



Transformation through fragmentation: (Dis)engagement with alternative energy projects within a fracturing oil industry

Michiel Bron, Jelena Stankovic & Cyrus Mody

To cite this article: Michiel Bron, Jelena Stankovic & Cyrus Mody (07 Aug 2026): Transformation through fragmentation: (Dis)engagement with alternative energy projects within a fracturing oil industry, *Business History*, DOI: [10.1080/00076791.2026.2710666](https://doi.org/10.1080/00076791.2026.2710666)

To link to this article: <https://doi.org/10.1080/00076791.2026.2710666>



© 2026 The Author(s). Published by Informa UK Limited, trading as Taylor & Francis Group



Published online: 07 Aug 2026.



Submit your article to this journal [↗](#)



View related articles [↗](#)



View Crossmark data [↗](#)

Transformation through fragmentation: (Dis)engagement with alternative energy projects within a fracturing oil industry

Michiel Bron^a, Jelena Stankovic^b and Cyrus Mody^b

^aPublic Law and Governance, Tilburg University, Tilburg, the Netherlands; ^bDepartment of History, Maastricht University, Maastricht, the Netherlands

ABSTRACT

The oil industry is by no means a monolithic entity. This article argues that the fragmented nature of the oil industry played a key role in oil companies' decisions regarding their (often viewed as 'failed') diversification strategies into nuclear and solar energy during the long 1970s. By employing a long-term approach to oil industry involvement in these energy sources, the article shows how access (or lack thereof) to cheap-to-produce sources of oil in the 1950s and 1960s was crucial to firms' strategies in the face of rapid developments in the nuclear market. Only when access to cheap oil production seemed to become increasingly difficult did the major oil companies also seriously join alternatives such as nuclear and solar on a larger-scale. This changed in the mid-1980s when most of the major oil firms divested their alternative energy projects amidst a take-over battle that fractured the oil industry even more.

ARTICLE HISTORY

Received 24 September 2025
Accepted 25 June 2026

ACCEPTED BY:

Mar Rubio-Varas

KEYWORDS

Oil; fragmentation; nuclear; solar; energy transition; 1970s; diversification; industry; business strategy; sustainability; Kerr-McGee; Gulf Oil; Mobil

In the last nine months there have been radical changes in the world of oil and 1970 may appear historically as a watershed in the history of the industry. (G. Chandler, 1971)

1. Discussing 'fragmentation'

In the same years that continental drift became widely accepted among earth scientists (Oreskes, 1988), the oil industry – a key enabler of plate tectonic theory (Martinez-Rius, 2024) – underwent its own tectonic shift. For much of the twentieth century, the oil industry of the 'free world' (or World Outside Communist Area, WOCA) had been dominated by seven or eight 'majors,' much as the earth's geography is dominated by seven or eight continental plates.¹ Like the earth's crust, however, the majors have always co-existed with a dozen or so midsize firms like Atlantic Richfield Company (ARCO), Getty, or Occidental (the 'minor plates') and dozens of smaller independent producers, oilfield services firms, refiners, pipeline companies, engineering/construction firms, and so on (the equivalent of 'microplates'). As in plate tectonics, the majors often steered or rubbed along with smaller firms but also sometimes dramatically absorbed them; like the earth, the oil industry's history is one of continual splitting and combining and episodes of relative stability or instability. A

CONTACT Michiel Bron  m.bron@tilburguniversity.edu

© 2026 The Author(s). Published by Informa UK Limited, trading as Taylor & Francis Group

This is an Open Access article distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/4.0/>), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. The terms on which this article has been published allow the posting of the Accepted Manuscript in a repository by the author(s) or with their consent.

particularly far-reaching destabilisation began in the early 1970s, when it became clear to many in the oil industry that the industry structure comprising a few Western oil giants dominating global oil markets would not last. Since that time, national firms, especially in the BRICS, Middle East, and Global South, have taken control of much of worldwide oil production while the previously hegemonic Western majors have fused into 'supermajors' (analogous to supercontinents such as Gondwana) and moved into new territories in order to salvage their positions.

Like more prominent oil executives who had predicted structural changes at the end of the 1960s, in 1971 the industrialist, philanthropist, and Royal Dutch Shell manager, Geoffrey Chandler, described the factors forcing the oil industry's transformation. In Chandler's view, those elements were: increasing oil price (due to an unprecedented rapid rise in demand for oil in Western Europe, the pressure on vital supply lines in the Middle East in times of geopolitical conflict like the 1967 Six-Day War, and the preparedness of especially OPEC governments to use geographical advantage and financial power to force changes to existing agreements with oil companies), rising production prices (for pipelines, refineries and chemical plants), and – for Chandler, the biggest problem – difficulty in acquiring financing (G. Chandler, 1971).

According to Chandler, these changes drove – and were in turn driven by – an ongoing fracturing of the oil industry. During the 1960s, the majors' share of crude oil production, refining capacity, and market participation had steadily declined, while independents (smaller private oil and gas companies that are not part of one of the majors) and, above all, state-controlled companies grew their share significantly. This trend would only continue during the 1970s, Chandler thought, and would result in changing relationships among different types of companies within the oil industry (G. Chandler, 1971).

In this paper, we use the concept 'fragmentation' to describe these fundamental changes in the structure of the oil industry and explain the strategies various oil companies employed to deal with this fracturing. Specifically, we focus on the transition to – or addition of – alternative energy sources as actual, planned, or potential profit centres within various oil companies. By employing a long-term perspective, this article examines several transition pathways to oil firms' adoption of nuclear and solar energy from the 1950s to the 1970s and then focuses on the 1980s as a pivotal moment when many firms' earlier diversifications into alternative energy (and into other markets) were abandoned.

Grounded in legal scholarship and economic analysis, the concept of 'fragmentation' has mostly been utilised within debates on overlapping corporate governance in the 1970s and 1980s. The relative decline of 'interlocking directorates' (corporations that share their board members or both share directors with a third party) has been linked to increasing fragmentation in Western markets, which in turn is argued to be a major factor behind the increasing frequency of hostile take-overs, economic crises, the rise of neoliberalism, and the breakdown of the welfare state (Biermann et al., 2009; Mizruchi, 2013).

In our analysis we explore two related and sequential aspects of fragmentation. First, we examine the competing strategies that firms in the oil industry (varying in size, scope and role) adopted based on their positions within a postwar hierarchy dominated by a few Western oil majors (Biermann et al., 2009). We then show how the transformation of that industry structure into a more globalised and fluid hierarchy in the 1970s, combined with other factors, fuelled a fierce takeover battle leading to a shakeout among small and midsize

Western oil firms during the 1980s, a narrowing of almost all oil firms' operations, and the fusing of the majors into supermajors in the 1990s.

Of course, 'fragmentation' is a relative concept here. At least since Standard Oil's rise to hegemony in the 1860s, the oil industry has not had the classic character of a fragmented industry – ie 'many small- and medium-sized firms with few or no dominant firms'.² Still, framing the oil industry as 'fragmented' serves to critique both public and academic discourse that views the oil industry as monolithic, often represented by the moniker 'Big Oil' (Grasso, 2022; Jacobs, 2016; Mitchell, 2011).³ Although we acknowledge the tendency for internal cooperation, communication, and even collusion among the majors, we stress the fragmented nature of an industry that ranges from one-person engineering and geology consultancies to modest family-led refineries to some of the world's largest firms incorporating diverse activities both up- and downstream (Mason, 2014; Priest, 2015; Stevens, 2013).

Firms involved in the oil industry vary not just in size and degree of specialisation, but also in their ownership and geographic scope. Some are present in only one or two regions such as the North Sea or the Texas-Oklahoma 'oil patch,' while others operate worldwide; and some are privately held, some publicly traded, and some wholly or partially state-owned. These latter 'national' oil companies have long existed; especially the Mexican, French, and Soviet republics' governments owned significant stakes in large and globally influential firms from early in the twentieth century. However, national companies' share of worldwide oil production markedly increased after the creation of the Organization of Petroleum Exporting Countries (OPEC) in 1960 and the subsequent nationalisation of oil assets in many oil-producing countries in the Global South (Citino, 2002; Garavini, 2019; Morton, 2017).

We argue that the broad distribution of firms involved in the oil industry across all of these different axes (size, specialisation, geographic scope, ownership) yielded a fragmented industry structure, and that different firms' wildly varying positions within that structure gave rise to varied strategies regarding diversification into new markets and operations, including oil firms' – mostly 'failed' – diversifications into alternative energy. In the second section of our article, 'A Diversified 'Oil' Industry', we build on the existing literature in business history, history of technology and economic history to show how differences in size, in particular, incentivised oil firms to approach the initial development and commercialisation of alternative energy sources in different ways. In sections 3 and 4 of our article, we then specifically focus on oil firms' diversification into nuclear and solar energy through an analysis of external communication from the oil industry and internal reports, mostly focusing on companies such as Kerr-McGee, Gulf Oil, Mobil and Atlantic Richfield. Although unconventional liquid fossil fuels (oil shale, tar sands, synfuels from coal) were all regarded as 'alternative' sources of energy at the time, nuclear and solar were distinctive in that they were widely promoted as *literally* inexhaustible and were therefore regarded as petroleum's eventual successors even by some inside the oil industry itself.

