Cultural Meanings of Wood Gas as Automobile Fuel in Sweden, 1930-1945

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Researchers within the social and human sciences have conducted several interesting historical studies on alternative fuels to petrol.[1] Wood gas has not been given the same attention as a topic for scientific research[2], despite the fact that wood gas was almost fully implemented in an automotive society, albeit for a short period of time. Although based on a variety of conceptual frameworks and theoretical terms, research on the history of alternative fuels refute the notion that technological failures have lost out due to a natural selection in which the better performer wins the race. What causes market dominance is not a clear-cut case of undisputed technological superiority or one-dimensional price issues. It is also not necessarily true that a new form of technology finds a market as soon as the necessary infrastructure is erected.

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2 | For notable research on the history and user cultures of the electric vehicle see for example Michel Callon, Heidi Gjøen, Mikael Hård, Gijs Mom and David Nye. The steam engine automobile has been researched by e.g. Clay McShane, Mikael Hård and Andrew Jamison. Wood gas is currently researched by Camille Molles at L'Ecole des Hautes Etudes en Sciences Sociales, Paris.

This article investigates the cultural meanings of wood gas as an automobile fuel in Sweden in the 1930s and during World War II. I will show how the proponents for wood gas as an alternative fuel for automobiles understated its socio-technical problems in order to achieve a politically motivated socio-technical change: a national fuel transition from petrol to domestic alternatives. This could not be realised without the practical user evaluations of a sufficiently large group of pioneer users. The second part of this article discusses how the cultural meanings of wood gas changed during World War II, as user problems known to the wood gas proponents of the 1930s became common cultural goods. As has been shown by researchers of alternative fuels and of the automobile culture, personal transportation is more than the physical re-location from one place to another. It encompasses additional social values and symbolisms. It is therefore relevant to discuss the topic of wood gas in relation to the culture and ideals of an automotive age in formation. It is also interesting how the cultural meanings attached to wood gas related to those of other means of automotive propulsion, e.g. steam, electricity, petrol and ethanol.

Goods are neutral objects, but as an integral part of an information system goods communicate social meanings to consumers. Consumption is a ritual that takes place within and generates cultural patterns. Therefore the commodity under scrutiny must be analysed in relation to the social context in which it exists and is used.[3] A problem of using consumption theories on the wood gas case relates to the definition of consumption as an act or ritual performed by a free agent driven by want or desire.[4] This is true of wood gas use during the interwar years, whereas the wood gas case during the war years mainly was a matter of using wood gas as automobile fuel or not using an automobile at all. This makes wood gas a difficult commodity to make sense of from a consumption perspective, but it also raises the question of what happens to the cultural meanings of goods previously purchased and used through choice when these become more or less forced on consumers.

3 | Mary Douglas/Baron Isherwood: *The World of Goods. Towards an Anthropology of Consumption*. New York: Basic Books, 1979. Reprint, London: Routledge, 1996, 38-41, 44-45, 48-52; Arjun Appadurai: "Introduction: Commodities and the Politics of Value", in: Arjun Appadurai, ed. *The Social Life of Things. Commodities in Cultural Perspective*. Cambridge: Cambridge University Press, 1986.

4 | Douglas: *The World of Goods*, 36-37.

In this article, I analyse wood gas as automobile fuel through policy ideals and praxis, technicians' (engineers and wood gas specialist mechanics) assessments of wood gas, user testimonies and symbolic associations. The source material includes public official archives from state boards responsible for wood gas related issues, governmental commissions, parliament and government. These volumes contain a variety of source material types, such as correspondence within authorities and with individual civilians, meeting protocols, commission statements, formal reports from referral bodies in the official and private sectors and news articles. Popular press material about wood gas has also been accessed through the archive at *Tekniska Museet* (National Museum of Science and Technology) in Stockholm. The source material includes wood gas instruction publications written for wood gas users in the civilian sector and wood gas publications by the Royal Swedish Academy of Engineering Sciences (*Ingenjörsvetenskapsakademien*).

What is Wood Gas?

Wood gasification technology is a British invention from the 19th century. Initially, the technology was intended for industrial production, e.g. ironworks and smelting-houses. Stationary gasifiers were not compact enough to be used for fuelling vehicles but in the interwar years wood gasifiers for smaller, mobile internal combustion engines were developed. In Sweden, interest in wood gas as an automobile fuel arose in the 1920s when engineer Axel Svedlund constructed the first Swedish automobile gasifier.[5] Internationally, France and Germany were at the cutting edge, but wood gas as one of several alternative means of automobile propulsion also attracted interest in other nations with ambitions for fuel autarky, e.g. Italy, Switzerland, Yugoslavia, Lithuania, Austria, Hungary, the Soviet Union, Finland, Canada, Japan, Norway and India.[6]

5 | Ingenjörsvetenskapsakademien: *Gengas. Svenska erfarenheter från åren 1939-1945*. Stockholm: Generalstabens litografiska anstalts förlag, 1950, 1-3.

6 | Gasgeneratorkommittén, *Delbetänkande*, 09.12.1937, 9-12, in: Jordbruksdepartementet, konselj 56, 12.03.1938. Riksarkivet (National Archives, Sweden), henceforth abbreviated RA.

In simple terms, the wood gasifier produced combustible carbon monoxide gas, which was used to fuel internal combustion engines adapted for petrol. The gasifier could be fuelled with wood, peat or charcoal. For the sake of simplicity, I will use the term wood gas when referring to vehicle fuel gasification regardless of gasifier fuel. Because private individual automobility was limited during the investigated time period, especially during the war years, the driving and maintenance of wood gas vehicles was mainly an activity performed by professional bus and taxi drivers and repair shop personnel. Wood gas was also widely used within the military sector, but this paper's main focus is the civilian sector.

