Tel Aviv University

Fueling Conflicts: Oil and Geopolitical Tensions

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סדנת יובל נאמן למדע, טכנולוגיה וביטחון

הסדנה הוקמה בשנת 2002 ע"י פרופסור יצחק בן ישראל, בשיתוף עם בית הספר לממשל ולמדיניות ציבורית ע"ש הרולד הרטוך והתוכנית ללימודי ביטחון, באוניברסיטת תל אביב במטרה לעסוק בממשק שבין המדע והטכנולוגיה לביטחון. לשם כך, הסדנה מקיימת פעילות מחקרית וסדרה שנתית של כנסים. בין הנושאים בהם עוסקת הסדנה: יחסים בינלאומיים ואסטרטגיה, טילים ונשק מונחה, מדיניות וביטחון חלל, לוחמת מידע והמרחב הקיברנטי, רובוטים, אנרגיה גרעינית, ביטחון פנים, יחסי הגומלין בין חברה וביטחון, מדיניות בניין הכוח, תהליכי קבלת החלטות ועוד.

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Foreword

Oil is at the core of global geopolitical tensions and of economic downturns, which are likely to deteriorate with the expected depletion of oil resources. Oil and gas importing countries will be more and more dependent on undemocratic and politically unstable countries – unless they change their energy policies.

Dr. Navon, the author of this paper, argues that the most realistic and effective way of defusing geopolitical tensions over energy resources is to break the monopoly of oil by promoting the use of bio-fuels and electricity in transportation. This may have significant implications for the State of Israel because most of its adversaries are major exporters of oil.

Prof. Isaac Ben Israel

Head of Yuval Ne'eman Workshop for
Science, Technology and Security

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Introduction

The global competition over energy resources creates geopolitical tensions between the world's major powers. Russia leverages its oil and gas resources to assert its regional power and global clout. China has become a major energy player in Africa and in the Middle-East, shielding countries such as Iran and Sudan from strong UN sanctions. The geopolitical rivalries over energy resources between the United States and China have reached such levels that U.S. Senator Richard Lugar called for NATO to rephrase Article 5 of its Charter so as to define an energy embargo against a member state as an attack on the alliance.[1] Although NATO has not (yet) endorsed this proposal, it did add energy security to its mission in 2006.[2]

While the emergence of India and China has increased the demand for energy, oil and gas reserves are diminishing. The world's daily oil demand increased by 9.4 million barrels between 2000 and 2007, and nearly 85% of that growth came from emerging markets.[3] In recent years, oil and gas prices have risen to their highest level in history (from $17 for a barrel of oil in January 1999 to $147 in July 2008). The global energy demand will rise by 57% by 2030, and the combined energy demand of Asia will grow by 128% over that period.[4] Moreover, the remaining known oil and gas reserves are concentrated in the Persian Gulf, in Central Asia and in Russia. This means that oil and gas importing countries will be more and more dependent on undemocratic and politically unstable countries –unless they change their energy policies.

The oil crises of the 1970s prompted many countries to start developing nuclear and renewable energy sources as alternatives to fossil fuels. The discovery, in the 1980s, that fossil fuel combustion, by significantly increasing the amount of carbon dioxide in the atmosphere, contributes to the Earth's

[1] http://lugar.senate.gov/energy/press/speech/riga.cfm
[2] NATO's Riga Summit Declaration, November 289, 2006.
[3] Daniel Yergin, "It's Still the One," *Foreign Policy* (Sept.-Oct. 2009).
[4] Michael T. Klare, *Rising Powers, Shrinking Planet. The Geopolitics of Energy* (Henry Holt, 2009), p. 33.

"global warming" encouraged further research and investment in non-fossil energies. Today, reducing fossil fuel consumption is not only a matter of environmental concern, but also of national security and of international stability. Most of the world's oil reserves are held by countries that are generally unstable, corrupt, authoritarian and hostile to the West. Hence, the surge of oil prices in the past decade has enabled countries such as Saudi Arabia, Iran, Russia and Venezuela to defy U.S. foreign policy goals.

This paper argues that the most realistic and effective way of defusing geopolitical tensions over energy resources is to break the monopoly of oil over transportation. The paper's first section shows that the global competition over energy resources, especially oil, creates growing and potentially explosive geopolitical rivalries. The second section explains that the preponderance of oil in the global energy market has debilitating effects on the world economy and on international security, and that those negative effects are likely to worsen due to the depletion of oil reserves. The third section provides practical and realistic ways of reducing the world economy's dependence on oil. The article concludes that political will and international cooperation among oil-importing nations are critical to achieve energy security.

Energy and World Politics

Approximately 70% of conventional crude oil and about 65% of natural gas reserves are located in an area that spans from the Middle-East, via the Caspian region, to north-western Siberia. Europe's only source of oil production (in the North Sea) will be depleted by 2020 (the United Kingdom has once again become a net importer of petroleum products and of natural gas). Neither Russia nor the majority of the Gulf states are members of the World Trade Organization (WTO), which means that the mediation mechanism of the WTO would not be applicable to possible future conflicts between energy exporters and energy importers.

By the year 2030, the world's energy demand will be 57% higher than what it was in 2004. Since this demand will

still be met, mostly, by nonrenewable fossil fuels (87%), the supply of oil, coal, and natural gas will have to be correspondingly much larger than what it is today. The production of oil will have to rise by 42%, the production of natural gas by 65%, and the production of coal by 74%.[5] With many experts agreeing that worldwide oil production has reached a peak or is about to do so, a 42% increase is unrealistic.

In 2003, the Russian Government published an energy plan that openly admitted the policy goal of regaining control over energy distribution networks in neighboring countries.[6] The document states that Russia must assert its global clout via oil and gas sales. Venezuela offers subsidized oil and gas shipments to its neighbors in order to influence their foreign policy. The fact that Iran's foreign policy became openly confrontational vis-à-vis the United States in the mid-2000s is not unrelated to the rise of oil prices and revenues at the time.

Energy and world politics are closely intertwined. 75% of the world's proven oil reserves are controlled by government-owned companies.[7] National oil companies increasingly form strategic alliances with one another to serve the foreign policy objectives of their state owners. Two-thirds of the world's oil trade is transported by tankers, many of which go through strategically and politically sensitive routes such as the Strait of Hormuz (in the Persian Gulf), the Strait of Malacca (between Indonesia and Malaysia), and the Bosporus Strait (in Turkey).

In June 2006, Iran threatened that it would respond to an attack on its nuclear installations with the blocking of the Strait of Hormuz, which it the most critical strait for oil and liquid gas transportation (about 20% of the world's energy supply is exported via Hormuz). As for the Strait of Malacca, half of the world's oil trade passes through it, including the Middle East's oil exports to China and Japan. The Strait of Malacca is a 2.4 km wide bottleneck and constitutes an ideal target for terrorist attacks. The Bosporus Strait is also a critical

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[5] Ibid, p. 34.

[6] *Russia's Energy Strategy Until the Year 2020,* August 28, 2003 (http://ec.europa.eu/energy/russia/events/doc/2003_strategy_2020_en.pdf).

[7] Brenda Shaffer, *Energy Politics* (University of Pennsylvania Press, 2009), p. 7.

and sensitive route, especially for Russia's oil exports from its Black Sea ports.

Any major terrorist attack on energy infrastructures would have devastating effects. In February 2006, for example, a failed terrorist attack on Saudi Arabia's Abqaiq oil-processing tank caused a price increase of $2.5 per oil barrel. Al Qaeda has threatened many times to attack energy infrastructures in Saudi Arabia.

Energy competition can also fuel territorial conflicts. The Arctic Circle is case in point. In the past two decades, the Arctic's ice area has receded by about 10%. The cause is most likely climate change, but the result is a competition for newly accessible oil and gas resources. The five countries bordering the Arctic (Russia, the United States, Canada, Norway, and Denmark) dispute the formal limitations of the UN Convention on the Law of the Sea. The United States never ratified the convention, which is accused by the U.S. Congress of surrendering too much authority to the United Nations. In May 2007, Russia established a National Arctic Council (headed by the Prime Minister) "to defend Russia's interests in the world's polar regions." In August 2007, Russia dispatched two submarines to mark the sea floor with a Russian flag. The U.S. Coast Guard operates three polar icebreakers in the region, and Canada is operating a growing number of patrol ships.[8]

Another example is the oil and gas-rich Caspian Sea. Until the early 1990s, two countries used to border the Sea: The Soviet Union and Iran. Since the breakup of the Soviet Union, however, no less than five sovereign countries share access to the Caspian Sea: Russia, Kazakhstan, Turkmenistan, Iran, and Azerbaijan. The Caspian Sea's oil and gas resources make this shared access potentially explosive. So far, sovereignty delimitations have been agreed upon through bilateral agreements. The fuzzy legal status of the Caspian Sea is used by Russia to prevent the building of a gas pipeline through the Sea. The United States is promoting the construction of a Trans-Caspian pipeline (TCP) to transport gas from Turkmenistan and Kazakhstan to Azerbaijan. Such a pipeline could be connected to the South Caucasus one, and thus

[8] Shaffer, *Energy Politics*, p. 80.

provide an alternative gas route to Europe. Russia opposes this project (which would undermine its control over gas supplies to Europe) and tries to block it via legal claims based on the sovereignty disputes over the Caspian Sea. The geopolitical contest over the Caspian basin has become a triangle power struggle between the United States, Russia and China. As explained by Michael Klare: "No less than the Americans and the Russians, the Chinese have endeavored to protect their energy investments in the region by establishing military ties with local powers."[9] Indeed, the energy competition over the Persian Gulf, the Caspian Sea Basin and the Western Pacific has generated the emergence of de facto rival military alliances between the United States and Japan on the one hand and Russia and China on the other hand.

