Sustainability Challenges of the Mid-nineteenth-century Dutch Energy System

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Abstract

Energy consumption plays a central role in sustainability debates. However, how new are these sustainability challenges? Did sustainability challenges feature in historical energy transitions? This paper analyses societal debates concerning sustainability around the transition from peat to coal in the Netherlands in the mid-nineteenth century. By dividing sustainability challenges in *here and now, later* and *elsewhere*, this paper addresses to which extent elements of sustainable development featured in the historical resource transition. Digitized publications in newspapers and journals were analysed using discourse analysis in order to trace back the existence of themes related to sustainable development. Elements of the modern-day discussions can indeed be found in the contemporary discussion. Secondly the paper shows why contemporaries made certain choices that later caused new sustainability challenges. Many of our current energy-related challenges may find their origin in the nineteenth century; it is nevertheless unjust to blame them on these generations.

1 Introduction

This paper analyses societal debates concerning sustainability challenges around the nineteenth-century energy transition from peat to coal in the

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Netherlands. Energy consumption plays a central role in modern-day sustainability discussions: it is a key input in the economy and a continuous supply is vital. At the same time, the combustion of fossil resources is one of the major contributors to environmental distress as a result of its emissions of carbon dioxide and other pollutants. Energy is therefore a central challenge in the discussion on the transition to a sustainable economy. Sustainability challenges are defined here as (potential) threats perceived by contemporaries to (future) development related to resource availability and pollution. It will be shown that the 'old' peat-based energy system faced sustainability challenges, and that coal helped to overcome these, while at the same time introducing new challenges.

There are two main reasons to focus on this nineteenth-century energy transition. Firstly, the increased consumption of coal at the expense of traditional sources of energy is intimately linked to the Industrial Revolution. The large-scale introduction of coal has been hailed as the origin of modern economic growth.[2] At the same time, environmentalists have pointed at this transition as the origin of global environmental distress.[3] The transition to coal is therefore nowadays seen as the cause of long-term economic development and as the cause of global climate change. It is therefore of interest to study to which extent elements of sustainability challenges featured already at the time, and how the transition was perceived by contemporaries. Secondly, a historical approach allows for the analysis of a completed transition. This means that not only the existing challenges can be studied, but also the outcome of the transition.

1.1 Historiography

Concerns about pollution or the environment could be heard occasionally in the past.[4] Van Zon and Warde have both shown the long history of ideas related to sustainability and sustainable development.[5] Warde has traced back the origin of the ideas behind the modern concept of sustainability to the sixteenth century, while he asserts that since Justus von Liebig's 1862 publication *Die chemie und ihrer Anwendung* 'a new ethic emerged that

2 R. Allen, *The British Industrial Revolution in a global perspective* (Cambridge 2009); K. Pomeranz, *The great divergence: China, Europe, and the making of the modern world* (Princeton 2000).

3 W. Steffen c.s., 'The Anthropocene: Conceptual and historical perspectives', *Philosophical Transactions of the Royal Society A* 369 (2011) 842-867.

4 See for example the texts collected in D. Wall. *Green history: A reader in environmental literature, philosophy and politics* (Londen 1994).

5 H. Van Zon, *Duurzame ontwikkeling in historisch perspectief: Enkele verkenningen* (Nijmegen 2002); P. Warde, 'The invention of sustainability', *Modern Intellectual History* 8 (2011) 153-170.

knowledge of those fundamental biological and chemical processes (…) would dictate the ability of societies to endure'; i.e. to be (physically) sustainable.[6] To the classical economists scarcity was a central theme, and they questioned the limits to growth.[7] Yet the subterranean forests of coal and oil made unprecedented growth possible in the nineteenth and twentieth century.[8] And it was not until the second half of the twentieth century that sustainability in its modern meaning came to the attention of a wider public.[9]

Although sustainability concerns and the debate on the transition towards a sustainable economy are omnipresent nowadays, relatively little is known about how sustainability concerns featured in historical transitions. Environmental historians have produced large numbers of case studies on environmental challenges in the past; ranging from natural disasters to man-made pollution.[10] At the same time (economic) historians have illustrated the importance of resource availability for economic development.[11] Nonetheless, attention for historical sustainability challenges in which both resource availability and pollution feature, has been virtually non-existent in social and economic history research. Van Zon's explorative work on *Duurzame ontwikkeling in historisch perspectief* is an important exception, but it appears to have found little resonance. Even in the field of energy history, authors rarely bring together both sides of the same coin. Kander, Malanima and Warde provide a very comprehensive study on energy history in Europe, but even though they address some issues related to sustainability, they never make the historical sustainability challenges explicit.[12]

6 P. Warde, 'The invention', 170.

7 E.g. T.R. Malthus., *An essay on the principle of population; or a view of its past and present effects on human happiness; with an inquiry into our prospects respecting the future removal or mitigation of the evils which it occasions. Vol II*. (Cambridge, 1803, P. James 1989, Ed.).

8 R.P. Sieferle c.s., *Das Ende der Fläche: Zum gesellschaftlichen Stoffwechsel der Industrialisierung* (Köln 2006).

9 Which is not to say that concerns about the environment or the availability of resources completely disappeared in the nineteenth and early twentieth century; see Van Zon, *Duurzame ontwikkeling*, for an extensive overview.

10 E.g. P. Van Cruyningen, 'From disaster to sustainability: Floods, changing property relations and water management in the South-Western Netherlands, c. 1500-1800', *Continuity and Change* 29 (2014) 241-265; J.L. Van Zanden and S.W. Verstegen, *Groene geschiedenis van Nederland* (Utrecht 1993).

11 E.g. R. Allen, *The British Industrial Revolution*; K. Pomeranz, *The great divergence*.

12 A. Kander, P. Malanima and P. Warde, *Power to the people: Energy in Europe over the last five centuries* (Princeton 2013).