Domestic automobile fuel alternatives were interesting for Swedish politicians because oil production, and consequently petrol, had two globally universal problems: Its import was sensitive to international crises and in peacetime there were considerable concerns about the depletion of oil reserves.[7] During the interwar years, contemporary observers witnessed a steadily expanding automotive fleet. Due to the ever increasing importance of the various types of motorised vehicles, combustible oils became indispensable.[8] Sweden is a nation without direct access to oil reserves, a problem which needed to be addressed as the transport sector grew in importance. Political measures were directed both at developing domestic fuel alternatives and at controlling oil import.[9]

SUPPORTING THE FORESTRY INDUSTRY OF NORTHERN SWEDEN

Wood gas did not arouse much interest among elected officials until a crisis struck the expanding forestry industry. Early in 1930, a member

7 | Bosse Sundin: "Från avfall till möjligheter. Etanol i början av 1900-talet", in: *Polhem*. Uppsala: Svenska nationalkommittén för teknikhistoria, 2005, 72-74.

8 | Axel F. Enström: "Motorproblemet inom automobilindustrien", in: *Teknisk tidskrift: Automobil-och motorteknik*, 16.04.1938, 25.

9 | Thomas Jonter: *Socialiseringen som kom av sig: Sverige, oljan och USA:s planer på en ny ekonomisk världsordning 1945-1949*. Stockholm: Carlssons, 1995, 13, 98-103, 140-42; Erland Mårald: "Methanol as Future Fuel: Efforts to Develop Alternative Fuels in Sweden after the Oil Crisis", in: *History and Technology* 26:4 (2010), 335-36, 341-42, 349; Sundin: "Från avfall till möjligheter", 72-74.

of parliament called into question the social situation of workers in the region of Norrland. Considered an important supplier of natural resources, this geographical area of Sweden was an industrially and economically expanding region, but it had been afflicted by reduced production and industry close-downs at the end of the 1920s.[10] For the sake of general nationwide economic progression the state had to intervene. A governmental commission – in short called *Skogssakkunniga* and mainly consisting of leading figures within the forestry industry and its labour unions – was appointed to investigate how this could best be done. The commission's task was to propose policy measures for increasing the sales of domestic forestry products, predominantly from the northern regions, thereby increasing profits and creating employment opportunities.[11] *Skogssakkunniga* was part of larger policy crisis deliberations including social politics and the elimination of poverty. The progress of society stood in direct relation to the state of domestic industries, of which forestry had emerged as a cornerstone.

A possibility was the automobile fuel market, as forestry could provide two promising fuel alternatives: wood gas and sulphite ethanol, both based on the profitable utilisation of forest product waste. Gasifiers could be fuelled with poor quality timber and brushwood while sulphite ethanol was derived from sulphite lye waste from pulp and cellulose production. Market stabilisation of these two fuels would be a step towards two important goals: national self-sufficiency and an expansion of one of the nation's most important industries.[12]

The commission engineers also listed negative aspects of wood gas usage: poor hill-climbing and acceleration capacities, consistently lower speed and inconvenient user procedures such as refilling and emptying the gasifier. The lower engine effect and thermal value of wood gas compared with petrol could be parried by an increase in the engine's compression. Thus, the engine effect was not considered to be affected to a degree that would disqualify wood gas as an important fuel, especially considering that fuel costs with wood gas would be reduced to 70 percent of the price of petrol in 1932. Appropriate wood gas users were state authorities, boards of

10 | Parliamentary bill 1930:38, second chamber.

11 | Parliamentary bill 1930:38, second chamber, 17; SOU 1933:2. Stockholm: Jordbruksdepartementet, 1933, 9, 15.

12 | SOU 1933:2, 164-72, 180, 186.

road administration and farmers with adjoining forestry from which cheap gasifier fuel was easily accessible.[13]

In some parts of the report, the commission expressed optimistic hopes and visions for the future establishment of wood gas as a fuel, at least for the users mentioned above. But optimism seems to have been rhetorical. Although presenting measures for promoting increased wood gas usage, the commission made specific mention of a prevailing opinion among engineers that the technological development of charcoal gasification fuelling had not made significant progress, neither in Sweden nor abroad, during the preceding years. Nevertheless, nationalist incentives to improve national finances and diminish dependence on imported petrol motivated the introduction of a gasifier loan fund, which could aid civilian gasifier investments. The idea behind introducing gasifier loans was to achieve more widespread wood gas use without spending too much public means on a form of technology in its experimental phase. The consequence was that large costs and risks of politically desirable socio-technical change were transferred to private sector companies and some individual motorists.[14]

Wood gas technology was new and untried and could prove to be a risky investment, especially for farms and businesses that had felt the blow of financial crisis in the early 1930s. To sweeten the deal, the commission argued that the terms and interests of the loan should be especially favourable in order to attract loan applicants. This included compensation for expected infrastructural problems, as the commission suspected that access to charcoal briquettes would become difficult for wood gas pioneers.[15] If prematurely introduced and promoted, gasifiers could become labelled a bad investment whose teething problems would become symbolically confirmed as unavoidable socio-technical characteristics.

In order to avoid negative wood gas associations among prospective users, loan stipulations were designed to counteract unreflected investments. Due to uncertainties regarding quality, loan applications had to be approved by technical experts within academia. A market overflowing with badly functioning gasifiers would, according to the commission, fail to produce the desired effect: the continuing development of wood gas technology. The loan fund was also designed in accordance with

13 | SOU 1933:2, 94-95, 183, 186, 190.

