Chapter 2
Geopolitics of the Renewable Energy Game and Its Potential Impact upon Global Power Relations

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2.1 Introduction

Geopolitics is the scientific field of study belonging to both Political Geography and International Relations, which investigates the interaction between politically acting (wo)men and their surrounding territoriality (in its three dimensions; physical-geographical, human-geographical and spatial) (Criekemans 2007, 2009). The field of Geopolitics has always been very interested in energy questions since *conventional energy sources* such as oil, natural gas and coal constitute physical-geographical variables of strategic importance. Within Geopolitics, it is recognized that the energy regime of the global system and the energy relations between producer countries, transit countries and consumer countries are important variables which can influence international relations. The factor 'location'—where the energy resources are, and via which routes can they be brought to (potentially rival) consumer countries—constitutes an important area of study within the field of Geopolitics. The 'Geopolitics of (Conventional) Energy' entails a whole literature in itself. Exploring and developing conventional energy (oil, natural gas, coal) demands for huge capital investments and a military machine to control. Today, in an age of increasing scarcity, producer, transit and consumer countries are positioning themselves geopolitically so as to safeguard their energy security. Of course, energy and location in themselves do not explain everything in international relations, otherwise one would lapse into geographic or energetic determinism. But

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the way in which societies shape their *energy mix*, is central to both their chances for development and survival. Countries and areas which have energy (technology) at their disposal potentially have better cards compared to other countries. Nevertheless all countries, regions and areas are interconnected when it comes to the complexity of energetic relations, which in itself is translated into international-political relations and power dynamics. We know what the Geopolitics of Conventional Energy entails. But as countries in the world will in the coming decades move towards more renewable energy in their respective energy mixes, *how will this affect global power relations? What trends and developments can we see today? To what extend is the Geopolitics of Renewable Energy different or similar compared to the Geopolitics of Conventional Energy?* In this contribution we will focus on the great powers, although also some smaller states have become 'great' in the renewable energy world, such as Denmark or Switzerland. Remarkably enough the current literature in Geopolitics and International Relations has only barely scratched the surface with regard to exploring the potential geopolitical effects of the transition towards more renewable energy sources. This book can be seen as a first comprehensive effort to bring some thoughts on this matter together.

Renewable energy has come into the picture in the past years as a result of a number of combining factors and trends. First, the last decades have clearly shown that the burning of non-renewable, fossil fuels leads to CO_2-emissions, the exhausting of resources, local environmental degradation and climate change. Second, the entering into the world economic scene of a couple of billion people in especially Asia structurally impacts the demand for energy, as a result of which (conventional) energy scarcity could become a real possibility in the coming decades. On the other hand, unconventional sources such as shale oil and gas, tar sand and deep sea oil all try to make up for this expected shortage, but they all are—without exception—more 'dramatic' in terms of their environmental consequences. All these elements push decision makers to make new choices in the direction of more renewable forms of energy. Also the markets influence this process, although this evolved jerkily in the past couple of years. When the stock markets think a situation of scarcity might develop, like was the case in the summer of 2008 (when a barrel of oil reached the staggering record price of $147), then the prices of fossil energy can multiply in a short time frame and create volatility in the market. As a result of this, renewable energy becomes more interesting and economic in comparison to traditional forms of energy. When a few months later in 2008 the energy prices collapsed as a result of the economic crisis, a reverse process seemed to develop in the market—resulting finally in decreasing investments for several years in renewable energy. Such dynamics make the study of renewable energy not very easy within a broader geo-economical and geopolitical context. Many variables are at play. However, the efficiency of renewable energy has since 2008 dramatically

increased. Could fossil energy stocks become *stranded assets*[1] in the future? Much of the wealth of some of the major powers in the world was and still is founded on fossil energy resources. In July 2017, first France and then Great Britain issued a ban on petrol and diesel vehicles by 2040. Natural gas will quite probably become a "transition fuel" towards a renewable energy future. It will be able to top off the low peaks in the renewable energy production as long as the major technological issue of renewable energy storage is not yet solved. However, Paltsev has remarked correctly that if the world is serious about the Paris Agreement targets, then even natural gas producers will have to eliminate their own greenhouse gas emissions (Paltsev 2016, 3). However, natural gas is much cleaner than oil or coal. Within current technologies, it seems to fit neatly with renewable energy as a source of back-up power for intermittent renewables. So the geopolitics of renewable energy will be for the coming fifteen years at least also a geopolitics of natural gas. The era of conventional oil is nevertheless wining down. In the Middle East, we therefore see a major geopolitical struggle between Saudi Arabia (the world's biggest conventional oil producer) and Iran (with major natural gas deposits). The transition towards more renewable energy and the intermediate period in between might drastically impact the power relations between countries, and also within countries. Is Saudi Arabia perhaps trying to slow down such countries as Iran and Qatar? Perhaps the Saudi elite knows all too well that the basis of its power is hollowing out rapidly as a result of the global climate response and anticipated dwindling of conventional oil. The stakes could never have been higher. Who will be the winners, who will be the losers? And how will renewable energy reshape the global and macro-regional geopolitical landscape?

This chapter tries to bring together some ideas on the geopolitics of renewable energy and its potential impact upon global power relations. It is structured as follows:

- *First*, we will lay out some internal and external geopolitical consequences of the energy transition;
- *Second*, we explain that the transition towards renewable energy in fact entails an "energy technology-revolution" or ET-revolution;
- *Third*, we will study the geopolitics of renewable energy in more detail—we will look at the global control over patents and knowledge. We will next investigate the potential of renewable energy sources and their geopolitical consequences. Special attention will also be given to the very topical case of lithium and the electric car;

[1]Stranded assets are "assets that have suffered from unanticipated or premature write-downs, devaluations or conversion to liabilities." Stranded assets can be caused by a variety of factors and are a phenomenon inherent in the 'creative destruction' of economic growth, transformation and innovation, as such they pose risks to individuals and firms and may have systemic implications. Coal and other hydrocarbon resources may have the potential to become stranded assets as the world engages in a fossil fuel phase out.

- *Last but not least*, we will try to formulate some conclusions on the specificity of the geopolitics of renewable energy and its potential impact upon global power relations.

2.2 Geopolitical Consequences of the Energy Transition

The coming energy transition towards renewable energy will produce far-reaching consequences, both from an internal-geopolitical and an external-geopolitical point of view.

From an internal-geopolitical perspective, the technological conversion which we will witness in the coming 25 years will be comparable to the industrial revolution at the end of the nineteenth to the beginning of the twentieth century. An energy transition constitutes one of the most sweeping turnarounds from both an economical and societal point of view, whether it constituted the shift from steam to coal, from coal to oil (and later natural gas), or today towards renewable forms of energy. It questions the economic fabric, it has implications for the societal structure, but also it touches upon the very core of politics. It is not a coincidence that most national states in Europe (and later also in the rest of the world) were established during an energy transition period from steam to coal and later to oil, which demanded huge piles of capital and a central political decision making. The national state and central power supply and distribution go hand in hand. They need one another. Those areas in the world with an exceptional large energy hunger, such as the United States of America or the People's Republic of China, will moreover feel the need to invest additionally in their respective military apparatus. They do this so as to secure their access to oil and natural gas. The fact that this sometimes puts democracy under pressure, is "a price which has to be paid". The imminent energy transition towards more renewable forms will be accompanied by a huge decentralisation of the energy supply. This will also impact upon the *res publica*, the organisation of political life. Local and regional governments will, if they invest heavily in renewable energy (and thus cleaner) technologies, dispose of more levers vis-à-vis their central counterparts than is the case today. This could potentially also be beneficial for the democratic standard of societies. At the same time, one can detect here also actors wishing to discourage this. The former central energy suppliers do not want to lose their monopoly position, and are willing to use various strategies and instruments so as to frustrate the growth of small renewable energy companies, or they just buy them. Here lies a role for all governments at all policy-levels to create an economic landscape which is more diverse, and which guarantees that no one is able to gain an upper hand (Criekemans 2010a, b, 2011).

From a geopolitical point of view, regions within major states might also gradually become stronger vis-à-vis their respective central governments. This would certainly be the case if the central government keeps lingering on in the fossil energy era, whereas a region pursues an active policy of investment in renewable

energy combined with regulatory restrictions for fossil energy emissions. This is no longer something theoretical. Donald J. Trump as new president of the United States of America since January 2017 has championed the old oil and coal industry. On the other hand, states such as California are pursuing another high tech policy on climate change and energy transition. It is not a coincidence that a company such as the electric car manufacturer Tesla is based in California. On 1 June 2017, president Trump gave a major speech in the Rose Garden of the White House in which he stated that the United States would not implement the provisions embedded in the Paris agreement on climate change. The US, traditionally one of the major investors in renewable energy technology, would thus rather protect the old fossil industries. A state such as California would suffer greatly from such policies. Its whole business model is based upon marketing the technologies which they have pioneered in solar, wind and electric cars. In reaction to the decision of Trump, the governor of California Jerry Brown, immediately stated he would leave for China to make his own climate deal. California is the sixth economy in the world. Thanks to its continued investments since the oil crises of the 1970s, and the initiatives of Governor Arnold Schwarzenegger in the 2000s, a whole eco-system of renewable energy companies has emerged. The federal US policies under Trump have become detrimental to California, which now provokes a parallel diplomacy (also known as 'paradiplomacy') by the state governor vis-à-vis external actors. There is something about the renewable energy world that is potentially different compared to the old fossil world; it is all about the political will to invest in renewable technologies. That could thus even change the geopolitical power relations between the central government and its the regions in future geopolitics (Criekemans 2017). The jury is still out on how fundamental this change in relations will be.

From an external-geopolitical perspective, those countries who today invest in renewable energy sources and technology may become the dominant geopolitical players tomorrow. It is clear that the uni-multipolar order led by the US which came about after 1991, has waned. Some predict a duo-multipolar order (led by the US and China), others think that the external-geopolitical landscape of a world run on renewable energy will be more in terms of a *multipolar world* where power is more spread equally across the globe. Recently the landscape has however changed with Donald J. Trump in office. Direct and indirect subsidies for renewable energy are being cut back under this new Administration. On the other hand, China is emboldened. Its own National Energy Administration is predicting a further rapid growth in the clean energy sector; 2.5 trillion yuan ($361 billion) into renewable power generation by 2020. Some 700 billion yuan will go towards wind farms, 500 billion to hydro power with tidal and geothermal getting the rest (Mason 2017). Is Trump an opportunity for China to get ahead of the curve? At the same time, the Indian government of Prime Minister Moodi is investing heavily in renewable energy. There is strong growth over many years to be expected here, both in the public and private sector. However, with regard to the financing of renewable energy projects, India will need to invest close to $150 billion to meet its 2022 renewable energy targets (S.a. 2017). The potential of the Asian markets alone is

huge. Will these markets outpace the Western markets? With the federal US now in crisis and the pace of European investment growth in renewables being currently slower, that may prove to be a risk for the "status quo" powers of the West as consumer countries. If the global energy regime changes the underpinnings of Western power might also be affected. But to really understand the geopolitics of renewable energy and its consequences in terms of power distribution, one needs to appreciate the technological dimension better.