Russia and the West

Russia is the world's largest energy exporter. It holds the world's largest reserves of natural gas, second largest reserves of coal, and seventh largest reserves of oil. Russia is also a major producer and exporter of nuclear energy. It borders China and the EU, two major energy importers. Because it has limited sea access, Russia relies on pipelines for its natural gas exports. Those pipelines go through transit states, many of which used to be satellites of the Soviet Union and are now NATO and/or EU members. As for Russia's oil exports, most of them go through Turkey's Bosporus Strait (itself a NATO member). On the one hand, Russia purchases energy infrastructures in neighboring countries, but on the other hand it does not allow foreign companies to buy energy infrastructures in Russia (which explains why Russia has not signed the EU's Energy Charter).

In January 2006, Russia's state monopoly Gazprom interrupted gas supplies to Ukraine.[10] The official reason was that Ukraine refused to pay the sudden price increase imposed by Russia, but in reality Russia was blackmailing Ukraine into abandoning its bid to join NATO. U.S. Vice-President Dick

[9] Klare, *Rising Powers*, p. 137.
[10] Russian President Dmitry Medvedev is the former chairman of Gazprom.

Cheney denounced Russia's use of gas and oil supplies as "tools of intimidation or blackmail."[11] Gas supplies to Georgia were also interrupted, and the Georgian government accused Russia of sabotaging gas pipelines as a way of meddling in the dispute with the separatist republic of Southern Ossetia (in August 2008, Russia intervened militarily to secure Southern Ossetia's secession from the pro-Western Georgian Republic). As Argued by Daniel Freifeld, "If there were still any doubt about how far Russia would go to fight for its interests in the Caucasus, Azerbaijan need only look at Georgia… By attacking its small neighbor, Russia effectively warned not only Georgia but the whole neighborhood."[12] Russia's strategy vis-à-vis Ukraine eventually "convinced" the latter to abandon the very idea of joining NATO: In April 2010, Ukraine's parliament ratified an agreement with Russia to keep the Russian Black Sea fleet in Sebastopol in exchange for the long-term delivery of cheaper Russian gas.[13] This agreement removed any chance of Ukraine joining NATO.

The 1994 European Energy Charter forbids the deliberate interruption of energy transport, but Russia never ratified it. As argued by Sacha Müller-Kraenner, "The new great power politics of Russia focuses on the power of Gazprom, not on the weapons of the Red Army"[14] and "Today, Russia has hardly any neighbor that it has not threatened with energy depravation as a weapon in the event of any political insubordination."[15] Russia's use of energy to reassert its economic strength and international clout has undoubtedly paid off.

The main oil and gas pipelines that spread into Europe and Asia originate in Russia; they are controlled by the state

[11] Speech in Vilnius, Lithuania, May 4, 2006 (http://www.nytimes.com/2006/05/04/world/europe/04cnd-cheney-text.html).
[12] Daniel Freifeld, "The Great Pipeline Opera," *Foreign Policy* (Sept.-Oct. 2009).
[13] "A normal day's debate in Kiev," *The Economist* (May 1, 2010).
[14] Sascha Müller-Kraenner, *Energy Security* (Earthscan, 2007), p. 35.
[15] Ibid, p. 54.

monopolies Gazprom (for natural gas) and Transneft (for oil).[16] Europe purchases most of its natural gas from Russia, and is therefore trying to diversify its gas imports in order to reduce its dependency on Russia.[17] Meanwhile, European countries tend to act separately in order to guarantee their own secure gas deliveries from Russia. Hence is former German Chancellor Gerhard Schröder the chairman of the consortium in charge of building the Baltic Sea pipeline (the "Nord Stream Pipeline") between Russia and Germany. The fact that a former German Chancellor is on the Kremlin's energy payroll is highly symbolic and disturbing to many, given the fact that Russia supplies about a third of the EU's gas and that Europe's gas consumption is expected to be 40% higher by 2030.

Although Mr. Schröder claims that the Nord Stream pipeline will make Europe safer, a study by Sweden's Defense Research Agency argues that it will actually divide the EU and increase dependence on Russia.[18] Poland's Foreign Minister went as far as to compare the North European Pipeline to the Molotov-Ribbentrop Pact. Rather than working together, European countries are striking bilateral deals with Russia. Many European state-owned or state-controlled energy companies have signed separate contracts with Gazprom: DONG (Denmark) in June 2006, ENI (Italy) in November 2006, and Gaz de France in December 2006.

While using the "divide and rule" method between EU members, Russia is also trying to play Europe against China. If Russia were to build new gas pipelines towards the east, China and Europe would end up competing for Russia's gas, which would put Moscow in a strong bargaining position. A Gazprom communiqué from April 2006 outlined this possibility in unveiled terms: "We want European countries to understand that we have other alternatives in terms of gas sales. We have a fast growing Chinese market."[19] Russia tries to play the

[16] The monopolistic and state-controlled nature of Russia's energy market constitutes an obstacle to Russia's membership in the World Trade Organization (WTO).

[17] The first major Soviet natural gas pipeline to Western Europe was built in 1973.

[18] "A Bear at the Throat," *The Economist*, April 12, 2007.

[19] "Gazprom Threat to Supplies," *Financial Times*, April 20, 2006.

European and Chinese markets against each other in order to maintain high prices for its natural gas supplies.

Russia is also trying to undermine the trans-European Energy Networks (the European Commission's alphabet-soup code for energy independence from Russia). The European-sponsored Nabucco pipeline, a project signed in July 2009 between Turkey, Romania, Bulgaria, Hungary and Austria, is meant to diversify the current natural gas suppliers and delivery routes for Europe and thus to reduce Europe's dependence on Russian energy. The project is backed by the European Union and by the United States. Gazprom is trying to undermine the Nabucco pipeline by building the South Stream pipeline, which will link Bulgaria to Austria, via Serbia and Hungary. Former German Foreign Minister Joschka Fischer was appointed senior advisor to the Nabucco project in 2009, thus competing with his former boss Gerhard Schröder (who heads the rival "Nord Stream" pipeline), whose pro-Russian policies he strongly criticized. As opposed to Schröder, Fischer is a vocal opponent of what he calls "Moscow's divide-and-conquer politics."

The fact that Gerhard Schröder and Joschka Fischer respectively head two competing natural gas projects is in itself an expression of two different visions for Europe's energy strategy. While the former communist countries of Central and Eastern Europe are eager to limit their dependence on Moscow, some Western European countries see in Europe's privileged ties with Russia both a geopolitical imperative and an economic boon.

Russia is promoting the completion of the "Nord Stream" pipeline, which will link Russia to Germany along the Baltic seabed, bypassing transit countries such as Ukraine and Poland. Gazprom cannot afford to build this pipeline alone, however, and therefore needs European investments. One the one hand, Germany wants to limit its reliance on Russian gas. On the other hand, Germany needs a reliable, long-term supply. Therefore, Germany will likely simultaneously proceed with the building of the pipeline (with EU money) and insist on the construction of the Nabucco pipeline, which will allow gas from Kurdistan (in Iraq), Azerbaijan and other sources to reach Europe directly. Ultimately, as Daniel Freifeld argues, "the real question that will determine Nabucco's future… is whether

Europe has the stomach to fight as hard for its interests as Russia does for its own."[20]

In addition, Russia is trying to limit Iran's gas exports to Europe, not through economic sanctions but by redirecting those exports toward Asia. Russia does not wish to "share" the European gas market with Iran, which holds the world's second largest natural gas reserves. In order to prevent Iran's access to the European gas market, Russia purchases (via Gazprom) pipelines that could be used by Iran to deliver gas to Europe. In April 2006, for example, Gazprom bought a pipeline linking Iran to Armenia. In June 2006, Russia announced that it would support the construction of a new gas pipeline from Iran to China, via Pakistan. The proposed pipeline would merge the Russian and Iranian pipeline networks –something that would run against U.S. efforts to isolate Iran politically and economically.

As for the United States, it hardly imports any oil and gas from Russia but it tries to limit Russia's leverage over its neighbors by promoting alternative pipeline routes. With the demise of the Soviet Union, the U.S. Government encouraged investments of American oil companies in the newly independent republics of the Caspian Sea in order to reduce U.S. dependence on Middle Eastern oil. In addition, the United States actively supports the efforts of Central Asian countries to export their natural gas and oil resources without using Moscow's dominant grid. For example, the U.S. government has been involved in building the Baku Tbilisi Ceyhan (BTC) pipeline (inaugurated in May 2005), which transports oil from the Caspian region via Tbilisi in Georgia to the Turkish harbor of Ceyhan in the Mediterranean Sea. The BTC pipeline bypasses both Russia and Iran. Initiated by the United States (and funded mostly by European companies such as British Petroleum), the BTC pipeline undermines Russia's energy domination in the Caucasus. Russia fought back in 2006 by taking over, via Gazprom, the Armenian section of a new gas pipeline into Iran, as well as the largest thermal power plant in Armenia.

