, Bodem, Lucht* 21(1931), 8–9; E. Buijsman, *'De Moordende Mist: De Ramp in Maasvallei bij Luik in 1930* (Houten 2010).

[47] Buijsman, *Er zij een meetnet, 20–21.*

more explicitly on regions rather than on specific industrial plants. Rotterdam was a prime example of a region with a high concentration of industry and was the first municipality to focus attention on the regional situation. In 1953 TNO followed in Rotterdam's footsteps, investigating pollution in the environs of the Hoogovens. In 1956 the National Institute for Public Health (RIV) started investigations into air pollution around the State Mines in Limburg and in Amsterdam's harbour area.[48]

The measurements showed an extremely high level of air pollution. Scientists began to use ever more forceful terminology. In 1958, prof. W.F.J.M Krul, chairman of TNO's Institute for Health Technology, stated that the future habitability of the 'Randstad Holland will depend in large measure on whether the technical and economic problems of air pollution will admit of a solution.'[49] But according to the minister of Social Affairs and Public Health:

> ... the air pollution is [...] not so serious, that it endangers public health...According to the National Weather Service (KNMI) the Netherlands does not have to fear for inversions such as those that in combination with a number of other factors cause London "smog".[50]

But in January 1959 and December 1962 Rotterdam suffered 'winter smog' under the influence of the polluted air. This added fuel to the fire in the debate among scientists, politicians and policy makers, a debate that now found its way to the pages of the public media. The research focused on the health effects of air pollution. The Rotterdam Commission for Soil, Water and Air registered a slight increase in mortality rates, hospitalisations and sick-leave, but did not consider the situation alarming. It concluded that air pollution still 'played an insignificant role compared to sickness and mortality associated with traffic accidents, poor nutritional habits, substandard housing and spoiled food.' And other research that focused especially on the increase in lung cancer concluded that explanations should be sought in smoking, rather than in polluted air.[51] Public review of the various investigations expressed increasing concern about air pollution. The unease was not quelled, despite the soothing conclusions. Protest groups like the Society against Air Pollution in and around the New Waterway (1963) and the Committee for the Habitability of the Waterway Region (1968) became the protagonists of the dissatisfaction. Municipal politicians, scientists and local experts took the initiative. The local groups continued to demand attention for liveability and environmental issues.

[48] E. Buijsman, *Een geannoteerd overzicht van publicaties over chemische samenstelling van lucht en neerslag in Nederland* (Houten 2011), 10.

[49] Cited in J.W.Tesch 'Volksgezondheidsaspecten van luchtverontreiniging' in *Water Bodem, Lucht*, 50(1960), 44.

[50] 'Verslag van het mondelinge overleg betreffende afdeling VII (Volksgezondheid)', Rijksbegroting voor het dienstjaar 1960, *Handelingen van de Tweede Kamer*, zitting 1959–1960, Kamerstuk Tweede Kamer 1959–1960 kamerstuknummer 5700 XII ondernummer 19, p. 17–18.

[51] 'Uit Rotterdams rapport blijkt: Sterke luchtverontreiniging werkt ziekte in de hand- Lichte toename sterfgevallen tijdens zware mist', in *De Waarheid*, 25 april 1984, p. 3; 'Dr. Bierstekers verrast in proefschrift: Verontreinigde lucht zo gevaarlijk nog niet.' in *De Tijd, dagblad voor Nederland*, 30–6-1966, p.5.

In 1963 the government moved to appoint a Council on Air Pollution. A year later it produced a draft law on air pollution. The law was ratified in 1970 and came into force a year later. It coupled the air pollution of emissions to specific limiting values. The limit value was defined as that point where emissions 'can negatively affect human health or create a nuisance for humans, or cause damage to animals, plants or goods.'[52] The law was a so-called framework law. General Administrative Ordinances were to fill in the further details.

The new regulative structure was thus impossible without knowledge of air quality. In 1965 the ministry of Social Affairs and Public Health consulted with experts in the Inspectorate of Environmental Hygiene, Royal Dutch Meteorological Institute (KNMI), TNO and RIV (National Institute for Public Health). These talks resulted in a number of investigations and a design for a national air quality monitoring network. The RIV was assigned the task of realising a completely automated measurement network. By 1967, in cooperation with the KNMI, TNO and Philips, it had a test network up and running in Twente. Automation placed new demands on the measurement system and the processing of the data. The first automated piece of apparatus was a sulphur-dioxide monitor designed in part by Philips. While experts realised that other substances were also relevant for determining the level of air pollution, sulphur-dioxide levels thus became the benchmark for air quality. The first fully automated measurement network, using so called 'sniffing poles' to monitor air quality, was set up in 1969 in Rotterdam's harbour region at the behest of local health services and the Rijnmond Regional Authority (*Openbaar Lichaam Rijnmond*). Provinces and municipalities got involved in the plans for a national monitoring network. In November 1970 the under-minister of public health granted approval. In 1975 a national air-quality monitoring network was completed.[53]