By the 1980s, the concept of 'sustainable' energy had largely replaced the earlier idea of inexhaustibility and was thus applied to nuclear and solar power. *Today*, though hardly at the time, nuclear and solar power are valued as less carbon-intensive energy sources than fossil fuels, and thus as necessary for addressing climate change. Given the topic of this special issue (sustainability transitions in business history) we therefore focus on oil firms' involvement with nuclear and solar energy, though we believe the lens of fragmentation applies also to their investments in unconventional fossil fuels and non-energy markets.

The final section focuses on the mid-1980s when most oil firms divested their solar and nuclear projects in the face of falling oil prices. In the United States, declining profits combined with regulatory changes unleashed a wave of hostile takeovers that encouraged oil firms to abandon unprofitable (and even somewhat profitable) ventures and focus on oil production alone. Canadian and Western European firms participated in raids on US firms while enjoying protection from being raided. The leading firms in those regions therefore remained in solar energy (and to a lesser extent nuclear energy) longer than most US counterparts (and/or absorbed US firms that continued in solar). However, a parallel wave of privatisations encouraged some previously state-owned firms to similarly abandon alternative energy and focus on oil production.

The end result of rampant mergers and acquisitions in the '80s and '90s was a more consolidated and thus superficially less fragmented oil industry. However, increasing competition and continual corporate raiding eroded industry cohesion, causing collaboration in innovative R&D projects to be replaced by more 'secure' investments in petroleum production (Mizruchi, 2013). Superficially, fragmentation lessened in quantitative terms; but qualitatively, relationships among firms became more fractured and adversarial. That is, fragmentation is not just a matter of degree but also of *kind*; just as there are different types of boundaries between plates in geology, so there are different, and evolving, boundaries between firms in the oil industry.

Our analysis rests on a variety of both primary and secondary sources. The former comprise both public statements issued by oil firms (ranging from corporate annual reports to lectures and media appearances by CEOs) and internal discussions of strategic decisions made at the boardroom level. We also rely on sources produced by industry observers and representatives, such as the American Petroleum Institute, the oil economist Walter Levy, the widely-read newsletter *Platt's Oilgram*, and fact-gathering critics such as Friends of the Earth. Thus, although we have not been granted access to private corporate archives, we have been able to achieve insights into internal discussions via a mix of workarounds (eg accessing internal documents from the personal papers of oil CEOs) and triangulation (inferring strategy by comparing firms' public statements to reporting by analysts and critics).

2. A diversified 'oil' industry

The oil industry has always comprised a mix of activities that participants understood as relating to distinct markets and which were therefore often conducted by distinct firms: producers, transporters, refiners, distributors, etc. From the beginning of the industry in the 1850s, however, companies started to integrate across multiple operations and markets. A handful of firms eventually developed an integrated business incorporating all steps from up- to downstream (ie from exploration and extraction to selling the petroleum products) within the company itself. This 'vertical integration' occurred both through the establishment of up- and downstream subsidiaries and through acquisition of other firms (or their subsidiaries) operating in those markets (Jonker & Van Zanden, 2006; Mahmoud, 2017; Rutterford & Sotiropoulos, 2016a, 2016b; Sotiropoulos & Rutterford, 2019). Many oil firms also engaged in 'horizontal integration' (acquisition of other firms operating at the same point on the up/downstream continuum) and 'horizontal diversification' into business activities outside of the 'traditional' oil business (Jonker & Van Zanden, 2006). Horizontal diversification, like vertical integration, could involve either acquiring or establishing new units.

The oil industry – particularly but not only in the United States – has also always been characterised by extreme booms and busts. The booms have often featured rapid firm formation. The busts have almost always resulted in shakeouts where multiple firms have gone bankrupt, leaving the survivors to buy them out. Those survivors – most notoriously Standard Oil – therefore came to consist of patchworks of acquired subsidiaries.

Some firms instead formed through mergers among equals that were intended to allow the merged company to defend against predation by larger conglomerates. In such cases, firms located at different points on the up/downstream continuum often combined forces. For instance, Royal Dutch Shell was formed in 1907 from an oil producer (Royal Dutch) and a transport/sales company (Shell) in order to more effectively challenge Standard Oil's global hegemony.

In the US, however, oil firms' attempts at both vertical and horizontal integration have also been contested by politicians and the public and scrutinised by the legal system for almost a century and a half. The most famous outcome of that scrutiny was the breakup of Standard Oil in 1911. Ever since, the US Department of Justice has occasionally refused permission for oil firms' mergers and acquisitions, and more often imposed changes to the original conditions of sale. For instance, going back to the 1930s, Sinclair Oil and Cities Service together owned a controlling interest in Richfield Oil, which the Justice Department ordered them to divest in 1962. In 1966, Sinclair attempted to re-acquire Richfield *in toto*, but before the deal was completed Richfield agreed to a defensive merger with Atlantic Refining, thereby forming the vertically-integrated firm Atlantic Richfield (ARCO). Then in 1969 ARCO bought Sinclair Oil, but the government required some of Sinclair's assets to be excluded from the purchase. Similar back-and-forth wrestling matches – refereed by an anti-monopolist Justice Department – occurred sporadically until the 1970s.

Because of Justice Department scrutiny, therefore, US firms (not just oil firms) often preferred to grow through diversification instead of horizontal or vertical integration. That *legal* rationale for diversification was then complemented by a *risk management* rationale that became popular among individual investors and companies after the Second World War (Martin & Sayrak, 2003). In the 1950s and 1960s, diversification strategies gained further popularity as an alternative to costly market insurances, a trend further supported by rapid economic growth in Western countries that provided companies with the capital needed for diversification investments (Chambers et al., 1971; Dionne, 2013; Sluyterman, 2006).

Yet while diversification mitigates some risks (by buffering against downturns in one part of a portfolio), it also entails other risks. Diversified businesses may be too complex for information to flow where it is needed, while managers may not fully understand the markets they have newly ventured into and/or may establish fiefdoms that resist direction from headquarters. Nevertheless, influential mid-century management theorists argued that when done correctly – eg by using new long-range planning techniques to anticipate the formation of new markets – managers should be able to successfully guide their companies into fields far from their core operations (A. Chandler, 1969; Drucker, 1954; Fast, 1978; Sluyterman, 2006). According to some business historians, this new style of management provided the framework for oil companies' postwar diversification into hotels and restaurants, insurance and financial services, manufacturing cardboard boxes and animal feed, cable television, agricultural production, and so on (Pratt & Hale, 2013; Sluyterman, 2006, pp. 102–109; G. D. Taylor, 2019).

More important for our article, however, were their investments in coal and unconventional fossil fuel production, and solar, geothermal, and nuclear energy, which allowed oil firms to rebrand as 'energy companies'. In 1973, 14 oil companies were represented among the top 32 owners of coal reserves in the United States, contributing 15–20% of the country's coal production and owning about one-fifth of the more readily minable coal reserves (McCloy, 1976). In the nuclear and solar industries, too, oil companies were ubiquitous. In 1975, approximately eighty companies were searching for US uranium reserves. Twenty of these were oil companies, controlling about one-half of the country's uranium reserves and contributing about one-third of annual uranium production (McCloy, 1976). Gulf Oil's subsidiary General Atomic sold 18% of all nuclear reactor orders in the US in 1971. Service companies previously mostly focusing on the oil industry, like Enserch, Fluor, and Halliburton, established a 21.3% market share in the nuclear reactor engineering sector by 1981, while oilfield service company Stone & Webster even possessed a 24% market share on its own (Hertsgaard, 1983, pp. 282–287). In the emerging solar energy sector, oil firms such as Exxon, Shell, and Atlantic Richfield were among the first and largest investors (Stanković, 2024).

Since the 1980s, executives in many industries, as well as economists and management scholars, have come to view the diversification strategies of the 1970s as mismanagement. For instance, former Secretary General of OPEC Francisco Parra has characterised Western oil firms' diversification efforts as 'sometimes bizarre, comic even' and claimed that they were 'dumped as quickly and quietly as possible' because of their unprofitability (Parra, 2010, pp. 212–213). Likewise, several corporate histories and business analysts interpret the 'diversification episode' of the 1970s as a cautionary narrative, retrospectively framed to explain a supposedly inevitable reorientation towards core business activities (Amatucci & Grant, 1993; Cohen, 1981; Grant & Cibin, 1996; Lamont, 1997; Ollinger, 1993, pp. 88–92; Prahalad & Hamel, 1990; Pratt & Hale, 2013).

