The oil endgame : strategies of oil exporters in a carbon-constrained world

Reference:
Van de Graaf Thijs, Verbruggen Aviel.- The oil endgame : strategies of oil exporters in a carbon-constrained world
Environmental science & policy - ISSN 1462-9011 - 54(2015), p. 456-462
Full text (Publisher's DOI): http://dx.doi.org/doi:10.1016/J.ENVSCI.2015.08.004
To cite this reference: http://hdl.handle.net/10067/1269040151162165141

Published in Environmental Science and Policy 54 (2015) 456-462

The Oil Endgame: Strategies of Oil Exporters in a Carbon-Constrained World

Thijs Van de Graaf (Ghent University) and Aviel Verbruggen (Antwerp University)

Abstract: There is mounting evidence that global oil demand will peak between 2020 and 2040, supported by rational economics (inter-fuel competition and efficiency gains) and environmental policies. The perspective of a peak in world oil demand poses a serious economic threat to petrostates whose GDP largely depends on oil export revenues. This article develops a repertoire of five possible strategies that oil-exporting countries can follow in a carbon-constrained world: quota agreements, price wars, efficiency, compensation, and economic diversification. The analysis suggests that the strategic behavior of oil exporters could yield important effects on climate policies, oil prices and related rents, the energy security of importers, and global geopolitics. The findings suggest that models of decarbonization and global energy security need to incorporate more explicitly the strategic behavior of oil exporters.

Keywords: peak oil demand; petrostates; OPEC; climate policy; decarbonization; green paradox

Highlights:

- Global oil demand may peak between 2020-2040 because of climate policies
- Identification of five strategies for oil exporters to cope with loss in oil rents
- Economic diversification is considered the optimal strategy in the long run
- Decarbonization scenarios often neglect strategic behavior of oil exporters

1. Introduction

Projections by the International Energy Agency (IEA) indicate that a global peak in oil demand is likely to occur between 2020 and 2040, supported by economics (inter-fuel competition and efficiency gains) and environmental policies (mitigation of climate change and of air pollution). The perspective of a peak in world oil demand poses a serious economic threat to petrostates, states in which oil revenues exceed 10% of gross domestic product (GDP) (Colgan, 2013a). These petrostates are likely to react strategically to the threat of a demand peak, rather than being mere passive bystanders. Understanding their possible countermoves is important since they could affect critical issues such as climate policies, oil prices and related rents, the energy security of importers, and global geopolitics.

While the depletion of oil and the risk of an oil supply peak have attracted considerable attention, there is only scant literature that examines the possibility of a global demand peak for oil (Verbruggen and Al Marchohi, 2010; Brandt et al., 2013). Similarly, the extraction policies of oil exporters are typically absent from debates about climate change policy even though they ‘will ultimately determine how much carbon will be extracted and burned, eventually reaching the atmosphere as CO_2’ (Sinn, 2013, p. 129). There are a few studies of how oil producers are affected by and could respond to climate policies but they mostly involve econometric and game theoretic models, based on narrow assumptions, that do not consider the full range of options oil exporters have at their disposal (e.g., Persson et al., 2007; Johansson et al., 2009; Wei et al., 2012; Wirl, 2012).

To fill the gap, this article reviews the recent evidence in support of an imminent peak in global oil demand (section 2). Next, it develops a repertoire of five possible strategies that oil-exporting countries can follow in a carbon-constrained world (section 3). Finally, it briefly reflects on the implications of the oil-exporter strategies for modelling assessments of global energy and climate security (section 4).

2. Scenarios of peak oil demand

After decades of robust growth in oil demand, conventional wisdom holds that the oil market will continue to expand over the next 25 years, driven in large part by economic and population growth. Table 1 compares projections of future oil demand from several international institutions (IEA and OPEC) and oil majors (BP, Shell, and ExxonMobil).[1] It shows that most projections are bullish on oil demand growth. The IEA's Current Policies Scenario, for example, projects that oil demand will grow to 116,6 million barrels per day (mb/d) in 2040 up from 90,1 million barrels in 2013 (IEA, 2014c).[2]

Table 1. Projected change on average per year in oil demand under different scenarios

Institution	Scenario/source	Projection period	CAGR
IEA	Current Policies – WEO 2014	2013-2040	0,96%
BP	Energy Outlook 2035	2013-2035	0,82%
ExxonMobil	Outlook for Energy – A View to 2040	2010-2040	0,80%
OPEC	Reference Case – World Oil Outlook 2014	2010-2040	0,70%
IEA	New Policies – WEO 2014	2013-2040	0,53%
Shell	Oceans Scenario	2010-2060	0,30%
Shell	Mountains Scenario	2010-2060	-0,53%
IEA	450 Scenario – WEO 2014	2013-2040	-0,83%
IEA	2DS Scenario – ETP 2015	2012-2050	-1,22%

Notes: CAGR = Compound Annual Growth Rate. WEO = World Energy Outlook. ETP = Energy Technology Perspectives
Sources: IEA (2014c; 2015), BP (2015a), ExxonMobil (2015), OPEC (2014b), Shell (2013)

However, several developments suggest that the inexorable growth of the oil market may be a thing of the past, not because of supply shortages but because of decreasing demand. To begin with, *all* projections show demand growth slowing down to levels below the 1990-2013 historic rate of 1,36% (IEA, 2014c: 98). The further these projections reach in time (e.g., 2050

[1] It is difficult to compare *actual levels* of projected oil demand due to fact that these institutions use different definitions. That is why the table compares the projected compound annual growth rates.
[2] The IEA's Current Policies Scenario assumes only the implementation of government policies and measures that had been enacted by mid-2014.

for the IEA's 2DS Scenario or even 2060 for Shell's scenario's), the lower the CAGR becomes. Advances in efficiency and fuel-switching play key roles in moderating future oil demand throughout all these scenarios. More importantly, several of these scenarios project a peak in global oil demand. Here we discuss two such scenarios from the IEA's *World Energy Outlook*, probably the most widely cited source of global energy projections: the *New Policies Scenario*, which expects oil demand to level off by 2040, and the *450 Scenario*, which foresees a peak in oil demand by 2020.

