



# Transition to Renewable Energy in China: Impacts on Geopolitics

Philippe Couste and Su Qin

Xi'an Jiao tong University, School of Management, Xi'an, P.R. China.

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## ABSTRACT

China is considered as one of the biggest consumers of energy in the world, creating a lot of pollution. There is a noticeable shift to renewable energy in China to solve this issue. However, the geopolitical consequences of such a significant transition have received relatively little academic study. With existing literature and most recent data, this paper suggests a general framework for exploring this topic. This paper will briefly explain the energy and environment challenges faced by China and will demonstrate the most recent and significant commitments of the Chinese government to address those challenges. Then it shows the considerable progress already made by China in the energy efficiency of their economy and how China has used renewables to diversify its energy mix. Finally, the paper studies the implications, opportunities and challenges, on global politics of such an energy transition. This paper shows how a fast development of renewable energy in China affects geopolitical balance with Japan, EU and US. This paper goal aim is to enrich the theoretical literature about renewable energy geopolitics with a special focus on China. This paper demonstrates that a global energy system dominated by renewable energy will be more sustainable, just and peaceful than the one only dominated by fossil fuels.

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## Introduction

The smog that covers most major Chinese cities has raised awareness of the unsustainability of energy development in China. We remember the 2015 self-financed, Chinese documentary film by Chinese journalist Chai Jing. In 2013, of the 74 agglomerations that measured air pollution, 71 exceeded the rates considered problematic. The fast-economic growth these last four decades (1978 Deng Xiaoping reform of the economic system and an opening up to the outside world with an acceleration in 2001 with the China's accession to the WTO) has generated immense environmental challenges. China is the world's biggest carbon dioxide emitter, the world's biggest emitter of greenhouse gases, which lead to global warming, a capital issue not only for China but the future of all planet. Until now, the primary source of energy has been the most accessible on site, namely coal. 500 million tons in 1990, six times more, last year. Coal continues to dominate the Chinese energy mix, providing 2/3 of the demand. The primary challenge for China is to reduce the consumption of coal which generates too much pollution. China's ability to quickly sequence - economic downturn, the cap on emissions, long-term decarbonization, use of renewable energy- depends on the future of the planet's climate. The aim of China is to decrease the share of coal consumption to 58 % by 2020 (is around 62 % today). China is investing massively in renewable energy and the growth of renewables in China is really impressive. The energy mix of China is now considerably changing with the increase of the use of renewable sources of energies (wind, solar, hydroelectricity). Renewable energy in total generation of electricity production increased from 17% in 2008 to 24% in 2015.

What are the geopolitical implications of such an energy transition? Literature almost ignores the geopolitical impacts of the replacement of fossil fuel by renewable energy in China. This topic has indeed received relatively little academic study probably because this energy shift is relatively new. This paper first briefly shows the magnitude of the environmental problem caused by fossil fuels in China. Then it simply explains the most recent commitments of China to reduce pollution. This paper then demonstrates the enormous progress of China to address pollution changing completely its energy mix turning towards renewable energy. Using the method of case studies, this paper analyses the impacts on geopolitical balance. This paper studies how renewable energy affects geopolitical relationship between China and Japan, China and Europe, China and US.

## Literature Review

A significant number of researches have focused on how production, supply and demand of oil and gas affect geopolitical balance and can sometimes lead to international conflicts. However how renewable energy transition in China affect and will affect geopolitics is a topic almost not covered. Only North West European (German, Dutch and Belgium) researchers have been interested in the geopolitics of renewable energies. Probably cause of the early development of renewables in the domestic policy of these countries compared to the rest of the world.

We can distinguish 3 main trends in the analysis of impacts of renewable energy transition on geopolitics. Some scholars emphasize the geopolitical advantages, other the disadvantages of such a transition for the global geopolitics. A third group raise uncertainties and make proposals for the future.

