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Business as UNusual

The implications of fossil divestment and green bonds for financial flows, economic growth and energy market

Solveig Glomsrød and Wei Taoyuan



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Abstract: Green bonds and fossil divestment has emerged as a bottom-up approach to climate action within the business community. Recent pledges by large banks and institutional investors have reached levels that have the potential to contribute markedly to a low carbon transition. This paper traces the impact of green finance in a multiregional global general equilibrium model with non-fossil and non-coal segments of financial flows in addition to the usual unconstrained market for funding. Our high green finance scenario reflects a reasonable upscaling of current level of pledges towards 2030.

The study shows that green finance shifts the investments towards industries generating more value added and increasing GDP, future savings and investments. The green finance leads to a lower return on investments and a transfer of income from investors to wage income. Russia and China see the largest cost increase in coal investments due to constraints on finance for fossil industries. The green finance reduces coal consumption by 2.5 per cent below BAU in 2030 and raises the share of non-fossil electricity from 42 to 46 per cent at the global level. Over the whole period towards 2030, the green finance avoids global CO₂ emissions corresponding to the total emissions of European Union and Japan in a recent year.

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1 Introduction

The Chinese teacher, politician and philosopher Confucius stated 2500 years ago that «The gentleman understands moral duty, the petty person knows about profit» (Ebrey 2010). Was Confucius advocating a division of labour, freeing the gentlemen from trivial and un-ethical business transactions, or should a broader set of targets based on moral duty be imposed on business? Whatever the answer, Confucius saw a potential for the business community to better integrate moral duty and the ethical dimension of business has gained territory over the last two millennia.

However, taking ethical values into account have been seen as a threat to profit as some golden investment opportunities might be foregone or even worse, lost to competitors. More recently, that might have changed. Increasingly both consumers and shareholders pursue the same ethical targets, resolving some of the perceived conflict between profit and ethics in production and trade. Ethical aspects are frequently stated aims of private companies. Ethics “sells”, and violations might be extremely damaging to companies and investors.

As more corporations, institutions and individuals are considering ethical aspects, the threshold for others to join the campaign and comply with ethics is lowered. It becomes increasingly unfavorable for competitors to engage in the stigmatized projects. Further, if investment opportunities are forsaken, like in the case of green finance, they will also more frequently be lost to investors outside the campaign, as the un-ethical projects must compete harder for funding. Hence, every decision to avoid controversial investments will have an indirect effect supporting the ethical campaign.

The ability in our times to collect and rapidly spread information worldwide facilitates the bottom-up efforts of consumer and shareholders in imposing ethical issues upon the commercial sphere. The tragic collapse of a textile factory in Bangladesh taking the lives of 1100 women in 2013 reached the whole world immediately, and set a milestone for ethical aspects in work environment issues in developing countries (BBC 2015). Climate change has so far not been prominent among the ethical concerns of societies, partly because of lack of confidence in scientific documentation, partly because of the strong economic position and political influence of the energy sectors. Politicians have been late to take action and the electorate interpreted the lack of action as no serious climate problem.

However, this is changing. The IPCC 5th Assessment Report concluded that human influence on the climate system is clear and that recent climate change has had widespread impact on human and natural systems, also warning that climate change will amplify existing risks (IPCC 2014). Increasingly people around the world perceive that the climate is changing and the challenge of climate change has reached the minds of both investors and consumers. So far, politicians have been negotiating with a meagre result, although the recent climate agreement at

the 21st Conference of the Parties (COP21) meeting in Paris might represent a change in direction.