2.1. Oil demand trends in the IEA's New Policies Scenario

The IEA's New Policies Scenario, the agency's central scenario, projects oil to retain its position as the largest single fuel in the global energy mix out to 2040. In this scenario, oil demand rises by 14 mb/d to reach 104 mb/d in 2040, moving towards a plateau in global oil consumption (IEA, 2014c: 95). The 2014 edition of the World Energy Outlook thus marks the first time that the IEA projected a peak in oil demand in its central scenario. Moreover, a closer look reveals significant regional and sectoral shifts in oil consumption.

In the OECD, oil demand is expected to decrease. Oil demand in the OECD has already fallen from 50,1 mb/d in 2005 to 45 mb/d in 2014 (BP, 2015b). Broken down by region, oil demand has fallen in the US since 2007, in the EU since 2005, and in Japan since 2003 (BP, 2015b). The industrialized countries now use the same amount of oil as they did in 1995, and the EU countries are even back at consumption levels last seen in 1967 (Rühl, 2014). The fall in oil demand predated the Great Recession and cannot be solely attributed to the economic downturn of 2008-2009 (Geman, 2009). Most projections confirm that oil demand in the US, Europe and Japan is in structural decline, rather than experiencing a (long) cyclical downturn (Hamilton, 2014).

The key factor making it unlikely for OECD oil demand to *ever* return to its 2005 peak is that petroleum demand in the transportation sector – which accounts for 65% of total OECD petroleum demand (IEA, 2014a) – is likely to shrink. Oil demand outside the transportation sector (i.e. mainly for industry, buildings, and power generation) has already been relatively flat since 1980, due to an effort to reduce oil use after the oil shocks of the 1970s. The consultancy firm IHS Cera expects that oil demand from transportation will now also decrease in the OECD due to a combination of three long-term trends: vehicle ownership rates have reached a 'saturation' level, fuel economy standards become ever tighter, and alternative fuels and vehicle technologies are gaining market share (IHS CERA, 2009).

All of the projected increase in oil demand in the IEA's New Policies scenario for 2040 comes from the non-OECD countries, where rising oil consumption is expected to more than offset the contraction in the OECD (IEA, 2014c). There are, however, key potential uncertainties that could undermine this projection. To begin with, the IEA's analysis is very sensitive to assumptions about GDP growth rates. A slowdown in the growth of China and other emerging economies could make a huge dent in global oil demand, causing the rate of demand growth to flatten already between 2020 and 2030 (Capalino et al., 2014).

Even if these economies grow as expected, a number of developments on the demand side could strengthen the ongoing decoupling between economic and population growth, on the one hand, and oil demand, on the other (IEA, 2014c: 96). Two drivers stand out (IEA, 2014c):[3] *technological advances*, such as the shale gas revolution, which has strengthened the position of natural gas as a tough competitor for oil in many of its uses; and *government policies*, at the local, national and global level, to mitigate the financial and environmental costs of oil consumption—for example, the recent curtailing of oil subsidies in countries such as China, India and Indonesia, the main engines of oil demand growth in Asia over the coming years.

Some observers therefore expect that global oil demand will peak earlier than 2040, the peak year anticipated in the IEA's New Policies Scenario. Brandt et al. (2013) project that global oil demand may peak in 2035 on current trends in travel behavior and vehicle efficiency improvement, and even as early as 2025 in a scenario which assumes rapid penetration of alternative liquid fuels. Interestingly, in all these scenarios, cumulative demand remains below the U.S. Geological Survey estimates of remaining conventional oil, implying that not all known conventional oil will be pumped out of the ground. Citigroup (2013) estimates that global oil demand could level off even sooner, by 2020, because of substitution and efficiency.

2.2. Oil demand trends in the IEA's 450 Scenario

It is well established that fossil fuel consumption must decrease strongly to achieve 450-550 parts per million (ppm) CO2-equivalent concentration stabilization targets, corresponding to acceptable likelihoods that the average surface temperature increase is limited to the 2 to 3 degrees Celsius range, respectively (McCollum et al., 2014). Although there is no agreement on the individual contributions from coal, oil and gas to reduce overall fossil fuel consumption, it is clear that oil demand will be affected. Oil consumption currently accounts for 35% of total CO_2 emissions (IEA, 2013a). A peak in oil demand by 2030, followed by a rapid decline, is a consistent feature of all the decarbonization scenarios developed in the Global Energy Assessment (Riahi et al., 2012). Van Vuuren et al. (2011) project that, in order to stabilize the climate at 2°C (what they refer to as the 'Representative Concentration Pathway 2.6'), oil consumption is to drop sharply before 2025. According to the IEA's 450 Scenario (2014c: 96-97), world oil demand would need to shrink by at least 0.8 percent on average each year between 2013 and 2040 to keep global warming below 2°C, implying a peak in oil demand already by around 2020.

In theory, the use of carbon capture and storage (CCS) could expand the use of fossil fuels in filling the permitted 'emission space', including the amount of oil that can be consumed without jeopardizing the 2°C target. Yet CCS is fraught with huge uncertainty, technically, economically and politically. Moreover, McGlade and Ekins (2014) find that, even in a scenario with widespread and rapid adoption of CCS, nearly 500 Gb of oil must remain

---

[3] The IEA also mentions elevated oil price levels as a key driver of the push away from oil. Crude oil prices have averaged above or around 100 dollars a barrel from 2011 to 2014. Yet, this factor has obviously been muted since the dramatic fall in oil prices in mid-2014.

unused to have an even chance of limiting average global temperature change to 2°C. This is not so very different from the 600 Gb of 'un-burnable' oil in a scenario where CCS is not available. The utilization of oil in a 2°C world inches up by only two percentage points if CCS is massively deployed (from 65% to 67%). The upshot is that, even with CCS, one-third of available oil reserves must remain in situ from 2010 to 2050 (McGlade and Ekins, 2015).