2.3 The Transition Towards Renewable Energy Entails an 'ET-Revolution'

The transition towards more renewable energy in countries and regions entails more than a mere change in the energy mix (See also: IEA 2004, 2005, 2007a, b, 2008a, b, 2009). The transition entails the conversion of an energy industry which was merely based upon the extraction of fossil energy sources to a mainly technology driven sector. The energy industry will thus gradually become a technological sector, and will be combined with the decentralised developments from the IT-sector of the nineties. That is why the evolution towards renewable energy is sometimes called an "*ET-Revolution*", or "*Energy Technology-Revolution*" (See also: Weiss and Bonvillian 2009). This technological revolution is certainly developing in the sectors of solar energy and wind energy. Critics could state that it is less visible in the area of biomass/bioenergy, because this source of energy potentially needs less technological innovations. To a certain extent this could be true. However, this traditionalist view does not take into account the awakening sector of *biobased chemistry*, which will gradually replace the petrochemical industry. As the conventional oil production will peak somewhere between the short and medium term, it will become technologically necessary to find replacements for all consumer products which are used and based upon oil. One would be amazed how dependent current societies still are upon oil, and how necessary it is to find replacement products in each and every of these domains. Moreover, one of the main reasons why the agricultural sector in the developed world is performing so well, is because fertilizers are used. Most of these are today still derivatives of oil products.

Those who study the geopolitics of renewable energy must thus take into account that technology plays a very important component in this. Here the geopolitical concept coined by Daniel Deudney, '*geotechnical ensemble*', could be applied (Deudney 1989, 1997, 2000). The new technologies that are developed together with the geographical opportunities and limitations of certain geographical areas, will determine the new geopolitical context within which countries, regions and territories will be able to operate, create welfare and wellness, and develop a *power base*—literally but also figuratively. Those territories, who invest today in developing the technologies and the standards that accompany them, will therefore

have a much better starting position from which to create that power base. On the other hand, most technologies in renewable energy and the clean tech sector are so complex that international cooperation is needed to bring them about.

In 2010, Levi, Economy, O'Neill and Segal convincingly wrote in *Foreign Affairs* that "*an energy agenda built on fears of a clean-energy race could quickly backfire. Technology advances most rapidly when researchers, firms and governments build on one another's successes. When a clean-energy investment is seen as a zero sum game aimed primarily at boosting national competitiveness, however, states often erect barriers. They pursue trade and industrial policies that deter foreigners from participating in the clean-energy sectors of their economies, rather than adopting approaches that accelerate cross-border cooperation. This slows down the very innovation that they are trying to promote at home and simultaneously stifles innovation abroad.*" (Levi et al. 2010, 111).

Patrick Criqui, director of research at CNRS @ the University of Grenoble wrote in 2016 that the climate agreement of Paris constitutes a major break in the geopolitics of energy, at three levels (Criqui 2016). First, it will dramatically change the dynamics between forms of energy and technology in all regions of the world; carbon intensive technologies will gradually be disqualified. Second, 'Paris' strengthens a multilateral solution to the battle against climate change instead of a national one. Third, 'Paris' is adaptive—which means that the diversified technological routes which countries will choose are left up to themselves.[2] They will most likely choose different routes or make other technological choices. From that diversity, there is a chance that some of these countries quite unexpectedly will make 'better choices'. Predicting future power relations then becomes a quite difficult undertaking. In total, Criqui believes this brings a new dimension to the technological quest for searching new renewable energy technologies. Criqui really believes a "fourth industrial revolution" is imminent, combining information technologies with the transformation of the material world. A combination of geopolitical and technological factors, the geo-technical ensemble, will play a role in determining who will be more and less successful. Let us explore its dimensions more in depth.

2.3.1 The Possibility of a Positive 'Societal Revolution' if the New Technologies Are 'Managed' in the Right Way

With renewable energy, geopolitics is potentially also at play *within* societies. The decentralisation of both the energy production and consumption of *renewables* entails the possibility of a societal revolution, in which local and regional groups of

[2]Trump has put this back into question. However, the US can only officially exit 'Paris' on 4 November 2020 at the earliest, one day after the next American elections.

people can organise themselves more independently. If renewables are also managed in a decentralised way, one would no longer be dependent of central energy companies as was the case in the conventional energy regime. At least, this could be true with regard to the production of energy. Regarding the distribution, the story is more complex. Important will be who will manage the new electricity and energy grids of the future. Technology also here offers some new opportunities. The very latest technological evolutions with regard to '*smart grids*' could eventually make it possible for consumers to send their excess in produced solar energy *peer to peer* to other consumers across the grid. Currently, there are already some experiments in this regard in the Netherlands. Then it would become necessary to install 'smart meters' which have the capacity to detect instantly who has excess capacity and who does not. In this way, renewable energy potentially deals in a much more efficient way with energy shortages both within and between countries. Different sources of renewable energy can complement one another in an efficient way via smart grids. When the sun does not shine, the wind may blow harder, or there might be more tidal waves on the sea. Potentially all these technological developments could give "*power to the people*", as the American economist Jeremy Rifkin states. Rifkin calls this process a "re-globalisation from the bottom up" (Rifkin 2002).[3] Whereas the international energy regime of the oil age was top down, the energy regime of renewables will be bottom up, but only if individuals and societies take the chances to organise themselves and their energy needs. However, the central energy suppliers and network managers are not so pleased with these developments because it threatens the power structures upon which they base their activities. They offer to install renewable capacities in houses at reduced prices, as long as they get a service-monopoly. According to Rifkin, such an evolution could threaten the chances which renewable energy offers in the reinforcement of a country's own societal structures and nullify the advantages of a societal feeling of belonging together as a result of an interwoven web of *renewables* and smart grids. It is exactly in this *potential* for societal rejuvenation that the geopolitics of renewable energy is different from the geopolitics of conventional energy. However, the jury is still out of how this will further evolve. In the last couple of years, central energy companies are installing smart meters for free and build new business models around the data that is then being collected from their consumers. Will only those who manage to go completely off grid be really free? In that sense the chances for a societal revolution have perhaps grown smaller instead of bigger during the last

[3]Again according to Rifkin, globalisation from the top down, has failed. It was based upon a too narrow energy regime; it involved only a fraction of the world's population and needed an enormous concentration of capital and military power to keep together. Rifkin states that the financial-economic crisis of 2008 was not so much created by the housing bubble in the US, but rather by the high energy prices in the summer of 2008. Less than two months later, the economic crisis took hold. Rifkin sees a direct relation or "perfect storm" between the economic crisis, the (conventional) energy crisis and the climate crisis. In this, he sees evidence that the oil age has reached its dawn, and thus that a new energy regime—this time based upon *renewables*—will gradually take its place.

years. In the geopolitics of renewable energy, states still seem to be the main actors. Their investment choices will highly affect the power game amongst them.

2.3.2 The Choices Which Have to Be Made by Governments: Which Renewable Energy Technologies Should One Invest in?

The current "Energy Technology-Revolution" makes it difficult for governments to make choices. The technological applications are often developing so fast that it is difficult to predict beforehand which technology will be economically more viable than the other. In the framework of the research for this chapter, we had conversations will many people from different sectors and backgrounds. Most of them state that governments should not lay their eggs in one basket, but should rather support a multitude of initiatives in renewable energy. The task of the government should be to create a good investment and enterprise climate so that the society itself and the research centres within it can produce new varieties of renewable energy. The government should also invest in innovation policy, but in a way so as to trigger innovation within the society and ground the innovations via patents and licence agreements. In this vision, the government should also stimulate different types of renewable energy-applications, and not focus only on *transport* or on *energy usage at home*, but also on *consumer products.* These three pillars should be taken into account when a government tries to deal with the energy-technology revolution.

2.3.3 The Choices Which Should Be Made by the Government Regarding the Scale of the New Technologies in Which One Should Invest

Another aspect and consequence of the ET-revolution is that one must take into account the scales of renewable energy projects. From a geo-economical and geopolitical point of view, one could make a plea for governments to focus on those projects which in an international context offer much visibility. Two cases are very revealing in this regard.

A first example is the failed *Desertec*-project, a proposed renewable energy grid in North Africa and the Middle East. However, in the wake of severe geopolitical destabilization in Northern Africa after the Arab Spring, the Desertec Industrial Initiative (DII) abandoned in 2013 its strategy to export solar power generated from the Sahara to Europe. It was also deemed "too expensive and too utopian". A combination of geopolitical and technological factors finally killed it, for now.

A second example is the *North Sea Offshore Grid Initiative*, a complex of thousands of windmills in the North Sea (see Fig. 2.1). The North Sea Offshore Grid was proposed by the European Commission in November 2008, in the Second Strategic Energy Review. This initiative identified this project as one of the six priority energy-infrastructural actions of the European Union. According to the Commission, the North Sea Offshore Grid could develop into one of the corner stones of a future European super grid. The political statement of the North Seas Countries Offshore Grid Initiative was signed on 7 December 2009 in the Energy Council of the European Union. This statement was signed by Germany, the United Kingdom, France, Denmark, Sweden, the Netherlands, Belgium, Ireland and Luxemburg. On 9 February 2010, the directors-general of Energy of the ten countries endorsed the proposals for a Memorandum of Understanding. On Friday 3 December 2010, in the run-up to the formal Council of Energy and during the Belgian EU Presidency, the ten states signed a cooperation agreement in order to jointly develop the offshore wind parks of the Northern Seas (the North Sea, the Channel, the Celtic Sea, the Irish Sea), a surface of 760.000 km^2 in total. This agreement constitutes an important step in the further development of renewable energy, since the theoretical energy capacity of European offshore wind energy is almost as big as the petroleum which is found in the Middle East. In this project, electricity would be transmitted via high-voltage direct current cables, allowing it to be sold and exchanged in all involved countries. It would also make it easier to optimise energy production (S.a. 2009). Norway's hydroelectric power plants could act as a "giant battery", storing the power produced and releasing it at peak times, or when wind strength is low. Several high-voltage direct current interconnectors such as a proposed cable between Norway and the United Kingdom have been seen as integral parts of the project. In a study for the European Commission, De Decker and Woyte identified four offshore grid scenarios for the North and Baltic Sea (De Decker and Woyte 2010). The exact positioning of the grid, and the required size, are in 2017 still under study.