[20] Freifeld, "The Great Pipeline Opera."

It sometimes seems that the U.S. is more concerned than the EU itself about Europe's dependency on Russian gas. Indeed, the U.S. started promoting the trans-Caspian pipeline (meant to transport natural gas from Central Asia to Europe) before the EU.

Russia's accessible energy reserves are certainly impressive. Russia holds the world's largest gas and coal reserves, and its seventh largest oil reserve. In terms of oil resources (i.e. potentially exploitable reserves), Russia's are the second largest in the world. Russia produces as much oil annually as Saudi Arabia (in 2005, Russia overtook Saudi Arabia's oil production), even though Saudi Arabia has larger reserves. However, unless Russia invests in new oil and gas fields, it will not maintain its current production levels for long. While Russia needs foreign investments to maintain its oil and gas production levels, it is also unwilling to dilute the government's majority stake in Gazprom and Transneft. Since Russia never ratified the European Energy Charter, European investors in the Russian energy industry are not protected from hostile takeovers by the Russian government. Gazprom cannot alone afford the cost of increasing Russia's energy production because the company is not profitable enough (Government regulation entails Gazprom to sell to the domestic market at low prices). This is why the Yamal Peninsula project will provide Russia with additional oil and gas reserves only thanks to foreign investments. In a way, the use of Gazprom by the Russian government contains the seeds of its own destruction, and only high oil and gas prices have enabled Russia to push off the strategic decision it will eventually have to make.

The United States and China

In recent years, the United States has been competing with China over the planet's last oil reserves. China is the world's second largest energy consumer after the United States. China buys oil from countries that are antagonistic to the United States (such as Iran and Venezuela), as well as countries that has blacklisted by the United States for their human rights violations (such as Sudan). The United States and China are

competing over Kazakhstan's oil (Kazakhstan has the Caspian Sea region's largest recoverable crude oil reserves). Kazakhstan exports oil and gas both to the West (via the Caspian Pipeline Consortium since 2003) and to China (via the Atasu-Dushanzi pipeline since 2006). Both the United States and China are trying to tap into the energy resources of the Caspian Sea basin. The United States championed the construction of the Baku-Tbilisi-Ceyhan (BTC) pipeline that delivers oil from the Caspian to the Mediterranean. The Chinese Government, for its part, is sponsoring the construction of a pipeline that would deliver Caspian oil directly to China. Tellingly, a representative of the U.S.-China Economic and Security Review Commission (a Congress-chartered body) declared that "China's energy strategy in general is a concern for U.S. energy security because of the Chinese government's interest in controlling oil and other natural resource production at the source, rather than making investments to ensure that there is greater supply on the world market."[21]

China's oil consumption increased from 1.7 million barrels a day in 1980 to 7.4 million barrels a day in 2006.[22] In 1993, China ceased to be an oil exporter and became an oil importer. In 2003, China became the world's second largest oil importer after the United States. According to the International Energy Agency (IEA)'s 2009 *World Energy Outlook Fact Sheet*, China will overtake the U.S. after 2025 to become the world's largest spender of oil and gas imports.[23] The Chinese government has set up three large oil companies that are among the world's largest: China National Petroleum Corporation (CNPC), SINOPEC, and China National Offshore Oil Company (CNOOC). Since 2002, China's state-owned oil companies have been active in oil-exploration and production in Africa. CNPC is the world's leading oil production company in Sudan, and it is active in other African countries such as Nigeria, Algeria, and Chad. As explained by Mikkal Herberg,

[21] Klare, *Rising Powers*, p. 172.
[22] Ibid., pp. 63-64.
[23] http://www.worldenergyoutlook.org/docs/weo2009/fact_sheets_WEO_2009.pdf, p. 1.

"For China's leaders, energy security is too important to be left to the markets, and so far its approach has been decidedly neo-mercantilist and competitive."[24] In June 2005, for instance, CNOOC announced an $18.5 billion bid to buy Unocal, an American energy firm with large oil and gas reserves in North American and in Asia (the bid was blocked by the U.S. Congress).

The Chinese Government has been developing close ties with oil-exporting African countries, investing heavily in Africa and securing long-term concessions on African oil fields. As a result, China's economic clout in Africa is increasingly competing with America's. U.S. oil firms are attracted to West Africa's offshore production sites. Tanker routes linking West Africa to the United States pass through the Atlantic Ocean (which is dominated by the U.S. Navy) and avoid the congested choke points of the Straits of Hormuz and of the Bosporus.

China is the world's most influential and economically involved country in oil-rich Angola (in 2006, Angola became China's first oil supplier). The Sino-African summit held in Beijing in November 2006 (with 41 African heads of state) symbolized China's predominant role in Africa. Nearly one third of China's oil imports come from Africa (mostly from Sudan, Angola, DRC, and Nigeria). China has also become Sudan's main supplier of weapons, mostly to enable the Khartoum government to defeat the rebellion of Soudan's oil-rich south. The Khartoum government would not have been able to kill 200,000 people and displace 2.5 million in Darfur in the past five years without the diplomatic protection of China at the UN Security Council.

China's heavy investments in and cheap loans to Africa, make the IMF and the World Bank unattractive if not irrelevant in a continent where those two Washington-based institutions used to be the major finance providers. Indeed, African countries are more attracted by Chinese loans because China (as opposed to the IMF and the World Bank) does not demand institutional reforms involving economic and political liberalization.

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[24] Klare, *Rising Powers*, p. 24.

China's energy policy is likely to eventually clash with the U.S. military presence in East Asia. The Strait of Hormuz and the Strait of Malacca are altogether strategic energy waterways and sensitive geopolitical spots –both of them guarded by the U.S. navy. The Strait of Hormuz is crossed both by Iranian oil tankers and by American submarines. The U.S. Navy controls the sea routes in the Pacific and in the Indian Ocean, and thus the shipping and tanker routes that are vital to China's energy imports and exports. Over half of China's oil supplies transit via the Strait of Malacca, and one wonders how long China will accept America's dominant maritime role there.

U.S. and Chinese energy interests are also clashing over Iran. China has been stalling U.S. efforts to impose strong UN sanctions on Iran, mostly because such sanctions would affect China's economic interests.[25] In October 2004, for instance, SINOPEC signed a $100 billion deal with the National Iranian Oil Company (NIOC) to acquire a controlling stake in the Yadavaran oil field, whose production is expected to reach 300,000 barrels per day in the second decade of the twenty-first century.

Oil and the World Economy

The World's addiction to oil is a man-made tragedy. In 1912, Winston Churchill (then First Lord of the Admiralty) ordered the warships of the Royal Navy to switch from coal to oil. Churchill's purpose was to gain an advantage over Germany. Britain had both discovered large oil reserves in Persia and succeeded in sabotaging the German oil supply from Romania. During World War I, most armies followed the British example and switched to oil as well. Since then, oil has both been the cause of major conflicts and a tool to settle geopolitical rivalries.

[25] The sanctions imposed by the UN in June 2010 are hardly "strong" ones. Even *The Economist*, itself a supporter of these sanctions, admitted that "searching ships and bouncing a few cheques is not about to get Iran to change its behavior, let alone to open its nuclear programme to inspection" ("A Step away from the bomb," *The Economist*, June 12, 2010).

During World War II, Germany attacked the Soviet Union partly to control the Caucasus oilfields. The Anglo-American sea blockade, by cutting off the German economy from vital oil imports, was critical in achieving victory. The Japanese government similarly invaded the Dutch East Indies in 1941 because of this territory's oil reserves. After the Yom Kippur War (1973), the Arab members of OPEC used the oil blackmail to build up an international momentum against Israel. Because of its dependency on Middle-Eastern oil, the United States backed the authoritarian regime of the Shah in Iran, and has been a strong ally of the Saudi theocracy for nearly eight decades.

U.S. oil security is one of the reasons why America fought the first and second Gulf Wars (in 1991 and in 2003). Oil dependency also creates a heavy military burden for the United States. It is because of oil that America needs to protect the "oil states" (hence, as mentioned before, the 1991 Gulf War and the 2003 Iraq War), to guard the "oil routes" with the U.S. Navy (The Straits of Hormuz, of Malacca, and of the Bosporus), and to fight radical Islam (Afghanistan, Pakistan). Until the withdrawal of American troops from Iraq in August 2010, U.S. military forces consumed about 2 million gallons of fuel a day in Afghanistan and Iraq.[26]

Oil and the "Resource Curse"

Oil exemplifies what economists call the "resource curse" or the "Dutch disease."[27] As shown by the research of Paul Collier and Anke Hoeffler, countries that derive a significant

[26] "Greenery on the March," *The Economist*, December 10, 2009.

[27] The "Dutch disease" refers to the process of deindustrialization that can result from a sudden natural resource windfall. In the 1960s, the Netherlands discovered substantial deposits of natural gas. Thanks to the new income from natural gas export, the value of the Dutch currency rose, making manufactured exports uncompetitive and imports cheap. This phenomenon leads to the decline of the domestic industrial sector, a phenomenon also known as "deindustrialization."

percentage of their national income from natural resources are more likely to be engaged in civil war.[28]

In many countries, oil deepens poverty, encourages conflicts and corruption, and stalls democracy. In his article "Does Oil Hinder Democracy?" Michael Ross argues that the absence of democracy in oil-exporting countries is the combined result of three factors:

a. Oil governments use patronage to prevent democratization;
b. Oil governments use their revenues to fund a repressive, police state;
c. Oil governments prevent economic diversification and thus the emergence of a middle class required for regime change and democracy.[29]

Oil revenues, for instance, enable the Islamic regime of Iran to remain in power despite the economy's poor performance and despite the lack of political freedom. It is because of its dependency on Saudi oil that the United States does not pressure Saudi Arabia to meet basic human rights standards.