Over the longer term, Bauer et al. (2015) show that climate policies actually have very little impact on *cumulative* oil use. Climate policies primarily affect coal extraction and to a lesser extent gas extraction. Still, climate stabilization policies lead to a very large drop in crude oil revenues, much larger than the fall in coal and gas revenues. The loss in crude oil revenues is not caused by a change in the volume of crude oil production under climate policies but rather by changes in the price of oil.

3. Oil exporter strategies

In light of the above projections, it is safe to assume that global oil demand will peak in the coming years for a combination of two reasons: rational economics (increased efficiency and fuel switching, for example, due to high oil prices) and government policies to mitigate the environmental and financial costs of oil consumption (e.g., climate change, air pollution, fuel subsidies). Estimates for the timing of peak oil demand vary from 2020 to 2040, depending on the exact mix of these driving forces. In any case, climate policies are a necessary condition for peak oil to occur in this time frame. Without any additional climate policies, oil use will increase with almost 30% between 2013 and 2040 (IEA, 2014c; Current Policies Scenario). In other words, an imminent peak in oil demand only occurs when governments act to constrain the amount of carbon emissions in the global atmosphere. Recent trends such as the emergence of the fossil fuel divestment movement, new climate and clean energy pledges by major emitters, and the G7's embrace of decarbonization in June 2015 only add credibility to the peak oil demand scenarios outlined above.

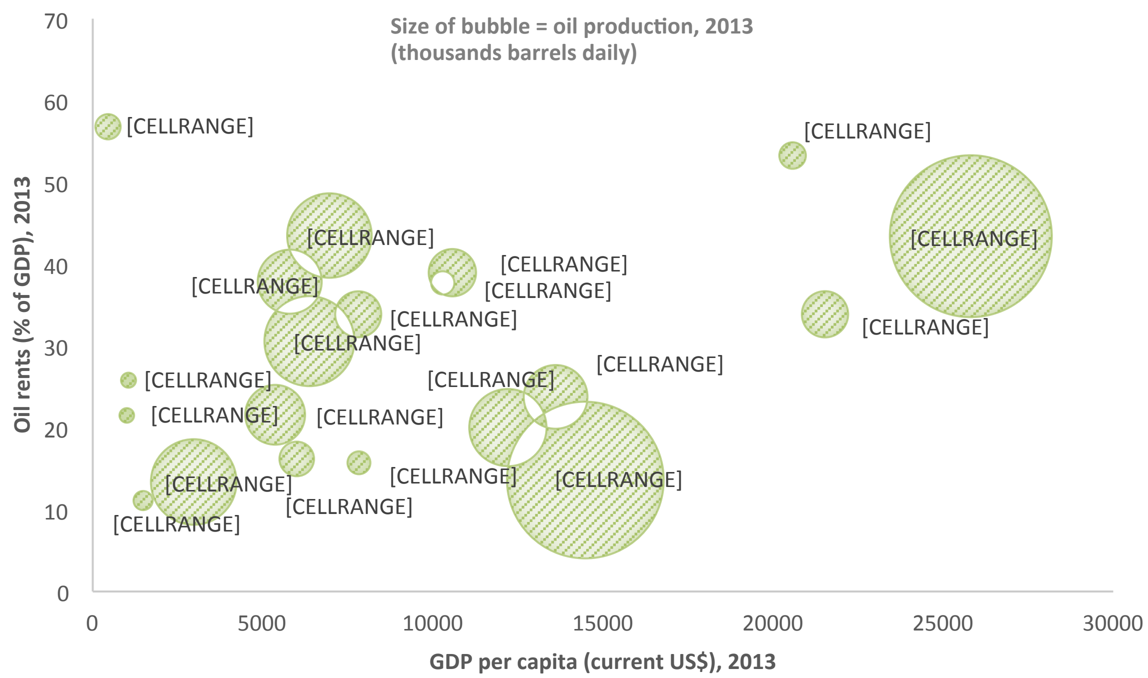
The transition towards a society less based on petroleum is likely going to meet resistance. Members of the Organization of Petroleum-Exporting Countries (OPEC) and other oil producers will suffer economically from a peak in global oil demand. A wide range of energy-economy models forecast losses to the members of OPEC if strong climate policies are implemented (e.g., McKibbin et al., 1999; Bartsch and Müller 2000; van Vuuren et al., 2003; Barnett et al., 2004; Bauer et al., 2013; Tavoni et al., 2013; Waisman et al., 2013).

Some studies argue that OPEC gains rent, in the order of a few percent, due to atmospheric CO_2 stabilization targets. The explanation is that conventional oil reserves correspond to only a quarter of the allowable emission space over the next 100 years and are cheaper to produce and have less carbon content than most of their liquid substitutes. Yet, 'if climate policy is implemented through energy efficiency standards and subsidies to renewables, then energy demand will drop, but the price of oil will not increase' and so OPEC will not gain (Persson et al., 2007: 6347; see also Johansson et al., 2009).

Oil-exporting countries are hence not going to be passive bystanders in the transition towards a society less based on petroleum. This begs the question: what are some of the strategies they might consider to adopt? We list and discuss five such strategies, each of which starts from the assumption that the governments of major oil producers are rational actors who seek to preserve their respective country's economic development. The strategies are: quota agreements, price wars, efficiency, compensation, and economic diversification.