Tele:

E-mail address: [philippecouste@hotmail.com](mailto:philippecouste@hotmail.com)

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### Geopolitical advantages

Peters (2002) is one of the scholars who argued that developing renewable energy would lead to more equitable energy distribution and lower geopolitical tensions. Casertano (2012), explains that renewables are less geographically concentrated than traditional energy sources, making it difficult for individual countries to control or limit the energy supply and manipulate the market price. Renewables becoming primary sources of energy will allow a high degree of energy self-sufficiency in all countries, shifting the focus from securing an external supply of fossil fuels to managing the internal supply of fossil fuels to managing the internal supply of renewable energy. Verrastro et al. (2010) and Johansson (2013) argue that renewable energy may strengthen energy security while at the same time it will inevitably lead to the emergence of new interdependencies between the countries. According to Kostyuk et al. (2012), renewable energy expansion is likely to lessen the role of geopolitics in international relations. In their view, renewable energy will increase the availability of energy and thus make it less prone to political tension.

### Geopolitical disadvantages

Other authors note that energy transition generates new types of conflicts and that renewable energy may take over the role that has been played by fossil fuels and become a driver of new political tensions. In case of large-scale renewable energy production and transportation across borders in the form of electricity, the principle of territorial control will be similar to that for oil and gas pipelines. The metamorphosing global energy mix will bring more diversity but also less secure. Rothkopf (2009) argues that the decline of petro states will have complex consequences and the energy transition will cause instability. Mecklin (2016) notes that transition to a global energy system dominated by renewable energy will create new geopolitical winners and losers. De Ridder (2013) notes that the main losers of the new geopolitics of minerals for renewable energy are the resource-poor countries of the developing world which have limited financial resources available to purchase new technologies. For Westphal and Droege (2015), the metamorphosing global energy mix will bring more diversity, but also less secure.

### Uncertainties and proposals

Paltsev (2016) holds that the future of geopolitics of renewable energy will be similar to the post-cold-war situation, where it was often uncertain. Paltsev argues that supply and demand for energy will remain an important factor influencing the global balance of power in the future. Bradshaw (2010) notes that energy transition brings uncertainty regarding energy supply and demand and that it is unclear how energy transition will be attained. Bosman and Scholten (2013) argue that "while a large-scale utilization of renewables diminishes energy scarcity and lower various kinds of pollution, their potential to address energy-related geopolitical tensions among producer, consumer, and transit countries remains to be seen." Hache (2016) notes that the challenges posed by energy transition could be as complex as the present geopolitics of fossil fuel energy. He notes that "the combination of local and decentralized relations as well as technical, economic, sociological, behavioral, spatial and legal dimensions add to the overall complexity and create new unexpected and unexplored interdependencies among the states". De Ridder (2013) envisages that an energy transition will lead to the emergence of new players and will move the international system toward greater multipolarity. She lists

three significant geopolitical implications: 1) countries with reserves of critical industrial minerals will become more powerful ; 2) parts of the world with major mineral reserves such as the South China Sea will rise in strategic importance ; 3) there will be a gravitational shift towards countries that control technologies and know-how on minerals and technologies for renewable energy. De Ridder notes (2013) that "countries with high R&D expenditures on renewable energy, such as Japan and China and countries with strong growth in renewable energy capacities such as Denmark and Germany, will gain (geopolitical) power". Overland and Kjaernet (2009: 1) present the transition to renewable energy as a « global strategic race» in which prosperous countries will gain an economic advantage over other countries. To regulate this new market of renewable energy, which is changing the geopolitical map of the world, Dreyer (2013) calls for a more active role for an international organization such as OECD (including the International Energy Agency) and the WTO.

### China's 4 most significant commitments

China is trying to solve this environmental problem without damaging the economy. The coal mining industry employs 4 million people and China should think about their reconversion. Massive investment in green technologies creates a lot of new employment opportunities.

Firstly, China has participated in the 2015 United Nations Climate Change Conference, COP 21 which was held in Paris in 2015. The conference negotiated the Paris Agreement, a global agreement on the reduction of climate change. The universal agreement's primary aim is to keep a global temperature rise this century well below 2 degrees Celsius and to drive efforts to limit the temperature increase even further to 1.5 degrees Celsius above pre-industrial levels. According to Stang (2016) and Umbach (2016), the geopolitical implications for energy markets of the Paris climate agreement are numerous and need to be better understood. China is the largest developing country in the world and places reduction of climate change as the priority. This is one of the government most significant commitment to addressing China's energy and environmental challenges to date.