15.3.4 The Overture to New Sustainability Problems

During the 1960s for the first time an overall picture of the national diffusion of air pollution became available. How serious was air pollution? The measurements focused on two important components: sulphur-dioxide (SO_2) and so-called 'black smoke,' dust particles smaller than four microns. Both substances were related to the combustion of coal, the customary fuel in industry and households. The concentration of sulphur-dioxide was measured by means of sampling and chemical analysis, that of black smoke by means of filtration techniques.

The first investigations focused on problems around specific factories and on extreme situations such as the smog episodes in the winters of 1952 and 1962. The

[52] Cited in and translated from: G.H. Dinkelman, *Verzuring en broeikaseffect: De wisselwerking tussen problemen en oplossingen in het Nederlandse luchtverontreinigingsbeleid (1970–1994)* (Amsterdam 1995), 36.

[53] Buijsman, *Er zij een meetnet*., 13–75; E. Buijsman, 'Van mosterdgas naar zwaveldioxide: Over de oorsprong van de eerste zwaveldioxidemonitor,' *Studium* 3(8) (2015),159–62.

Table 15.4 Extreme air pollution in Europe, 1952 and 1962

	Sulphur Dioxide (SO_2) in μg/m^3	Smoke (dust) in μg/m^3
1952		
London (8 Dec)	1800–2000	1200–1500
1962		
Rotterdam & Surr. (5 Dec)	1040–1610	160–530
Paris (7 Dec)	840–1260	600–800
Ruhr (6 Dec)	2300–4000	–
London (5 Dec)	1400–4650	1700–4550
Norm 2016		
Daily average (max 3 days)	125 (Limit value)	
Hourly average (24x p.j.)	350 (Limit value)	
Hourly average (3 hours)	500 (Alarm value)	

Sources: E. Buijsman, *Er Zij een Meetnet..., Een Geillustreerde Geschiedenis van het Luchtmeetnet van het RIV(M)* (Bilthoven 2003), 38 and F.M.W. de Jong and P.J.C.M. Jansen, *Luchtnormen Geordend*, (Bilthoven 2010)

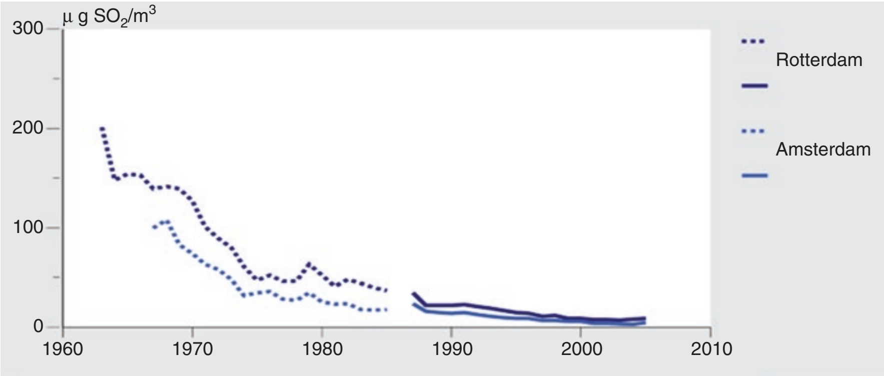
measurements showed that the sulphur-dioxide levels at Rotterdam in 1962 began to approach those of the Big Smog in London 10 years earlier (Table 15.4).

Systematic measurements dating from the 1960s revealed high concentrations of sulphur dioxide and 'black smoke.' The concentrations of both substances declined after the mid-1960s (Graph 15.3). The transition from coal to natural gas had beneficial side-effects. The switch liberated the Netherlands from the strongly polluting coal fumes in the cities and the surrounding industrial parks. The heyday of choking air pollution seemed to be definitely on the way out by the end of the 1960s.