Before discussing each strategy in detail, two remarks are in order. First, these strategies are to some extent ideal types. Blended strategies are certainly possible as are shifts from one strategy to another over time. Second, these strategies are conceived with reference to oil-exporting countries, and not with regard to the international oil companies or other actors involved in the global oil value chain. More precisely, we focus on the petrostates, states that derive at least 10% of their national income from oil rents. There are currently 66 net oil exporting countries, 24 of which qualify as petrostates (World Bank, 2014). Twenty of them are represented in Figure 1. The transition away from oil can be assumed to be the most difficult for countries with high oil dependence (Y-axis), low wealth (X-axis), and large oil production (bubble size).

Figure 1. Overview of petrostates and selected economic indicators



Source: World Bank (2014), BP (2014)
Note: Brunei, the United Arab Emirates, Kuwait and Qatar are not depicted due to their very high per capita GDP

3.1. Quota agreements

In response to shrinking oil demand, major oil producers may come together and collectively attempt to agree on production quota to preserve their oil rents through higher prices. The coordination may be done among the twelve members of OPEC, which currently supplies about 40 percent of the world's oil, or among any ad hoc coalition of oil producers. In March 1998, for instance, when the oil price fell to record lows, four non-OPEC producers (Mexico, Norway, Russia and Oman) decided to cooperate with the cartel and were explicitly included in the OPEC scheme of production cuts (Claes, 2001: 292). This was, however, the *only* occasion to date in which OPEC and non-OPEC members formally cooperated on a cutback in oil production, illustrating how difficult it is to establish this kind of cooperation.

Even OPEC itself has a poor track record in terms of quota discipline since the introduction of the quota system in April 1982. Previous research on OPEC's performance as a cartel produced either negative or inconclusive evidence.[4] The pattern that emerges is one in which the oil club regularly adjusts its quota to bring them into alignment with actual production levels, rather than the other way around. Colgan (2014) finds that OPEC's nine core members cheated on their aggregate quotas a staggering 96% of the time in the period 1982-2009. Another study finds that, although the producer group was able to extract prices somewhat above the competitive level for limited periods of time, OPEC has not been effective in systematically raising prices above Cournot competition levels during the period 1974-2004 (Almoguera et al., 2011).

One of the prime reasons why OPEC has serious difficulties in overcoming the dilemmas of collective action are the wide differences that exist within OPEC's membership. The 'price hawks' within OPEC typically have smaller oil reserves and larger populations, compelling them to focus on high oil prices in the short term. Iran and Venezuela are often seen as the most vocal price hawks within OPEC. Their view differs from the perspective of the so-called 'price doves', of which Saudi Arabia is the main exponent, along with other Gulf member states that have low-cost reserves and smaller populations. Rather than to raise the oil price to extract monopoly profit, Saudi Arabia and its Gulf allies are interested in restraining the price to conserve their market in the long run (Cairns and Calfucura, 2012). They have an incentive to moderate prices for now to mitigate the challenge from non-OPEC producers and to ensure that developed nations do not implement effective oil-substitution policies that lead to oil demand destruction.

A peak in oil demand due to climate policies could lead to a higher concentration of production in the hands of those states holding the largest conventional oil reserves, which are generally cheaper and less carbon-intensive (Cherp et al., 2013). Such a concentration could increase the strength and cohesiveness of the cartel. Yet, assuming OPEC would be able to overcome these internal differences and agree on strict quota to maintain oil prices in the face of falling demand, this strategy would only provide temporary relief if the slide in oil demand is structural (e.g., driven by carbon constraints). It would allow OPEC countries to maintain (part of) their income through higher oil prices for a certain period, but in the long run, they

[4] The literature on this subject is huge. For a good overview, see: Fattouh and Mahadeva (2013).

cannot escape the predicted loss of revenue in oil rents (Bauer et al., 2015). The animosity among the petrostates may promulgate less peaceful processes for appropriating a larger share of the shrinking rent volumes (Verbruggen and Van de Graaf, 2013).

3.2. Price wars

Should major oil exporters fail to cooperate, they could resort to competitive price undercuts to gain market share and fill as much as possible of the remaining 'emission space' with their own oil. To understand this kind of behavior it is worth recalling Hotelling's rule, according to which the price of oil and other exhaustible natural resources tends to rise at a rate that equals the capital market's interest rate. The mechanism behind the rule is that the resource owners have to decide between the option of leaving their oil wealth underground for future extraction and the alternative option of exploiting their deposits now and investing the proceeds in the capital markets (Hotelling, 1931).

Faced with the prospect of a structural decline in oil demand, petroleum in the ground can no longer be considered as the equivalent of a safe financial deposit. The future value of oil deposits is likely to decline and this anticipated depreciation puts pressure on the reserve holders to sell as much of their oil now and invest the returns in capital markets. Situations where the oil-producing countries competitively reduce prices in order to make zero-sum gains in market share at each other's expense are referred to as 'price wars' (Fang et al., 2014). Price wars have occurred several times on the global oil market, most notably in 1986 when Saudi Arabia decided to flood the market with oil to enforce quota discipline within OPEC. More recently, OPEC's decision in November 2014 not to cut production in the face of drastically falling prices is widely interpreted as a price war against US shale oil.

Naturally, if producers engage in a race to sell as much of their oil as possible, they could foster a price collapse, which could lead to some recovery of the market for oil and may hook consumers to oil again. This is an example of what Sinn (2012) has termed the 'green paradox', according to which the introduction of climate policy is an incentive for oil exporters to accelerate the extraction of their reserves and, hence, exacerbate global carbon dioxide emissions.