14 | SOU 1933:2, 185, 187, 190; Governmental bill 1932:212, 11, 15, 17.

15 | SOU 1933:2, 187-89.

nationalist sentiments. Eligible loan applicants were Swedish citizens in sound economic circumstances and joint-stock companies who wished to purchase a charcoal-fuelled gasifier for use within the country. The latter condition was stipulated in accordance with the proposal's main aim, namely to promote national industry through increasing sales of domestic timber and job opportunities within Sweden.[16]

Immediate Disappointment

Initially, the loan fund seemed successful. After its introduction in 1932 gasifier manufacturer AB Gasgenerator received 250 orders for gasifiers, compared to 57 orders placed during the six months preceding the introduction. Interest had been so considerable that demand had surpassed supply, causing delivery problems.[17] Due to high consumer demand, an additional 500,000 SEK (approximately 15 million SEK of today's value) was added to the loan fund for the budget year of 1933/1934.[18]

During the same time period, however, dissatisfied wood gas pioneers dismantled their gasifiers. Low fuel effect, questionable dependability, few wood gas education opportunities for the users, inferior service and difficulties in acquiring charcoal put wood gas at a disadvantage. In 1932, 201 wood gas automobiles were in use. Gasifier producers received orders for an additional 672 gasifiers. Almost all of these orders were cancelled within a year. Approved gasifier loans dropped from 225 in 1933, to four in 1934 and 1935 respectively. In 1936, no loans at all were extended and in 1937 only a single loan was approved. The 500,000 SEK that had been added to the loan fund budget in 1933 were therefore not utilised.[19]

The loan fund fiasco illustrates a discrepancy between policy anticipations on the one hand and user experience on the other. More than double the original loan fund sum was added for a budget year

16 | SOU 1933:2, 1933, 187, 189.

17 | SOU 1933:2, 94-95.

18 | Parliamentary communication 1933:210. Money value recalculation through the National Museum of Economy's online re-calculator. http://www.myntkabinettet.se/web/Hem.aspx, Accessed 01.01.2011.

19 | Gasgeneratorkommittén, *Delbetänkande*, 09.12.1937, 13, 16, 28, in: Jordbruksdepartementet konselj 56, 12.03.1938, RA.

when user interest dropped to near insignificancy. Wood gas had seemed promising but optimism was swayed by user discontent. For government politicians and high-ranking military officials the fuel issue was no less important than it had been in 1932. Another governmental commission (*Gasgeneratorsakkunniga*) was initiated in 1937 to examine how wood gas users could overcome their strained relationship with the new technology. Just as in 1932, the well-being of the Swedish forestry industry was an important factor in 1937. However, the main objective behind appointing *Gasgeneratorsakkunniga* was to safeguard military preparedness. The mission was to investigate the technical and economic preconditions for the wider use of wood gas for vehicles and how to guarantee sufficient production of gasifiers in peacetime – creating an infrastructure that would ease a fuel transition should war break out. Sulphite ethanol fuel was briefly addressed as a potential petrol surrogate but then dismissed, since it could not be produced in satisfactory amounts. Wood gas was deemed a more reliable surrogate fuel in both civilian and military sectors.[20]

Although the views regarding the usability of wood gas had changed, the commission saw questionable loan benefits and infrastructural problems as more plausible explanations for the loan fund failure. Infrastructures had been insufficient: no streamlined industrial production of gasifiers, too few education possibilities for wood gas user and inefficient charcoal distribution. Also, the price of charcoal had risen, increasing fuel costs by 40 percent in 1937 compared with 1932. Choosing wood gas over petrol was thus no longer a cost-saving measure for the user.[21]

During their investigations, the *Gasgeneratorsakkunniga* commission received letters expressing a variety of opinions from the wood gas pioneers of 1932. One factory owner claimed he had been fooled into the most deplorable investment he had ever made. After his chauffeur quit his employment in refusal to use wood gas, the factory owner had dismantled the gasifier and urged the state to cover the expenses he had incurred for

20 | Gasgeneratorkommittén, *Betänkande*, 08.07.1939, 6-8, in: Jordbruksdepartementet, konselj 58, 29.09.1939, RA; Gasgeneratorkommittén, *Delbetänkande*, 09.12.1937, 7. Jordbruksdepartementet, konselj 56, 12.03.1938, RA.

21 | Gasgeneratorkommittén, *Delbetänkande*, 09.12.1937, 25, in: Jordbruksdepartementet, konselj 56, 12.03.1938, RA.

trying out wood gas.[22] Experiences with unsuccessful wood gas usage had caused loan takers difficulties. Not only had gasifiers of questionable quality and durability been a bad investment. Some loan takers had incurred additional costs brought about by engine failure.[23] After four years of using the Svedlund gasifier, another company compared wood gas usage to that of *Lättbentyl* (a 75 percent petrol and 25 percent ethanol blend fuel), arriving at the conclusion that the truck fuelled by wood gas had required two weeks longer repair service than the *Lättbentyl*-fuelled counterpart. Not only had maintenance been more time-consuming, the wood gas fuelled vehicle had a lower average speed than the vehicle fuelled by the petrol-ethanol blend.[24]

New Evaluations

Early accounts of user experiences were deemed subjective and unreliable by *Gasgeneratorsakkunniga*, who effected systematic user evaluations by equipping ten test groups within state road administration and private sector companies with wood gas vehicles. Usage was regularly documented and evaluated by users and the commission alike.[25] Although some deemed wood gas user-friendly and reliable[26], commonly reported operational problems included user inconvenience, poor effect due to moist charcoal, burnt soot filters and nozzles and starting difficulties. For two test groups, burnt soot filters and a faulty rubber packing led to severe engine failures requiring thorough repairs since soot and small gravel had leaked into the system. More dramatic examples of operational problems were carburettor fires due to gas accumulation under the engine bonnet prior

22 | Letter from Oscar Rylander, 04.03.1937, in: Gasgeneratorkommittén 1937, RA.