Within the business community, there is more willingness to act. On the investors' side, a trend towards green finance has emerged, surfacing as pledges to invest in green projects or to abstain from investments in fossil industries. Besides being exposed to divestment driven by environmental priorities of investors, fossil industries are also vulnerable to future tightening of climate policy. The risk of stranded assets in fossil industries is increasingly seen as a real and non-negligible threat in the medium term (Carbon Tracker Initiative 2013; 2014). With rising awareness of global warming, there is now international political support for climate mitigation. At the COP21 in Paris, the Parties confirmed their commitment to a maximum temperature rise of 2°C above pre-industrial levels (UNFCCC 2010), and even pledged to strive for lowering the maximum warming to 1.5°C. According to the International Energy Agency (IEA) chief economist Fatih Birol (The Irish Times 2013), two thirds of proven reserves of coal, oil and gas must remain in the ground if the world is to achieve the 2°C target.

Dedicated green finance targets projects that mitigate or adapt to climate change or otherwise improve the environment. Hence, green finance can play an important role in raising the awareness of an ongoing green shift within energy systems and the society. Green investment pledges serve as labels signaling that the shift is feasible and financially attractive as well as urgent. The increasing volume of green pledges and investments makes it harder to ignore sustainable options, clinging to the fossil era. The determination of investors to go in a green direction is visible in the market for green bonds and in pledges to divest in fossil energy.

The fossil divestment movement started as an activist campaign and has developed into a policy of corporate social responsibility among large investors over the last few years. Students inspired by anti-war and anti-apartheid divestment movements coordinated a campaign at half a dozen university campuses in the United States in 2011 and by 2012 as many as 50 university funds were under pressure to divest (Arabella Advisors 2015). Besides university assets, numerous faith-based foundations, municipalities and pension funds soon supported divestment. The Unburnable Carbon-report by Carbon Tracker Initiative (2013) represents another milestone, bringing the risk of carbon bubbles into the divestment perspective, making it increasingly clear to the business community that fossil energy not only contradicts urgent climate policies, but also challenges the profitability of their holdings in fossil industries, in particular coal.

Today, large financial institutions have aligned with the divestment campaign through pledges to divest in coal. During the UN Climate Summit in New York in September 2014 the Rockefeller Brother Fund pledged to divest its total endowment, eliminating its exposure to coal and tar sand (RBF 2014) to less than 1 per cent of the total portfolio by the end of 2014. An overview of pledges made in the wake of the Summit is found in UN (2015). Further breakthroughs occurred in 2015 when the Norwegian Government Pension Fund Global (GPF) decided to divest its portfolio of USD900bn by 2020 at the latest, and the French global insurance company AXA with around €1200bn in assets pledged to divest in coal extraction and coal based power production (AXA 2015; Bloomberg 2015). Bank of America was the first large bank to join the divestment initiative early in 2015, followed recently by Citigroup's pledge to cut lending not only to mountain top removal strip mining, which they already practice, but also extending their policy to all coal mining (Financial Times 2015).

Thus, the divestment campaign is about to succeed in making businesses aware of and considering the risk of stranded assets. A Citigroup analyze warns that the 2 degree target might involve stranded assets of USD 100tr by 2050 (Citigroup 2015). The risk of stranded assets is also starting to worry national banks. The Bank of England Governor Mark Carney warned investors that “the vast majority of reserves are unburnable” if the 2 degrees target shall be reached (The Guardian 2015).

The phenomenon of stranded assets is well- known from numerous cases when technologies and trends have shifted substantially, leaving the capital to rust and ending its economic lifetime long before the expected time horizon for the investments. In the case of climate change, politics more than business internal issues impose the risk of stranded assets. Policies can be influenced and delayed. Investors might put the risk warnings in the denial box, and the preoccupation with short-term returns might leave the long-term concerns in oblivion. However, the challenge of climate change is global, making the issue different from earlier experiences and hard to come around. It represents a milestone for the divestment campaign that warnings start to come from authoritative voices, like the governor of Bank of England and IEA.

A timely question is how green bonds and divestment in fossil fuels will affect the economy at large and the target of climate mitigation in particular. In this article we report from a study of how dedicated green investments flows and divestment in fossil industries might impact the economy, the financial flows, energy trends and the climate emissions. The analysis is based on a multiregional global economic model with emphasis on production and consumption of energy. The model is adapted to deal with alternative labeled segments of financial flows in the global financial market.