1.2 The mid-nineteenth century as transition period

The mid-nineteenth century represents an intriguing period in Dutch energy history. In transportation as well as in industry, mechanization (i.e. the steam engine) brought about major changes in energy consumption; even though this industrialization process happened relatively slowly in the Netherlands.[13] In industry both thermal and kinetic energy can be required, depending on the production process. As source of thermal energy, peat was the most common choice. However, for certain industries, and at certain locations, coal had already been preferable for a long time.[14] In the mid-nineteenth century coal started to outpace peat and by 1863 it surpassed peat as the most important thermal energy source.[15] For kinetic energy the Dutch industry was largely dependent on wind power. At various locations also watermills could be found, but as the height differences in the Dutch landscape are small, the potential for waterpower remained limited. Animal-powered mills were also in use. The importance of coal-based steam power was still small around 1850 (less than 4% of all mechanical power was derived from steam engines), but it grew rapidly in the second half of the nineteenth century.[16]

Did sustainability challenges or sustainability concerns feature in this transition to coal? Oftentimes the introduction of coal in the Dutch economy is described in a rather deterministic fashion. Historians have concluded that the Dutch economic structure required less energy, and that coal was therefore less crucial for the Dutch development.[17] Coal is nevertheless still often described as a superior source of energy, whose introduction was unavoidable. However, in this paper I will argue that the Netherlands also faced sustainability challenges in relation to its conventional energy source: peat.

By dividing sustainability challenges in three categories: *here and now,*

13 H.W. Lintsen, *Een revolutie naar eigen aard: Technische ontwikkeling en maatschappelijke verandering in Nederland* (Delft 1990); J. Mokyr, 'The industrial revolution and the Netherlands: Why did it not happen?', *De Economist* 148 (2000) 503-520.

14 R.W. Unger, 'Energy sources for the Dutch Golden Age: Peat, wind, and coal', *Research in Economic History* 9 (1984) 221-253; J.L. Van Zanden, 'Werd de Gouden Eeuw uit turf geboren? Over het energieverbruik in de Republiek in de zeventiende en achttiende eeuw', *Tijdschrift voor Geschiedenis* 110 (1997) 484-499.

15 B.P.A. Gales c.s., 'North versus South: Energy transition and the energy intensity in Europe over 200 years', *European Review of Economic History* 11 (2007) 219-253, henceforth EREH.

16 H.W. Lintsen, 'Stoom als symbool', in H.W. Lintsen c.s. (eds.), *Geschiedenis van de techniek in Nederland: De wording van een moderne samenleving 1800-1890, Deel IV: Delfstoffen; machine- en scheepsbouw; stoom; chemie; telegrafie en telefonie* (Zutphen 1993) 105-109.

17 H.W. Lintsen, *Een revolutie*.

later and *elsewhere*, and by focusing on resource availability and pollution, this paper addresses to which extent elements of sustainable development concerns featured in the energy transition. Although pollution was a much smaller, and often local problem, the availability of long-term supplies of energy were of immediate concern. I will therefore argue that the 'old' Dutch peat-based energy system faced sustainability challenges already in the mid-nineteenth century. These concerns were to a large extent comparable to modern-day sustainability challenges, although not all aspects of our modern challenges were equally present.

2 Methodology

2.1 Sustainability challenges

In order to analyse the existence of sustainability challenges in the mid-nineteenth century, we first need some guidance on how to understand the (modern) concepts of *sustainability* and *sustainable development* in historical context. Sustainable development is about quality of life.[18] Pezzey reviewed various definitions of sustainable development and concluded that they all contain an element of intergenerational equity:[19] it is about 'meeting the needs of the present without compromising future generations to meet their needs.'[20] This implies that the quality of life in the *here and now* has to be maintained, while at the same time allowing the people living *later* or *elsewhere* to also meet their needs.[21]

This paper is limited to physical aspects of sustainability. This means that it examines which sustainability challenges contemporaries experienced in relation to resource availability and pollution. An important aspect of sustainable development concerns the question 'what can I know?'.[22] Sustainability challenges only become a problem when we have the knowledge to recognize them. It is therefore important to not impose current views on sustainability challenges on previous generations. As sustainability is prone to changing preferences and advancing (scientific) knowledge, long-term sustainability assessments are risky of becoming

18 B.J.M. De Vries, *Sustainability science* (Cambridge 2013) 7.

19 J. Pezzey, *Sustainable development concepts: An economic analysis* (Washington, DC 1992).

20 WCED, *Our common future* (Oxford 1987), 43.

21 H. Kolfoort and M. Rensman (eds.), *Monitor duurzaam Nederland 2011* (Den Haag 2011).

22 See also B.J.M. de Vries, *Sustainability*, 9.

anachronistic. Lindmark and Acar illustrate how societies have only been able to really act upon sustainability problems with advancing knowledge.[23] A polluting substance may be brought into the environment, but as long as there is no knowledge about its harmful effects, there will be little reason to act. Only once the harmful effects are known, it becomes possible to act. This insight is important when analysing the historical developments with current sustainability indicators.

2.2 Sources

In order to examine the prevalence of a public debate on the existence of sustainability challenges in the mid-nineteenth century energy system, a discourse analysis of contemporary newspapers and journals was executed. The digitization of nineteenth-century publications has made it possible for historians to scan through large amounts of contemporary texts. I focussed on digitized publications, made available by the Dutch *Koninklijke Bibliotheek*.[24] This source provides a wealth of information, although there are also a number of possible pitfalls.

Broersma discusses how the digitization of newspapers has provided historian with massive amounts of easily accessible data.[25] This requires a new way of working and it compels historians to deal with a completely new challenge: an overflow rather than scarcity of information. The advantage is that it becomes easier to collect opinions of a wider section of society and, as done here, general trends or tendencies can be determined. The downside is that the sheer quantity of findings makes it virtually impossible to critically assess the positions and backgrounds of all the authors. Depending on the topic and the length of the period studied, the number of articles found may even make reading them all impossible.[26]

Searching in the digitized sources is made easy through OCR (optical character recognition). This software recognizes letters in scanned pages and enables a quick search through the digitized texts. The low quality of

23 M. Lindmark and S. Acar, 'The environmental Kuznets curve and the Pasteur effect: environmental costs in Sweden 1850-2000', *EREH* 18 (2012) 306-323.