From a geopolitical and geo-economical point of view, the *North Sea Offshore Grid* will be very important for the countries bordering the North Sea. But in June 2016, the people of Great Britain voted in favour of 'Brexit', and exit out of the European Union by March 2019. From a geopolitical perspective, this could endanger the North Sea Offshore Grid Initiative. This is why the minister-president of Flanders, Geert Bourgeois, proposed on 29 June 2017 in Göttingen an '*Integrated Strategy for the North Sea*' as a macro-strategy of the European Union to its neighbourhood region of the countries bordering the North Sea. Co-organising offshore wind energy, tidal wave energy and energy storage would constitute one of the main dimensions in such a new geopolitical cooperation project (Bourgeois 2017). It would also help to soften the blow from the UK's 'Brexit' out of the European Union. Renewable energy technologies are thus seen by the Flemish government (which is exclusively competent in areas as renewables and energy efficiency, internally but also in foreign affairs) as an important diplomatic tool and geopolitical strategy to bridge the current divides between 'Brussels' and 'London'. There is thus interesting evidence that new geopolitical challenges within Europe

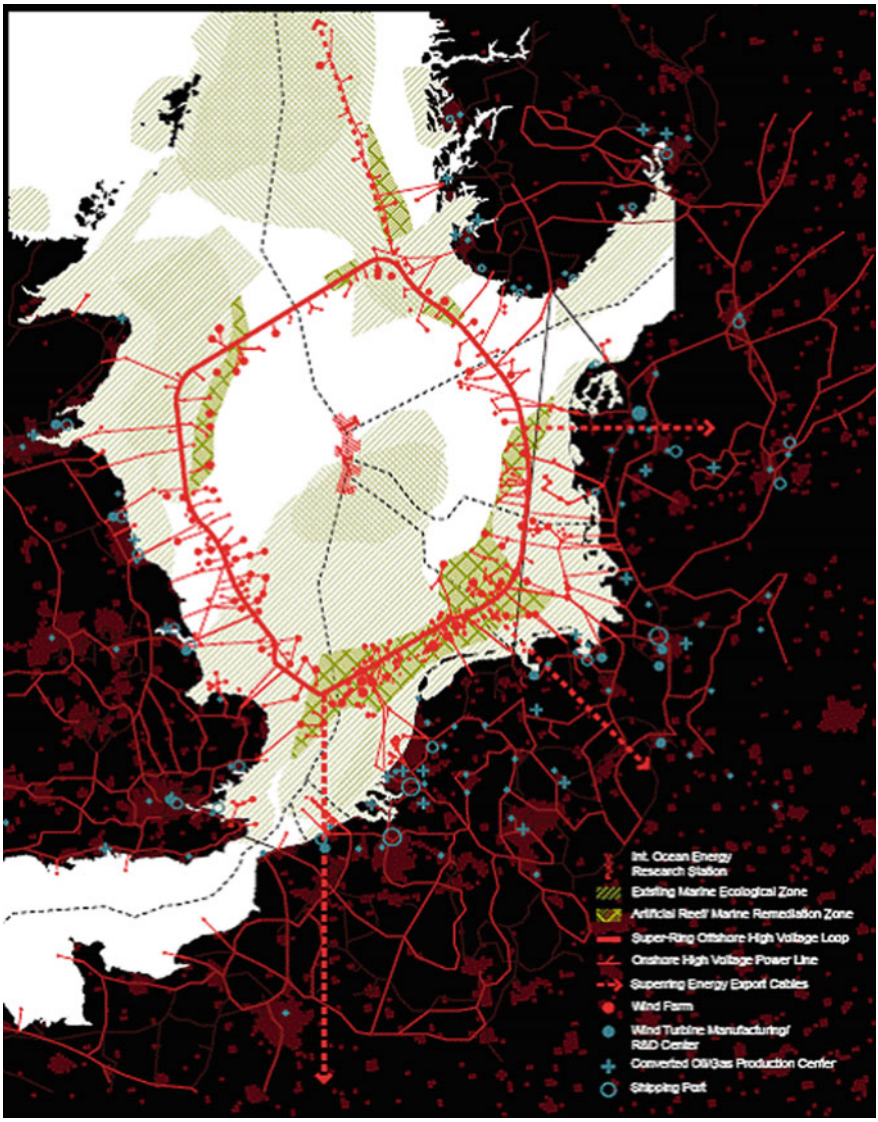

Fig. 2.1 The North Sea offshore grid initiative. *Source* European Commission

could also be softened via joint projects of renewable energy technology, inter-linkage and storage. The geo-technical ensemble also shows itself in interaction in these very dynamic cases.

Projects such as *Desertec* and the *North Sea Offshore Grid Initiative* are very *big projects*, which require a lot of international cooperation and coordination. However, from a geo-economic and geopolitical point of view, renewable energy

projects are much more adaptable to different scales compared to conventional energy operations. Governments may want to invest in projects closer to home and *applications at a lower scale*, in houses (solar energy) or on the sea (wind energy and wave converter technology). A mass application of smaller projects in the existing energy systems would make renewable energy more stable and decentralised compared to conventional energy. The big projects in renewable energy suffer from similar security issues as compared to traditional energy projects; renewable electricity power lines could be as vulnerable as conventional energy pipelines. Important will be again where the power lines will run, and who will control them. The longer the distance of these power lines, the more they will also lose energy.

Perhaps it would be more wiser for governments to invest in small scale projects, that can be scaled up later? It is perhaps in this multiplying effect that an investment in renewable energy technologies can transform itself into a factor of geopolitical importance and 'power'. However, there is also a last element to consider in this equation.

2.3.4 New Technologies Vis-à-Vis 'Vested Interests'

A 'societal revolution' which brings energy closer to the people, in the end also offers chances to strengthen one's own democracy. It may even lead to lesser dependence vis-à-vis foreign energy companies, and the geopolitical objectives of some energy producer countries. However, much depends on how renewable energy is developed. Is it broadly developed within different parts of society, or is it rather developed by big existing energy groups? Within Europe, we see different situations in different countries. For instance, in France mostly the big energy chains are the ones that are developing renewable energy in a rather centralistic way. This has not always been very successful. Currently France is lagging behind Germany in this regard. In the Nordic countries, renewable energy is much more distributed. The Netherlands offers a more mixed situation—in first instance renewable energy seems much more distributed, on the other hand the vested interests of the bigger energy corporations such as the Gasunie are at play; biogas is only subsidized if it is pumped into the existing pipelines of the Gasunie and similar vested companies. This could potentially break the societal advantages that *could* be linked with the energy-technology revolution. Some interviewees state that one should not be naïve; only if renewable energy is applied everywhere in society, can the transition towards renewable energy take place. Only then will we also really see the multiplying effect in terms of shifting geopolitical power. In the Western model, a combination of private and public capital is needed, whereas in for instance China the state capitalist system seems to be the central financing and decision-making system in terms of the technologies that are being invested in. One could hypothesize that state capitalism will probably be more prudent with regard to the 'vested interests' in society. In private capitalist systems however, the process of

'creative destruction' can wield more freely—provided the rules of the game are not rigged in favour of the vested interests. Unfortunately, they often are via old subsidy and regulatory regimes designed for conventional fossil energy firms.

One needs a lot of capital to create this transfer and thus big energy companies will remain players, and there will remain a collusion between the economic and political elites on the bigger geo-economic and geopolitical stakes in the energy business. The only difference will be that the form of energy upon which this process will be based, will be another one, or a combination of many different forms of renewable energy.

2.4 The Geopolitics of Renewable Energy in More Detail

2.4.1 The Global Control Over Patents and Knowledge

According to Guillaume Sainteny, there are also some other geopolitical dimensions in the global developments related to renewable energy. One can speak of *a global struggle for the control over companies and the added value that they will produce*. In order to determine the position of countries and regions, one could utilize three criteria; (1) how many patents are awarded; (2) the relative weight of the capital investments in renewable energy, and (3) the presence of leading companies in this new industry. What is interesting, is that an application of these parameters leads to similar countries popping up on the radar screen of the researcher (Sainteny 2010).

For the period 2001–2005, the figures with regard to the awarded patents, are as follows:

- In the *wind energy-industry*, Germany owned 24% of all patents in the world, Japan 23%, the US 10%, followed by China 5%, Russia 5%, South Korea 5%, Denmark 4.5%, the United Kingdom 3%, Spain 3%, and France 2%;
- In the *solar energy-industry* Japan owned 50% of all patents, South Korea 11.5%, the US 11%, China 7%, Germany 6.5%, followed by Russia 1.5%, the Netherlands 1.5%, Australia 1%, the United Kingdom 1%, and France 0.8%;
- With regard to *fuel cells (on hydrogen)* Japan owned 60% of all patents, the US 14%, Germany 7%, South Korea 7%, China 3%, Canada 3%, the United Kingdom 2%, and France 1%.

From this overview one learns that again and again the same countries seem to have patented a lot of know-how in renewable energy.

With regard to capital investments, the figures are moderately different dependent on the sources one uses, and the way in which one defines a domain. Often the best indicator of investments in renewable energy, is to look at the figures official bodies publish on '*cleantech*' or '*clean technology*'. Internationally this is often accepted as a useful indicator. Between 2003 and 2008, the production of energy,

the conserving of energy and energy-efficiency constituted about 60% of all investments in the *clean tech*-industry in the United Kingdom. In Israel this figure was 85%, and in France 80% for the same period. In general, all aspects of renewable energy in Europe constitute about 75% of all investments in the *clean tech*-industry.

Based upon the *2008 Annual Review and 4Q08 Investment Innovation* of the Cleantech Group LLC in 2009, the following countries are the most important investors in the world in *clean* technologies (see Table 2.1):

As regards the leading companies in the sector, the following countries were important in 2008:

- *American companies* (Sharp, SunEdison, SunPower, EverGreen Solar, General Electric, Tesla, Quantum Fuel Systems);
- *Canadian companies* (Ballard Power Systems, FuelCell Energy, Dynetek Industries Ltd.);
- *German companies* (Enercon, Nordex, Q-Cells, Conenergy, SolarWorld, Siemens);
- *Spanish companies* (Gamesa, Acciona, Isofotón, Iberdrola);
- *A Danish company* (Vestas);
- *Japanese companies* (Tokuyama, Kyocera, NEC, Sanyo, Toyota, Honda);
- *An Indian company* (Suzlon);
- *Chinese companies* (Suntech, BYD).