In contrast, we explicitly do not judge the success or failure of oil firms' diversification into alternative energy. We are instead interested in the ways that the oil industry's peculiar and evolving structure fostered a variety of strategies regarding the extent and timing of moves into (and out of) alternative energy. We argue that those moves were neither 'bizarre', nor inevitably doomed, nor entirely insincere. They were, rather, reasonable if imperfect choices made on the basis of evolving conditions – choices and conditions which we will now explain.

3. Diversification through fragmentation: varying oil strategies for nuclear energy, 1950s–1960s

'All [new uranium finds were] made by either damn fools or oil companies,' a geologist from the US Atomic Energy Committee recalled about the 1950s uranium booms in the American Mountain West (Taylor & Yokell, 1980, p. 26). Both lone oil entrepreneurs – so-called 'wildcatters,' such as Charles Steen and Stella Dysart (Amundson, 2002, pp. 24–25; McLemore, 1983, pp. 46) – and larger independent companies like Phillips Petroleum and Getty Oil jumped into the uranium business, sometimes working together in joint ventures such as Petrotomics, which was co-owned by Getty, Skelly Oil, and Kerr-McGee (Cobb, 1961; Ezell, 1979, pp. 298–299; Ollinger, 1993, 18).

The latter was one of the biggest oil companies to diversify into uranium mining and milling already during the 1950s. Founded by geologist Dean McGee and entrepreneur – and

later flamboyant Democratic Senator – Robert S. Kerr, Kerr-McGee had previously mainly focused on oil drilling and refining projects within the boundaries of the United States. In the 1950s however, following the first attempts to build national industries for peaceful nuclear energy, McGee transformed their company into an oil-nuclear conglomerate (which also had operations in wood products, mining of potash and other minerals, and chemical manufacturing) while Kerr shaped US nuclear policy and relayed valuable information about the US Atomic Energy Commission (AEC) from his Senate seat in Washington. In 1954, 10% of all Kerr-McGee's capital expenditures consisted of investments in the uranium sector, a percentage that even increased to 52% in 1959 with more than \$15 billion (Bron, 2025; Ezell, 1979, pp. 298–299; J. Taylor & Yokell, 1980, pp. 26–27).

With this active diversification strategy, Kerr-McGee adopted a significantly different path than the oil majors. In 1954, the board of Shell recognised that there were increasing discussions about the roles of energy sources like oil, coal, and atomic power, but still argued that the company should keep focusing primarily on oil production (Royal Dutch Petroleum Company, 1955, pp. 16). Similarly, the board of Socony expected demand for petroleum energy to grow faster than the increase in demand for other energy sources, prompting the board to emphasise oil production for the foreseeable future. As Socony's board stated in 1960, 'much had been said about the prospects for atomic power [...] Even by 1970, however, it appears that the atom will be supplying no more than 2% or 3% of the world's vastly enlarged energy requirements' (Socony Mobil Corporation, 1961).

Kerr-McGee's nuclear investments are all the more remarkable given the contemporary discovery and exploitation of 'elephants', ie the largest known oil fields, in the Middle East and the resulting (over)abundance of oil (Cantoni, 2017, pp. 170; Yergin, 1990, pp. 482). From 1948 to 1972, world oil production increased from 438 million tons to 2.1 billion a year, while the price of a barrel of oil *decreased* from \$15 to \$10 dollar between 1954 and 1970 (after adjusting for inflation). Oil was cheap to produce and there was a lot of it, therefore making it likely that petroleum would remain the primary energy source for decades to come (Parra, 2010, pp. 73–74; Yergin, 1990, pp. 481–482).

Yet for smaller oil companies operating only – or mostly – in the United States, overproduction in the Middle East was a reason to diversify away from oil. Because smaller companies had little or no access to cheap Middle East production, the decreasing price of oil made it increasingly difficult to keep production costs low enough that investments in exploration and extraction would not outstrip their profits with the return of investment in the domestic oil industry had declined from 27.9% in 1948 to 10.2% in 1958 (Bell, 1959). Companies primarily operating in the US domestic oil market therefore had to find other ways to make money. Some firms managed to move into offshore drilling or new onshore regions such as the North Slope of Alaska, but for many companies the search for oil on both land and sea was prohibitively expensive and risky (Pratt et al., 1997).

Even Kerr-McGee – the first company to drill for oil in the Gulf of Mexico from a rig not visible from shore (Pratt et al., 1997) – saw no choice but to diversify in response to shrinking profit margins on oil production. Already in 1952, Dean McGee's assistant, Frank C. Love, made this calculus explicit: 'a company the size of Kerr-McGee has to compete. If it doesn't get the opportunities, it is looking for in one area, it must direct its efforts in other directions' (Ezell, 1979, pp. 210; Love, 1952). Likewise, looking back in a 1973 interview, Dean McGee recalled that 'It was clear [in 1952] that the oil business was headed for trouble, and that medium-sized companies such as ours could get badly hurt' (Leder, 1973).

Kerr-McGee could have – and indeed did – address its dilemma by diversifying in a number of directions, yet only one of those diversification efforts represented an existential bet on the company's future: entering the uranium industry. That choice stemmed partly from affinities between oil and uranium extraction, but the main attraction was a framework of subsidies and support offered by the US AEC. In 1948, the AEC had introduced a program to ensure a steady supply of uranium for the new nuclear industries (both weapons manufacturing and peaceful nuclear energy), under which it promised to buy all the uranium delivered by private parties. For companies like Kerr-McGee, this program guaranteed a steady source of income and relatively risk-free conditions for entering the uranium business (Amundson, 2002). As Jones (2017) has argued, entrepreneurs in green industries require (semi)governmental subsidies to succeed; Kerr-McGee and its peers show that the same is also true of established firms that diversify into green industries.

For the majors, meanwhile, access to cheap Middle Eastern oil afforded the opportunity to wait and assess whether and when nuclear energy would develop into a competitive energy regime. The majors' economic planning departments and geophysicists therefore carefully monitored developments in the early nuclear industry (Gulf Oil Corporation, 1958). The majors' research labs also engaged in low-level nuclear research and development in order to retain skilled nuclear engineers and physicists and for advertising purposes. Paradoxically, this meant that the varying business logics of large and small oil firms was somewhat obscured at the time by the fact that small firms sometimes tried to diminish the 'nuclearity' (Hecht, 2014) of their operations, while large ones exaggerated their presence in the nuclear industry. On the one hand, during debates over labour safety standards in the 1960s, lobbyists from Kerr-McGee argued that uranium extraction should be categorised as 'conventional mining' rather than a 'nuclear' activity in order to avoid more rigorous safety protocols and costs mandated for the nuclear industry (Davis, 1960). Conversely, Mobil and Shell labelled activities such as production of specialised lubricants for reactors and the use of radioactive isotopes in product research as involvement in the 'nuclear sector' in order to advertise their companies' technological prowess, despite having almost no connection to the actual production of nuclear energy themselves (Howarth, 1997, pp. 246–247; Royal Dutch Petroleum Company, 1957).

At the end of the 1960s, however, the majors also became involved in nuclear energy in a more serious way. Indeed, large companies could afford to diversify across the entire nuclear lifecycle (from exploration to mining to processing to energy production and finally waste disposal) in a way that smaller firms like Kerr-McGee could not. Gulf Oil, in particular, explicitly coupled its uranium investments with other nuclear projects; just as Gulf traditionally had sought an integrated position in petroleum, now it would 'likewise seek integration in the nuclear energy business' (Gulf Oil Corporation, 1968). Similarly, H. Eugene McBrayer, chemical engineer and former manager of the Exxon Nuclear division (later becoming CEO of Exxon Chemical Corporation between 1985 and 1992), later stated that 'nuclear power, if it was going to be successful, had to have an integrated nuclear fuel cycle' (Bohning, 1995).

The majors' move into nuclear energy stemmed from a combination of push and pull factors. The pull was that, as energy historian Robert Lifset has shown, at the end of the 1960s leaders in the US utility industry became convinced that nuclear power was a safe, reliable, less polluting, and cost-competitive alternative to fossil fuels (Lifset, 2019, pp. 525–526). This created a bandwagon effect where utilities competed to order new nuclear reactors which would peak during the early 1970s.

At the same time, the petroleum industry was dealing with problems that ‘pushed’ firms to embrace nuclear energy. Although the industry expected to add over half a million barrels per day from new oil fields outside the United States in 1967 and had added about 300 million barrels of crude oil and condensate to U.S. reserves from new pools and fields, the outlook for the future was decidedly pessimistic. The increasing assertiveness of host governments in oil-producing countries (especially in the Middle East) led to renegotiation of Western oil firms’ concessions; and because of decreasing US production, those firms had far less negotiating leverage than in earlier years. This problem was magnified by the increasing number of government-sponsored, or even state-owned, companies that were able to drill for oil themselves and compete with the Western majors and that in some cases even expropriated the majors’ assets (Lumpkin, 1967; see for the rise of OPEC Garavini, 2019). At the same time, the emergence of the modern environmental movement further pushed oil firms to explore ways to reduce their (and the West’s) dependence on petroleum, and especially petroleum produced in the Middle East.