Secondly, China also strongly supported the United Nations' adoption in September 2015 of the 2030 Agenda for Sustainable Development, which sets 17 Sustainable Development Goals for the world. The 2030 Agenda for Sustainable Development was adopted at the United Nations Summit in New York from 25 to 27 September 2015. The Agenda is a broad and universal policy agenda, with 17 Sustainable Development Goals (SDGs). Goal 6 clean water and sanitation, goal 7 affordable and clean energy, goal 12 responsible consumption and production, goal 13 climate action, goal 14 life below water, goal 15 life on land. Many goals are linked to the protection of the environment with the use of new energies.

Thirdly, in the 13th Five Year Plan (2016-2020), which was reviewed and approved by the Fourth Session of the 12th National People's Congress in March 2016, Chinese government engaged in redefining the future Chinese development concept featuring, green and shared development. China sets stronger reduction of carbon intensity target. With the Copenhagen pledge of 2020 a 40 % to 45 % reduction from 2005 levels by 2020 (World Resources Institute). As Li et al. (2017) note, in the coming

years, China will pursue innovative development and improve the quality and efficiency of development.

Fourthly, "Made in China 2025" is an initiative inspired directly from Germany's "Industry 4.0" plan to upgrade Chinese industry comprehensively. Its guiding principles are to have manufacturing be innovation-driven, emphasize quality over quantity, achieve green development. In this initiative, there are clear and specific measures for innovation, quality, intelligent manufacturing, and green production.

#### **First results of China policy**

The Chinese government in last years has made many commitments and took efficient measures to solve an environmental problem. Studying recent data, we will present the new China energy mix more relied on renewable energy.

Firstly, we have to consider and admit the considerable progress already made by the Chinese in the energy efficiency of their economy in last decades. Between 1978 (opening reform of China) and 2017, almost 40 years, the Chinese economy was "multiplied by a factor of 18, while its energy consumption was multiplied by only 5". That is a 70% decrease in energy intensity per unit produced.

China intends to promote non-fossil energies so that they cover 30% of the country's energy consumption by 2020 and 40% in 2030. The Chinese leadership announced that the country would reach its peak greenhouse gas emissions by 2030 and then pledged to reduce them gradually. China is now the world leader in renewable energy and would spend more than \$ 100 billion a year in China to develop green technologies sector. It also invests in renewable energy projects abroad (32 billion dollars a year).

China occupies the first place for the construction of photovoltaic solar panels and is the largest producer of photovoltaic power. Its prices are nearly 20% lower than those of its competitors.

In the field of wind turbines, it has made up for lost time. China is the world's leading country in electricity production from renewable energy sources. In 2015 China use renewable power (solar energy, hydroelectricity and wind power) to provide over 24% of its electricity production. Electricity production is still provided mainly by coal power plants. But renewable energy sector in China energy mix has not ceased to develop and much faster than fossil fuels and nuclear energy.

We can see efforts have been made by Chinese government to increase the share of renewable in China's energy mix. Some may think that unlike oil, coal and gas, the supplies of which are finite and subject to geopolitical tensions, renewable energy systems can be built and used wherever there is sufficient water, wind, and sun. However, we will see that a shift from coal to green technologies can also have geopolitical consequences that merit study as well.

#### **Research design and methodology**

The problem with all the literature available related to this subject is that it does not take in consideration the emergence of China as a main energy power, leading the race in renewable energy and how it has already shaken the geopolitical balance through international trade disputes.

This paper uses case studies analysis. Case study research will allow the exploration and understanding of complex consequences on geopolitics of renewable energy transition in China. In order to explain concretely and practically the impacts of China renewable energy transition,

the paper focus on three main trade disputes linked to renewable which occurred in the last past years.

#### **Analysis**

##### **China/ Japan**

In 2010 following a maritime conflict, the Chinese government has blocked exports to Japan of rare earth used in products like hybrid cars, wind turbines, and guided missiles. China has taken over the "rare earth" needed to manufacture solar panels, batteries and electric motors. They are also used extensively in electronic gadgets such as cellphones, and in national defense equipment. Rare earths are sold for several hundred dollars a pound.

Rare earth elements such as Lithium, Cobalt, Indium (17 elements) are widely used in green technologies, including solar panels and wind turbines and difficult to extract. Today almost most mining, production and processing of rare elements takes place in China. Lower labor costs have now enabled the country to be the world's predominant supplier of rare earth, accounting for 97% of the current supply. As a transition to renewable energy accelerates, there are opportunities for cartelization. Even if these cartels are unable to achieve the kind of impact that OPEC did in the 1970s oil market, they might exert influence over consumers of these materials.