23 | Statement from Kommerskollegium (National Board of Trade), 2-3, in: Gasgeneratorkommittén 1937, RA.

24 | Letter arrived 26.04.1937, 2, in: Gasgeneratorkommittén 1937, RA.

25 | Gasgeneratorkommittén, *Delbetänkande II*, 07.02.1939, 3, in: Jordbruksdepartementet, konselj 58, 29.09.1939, RA.

26 | Letter dated 04.08.1937, 1-3, in: Gasgeneratorkommittén 1937, RA; Gasgeneratorkommittén, *Betänkande*, 08.07.1939, 9, in: Jordbruksdepartementet, konselj 58, 29.09.1939, RA.

to gasifier ignition, and an explosion in a gas purifier. Roughly half of the difficulties could be repaired in only one or two hours by the driver, but the commission stated repeatedly that wood gas usage required knowledgeable and interested drivers, whose patience would not be strained by frequent small repairs.[27]

Despite this, the commission stated that technological development had advanced to a point where wood gas was a satisfactory surrogate fuel.[28] In peacetime, wood gas was not a fuel technology that would replace petrol for all types of automobility, but it would serve the needs of certain user groups and sectors. Usage preconditions included a high total vehicle weight, sufficient engine cylinder volume and continuous long distance driving with few stops. It was concluded that wood gas was best suited for heavy trucks used for long transports of approximately 200 kilometres and ten hours of driving, during which gasifier maintenance was said to possibly constitute a welcome break.[29] The availability of qualified service personnel also made the military sector a potentially appropriate wood gas consumer.[30]

World War II – The Wood Gas Era

The outbreak of World War II finally brought the wood gas issue to the fore. Not only had the total number of civilian vehicles increased; the armed forces were also highly dependent on motorised transportation. In the autumn of 1939, political efforts endeavoured to smoothen the transition from petrol to wood gas by addressing infrastructural problems. A state

27 | Gasgeneratorkommittén, *Delbetänkande II*, 07.02.1939, tabell III:1-12, in: Jordbruksdepartementet, konselj 58, 29.09.1939, RA; Gasgeneratorkommittén, *Betänkande*, 08.07.1939, 22a, in: Jordbruksdepartementet, konselj 58, 29.09.1939, RA.

28 | Gasgeneratorkommittén, *Betänkande*, 08.07.1939, 30, 62, in: Jordbruksdepartementet, konselj 58, 29.09.1939, RA.

29 | Gasgeneratorkommittén, *Delbetänkande II*, 07.02.1939, 20, in: Jordbruksdepartementet, konselj 58, 29.09.1939, RA; Gasgeneratorkommittén, *Betänkande* 08.07.1939, 22a, in: Jordbruksdepartementet, konselj 58, 29.09.1939, RA.

30 | Gasgeneratorkommittén, *Delbetänkande*, 09.12.1937,32-33, in: Jordbruksdepartementet, konselj 56, 12.03.1938, RA.

wood gas board, *Gengasnämnden*, was set up to further the technical advancement of wood gas. To streamline its related trade, the state-controlled *Svenska gengasaktiebolaget* was launched in the summer of 1940 to distribute and supervise the trade of wood and charcoal.[31]

Gengasnämnden stated that operational disturbances and high conversion costs put motorists off wood gas. The only factors that could make motorists use wood gas were a state forced fuel shift and the threat of Swedish capital disappearing to foreign petroleum interests. However, *Gengasnämnden* did not want to present drastic measures to achieve a fuel transition through scare tactics. Instead, endeavours were aimed at making a transition attractive to consumers by solving immediate problems such as the insufficient gasifier fuel distribution and hazards linked to technical flaws. Potential wood gas users would be won over with tax exemptions.[32] Another issue was the plethora of different gasifiers.[33] Streamlining and rationalising all levels of wood gas infrastructure was essential for a large-scale wood gas launch.

With the occupation of Norway and Denmark in the spring of 1940, the primary import routes of petrol to Sweden were cut off. Petrol import dropped dramatically, forcing a fuel transition from petrol to wood gas.[34] Fuel ethanol and shale oil were reserved for emergency rescue automobiles and some military vehicles, whose purpose disallowed time-consuming maintenance and starting procedures. Electric propulsion was used to some extent for remodelled petrol-fuelled internal combustion engine trucks operating in city traffic and for motorcycles. Approximately 16 percent of all heavy motorcycles in 1942 and 1943 were electric.[35] But wood gas was the primary automobile fuel.

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31 | Governmental bill 1940:298.

32 | Protocol 21.12.1939, 1-2, 4, 6, in: Gengasnämnden, vol. A1. Statens bränslekommission (1940), RA; Protocol No. 27 23.11.1939, appendix C, 1-5. Gengasnämnden, vol. A2. Statens bränslekommission (1940), RA; Governmental bill 1940:298, 12.

33 | Governmental bill 1940:298, 12.

34 | Protocol 2.11.1944, 7, in: Drivmedelsutredningen 1944, vol. 3, RA; Kommerskollegium: *Sveriges offentliga statistik, handel*.