Thomas Friedman has pointed out the fact that "The price of oil and the pace of freedom always move in opposite directions in oil-rich petrolist states."[30] Indeed, the only Arab oil-rich country that has held free elections and liberalized its political system is, incidentally, the first Arab state that is expected to run out of oil: Bahrain. According to Friedman, because of a "counter-wave of petro-authoritarianism, made possible by $60-a-barrel oil… regimes such as those in Iran, Nigeria, Russia, and Venezuela are retreating from what once seemed like an unstoppable process of democratization, with elected autocrats in each country using their sudden oil windfalls to ensconce themselves in power, buy up opponents

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[28] Paul Collier and Anke Hoeffler, "Greed and Grievance in Civil War," *Oxford Economic Papers* No. 56 (2004), pp. 563-595.

[29] Michael Ross, "Does Oil Hinder Democracy?" *World Politics* Vol. 53, No. 3 (2001), pp. 325-361.

[30] Thomas Friedman, "The First Law of Petropolitics." *Foreign Policy*, 25 April 2006. Friedman defines "petrolist" states as "states that are both dependent on oil production for the bulk of their exports or gross domestic product and have weak state institutions or outright authoritarian governments" such as Azerbaijan, Angola, Chad, Egypt, Equatorial Guinea, Iran, Kazakhstan, Nigeria, Russia, Saudi Arabia, Sudan, Uzbekistan, and Venezuela.

and supporters, and extend their state's chokehold into the private sector."[31] Oil creates "rentier economies" where the government buys political support with oil revenues instead of earning it through elections. Oil states create huge bureaucracies that employ docile citizens and deprive political opponents from economic opportunities. Gal Luft and Ann Korin note that "In authoritarian countries highly dependent on oil and gas for their income, such as Myanmar, Sudan, Azerbaijan, Uzbekistan, Kazakhstan, Angola, Nigeria, Chad and Russia, freedom has been in retreat since oil prices began their climb."[32]

Nigeria is a good, and sad, example. Nigeria is Africa's most populous country (160 million people) and the world's eighth-largest oil exporter. It has earned about $223 billion in revenues between 1999 and 2007, yet most Nigerians continue to be poor and Nigeria ranks 159th out of 177 on the UN's human-development index.[33] Oil accounts for 90% of Nigeria's exports and 80% of the government's revenues. The country has failed to promote education, the rule of law, innovation and entrepreneurship. The economy is not diversified. In the public's psyche, wealth is not the product of innovation and hard work, but only a matter of getting closer to the oil tap. Despite billions of petrodollars flowing in since the 1970s, Nigerians are considerably worse off today than they were in 1980. About 70% of Nigerians live on the equivalent of less than $1 a day, and a U.S. intelligence report from 2005 speculated that Nigeria might be on its way of becoming a failed state.[34]

In a globalized world economy, the "energy curse" affects everyone. As explained by Mahmoud El-Gamal and Amy Myers Jaffe: "Today, the Middle East's resource curse is spilling over into the international financial system."[35] During boom times, the increase in oil demand generates high profits

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[31] Friedman, "The First Law of Petropolitics."
[32] Gal Luft & Anne Korin, *Turning Oil into Salt. Energy Dependence through Fuel Choice* (Booksurge, 2009), p. 20.
[33] "Mission Impossible, Nearly," *The Economist*, August 2, 2007.
[34] "Hints of a New Chapter," *The Economist*, November 12, 2009.
[35] Mahmoud El-Gamal and Amy Myers Jaffe, "Subpriming the Pump." *Foreign Policy*, September-October 2009.

for oil producers. As oil prices continue to rise, oil producers accumulate enormous amounts of capital that is invested overseas, inflating financial markets and creating investment bubbles that eventually burst. After investment bubbles burst, demand for oil (and, subsequently, oil prices) decrease, and overseas petrodollars investments dry up thus affecting economic growth worldwide.

With the exception of Malaysia's Petronas and Norway's Statoil, government-run oil companies are generally corrupt and inefficient. The citizens of oil-rich countries rarely benefit from oil revenues. Despite the hundreds of billions of dollars earned by Venezuela from oil, ordinary Venezuelans are poorer than they were 30 years ago. As Jeffrey Sachs and Andrew Warner demonstrate in their empirical study of 97 seven countries over a twenty-year period (1971-1989), countries that are rich in natural resources grow at a slower pace than countries that have no or little natural resources.[36]

China's dependency on Iranian and Sudanese oil shelters those regimes from UN sanctions. Hence is Teheran able to develop nuclear weapons and Khartoum to perpetuate its genocidal policies in Darfur and in Southern Sudan. Oil revenues enabled Vladimir Putin to turn Russia into an authoritarian state and Hugo Chavez to make Venezuela an autocracy. Every major economic downturn in the past forty years was preceded by a rise in oil prices.

Oil is also a major polluter. 44% of U.S. carbon dioxide emissions come from oil and the average American car releases 1.5 tons of carbon dioxide into the air every year.[37] Oil burning is a major cause of global warming: 40% of fossil fuel carbon dioxide emissions worldwide come from oil. According to the Intergovernmental Panel on Climate Change (IPCC), global climate warming is "unequivocal" and temperature increases will be greater in the 21st century than what they were in the 20th century.[38]

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[36] Jeffrey Sachs and Andrew Warner, "Natural Resource Abundance and Economic Growth," *NBER Working Paper* No. 5398 (Cambridge, Massachusetts: National Bureau of Economic Research, 1995).
[37] David Sandalow, *Freedom from Oil* (Mc Graw Hill, 2008), p.17.
[38] Sandalow, *Freedom from Oil*, p. 29.

The Prospects of Oil Depletion

According to the International Energy Agency (IEA)'s Report *World Energy Outlook 2005*, "If governments stick with current policies … the world's energy needs would be 50% higher in 2030 than today. Over 60% of that increase would be in the form of oil and natural gas."[39] While the IEA report estimates that existing fossil fuel resources shall be able to meet global demand in 2030, it also points out a growing (indeed, worrying) asymmetry between a small number of exporting countries and a large number of importing ones, as well as to increasing emissions of greenhouse gases due to continued fuel combustion.

Besides the growing feeling of "energy insecurity" and the environmental damages caused by fuel consumption, is the world about to exhaust its crude oil reserves? Since the early 1980s, worldwide oil extraction is higher than worldwide oil reserve discoveries. Between 1960 and 1989, the world discovered more than twice the amount of oil it produced. Between 1990 and 2006, worldwide oil discoveries were about half of oil production. As argued by Ferdinand Banks, "the aggregate amount of oil discovered is on a falling trend."[40] About 365 billion barrels of oil were discovered in the 1960s, as opposed to 275 billion in the 1970s, 150 billion in the 1980s, and 40 billion in the 1990s.[41] Nearly 80% of the world's global oil output comes from oil fields that were discovered over twenty-five years ago, and the output of these fields is declining.[42]

It might be argued that long periods of relatively low oil prices have discouraged oil exploration; yet the explorations and discoveries made when oil prices were high are not significant. Restricting the increase in global temperature to 2°C would require a decline in global demand for oil from

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[39] *World Energy Outlook 2005 – Middle East and North Africa Insights.* International Energy Agency (2005), p. 43.
[40] Ferdinand E. Banks, *The Political Economy of World Energy* (World Scientific Publishing, 2007), p. 36.
[41] Banks, *The Political Economy of World Energy*, p. 36.
[42] Ibid., p. 108.

today's 105 million barrels per day to 89 million barrels per day in 2030.[43]

According to the IEA's chief economist, "the output of conventional oil will peak in 2020 if oil demand grows on a business-as-usual basis" and if no major oil reserve discoveries are made in the near future.[44] This recent statement is significant, because it indicates that the IEA has joined the "pessimistic" side of the "peak oil" debate. In that debate, pessimists (such as the Association for the Study of Peak Oil and Gas, founded by Prof. Kjell Aleklett from the University of Uppsala, Sweden) argue that global oil supply has peaked or is about to peak and that, given consistent projections of increasing worldwide demand, the world economy is heading toward disaster. In his book *Twilight in the Desert,* oil expert Matthew Simmons argues that production from Saudi Arabia (especially from Ghawar, the world's largest oil field) has reached a peak.[45] Other leading "petro-pessimists" are Colin Campbell and Jean Laherrère, who predicted in 1998 that the oil peak would happen in 2007.[46]

Optimists (such as Cambridge Energy Research Associates, an energy research firm based in Boston), on the other hand, believe that higher oil prices will enable oil firms to afford the exploration of new oil fields, as well as new technologies that will increase the amount of oil extracted from existing fields. The Island of Sakhalin, for example, could provide new oil resources. Russia, together with international energy companies, is actively exploring oil and gas resources there. However, even though an estimated 45 billion barrels of oil equivalent lie beneath the icy seas off the shores of Sakhalin, developing those resources is proving both challenging and costly.[47]

The fact that the IEA is pessimistic about future oil supplies seems to be the result of a study the agency conducted

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[43] "2020 Vision," *The Economist*, December 10, 2009.
[44] Ibid.
[45] Matthew Simmons, *Twilight in the Desert: The Coming Saudi Oil Shock and the World Economy* (Wiley, 2005).
[46] Colin Campbell and Jean Laherrère, "The End of Cheap Oil", *Scientific American* (March 1998), pp. 80-85.
[47] "Sakhalin Island: Journey to Extreme Oil," *Business Week*, May 15, 2006.

recently. It analyzed the production trends of 800 oil fields in 2008, and concluded that the decline in annual output from many of these fields could average 8.6% in 2030.[48] In such a context, even if oil demand were to remain flat (an unlikely scenario), the world would need to find over 40 million barrels per day of gross capacity only to offset the decline predicted by the IEA.