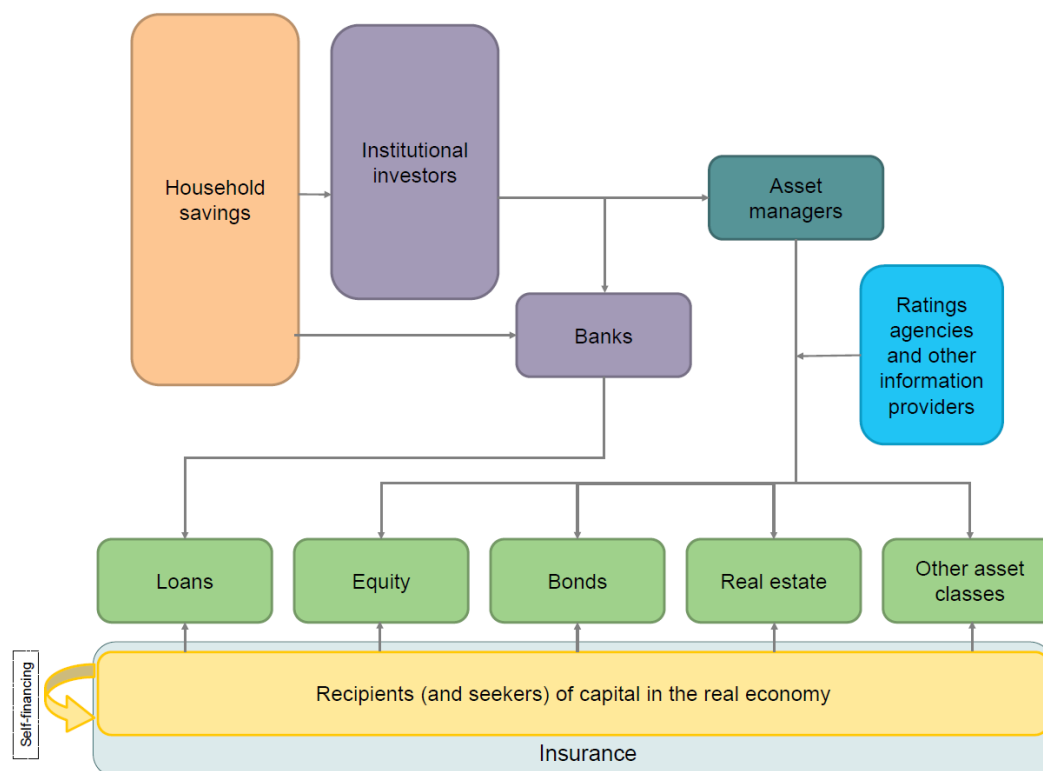
2 Channels for green finance

Green investment is funding for environment and climate friendly projects and can be categorized based on their project qualities. Divesting by declining to finance projects or industries that are damaging the environment encourage green investments indirectly by giving priority to other investment objects, in particular the green ones which compete directly with the polluting projects. Below we illustrate the flows of funding in a stylized illustration taken from UN (2015). This figure 1 illustrates the path of financial flows from private investors, showing the main business segments involved along the investments flows and the different asset objects on the recipient side.

Households generate savings which are deposited in banks or enter funds of institutional investors. Institutional investors include funds like pension funds, faith based foundations, and university funds, managing assets risk differently due to future liabilities. Insurance companies are included among the institutional investors.

Deposits of households and institutional investors represent the supply of loan finance from the banking sector. Besides bank deposits there is a flow of finance from households and institutional investors passing through asset managers. The asset managers are tracking the performance and potential of asset classes and objects.

The role of rating agencies is important in relation to green and climate finance. Upcoming industries like renewables or other environmentally benign projects have shorter records and might be perceived as more risky than conventional technologies. Rating agencies contribute to green and climate finance by increasing the flow of information, convey price signals and raise investors' confidence (UN 2015). New indices on the performance of investment bundles excluding fossil projects or including green projects facilitate decisions to reduce exposure to fossil industries or raise involvement in green projects. For example, the Standard & Poor's Green Project Bond Index is designed to track the performance of project finance segment of the global green bond market (Arabella Advisors 2015).