24 http://www.delpher.nl (downloaded between March 2013 and May 2013).

25 M. Broersma, 'Nooit meer bladeren? Digitale krantenarchieven als bron', *Tijdschrift voor Mediageschiedenis* 14:2 (2012).

26 Laan and Lintsen, for instance, used the digitized newspapers to study complaints about poverty between 1820 and 1850. They found over 10,000 articles containing the word '*ellend**'. L.S. Laan and H.W. Lintsen, A historical perspective on sustainable development: First results of content analysis of Dutch newspapers on 'misery' 1820-1850 (Paper prepared for the ESEH conference 2015).

the old papers may make this scanning difficult. However, by searching for different relevant keywords most relevant text will be found. A more important challenge when studying the topics of 'energy' and 'sustainability' is that the terms were not in common use yet in the nineteenth century.

The search period was limited to the key transition period 1835-1865. Furthermore I used a variety of search terms such as *warmtestof, veen, verveening, steenkool, kolen, schaarste, gebrek, rook, verbranding*, etc. This resulted in several thousand hits. Whereas Laan and Lintsen decided to analyse a randomized set of 5% of the text they found, I opted for a sampling approach more common to the social sciences. In qualitative interviewing the first selection of interviewees is often based on the identification of the relevant actors.[27] As the relevant actors were initially unknown, I relied on the search engine of *Delpher* to identify the most relevant texts. I followed Glaser and Strauss's concept of *theoretical saturation* to determine the limits of the samples.[28] The reason not to take a fixed sample size was that I included various search terms, some of which are more omnipresent than others and *theoretical saturation* provides a more satisfying sampling methodology.[29]

3 Sustainability challenges: the 'old' energy system

3.1 Here and now

When peat is extracted it needs to be dried before it can be efficiently burnt. This drying happened outside in the sun and took up to several weeks. In a rainy country like the Netherlands, this could cause difficulties. When the peat could not sufficiently dry, the quality of the harvest – and therewith the amount of energy that could be extracted – decreased.[30]

27 B, Byrne, 'Qualitative interviewing', in: C. Seale (ed), *Researching Society and Culture* (2nd ed) 179-192, 186-188.

28 Glaser and Strauss (1967), quoted in C. Seale, 'Generating grounded theory' in: C. Seale (ed), *Researching Society and Culture* (2nd ed) 239-247, 242, wrote: 'The criterion for judging when to stop sampling (…) is the category's *theoretical saturation*. *Saturation* means that no additional data are being found whereby the sociologist can develop properties of the category. As he sees similar instances over and over again, the researcher becomes empirically confident that a category is saturated.'

29 The search term *veen*, for instance, generated 764 hits in journals and 56,093 hits in newspapers, while *warmtestof* resulted in only 46 and 84 hits in journals and newspapers respectively (figures from July 2016).

30 M.A.W. Gerding, *Vier eeuwen turfwinning: De vervening in Groningen, Friesland, Drenthe en Overijssel tussen 1550 en 1950* (Wageningen 1996) 29-34.

The vulnerability to the weather presented a direct challenge (i.e. a *here and now* sustainability challenge). This can be illustrated with a few examples. First of all, not only rain could disturb the harvest. S.P. Van der Tuuk, major of the small village of Bellingwolde and regular reporter to the *Tijdschrift ter Bevordering van Nijverheid*, reported for example that peat digging in Groningen in 1855 was hampered because it took a long time until the peat was sufficiently defrosted. This, combined with a shortage of labour, meant that the price of peat rose considerably.[31] In Enschede, a region not particularly endowed with an efficient infrastructure, factories often experienced difficulties regarding the availability of fuel. It was reported to the *Tijdschrift ter Bevordering van Nijverheid* that these difficulties in 1838 were twice as oppressive because of the wet weather and the scarcity of peat.[32]

In the *Kolonie-Berigten over Augustus 1841* we find another example of the negative influences the weather could have on the availability of peat. J. Van Konijnenburg, who was involved in charity initiatives in the region and was the director of the *Rijksgestichten Veenhuizen en Ommerschans*, reported:

> 'The peat digging in *Ommerschans* and the regular colonies has, because of the rain, experienced a lot of delay, so that numerous dry days and sunshine are required before winter, to acquire a sufficient amount of dry peat. In *Veenhuizen*, where a large amount of peat is still stored, and the people did not dig, the people do not have that fear; one could even, if necessary, transfer peat from there to the other colonies, which, however, because of the costs of transportation, is not preferable.'[33]

31 Uittreksels uit de berigten van leden correspondenten en departementen der Nederlandsche Maatschappij ter Bevordering van Nijverheid, en van verschillende Commissiën, Maatschappijen en Genootschappen van Landbouw in het Koningrijk der Nederlanden (Haarlem 1855).

32 J.A. Van Bemmelen c.s., 'Bijdragen voor de nijverheid, bepaaldelijk ten aanzien van de kunsten, handwerken, fabrijken en trafijken, den koophandel, de zeevaart en de visscherijen', *Tijdschrift ter Bevordering van Nijverheid* 6 (1840) 86-121, 98, henceforth TBN.

33 J. Van Konijnenburg, 'Kolonie-berigten over augustus 1841', *De Vriend des Vaderlands* (1841) 627-630, 629. Original quote: 'In de turfgraverijen te *Ommerschans* en de gewone Koloniën is, door den regen, ook veel vertraging ondervonden, zoodat er nog onderscheidene drooge dagen en veel zonneschijn gevorderd wordt, om, nog voor den winter, eene genoegzame hoeveelheid droogen turf te bekomen. Te *Veenhuizen*, alwaar nog eene groote hoeveelheid oude turf staat, en daarom dit jaar niet gegraven is, heeft men die vrees niet; zelfs zou men des noods vandaar aan andere Koloniën kunnen overdoen, hetgeen echter, om de kosten van het vervoer, niet verkieslijk is.'