Thus, over the first 25 years after the end of the Second World War, the fragmented nature of the oil industry shaped oil firms’ diversification into nuclear energy in two distinct phases. In the first phase, the differences between the ‘haves and the have-nots’ regarding access to relatively cheap oil production in the Global South forced some small and midsize US-based oil firms to diversify into uranium mining to stay competitive during the 1950s. In that period, the majors dabbled in nuclear research, but mainly to hedge their bets and enhance the reputations. Then, from the late 1960s onward, increasing fragmentation on a global scale with the decline of the majors and the growing power of national oil firms led even the Western majors to also make major investments spanning the nuclear lifecycle. As we will show in the next section, the same conditions encouraged a variety of oil firms to explore other alternative energy sources in the 1970s as well, particularly solar energy.

4. Competing interests? Oil’s solar investments

Even though some have argued (both at the time and ever since) that oil firms’ investments in solar energy were not genuine and halted the industry’s development (Reece, 1979), recent work has shown that investments in the formative years of the 1970s and 1980s were at least somewhat motivated by genuine interest (Stanković, 2024; Stanković & Bron, 2025). But an interest in what? Business historians have commonly interpreted these investments as diversification for its own sake, a symptom of a diversification fad that started faded away in the 1980s when refocusing on the core business was back on the corporate agenda (Grant, 2005; Jones & Bouamane, 2012). It is true that management theorists of the day believed that diversification per se made firms less vulnerable to disruptions in their primary sectors (Cibin & Grant, 1996; Martin & Sayrak, 2003). Given that the oil shocks of 1973 and 1979 sharply increased many oil firms’ profits but also destabilised their industry, those firms had both the means (ready cash) and motive (insulation from risk) to diversify with little regard for the content of their diversified portfolios.

Indeed, some oil firms’ acquisitions in the 1970s seemed to defy business logic: for example, Gulf Oil’s aborted purchase of the Barnum & Bailey Circus, Mobil’s successful absorption of retail chain Montgomery Ward, and ARCO’s takeover of British newspaper *The Observer* all bewildered business journalists at the time. Yet according to Montgomery’s resource-based perspective (Montgomery, 1994), companies with excess capacity and *transferable*

resources and capabilities are best positioned to pursue diversification. Thus, in most cases the content of diversifications did matter, because oil companies preferred to acquire firms to which they could most readily transfer their technical expertise and from which they could gain economies of scope (Penrose, 1959).

Yet what different oil firms could transfer to or gain from their acquisitions depended on how those firms' positions within a fragmented industry⁴ (Christensen, 1997) affected their structure, capabilities and readiness to explore future growth market (Bower & Christensen, 1995). Thus, different oil firms followed different diversification strategies, and sometimes different strategies even coexisted within different arms of the same firm (Skodvin & Skjaereth 2010; Sluyterman, 2010). That variability was particularly evident in oil firms' diversification into solar energy (Stanković, 2024)

One thing oil firms did *not* expect to gain from their solar acquisitions, however, was significant profit (Boon, 2019; Kaartemo, 2016; Miller, 2013; Pinkse & van den Buuse, 2012). Oil CEOs' speeches from the 1970s were unanimous that solar energy would not be a profitable market except in tiny niche applications until sometime after the year 2000, even if the Carter administration's subsidies continued and the price of oil remained high (Heldman, 1977; Mobil Solar Energy Corporation, 1977; Potts, 1982). For many small independents, that was reason enough not to diversify into solar.

As with nuclear energy, though, the majors could afford patience; unlike in nuclear, in solar the majors' patience meant they could be first-movers because they had the resources to withstand a long period of unprofitability. Thus, the first oil firm to make a substantial foray into solar energy was the largest major of all, Exxon. In 1968, Exxon invested \$2.5 million in Eliot Berman's photovoltaic start-up, Solar Power Corporation (SPC), followed by complete acquisition by 1975 (Exxon Corporation, 1974). Even though SPC proved promising, with time Exxon progressively reoriented towards maximising profitability at the expense of ventures in niche markets. The emergence of competitors such as Solarex and ARCO Solar, and the discontinuation of major government contracts, also made the solar business less attractive. By 1983, it was apparent that SPC would not achieve Exxon's criteria that investments should 'be worth a billion dollars within five years and 30% share of the world market' (J. Stanković, personal communication, September 2023). Therefore, SPC was shut down and its assets liquidated to Solarex (Wolfe, 2018). Exxon also established a solar thermal subsidiary, Daystar, in 1974 and turned it into a leader in solar water heating systems for residential and commercial properties. However, despite Exxon's \$10 million investment Daystar remained unprofitable. In 1981 Exxon sold Daystar at a steep loss to American Solar King Corporation for \$2.3 million (Buchsbaum, 1985).

Also, as with nuclear energy (Cohen, 1981), Exxon's solar ventures created a bandwagon of large and midsize firms following the industry leader. The two leading followers were ARCO and Shell, both of which pursued solar energy over considerable lengths of time and through multiple channels. ARCO acquired Bill Yerkes's photovoltaic start-up, Solar Technology International (STI), in 1977 'for a song, paying less than \$1 million, hardly big bucks for a company that in 1978 had revenues of \$12.7 billion' (Johnstone, 2011, p. 50). In 1980, ARCO also acquired a solar heating and cooling firm, Northrup Energy; the two solar subsidiaries were then combined into one, ARCO Solar, into which the parent company eventually poured at least \$200 million over the next decade. ARCO also invested around \$25 million in Stanford Ovshinsky's Energy Conversion Devices (ARCO, 1980) before the agreement was discontinued, reportedly due to Ovshinsky's tendency to overpromise and

under-deliver. Yerkes, who became a director of ARCO Solar, noted their ambition: 'They wanted ARCO Solar to grow as fast and as big as they could, because of the tax implication' (Johnstone, 2011, p. 50).

Tax implications were not the only motivation, however. ARCO's solar energy commitment was also driven by the personal interests of its colourful CEO, Robert O. Anderson. Anderson mixed ARCO's business with his leadership of the Aspen Institute for Humanistic Studies, patronage of environmental organisations such as the Worldwatch Institute, and his *private* diversification into large-scale ranching (Harris, 1987). Regarding the latter, Anderson saw ARCO Solar partly through the lens of water scarcity on his landholdings: as he once told Eliot Berman, 'Don't forget the water pumping' (same, p. 51).

ARCO's solar business was also shaped by Atlantic Richfield's ambiguous position within the oil industry, however. As one of the largest midsize firms, and with substantial operations in the Middle East, ARCO was viewed by some as gradually evolving into a major (Levy, 1970), aided by aggressive deals (eg the acquisition of Sinclair) and its early stake in Alaskan oil. Yet ARCO was smaller and risked more than the other firms operating in Alaska and was therefore more dependent on rapid construction of an Alaska pipeline – which, in turn, meant overcoming objections from environmentalists and Indigenous communities. ARCO Solar should therefore be seen – alongside Atlantic Richfield's pioneering Corporate Social Responsibility initiatives and ARCO executives' frequent dialogues with environmentalists – in the context of ARCO's attempts to move upward within the oil industry's fragmented structure.

By 1981 ARCO Solar was a world leader, especially in photovoltaics. Over the next five years it expanded rapidly and internationally through strategic joint ventures, notably with Showa Shell of Japan for the Far East market and with Siemens of West Germany for ventures in Europe, Africa, and the Middle East (ARCO, 1986). Interestingly, 1986 marks the last year when a substantial part of ARCO's annual corporate report was dedicated to its solar business. This coincides with the precipitous drop in oil prices (see next section), but also with Anderson's retirement. As a result, ARCO Solar incurred growing losses without Anderson to protect it. Perhaps unsurprisingly, ARCO sold its solar holdings to Siemens A.G. in 1989, reportedly for between \$30 million and \$50 million (Wald, 1989).

Other US oil firms also ended their solar ventures in the 1980s or early 1990s, thanks in part to Ronald Reagan's retreat from Carter administration pro-solar initiatives such as government procurement of photovoltaics, renewable energy tax credits, and the Solar Energy Development Bank which operated as a federally-backed financing mechanism to drive large-scale solar adaption from 1980 to 1986 (Johnstone, 2011, p. 26). As Jones (2017) argues, subsidies have been decisive for the survival and growth of alternative energy sectors, and Reagan's curtailing of government support for solar energy happened at the same time that investors increasingly demanded that firms prioritise shareholder value maximisation on a shorter time horizon, fostering a culture of 'quarterly capitalism' that undermined projects that required patient capital. This dynamic was especially problematic for capital-intensive green industries, such as solar, whose long payback periods make them unattractive to investors focused on short-term returns. Such industries therefore require state subsidies and stable policy frameworks – which, at least in the United States, disappeared just when they were needed most.