Source: Vivid Economics

Figure 1. Investments flows

Green priorities in investments decisions are made at all stations along the investment flow. Banks might pledge to finance renewable energy or to keep certain technologies out of their loan portfolio. Institutional investors have made a variety of pledges to divest and to pledge funding for green projects.

Figure 1 illustrates the flows of private savings and investments. However, municipal and government funds and investments follows similar pattern, like the vast sovereign wealth funds built up by natural resource incomes or foreign exchange funds from trade surpluses.

Green finance creates a parallel system of flows to what is illustrated in figure 1. At all the stations along the parallel flows decisions are taken choosing between shades of green versus investments that are more or less damaging to the environment.

The green finance pledges take various approaches. Investors can move towards a low carbon economy by actively investing in green solutions, including energy efficiency or by selling out of companies in fossil energy extraction and production, pledging not to invest in fossil industries in the future. For our study of the impact of green finance we distinguish between the following categories:

- 1) Pledges to invest in green solutions
- 2) Pledges to not invest in any fossil based activity
- 3) Pledges to not invest in coal

Investments in green solutions can be renewable energy, low carbon infrastructure or belong to a large variety of investments that reduce the broader environmental footprint. Green bonds, where the proceeds are used to finance climate benign or other green projects, fall into this first category.

Green bonds are issued by public and private organizations. The green bonds are explicitly issued to finance climate or other environment - friendly projects. The majority are labeled green in common understanding between the bond issuer and the project owner, however, some have been exposed to an external review or independent 2nd opinion of their green profile. The project investors financed by the green bond proceeds carries the responsibility to comply with the labeled green profile.

There is no unifying standard or definition of green bonds. Although the majority avoids projects in fossil industries, they do not totally exclude such investments, as some green bonds are addressing energy efficiency projects in fossil industries. Besides the economic return, the incentives to comply with the green label lie in a strong corporate social responsibility (CSR) profile in promoting a sustainable development. In 2014, the issues of labeled green bonds amounted to USD 37bn, up from USD 11bn in 2013, and are expected to reach USD 70-80bn in 2015 (Climate Bonds Initiative 2014; 2015).

The Climate Bond Initiative (Climate Bonds Initiative 2015) also operates with a class of bonds called climate-aligned bonds. These are bonds without explicitly declared or labeled green obligations, but nevertheless are clearly promoting a transition to a low carbon economy. Bonds issued to finance low-carbon infrastructure and renewable energy are dominating the climate-aligned bonds, and China Railways with bond issues of USD 140bn is a dominant actor. In 2015 China established a framework for green bonds and the Agricultural Bank of China issued the first green bonds in China on 13 October 2015 (Reuters 2015), opening up an expected boom in green bond issues in the Chinese bonds market. Recently Bank of China announced a green bond quota system for financial sector (Climate Action Programme 2016). In the future, climate aligned bonds can be expected to be replaced by labeled green bonds.

In 2014 the climate-aligned bonds outstanding amounted to USD 503bn globally, increasing to USD 597bn in 2015 (Climate Bonds Initiative 2014; 2015).

The divestment flows in categories 2 and 3 are also depicted as separate flows in our study. As the divestment movement has been gaining territory, the diversity in pledges has increased. Also among the large investors there are multiple approaches to divestment. The Norwegian Government Pension Fund Global (GPF) divests in companies with more than 30 per cent exposure to coal, whereas AXA divests from companies with more than 50 per cent coal exposure and Citigroup divests from coal and tar sands, above 1 per cent of their holdings. When we model the divestment under categories 2 and 3 we have to simplify and assume that all coal or fossil industries are targeted for the divestment pledges, as our model cannot distinguish between single product and mixed companies. In the national accounts, which are the basis of our model input data, mixed companies will generally be split and each item merged with similar production activities into a separate statistical sector.