In its most recent 2017 report, the Cleantech Group LLC has created a new geography of the *top ranked* cleantech companies in the world. The United States is still on top of the world with 51 companies (of which 31 in California), Canada has 11, France, Germany and the UK each boast 7 leading cleantech companies, Israel has 4, the Netherlands has 2. Then follows a list of countries which each have at least one leading cleantech company; Belgium, Finland, Ireland, Norway, Sweden, Kenya, Tanzania and South Africa. Western companies still seem to dominate the cleantech scene.

Taking all factors into account, it is however interesting to note how active Asia (and more specifically Japan, India, China, South Korea) is becoming in the domain of renewable energy and venture capital. What is also interesting from a geopolitical and geo-economical point of view, is that many companies in Asia are trying to position themselves in niches in which they can generate added value. As the old economy will gradually be replaced by a new, greener economy, Asia will thus be able to take a more strategic position. In other words, one could today already speak of a *certain geo-economic power shift* in favour of Asia. An extra advantage is that countries such as China and India have lower costs for the assembly and construction of renewable energy projects, that is why they are sometimes more faster and competitive compared to companies in e.g. Western Europe. From a geo-economic and geopolitical point of view, already for several years Western countries in the OECD group demand a '*level playing field*' with Asia in terms of tariffs and non-tariff obstructions to the Asian markets. Interviewees in the sector of

Table 2.1 Total capital investment in clean tech

Country	Total capital investment in *clean tech*
United States of America	5.6 billion US dollar
United Kingdom	974 million euro
Germany	544 million euro
China	430 million euro
Ireland	423 million euro
Spain	288 million euro
India	277 million euro
Israel	247 million euro
Norway	188 million euro
Sweden	156 million euro
France	120 million euro

Source Cleantech Group LLC, 2008 Annual Review

the solar industry raise the question whether the competitive conditions upon which Asian countries work, are correct. China produces "cheaper photovoltaic solar panels" (PV) with which they could in time flood the market, but do these reflect the real price? First, one can observe that the Chinese government invests substantial amounts of capital in PV. Second, there exists a distorted exchange rate between the yuan on the one hand and the euro and dollar on the other hand, which according to critics does not reflect the "real" economic position of China. Many of the advantages in efficiency within the sector PV which exist in Europe and the US are thus nullified. Thirdly, the labour cost in China is low while the price for electricity remains relatively cheap, exactly because China has so many energy plants working on coal… Interviewees think policy officials should strive towards measures and arrangements with countries such as China in order to remove the trade imbalances, but this will be a long term effort. Interviewees also state that in the PV-sector, real innovation still rather remains an OECD-story. What Asia does best is applying existing technologies in larger scales. This is true in the solar energy sector, but also in the wind energy sector. With regard to Asia, Japan is the exception to the rule. With Japan, most other OECD countries have a genuine level playing field, and can enter the Japanese market, although in itself the Japanese home market for renewables is rather limited compared to other countries in Asia.

In its most recent 2017 report, the Cleantech Group LLC states that Asian Investors are increasing their investments in non-Asian top-100 clean tech companies. That trend seems to become stronger every year; Asian equity investment is steadily increasing. As the 2017 report rightly states, one point is that Asia has strong demand for technologies that address acute needs and problems of the not so far away future. A second one is that, at stake here in the ongoing transition of industry, is the future competiveness for multi-national companies and countries: "*No wonder, therefore, to see corporations as the most dominant investor type in this sample. Japan was the more dominant source of such investors, but China (and*

certainly if looked at through the "Greater China" lens) is now starting to dominate." Energy storage and batteries have been high on the activity levels of Asian based investors.

According to Sainteny, the awakening '*geopolitics of renewable energy*' will structure itself around three geographical zones and three thematical playing fields (Sainteny 2010, 114). The three geographical zones are the European Union with Germany as a core country, the United States of America and Asia (with China, India, South Korea and Japan as core countries). The three thematical playing fields are: (1) the control over the technologies which have to be developed further, and the division of the added value these technologies will generate, (2) diminishing energy dependence, and (3) the impact on national development models in the post 2012-era of climate policy. These last two thematical playing fields urge policy-makers to invest more in renewable energy so as to realize win-win-scenarios. The most 'exciting' geopolitical game will however play out in the first domain, the "control" over the technologies that are to be developed further. With regard to '*downstream*'-activities in renewable energy, the European Union and the United States of America are still dominant. One can expect that this general head start can be retained for a while longer, although the developments in Asia can go fast. If the US and the EU are to retain their position, then it will become necessary to invest much more in all facets of renewable energy. In the United States of America, often a triple approach is utilized; "*research/capital investment (including in demonstration projects)/start-up of new companies*". Europe often gets stuck in phase 1 or 2. Within Europe, Germany succeeds best in trying to activate its research community, firms and SME-network in structurally linking together the three phases.

On the front of investments in research, one can detect serious differences both through time and between different countries. The share of research into energy questions compared to the total research budgets has dropped in the IEA-member states (OECD countries) from 11% in 1985 to 3% in 2006. The average company in Europe invests only 3% of its turnover into research (compare to the cell phone industry, where this percentage lies at around 15%). This is why more public-private partnerships in renewable energy research are so important in the near future. After the economic crisis in 2008, the energy prices for fossil energy collapsed. As a result, investments in renewable energy technologies suffered for several years. Nowadays they are recovering again, thanks to their growing efficiency as a result of new technological breakthroughs.

In their article "*Financing Innovations for the Renewable Energy Transition in Europe*" published at the end of 2016, Bointner Pezzutto, Grilli and Sparber have created predictive scenarios of public investment in renewable energy research and development in Europe based on this historical dataset and current trends (Bointner et al. 2016). Herein, they present several figures and scenarios which offer insights concerning the EU R&D expenditures from late 1980s until 2030. Here some of their very interesting conclusions:

- Investments in research and development for renewable energy sources will probably increase in the future, largely driven by the European Union 2020 climate targets, and the European Union 2030 framework for climate and energy policies. Renewable energy sources are expected to grow more important for the European Union Member States and the European Commission, creating an expected knowledge stock for renewable energy sources of 12–21 billion EUR in 2030.
- The increases in spending from both Member States and the European Commission, demonstrate the importance of achieving energy independence, which could bring several advantages to European society in terms of declining energy costs, job creation, etc.
- As of 2014, the cumulative knowledge stock in renewable energy sources created by public research and development expenditures was 6 billion EUR for the European Union Member States and 1 billion EUR for the European Commission. The largest share of the knowledge stock is in bioenergy, with an estimated value of 3 billion EUR. Photovoltaics follow with approximately half of the research and development budget of Bioenergy. Solar heating and cooling, wind energy, concentrated solar power, and renewable heating and cooling, are all tied for third with around 1 billion EUR. Other and unallocated renewable energy sources have a knowledge stock of around 400 million EUR. Ocean and geothermal energy are second to last, with approximately 200 million EUR. Hydroelectricity is last with less than 100 million euro (Bointner et al. 2016).

According to a new report by the Brookings Institution, the number of patents issued in the US in fields related to cutting carbon emissions climbed from 15,970 in 2009 to approximately 35,000 in 2014 and 2015, before slipping back slightly to about 32,000 in 2016 (Saha and Muro 2017). The conclusion of the report is very revealing; it states that given the size of the global clean energy economic opportunity, the United States can ill afford to relinquish its lead on innovation in the burgeoning global cleantech market to China or other countries. According to this report, Congress should set aside the skinny budget and draw on years of bipartisan support for energy innovation to coalesce around a core list of minimum viable supports for low-carbon innovation and growth. Most crucial will be provisions to maintain clean energy R&D appropriations at viable levels; maximize the impact of the nation's 17 national energy laboratories; and preserve the Advanced Research Projects Agency (ARPA-E) while maintaining and scaling up the nation's energy innovation hubs and institutes: "*States and regions can and must step up to invest more robustly on their own in low-carbon innovation, just as must the private sector, which must argue more forcefully for essential federal supports even as it moves to shoulder more of the burden itself*" (Saha and Muro 2017). There are clear signs other world powers are catching up. If the US does not compete with them, it could thus affect its long term power position.

2.4.2 The Potential of Renewable Energy Sources and Their Geopolitical Consequences

According to Professor Marianne Haug[4] of the University of Hohenheim, in Stuttgart, the transition in the direction of '*renewables*' creates at least five geopolitical challenges:

1. Imbalances in the locations where these sources can be developed (a problem very similar compared to conventional energy sources);
2. Traditional biomass linked to problems of poverty, health and gender;
3. Hydropower and its disruptive effect on its surroundings;
4. "*New renewables*"—solar, wind, geothermal, waves and tides—the question of central vis-à-vis decentral production;
5. The challenges of a sustainable bioenergy sector—is this feasible?

Current technologies in renewable energy only capture a fraction of the available solar energy, wind energy, biomass, geothermal energy, ocean thermal energy, wave energy and hydropower, as Fig. 2.2 shows very interestingly:

Next to the technological factor, also the geographical factor is at play. Potential geopolitical tensions, solutions, or potential for cooperation is linked very specifically with each type of renewable energy, and also with the natural resources which are available in a country. We already referred to Daniel Deudney's concept of the '*geo-technical ensemble*'. The new technologies that are developed together with the geographical opportunities and limitations of certain geographical areas, will determine the new geopolitical context within which countries, regions and territories will be able to operate, create welfare and wellness, and develop a *power base*—literally but also figuratively. As it is the case in the 'Geopolitics of Conventional Energy', also the 'Geopolitics of Renewable Energy' creates geo-technical opportunities and limitations. Countries are most successful if they can maximize the opportunities while reducing the importance of the limitations as much as possible.