Today, oil is a depleting asset. Oil companies lose assets if they don't invest to increase their production capacities and to find new fields. According to the IEA, "converting the world's resources into available supplies will require massive investments… Meeting projected demand will entail cumulative investment of some $16 trillion from 2003 to 2030, or $568 billion per year."[49] Most of that money will not go to increase global supply, but merely to replace output from today's ageing oil fields. In other words, large oil companies (and oil exporting countries) are threatened by a rundown of reserves.

According to Matthew Simmons, the "Peak oil debate" boils down to an argument about timing. Optimists believe that technology will advance quickly enough to offset declining production from large oil fields. Pessimists, by contrast, think the decline will come too soon and that it will be too sharp for the world economy to adapt in time.

If and when the oil peak does occur, one immediate consequence will be a sharp increase in oil prices (since demand will exceed supply). Most countries will not be able to afford oil, and they will experience what Sascha Müller-Kraenner calls "energy poverty."[50] Yet even reach countries are starting to show concern about their reliance on oil: they, too, would be badly affected by the economic consequences on an "oil peak," and they no longer wish to be held hostages by unfriendly, or even hostile, regimes.

Regardless of the real prospects of oil depletion, the oil age might end long before the world runs out of oil. After all, the Stone Age did not end for lack of stone.

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[48] Ibid.
[49] *World Energy Outlook 2004*, International Energy Agency, p. 30.
[50] Müller-Kraenner, *Energy Security*, p. 4.

Weaning the World from Oil

The internal-combustion engine will never be able to overcome the problem of carbon emissions, which are an unavoidable side-effect of burning petrol. The growing popular pressure for governments to tackle global warming poses a serious challenge to the oil industry. However, an even more powerful reason for governments to promote alternatives to oil stems from geopolitics. The oil market has become increasingly volatile. According to most forecasts, the Persian Gulf's share of the oil trade will grow inexorably over the next two decades. As a result, any major terrorist attack, embargo or economic shock could have catastrophic economic consequences on a global scale.

The United States is especially sensitive to the question of oil dependency. During the invasion of Iraq in 2003, U.S. troops often outran their fuel supplies. In July 2006, General Richard Zilmer (the marine general then in charge of U.S. forces stationed in Iraq) asked the Pentagon for solar panels and wind turbines to reduce his troops' dependency on gasoline. In 2008 alone, the Pentagon spent $20 billion on fuel.[51] Former U.S. Secretary of Defense and former Secretary of Energy James Schlesinger has warned that the U.S. army might soon be unable "to obtain the supply of oil products necessary for maintaining our military preponderance."[52]

Former U.S. President George W. Bush called upon America, in his 2006 State of the Union speech, to wean itself from oil. He declared that "our addiction to oil must end" and called for reducing U.S. oil imports from the Middle East by 75% by 2025. During his presidential election campaign, Barack Obama released the "New Energy for America Plan" (NEAP), which called among other things for eliminating U.S. oil imports from Venezuela and the Middle East within ten years. In his first address as President, Obama declared that "America's dependence on oil is one of the most serious threats that our nation has faced. It bankrolls dictators, pays for nuclear proliferation, and funds both sides of our struggle

[51] "Greenery on the March," *The Economist*, December 10, 2009.
[52] Klare, *Rising Powers*, p. 27.

against terrorism. It puts the American people at the mercy of shifting gas prices, stifles innovation and sets back our ability to compete."[53] President Obama's plan for America is that 10% of electricity be generated from renewable sources (e.g. wind, solar, hydroelectric, and solar) by 2012 and 25% by 2025.

The United States will not be able to achieve energy independence without weaning itself from oil, for a simple reason: It consumes a quarter of the world's oil but owns less than 3% of the world's proven reserves. The United States is more dependent on oil imports today than it was forty years ago because of a declining domestic production. In 1973, the U.S. imported 35% of its oil consumption, as opposed to 60% in 2007.[54] Among the United States' main oil providers are Saudi Arabia and Venezuela.

The United States will not reduce its dependence on foreign oil by "drilling more" (as suggested by Republicans) or by "using less" (as suggested by Democrats). As Thomas Friedman accurately put it "An America that is focused first and foremost on drilling for oil is an America more focused on feeding its oil habit than kicking it."[55] As for energy efficiency, it will not solve the oil-dependence problem either: gasoline-efficient cars use less oil, but they use oil nonetheless. In 2008, the U.S. demand for oil dropped by nearly 10% under the combined effect of sharp increases in oil prices and of the economic slowdown. The economic crisis produced what energy efficiency is supposed to achieve, i.e. lowering oil consumption. OPEC reacted to this decrease in oil demand by reducing production in order to prevent a further drop in oil prices. Legislation and taxation can be useful to improve energy efficiency.[56] However, as long as oil monopolizes

[53] http://www.whitehouse.gov/blog_post/Fromperiltoprogress/

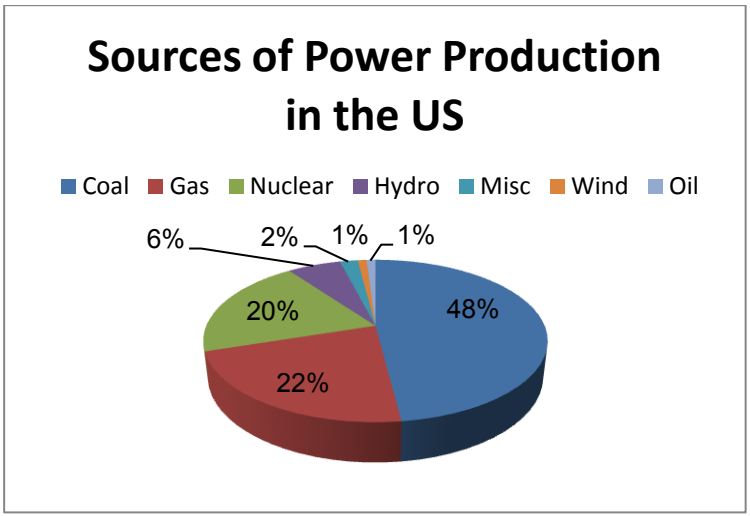
[54] Shaffer, *Energy Politics*, p. 137.

[55] Thomas Friedman, "Making America Stupid," *New York Times*, September 13, 2008.

[56] After the oil shock of 1973, the US Congress passed the Corporate Average Fuel Economy (CAFE) law. Between 1978 and 1987, the CAFE law improved the fuel efficiency of new American-made cars to such an extent that the volume of US net oil imports fell by nearly 50% while the economy grew by nearly 25%. CAFE standards have helped reduce US vulnerability to oil price fluctuations. US consumption of oil went down from 1.46 barrels of oil for every $1,000 of GDP in 1973 to 0.66 in 2006. It partly thanks to

transportation and as long as OPEC controls oil offer, reducing oil consumption will make little difference.

The United States' dependence on oil is not related to power generation. Indeed, between 1 and 2% of the electricity used in the United States is produced from oil (see chart: "Sources of Power Production in the U.S."). [57] Similarly, only 4% of the EU's electricity is produced from oil. [58] Since the industrialized economies no longer generate electricity from oil, promoting nuclear power or renewable energy will have no effect on reducing dependency on oil. Building more nuclear plants, solar panels and wind farms would only reduce the use of coal and gas in power production. This would have a positive impact on the environment (because producing electricity from coal is polluting), but nearly no impact on oil consumption. The United States is nearly self-reliant for power generation, but it is entirely dependent on imported oil for transportation.



this trend that high oil prices were less harmful to the US economy in the mid 2000s than in the mid 1970s.

[57] http://www.eia.doe.gov/oiaf/archive/aeo09/electricity.html

[58] Shaffer, *Energy Politics*, p. 130.