The divestment campaign took off before the COP21 in Paris. Pledges were announced and overviews of the divestment activity have become available (UN 2015). However, there is a need to make pledges more transparent and operational for analysis from a watch perspective and for analysis of their impacts. Some green bonds are equipped with a second opinion from an independent actor. A similar approach for divestments in climate and environmental damaging project might be useful, clarifying the divestment framework and coverage of pledges. Second opinions might also help in standardizing the divestment terminology and increase the compatibility between ethical pledges and economic statistics, thus improving the basis for analysis of the impact from a macro level perspective.

3 Modeling green finance in GRACE

3.1 The GRACE model

Our study of the impact of green finance and divestment uses a multi-sector, multi-regional, recursively dynamic global computable general equilibrium (CGE) model GRACE (Aaheim and Rive 2005). GRACE stands for the Global Responses to Anthropogenic Change in the Environment. The model has been applied to studies on climate impact, adaptation, mitigation, and related policy analysis (e.g. Aaheim et al. 2012; e.g. Glomsrød et al. 2013; Liu and Wei 2014; Underdal and Wei 2015).

GRACE covers eight regions: United States, European Union, Japan, Russia, China, India, Brazil, and the Rest of the World. Each region's economy describes 15 production activities including three agricultural sectors, three manufacturing sectors, three transport sectors, one services sector, and five energy sectors of coal, crude oil, refined oil, gas and electricity. In the electricity sector, we introduce nine technologies generating electricity from coal, gas, oil, hydro, nuclear, biomass, solar, wind, and other renewables.

The base year economy (2011) is calibrated around the GTAP v9 database (Badri et al. 2015). The cost structure of electricity generation technologies in the base year (2011) is estimated from Tables 4.1A and 4.2A of OECD/NEA (2010). The business-as-usual (BAU) scenario 2011-2030 roughly follows the New Policies Scenario of World Energy Outlook in terms of regional GDP and energy consumption (IEA 2014). Regional population growth is taken from the medium fertility scenario of UNPD (2013).

In each region and year, the exogenous endowments of productive resources (i.e. labour, capital, and natural resources) are fully used for production. Labour can flow freely from one activity to another, whereas capital and natural resources are activity-specific.

Producers pursue profit maximization and consumers pursue utility maximization. Bilateral trade allows substitution among regional contributions. Regional income includes the remuneration for productive resources and taxes.

Economic growth is mainly driven by savings and investments, but is also determined by population growth, change in the availability of natural resources, and technological change. The regional rates of technological change are the same for all simulation cases.

3.2 The investment mechanism

The investments are global in nature, flowing to the regions where the return is the highest. However, regions tend to have somewhat different rates of return because their economic growth potential and performance differs. Hence, the supply and demand of finance is modeled in two layers. One part of supply responds to the expected regional rate of growth along BAU, indicating that some regional markets are in a more expansive mode than others are. This makes it more plausible to achieve a certain regional return to investments, which can be regarded as relatively risk free. Further, there is a race among industries worldwide in attracting investments based on their special dynamics, coming from favorable trends in demand or from a rapid technological change at the supply side. Equilibrium in the global financial market is achieved when the rate of return to capital is equalized across regions and industries, given that there is a basic flow of investments to regions responding to the risk free investment component. This means that there are certain regional differences in overall rate of return to investments, although the supply of finance in the global competitive market for funding achieves the same rate of return.

3.3 Introducing green finance

When green finance enters the financial market, it interferes with the access to new real investments in fossil and environmental-friendly industries. Rather than having one global financial market, we split the investment flow in segments corresponding to the three categories: non-fossil finance, non-coal finance and the unconstrained finance.