35 | Bevillningsutskottet (the Committee on Supply), report 1945:33, 2; Pär Gierow: "Svenska erfarenheter av elbilen", in: *Teknisk tidskrift*, 18.05.1946, 485, 490, 493.

Switching to wood gas was no longer a matter of choice; it was a necessity for those wanting to continue to use an automobile. Although bus and truck transportation was maintained at a level close to that prior to the war, the number of registered civilian passenger cars dropped from circa 180,000 in 1939 to circa 32,000 in 1941.[36] In only one year, from 1940 to 1941, the number of civilian wood gas vehicles increased from 9,141 to 68,872. In 1943, it peaked at 73,853 wood gas automobiles, constituting around 90 percent of the land-bound civilian motorised transportation in Sweden.[37]

A substantial number of passenger car owners did not acquire gasifiers, but deregistered their vehicles, putting them out of operation. This is not necessarily proof of widespread antipathy towards wood gas. It could also be a result of infrastructural problems. Moreover, purchasing a gasifier caused additional expenses that the ordinary household might not have been prepared to prioritise in times of crisis, unless individual automotive transportation was of vital importance. During the interwar years, private ownership of passenger cars and motorcycles was a luxury enjoyed by only a minority of the Swedish population. The outbreak of the war further diminished this minority. It is possible that the cultural perceptions of wood gas were affected not only by the practical issues linked to driving a wood gas fuelled automobile, but also by the fact that the majority of passenger car and motorcycle owners could not use their vehicles at all. Wood gas perception was effected by the experience of enforced privation that was characteristic of wartime consumption restrictions in general.

Although there were still infrastructural problems such as limited access to gasifier fuel[38], wood gas was now the fuel that upheld motorised transportation on a diminished scale. Initially, contemporary observers were optimistic regarding the future of wood gas (Fig. 1). Although technically a wartime surrogate, the widespread usage was seen by enthusiastic optimists as the breakthrough of wood gas that would carry over into peacetime. If and when petrol returned, wood gas would retain

36 | Statistiska centralbyrån: *Statistisk årsbok för Sverige*. Stockholm 1924-1940, 1949.

37 | Ingenjörsvetenskapsakademien: *Gengas*, 10; Motormännens Riksförbund: *Motormännens gengasbok*. Stockholm 1940. Reprint, Stockholm 1941, 12-13.

38 | Parliament communication No. 93, of the extraordinary session of the Riksdag, 1940.

a market niche. The crisis meant an opportunity for wood gas to prove its worth for users sceptical towards new technologies.[39]

Figure 1: "I am Wood. The Automobile Fuel of the Future." During the first war years, advertisements for Swedish gasifier manufacturers expressed optimistic expectations of a bright future for wood gas usage.

39 | See for example "En knuff framåt", *Aftonbladet* 24.09.1940; "Gengasens definitiva genombrott i Sverige", *Aftonbladet* 16.11.1940; "Gengasen surrogat eller framtidens motorbränsle?", *Aftonbladet* 12.11.1940; "Gengasen är här för att stanna!", *Gengas-journalen* (special edition of *Vecko-journalen*) 17.11.1940; Motormännen: *Motormännens gengasbok*, 7, 63; "Jag tror på gengasen…", *Biljournalen* No. 2 1940, 3; "Se till att ni köper ett godkänt aggregat!", *Biljournalen* No. 2 1940, 10; "Philipsons står rustat!", *Biljournalen* No. 2 1940, 24. Bränsletekniska kommittén vid Ingenjörsvetenskapsakademien: *Gengasdagen 8 juni 1943: Meddelande och diskussionsinlägg, Meddelande nr 15, 1943*, 3.

HAZARDS

One of the most defining negative user associations of wood gas was danger, specifically in the forms of fire and poisoning. Between 1939 and 1944, 2,865 wood gas related fires were reported. The fire frequency was at its highest during the first two years of widespread wood gas usage, before fires caused by erroneous technical design were averted as lessons learnt led to new safety regulations.

Figure 2: "Well Equipped during Gasifier Emptying and Refilling. Protect Yourself against Soot and Heat." Due to the unpredictability and hazard associated with wood gas usage, protective gear was marketed, although with questionable success.

Gengasnämnden received several reports of flames shooting out from open gasifier fuel filling shutters, inspection hatches and ash container shutters, leading to burn injuries on the arms and faces of those standing

in front of shutters.[40] To avert fires caused by careless gasifier cleaning, locations especially assigned for emptying gasifiers were decreed. Wood gas fuelled automobiles had to carry fire extinguishers and a ten litre vessel for emergency fire extinguishing. Fires ascribed to the human factor also declined as users became more adept through practical experience (Fig. 2).[41]

Another hazard connected to wood gas usage was acute and chronic carbon monoxide poisoning. Emissions from petrol-fuelled cars consisted of 6-7 percent carbon monoxide, compared with 20-30 percent for wood gas. When inhaled, even in small doses, carbon monoxide blocks the blood cells' absorption of oxygen, causing suffocation. In 1940, 60 cases of wood gas induced acute carbon monoxide poisoning became known, seven of which resulted in death. The following year the number of known cases had increased to 901 (17 deaths) and 1,135 (eleven deaths) in 1942.[42] During the war years, carbon monoxide poisoning was so strongly associated with wood gas usage that it often was referred to as wood gas poisoning, rather than carbon monoxide poisoning.