Thus, Chevron, Union Oil of California, General Atomic Co. (co-owned by Gulf Oil and Shell), Occidental Petroleum, Phillips, Standard Oil of Ohio (Sohio) (Ethridge, 1980), and Texas

Instruments (an oilfield services firm) all exited the solar business in the 1980s. One of the last to follow was Mobil, which in 1974 had entered a joint venture with Tyco Laboratories, Mobil Tyco, aiming to radically reduce the cost of solar cells (Mobil Oil Corporation, 1975). Even though the venture was successful in that regard, slow growth and adverse conditions led Mobil to shut the venture down after 19 years and around \$50 million of investment (Southerl, 1993).

Thanks to the Reagan administration's antipathy, the solar industry's centre of gravity therefore moved to Western Europe over the course of the 1980s – as did the oil-solar nexus. Thus, a few US oil firms (such as ARCO) were able to partially recoup their solar investments by selling their assets to European firms (such as Siemens) with at least a distant connection to oil.⁵ For instance, Amoco's solar involvement began with investment in Joseph Lindmeyer's and Peter Varadi's start-up, Solarex, in 1979, which it absorbed entirely in 1983 (Varadi, 2014). Heavy losses, however, led the parent company to move Solarex within its technology development arm, Amoco Technology Company, in 1987 and then to sell half of Solarex to Enron in 1994 – just when Enron was embarking on an enormous, eight-year run of fraud (McLean & Elkind, 2004). From that point on – and perhaps as early as 1987 – Solarex's prospects for scaling up photovoltaic manufacturing were severely limited.

In 1998, however, Amoco merged with BP, which the next year bought back Enron's half of Solarex and merged it into a pre-existing subsidiary, BP Solar. By that time, BP had already been spending around \$20 million annually on solar since 1980 (Johnstone, 2011), when it had acquired Lucas Energy Systems as a part of a broader diversification strategy. In 2000, following its acquisition of Amoco and ARCO, BP rebranded its mission to a wider energy focus, symbolised by its 'Beyond Petroleum' slogan (Pinkse & van den Buuse, 2012). By the end of 2011, however, BP had exited the solar market completely.

Similarly, the French oil companies Elf Aquitaine and CFP, predecessors to Total Énergies, also have a significant history in photovoltaics (Jones & Bouamane, 2012), and unlike BP, Total Énergies maintains a notable presence in the solar industry to this day. However, the oil major that sustained its involvement in the solar business the longest, and that best exemplifies the shift of the oil-solar nexus from the US to Europe, was Shell. Already in 1973, shortly before the first energy crisis began, Shell Oil – Royal Dutch Shell's largely autonomous US affiliate – started putting money (eventually totalling \$18.2 million) into Solar Energy Systems (SES), a US academic start-up (Stanković, 2024). By the early 1980s, it became clear that SES faced significant challenges in transforming its technology into a viable commercial product. Consequently, in 1981, the company was subsumed into Solavolt, a new joint venture between Shell Oil and Motorola (SCS, Inc., 1983). Solavolt was operational until 1987, when the Utility Power Group (UPG) purchased its test equipment and software for \$1 million (PennWell Corporation, 1987). Next to investments in SES, Royal Dutch Shell also owned a 35% minority stake in Photowatt, the top French photovoltaic company, between 1991 and 1997, as well as earlier small solar ventures in Japan and Australia.

Meanwhile, Royal Dutch Shell started a new solar venture in Europe by acquiring Holec-sol Systems in 1984, later known as Renewable Energy Systems (R&S). What started as a small and marginal interest in photovoltaics (Verbong et al. 2001) evolved into a major subsidiary, Shell Solar, when Royal Dutch decided to establish 'Renewables' as its 5th core business in 1997 (Boulton, 1997), committing \$500 million over five years. At the time, Shell appeared to be significantly scaling up its solar operations, evidenced by its participation in building one of the largest and most technologically advanced PV manufacturing sites in Europe, in

Gelsenkirchen, in 1999. Nearly simultaneously, Shell Solar also entered a joint venture with Siemens and E.ON and even began cooperating with Greenpeace (Wermeskerken van, 1999). Yet despite these commitments, and a relatively good position on the market, Shell Solar was divested to a German firm, Solar World (Miller, 2013) in 2006. Backer and Clark (2008) suggest that Shell's investment and divestment patterns in solar PV have been characterised by considerable uncertainty and a less consistent trajectory reflecting more volatile shifts in the perceived future growth potential of solar as a market.

5. Ending transitions: competition and hostile take-overs during the 1980s

Earlier, we noted the legal obstacles to vertical and horizontal integration that encouraged US conglomerates to pursue growth through horizontal diversification instead. In that regard, oil firms were followers (especially behind electrical giants such as RCA and General Electric) rather than leaders. In the 1970s, however, US oil firms enjoyed windfall profits while firms in other industries suffered from sluggish growth. Thus, the oil industry suddenly became the centre of diversification activity. Yet their acquisitions – especially the majors' less-explorable offers for circuses, retail chains, and newspapers – attracted negative attention from the public and politicians who demanded that they invest in lowering the cost of energy instead.

The years between the 1973 and 1979 energy crises therefore saw a series of legislative attempts to constrain further oil industry diversification and/or force divestiture of their subsidiaries (or 'dismemberment', as the oil industry described it). These efforts were led in the US Senate by the maverick James Abourezk (Democrat, South Dakota), liberal lion Edward Kennedy (Democrat, Massachusetts), and centrist Robert Packwood (Republican, Oregon). Together, they mounted various strategies. Targeting primarily vertical integration, they tried to force firms to occupy only one upstream/downstream function (exploration/production, pipeline transportation, refining, or sales – in some bills, the latter two could be combined). Targeting horizontal integration *and* diversification, they tried to 'prevent the nation's sixteen largest oil companies from acquiring any company with assets in excess of \$100 million' (Blauvelt, 1979). Finally, specifically targeting oil firms' potential control of competing fuels, they attempted to forbid 'major oil companies from acquiring any more of the nation's coal and oil reserves' (Parisi, 1977) and to require the 20 largest US oil firms to divest their 'interests in coal, uranium, geothermal, solar energy, and other alternative sources of energy' (Warner, 1977).

Abourezk's first such bill, in late 1975 failed, but by a close enough margin (45–54 in the Senate) to provoke a concerted and norm-breaking propaganda campaign that united an otherwise fragmented industry. Even independents that were 'far below the size to occasion dismemberment under proposed divestiture bills' (Husky Oil, 1976) contributed in order to protect their joint ventures with the 16 to 20 largest firms. Unsurprising, then, legislative opposition to divestiture grew, and the margins on later bills and amendments were more lopsided than Abourezk's first. The Carter administration, too, was lukewarm on divestiture, although during the 1979 energy crisis the president occasionally employed the rhetoric of divestiture – provoking savage criticism from Mobil and other oil firms.

Thus, the oil industry was willing to spend considerable political capital to defend its horizontal diversifications. Yet as neoliberal principles took hold in US governance gradually

during the Nixon to Carter administrations, and much more enthusiastically under Ronald Reagan, growth through horizontal *integration* started to become a more attractive strategy. As the divestiture battle shows, a broad political spectrum – from centre-right Republicans like Packwood to New Dealers, Keynesians, and '60s student radicals – all believed that market concentration achieved through horizontal acquisitions would inevitably harm the public and corrupt the political system. Neoliberals, in contrast, argued that market concentration could result in efficiencies that would benefit consumers and should therefore be tested by the market, rather than government (Davies, 2010). The Justice Department did continue to intercede in major mergers and acquisitions even under Reagan – for instance, Chevron was required to sell off parts of Gulf Oil in order to merge with that company in 1984. Yet from 1974 onward, the pace of attempted mergers, acquisitions, and takeovers in the US oil industry picked up considerably.

Initially, there was no sharp turn towards horizontal integration nor any retreat from diversification. In early 1980, however, the price of oil peaked and began falling, with ups and downs, until early 1983 – at which point it stabilised at about a 25% higher level than the previous plateau of 1974–1979. Then in 1986 the Saudis – frustrated with their OPEC partners' flouting of agreed production quotas – turned on the taps and the price of oil suddenly plunged to almost where it had been before the 1973–1974 shock. That price decline – *combined* with the entrenchment of neoliberal governance – spelled the end for many oil firms' ventures into alternative energy.

The reason was twofold. First, oil firms were no longer receiving windfall profits and thus were less able to afford large, risky, long-term investments, especially in energy alternatives such as solar, nuclear, oil shale, and synfuels that were now less likely to be profitable because fossil fuels had suddenly become so cheap and because Reagan had cancelled most of his predecessor's investments in and subsidies for synfuels, nuclear energy, and renewables. Second, oil became so cheap that it was now more profitable for a firm to acquire another company purely for its oil reserves than to explore for new reserves of its own – and the Reagan administration's interpretation of antitrust law meant fewer barriers to such acquisitions (Pollack, 1981). Thus, 1981 saw the start of a wave of hostile takeovers in the US oil industry that only petered out in 1987.