Yet, there are reasons to doubt whether oil producers will be able to turn the tides of lower oil demand through accelerated oil extraction. Cairns (2014) shows that 'green paradox' concerns are overblown in the case of oil production. Oil producers simply cannot rapidly increase oil production as they desire because of natural and technical capacity constraints. The productivity of a well decreases after an initial period of capacity production through what is known as 'natural decline'. Moreover, any current increase in exploration depends on whether equipment (e.g., drilling rigs) and professionals are available. Apart from Saudi Arabia and a few other Gulf producers, there is hardly any 'spare capacity' in the oil market, defined by the IEA (2014b) as capacity that can be reached within 30 days and sustained for 90 days.

The key decision that oil producers thus face is whether or not to increase spending and investment in exploration capacity, since modulating oil supply in the short term is no option for most of them. Given the long lead times from the start of exploration through development to production, it takes several years before oil supply can be substantially raised. The prospect of a looming oil demand peak casts a shadow over these investments. The return on these investments is likely to be reduced as compared to previous investments that were typically made in anticipation of rising demand for oil. As Cairns (2014) observes: ‘Prospective professionals, especially more promising minds, may shy away from training in an industry that is expected to be subject to increasing taxation, reduced rents, and societally mandated attempts to develop substitutes for its product.’

3.3. Efficiency

Oil-producing countries can also sustain rents from their oil fields by becoming more efficient in how they produce petroleum and spend their oil revenues. In many oil-exporting countries, valuable resources are currently wasted because of routine gas flaring, under-utilization of enhanced oil recovery techniques, poor resource management practices, and domestic fuel subsidies. Consider first the problem of flaring. The World Bank estimates that thousands of gas flares at oil production sites around the globe burn approximately 140 billion cubic meters of natural gas annually. This not only leads to more than 300 million tons of CO_2 emissions but also wastes a valuable energy resource that, if used for power generation, could provide more than the African continent’s current annual electricity consumption (World Bank, 2015).

In addition, oil producers often do not make full use of the most advanced extraction technologies. A typical oil reservoir has a recovery rate of 35% but a slate of enhanced oil recovery (EOR) techniques permit to increase that share. Injection of CO_2 into oil reservoirs is one such proven EOR technique that, given the right incentives, could also develop as a way to store CO_2 (IEA, 2013b: 421). The IEA estimates that systematic application of EOR technologies to large fields throughout the world would unlock at least 300 billion barrels of extra crude (IEA, 2013b: 440), or more than the entire reserves of Saudi Arabia (BP, 2014).

In many instances, resource-rich countries need to become more open to foreign investors in order to gain access to state-of-the-art EOR technologies. The oil sector in most petrostates is organized around a national oil company (NOC). While there is huge variety in the performance of NOCs, they typically are less efficient than international oil companies (Victor et al., 2013). Moreover, revenue from natural resources is often associated with corruption, graft and bad governance, which in turn undermines economic and human development.

Finally, oil-exporting countries can lower their domestic fuel use through building more natural gas systems and phasing out domestic gasoline and diesel subsidies. Lowering domestic subsidized oil use would not only directly ease the pressure on the state budget, it would also free up more petroleum for exports, thereby potentially increasing export revenues. It would also enable NOCs to upgrade their internal capabilities, invest in new infrastructure, and shift to modern and more efficient technology (Fattouh and El-Katiri, 2012). Lastly, it would allow deep cuts in CO_2 emissions by the oil-exporting countries themselves and, by raising retail energy prices, make renewable energy more competitive (Wittmann, 2013).

Wei et al. (2012) argue that oil exporters may also choose to ramp up domestic oil subsidies, rather than reduce them, in response to unilateral carbon pricing imposed by the major consumer governments. This would allow them to attract some of the petrochemical, plastics, fertilizer, and other industries that make intensive use of energy inputs (either as energy source or as a feedstock). Such a shift constitutes a case of 'carbon leakage'. It starts from the assumption of a world with fragmented emission mitigation policies, in which the oil exporters have no (significant) emission constraints. Yet, whether this strategy will enable oil exporters to maintain their oil rents is questionable. Governments of consuming countries will likely retaliate with carbon border adjustment taxes or free emission allowances to emission-intensive industries. Moreover, strategic behavior by OPEC itself could affect leakage rates (Böhringer et al., 2014).

3.4. Compensation

Large oil-exporting countries could strive for monetary compensation within the UNFCCC negotiations for their envisaged losses in oil revenue. Article 4.8 in the UNFCCC and articles 2.3 and 3.14 in the Kyoto Protocol require parties to the treaties to take measures to minimize the impacts of emission reduction measures on energy-exporting countries. OPEC argues that this should include monetary compensation for lost oil revenues and assistance for economic diversification. It has also pleaded for taxes at the source of oil production rather than at the point of consumption (Barnett and Dessai, 2002; Depledge, 2008), in recognition of the fact that the oil-consuming countries make more money from the sale of oil products than oil-producing countries earn from the export of crude (OPEC, 2014a).

In 2007, Ecuador proposed to leave nearly 900 million barrels of oil underground in the Yasuni National Park if the international community would pay 50% of the value of the reserves for the avoided emissions to a trust fund, administered by the United Nations Development Program (UNDP). This would mean that Ecuador would leave about 20% of its proven oil reserves underground, a bold move for an OPEC member country that relies on oil for about 35% of its national budget (Martin, 2011). In August 2013, however, Ecuadorian President Correa announced that he was ending the initiative for lack of sufficient pledges.