Wood gas users and automobile mechanics were advised to never work alone and to keep a close watch on co-workers' state of health.[43] As most automotive transportation and repair during World War II took place within the professional transport sector, carbon monoxide poisoning was mainly discussed as a work place hazard.[44] Particularly dangerous aspects were gasifier ventilation and the gas accumulation after the engine was shut off. Gas could also leak into vehicles during driving – a consequence of poor welding and faulty packings. The cold winter season proved particularly problematic as employers and workers were less inclined to air out their premises with cold outdoor air. According to the *Gengasnämnden*

40 | Ingenjörsvetenskapsakademien: *Gengas*, 328-331; Gengasnämnden, vol. EIIbc:2. Statens bränslekommissionen (1940). RA; Gengasnämnden, vol. EIIc:1. Statens bränslekommission (1940), RA.

41 | Ingenjörsvetenskapsakademien: *Gengas*, 331, 333, 341; Motormännen: *Motormännens gengasbok*, 71-73.

42 | Ingenjörsvetenskapsakademien: *Gengas*, 316-317; *Gengas*. Stockholm: Sveriges läkarförbunds förlagsaktiebolag, 1943, 7.

43 | Ingenjörsvetenskapsakademien: *Gengas*, 318; Motormännen: *Motormännens gengasbok*, 78.

44 | See for example Governmental bill 1945:215, 7.

employed engineer Nils Gustafsson, faulty gasifiers and the users' negligence of safety instructions were equally common causes of carbon monoxide poisonings.[45] According to carbon monoxide specialist medical doctor Ernst B. Salén, traffic accidents increased as a direct result of the obscured judgement of drivers in the early onset of acute carbon monoxide poisoning.[46]

Awareness of the poisoning risk linked to wood gas became widespread, resulting in several brochures on wood gas safety and chapters in wood gas maintenance instruction books and leaflets.[47] Labour unions and state authorities responded to the poisoning risk by decreeing that warning signs should be hung up in all work places where wood gas was used. Carbon monoxide indicators and information campaigns became relatively effective tools for decreasing the percentage of carbon monoxide poisonings with a lethal outcome from 11.7 percent in 1940 to less than one percent in 1942.[48]

Acute carbon monoxide poisoning was the first known poisoning hazard of wood gas. Gradually, however, attention was also directed towards chronic carbon monoxide poisoning (during the war more commonly referred to as chronic wood gas poisoning). Because of the correlation to wood gas usage it was defined as an occupational disease during the war years. The hypothesis behind the diagnosis was that constant exposure to small doses of carbon monoxide over a prolonged period of time caused a state of lethargy. The most common symptoms included fatigue, headache, vertigo, broken sleep, apathy, change in temperament and cardiac symptoms. Due to the diffuse nature of the condition and the difficulties in proving a somatic origin to the condition, the diagnosis became the subject of a post-war medical-scientific controversy.[49] Regardless of the

45 | *Gengas*. Stockholm: Sveriges läkarförbunds förlagsaktiebolag, 1943, 19-25.

46 | Ingenjörsvetenskapsakademien: *Gengas*, 332.

47 | Tore Leonhart: "Kontroversiell förgiftningsepidemi lade grund för yrkesmedicinen", in: *Läkartidningen* 102:14 (2005), 1062.

48 | Ingenjörsvetenskapsakademien: *Gengas*, 318; Motormännen: *Motormännens gengasbok*, 325-26, 333-43.

49 | Helena Ekerholm: "Gengas och ohälsa. Den medicinsk-vetenskapliga kontroversen kring kronisk koloxidförgiftning 1944-1961", in: *Lychnos*. Uppsala: Lärdomshistoriska samfundet, 2010.

scientific controversy surrounding it, chronic carbon monoxide poisoning was often pinpointed as a serious risk of wood gas usage. From 1943 to 1944, the officially recognised cases of chronic carbon monoxide poisoning increased from circa 300 to circa 1,600.[50] For labour unions and *Sveriges kommunistiska parti* (the Swedish communist party represented in Parliament) combatting chronic carbon monoxide poisoning became a work place safety issue. Necessary measures could not wait for medical science to resolve the controversy.[51] Wood gas usage, with its negative health effects, thus became a political issue for left-wing organisations and labour unions.

Troublesome Maintenance

As the wood gas commission had stated in the interwar years, the preconditions for successful wood gas use were substantial user interest in and knowledge of the socio-technical characteristics of wood gas. However, not all drivers or repair shop personnel could summon up sufficient enthusiasm. Employers who had the good fortune of finding employees with the necessary skills for dealing with wood gas ran the risk of losing their wood gas specialist to the conscription army.[52] The specific wood gas driving technique demanded special attention from the driver.[53] Apart from the extra workload of emptying the gasifier and then, carefully and with precision, refilling and lighting it again, which in itself was a process that could take up to 15 minutes, driving a wood gas propelled vehicle required a different driving technique from that used by petrol-driven vehicles. The driver had to keep a constant eye on the air-gas mixture proportion in order to avoid engine stops. Engine rpm needed to be kept

50 | Preliminary report from Sabbatsbergs sjukhus, 21.09.1945, in: Drivmedelsutredningen 1944, vol 1, RA; Sveriges officiella statistik/ Riksförsäkringsanstalten: Socialstatistik. *Olycksfall i arbete*. 1938-1951, tables 11a-b.

51 | Governmental bill 1945:215; Parliamentary bill 1945:348, second chamber; Statsutskottet (Budget Committee), formal report 1945:68, 6-7.

52 | Letters from Aktiebolaget Lovén & Co 07.05.1940 and Motorkompaniet Linder & Forsberg 26.04.1940, in: Gengasnämnden, vol Ela:4. Statens bränslekommission (1940), RA.