It is easy to understand all the importance of these resources for Japan in a globalized economy. For example, in order to manufacture the Toyota Prius, hybrid cars, Toyota need rare earth. This Toyota model has been one of the best-selling cars in the United States. United-States is one of the largest markets for Toyota. If Toyota cannot produce or sale these cars, it will affect all company business, many Japanese will be unemployed, Toyota being one of the largest Japanese company, it can shake the economy of an entire country. It has already administered the demonstration of the geostrategic use that it can make of rare earth and renewable energies in general. When China cut these supplies, vital for Japan, it can shake all world economy and geopolitical balance.

##### **China/ EU**

The solar panel industry has known a growing demand in the EU (European Union) market in the past few years. Facing the challenges of growing energy consumption and climate change, the EU launched new targets for the year 2020 "the 2020 climate and energy package". In 2020, 20% of EU energy will come from renewable. The demand of solar panels has increased a lot in E.U. China seized this opportunity and crowded out the EU manufacturers. EU launched in 2013 anti-dumping measures on solar panels imported from China on the request of EU manufacturers. Despite of the significant trade dispute between the EU and China these anti-dumping measures have been extended in 2017. The EU is China's largest trading partner and China is the EU is the second largest trade partner after the US. Since the trade relationship between the EU and China is admittedly too big to fail, settling the solar panel dispute can be considered successful for having avoided a trade war. It is crucial for both the EU and China to maintain good trade relations based on mutual benefit. However, differing trade interests with China of Member States have divided the EU in the negotiations. In facing the increasing bargaining power of China, a joint effort among the EU Member States is advisable. For the solar manufacturing industry, global competition has resulted in reduced prices. The lower solar panel prices bring benefit to the customers, as well as the

Member States that are promoting the adoption of renewable energy consumption by subsidizing the installation of solar panels. Meanwhile, fair competition should be guaranteed under the WTO.

#### **China/ US**

In February 2018, to help American solar manufacturers who cannot compete with imports of cheap solar panels from China, US (United States) decided to set a 30% tariff on this particular product. It seemed to be a good measure for American manufacturers and American industry. However, this tariff increased the cost of solar panels and around 20 000 American not manufacturing but working on solar projects have lost their jobs. Donald Trump's trade war with China has not done the US any favors so far. US have not such an accomplished strategic plan developing renewable sector. President Donald Trump is a climate change doubter and US. China on the contrary has a very developed winning strategic plan. China is making itself an energy exporter. China is the world's largest importer of oil and wants to limit dependence on producers. China choose to invest \$126,6 billion in 2017 on new renewable energy, half of the world's renewable energy investment and more than three times the investment of U.S. (\$40.5). There is the need for China to control supply routes, a concern to which the One Belt, One Road project is supposed to provide an answer. According to forecasts, China will absorb up to 28% of world's energy in 2035, when the United States will claim only 12% of the world total. But China is also becoming an energy producer and could use same routes to export energy and compete with U.S. China huge investment and export of renewable energy gives other countries the opportunity to reduce their reliance on foreign oil, gas or shale gas. China this way is also decreasing its carbon emissions. What is good for environment, for Chinese people and what gives a good image to the world? China is developing his soft power. The ultimate goal is to replace U.S. as the most significant actor in different regional alliances and business relationships.

#### **Discussion**

In a world where renewable is becoming a leading source of energy, green technologies may be a source of international cooperation or rivalry.

Indeed, renewable energy becomes a more dominant source of energy in China and most of the countries. It involves some apparent challenges particularly for the countries which have long relied heavily on oil and gas exports. Oil producers including US, Russia, Nigeria, Saudi Arabia, and Venezuela have faced fiscal challenges from oil price decline. In the US the oil price drop has created significant unemployment in oil-producing regions. There is a real shift toward renewable and one of the main effects is the decline in revenue generated by fossil fuel energy export and the huge impetus for political and economic reform and diversification of the economies of these countries. It can lead to regime destabilization and affect the relationships between countries. Wood (2016) notes that this could potentially affect the relative balance of power between countries and spurs global conflict.