Oil dependency is related to transportation because oil enjoys a worldwide monopoly over fuel for transportation. The United States (like most developed economies) depends on oil for transportation (by land, sea, and air). While oil was an all-purpose fuel in the U.S. economy until the energy crisis of the 1970s, today it is mostly a transportation fuel. About 70% of the oil consumed in the United States is used to produce fuel for cars, trucks, ships and airplanes. Thus, the only way to really reduce oil dependency in a country like the United States is to change the energy consumption of engines.[59] In other words, the world will be able to wean itself from oil only by breaking the monopoly of oil in transportation. The same way that Churchill's decision to switch from coal to oil generated our dependency on oil, switching from oil to other combustibles is key for achieving "freedom from oil." As argued by Gal Luft and Anne Korin, there are precedents to the world's overdependence on strategic commodities. Salt was once such a strategic commodity. Because salt used to have a monopoly over food preservation, it was a strategic commodity over which wars were fought. Salt, however, lost its monopolistic status with the advent of canning, of electricity, and of refrigeration.[60]

Paradoxically, one major obstacle to the gradual replacement of oil is the fact that oil prices do not reach unsustainable levels. Oil is not a freely traded commodity. Its price is controlled by the OPEC cartel. Thanks to its dominant position within OPEC, Saudi Arabia maintains oil prices at affordable levels so as to discourage the search for oil substitutes, which are generally costly. It is no coincidence that Saudi Arabia is showing signs of concern about the growing awareness, in the West, of the dangers of oil dependency. Prince Turki al-Faisal, Chairman of the King Faisal Centre for Research and Islamic Studies and a former Saudi intelligence and ambassador to the U.S., recently wrote that "this 'energy independence' motto is political posturing at its worst -- a

[59] Sandalow, *Freedom from Oil*, p. 39.
[60] Luft and Korin, *Turning Oil into Salt*, pp. 3-4.

concept that is unrealistic, misguided, and ultimately harmful to energy-producing and -consuming countries alike."[61]

Diversifying Energy Production

Many countries are starting to convert power plants and heat generation from oil to natural gas. Natural gas has the advantage of being currently available in larger quantities than oil, and of being less polluting than oil during combustion. However, transporting gas over long distances is expansive because of the cost of maintaining pressure in gas pipelines that are over 4,000 km long. Moreover, natural gas dependency is politically costly, as illustrated in recent years by Europe's reliance on Russian-controlled pipelines. Hence the worldwide tendency of using liquefied natural gas (LNG) with the combined use of high pressure and low temperature. While the pipeline transportation of cost of gas grows exponentially with long distances, LNG can be transported by tankers. This is why pipeline transportation of gas is regional (because of long-distance costs), while the transportation of LNG is becoming global.

However, because Russia and Iran own together 42% of the world's gas reserves, expanding the use of natural gas in the West might eventually have too high a political cost. Indeed, there have been talks in the past few years about a "gas OPEC" between Russia, Iran and Qatar (which together control two thirds of the world's natural gas reserves and a quarter of the world's natural gas production) in which Russia and Iran would be the two dominant countries and operate as allies. Switching from oil to gas would hardly serve the West's geopolitical interests. Finally, natural gas sources might soon reach a peak, just like oil itself. Natural gas production is expected to peak between 2020 and 2030.[62]

As for coal, it will only provide a sustainable alternative to energy production if pollution-reducing techniques are widely adopted, if the cost of these techniques is significantly reduced, and if their efficiency improves. Worldwide coal reserves are

[61] Prince Turki al-Faisal, "Don't Be Crude," *Foreign Policy* (Sept.-Oct. 2009).
[62] Klare, *Rising Powers*, p. 45.

plentiful. However, current coal thermal power points are extremely polluting in terms of carbon dioxide emissions. Current carbon dioxide-filtering technologies in coal-based energy power plants significantly affect the energy efficiency of those power plants. Thus, these technologies involve a cost which developing countries are not willing to bear. Recent pilot projects for the carbon dioxide reduction of coal power plants in Europe will remain irrelevant as long as thousands of traditional coal power plants are used and built in China and India. Curbing the use of coal for electricity production in the United States is an electoral non-starter because of the power of the coal industry (Al Gore's support for reduced coal use in the United States is believed to have cost him the 2000 presidential election). Coal can be liquefied and turned into fuel (30% of South Africa's fuels are produced from coal, a sequel of the Apartheid regime's attempt to find alternatives to banned oil imports). However, liquefying coal is expansive, and liquefied coal is at least as polluting than oil.

As the era of fossil fuels is approaching an end because of limited resources and environmental concerns, two possible alternatives to energy production are nuclear energy and renewable energies.

Nuclear energy will play a central part in energy diversification. Theoretically, nuclear power can replace fossil fuels (such as coal, oil, and gas) to generate electricity. The nuclear option has many supporters in Europe. France made a strategic decision in the 1970s to develop civilian nuclear energy. Today, France has 58 active plants that provide 80% of the country's electricity needs and 39% of its energy consumption. Soon after his election in May 2007, Nicolas Sarkozy toured countries from China to Libya to sell France's nuclear expertise. In a March 2010 speech, President Sarkozy declared that civilian nuclear energy was vital in order to meet the expected 40% increase in world energy consumption by 2030 and that France would take the lead in sharing civilian nuclear energy with emerging economies. He called upon the World Bank to reverse its 50-year old abstention from funding

the construction of nuclear plants.[63] Areva, a French government-owned company and world leader in nuclear energy, is currently building large nuclear reactors in France (at Flamanville), in Finland (at Olkiluoto), and in China (at Taishan).

China is also developing nuclear power. Only 1% of China's energy needs are currently provided by nuclear power. China has nine nuclear reactors and is planning on building another thirty.[64] Japan is expected to build twelve nuclear plants in the coming years in order to meet the country's carbon-emission reduction target. South Korea, the world's second largest coal importer and third oil importer, is also eager to reduce its energy dependency through nuclear power.

There are four main concerns about nuclear energy: proliferation, safety, production costs, and uranium resources. In his abovementioned speech, President Sarkozy warned that countries that "cheat" with nuclear energy (i.e. that try to use their nuclear plants for military purposes) would be penalized. However, the inability (or unwillingness) of the international community to prevent Iran from doing just that raises doubts about Sarkozy's pledge that selling civilian nuclear plants can be risk-free in terms of proliferation. As for safety, there is an understandable concern since the 1979 Three Mile Island accident in the United States, the 1986 Chernobyl disaster in Ukraine, and the 2006 near-accident in Sweden. However, no accidents have occurred so far in Western Europe, and there is no reason why strict security measures shouldn't make nuclear energy safe.

Regarding the cost competitiveness of nuclear energy, government subsidies are likely to be needed in the foreseeable future –even though the issue is still a matter of debate between economists. Carbon taxes, which force fossil-fuel plants to pay for the environmental cost of the carbon they generate, seems to be crucial to make nuclear energy economically competitive.

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[63] http://www.elysee.fr/webtv/discours-de-m-le-president-de-la-republique-pour-l-ouverture-de-la-conference-internationale-sur-l-acces-a-l-energie-nucleaire-civile-a-l-ocde-video-3-1580.html

[64] "The Shape of Things to Come?" *The Economist*, July 7, 2005.

The fourth concern is the possible shortage in uranium resources –the fuel used for conventional power stations. There is a question mark about how long the world's known uranium reserves will last. However, the uncertainty about the long-term availability of uranium does not constitute a reasonable reason for disqualifying nuclear energy. Moreover, the world's largest known uranium reserves –as opposed to oil reserves- happen to be in two Western democracies: Canada and Australia.

For nuclear countries such as the United States, Russia and France, exporting nuclear technology is a profitable business. It is also a tool for geopolitical clout. Since 2008, France has been actively selling civilian nuclear technology to Saudi Arabia, the United Arab Emirates, Qatar, Libya, Egypt, Algeria, and Morocco.[65] The United States is helping India to become a regional counterweight to China through nuclear technology (2008 Indo-American Nuclear Agreement). China, for its part, is sharing its nuclear knowledge with Pakistan, India's rival. Russia is providing Iran with the nuclear knowledge and plants that will likely enable to Islamic Republic to defy the United States militarily.

Renewable energies are unlikely to be the only feasible way of guaranteeing energy independence and of meeting carbon emission quotas. Windmills and solar panels provide power only intermittently and could therefore generate blackouts. Nuclear power, whose carbon emissions are negligible, works regardless of the weather. As argued by Ferdinand Banks, "the irrational ostracizing of nuclear energy cannot be continued indefinitely in a world where voters want less carbon dioxide, but where –according to a UN forecast- there will be at least a doubling of the demand for energy over the next 25-30 years."[66]

The diversification of energy production needs to involved renewable energies. The main current obstacle to the widespread adoption of renewable energies is cost. Producing electricity and heat from solar, wind, and geothermal energy is

[65] "Sarkozy Pushes Nuclear Energy in Mideast," *Washington Post*, January 20, 2008.
[66] Banks, *The Political Economy of World Energy*, p. 7.

more expansive than producing them from coal, oil, and gas. While the cost of generating electricity from wind turbines is at least 5 cents per kilowatt hour (kWh), and while solar power costs at least 18 or 20 cents per kWh, the cost of electricity from conventional sources (such as coal) is typically between 3 and 5 cents per kWh. Barring some dramatic breakthrough, renewable sources cannot, on the face of it, possibly compete.