Every energy source has its own specific characteristics and creates its own '*geo-technical ensemble*' which generates an impact upon the macro-regional and international relations. In a world in which renewable energy would dominate as the most important source of energy, those relations could potentially be very different as compared to a world dominated by conventional energy. Moreover, the network of dependencies will be considerably more complex in a renewable energy world,

[4]Marianne Haug is among others president of the Board of Directors of the '*Forum für Zukunftsenergien*' in Berlin, an independent think tank on energy policy. She is also member of the advisory group *OMV Future Energy Fund*. For the European Commission, she is president of *AGE7—Advisory Group for Energy for the 7th Framework Programme* and member of the *High-level Advisory Council for the European Technology Platform on Hydrogen and Fuel Cell*. Between 2001 and 2005, she was Director in the *International Energy Agency* (IEA) in Paris, responsible for the '*Office of Energy Efficiency, Technology and R&D*'.

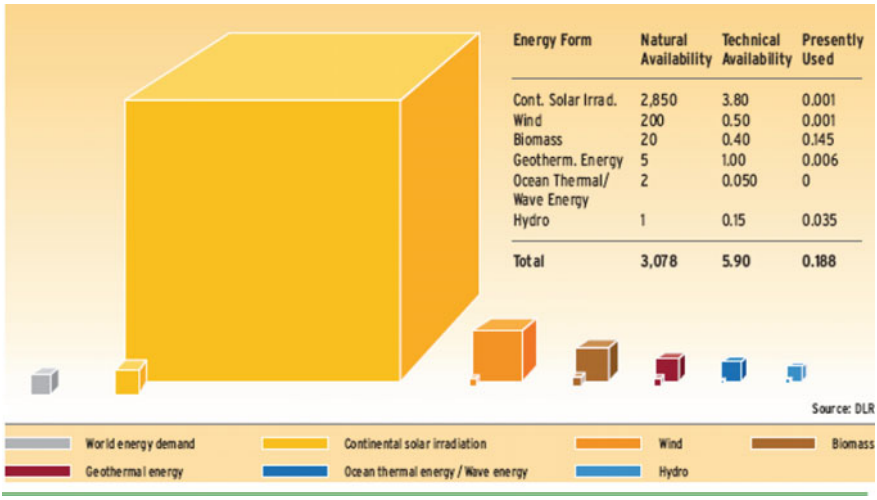

Fig. 2.2 Renewable energy potential versus how much of it is captured by current technologies. *Source* Haug (2008)

exactly because different types of renewable energy create their own specific '*geo-technical ensemble*'. And to make matters even more complex, these relations can be susceptible to new advancements at the technological front. Hereafter, we will briefly "zoom in" to the potential in renewable energy domains such as solar, wind and biomass, and their geopolitical consequences.

A last element which is sometimes forgotten, is that more renewable energy in the energy mix sometimes may create *new* dependencies upon the outside world for natural resources such as lithium (which is being used in batteries of electrical cars), or silicium (which is being used in solar panels). This entails an unexpected geopolitical side effect of the rapid growth of renewable energy. Hereafter we will briefly study some of these developments.

2.4.2.1 Solar Power Potential and Its Geopolitical Consequences

Certain areas in the world are much more interesting to 'harvest' sun light then others because the number of sun hours in the world is higher each month or because the sun shines with a greater intensity. The following world map by Haug (Fig. 2.3) shows this more clearly:

The map by Haug shows a belt beginning in California over Mexico, crossing the Sahara desert over into the Middle East and then going into Central Asia. Also Southern Africa and Australia clearly are on the map. These regions are ideal to invest in solar energy. Another, more accurate map in Fig. 2.4 provides a better overview of solar insolation in hours:

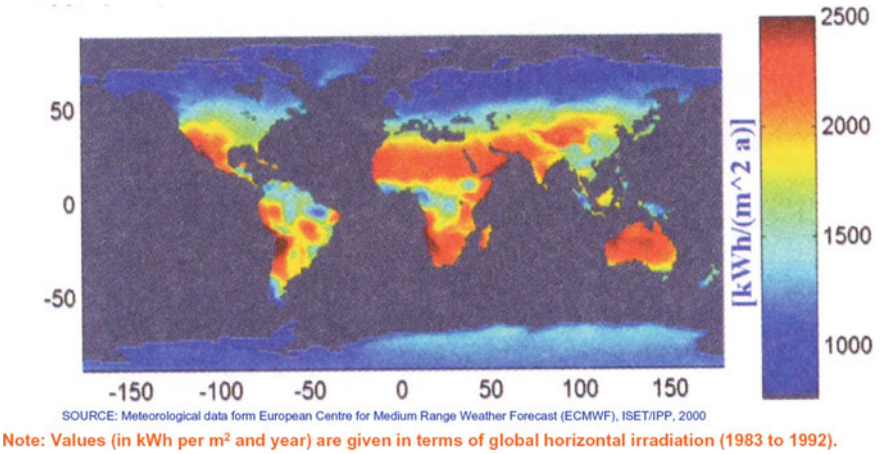

Fig. 2.3 Solar power potential and solar irradiance (1). *Source* Haug (2008)

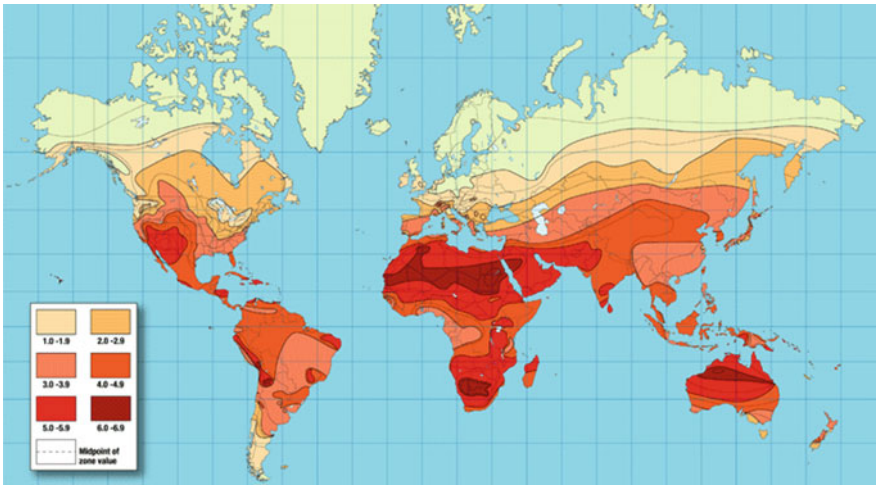

Fig. 2.4 Solar power potential and solar irradiance (2). *Source* http://www.scorigin.com/diy_-_solar_power

From a geopolitical point of view, it is not so difficult to imagine what kind of relations between producer, transit and consumer countries might be developed provided the necessary power lines are invested in. In the Americas it might bring about a closer cooperation between Mexico and the United States of America for example. California and its neighbouring states could be transformed into a power house. In South America one could also imagine interesting new cooperations between countries, although the terrain will make it difficult to actually build the necessary power lines. Between Europe and Northern Africa and the Middle East,

an interesting geopolitical and geo-economic relationship might develop. The failed Desertec project which we mentioned earlier tried to take advantage of this. In Asia, India may very well be able to cover its own needs, although China's territory only offers possibilities in very specific regions.

In the northern hemisphere, countries such as Canada, the Nordic countries in Europe and the Russian federation will not be very big players in the solar energy market. They will have to invest in other niches of renewable energy.

The Middle East might be able to retain part of its position as an energy producer. In fact, we see interesting developments in the region on this issue. All countries in the region have excellent possibilities with regard to solar power, with values between 4 and 8 kWh/m. The sun is positioned higher in the sky and clouds are less numerous compared to e.g. Europe. Both *concentrated solar power* (CSP) and *photovoltaic panels* (PV) have a good *return on investment* here. The most important country of all for the moment in renewable energy technologies in general is the United Arab Emirates (UAE). One of the most prominent initiatives is the '*Masdar initiative*', the creation of the first CO_2-neutral city in the world, in Abu Dhabi. Best available technologies are being implemented there. The project combines waste management with renewable technologies such as solar and wind. Also energy efficiency is part of the concept of 'Masdar'. The UAE also plans building gigantic energy islands off the coast, based upon solar technology. The concept was tested in the region a few years ago by Dr. Thomas Hinderling of the *Swiss Centre for Electronics and Microtechnology* (CSEM). With projects such as these, the UAE may very well become a very important player indeed. On the other hand, one notices that countries such as Saudi Arabia, who have large oil reserves, are somewhat lagging behind compared to some smaller countries in the region.

Another country in North Africa which is embracing solar energy is Morocco. The country is investing 6.6 billion euros in the next years into solar projects. By 2020, Morocco will have five solar energy power stations operational, enough to cover 20% of the country's energy needs. Morocco poised to become a solar superpower. In 2015 the country decided to install the world's largest concentrated solar power (CSP) plant, set to help renewables provide almost half the country's energy by 2020. The relative internal stability of the country compared to some other countries in Northern Africa may well result in Morocco becoming an important player, also because of its interesting location not so far from Europe. Hence, one can see that solar power can potentially create new and interesting shifts in geopolitical power relations for those countries who have the potential and invest in it.

2.4.2.2 Wind Energy Potential and Its Geopolitical Consequences

The map in Fig. 2.5 offers an interesting idea of wind power potential in the world:

Wind energy at roughly 7 meters/second (m/s) and faster are economically worth exploiting today even in higher-cost offshore locations; those are the orange, pink, and shades of red and brown in the figure above. In many areas, especially on

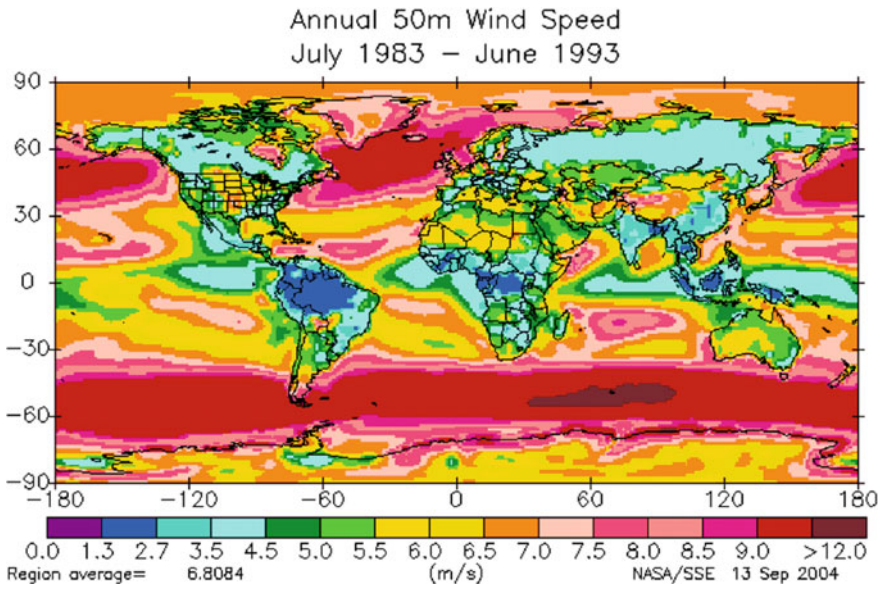

Fig. 2.5 Wind power potential in the world. *Source* http://www.ceoe.udel.edu/windpower/ResourceMap/index-world.html

land, the 6 m/s areas are already economically viable, those are the yellows. We see that the largest wind resources are above the oceans and mid-continental plains of each of the major continents. The coastal oceans are of special interest because they have strong winds and they are close to most of the world's population and electric use. How much of the vast ocean wind resource is likely to be tapped? Offshore wind towers available today are rated to 20 m water depth (some manufacturers say 30 m). Designs now under development would extend this to the entire continental shelf areas (up to 150–200 m depth).