53 | Motormännens Riksförbund: *Motormännens gengasbok*, 63.

at a constant level, which entailed energetic gear shifting. Stops needed to be kept to a minimum, both in occurrence and length of time. After three hours the gasifier had to be completely restarted.[54] Also, due to a relatively low thermal value, wood gas propelled vehicles were slower, had poorer acceleration and hill climbing capacity than petrol and ethanol-fuelled automobiles. Wood gas specific waste such as odour, grime and cinders, forced authorities to decree premises for starting, cleaning and maintenance of wood gasifiers.[55] Wood gas maintenance was described as specifically unfit for women and minors, due to the difficulties of adapting to wood gas user practice. But imagery of women engaged in wood gas maintenance was sometimes used to illustrate the simplicity of wood gas use in gasifier manufacturers' marketing strategies and cheerful articles in popular press.[56] If women could use wood gas, then anyone could.

Although it could be used in a large number of application fields, wood gas did not have the multifunctional, easy-usage qualities of liquid-fuelled internal combustion engine automobiles. In this capacity, wood gas vehicles could be likened to electric and steam vehicles, which also had socio-technical characteristics seen as being disadvantageous within automobile culture: slowness, starting procedures with higher demands

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54 | Motormännen: *Motormännens gengasbok*, 31-32, 53-59; Carl Skånberg: *Gengasboken*. Stockholm: Saxon & Lindströms förlag, 1940, 51-53.

55 | "Våldsam reaktion mot gengaslukten tvingar myndigheterna till handling. Generalplan för 70 'gengaskarantäner' framlägges i Stockholm. Chaufför som slaggade på gatan fick två tänder utslagna", in: *Nya dagligt allehanda* 09.01.1941; "Att slagga på kvällen – medel mot gengasos. Illaluktande nytändning på gatan ofrånkomlig, men det rör sig...", in: *Svenska Dagbladet*, 12.01.1941. Both articles from volume 5:45 at Tekniska museets motorhistoriska samling, (Archive, Tekniska museet) Stockholm. See also advertising for the gasifiers Vedi and Koli, which were advertised as clean, easy-use gasifiers that would "spare your suit" and make driving a "'pure' pleasure", in: vol. L7, Tekniska museets motorhistoriska samling, (Archive, Tekniska museet) Stockholm.

56 | See letter from Lovén & Co, 07.05.1940, in: Gengasnämnden, vol Ela:4. Statens bränslekommission (1940), RA; Communication to Folkhushållningsdepartementet from R. Bennet, 17.04.1940, 9, in: Gengasnämnden Ela:6. Statens bränslekommission (1940), RA. See also photo of women in wood gas related occupation in: *Biljournalen* 2, 1940, 16.

for user effort and a symbolic label of old-fashionedness.[57] Like wood gas vehicles, the steam automobile was considered dirty and dangerous. Fear was a common negative association with the steam engine[58], and was also one of the most defining perceptions of wood gas. But a comparison also shows considerable differences between these three automobile types. The sources suggest that wood gas usage was seen primarily as an occupational activity entrenched in masculine working-class symbolism, whereas the use of an electric vehicle encompassed feminine higher strata coding.[59] The defining qualities of the wood gas, electric and steam automobiles were not in line with user practice ideals: trouble-free operation, long uninterrupted driving distances, high speed and multi-functionality.

Petrol Returns

As the prospect of peace appeared on the horizon, there was evidence in the popular press of growing hopes for a future without wood gas. The assessments of wood gas were, however, ambiguous. On the one hand, it had enabled vehicle transportation for private and enterprise consumers alike during a time of great hardship. On the other hand it was inconvenient.[60]

57 | Mikael Hård/Andrew Jamison: "Alternative Cars: The Contrasting Stories of Steam and Diesel Automotive Engines", in: *Technology in Society* 19:2 (1997), 148-49.

58 | Clay McShane: *Down the Asphalt Path. The Automobile and the American City*. New York: Columbia University Press, 1994, 97.

59 | About the properties of the electric vehicle see Gijs Mom: *The Electric Vehicle. Technology and Expectations in the Automobile Age*. Baltimore, MD: The Johns Hopkins University Press, 2004, 128, 150, 278-81.

60 | "Moren kan gå", in: *Dagens Nyheter*, 03.11.1944; "Bränslet skapar nästan panik i bussbolag och verkstäder", in: *Stockholms-tidningen*, 18.10.1945. Both from volume 5:45 at Tekniska museets motorhistoriska samling, (Archive, Tekniska museet) Stockholm. See also: "Moren har gjort sin plikt, moren går, säger gengasman", in: *Dagens nyheter*, 02.11.1944; "Gengasen högst impopulär bland vår orts trafikbilägare", in: *Lidköpings-tidningen*, 25.10.1944; "Fortsätter Ni med gengasen efter kriget? 100 svara NEJ – d.v.s. under förutsättning att bensinen inte blir alltför dyr", in: *Aftonbladet*, 23.07.1944; "Försvinner gengasen med kriget? Motormännen spå återgång till bensindrift", *Mellersta Skåne*,

In competition with other 'strong' and 'powerful' fuels it was expected to become a fuel to look back on, rather than having hopeful visions of. News articles on the topic of automobile fuel mainly focused on the less attractive characteristics of wood gas usage: messy maintenance, low effect and hazard. There is also an interesting comparison to ethanol which was the other main fuel alternative in Sweden during the war years. Although petrol and ethanol have been in on-and-off contestation for decades, they are quite similar when compared with other fuel alternatives. Apart from adjusting the engine for one or the other, user practice required few, if any, adjustments. Automobile design aimed at constructing engines of higher speeds, with ever increasing rpm and more horsepower, as these have been desired socio-technical characteristics of an automobile, symbolising the independence of the modern life-style.[61] Speed, covered distance and maintenance procedures were technical characteristics similar enough to make petrol and ethanol symbolic equals. Whereas a bus propelled with liquid fuels was 'real', a wood gas fuelled bus was something else, even if it performed essentially the same task, namely the transport of people from point A to point B. Automobility entailed freedom of mobility with high speed and power and a minimum of operational hassles. The passenger car served as a symbol of modernity and development.[62] None of these attributes were credited to wood gas usage. For the contemporary