3.5. Economic diversification

The final major strategy is that oil exporters diversify their national economies and prepare for a future in which the oil market shrinks substantially. Economic diversification is not only the most desirable strategy from a global welfare standpoint, as it meshes well with efforts to mitigate climate change, but also from a national welfare standpoint, as it could help to mitigate the 'resource curse'. There is a broad (but by no means universal) consensus among scholars that, on average, oil-producing countries suffer from a number of political ailments such as being less democratic, more patriarchal, and more frequently marked by violent insurgencies. They also suffer from economic maladies, such as destructive boom-bust cycles due to the volatility of oil revenues and fewer economic opportunities for women (Auty, 2002; Ross, 2012).[5]

'Sowing the oil' to diversify the economy has been a longstanding goal for many oil exporters. There is sound evidence that export diversification is associated with higher long-term growth and that countries that get 'locked in' to dependence on a limited range of products do less well in the long run (Lederman and Maloney, 2007; Gelb, 2010). Diversifying the economy can overcome the 'crowding out' of other productive activities, usually the manufacturing sector, that often results from petroleum dependence (Sachs and Warner, 2001; Karl, 2007). It is one of the few strategies available for resource-rich countries to ensure economic growth beyond the point where their oil reserves are depleted or, indeed, world oil demand enters into structural decline.

Yet, only few petrostates have managed to break free from their dependence on the oil sector. Malaysia and Indonesia have successfully diversified as manufacturers, while Dubai has attracted foreign investment in infrastructure, services and business thanks to the creation of a massive special economic zone (Gelb, 2010). It is doubtful that these experiences can simply be copy-pasted by other large oil exporters. On a per capita basis, Malaysia and Indonesia never produced as much oil and gas as the members of OPEC (Ross, 2012). The Dubai model of development has also been described as 'sui generis' because the country so heavily depends on expatriate labor and skills, with nationals constituting only 10% of the population (Gelb, 2010).

4. Conclusions and implications

Following a review of the evidence in support of an imminent global peak in oil demand, this article has identified five basic strategies that oil exporters can follow to cope with structurally shrinking demand and concomitantly falling oil rents. Neither strategy is without difficulties and huge obstacles have to be overcome to implement them. From a global and national welfare perspective, the strategy of economic diversification in oil-exporting countries is the most optimal outcome.

The identification of the different oil-exporter strategies opens up new questions in at least three streams of literature. First, it has implications for the literature on oil exporter behavior. Some formal energy-economic models of decarbonization and oil supply fail to appreciate that the owners of oil resources act and react strategically. For example, Persson et al. (2007) analyzed whether OPEC would lose or gain oil rent from climate policies under the assumption that OPEC is a price-taker in the energy market. Yet, OPEC can pursue different pricing strategies and the choice of these strategies could affect the pace and trajectory of decarbonization. The price war scenario, for example, would seriously test the resolve of the international community to move away from oil. It could lead to more oil being burned, at the

[5] For an adverse perspective, see Haber and Menaldo (2011) who argue that increases in resource reliance are not associated with the undermining of democracy.

expense of the shares of coal and gas in the overall carbon budget. Neither coal nor gas benefit from a global cartel in the same way as oil does.

Second, the analysis could also inform studies of global energy security in a carbon-constrained world. A host of studies argue that climate policies would lead to an improvement of energy supply security for consumers through decreased imports, increased diversity of energy options, and decreased resource depletion (McCollum et al., 2014; Jewell et al., 2014). However, Cherp et al. (2013) point out that as oil is phased out in a climate-constrained world, the diversity of suppliers precipitously falls because only the cheaper, lower carbon-intensive resources are developed. What the modeling papers exclude, however, is the strategic behavior of energy exporters. Future research could examine the implications for energy importers of the different strategies laid out in this article.

Third, the analysis suggests that the geopolitics of oil should not be seen so much as a struggle to obtain access to a scarce and shrinking resource (e.g., Klare, 2012) but rather as a contest between oil producers to maximize financial rents in the face of excess oil supplies. This pattern is not different from the past as the oil industry has always been preoccupied with 'how to organize scarcity in the face of prodigious abundance' (Bridge and Wood, 2010). Monopolies such as Rockefeller's Standard Oil and cartels such as the Texas Railroad Commission and OPEC serve as glaring reminders that unfettered oil markets have, in fact, never really existed.

References

Almoguera, P.A., Douglas, C., Herrera, A.M., 2011. Testing for the cartel in OPEC: non-cooperative collusion or just non-cooperative? *Oxford Review of Economic Policy*, 27(1): 144-168.

Auty, R., 2002. *Sustaining Development in Mineral Economies: The Resource Curse Thesis*. Routledge.

Barnett, J., Dessai, S. 2002. Articles 4.8 and 4.9 of the UNFCCC: Adverse effects and the impact of response measures. *Climate Policy* 2, 231-239.

Barnett, J., Dessai, S., Webber, M., 2004. 'Will OPEC lose from the Kyoto Protocol?' *Energy Policy*, 32(18), 2077-2088.

Bartsch, U., Müller, B., 2000. *Fossil Fuels in a Changing Climate*. Oxford University Press, Oxford, UK.

Bauer, N., Mouratiadou, I., Luderer, G., Baumstark, L., Brecha, R. J., Edenhofer, O., & Kriegler, E. 2013. Global fossil energy markets and climate change mitigation–an analysis with REMIND. *Climatic Change*, 1-14.

Bauer, N., Bosetti, V., Hamdi-Cherif, M., Kitous, A., McCollum, D., Méjean, A., et al. (2015). CO2 emission mitigation and fossil fuel markets: Dynamic and international aspects of climate policies. *Technological Forecasting and Social Change*, 90(PA), 243-256.

Böhringer, C., K.E. Rosendahl, Schneider, J., 2014. Unilateral Climate Policy: Can OPEC Resolve the Leakage Problem? *The Energy Journal* 35 (4), 79-100.

BP, 2014. *Statistical Review of World Energy*, June 2014. Available at: http://www.bp.com/statisticalreview [last accessed: October 20, 2014].