If we look again at the data above with a geo-economical and geopolitical lens, then one could state that of all renewable energies, wind is most dispersed. However, when one looks at the areas in the world which are more economically viable compared to other regions, another picture arises. Central America and a big part of South America seem to be the biggest losers with regard to wind power energy. The same can be said for Central Africa and Indonesia. The reason is quite straight forward; because they are at the equator (see also Troen and Petersen 1989).

Other parts of the world are more interesting with regard to wind energy, but the situation within each continent is very specific indeed. Let us now briefly look at Europe in Fig. 2.6:

In the Mediterranean, only the shores of the coast of southern France are interesting for wind energy. The same can be said for some islands in the east of Greece. The most potential can be found in the North Sea. It is therefore not a coincidence that the European Commission proposed a *North Sea Countries*

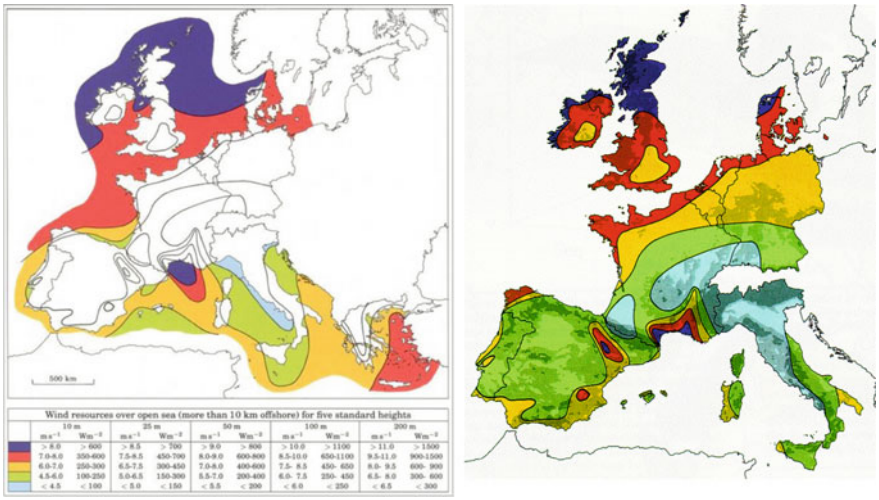

Fig. 2.6 Wind power potential in Europe. *Source* http://stro9.vub.ac.be/wind/windplan/; http://www.all-creatures.org/hope/gw/GD_wind-offshore_potential_Europe.jpg

Offshore Grid (see supra). What especially seems important from a geopolitical and geo-economic point of view, is the interconnection between this project and the European mainland.

2.4.2.3 Bio-energy Potential and Its Geopolitical Consequences

In first instance, biomass does not seem as 'sexy' as other sources of renewable energy. Its applications are multifarious, that is why biomass is much more difficult to capture in its potential from a geo-economical and geopolitical point of view. Who says biomass, may think of biofuels. This may immediately spur debates on the deontological questions regarding biofuels and their competition with the food production. However, this reflects only a fraction of the story, biomass entails much more than this. Biomass has many different manifestations. Not using biomass would be like excluding a very important source of renewable energy.

Biomass can make an important contribution in geo-economical and geopolitical terms to reducing poverty in the world (see Fig. 2.7). As Haug indicates, many households in the world, and especially in Africa and Asia use biomass as their most important source of energy, but not in an efficient way. Modern biomass-stoves and similar more efficient technologies, could become '*game changers*' in the developing world. Some groups such as *BioPact* make a plea for a geopolitical cooperation, "a green energy pact", between Europe and Africa.

A more detailed map on the usage of biomass in households can be found in Fig. 2.8:

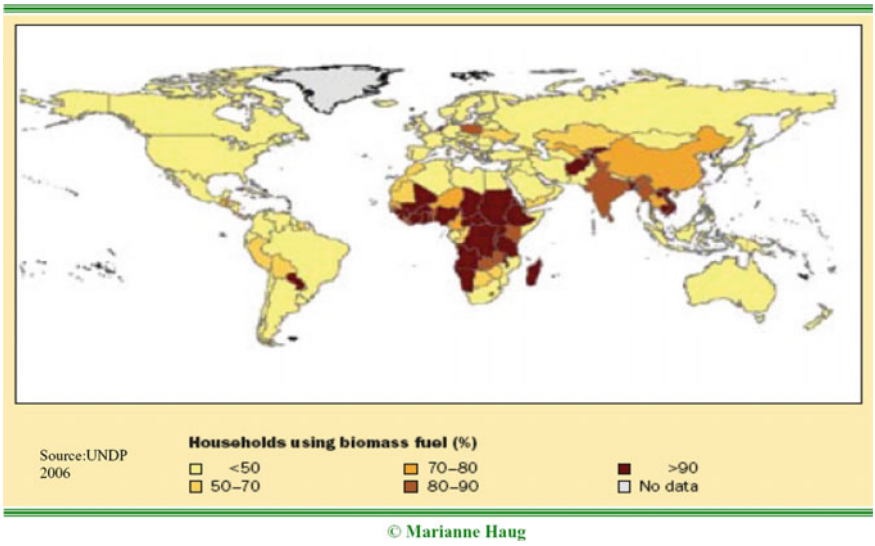

Fig. 2.7 Households using biomass fuel (%). *Source* http://news.mongabay.com/bioenergy/site/goals.html

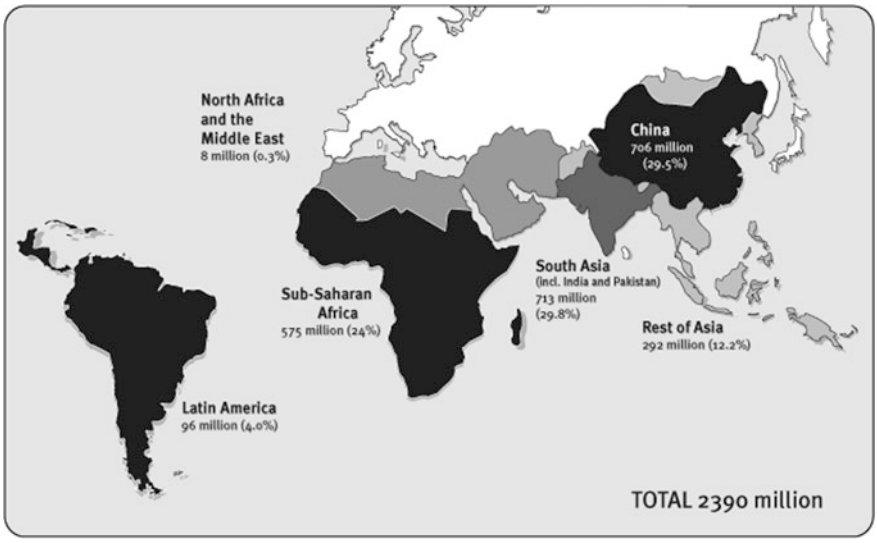

Fig. 2.8 Usage of biomass in households. *Source* http://practicalaction.org/smoke_report_2

But this is not the only aspect of the *Geopolitics of Biomass*. Some claim that a biomass-revolution is at hand. Central in this is the idea that the current economy focuses too much on fossil fuels and conventional energy sources. These are not only used in transport, but also in many products which we use in daily life. Oil is for instance also used in fertilizers. The industry which makes this all happen is the petrochemical industry. The big petrochemical clusters in the world, e.g. in Houston, Texas (ranked first in the world) or in Antwerp, Belgium (ranked second in the world), will in the coming decades come under pressure. For each of the products that they produce, alternatives will have to be found which are not based upon oil, but rather based upon biomass. This suddenly places biomass centre stage in the international energy regime of the future.

One of the leading countries in the world with regard to the *bio-based economy*, is the Netherlands. In October 2007, the Dutch ministry of Agriculture, Nature and Food Quality published the document '*Closing The Chain*'. In it, the government vision is presented on the role the *bio-based economy* can play in the green transition in the Netherlands. Some of the pillars are: the efficient use of biomass via biorefinery (the unravelling of biomass into green raw materials as the base for a wide diversity of products), sustainable production of biomass worldwide (for which specific criteria are developed), the production of green gas and sustainable electricity. Next to this, the government sees it as its task to reduce the risk of a possible competition with the food production. Even more important is that the Dutch sector of the petrochemical industry has defined the goal in twenty years' time of having 30% of all its applications based upon biomass instead of oil. In the Netherlands, a process has started to bundle all existing competences and create a *Biorefinery Cluster*. The Netherlands has special assets with regard to the biomass-revolution, especially in the combination of its logistical role with its technological expertise and its agricultural tradition as second exporter in the world. The Netherlands' case also shows that in the biomass-revolution, a special role will be assigned to the harbours. In this regard, Rotterdam, Delfzijl and even the Belgian harbour of Antwerp are mentioned as possible hubs in biomass trade in the world. Some even plea to install a world exchange in biomass in the Netherlands and Flanders. In the past, our former Flemish Centre for International Policy showed that Flanders (the northern part of Belgium) and the Netherlands are quite complementary as regards to know-how in biomass, which could be the basis for a further cooperation between these two entities. Currently, this is further being explored at the diplomatic level between Flanders and the Netherlands.