12.08.1944. Examples of articles which address the usefulness of wood gas during war time, in spite of substantial user problems: "'Giftburkens' saga ej slut i och med det att kriget upphör", in: *Aftonbladet*, 06.11.1944; "Gengasen får stor uppgift även i fred, anser Svedlund", in: *Örebro-kuriren*, 04.11.1944. All from Drivmedelsutredningen 1944, vol. 1, RA.

61 | Tom McCarthy: *Auto Mania. Cars, Consumers and the Environment*. New Haven, CT: Yale University Press, 2007, 28, 253, 262; Wolfgang Sachs: *For Love of the Automobile. Looking Back into the History of Our Desires*. Berkeley: University of California Press, 1992, 91-124.

62 | Georgine Clarsen: *Eat My Dust. Early Women Motorists*. Baltimore, MD: The Johns Hopkins University Press, 2008, 158; Olle Hagman: *Bilen, naturen och det moderna: om natursynens omvandlingar i det svenska bilsamhället*. Göteborg: Socialantropologiska institutionen, 1999, 69-72; Sachs: *For Love of the Automobile*, 8-9; Virginia Scharff: *Taking the Wheel. Women and the Coming of the Motor Age*. New York: Free Press, 1991. Reprint, Albuquerque: University of New Mexico Press 1992, 165-66.

observer, the use of wood gas did not correlate to the ideals of modernity. Instead, the characteristics of wood gas usage can be likened to those of the horse and carriage at the beginning of the 20th century: powerlessness, slowness, tangible dirt, danger and frailty.[63] General Manager of *Svenska gengasaktiebolaget*, Gunnar Magnusson, concluded that the Swedes' inherent dislike of the relatively troublesome and dirty gasifier maintenance was likely to cause a general return to petrol.[64] Similar sentiments were aired at a confidential meeting held in November 1944, at which civil servants responsible for fuel issues and representatives for the automobile industry discussed the future of wood gas. The meeting was arranged by the Swedish government to foresee the future of automobile fuels during peacetime. Although representatives for the gasifier production industry were hopeful, or at least gave that impression, others concluded that without incentives such as tax exemptions, most wood gas users would dismantle their gasifiers at the first possible opportunity. The army, some state authorities and farms were mentioned as possible wood gas using sectors in the future, although the participants at the meeting had varying opinions on the usability of wood gas even for these users.[65]

In 1948, *Gengasaktiebolaget* was dissolved. Although wood gas usage was still of value for military purposes, in the civilian sector it was not continued as petrol import was resumed. The loan fund which had not been used since World War II, was discontinued in 1961 as the social democratic Minister for Agriculture thought it unnecessary to retain the loan funds merely for the sake of military preparedness.[66]

63 | For the horse carriage see Sachs: *For Love of the Automobile*, 1992, 5-9.

64 | "Moren har gjort sin plikt, Moren går, säger gengasman", in: *Dagens nyheter*, 02.11.1944; KAK, gengasenkät, appendix 5, 3, 18, in: Drivmedelsutredningen 1944, vol 2, RA.

65 | Meeting protocol 02.11.1944, in: Drivmedelsutredningen 1944, vol. 3, RA. For information about the meeting participants affiliation, see short meeting protocol summary, 7, in: Drivmedelsutredningen 1944, vol. 1, RA.

66 | Budget bill 1961:1, appendix 31:6; Parliamentary communication 1961:6.

CONCLUDING DISCUSSION

At the outbreak of World War II, the replacement of petrol with wood gas was no longer a policy vision but a necessity. As wood gas usage became more common, so did voices airing discontent with the drawbacks of wood gas. Influential trade unions representing professional wood gas workers cooperated with equally influential figures in the medical profession to pursue the debate on workplace safety. Wood gas became symbolically labelled as being hazardous. Although the negative health effects of wood gas were probably the main concern, the other characteristics did little to award it even a rhetorical civilian market niche in peacetime. Users were not ready to make the necessary adjustments to the socio-technical traits of wood gas. Furthermore, one of the most important political arguments for promoting wood gas in the interwar years had been to widen the market for forestry products. Rebuilding Europe after World War II, however, meant increased sales for Swedish forestry. There were no longer an economic crisis and production surplus motivating state initiatives for wood gas promotion.

Although the use of wood gas was in line with the idea of basing Sweden's wealth on the forestry industry, wood gas breached the standards set by ideologies more influential in daily life, namely automotive culture and progress-oriented ideals. Wood gas for automotive propulsion was a chronologically younger invention, but petrol (and to some extent ethanol) propulsion had the status of symbolic modernity for interwar and World War II automobile users. The symbolic connotations of surrogate and war gave wood gas a dating, a kind of 'best-before' label, which strengthened the symbolic division between wood gas as outmoded and low-tech, and liquid fuels as innately modern.

Viewed from an environmental perspective, the contemporary definition of dirt put wood gas at a disadvantage. The sooty refuse and odorous exhausts from wood gas were highly tangible; petrol emissions were discreet to the eye, hands and nose. To sum up, if wood gas propulsion meant reversing progress and moving back in time, the use of liquid fuels, especially petrol, was the self-evident choice for the future.

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