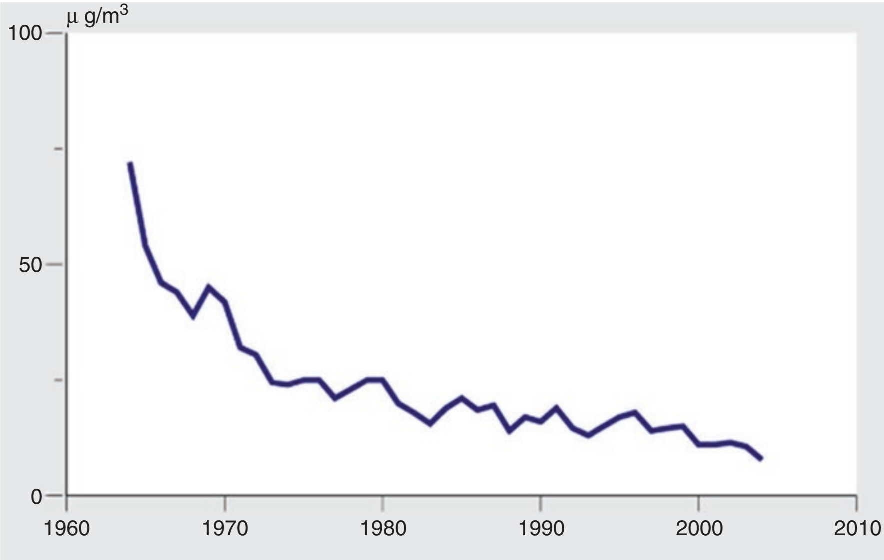
The difference in rates of decline between sulphur dioxide and black smoke were the first indication of other developments (Graphs 15.3 and 15.4).[54] Measurements in Utrecht showed that motorised traffic contributed strongly to the presence of dust particles (Graph 15.5).[55] More research was needed. The need for more data on the composition of the air and its consequences for health shaped a new agenda for research institutes and policy makers. Local interests groups developed into environmental organisations. The new organisations in the 'societal midfield' developed new strategies to influence public opinion and government. While during the first decades after the war, water and air pollution were still dismissed as inevitable collateral consequences of welfare, around 1970 some were concluding that the price of this kind of welfare was far too high. New demands on the quality of air, water and soil became the overture to the sustainability problems of the following decades.

[54] Buijsman, *Een geannoteerd overzicht van publicaties over chemische samenstelling van lucht en neerslag in Nederland*; E. Buijsman, *Meten waar mensen zijn: De ontwikkeling van stedelijke luchtkwaliteit in Nederland* (Houten 2010).

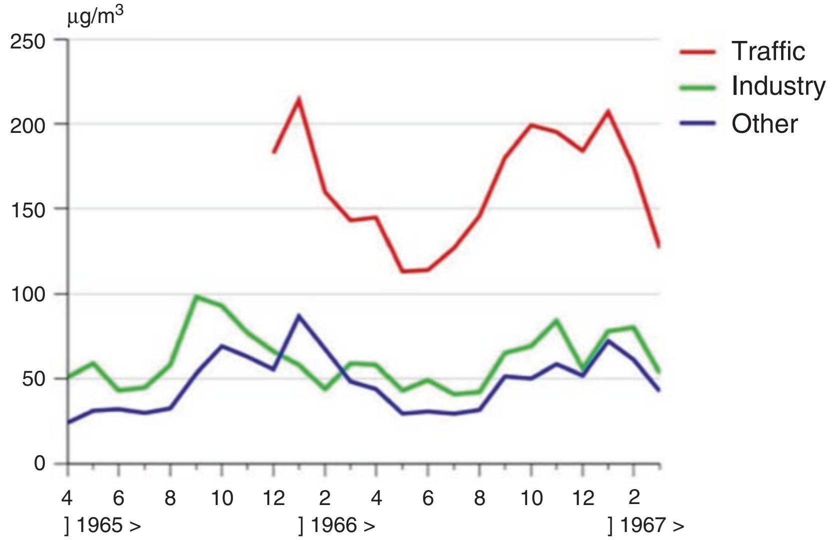
[55] E. Buijsman, *Stof in Nederland: Een reconstructie van historische metingen in Nederland* (Houten 2010).



Graph 15.3 Yearly average sulphur dioxide concentrations in Amsterdam and Rotterdam, 1965–2005
Source: E. Buijsman, *Meten Waar Mensen Zijn, de Ontwikkeling van Stedelijke Luchtkwaliteit in Nederland* (Houten 2010), 14–17



Graph 15.4 Concentration black smoke, 1963–2005
Source: E. Buijsman, *Meten Waar Mensen Zijn, de Ontwikkeling van Stedelijke Luchtkwaliteit in Nederland* (Houten 2010), 14–17



Graph 15.5 Monthly average concentrations of black smoke in Utrecht, 1965–1967
Source: E. Buijsman, *Stof in Nederland, een Reconstructie van Historische Metingen in Nederland* (Houten 2010), 19

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