Illustration 1: A peat digger builds a round pile of peat blocks to enhance the drying. Source: Nationaal Archief/Collectie Spaarnestad SFA001020747

There are two points we can derive from this quote. First of all, unfavourable weather conditions had tremendous effects on the availability of energy. With energy, as with food supplies, people were highly dependent on their land and the weather and when that was unfavourable, scarcity could be a direct and real threat. Second, scarcity could be a very local phenomenon. Ommerschans and Veenhuizen are about 60 kilometres apart, but because of problematic inland infrastructure at the time, transportation was prohibitively expensive. *Here and now* sustainability challenges in relation to resource availability were thus omnipresent in the peat-based thermal energy system.

As the smoke from the combustion of peat was relatively clean – the Dutch peat contains only small amounts of sulphur – nuisance from smoke

pollution was minimal.[34] The only challenge related to pollution from peat combustion was the relatively large amounts of ash that were left after burning. Although this ash contained useful components it could cause nuisance in cities because it could be blown away and transportation out of the city could be costly.[35]

3.2 Later

The Netherlands was rich in peat, and while peat had its limitations regarding the aforementioned vulnerability to weather conditions and high transportation costs, it was a relatively secure source of energy as it could be extracted domestically. However, the peat could not be regrown, so the energy stock slowly vanished.[36] A serious *later* sustainability challenge therefore presented itself: how to deal with the diminishing energy reserves?

While various industries, especially in cities with proper connections to sea ports, had already been using coal for centuries, peat was still the most important source of thermal energy for large parts of the country in the first half of the nineteenth century. According to E. Van Voorthuijsen, who wrote extensively about the production of peat and who was especially active in the debate on the abandonment of the excises, peat from the *Lage Veenen* was economically unattractive because of the quality of the peat.[37] Others also stressed the loss of valuable land.[38] As E.A. Wrigley writes about pre-industrial societies, which the Netherlands still largely was, land was 'almost the sole source not only of food but of the great bulk of the raw materials used in manufacture'.[39] Peat from the *Hooge Veenen* was more valuable and even resulted in cultivation of unused and unproductive lands, the so-called *woeste gronden*.[40] *Hooge Veenen* were

34 R. Hölsgens, Long term CO_2 and SO_2 emissions in the Netherlands: Industrialization and structural change (Paper prepared for WEHC2015).

35 F. Knapp, 'Over de takken van nijverheid die op verbranding rusten', *TBN* 9 (1845) 204-243, 396-484, 642-718, 220-223.

36 Peat can re-grow at a very slow rate, but given the rate of extraction in the Netherlands in the nineteenth century, it should be considered non-renewable.

37 E. Van Voorthuijsen, 'Onze veenderijen', *TBN* 15 (1852), 231-301.

38 H.A. Wynne, 'Bijdrage tot de kennis van de nijverheid in de provincie Groningen', *Tijdschrift voor Staathuishoudkunde en Statistiek* 13 (1856) 315-336, 317, henceforth TSS.

39 E.A. Wrigley, *Continuity, chance and change: The character of the industrial revolution in England* (Cambridge 1988) 34.

40 The *woeste gronden* were not completely unproductive, but their economic importance was small, A. Van der Woud, *Het lege land: De ruimtelijke ordening van Nederland, 1798-1848* (Amsterdam 1987) 25-27, 213-242; P.E. de la Court, *De Peel en bedenkingen over denzelven* ('s Gravenhage 1841) 9.

still present in the Netherlands in rather large quantities. Nevertheless, it was also generally recognized that the reserves were not unlimited.[41]

Evidence of rising prices is scarce, suggesting that there was no direct pressing scarcity. The anonymous author of *Iets over de eindelijke verdwijning onzer hooge veenen* mentioned rising prices, but this appears to refer to firewood only. However, the author seemed to fear even higher prices when peat would become exhausted.[42] Given the improvements in infrastructure one wonders whether in absolute terms, prices of peat will have gone up.[43] Relatively, it seems rather that the price of coal came down during the nineteenth century, especially after the excises on coal and peat were abolished in 1863.[44] With hindsight we may thus conclude that, in absolute terms, peat never became truly scarce.[45]

However, this does not mean that contemporaries did not perceive potential future shortages as threatening. Although Van Brussel wrote in 1865 that 'our peat lands are a California, richer and more inexhaustible than the American region', it was generally recognized already in the preceding decades that the Dutch peat was in fact being exhausted.[46] Some local communities had already become deprived of their peat reserves.[47] With the disappearance of most forests in the Netherlands, and with a growing population, peat had become the most common source of (thermal) energy and alternatives were not readily at hand within the country. As an anonymous contributor to the *Tijdschrift voor Staathuishoudkunde en Statistiek* noted:

> 'The peat lands have become accessible through canals and roads. Without wanting to establish impediments to consumption or transport, we cannot suppress our fear that, within 100 years, such a short period in the life of a

41 'Het amortiseren van onze staatsschuld', *Grondtrekken der Staathuishoudkunde* 12 (1855) 415-420; 'Iets over de eindelijke verdwijning onzer hooge veenen', *TSS* 13 (1856) 81-85; W.C.H. Staring, 'Nog iets over onze veenen', *TSS* 13 (1856) 343-347.

42 'Iets over eindelijke', 82.

43 Transportation was costly nonetheless, not least because of the high tolls that had to be paid on the waterways; M.A.W. Gerding, *Vier eeuwen*, 305-307.

44 J.L. Van Zanden and A. Van Riel, *The strictures of inheritance: The Dutch economy in the nineteenth century* (Princeton 2004) 206-210.

45 See also H. Leenaers (ed.), *De Bosatlas van de energie* (Groningen 2012) 15.

46 A.A. Van Brussel, 'Nederlandsche Maatschappij ter Bereiding van De Lara-kolen, tot verwarming en verlichting', *TBN* 28 (1865) 88-91, 90. As the Dutch representative of the peat-based De Lara coal, Van Brussel had personal motivations to convince potential customers of the availability of peat. Original quote: 'dat onze veenen een Californië zijn, rijker en onuitputtelijker dan het Amerikaanse gewest'.