The US oil industry therefore became a proving ground for financial innovations such as the 'poison pill' (a defence against hostile takeovers) and financial innovators – known less euphemistically at the time as 'corporate raiders' – such as T. Boone Pickens, Carl Icahn, Ivan Boesky, Michael Milken, Samuel Belzberg, Paul Nathanson, and Irwin 'Irv the Liquidator' Jacobs. The 1980s saw some exceptionally complicated takeover fights, such as Mobil, Dupont, and Seagram's simultaneous attempts to buy Conoco, which at the same time was competing against Gulf, Mesa, and Occidental for the right to buy Cities Service. The majors were generally too large for the raiders to pick off, although not entirely insulated; Texaco, for instance, warded off several hostile offers between 1984 and 1989. Notably, the one major that did succumb was Gulf; its sale to Chevron was largely blamed on Gulf's overcommitment to nuclear energy just at the moment when reactor orders evaporated (Amatucci & Grant, 1993).

The corporate raiders, especially Pickens, acidly criticised oil industry executives for investing in speculative investments rather than focusing on short-term profits. Thus, both firms that were raided and those that feared a raid cut back on long-term projects and activities that did not directly contribute to their immediate revenue stream. The departments and

subsidiaries targeted for downsizing and elimination included exploration, unconventional fossil fuel production (eg oil shale), and R&D. Reagan's own Department of Energy (1986) warned that oil industry research capacity could fall by 10% to perhaps 100% by 1990! Even Halbouty (1986), a veteran wildcatter and cornucopian widely known as Reagan's 'energy guru,' complained that all the raids, mergers, and acquisitions were destroying the US oil industry's ability to invest for its future.

In Europe, the privatisation of former state-owned oil companies – again, a product of the neoliberal shift – had a similar result, as firms now found themselves answerable to investors, not politicians. Thus, on both sides of the Atlantic, oil firms shed their long-range, risky investments in activities not directly related to oil production. Nuclear energy production was the first to go, given the huge cost and risk associated with reactors. Oil firms got out of uranium mining and -refining more slowly, but by 1990 their footprint – which dated to the 1940s! – had almost vanished. Solar subsidiaries, meanwhile, were cheaper and less contentious than nuclear; thus, while most oil firms also exited with the solar bust of 1983, a handful held on for another decade. By then, the raids and takeovers of the '80s had turned into the mega-mergers of the '90s and early '00s, such as ConocoPhillips, ExxonMobil, and BP Amoco. Under the 'supermajors' that came out of those mega-mergers, the oil industry recovered its capacity for investment in exploration and R&D. However, continuing leverage by activist investors, combined with the new management school orthodoxy of 'core competencies,' meant that even the supermajors remained focused on fossil fuel production and refrained from long-term investments in lower-carbon alternatives.

6. Concluding observations

When Geoffrey Chandler published his reflections on the status of the oil industry at the beginning of the 1970s, he predicted transformative shifts in the way the oil industry was organised up till then. Based on the emergence of new oil majors in Global South, Chandler argued that increasing fragmentation would cause disruptions of the global oil price, higher production costs for petroleum extraction and refining, and more difficulties for Western oil companies to acquire finance. Based on the cases presented in this article, we might add to the list here: changes in the fragmented nature of the oil industry also shaped the various diversification strategies of Western oil companies.

The oil industry is, and never was, a monolithic entity. Still, Chandler was right that the nature of its fragmentation changed over the decades. In this article we mostly focused on the developments within the Western oil industry, but even there – without putting the emergence of new, often national, oil majors in the Global South and in the (former) Soviet hemisphere to the forefront – the Western industry transformed, and companies changed shape over the decades. As we showed in this article, both this fragmented nature of the oil industry *and* the transformation of this fragmentation serve as useful explanatory tools in understanding the variety of oil firms' diversification strategies into nuclear and solar energy over the second half of the twentieth century.

As we showed, differing market positions and degree of access to relatively cheap oil production in the Global South incentivised several smaller oil companies in the 1950s to enter the uranium market while larger oil companies with access to the Middle East could wait for alternatives such as nuclear energy to develop further. Some of the resulting

differences in business strategies were reversed, however, when OPEC became more assertive at the end of the 1960s and a global price shock loomed. At that point, the oil majors also entered the nuclear arena on a larger scale and with a higher degree of vertical integration than smaller firms could manage.

The same conditions also encouraged large and midsize Western oil companies such as Exxon, Shell, and ARCO to become major players in developing early solar technologies in the 1970s. Here too, firms' positions within a fragmented industry structure shaped their decisions to continue or divest their solar subsidiaries. The first oil firm to make major investments in solar was the industry leader, Exxon – though Exxon exited solar once it became clear that the bandwagon it started would limit the potential profitability of its solar subsidiaries. Solar leadership among US oil firms therefore fell to ARCO, owing both to its CEO's personal interests and its need for good relations with environmentalists in order to attain major status. Due to the Reagan administration's neoliberal policies, however, most US oil firms exited solar in the 1980s or early '90s; the centre of the oil-solar nexus therefore moved to Europe and especially the two European majors, BP and Royal Dutch Shell.

So, in the end the longstanding but evolving fragmentation of the oil industry shaped firms' decisions to embark upon development of alternatives to oil, thus enabling early transition pathways. Yet further evolution in industry structure also shaped their decisions to exit alternative energy, thereby slowing sustainability transitions globally. Thus, we believe that fragmentation offers a useful lens to tell an overarching story of ('failed') transitions towards alternative energy sources within an oil industry consisting of a multitude of varying companies.

Notes

1. For both the oil industry and plate tectonics there is disagreement as to whether the number should be seven or eight. The 'Seven Sisters', as coined by ENI's Enrico Mattei and popularised by Sampson (1975), were: Standard Oil of New Jersey (Exxon), New York (Mobil), and California (Chevron); Gulf Oil; Texaco; Royal Dutch Shell; and British Petroleum. However, *Compagnie Française des Pétroles* (Total) was an important member of some of the consortia that controlled oil production in the Middle East and could be considered an eighth 'continent'. We will use the names of firms that were most widely used in the period that we are discussing at different points in our article.
2. The quote is from one of our anonymous reviewers, whom we thank for pressing us to clarify our conceptualisation, even if we still disagree whether 'fragmentation' is the appropriate term.
3. For examples of public debates on the existence of 'Big Oil' during the 1970s, see American Petroleum Institute (1975) and Abourezk (1989).
4. While Christensen does not use the term "fragmentation", one of his main arguments is that incumbents' inability to deal with disruptive innovation (e.g., solar PV see also Miller, 2013) is not because incumbents were unaware of the emerging technology or its risks, but rather thanks to their organizational culture and business models, and thus their structurally-embedded position within the industry.
5. Siemens has an Oil and Gas division and offers some oilfield services, though its involvement in oil production is modest compared to its overall size. Siemens would also buy part of Exxon Nuclear's enrichment capacity.

Disclosure statement

No potential conflict of interest was reported by the author(s).

Funding

This work was supported by NWO (Dutch Research Council), VI.C.191.067.

Notes on contributors

Dr. Michiel Bron is a postdoctoral researcher in the governance of the future energy system at Tilburg University. In his research, he focusses on the historical development of energy transitions, with the role of (oil) companies in alternative energies (most notably nuclear energy) in particular.

Jelena Stankovic, MA, is a PhD candidate in history. Her research focusses on the involvement of oil actors in the development of solar energy during and beyond the Twentieth Century.

Prof. Dr. Cyrus Mody is professor in the History of Science, Technology and Innovation at Maastricht University. He focusses on the history of recent science and technology, specifically the applied physical sciences in the United States since 1965. He studies the commercialization of academic research, the *longue durée* of responsible research and innovation (RRI), and the technopolitics of scarcity in the long 1970s.