We have presented the energy and environmental challenge faced by China. We have described the central commitments that Chinese government has made in recent years to tackle severe pollution problem. Moreover, we have analyzed the first very positive results of these policies. China has chosen a cleaner or greener energy mix. The transition in the energy system marks the end of the boom years for coal.

There is now a rapid development and bright future for renewable sources of energy. What are the implications, opportunities and challenges, of this China energy shift on the geopolitics of renewable energies?

Renewable resources, in contrast to conventional fossil resources, are more difficult to control in time and space. Renewable energy are more fairly distributed. As Mansson, (2015) argues that as a consequence, economic and geopolitical incentives for states to engage in conflicts to secure or control renewable energy resources are low.

However, in a world in which renewable could become a dominant source of energy, investment and technology may increasingly become a source of cooperation or a node of geopolitical rivalry. It exists tensions between developing and developed countries over the transfer of technology. As Crikemans (2011) indicates, "from an external-geopolitical perspective, those countries that today invest in renewable energy source and technology may become the dominant geopolitical players tomorrow." There is potential competition concerning renewable energy infrastructure. China proposed a \$50 trillion worldwide wind and solar power super grid, the "Global Energy Interconnection" which China envisions could be in operation in 2050. The project envisions both global power connectivity and global power generation from the North Pole to the farms in the equator.

Some like Overland and Indra (2015) argue that there is a risk of cartelization of multinationals companies involved in renewable energy. Only companies with substantial balance sheet may be best positioned to succeed in the renewable energy sector as it grows. In recent years large oil and gas companies have started to move into the renewable energy market. For example, Total's (French oil company) expansion into renewable has included the acquisition of SunPower, a US solar panel manufacturer for \$1.4 billion and Saft a leading battery designer for \$1 billion. As a transition to renewable energy accelerates, there are risks for cartelization.

However, another aspect of the problem to considerate is the nature of renewable energy which makes its development better suited to smaller companies and privately funded start-ups, rather than the large state-owned companies predominant in the world of oil and gas. This is because renewable energy lends itself to a more decentralized and distributed energy generation than fossil fuels. We are already assisting to the emergence of new entrepreneurs creating startups with innovative ideas who want to revolutionize the energy sector. They focus on off-grid or mini grid to give access to power to the billion people in the world who does not have a proper access to it. In Sub Saharan Africa and developing poor regions of Asia, the need is huge. Africa represents 16% of the global population but less than 6% of the global energy demand. However, this situation could change with the exploitation of the various sources and reserves of renewable energy in Africa. The rise of these successful start-ups that enable demand response is leading to increasingly more distributed energy systems.

#### **Conclusion**

This paper has presented the energy and environmental challenges faced by China. It has described the significant commitments that Chinese government has made in recent years to tackle severe pollution problem. Moreover, this paper has analyzed the first very positive results of these policies. China has chosen a cleaner or greener energy mix. The transition in the energy system marks the end of the boom years for coal. There is now a rapid development and bright

future for renewable sources of energy. As this paper suggests that China energy shift has significant implications for geopolitics including both opportunities and challenges.

Transition to renewable energy may create geopolitical advantages and disadvantages as well as uncertainties for the geopolitical balance of the world. It creates new challenges and new opportunities. Despite the risks of national monopolies, cartelization and trade disputes, there are reasons to believe that renewable energy can effectively replace fossil fuels in the long term. A global energy system dominated by renewable energy will be much more sustainable and fairer than one only dominated by fossil fuels and nuclear technology. Renewable energy lends itself to a more decentralized and distributed energy generation than fossil fuels. Decentralized renewable energy systems such as hydro, solar, wind can provide the opportunity for clean and cost-effective electricity and heat generation, especially in rural off-grid areas. This paper shows that renewable energy can “democratize” the energy supply and create new network structures that can be called “Internet of Energy.” Deployment of renewable energy will help to improve the climate by reducing greenhouse gas emissions. Finally, this deployment will avoid some of the geopolitical consequences (migration especially among weakest populations) of a changing climate. China a champion in renewable energy could own a significant credibility advantages over countries not investing enough in renewable energy or skeptical about climate change. China in recent years leading the renewable energy revolution has gained more soft power and has now the opportunity to take global leadership.

#### References

Bosman, Rick and Scholten, Daniel (2013) How renewables will shift the balance of power? <http://reneweconomy.com.au/2013/how-renewables-will-shift-the-balance-of-power-78579>.