47 See for example P.E. de la Court, *De Peel*, 11.

> nation […], our population will eventually be deprived of peat. Such an outlook deserves attention from the government, and from the people. – The population of the state has increased by 30,000 per year over the last 5 years. If one assumes a similar increase of our population, she would have grown with 3 million in hundred years, that is double the current population, wherewith the consumption of fuel also shall double.'[48]

The author continued:

> 'To be sure, coal also has a greater share in the fuels of our times; but by contrast, less wood and more peat is burned, since the wide hearths have been replaced by stoves and the prices of fuelwood have increased. One should also have eyes for the use of peat in our brick kilns, tile works, potteries, limekilns and other factories. In our country alone there are 332 brick kilns operating, which drag in a large and continuous consumption of peat. – Against this consumption, we do not believe that our peat lands can withstand one century. To be sure, in the eastern frontiers of Groningen, Drenthe and Overijssel, there are still extensive uncultivated peat lands, where the eye, as it were, cannot see an end; but it also did not see this at the peat volumes of the Smilde, the Hoogeveen, the Dedemsvaart, when they were first cut into. And yet, experts tell us that within 50 years, all of those peat lands will be exhausted.'[49]

48 'Iets over eindelijke', 81-82. Original quote: 'De veenen zijn toegankelijk geworden door kanalen en wegen, en zonder dat wij eenige hinderpalen aan verbruik of vervoer in den weg willen stellen, kunnen wij onze vrees niet bedwingen, dat althans over 100 jaren zulk een kort tijdperk in het leven van een volk, (…), ons volk ten eenenmale van turf verstoken zal zijn. Zulk een vooruitzigt verdient al de oplettendheid van de regering en het volk. — De bevolking van het rijk is over het laatste vijfjarig tijdvak telkenjare met 30,000 zielen vermeerderd; wanneer men eene gelijke toename van onze bevolking voor het vervolg stelt, (…) dan zou zij over honderd jaren met 3 millioen vermeerderd zijn, dat is, de dubbele bevolking van thans uitmaken, waarmede ook het verbruik van brandstof verdubbelen moet.'

49 'Iets over eindelijke', 82. Original quote: 'Wel is waar bekleedt ook de steenkool een grooter aandeel in de verwarmingsstoffen van onzen tijd; maar daarentegen wordt er minder hout en meer turf verbrand, sinds de ruime schouwen door de kagchels verdrongen en de prijzen van het brandhout gestegen zijn. Ook moet men hier het oog hebben op het verbruik van den turf in onze tigchelarijen, pannen- en pottebakkerijen, kalkovens en andere fabrijken. Er zijn toch in ons rijk alleen 332 steenbakkerijen in werking, welke een aanhoudend en ontzettend verbruik van turf naar zich slepen. — Tegen dit verbruik gelooven wij niet, dat onze veenen eene eeuw lang bestand zullen zijn. Wel is waar zijn aan onze oostelijke grenzen in Groningen, Drenthe en Overijssel nog uitgebreide onontgonnen veenen, waar het oog als het ware geen eind aan kan zien; maar het zag dit evenmin aan de veenmassa's van de Smilde, het Hoogeveen, de Dedemsvaart, toen die het eerst begrubt werden, en toch verklaren ons deskundigen, dat binnen 50 jaren al die veenen uitgeput zullen zijn.'

Although the author believed in the inexhaustibility of the coal mines in England, he also wondered whether there were no circumstances imaginable, in which the supply of coal could be hindered. He therefore suggested the Netherlands to embark on a path to remain largely autarkic in terms of energy. To him this meant investing in forestry. During the nineteenth century, silviculture did indeed take place in the Netherlands; although it remains unclear to what extent the wood was used energetically.[50] Nonetheless, examples of commentaries on wood as a possible substitute for diminishing peat stocks abound in the mid-nineteenth century. The author Haasloop Werner commented, for example, about the forests on the Veluwe: 'We consider these forests useful, because they protect the Veluwe, stimulate rain, and with the exhaustion of our peat lands, can continue to provide fuel to the hearths in Holland'.[51]

Illustrative for the importance of fuel wood is also Robidé van der Aa's report to the *Tijdschrift ter Bevordering van Nijverheid*. Robidé van der Aa was a lawyer and writer who responded to a prize contest by the *Society for the Advancement of Industry* to test the possibility to grow the Acacia tree on Dutch sandy soils. His conclusion was that 'there is no doubt that, once the value of the *Acacia* as fuelwood is more generally known, and with the diminishing peat reserves, the price of this firewood will rise considerately, as it is extraordinarily suitable for certain factories'.[52] The exhaustion of peat was thus considered worrisome since peat was still the main supplier of energy. In the words of Van Voorthuijsen: 'In case fuel is indispensable for humans, and we have received a generosity of peat from nature, so it appears doubtful to us to use this treasure light-footedly, without being cautious for means, in which this so useful product could be fostered'.[53]

50 J. Buis, *Historia forestis: Nederlandse bosgescheidenis, bosgebruik, bosbeheer en boswetgeving tot het midden van de negentiende eeuw* (Wageningen 1985).

51 Haasloop Werner, 'Eene geschiedkundig-statistische wandeling in de gemeente Putten op de Veluwe', *TSS* 11 (1855) 65-85, 85. Original quote: 'Deze bosschen beschouwen wij nuttig, omdat zij de Veluwe beschutten, den regen bevorderen, en bij de uitputting van onze veenderijen kunnen voortgaan om de brandstof aan de schouwen in Holland te verschaffen'.

52 C.P.E. Robidé van der Aa, 'De aankweking der Acacia in Nederland beproefd, en derzelver uitkomsten ontwikkeld (1)' *TBN* 8 (1843) 114-129, 124. Original quote: 'Ook lijdt het geen twijfel, dat, zoodra de waardij van de *Acacia* als brandhout meer algemeen bekend zal worden, bij de vermindering der voorraad turf, de prijs van dit hakhout aanmerkelijk stijgen zal, als bijzonder geschikt voor sommige fabrijken'.