References

- Abourezk, J. G. (1989). *Advise and dissent: Memoirs of South Dakota and the US senate*. Lawrence Hill Books.
- Amatucci, F. M., & Grant, J. H. (1993). Eight strategic decisions that weakened gulf oil. *Long Range Planning*, 26(1), 98–110. [https://doi.org/10.1016/0024-6301\(93\)90238-B](https://doi.org/10.1016/0024-6301(93)90238-B)
- American Petroleum Institute. (1975). *Who owns big oil?. Gulf oil corporation records*. Heinz History Center - Detre Library and Archives. Box B, folder 9.
- Amundson, M. A. (2002). *Yellowcake towns: Uranium mining committees in the American West*. University Press of Colorado.
- Atlantic Richfield Company. (1980). *Annual report 1979*. Atlantic Richfield Company.
- Atlantic Richfield Company. (1986). *Annual Report, 1986*. Atlantic Richfield Company.
- Backer, L., & Clark, T. S. (2008). Eco-effective greening decisions and rationalizations: The case of shell renewables. *Organization & Environment*, 21(3), 227–244. <https://doi.org/10.1177/1086026608321328>
- Bell, J. S. (1959). Engineer's oil: A challenge and an opportunity. *Journal of Petroleum Technology*, 11(11), 11–14. <https://doi.org/10.2118/1385-G>
- Biermann, F., Pattberg, F., Van Asselt, H., & Zelli, F. (2009). The fragmentation of global governance architectures: A framework analysis. *Global Environmental Politics*, 9(4), 14–40. <https://doi.org/10.1162/glep.2009.9.4.14>
- Blauvelt, H. W. (1979, August 12). Why harass the oil companies?. *New York Times*. <https://www.nytimes.com/1979/08/12/archives/point-of-view-why-harass-the-oil-companies.html?searchResultPosition=1>
- Bohning, J. J. (1995). *H. Eugene McBrayer: Transcript of an interview conducted by James J. Bohning at Mercer Island, Washington* (Oral History Transcript #0144). The Chemical Heritage Foundation, Science History Institute.
- Boon, M. (2019, January 01). A climate of change? The oil industry and decarbonization in historical perspective. *Business History Review*, 93(1), 101–125. <https://doi.org/10.1017/S0007680519000321>
- Boulton, L. (1997, October 7). *Solar expansion planned by shell*. *Financial Times*. <https://archive.org/details/FinancialTimes1997UKEnglish/Oct%2007%201997%2C%20Financial%20Times%2C%20%2336%2C%20UK%20%28en%29/mode/2up>
- Bower, J., & Christensen, C. (1995). Disruptive technologies: Catching the wave. *Harvard Business Review*, 1, 43–53.

- Bron, M. (2025). *The petro-atom: A century of ubiquitous oil involvement in nuclear energy, 1896–1993* [PhD dissertation]. Maastricht University.
- Buchsbaum, S. (1985, May 1). New faces of 1985. *Inc.Com.* <https://www.inc.com/magazine/19850501/6431.html>
- Cantoni, R. (2017). *Oil exploration, diplomacy and security in the early cold war: The enemy underground*. Routledge.
- Chambers, J. C., Mullick, S. K., & Smith, D. D. (1971). *How to choose the right forecasting technique*. Harvard University, Graduate School of Business Administration.
- Chandler, A., Jr. (1969). *Strategy and structure: Chapters in the history of the industrial enterprise*. MIT Press.
- Chandler, G. (1971). *Oil in the 1970s*. Warwick Modern Records Center. Box 1302, folder 4.
- Christensen, C. (1997). *The innovator's dilemma: When new technologies cause great firms to fail*. Harvard Business Review Press.
- Cibin, R., & Grant, R. M. (1996, December 01). Restructuring among the world's leading oil companies, 1980–92. *British Journal of Management*, 7(4), 283–307. <https://doi.org/10.1111/j.1467-8551.1996.tb00120.x>
- Citino, N. J. (2002). *From Arab nationalism to OPEC: Eisenhower, King Sa'ūd, and the making of U.S.-Saudi relations*. University of Indiana Press.
- Cobb, G. B. (1961). *2nd Amendment of partnership: Agreement – Petrotomics*. Dean McGee Papers (. University of Kansas – Kenneth Spencer Research Library. Box 119, folder 7.
- Cohen, W. (1981). *Firm heterogeneity, investment, and industry expansion: A theoretical framework and the case of the uranium industry* [PhD dissertation]. Yale University.
- Davies, W. (2010). Economic and the 'nonsense' of law: The case of the Chicago antitrust revolution. *Economy and Society*, 39(1), 64–83. <https://doi.org/10.1080/03085140903020655>
- Davis, H. (1960). *Nuclear energy liability exclusion endorsement to liability policy no. CL 1196*. University of Kansas – Kenneth Spencer Research Library. Dean McGee Papers Box 117, Folder 4.
- Department of Energy. (1986). *Viewgraphs for John Metzler's presentation to energy research advisory board entitled "The impending energy crisis."* Ruth Patrick Papers (Academy of Natural Sciences, Philadelphia). Box 8, folder ERAB Reference 1986 2 of 2.
- Dionne, G. (2013). Risk management: History, definition, and critique. *Risk Management and Insurance Review*, 16(2), 147–166. <https://doi.org/10.1111/rmir.12016>
- Drucker, P. (1954). *The practice of management*. Harper and Row.
- Ethridge, M. (1980). *The U.S. solar energy industries and the role of petroleum firms* (Research Study #018). American Petroleum Institute.
- Exxon Corporation. (1974). *Annual report, 1973*. Exxon.
- Ezell, J. S. (1979). *Innovations in energy: The story of Kerr-McGee*. University of Oklahoma Press.
- Fast, N. D. (1978). *The rise and fall of corporate new venture divisions vol. III, research for business decisions*. UMI Research Press.
- Garavini, G. (2019). *The rise and fall of OPEC in the twentieth century*. Oxford University Press.
- Grant, R. M. (2005). Oil company strategies from 1970 to the present. I. Eni (Ed.), *Encyclopaedia of hydrocarbons* (Vol. IV, pp. 301–321). The Instituto Della Enciclopedia Italiana Treccani.
- Grant, R. M., & Cibin, R. (1996). Strategy, structure and market turbulence: The international oil majors, 1970–1991. *Scandinavian Journal of Management*, 12(2), 165–188. [https://doi.org/10.1016/0956-5221\(95\)00031-3](https://doi.org/10.1016/0956-5221(95)00031-3)
- Grasso, M. (2022). *From big oil to big green: Holding the oil industry to account for the climate crisis*. MIT Press.
- Gulf Oil Corporation. (1958). *United States energy consumption 1910–1970*. Gulf Oil Corporation, Planning and Economics Dept. Gulf Oil Corporation Records. Heinz History Center - Detre Library and Archives. Box 3, folder 4.
- Gulf Oil Corporation. (1968). *1967 Annual report gulf oil corporation*. Gulf Oil Corporation.
- Halbouty, M. T. (1986). Mergers and hostile takeovers: Effects on R&D programs in the petroleum industry. *Issues in Science and Technology*, 2(2), 15–16.
- Harris, K. (1987). *The wildcatter. A portrait of Robert O. Anderson*. Weidenfeld and Nicholson.
- Hecht, G. (2014). *Being nuclear: Africans and the global uranium trade*. MIT Press.

- Heldman, J. D. (1977). *The solar market, proceedings on the symposium over the competition in the solar energy industry*. FTC. Arizona State University, Maria Telkes Collection. Box 58, folder SES Contract, Solar Energy Systems 1973, 1978, 1979, 1984, 1986.
- Hertsgaard, M. (1983). *Nuclear Inc.: The men and money behind nuclear energy*. Pantheon Books.
- Howarth, S. (1997). *A century in oil: The "shell" transport and trading company, 1987–1997*. George Weidenfield & Nicolson.
- Husky Oil. (1976). *The impact of divestiture on husky oil company*. Carl Albert Collection (Carl Albert Center, University of Oklahoma). Box 199 (legislative series), folder 17.
- Jacobs, M. (2016). *Panic at the pump: The energy crisis and the transformation of American politics in the 1970s*. Strauss and Giroux.
- Johnstone, B. (2011). *Switching to solar: What we can learn from Germany's success in harnessing clean energy*. Prometheus Books.
- Jones, G. (2017). *Profits and sustainability: A history of green entrepreneurship*. Oxford University Press.
- Jones, G., & Bouamane, L. (2012). "Power from sunshine": A business history of solar energy (Working Paper, No. 12–105). Harvard Business School.
- Jonker, J., & Van Zanden, J. L. (2006). *From challenger to joint industry leader, 1890–1939 a history of royal dutch shell* (Vol. 1). Oxford University Press.
- Kaartemo, V. (2016, December 14). Creation and shaping of the global solar photovoltaic (PV) market. *Advances in Sustainability and Environmental Justice*, 19, 227–247.
- Lamont, W. (1997). Cash flow and investment: Evidence from internal capital markets. *The Journal of Finance*, 52(1), 83–109. <https://doi.org/10.1111/j.1540-6261.1997.tb03809.x>
- Leder, B. (1973). *Bob Leder, KTUL-TV Tulsa, interview with Dean A. McGee (19 September 1973)*. Dean A. McGee Collection. University of Kansas-Kenneth Spencer Research Library. Box 170, folder 9.
- Levy, W. (1970). *Atlantic Richfield: Performance and prospects 1969–1970*. Walter J. Levy Papers (University of Wyoming – American Heritage Center). Box 71, binder Reports October–December 1970.
- Lifset, R. D. (2019). Nuclear Power in America: The Story of a Failed Energy Transition. *Environmental History*, 24, 524–533.
- Love, F. S. (1952). *Introduction*. Kermac News.
- Lumpkin, T. D. (1967). *The long-range outlook for the petroleum industry*. Gulf Oil Corporation Records (Pittsburgh Heinz History Center - Detre Library and Archives). Box 1, folder 20.
- Mahmoud, O. (2017). The origin of diversification: An evolutionary theory. *SSRN Electronic Journal*, 3004574. <https://doi.org/10.2139/ssrn.3004574>
- Martin, J. D., & Sayrak, A. (2003). Corporate diversification and shareholder value: A survey of recent literature. *Journal of Corporate Finance*, 9(1), 37–57. [https://doi.org/10.1016/S0929-1199\(01\)00053-0](https://doi.org/10.1016/S0929-1199(01)00053-0)
- Martinez-Rius, B. (2024). An open secret: Marine geosciences, offshore oil exploration and industrial secrecy in the mediterranean seafloor. *History and Technology*, 40(3), 173–200. <https://doi.org/10.1080/07341512.2024.2431369>
- Mason, C. F. (2014). *The organization of the oil industry, past and present*. Now Publishers. <https://doi.org/10.1561/07000000051>
- McCloy, J. J. (1976). *Horizontal divestiture*. College Archives and Manuscript Collection. S. John J. McCloy Papers, Box 38, Folder 43.
- McLean, B., & Elkind, P. (2004). *The smartest guys in the room: The amazing rise and scandalous fall of enron*. Penguin.
- McLemore, V. T. (1983). Uranium industry in New Mexico – History, production, and present status. *New Mexico Geology*, 5(3), 45–51. <https://doi.org/10.58799/NMG-v5n3.45>
- Miller, D. (2013, September 01). Why the oil companies lost solar. *Energy Policy*, 60, 52–60. <https://doi.org/10.1016/j.enpol.2013.05.043>
- Mitchell, T. (2011). *Carbon democracy: Political power in the age of oil*. Verso.
- Mobil Oil Corporation. (1975). *Annual report 1974*. Mobil Oil Corporation.
- Mobil Solar Energy Corporation. (1977, November). *The sun's future is brightening*. Dolph Briscoe Center for American History. ExxonMobil Collection, 2.207,_G117.
- Mizruchi, M. S. (2013). *The fracturing of the American corporate elite*. Harvard University Press.