The transition towards biomass will be knowledge-intensive. This will mean that a lot of investments will be needed to make biomass a more efficient and applicable source of energy around the world. Only certain industrial centres in the world are currently equipped to deal with this transition, whereas other parts in the world—often in the southern hemisphere and in Russia—have a strong position in the fact

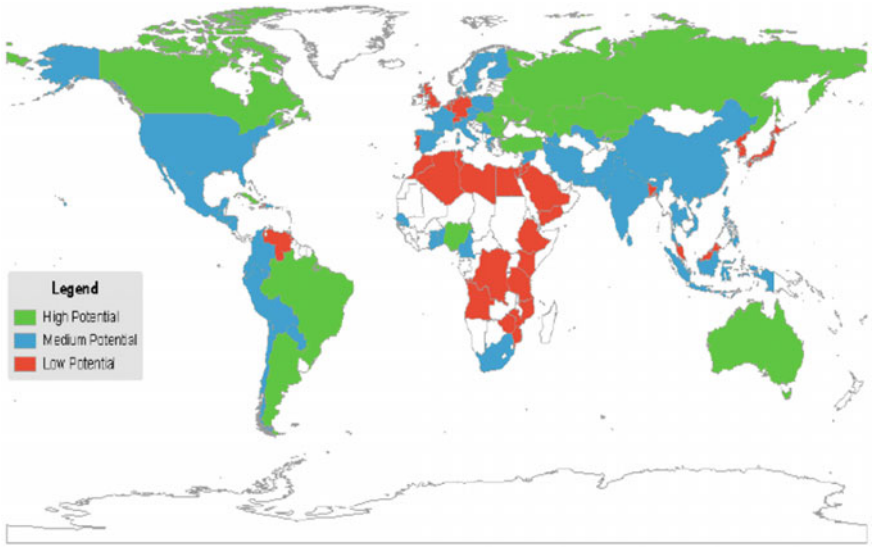

Fig. 2.9 Potential countries have with regard to biofuels. *Source* IFPRI (2008)

that they have the biomass themselves. New relations between importer and exporter countries will thus arise and shape the Geopolitics of Biomass. However, there is a danger of new dependencies.

With regard to *biofuels*, similar concerns can be raised which could influence global geopolitical and geo-economic relations. Figure 2.9 developed by the International Food Policy Research Institute (IFPRI), offers an idea of the potential countries have with regard to *biofuels*:

Among the potential leaders with regard to the export of biofuels, the following countries can be mentioned; Brazil, Argentina, Canada, the Russian federation, Turkey, Belarus, the Ukraine, Kazakhstan, Uzbekistan, Romania, Hungary, Australia and Nigeria. If these countries invest in biomass and biofuel applications, then they could become actors which play a role in the geopolitical relations which will be shaped around biofuels. Today, we can already detect a fierce competition between the United Stated of America and Brazil for a *control over* and more importantly *access to* markets—which already is played out at international fora such as the World Trade Organization. Often this 'battle' is fought via technical measures and standards.

Back in 2006, the International Energy Programme of the Dutch Institute for International Relations 'Clingendael' published an interesting study on '*Future Fuels and Geopolitics: The Role of Biofuels*' (Van Geuns 2005). In this document, bioenergy and *biofuels* are seen as important so as to bridge the energy gap which

many countries will experience. Especially bio-energy is important from a geopolitical point of view, since it can be produced locally. The import-portfolio of countries producing it will change, and they will become less dependent upon fossil fuels. It will also foster the scientific and technological development of these countries, and stimulate international trade. Biofuels are more easy to implement because the adaptations which have to be made on an infrastructural level are less sizeable compared to electrical cars or cars on hydrogen. Bioenergy also clearly affects the geopolitics of energy. Regions with a high production potential for bioenergy can gradually decrease their dependence from the Middle East and unstable countries in the world (e.g. Nigeria) and become themselves exporters of energy. Regions with a lower production potential for bioenergy will have to develop other strategies.

The Clingendael International Energy Programme also referred to studies of the *IEA Bioenergy Task 40* in order to identify some potential 'winners' and 'losers'. According to these projections, Sub-Sahara Africa seems to encompass the biggest potential with regard to bioenergy, closely followed by South America and the Russian federation. The European Union and the United States of America are in the 'middle group', and could become potential biofuel-importers. Asia seems to be a more complex story; East Asia in general and China in particular have a clear potential, there where Japan finds itself in a less comfortable position. Southeast Asia in general and India in particular have a clear potential, but this is not in proportion to its rapidly growing population. Australia and the islands in the Pacific Ocean will probably become major exporters, six times more than their domestic consumption. The biggest loser in the story of bio-energy seems to be the Middle East. But the Middle East does not necessarily need bio-energy. In our opinion, these projections can considerably be influenced by the degree to which countries may succeed in developing specific technologies, and link these to innovative sales strategies. Also important is whether the countries will be vigilant in detecting trade obstructions. Nevertheless, from a geopolitical point of view, biofuels and bio-energy will probably offer important chances to parts of Africa and South America (Slingerhand and van Geuns 2006; Slingerhand et al. 2008).

With biomass, there is now a new chance—the first real one in 200 years—to strengthen the economic function of agriculture in national and regional economies. For two centuries, agriculture has decreased as a percentage of the economic activity in places across the globe. The transition towards biomass and bio-energy creates a new role for agriculture, not only in the production of food, but also in energy and raw materials for a biobased economy. With biomass, the energy production and consumption could be again brought into a balance. In the long term, this may lead to more autonomy in terms of energy or energy security. A new international import- and export market may be developed, and certain countries and regions may play a pivotal role in this.

2.4.2.4 Electric Cars, 'Renewables' and the Rising Geopolitics of Rare Earth Materials

Up until now, this chapter identified some potential positive aspects of the transition towards renewable energy. However, there is also another side of the coin. Ryan Hodum wrote in his article '*Geopolitics Redrawn: The Changing Landscape of Clean Energy*' about another, less benign aspect of the transition towards renewable energy systems; the Geopolitics of Rare Earth Materials (Hodum 2010). Notwithstanding the progress that has been made, significant problems remain. The production of wind turbines and electric vehicle batteries is dependent upon rare earth materials, which raises concerns among technology developers and national security planners. Wind turbines are among others composed of steel, concrete, magnetic materials, aluminium and copper. The magnets used in wind turbine gearboxes require *neodymium*, a rare earth element. The increasing demand for neodymium may strain production and lead to dependency on insecure supplies. The world's largest rare earth deposits are situated in China. Around 90% of U.S. rare earth imports come from China.

Just as demand for rare earth elements needed to produce sophisticated electronics is exploding, China—which has a monopoly on supply over the rare earths—has in the past tried to cut back on exports. In order to do this Beijing cited *industry restructuring* and *environmental concerns*. In 2010, Beijing slashed export quotas by around 40% from 2009 levels, saying it must protect its reserves that have been recklessly exploited over the past 20 years. Government officials contend that with one-third of the world's known reserves of 'rare earths', China has satisfied more than 90% of the world's need for those elements (Becker 2010).

The 21st Century Economic Herald newspaper, stated the following in 2010; "*China is the land of rare earths in the same way that the Middle East has oil and Australia has iron ore. But China has not enjoyed the handsome profits that those countries have ripped from their control over precious resources*". Former Chinese leader Deng Xiaoping said once during a tour of China's export zones in 1992: "*The Middle East has oil*, *China has rare earths*". Beijing has repeatedly denied that it would use its dominance of this crucial industry as a "bargaining tool" with rival nations. Hillary Clinton, U.S. Secretary of State, stated in October 2010 in Hanoi that she had received assurances from her Chinese counterpart, Yang Jiechi, that Beijing had "*no intention of withholding these minerals*" from the world market. However, the question remains a sensitive one.

With electric vehicles, not only the abovementioned rare earth materials are problematic, but also the lithium used in lithium-ion batteries. Half of global lithium reserves are located in Bolivia, though they are not yet economically recoverable. The majority of the world's recoverable reserves are to be found in neighbouring Chile (Hodum 2010).

Also China has important lithium reserves, which it is using strategically. It is not a coincidence that China is developing electric cars. One of the big companies in this new car sector is BYD ('*Build Your Dreams*'), a company from Shenzhen, in the southeast of China. It was set up in 1995. BYD originally started with the production of Lithium-ion batteries, and in 2005 diversified into electric cars. In a very short time it became an important player. In October 2016, BYD became the world's second largest plug-in electric passenger car manufacturer with more than 171,000 units delivered in China in one year. A similar company with an equal amount of know-how is the Japanese company Nissan. In the past, Nissan tried to sell its electric car on the Chinese market, the only market in the world where it would be possible to a sell relatively high volume in a short time (Nissan aims at 400,000 a year). An important asset is this is Nissan's own Lithium-ion battery. But, in order to produce this car in China, it needed to have access to the Chinese Lithium-supplies. Japan does not have as many supplies. The Chinese government does not allow foreign players to alone develop activities with regard to the electric car. The access to the Lithium-mines was blocked for Nissan until it agreed to set up a *joint venture* with a Chinese partner, promising also a technology-transfer. The story on the electric car in Asia thus transforms into a tale with a geopolitical nature; a battle for the access to raw materials linked to know-how on battery technology. Today, China is clearly protecting its own market in electric cars so as to be in better shape to sell cars tomorrow to the US and Europe. All this produces a new picture of the transition to renewable energy, which isn't always as benign as thought in advance. In September 2016, the Renault-Nissan Alliance hit a milestone of 350,000 electric vehicles sold, through which it maintains its position as global electric car manufacturer. Without its alliance with China, that would have been impossible. Figure 2.10 offers an overview of the world's lithium supply:

On the other hand, solar photovoltaic panels require among others indium, gallium, germanium and silicon (Hodum 2010). The US depends completely on foreign gallium and indium, and for over 80% on germanium. In addition to China, these materials are also located in Central Africa and Russia. The *Geopolitics of Renewable Energy* may in this sense look more similar compared to the *Geopolitics of Conventional Energy*; whereas the West might be trying to wane its dependence on e.g. the Middle East, new dependences may be developed, for instance on Chinese minerals…

Of all the countries in the world, the United States of America are among the first countries to develop a *Critical Materials Strategy* with regard to clean energy components (U.S. Department of Energy 2010). However, even with such a strategy in place, companies such as the electric car manufacturer Tesla have to adapt to today's realities. Tesla is highly dependent on China in two ways; it needs access to its lithium deposits and consumer market in order to sell its cars. Recently in 2017 China and Tesla made a deal; technology transfer in exchange for access to lithium. Japan's Panasonic, a Tesla battery supplier, is now also active in China and