53 E. Van Voorthuijsen, 'Onze veenderijen', 237. Original quote: 'Indien brandstof nu onmisbaar is voor den mensch, en wij in onze veenen eene weldaad van de natuur ontvangen hebben, zoo kan het ons bedenkelijk voorkomen dezen schat ligtvaardig te verbruiken, zonder op middelen bedacht te zijn, waarop dit zoo nuttige voortbrengsel zoude kunnen worden aangekweekt.'

The geologist Staring, whose contribution was a direct reply to *Iets over de eindelijke verdwijning onzer hooge veenen*, was less worried about the vulnerable position the Netherlands would place itself in if it would become dependent on foreign coal. To him, silviculture was beneficial for the Dutch economy because it could convert waste lands into very productive possessions. However, the main energy source of the future would be coal. The Netherlands, so Staring claimed, should exhaust its peat supplies as quickly as possible in order to create valuable agricultural land. With the revenues of these agricultural lands, it would become possible to buy the necessary coal, and thus enable a flourishing trade.[54]

3.3 Elsewhere

The third dimension of sustainability challenges concerns problems exported to 'elsewhere'. This element was not addressed by contemporaries. If anything, the cultivation of *woeste gronden* through extraction in the peat colonies was seen as beneficial for the economies of the peripheral areas of the Netherlands.[55] The cultivation of *woeste gronden* created valuable agricultural land and the extraction generated an income for the peat diggers. As mentioned, the smoke from the combustion of peat was relatively clean; therefore also nuisance from pollution exported to other locations was minimal.[56]

3.4 Sustainability challenges of the peat regime – an evaluation

Interestingly, the Dutch peat supplies never became truly scarce; the resource was never fully extracted and, as mentioned above, evidence of rising prices is non-existent. However, as the discussion illustrates, sustainability challenges with regards to acute as well as future energy scarcity were not uncommon in the middle of the nineteenth century. *Here and now* and *later* sustainability challenges related to the availability of energy thus presented themselves.

In relation to the second aspect of sustainability challenges, pollution, the combustion of peat for energetic purposes did not cause any serious challenges at any of the three levels. Obviously, the combustion of the carbonaceous peat resulted in emissions of carbon dioxide, which we might nowadays consider a *later* sustainability challenge related to the

54 W.C.H. Staring, 'Nog iets'.

55 E.g. P.E. de la Court, *De Peel*.

56 R. Hölsgens, Long term.

peat-based energy system. However, even though the chemical reactions of combustion were well understood in the nineteenth century and knowledge emerged on carbon dioxide's impact on the climate, this was not considered problematic until the 1950s.[57]

Increasing demand for energy in the Netherlands, coupled with decreasing prices of imported coal, led to an acceleration of coal consumption in the nineteenth century; especially after the excise on coal was removed in 1863.[58] This addition of coal to the energy supply prevented peat from becoming exhausted and thus solved a potential *later* sustainability challenge that was feared in the mid-nineteenth century. It also reduced the dependence on the weather and thus reduced *here and now* challenges related to availability.

4 Changing challenges

Coal – next to domestic wood – was actively discussed as a possible solution to the *later* challenges of exhaustion of the domestic stocks of peat. It was hardly ever mentioned as a potential substitute to overcome direct scarcity because of unfavourable weather conditions.[59] While some searched for a sustainable domestic source of energy, the falling prices of coal after 1863 eventually led to an increased dependence on imported coal. Coal quickly became more and more important, for industrial uses as well as for residential heating. By the turn of the century it was discussed as *miracle substance*.[60]

Regardless of whether coal was being discussed by contemporaries as a solution to their sustainability challenges, we may conclude, with hindsight, that coal indeed solved the sustainability challenges related to the peat-based energy regime. However, as Morris has written in quite a differ-

57 Ibidem.

58 Van Zanden and Van Riel, *The strictures*, 207. According to J.P. Smits, 'The determinants of productivity growth in Dutch manufacturing, 1815-1913', *EREH* 4 (2000) 223-246, the dramatic increase of coal consumption should not only be seen in terms of its cheaper availability, but also as a result of an overall increase in purchasing power because of demises of various excises.

59 One example of where coal was discussed as a potential solution to direct scarcity can be found in F.H.C. Drieling and I.J. Van Ryckevorsel, 'Mijne Heeren! Geachte medeleden der Commissie van Toezicht', *De Vriend des Vaderlands* 14 (1840) 862-869.

60 As Dopler, quoted in: B.P.A. Gales, *Ondergronds bovengronds: Techniek en markt van de Limburgse steenkolenmijnbouw gedurende de achttiende en negentiende eeuw* (Capelle aan de Ijssel 2002) 9, called it: 'The black diamond is the life line of the modern-day Society'. Original quote: 'De zwarte diamant is de levensader der hedendaagse Maatschappij'.

ent context, societies face the *paradox of development*: 'People's success in reproducing themselves and capturing energy inevitably puts pressure on the resources […] available to them. […] Success creates new problems; solving them creates still newer problems.'[61] As mentioned in the introduction, the advantage of studying a historical transition is that it allows observing this. We can again make a distinction between sustainability challenges on the three levels of *here and now, later* and *elsewhere*.

4.1 Here and now

As coal was not dependent on the weather, its availability was more secure than that of peat or wind. Direct *here and now* challenges related to energy availability could therewith be overcome. However, as extraction in the Netherlands was virtually non-existent, almost all of this coal had to be imported.[62] Although the import of coal was in many cases (especially in the western provinces of Holland) economically viable, a discussion emerged in the Netherlands on how sustainable this import was.

Most observers at the time agreed that the supply of coal was virtually inexhaustible. It was generally recognized that the amount of coal was limited, but given the (moderate) level of consumption, coal would be available for such a long period that it could be considered inexhaustible. Even Jevons, who in 1865 published his famous *Coal question* stressed in the preface to the second edition that England would not truly exhaust its mines.[63] Bleekrode, professor at the Royal Academy in Delft, who wrote extensively on the state of science and technology in the Netherlands and abroad, commented that:

61 I. Morris, *Why the West rules ˜ For now: The patterns of history and what they reveal about the future* (London 2010) 28.