This cost gap, however, is being narrowed by the combined effect of an increase in the price of fossil fuels and a decrease in the cost of renewable energies (through scientific research and government incentives). Governments can accelerate this process with incentives such as carbon emission taxes (carbon taxes exist in Scandinavia to discourage the use of carbon-emitting fossil fuels, and France announced in September 2009 that it would introduce such a tax as well). Improvements in the production of energy from renewable sources should be expected over the coming years (thanks to government-sponsored research) such as highly efficient solar cells and the ability to extract more energy from the wind and the sea.[67]

[67] One kWh of photovoltaic electricity cost 50 cents in 1995 and 20 cents in 2005. According to the IEA's latest figures, electricity produced from photovoltaic systems costs between $200 and $600 per megawatt-hour, as opposed to $50-$70 per megawatt-hour for onshore wind power. The costs of solar power, however, keep decreasing thanks to technological advances. Germany, though not among the world's sunniest countries, is expanding the use of solar power via feed-in tariffs (a guaranteed price for solar power that makes every panel installed a profitable investment). China has become one of the world's largest producers of machines to make solar cells. As for the wind-power industry, it has come a long way since the first wind farms appeared in California in the early 1980s. Although wind generates only about 1% of all electricity globally, it provides a much larger portion in many European countries: 20% in Denmark, 10% in Spain and about 7% in Germany. World capacity in wind power is growing at an estimated 30% a year. Wind power is also on the rise in the United States. In 2008, the United States overtook Germany to become the world's largest wind power generator after its wind energy generating capacity grew by 50%. America's "wind belt" runs from Texas to North Dakota –an area that is now called "the Saudi Arabia of wind." In China, the pace has been even faster: since the end of 2004, the country has nearly doubled its capacity every year. Internationally, wind power installations are expected to triple from 94 GW at the end of 2007 to nearly 290 GW in 2012. Accordingly, wind energy will account for 2.7% of world electricity generation in 2012 and 6% in 2017.

Admittedly, the cost gap between renewable and fossil energies has been reduced thanks to government subsidies. However, traditional energy producers are subsidized as well. The United States' 2005 Energy Act, for example, secured more government money for the oil, coal, and nuclear industries than for renewable energies.

Ending Oil's Monopoly over Transportation

Today's actual or potential alternatives to oil for engine propulsion are electricity, biofuels, and hydrogen.

Hydrogen is abundant and can be used as a fuel. Indeed, it is the most abundant element in the universe and is not polluting when burnt into fuel. Hydrogen, however, is not available in nature in a usable form and must therefore be separated from the materials of which it is an element (such as water, natural gas, or coal) in order to be used as a fuel. Known technologies for hydrogen separation are both expansive and polluting. According to the International Energy Agency (IEA), hydrogen production costs would have to be reduced three to ten-fold and fuel cell costs would have to be reduced ten to fifty-fold in order for hydrogen to make sense economically.[68] Moreover, storing and distributing hydrogen would require large infrastructure investments, since the temperature required for turning hydrogen into a liquid is -252.8 degrees Celsius. The IEA estimates that using hydrogen

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The cost of wind energy production has come down to about 8 cents a kilowatt-hour (kWh), and further research is bringing this cost down. Even though producing electricity from coal is still cheaper (about 5 cents a kWh), that cost would rise significantly with a carbon tax of $30 per ton or with some legislation making it mandatory to capture and store the carbon dioxide from coal-fired power stations. Asia may become the largest market for new wind installations in the coming years. China has invested, in the past few years, about $220 billion in wind, solar, hydropower and clean-coal technologies. As of 2010, the Chinese government provides a generous subsidy for low-emission cars in thirteen large cities, and subsidizes 50-70% of the cost of large solar-power projects. China's wind-generating capacity is expected to reach 20 gigawatts by the end of 2010.

[68] Sandalow, *Freedom from Oil*, p. 143.

for transportation would require a multi-trillion dollar infrastructure investment.[69]

Producing hydrogen from gas would defeat the purpose of limiting gas imports from Russia and Iran. Producing hydrogen from water (through electrolysis) would double electricity consumption in the United States alone –hardly an energy saver.[70] As for coal-based hydrogen, its production releases large amounts of carbon dioxide. The ultimate argument against fuel-cell and hydrogen cars is that the enormous amount of electricity needed to produce and store hydrogen and then using a fuel cell to convert that hydrogen back to electricity might as well be used directly to propel electric car engines.

Historically, the first cars actually ran on electricity. In the late 19th century and early 20th century, electric cars were more popular than gasoline cars. However, the longer range of gasoline cars, the faster refueling times, the growing petroleum infrastructure, and the mass production of gasoline vehicles by companies such as Ford (which reduced the prices of gasoline cars to less than half of that of electric cars) led to the decline and eventual disappearance of electric cars by the early 1930s.

In recent years, electric cars have reappeared on the world market because of increased concerns about gasoline pollution, because of high oil prices, and because of the prospect of peak oil. In the mid-1990s, General Motors (GM) released the EV1, a purely electric car. In 2001, however, GM withdrew the car from the market, claiming that it was not profitable. According to GM, customers were turned off by the time required to recharge the car, as well as by the driving range (up to 160 km) per charge. The popular movie *Who Killed the Electric Car?* claims otherwise, blaming the oil industry and rival car companies for undermining the electric car's success.

Electric cars, however, are far from being dead and are indeed coming back to life. In January 2008, Renault-Nissan and Better Place signed a partnership agreement to launch a new electric car project. Renault-Nissan is building the electric

[69] Ibid., p. 143.
[70] Ibid., p. 144.

vehicles while Better Place is building the electric recharge grid. Better Place's model provides a solution to the time required to charge a battery and to the shorter driving range of electric cars compared to gasoline cars. Better Place's electric recharge grid will enable its customers to recharge their cars wherever they park. More significantly, battery switching stations will enable to switch the car's battery in less time than what it takes to fill a tank with gasoline. Those switching stations will be spread-out just like gas stations, and switching batteries will not involve any extra cost for the customer since the battery is owned by the company and since the customer is only charged per kilometer.

Electric cars will dramatically decrease the world's addiction to oil, but their contribution to the global reduction of carbon dioxide emissions will be enhanced if the electricity they use is produced from renewable sources. This electricity can also be produced from coal, but doing so would limit the positive impact of electric cars on the environment –though it would not impede the electric car's contribution to the decline in oil consumption.

Replacing gasoline cars with electric car would only partially reduce the world's dependency on oil because of the massive use of petroleum by ships airplanes (both civil and military). There might, however, be promising scientific breakthroughs in that area as well.

According to *The Economist*, "diesel… is the aviation fuel of the future."[71] Many of the light planes manufactured in Europe now use diesel, both for cost and air-quality reasons. Aviation fuel could therefore use biofuels, such as the type recently developed by Purdue University and favorably rated by the US Federal Aviation Administration (FAA).[72] The U.S. Air Force is introducing the use of synthetic fuels made from gas derived from coal or biomass. Its target is to use a 50:50 blend of synthetic and traditional jet fuel for half of its aviation requirements by 2016.[73] As for the U.S. navy, it is testing biofuels in ship turbines. It also recently launched an

[71] "Into the Wild Green Yonder," *The Economist*, January 22, 2010.
[72] Ibid.
[73] "Greenery on the March," *The Economist*, December 10, 2009.

amphibious assault ship that runs on an electric motor at low speed.[74] The Navy's ambition is to ultimately develop all-electric ships. In the United States, the State of Arizona recently set-up a $100 Million project together with the National Energy Technology Laboratory (NETL) to produce airplane biofuel from algae.

Biofuels, of course, are also used in cars. Brazil is the first country that ended oil's monopoly on in its transportation through biofuels. Three decades ago, Brazil imported about 80% of its oil supply. After the 1973 Arab oil embargo, Brazil both started drilling oil off its shores and investing into a sugar-based ethanol industry. Because of its warm temperatures and long rainy seasons, Brazil has the ideal climate for sugarcane production. Today, 80% of the new cars sold in Brazil are "flexible fuel" vehicles, which means that they run on a combination of gasoline and ethanol. When oil prices soared in 2008, ethanol became Brazil's primary transportation fuel.

China is also investing in ethanol, or more exactly in methanol. Following the soaring of food prices in 2008, the Chinese government decided to ban the use of agricultural products for ethanol production (ethanol is generally made out of sugar cane or corn) and to promote the production of methanol (which can be produced from natural gas, coal, wood, or even carbon dioxide). Today, China is the world's largest producer and consumer of methanol (most Chinese-made cars are now certified to run on methanol).

Even oil-exporting countries such as Iran and Venezuela have put an end to oil's monopoly on vehicles by converting them to run on compressed natural gas rather than on gasoline. The rationale, in the case of Iran, is to keep oil available for the army and commercial airlines. In the case of Venezuela, the motivation is to avoid the risk of lifting the government's subsidy of gasoline.

In the United States and in Europe, biofuels have been promoted in recent years to end the monopoly of oil over transportation, both for environmental and strategic reasons.

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[74] Ibid.

There are two main types of crop-based biofuels: ethanol and biodiesel.[75] Ethanol is an alcohol produced from sugar cane, maize, or wheat. It is used as an additive in gasoline (generally 10%) to reduce carbon emissions and improve engine performance. Ethanol is the most widely used biofuel in the United States, where it is almost entirely made out of corn. Biodiesel, on the other hand, is derived from natural oils such as palm oil or soybeans oil, and is used for diesel engines (Rudolf Diesel had originally designed his engine to run on peanut oil). The European Commission's Renewable Energy Directive (RED) requires 10% of fuels in the EU to be composed of biofuels by 2020.

Brazil is a world leader in ethanol production (mostly from sugar cane) and an exporter of ethanol (mostly to North American and Europe). It has the world's second-largest (after the United States) biofuel industry, which provides 40% of the fuel consumed by its cars. All gasoline in Brazil contains about 20% of ethanol. Brazil's sugarcane ethanol is more efficient than the United States' maize ethanol. Besides producing 70% less carbon dioxide than oil, sugarcane ethanol needs less land than maize. While ethanol produced from corn requires substantial fossil fuel inputs for energy and fertilizer, ethanol produced from sugar requires relatively little fossil energy. Moreover, producing ethanol from sugarcane hardly deprives the world of food (although it affects the price of sugar).