BP, 2015a. *BP Energy Outlook 2035*. February, 2015. Available at: http://www.bp.com/energyoutlook [last accessed: July 2, 2015].

BP, 2015b. *Statistical Review of World Energy*, June 2015. Available at: http://www.bp.com/statisticalreview [last accessed: June 22, 2015].

Brandt, A.R., Millard-Ball, A., Ganser, M., Gorelick, S.M. 2013. Peak Oil Demand: The Role of Fuel Efficiency and Alternative Fuels in a Global Oil Production Decline, *Environmental Science & Policy*, 47(14), 8031-8041.

Bridge, G. Wood, A. 2010. Less is More: Spectres of Scarcity and the Politics of Resource Access in the Upstream Sector, *Geoforum* 41: 565‑576.

Bridge, G., Le Billon, P. 2013. *Oil*. Cambridge, UK: Politiy Press.

Cairns, R.D., Calfucura, E., 2012. OPEC: Market Failure or Power Failure? *Energy Policy*, 50: 570-580.

Cairns, R.D., 2014. The Green Paradox of the Economics of Exhaustible Resources, *Energy Policy*, 65, 78-85.

Capalino, R., Spedding, P., Fulton, M., 2014. Oil Demand: Comparing Projections and Examining Risks. Carbon Tracker Initiative, May 8. Available at: http://www.carbontracker.org/wp-content/uploads/2014/05/Chapter1ETAdemandfinal.pdf [last accessed: August 4, 2015].

Cherp, A., Jewell, J., Vinichenko, V., Bauer, N., & De Cian, E. (2013). Global energy security under different climate policies, GDP growth rates and fossil resource

availabilities. *Climatic Change*. http://doi.org/10.1007/s10584-013-0950-x.
Citigroup, 2013. *Global Oil Demand Growth – The End is Nigh*. Citi Research, 26 March 2013.
Claes, D.H., 2001. *The Politics of Oil-Producer Cooperation*. Oxford: Westview Press.
Colgan, J.D. 2013a. *Petro-Aggression: When Oil Causes War*. Cambridge: Cambridge University Press.
Colgan, J.D. 2013b. Fueling the Fire: the Pathways from Oil to War. *International Security*, 38(2): 147-180.
Colgan, J.D. 2014. The Emperor Has No Clothes: The Limits of OPEC in the Global Oil Market, *International Organization*, 68/3: 599-632.
Depledge, J. 2009. Striving for No: Saudi Arabia in the Climate Change Regime, *Global Environmental Politics*, 8(4): 9-35.
Deutch, J., Schlesinger, J.R., Victor, D.G. 2006. *National Security Consequences of U.S. Oil Dependency*. Independent Task Force Report No. 58. New York: Council on Foreign Relations.
EIA, 2014. *Short-Term Energy Outlook*. Available at: http://www.eia.gov/forecasts/steo/ [last accessed: December 12, 2014].
ExxonMobil, 2015. *The Outlook for Energy: A View to 2040*. Available from: http://corporate.exxonmobil.com/en/energy/energy-outlook [last accessed: July 2, 2015].
Fang, S., Jaffe, A.M., Loch-Temzedelis, T., 2014. 'New Alignments? The Geopolitics of Gas and Oil Cartels and the Changing Middle East,' *Economics of Energy & Environmental Policy*, 3(1), 1-12.
Fattouh, B., El-Katiri, L. 2012. Energy Subsidies in the Arab World. Arab Human Development Report. Research Paper Series. UNDP.
Fattouh, B., Mahadeva, L. 2013. OPEC: What Difference Has It Made? *Annual Review of Resource Economics*, *5*(1), 427-443.
Gelb, A., 2010. Economic Diversification in Resource-Rich Countries. Paper presented at seminar on 'Natural Resources, Finance and Development: Confronting Old and New Challenges', Algiers, Algeria, November 4-5, 2010. Available at: http://www.imf.org/external/np/seminars/eng/2010/afrfin/pdf/Gelb2.pdf [last accessed: October 29, 2014].
Geman, Ben, 2009. 'The Other Peak Oil: Demand from Developed World Falling,' *Scientific American*, October 13.
Ghanem, S., Lounnas, R., Brennand, G. 1999. The impact of emissions trading on OPEC, *OPEC Review*, 23: 79-112.
Haber, S., Menaldo, V. A., 2011. 'Do Natural Resources Fuel Authoritarianism? A Reappraisal of the Resource Curse,' *American Political Science Review*, 105(1), 1-26.
Hamilton, J.D., 2014. The Changing Face of World Oil Markets. *IAEE Newsletter*, fourth quarter 2014, pp. 7-16.
Hotelling, H. 1931. The Economics of Exhaustible Resources, *Journal of Political Economy*, 39: 137-175.
IEA, 2012. *World Energy Outlook 2012*. Paris: IEA/OECD.

IEA, 2013a. *CO_2 Emissions from Fuel Combustion: Highlights 2013.* Paris: IEA/OECD.

IEA, 2013b. *World Energy Outlook 2013*. Paris: IEA/OECD.

IEA, 2014a. *Key World Energy Statistics 2014*. Paris: IEA/OECD.

IEA, 2014b. *Oil Market Report*, 11 September 2014, available at: http://www.iea.org/oilmarketreport/omrpublic/ [last accessed: October 27, 2014].

IEA, 2014c. *World Energy Outlook 2014.* Paris: IEA/OECD.

IEA, 2015. *Energy Technology Perspectives 2015 - Mobilising Innovation to Accelerate Climate Action*. Paris: IEA/OECD.

IHS CERA, 2009. Oil Demand from Developed Countries Has Peaked. Press Release, October 13. Available at: http://press.ihs.com/press-release/energy-power/oil-demand-developed-countries-has-peaked [last accessed: October 20, 2014].