Bradshaw, Michael J. (2010) In search of a new energy paradigm: energy supply, security of supply and demand and climate change mitigation, *Mitteilungen der Osterreichischen Geographischen Gesellschaft*, 152.11-28.

Casertano, Stefano (2012) Risks of new energy- risks posed by renewable energy and climate protection. *Brandenburg Institute for Society and Security (BIGS)*, No 9.

Criekemans, David (2011), The geopolitics of renewable energy: different or similar to the geopolitics of conventional energy? *ISA Annual Convention*, 19 March, 2011, Montreal, Quebec, Canada, global governance: political authority in transition, the panel on “geopolitics, power transitions, and energy”.

Dreyer, Iana (2013) Renewables: do they matter for foreign policy? *Brief Issue*, No. 23, *European Union Institute for Security Studies (EUISS)*.

De Ridder, Marjolein (2013) The geopolitics of renewable energy technologies, *The Hague center for strategic studies*.

Eisen Joel, The new Energy Geopolitics? China, renewable energy, and the “greentech race” 86 *Chi.-Kent L. Rev* 9 (2011)

Gao Xinyu, Jin Bo, Li Bin, Yang Kai, Zhang Hongguan, Fan Boyuan (2011) *Science Direct*, Study on Renewable Energy

Development and Policy in China. Published by Elsevier Ltd. Selection and/or peer-review under responsibility of RIUDS Hache, Emmanuel (2016) La geopolitique des energies renouvelables : amelioration de la securite energetique et/ou nouvelles dependances? The geopolitics of renewables: does more energy security come with more energy’s dependencies? *Revue internationale et strategique*, 1 (101), 36-46.

Johansson, Bengt (2013) Security aspects of future renewable energy systems. A short overview, *Energy*, 61, 598-605.

Kostyuk, Valeriy, Mkarov, Alexey and Tatyana Mitrova (2012) *Energy and Geopolitics*, *Energocademy*, 1 (44), 46-59.

Li, Huijiong. Wang Jian, Wu He, (2016) Analysis of implementation of China’s 12<sup>th</sup> Five Year Plan and prospects of its next five years”, *Journal of Chinese Economic and Foreign Trade Studies*, Vol 9 Issue: 1, pp. 40-59, <https://doi.org/10.1108/JCEFTS-12-2015-0030>

Mansson, Andre (2015) A resource curse for renewables? Conflict and cooperation in the renewable energy sector, *Energy Research & Social Science*, 2015 – Elsevier.

Mecklin, John (2016) Introduction: international security in the age of renewables, *bulletin of the atomic scientists*, 72 (6), 377-377, DOI:10.1080/00963402.2016.1240927.

Overland, Indra (2015) Future petroleum geopolitics: consequences of climate policy and unconventional oil and gas, *Handbook of clean energy systems*, chichester: Wiley, pp. 3517-3544.

Paltsev, Sergey (2016) The complicated geopolitics of renewable energy: *bulletin of the atomic scientists*, 72 (6), 390-395.

Peters, S. (2002) Courting future resource conflict: the shortcomings of western response strategies to new energy vulnerabilities, *energy exploration and exploitation*, 20-1 (6-1), 26-60.

Rothkopf, David, (2009) Is a green world a safe world? Not necessarily. A guide to the coming green geopolitical crisis, *Foreign policy*, September/ October 2009.

Stang, Gerald (2016) Shaping the future of energy. *European Union Institute for Security Studies (EUISS) Brief issue*, 24, 2016.

Umbach, Frank (2016) Energy prices, climate change and geopolitics: what next? Presentation and background paper-plenary 4, *Asia Pacific roundtable- APR 30 “cooperation and contestation in a changing regional landscape”*.

Verrastro, Frank and Ladislav, Sarah (2010) The geopolitics of energy. Emerging trends, changing landscapes, uncertain times. A report of the CSIS energy and national security program.

Westphal, Kirsten and Droege, Suzanne (2015) Global energy markets in transition: implications for geopolitics, economy and environment, *Global trend 2015*, Prospects for world society.

Wood, A., Blackhurst, M., Garland, J., Lawler, D.F. (2016). Incentivizing Decentralized Sanitation: The Role of Discount Rates. *Environmental Science and Technology*. DOI: 10.1021/acs.est.6b00385.