Producing ethanol and burning it in an engine emits less carbon dioxide then refining and burning oil. The fact that it takes energy to produce ethanol is true of any raw energy conversion process. The energy needed to produce one gallon of gasoline, for instance, is huge (pumping the oil in Saudi Arabia, transporting it across oceans, refining the oil into gasoline, shipping the gasoline to gas stations, etc). Indeed, the energy requirement for the production of gasoline is higher than the energy requirement for the production of ethanol.[76]

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[75] Biofuels are generally divided between first-generation biofuels (i.e. crop-based biofuels) and second-generation biofuels (i.e. fuels derived from waste, algae, or other non-food vegetation).

[76] Luft and Korin, *Turning Oil into Salt*, p. 80.

Ethanol is also accused of causing deforestation and thus of creating more carbon dioxide emissions. However, there are billions of hectares of unused arable land around the world and growing more maize in America cannot reasonably be blamed for deforestation in Brazil. As for Brazil itself, the deforestation phenomenon there has nothing to do with ethanol. Rather, it is mostly caused by timber production and by cattle ranching. The Amazon forest is not being cut down for sugar cane production because its climate it not suited to sugar cane. Sugar cane production occupies about 10% of Brazil's cultivated farmland, and Brazil has about 90 million hectares of degraded pasture that can be used for farming without even touching the Amazon forest.

The assertion that growing crops for ethanol production is taking away food from hungry people is a popular (if not populist) claim but not necessarily a sound one. According to a study by the U.S. Departments of Energy and Agriculture, 1.3 billion tons of plant matter could be collected from America's soil without affecting food production. Converting this plant matter into ethanol would add up to the equivalent of 350 billion liters of oil, i.e. 65% of the current oil consumption in the United States.[77]

In addition, there are millions of unused hectares of fertile lands in sub-Saharan Africa and in South America. Setting-up large agricultural projects for ethanol or biodiesel production does not take away food from anyone since that food in not being produced in the first place. Setting-up large sugar-cane plantations for ethanol or large palm tree plantations for biodiesel can provide work for millions of otherwise unemployed or underemployed farmers. Moreover, not all of the crop production needs to be used for ethanol; part of it can be used for feeding the local population based on ad hoc agreements between investors and governments. Finally, crops can be combined so as to meet the food needs of local populations (for instance, combining sugar cane plantations for ethanol with maize plantations for local consumption). Surely, many sub-Saharan African countries that suffer from food shortages because of poor productivity would benefit from

[77] "Grow Your Own," *The Economist*, July 19, 2008.

foreign investments in large agricultural projects that combine biofuel production with local food supply.

The world's population is currently of 6.7 billion, and about 750 million people are born each year. This means that the world population will likely reach 9 billion in 2050. According to the Food and Agriculture Organization (FAO), the amount of food available in developing countries will have to double by 2050 in order to meet the needs of such as large population. The food conflict of 2007-2008, which caused riots in more than sixty countries, is an indication of what would likely happen if the FAO's food target is not met.

The average growth in cereal yields in developing countries has fallen from 3-6% a year in the 1960s to 1-2% a year today. This negative trend is partially due to a decline in public investment. In the developing countries that depend most on farming, public spending on agriculture as a share of total public spending decreased by almost 50% between 1980 and 2004. Foreign aid aimed at farming also diminished dramatically over the same period. The worst agricultural performance has been in Africa. There, agricultural output per farm worker was the lowest in the world during 1980-2004, growing by less than 1% a year, as opposed to over 3% a year in East Asia and in the Middle East.[78] Africa is also the continent where most of the largest land deals and agricultural outsourcing projects are taking place today. Therefore, the biofuel industry can actually contribute to the welfare of Africans by increasing foreign investments in Africa's agriculture.

According to the Energy Biosciences Institute, "about a billion acres of land around the world that was farmed in the past has been abandoned. It seems likely that much of this land could be used for production of energy crops without impacts on food production."[79] There are an estimated 6.8 billion acres of pasture lands in the world. Using only 10% of those lands

[78] "Outsourcing's Third Wave," *The Economist*, May 21, 2009.

[79] Energy Biosciences Institute, 2008 Annual Report, p. 14 (http://www.energybiosciencesinstitute.org/dmdocs/EBI-Annual-Report-2008.pdf).

for ethanol-producing crops would generate 88 million of barrels of ethanol per day.

Ethanol is often accused of contributing to the high price of food. Those who make this claim need to explain why the highest food price increases in 2007-2008 were for foods that are not used for ethanol production (such as fish and rice). The rise of food prices is also due to the fact that the demand for meat from hundreds of millions of formerly poor Chinese and Indians is putting pressure on the grain market (because of the amount of grain required to produce meat). The use of petroleum-derived fertilizers and insecticides in agriculture may also explain why high oil prices generate food price increases.[80] Indeed, there is a causal relationship between the price of oil and the price of food: when the price of oil is high, so is the price of food, and vice-versa. Between July and November 2008, oil prices decreased by almost 50%; so did the price of corn during that same period.[81] This correlation is not due to the production of ethanol, but to the fact that the price of oil affects the food supply chain from fertilizers to transportation.

Moreover, ethanol has a positive impact on the price of oil. According to Merrill Lynch, without the expansion of ethanol production and use in the U.S., Brazil and elsewhere, world oil prices would be 15% higher.[82] It should therefore come as no surprise that Saudi Arabia's Minister of Petroleum and Mineral Resources, Ali Al-Naimi, has declared that biofuels do not meet environmental and energy security goals.[83] In any case, biofuels do not need to be produced from crops. "Second generation" biofuels are produced from waste, algae, and non-food vegetation. One example is cellulosic ethanol. Cellulose is a major component of grasses, wood, and agricultural residues (such as corn stalks). It can be broken

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[80] Ardian Harri, Lanier Nalley, and Darren Hudson, "The Relationship between Oil, Exchange Rates, and Commodity Prices," *Journal of Agricultural and Applied Economics*, Vol. 41, No. 2 (August 2009), pp. 501-510.

[81] Luft and Korin, *Turning Oil into Salt*, p. 83.

[82] **"**As Biofuels Catch On, Next Task Is to Deal With Environmental, Economic Impact." *The Wall Street Journal*, March 24, 2008.

[83] http://www.menafn.com/qn_news_story_s.asp?StoryId=1093192420

down into sugars, which in turn can be used for ethanol production. Producing ethanol from cellulose is more expansive than producing ethanol from crops, but costs are declining. Another example is algae. Algae double their mass in a few hours and produce thirty times as much oil per acre as sunflowers. Most significantly, algae devour carbon dioxide, the primary culprit in global warming. Growing algae like a crop enables the production of biofuel. Biofuels will likely become more efficient and less controversial if cellulose-based (or second generation) biofuels progressively replace plant-based (or first generation) biofuels.

For all their advantages and disadvantages, however, biofuels alone will not be able to end the monopoly of oil over transportation. In order to stall the expansion of alternative fuels, OPEC manipulates oil supplies to lower the price of oil whenever importing countries are making headways toward alternatives. This is why investments in biofuels remain economically risky. Only the use of electricity as a transportation fuel can break the monopoly of oil. Fueling a car on electricity costs about two cents a mile. Oil prices would have to drop to less than ten dollars a barrel for gasoline to be as cheap. OPEC would unlikely be able to increase supply sufficiently in order to drop oil prices to less than ten dollars a barrel. To avoid the risky dependency on exclusively electric cars (an electric blackout caused by natural disasters could cripple transportation for entire regions), plug-in hybrid electric vehicles (PHEV), which run on electricity and automatically keep running on liquid fuel (including biofuel) when the electrical charge is used up, are most likely to become the most widespread vehicles in the future.

Conclusion

Achieving energy security is a strategic imperative because energy competition is a major cause of geopolitical tensions. Those tensions are likely to deteriorate with the combined rise of growing energy consumers (such as China and India) and of the depletion of oil reserves. Reducing oil consumption is key to improving energy security, and it can only be achieved by ending oil's monopoly over transportation through the combined spread of biofuels and of electric cars. While the diversification of energy production (essentially with nuclear energy and renewable energies) will contribute to the reduction of carbon emissions, its impact on oil consumption will be marginal at least in the U.S. and in the EU since those developed economies barely use oil to produce electricity.

The transition from oil monopoly to the widespread use of vehicles using electricity and biofuels will transform the global energy balance of power. Oil-producing countries will lose some of their geopolitical clout. By contrast, countries and regions that lack the economic power of OPEC have the potential of becoming major players in the global energy market. African and South American countries that are rich in lithium (a metal essential to the production of batteries used in electric cars) and that produce or can produce large amounts of sugar cane (used for ethanol production) will acquire an international stature they lack today.

The knowledge and technologies required to end the monopoly of oil over transportation are available and are being improved. Political will is what will determine the ability of scientific knowledge to free the international economy from the destabilizing grip of oil. While oil-importing countries and oil-exporting countries obviously have diverging interests in that regard, free nations whose fossil energy resources are scarce have an interest in working together toward energy independence, not only for their own sake but for the sake of international security.