- Montgomery, C. A. (1994). Corporate diversification. *Journal of Economic Perspectives*, 8(3), 163–178. <http://www.jstor.org/stable/2138225>. <https://doi.org/10.1257/jep.8.3.163>
- Morton, M. Q. (2017). *Empires and anarchies: A history of oil in the Middle East*. Reaktion Books.
- Ollinger, M. (1993). *Organizational form and business strategy in the US petroleum industry*. University Press of America.
- Oreskes, N. (1988). The rejection of continental drift. *Historical Studies in the Physical and Biological Sciences*, 18(2), 311–348. <https://www.jstor.org/stable/27757605>. <https://doi.org/10.2307/27757605>
- Parisi, A. J. (1977, September 9). *Senate defeats bid to curb fuel ties of oil companies*. New York Times.
- Parra, F. (2010). *Oil politics: A modern history of petroleum*. I.B. Tauris.
- PenWell Corporation. (1987). *Alternative sources of energy 1987-04: Iss 90 (with internet archive)*. PennWell Corporation.
- Penrose, E. T. (1959). *The theory of the growth of the firm*. Basil Blackwell.
- Pinkse, J., & van den Busse, D. (2012, January 01). The development and commercialization of solar PV technology in the oil industry. *Energy Policy*, 40, 11–20. <https://doi.org/10.1016/j.enpol.2010.09.029>
- Pollack, A. (1981, August 7). Post-conoco guessing game. *New York Times*. <https://www.nytimes.com/1981/08/07/business/post-conoco-guessing-game.html?searchResultPosition=1>
- Potts, M. (1982, July 12). Solarex: Money in sunshine. *Washington Post*. <https://www.washingtonpost.com/archive/business/1982/07/12/solarex-money-in-sunshine/5a0890a7-e121-4dbe-a6b7-86c3a09ef0b3/>
- Prahalad, C. K., & Hamel, G. (1990). The core competence of the corporation. *Harvard Business Review*, 68(3), 79–91.
- Pratt, J. A., & Hale, W. E. (2013). *Exxon: Transforming energy, 1973–2005*. Dolph Briscoe Center for American History.
- Pratt, J. A., Priest, T., & Castaneda, C. J. (1997). *Offshore pioneers: Brown & root and the history of offshore oil and gas*. Gulf Publishing.
- Priest, T. (2015). Crude history. *Reviews in American History*, 43(2), 333–339. <https://doi.org/10.1353/rah.2015.0035>
- Reece, R. (1979). *The sun betrayed*. Black Rose Books.
- Royal Dutch Petroleum Company. (1955). *Royal Dutch Petroleum Company: Annual report 1954*.
- Royal Dutch Petroleum Company. (1957). *Royal Dutch Petroleum Company: Annual report 1956*.
- Rutterford, J., & Sotiropoulos, D. P. (2016a). Financial diversification before modern portfolio theory: UK financial advice documents in the late nineteenth and the beginning of the twentieth century. *The European Journal of the History of Economic Thought*, 23(6), 919–945. <https://doi.org/10.1080/09672567.2016.1203968>
- Rutterford, J., & Sotiropoulos, D. P. (2016b). Putting all their eggs in one basket? Portfolio diversification 1870–1902. *Accounting History Review*, 26(3), 285–305. <https://doi.org/10.1080/21552851.2016.1219464>
- Sampson, A. (1975). *The seven sisters: The great oil companies and the world they made*. Viking Press.
- SCS, Inc. (1983). *Draft offering circular*. Karl-Wolfgang Böer Papers (University of Delaware Library, Special Collections). Box 58, folder F116 SCS Inc., and Solavolt.
- Skodvin, T., & Skjaereth, J. B. (2010). *Climate change and the oil industry: Common problem, different strategies*. Manchester University Press.
- Sluyterman, K. (2006). *Keeping competitive in turbulent markets, 1973–2007: A history of the royal Dutch shell*. Oxford University Press.
- Sluyterman, K. (2010). Royal Dutch shell: Company strategies for dealing with environmental issues. *Business History Review*, 84(2), 203–226. <https://doi.org/10.1017/S0007680500002580>
- Socony Mobil Corporation. (1961). *Annual Report 1960*. Socony.
- Sotiropoulos, D. P., & Rutterford, J. (2019). Financial diversification strategies before First World War: Buy-and-hold versus naïve portfolio selection. *Business History*, 61(7), 1175–1198. <https://doi.org/10.1080/00076791.2018.1512097>
- Southerl, D. (1993, November 5). Mobil ends solar project, citing market weakness. *The Washington Post*. <https://www.washingtonpost.com/archive/business/1993/11/05/mobil-ends-solar-project-citing-market-weakness/25a0a671-00de-44cd-a38c-ffe6881392e7/>

- Stanković, J. (2024). History of oil and solar relationships: Makeups and breakups. *Revue D'Histoire de L'Énergie*, 12(1), 1g–21. <https://doi.org/10.3917/jehrhe.012.0128>
- Stanković, J., & Bron, M. (2025). The cohort effect in solar energy and nuclear power: Unveiling collective agency in energy transitions. *Energy Research & Social Science*, 125, 104112. <https://doi.org/10.1016/j.erss.2025.104112>
- Stevens, P. (2013). History of the international oil industry. In R. Dannreuther & W. Ostrowski (Eds.), *Global resources: Conflict and cooperation* (pp. 13–32). Palgrave Macmillan.
- Taylor, G. D. (2019). *Imperial standard: Imperial oil, Exxon, and the Canadian oil industry since 1880*. University of Calgary Press.
- Taylor, J., & Yokell, M. (1980). *Yellowcake: The international uranium cartel*. Pergamon Press.
- Varadi, P. (2014). *Sun above the horizon, meteoric rise of the solar industry*. Jenny Stanford Publishing.
- Verbong, G. P. J., Selm, van, A., Knoppers, R., & Raven, R. P. J. M. (Eds.). (2001). *Een kwestie van lange adem: de geschiedenis van duurzame energie in Nederland [A matter of a long breath: the history of sustainable energy in the Netherlands]*. Aeneas Publishers.
- Wald, M. L. (1989, August 3). ARCO to sell siemens its solar energy unit. *The New York Times*. <https://www.nytimes.com/1989/08/03/business/ARCO-to-sell-siemens-its-solar-energy-unit.html>
- Warner, R. (1977). *The U.S. energy crisis—Horizontal divestiture*. ExxonMobil Historical Collection (Briscoe Center for American History). Series 2.207E119, folder The U.S. Energy Crisis—Horizontal Divestiture.
- Wermeskerken van, P. (1999, March 3). *Populariteit zonnestroom groeit enorm [Popularity solar energy expanding enormously]*. Algemeen Dagblad.
- Wolfe, P. R. (2018). *The solar generation: Childhood and adolescence of terrestrial photovoltaics*. Wiley.
- Yergin, D. (1990). *The prize: The epic quest for oil, money, and power*. Simon & Schuster.