62 Two small-scale coal mines were in operation in the nineteenth century. They contributed less than five percent to the total coal consumption after the 1840s; B.P.A. Gales, *Ondergronds*; B.P.A. Gales c.s., 'North versus South'.

63 W.S. Jevons, *The coal question: An inquiry concerning the progress of the nation, and the probably exhaustion of our coal-mines* (London 1866). He merely warned that extraction would eventually become more and more expensive, and observed that it would become difficult for England to keep its position as economic leader of the world as other countries might start large-scale coal production too and could surpass England.

> 'if at this moment all other coal mines were stopped, then the mines of only New-Castle would still suffice to provide coal for all industries worldwide, for 900 years; and in Saarbrucken, only on Prussian territory, mines have been opened which contain plenty of coal for 90,000 […] years.'[64]

Van Voorthuijsen, who called for caution regarding the diminishing peat reserves, also observed that the Dutch peat was not indispensable: 'Because although it is a true treasure for our fellow-countrymen in our inclement climate, in case of deficiency (of peat R.H.) the closeness of coal-rich Belgium and England would warrant us against the lack of fuels'.[65] The optimism about the possibilities of international trade was widely spread; see also Staring, referred to above.[66] Technological advancements were thought to contribute to a peaceful, friendly, competition among nations. Since the 1840s, the liberalization of international trade resulted in the removal of various trade barriers and in the growth of exports.[67] The dependence on foreign suppliers was thus not really seen as problematic at the time.[68] With hindsight we might conclude that the import dependence made the Netherlands vulnerable. However, this fear of possible unavailability of energy only truly emerged towards the end of the century.[69]

64 S. Bleekrode, 'De tentoonstelling der nijverheid van alle volken, XXXII. Werktuigen voor dadelijk gebruik, waaronder mede begrepen zijn rijtuigen en de vervoermiddelen van spoorwegen en stoomscheepvaart', in *Algemeen Handelsblad* (1851, December 15). Original quote: 'wanneer op het ogenblik alle andere steenkoolmijnen silstonden, dan zouden die van New-Castle alléén de geheele nijvere wereld nog 900 jaren lang voeden; en te Saarbrück zijn alléén op Pruisisch grondgebied mijnen geopend welke ruim steenkool bevatten voor 90,000 […] jaren'.

65 E. Van Voorthuijsen, 'Onze veenderijen' 274. Original quote: 'Onmisbaar zijn onze turven niet, want ofschoon zij in onze gure luchtstreek voor onze landgenooten een waren schat opleveren, zoude bij hun gemis de nabijheid van het in steenkolen zoo rijke België en Engeland ons waarborgen tegen het gebrek aan brandstoffen.'

66 W.C.H. Staring, 'Nog iets'.

67 This, according to Van Zanden and Van Riel, *The strictures*, did not actually result in a comparable acceleration of economic growth. See also K.H. O'Rourke and J.G. Williamson, *Globalization and history: The evolution of a nineteenth-century Atlantic economy* (Cambridge 1999), who explain the origins of the nineteenth century wave of globalization.

68 One exception can be found in the *Arnhemsche Courant* of 1850. It reported about an invention to make cokes from peat, and called upon Dutch capitalists to invest in this technology which would increase the value 'of a completely domestic product, the peat' and which would 'make our fatherland at this point completely independent of foreigners'. However, the motivation clearly lay with the selling of a peat-based innovation and it should be questioned to which extent a fear of supply shocks really existed. 'Binnenlandsche berigten', in *Arnhemsche Courant* (1850, November 7). Origininal quote: 'een geheel inlandsch product, de turf'; 'ons vaderland op dit punt geheel onafhankelijk van den vreemdeling maken zal'

69 R. Hölsgens, Import dependence, vulnerability and energy transitions in the Netherlands, 1800-2012 (Paper prepared for WEHC2015).

A different kind of *here and now* sustainability challenge was introduced in the form of pollution. Although the knowledge of harmful indirect environmental effects from the burning of fossils was limited, people in the Netherlands perceived direct nuisance from the thick black clouds coming from the burning of coal.[70] Historians such as Allen have claimed that one of the reasons why the Netherlands did not make the switch to coal more quickly was that peat was less polluting.[71] As mentioned above, the Dutch peat contained little sulphur and therefore caused less nuisance than coal. Unger, who focused his research more on the seventeenth century underwrites Allen's claim. He stated that coal was dirtier than peat and mentioned that 'complaints about the fumes (from coal-burning, R.H.) were common. […] The smoke and fumes were thought to be hazardous to health. Peat was much cleaner, important in densely populated Dutch towns'.[72] When Lodewijk Cantillon filed a request to install a steam powered mill in Amsterdam, residents opposed the plans because of the possible dangers of explosion of the steam boiler, but also because they feared their houses would lose their value because of the thick clouds of smoke, bad smells and other negative externalities.[73]

Nevertheless, in mid-nineteenth-century discussions on peat versus coal arguments concerning differences in environmental performance are hard to find. Bleekrode, for example, touched upon the nuisance caused by coal burning, although he pointed above all to the economic advantages of the use of the so-called *Argand Burner* to burn the smoke, rather than to its environmental benefits.[74] This also holds for the elaborate exposé by the chemist P. Brouwer.[75] In his essay on *The combustion of coal and ways to avoid smoke* the main concern was economic. He mentioned, pointing at the English situation, the political wish to minimize pollution from smoke. However, his main concern was not the pollution, but the complete – and thus money-saving – combustion of coal. We can thus conclude that nuisance was also experienced in the Netherlands in the mid-nineteenth cen-

70 S. Bleekrode, 'Overzigt van de vorderingen der verschillende takken van nijverheid, of verslag van de technologische wetenschappen gedurende 1843 en 1844', *TBN* 9 (1845) 339-395.