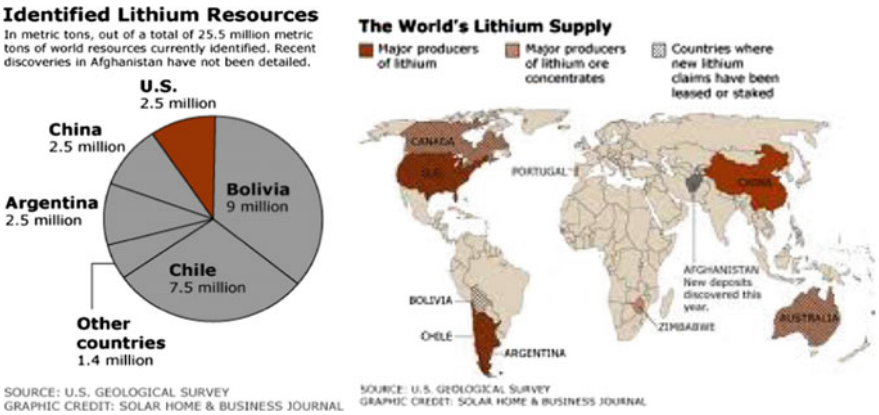

Fig. 2.10 Overview of the world's lithium supply. *Source* Coyle (2010)

will further expand its activities there. The deal is not unlike a similar one between Japan's Nissan and China. This Beijing strategy has meant that China is able to leap frog the technological curve. Its own electric car manufacturer, BYD ('Build Your Dreams'), is growing extremely fast. The latest figures are staggering. According to Desjardins, global lithium-ion battery production will increase by 521% between 2016 and 2020. By 2020, all lithium-ion battery production will still be concentrated in only four countries; 66% in China, 22% in the United States, 13% in South Korea and only 3% in Poland (Desjardins 2017). Have companies such as Tesla and Nissan sold their soul in exchange for access to China? The strategy of Beijing would mean that the country would become a major power in this technology, and quite probably will be able to jump ahead of the curve. This short case study with regard to lithium-ion battery technology and the electric car proves quite illustrative in terms of geopolitics. If in a post 2040-world, the French and British gasoline and diesel ban would become more universal, our dependency on OPEC countries in terms of oil would be replaced with an even more dramatic dependency on only five lithium resource countries and only three real producer countries of batteries. The question thus must be posed whether future policy officials will not judge such odds to be too dramatic to contemplate in terms of shifting global power relations. Diversifying one's portfolio will also become necessary in this regard. Whereas anno 2017 a growing consensus is mainstreaming that electric cars (with lithium-ion batteries) will be the future, geopolitical realities may soon kick in somewhere in the 2020s. The projected overall dominance of China in terms of both lithium resources and battery production capacity will probably prove to be a risky calculation for Western countries. Geopolitical realities might thus kick in. The lesson from this is that Western countries should invest in a more wider range of potential

technologies and not place all their eggs in only one technological basket. If not, the consequences could be dramatic. It would install a major geopolitical dependency that cannot be compensated anytime soon. Diversification in terms of technological investments will thus prove to be crucial in a geopolitics of renewable energy world.

2.4.2.5 Does a Renewable Energy Regime Foster a Multipolar World Order?

One of the most intriguing questions one can ask with regard to the transition to a world with a renewable energy regime, is what impact it will have on the international system.

The conventional energy regime fostered the accumulation of capital and military power, so as to be able to develop oil and natural gas fields. Much of the military power of the United States of America was built in the first half of the twentieth century, when the US was the 'Saudi Arabia' of its time. Equally, the Soviet Union was gifted with a wealth in oil, natural gas and other material resources, which formed the base of much of its economic, military and political power. We can detect for instance a correlation between the high energy prices of the seventies in the last century, and the elevated position of the Soviet Union during the Brezhnev era. In 1945, President Roosevelt grasped the idea that the US eventually would become dependent on foreign oil. He pioneered a foreign policy based on oil, by having a political agreement with Saudi Arabia (security for oil)—to make up for the decline of American reserves. This agreement became a dominant factor in American foreign policy in the decades thereafter. This later culminated in the Carter Doctrine which stated that an attempt by any outside force to gain control of the oil in the Middle East, would be considered an attack upon the vital interests of the United States. In effect, it is not a coincidence that the international oil regime eventually was one of the more important background variables which fostered the development of the international system into a *bipolar* one (Klare 2002, 2005, 2008). During the end of the bipolar system, between 1989 and 1991, oil prices were relatively low (20 US$/barrel), with the exception of the times during the Gulf War (40 US$/barrel). The nineties were years in which the global search for diversity in oil fields produced a stable international regime, a *uni-multipolar* one, led by the US under the banner of 'globalisation'. From the beginning of the 21st century, the smaller oil fields in many areas outside the Middle East gradually depleting. As a result of this, the oil price rose once more and this time more structurally because hundreds of millions of consumers in Asia (India and China) entered the global economic scene. The power of the US gradually declined in relative terms, and the Russian Federation used this period to

re-install parts of its international stature in the world. But the bipolar system was no longer in the cards. Henceforth power was more distributed, and one can debate where exactly the world today finds itself somewhere in between a *uni-multipolar order* and a genuine *multipolar one*.

If we agree with the assumption that the oil age has now gradually begun its long decline, which will take more than several decades, what kind of international system will come after this? This book chapter shows that much will depend upon the investments made by countries in renewable energy technologies, but also upon their access to several rare earth materials. Based upon these factors, one could build a strong case that the international system will most likely in the coming ten to twenty years evolve further into a *duo-multipolar system*. This means a world in which power is shared on a more equal basis among different regions in the world, but one in which the United States of America and the People's Republic of China play a pivotal role. For this argument, we can refer to two factors; (1) the research and money currently invested into renewable energy, and (2) the factor of rare earth materials.

First, the research in this book chapter shows the dominance of the US in terms of research money and patents in the area of clean tech. Indeed, the European countries individually also invest a lot of money and know-how into clean tech and renewable energy, but often their efforts do not lead to final products. Of all European countries, Germany has been able to acquire a pivotal position, but this position was achieved at a high cost relatively speaking. Whereas Europe pioneers a lot of projects in renewable energy, it is less clear whether the EU will be able to translate this into a power position. The People's Republic of China is less on the cutting edge of technology and know-how, but does what it does best; marry available technologies in renewable energy with the factor it has plenty of—labour. Since the mid-2000s, Chinese officials have increasingly realised the strategic importance of renewable energy, and have made the decision that Beijing should strategically invest in it. In just a few years, China has already become the world's largest producers in solar energy, wind energy and electric batteries. This gives China a lead over other countries. One can detect similar developments in e.g. India and the United Arab Emirates, but nowhere in the world are renewable energies combined with a deliberate strategy to strengthen the country's position in the world as is being done today by China.

Second, the factor of rare earth materials. A whole range of rare earth materials is needed for renewable energy technologies to work. As the need for these technologies will rise, different countries will benefit from it. China however is uniquely endowed with some of these crucial rare earth materials—for instance lithium, but the same can be said for a number of other rare earth materials. China is deliberately pursuing a policy whereby it wants to protect its own reserves. This creates potential dependencies, and will perhaps force other countries to be more subservient to China's wishes, or export cutting edge technological know-how in

exchange. This forms an added argument why China may well develop its position as a power, a position in the world it will probably share with the United States. It might be however, that this period of a duo-multipolar order will again subside in favour of a genuine multipolar one if the technologies are developed in such a way that they are less dependent upon 'rare earths'. Generally speaking, renewable energies themselves are quite complementary spread across the globe: for instance countries where the sun shines hardest, have less possibilities with regard to biomass, and vice versa.

2.5 Conclusion

This chapter studied the *geopolitics of renewable energy game and its potential impact upon global power relations*. The short answer is that the jury is still out. The complex geo-technical ensemble means that it is too early to really thoroughly grasp the consequences in terms of power distribution between the 'status quo' and the 'revisionist' states. Not only will it depend on a continued investment by private and public capital, government will also have to invest in a favorable regulatory environment. We have also seen that renewable energy by nature is much more decentralized, which would mean that there are several possibilities to create robust energy mixes, also in a renewable energy world. Key in this all remains the ultimate technological prize of renewable energy storage. Until then, the geopolitics of renewable energy will co-exist will a geopolitics of natural gas. We may thus expect a transition phase of two to three decades within which countries will of course try to defend their own business models. Just as Saudi Arabia currently is trying to slow down its regional natural gas rivals, the same may happen at a later stage with natural gas states who are being confronted by new renewable energy storage facilities that will upscale and come online.

The question was also asked whether the geopolitical world of renewable energy was different or similar compared to the geopolitics of conventional energy. The answer to this question seems to be a mixed one.

On the one hand, the answer could be that it is potentially *different*. Renewable energy is more decentralised in nature compared to conventional energy. An interwoven net of *renewables* combined with smart grids could potentially be more reliant and entails the *potential* for societal rejuvenation in the sense that it could empower people and regional authorities vis-à-vis central governments and interests. Moreover, those countries who invest in renewable energy may well become central players in the future. The US and China, but also some individual EU-countries such as Germany, are actors that invest a lot in renewable energy technology. As renewable energy will grow and gains a higher percentage of the energy mixes in countries, it will also alter their geopolitical positions. Countries

which geopolitically enjoy pivotal positions in the conventional energy world, will not necessary enjoy the same position in a world in which *renewables* grow in importance (e.g. Saudi Arabia). Eventually, geopolitical relations across the globe could be affected.

On the other hand, the answer could be that it is *similar*. The bigger projects in renewable energy suffer from very similar security issues as compared to traditional energy projects. The question for instance lies with where certain pivotal power lines will run, and who will control them. What about the physical security of these power lines? In addition, the *Geopolitics of Renewable Energy* also creates geo-technical opportunities and limitations. One of the major problems with which countries will be faced, concerns the issue of the rare earth materials that are needed in the technological advances of renewable energy technology. Rothkopf convincingly wrote that the green geopolitical crises might look similar to those of the conventional energy regime. There might be green protectionism in the western world, but also the condition of oil producing countries might be problematic in a world where renewable energy is growing fast (Rothkopf 2009).

In all probability, the geopolitics of conventional energy and that of renewable energy will exist next to each other for a period of several decades. Decision makers will have to be creative in trying to cancel out the drawbacks of one source of energy with the advantages of the other. In that sense, the geopolitics of energy will become more complex, and will have to deal with a variety of issues in foreign policy, diplomacy and international security. Instead of approaching this issue in *antithetical* terms, one should rather try to pursue more *synthetical* approaches in the study of geopolitics, power transitions and energy.

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