IPCC, 2014. *Climate Change 2014: Mitigation of Climate Change*. Geneva: IPCC.

Jewell, J., Cherp, A., Riahi, K. 2014. Energy security under de-carbonization scenarios: An assessment framework and evaluation under different technology and policy choices, *Energy Policy* 65: 743-760.

Johansson, D.J.A., Azar, C., Lindgren, K., Persson, T.A., 2009. OPEC strategies and oil rent in a climate conscious world, *Energy Journal*, 30 (3), 23-50.

Karl, T.L., 2007. Ensuring Fairness: The Case for a Transparent Fiscal Social Contract. In: Humphreys, M., Sachs, J.D., and Stiglitz, J.E., *Escaping the Resource Curse*, Columbia University Press.

Klare, M.T. 2012. *The Race for What's Left: The Global Scramble for the World's Last Resources*. New York: Metropolitan Books.

Lederman, D., Maloney, W.F., 2007. Trade Structure and Growth. In: Lederman, D., Maloney, W.F., eds., *Natural Resources: Neither Curse nor Destiny*. Washington D.C.: Stanford University Press and the World Bank, 15-40.

Loulou, R., Labriet, M., Haurie, A., Kanudia, A. 2008. 'OPEC Oil Pricing Strategies in a Climate Regime: a Two-Level Optimization Approach in an Integrated Assessment,' Cahier du GERAD.

Martin, Pamela L. 2011. Global Governance from the Amazon: Leaving Oil Underground in Yasuní National Park, Ecuador, *Global Environmental Politics*, 11(4), 22-42.

McCollum, D., Bauer, N., Calvin, K., Kitous, A., Riahi, K. 2014. Fossil resource and energy security dynamics in conventional and carbon-constrained worlds, *Climatic Change* 123(3-4): 413-426.

McGlade, C., Ekins, P. 2014. Un-burnable oil: An examination of oil resource utilisation in a decarbonised energy system, *Energy Policy* 64: 102-112.

McGlade, C., Ekins, P. 2014. The geographical distribution of fossil fuels unused when limiting global warming to 2°C, *Nature* 517: 187-190.

McKibbin, W., Ross, T., Shackleton, R., Wilcoxen, P., 1999. Emissions trading, capital flows and the Kyoto Protocol. *The Energy Journal*, pp. 287–335.

OPEC, 2013. *World Oil Outlook 2013*. Vienna: OPEC Secretariat.

OPEC, 2014a. Who Gets What from Imported Oil? September 2014. Vienna: OPEC Secretariat.

OPEC, 2014b. *World Oil Outlook 2014*. Vienna: OPEC Secretariat.

Persson T.A, C. Azar, K. Lindgren, and Johansson, D.J.A. 2007. Major oil exporters may profit rather than lose, in a carbon constrained world. *Energy Policy* 35: 6346-6353.

Riahi, K., Dententener, F., Gielen, D., Grubler, A. Jewell, J., Klimot, Z., Krey,V., et al., 2012. Chapter 17 – Energy pathways for sustainable development, in Global Energy Assessment: Toward a More Sustainable Future. Cambridge University Press, Cambridge, UK and New York, NY, USA and the International Institute for Applied Systems Analysis, Laxenburg, 1203–1306.

Rühl, C., 2014. 'Over the hump for oil demand,' *Financial Times*, January 15, 2014.

Sachs, J.D., Warner, A.M., 2001. Natural Resources and Economic Development: The Curse of Natural Resources, *European Economic Review*, 45, 827–838.

Shell, 2013. *New Lens Scenarios: A Shift in Perspective for a World in Transition*. Available from: http://www.shell.com/global/future-energy/scenarios/new-lens-scenarios.html [last accessed: July 2, 2015].

Sinn, H.W. 2012. *The Green Paradox: A Supply-Side Approach to Global Warming*. Cambridge, MA: MIT Press.

Tavoni, M., Kriegler, E., Aboumaboub, T., Calvin, K. V., De Maeure, G., Jewell, J., et al. 2013. The distribution of the major economies' effort in the Durban platform scenarios. *Climate Change Economics*, 4(4). doi:10.1142/S2010007813400095.

van Vuuren, D.P., den Elzen, M.G.J., Berk, M.M., Lucas, P., Eickhout, B., Eerens, H., Oostenrijk, R., 2003. Regional costs and benefits of alternative post-Kyoto climate regimes: comparison of variants of the multi-stage and per capita convergence regime. Report 728001025, RIVM, Bilthoven, the Netherlands.

Verbruggen, A., Al Marchohi, M. 2010. Views on peak oil and its relation to climate change policy, *Energy Policy* 38: 5572-5581

Verbruggen, A., Van de Graaf, T. 2013. Peak oil supply or oil not for sale? *Futures* 53, 74-85.

Waisman, H., Rozenberg, J., Hourcade, J.C. 2013. Monetary compensations in climate policy through the lens of a general equilibrium assessment: The case of oil-exporting countries, *Energy Policy* 63: 951-961.

Wei, J., Hennlock, M., Johansson, D. J., & Sterner, T. (2012). The fossil endgame: strategic oil price discrimination and carbon taxation. *Journal of Environmental Economics and Policy*, 1(1), 48-69.

Wirl, F., 2012. Global warming: Prices versus quantities from a strategic point of view, *Journal of Environmental Economics and Management*, 64(2), 217-229.

Wittmann, N., 2013. OPEC: How to transition from black to green gold, *Energy Policy*, 62, 959-965.

World Bank, 2014. *World Development Indicators*. Available from: wdi.worldbank.org [last accessed: October 20, 2014].

World Bank, 2015. Zero Routine Flaring by 2030. Available from: http://www.worldbank.org/en/programs/zero-routine-flaring-by-2030 [last accessed: August 4, 2015].