71 R. Allen, *The British Industrial Revolution*.

72 R.W. Unger, 'Energy sources', 233.

73 H.W. Lintsen, *Made in Holland: Een techniekgeschiedenis van Nederland* [*1800-2000*] (Zutphen, 2005), 133.

74 S. Bleekrode, 'Overzigt van de vorderingen'.

75 P. Brouwer, 'De verbranding van steenkolen en de middelen ter voorkoming van rook', *TBN* (1861) 1-41.

tury.[76] Nevertheless, it appears to have played only a minor role in resource preferences and discussions on the relative advantages of energy carriers.

4.2 Later and elsewhere

To contemporaries, the worst challenges related to the long-term supply of energy were overcome with the introduction of coal. As mentioned, it was generally believed that plenty of coal was still available in the various mines in neighbouring countries and the fears of possible supply interruptions only seriously started to manifest themselves at a later stage.[77] The fact that the Netherlands now had to make use of resources coming from *elsewhere* was also not seen in the light of Dutch responsibility for extraction of valuable resources elsewhere. First of all it was assumed that coal was virtually inexhaustible, meaning that there was little harm in importing exhaustible resources. But more importantly, in the peaceful environment of the mid-nineteenth century, specialization was economically attractive.[78]

In as far as pollution from smoke was addressed at all in the contemporary publications, it was only perceived as a direct *here and now* nuisance. One measure, besides the *Argand Burner*, to overcome nuisance from smoke was the construction of higher chimneys.[79] By bringing the smoke higher into the air before it was released, the nuisance in the immediate vicinity of a factory or steam engine could be reduced. It was commonly believed that with this measure the negative impacts of emissions could be solved. We may now observe that this meant that the Netherlands exported its emissions abroad. However, to the contemporaries, a sustainability challenge was overcome.

4.3 New challenges introduced in the mid-nineteenth century

With hindsight we might conclude that the transition to a coal-based regime resulted in new sustainability challenges. Some of these were experienced more or less immediately, as discussed above. However, most of the challenges introduced in this period only became apparent (much) later. We would nowadays, for instance, say that the Dutch import was an assault on resources held abroad and therefore that the Netherlands was

76 See also: S. Bleekrode, 'Op welke wijze kan de Staat voor de veiligheid der stoommachines waken?', *TBN* 10 (1846) 1-92

77 R. Hölsgens, Import dependence. The early warnings about coal's eventual exhaustibility, or rather unavailability due to increasing extraction costs, by Jevons, *The coal question*, appear to have enticed little reaction in the Netherlands.

78 Cf. W.C.H. Staring, 'Nog iets'.

79 S. Bleekrode, 'Overzigt van de vorderingen' 373; S. Bleekrode, 'Op welke wijze'.

responsible for sustainability challenges *elsewhere*. Similarly, the large-scale uptake of coal resulted in increasing emissions of sulphur dioxide and carbon dioxide. These products of combustion have *later* contributed to acid rain and climate change.

In modern-day discussions it is often suggested that richer countries should carry a larger share of the responsibility in adopting climate change abatement measures.[80] It is undeniable that richer countries historically emitted more pollutants than poorer countries.[81] They also have more means to combat the problems. We clearly thank our strong economic position to the (coal-based) industrialization that emerged in the nineteenth century. Nevertheless, blaming this generation for the sustainability problems that emerged later would be teleological. Contemporaries faced their own sustainability challenges regarding the threatening exhaustion of peat. Unaware of the *later* challenges with regards to acid rain or climate change, coal solved these challenges.

5 Conclusion

This article asked whether sustainability challenges already existed in the nineteenth century. And if so, how they were overcome. These questions were approached from the case of the mid-nineteenth century Dutch energy transition. By focusing on challenges related to resource availability and pollution, and by classifying the sustainability challenges in line with the modern-day framework of challenges *here and now*, for *later*, or caused *elsewhere*, contemporary texts were analysed in search of evidence of sustainability challenges.

In the 'old' peat-based energy system sustainability challenges indeed existed. The production of peat was highly vulnerable to weather conditions and direct *here and now* challenges could easily manifest themselves when the weather was less favourable. Although the Netherlands contained vast amounts of peat lands, nineteenth-century observers also began to realize that the reserves were not infinite. Some therefore called upon conservation of the existing peat lands, others sought for domestic alternatives, and others still pointed to the immense reserves of coal that

80 See also the outcomes of the Climate Summit in Paris 2015 (http://newsroom.unfccc.int/unfccc-newsroom/finale-cop21/ (last accessed 7 January 2016).

81 H.D. Matthews c.s., 'The proportionality of global warming to cumulative carbon emissions', *Nature* 459 (2009) 829-832.

could be imported. Because of declining prices, coal eventually began to replace peat. In fact, it already started doing so well before peat truly became scarce, but the introduction of coal solved a *later* sustainability challenge worrying contemporaries nonetheless.

The advantage of the analysis of a completed transition is that it allows for the study of newly introduced challenges. Whereas peat did not provide a lot of sustainability challenges in relation to pollution, coal caused more nuisance. The smoke from coal combustion could cause direct, i.e. *here and now*, challenge. Nonetheless, in discussions on the use of different energy carriers, the pollution was rarely an issue. The transition to coal thus resulted in a new challenge in the form of pollution, but it solved the challenges in relation to energy availability. The *elsewhere* dimension, which is such an important element in sustainability discussions nowadays, was not considered at all in the nineteenth century.

With hindsight we might conclude that both peat and coal caused *later* sustainability challenges in the form of CO_2-induced climate change; while coal also emitted sulphur dioxide, the cause of acid rain. We might also conclude that the Netherlands already in the nineteenth century caused problems *elsewhere*, for example by contributing to the exhaustion of the finite coal supplies. However, it is important to realise that these are problems that contemporaries were not aware of. Contemporaries faced their own sustainability challenges regarding the threatening exhaustion of peat. Unaware of the *later* challenges with regards to acid rain or climate change, coal solved these challenges. New challenges were introduced. Some of these, such as acid rain, have been more or less successfully dealt with by a previous generation, others, such as climate change are left for the current generation to combat.

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