Green pledges represented by green bonds are assumed to be non-fossil. The non-coal finance covers coal divestment flows and finally there is the usual unconditional finance with no constraints on the investment target. The constraints introduced by the two flows of green finance are imposing an endogenous premium on fossil capital accumulation reflecting the relative shortage of access to finance. The risk of investing in a sunset industry rather than in a solar future is, however, not an element in this premium, and would be an additional element of the cost of fossil finance. We assume that fossil industries cannot exceed their original global activity level in the BAU scenario. Further, if the gap between return to capital in the divestment and the unconditional finance segments is becoming unreasonable high, the borders between financial segments tend to loosen. That is, if for instance the coal industry offers a remarkably high return, the ethics is put under pressure and to some extent giving way for more narrow business priorities.

The divestment is assumed to target regions with various intensities. We assume that the funding targets regions with a particular focus on climate policy and renewable energy. In those regions both the risk of stranded fossil assets and the return on renewables and green investments might be high. Hence, we implement a regional divestment profile (Table A1) corresponding to the regional allocation of the climate aligned bonds as outlined by the Climate Bonds Initiative (2015).

4 Scenarios

The diversity of divestment pledges makes it beyond reach in this context to design divestment scenarios that precisely reflect the status and momentum of further development. Hence, we introduce stylized scenarios building upon major real pledges that indicate scale and direction of financial greening and divestment.

We consider two alternative scenarios (SN1, SN2) and compare the outcome with the BAU development path. Both scenarios introduce labeled Green Bonds as the only source of non-fossil funding and in addition, a dedication among investor groups to avoid investment in coal, i.e. coal extraction and coal based electricity generation.

SN1 assumes that issues of labeled green bonds increase from USD 100bn as expected for 2015 (Climate Bonds Initiative 2015) to USD 1000bn in 2020, before leveling off. The logic behind is that a rapid increase can be expected both because more green projects are created and financed by labeled green bonds, while at the same time finance in terms of climate aligned bonds increasingly will be labeled to emphasize a green profile. This might particularly be the case for renewable energy projects and low- carbon infrastructure, currently largely funded by ordinary bonds. The fact that China has imposed a green bond quota of USD300bn on its financial sector in 2016 might indicate that China already surpass our assumptions in the near future (Climate Action Programme 2016).

The labeled green bonds are assumed to be non-fossil, not eligible as finance to any kind of coal, oil and gas extraction or fossil energy transformation, including petroleum refineries.

Besides the growth of green bonds, investors pledge to keep out of coal. We assume a divestment path as shown in Figure 1 where the level of coal divestment in SN1 is rooted in actual pledges of the French global insurance company AXA and the decision by the Norwegian Government Pension Fund Global (GPF) to divest in coal. We assume that other investors follow suit, ensuring that the total annual flow of funding unavailable for the coal industry amounts to twice the dedicated pledges of the two forerunners AXA and GPF. In total, we implement a coal divestment pledge covering assets of USD 4200bn under management in 2015.

For the future, we let the assets under management of these institutional investors increase at the growth rate of GDP in the BAU scenario to sustain its relative contribution to the total investments. With a recycling period of 6 years, the annual non-coal investment flow amounts to USD 700bn in 2015.

Scenario 2 (SN2) is similar to SN1, keeping the same path for green bond increase, but SN2 further scales up the amount of assets subject to divestment in coal. We assume that funds of the entire insurance industry including AXA become subject to coal divestment. Insurance companies worldwide have closely followed the development of climate change and the cost of more frequent extreme weather events and natural disasters. Hence, they represent the part of

the business community that is the most alert to climate change impacts. A widespread low-carbon investment profile seems reasonable among insurance companies, and we assume the whole industry follows AXA in coal divestment. The insurance industry is managing assets of around USD 24,000bn (Wikipedia 2016)¹. With a 6 year recycle period and after adjusting for AXA as already included in SN1, the additional annual flow of coal divestment from the global insurance industry is set to USD 3780bn in 2015.

In SN2 we also include the potential divestment by sovereign wealth funds of oil and gas producing countries in the Middle East. Middle Eastern countries are not using coal for electricity production, and as gas producers, they might abstain from investment in coal industries out of own interest related to the development in the gas market. The Middle East sovereign wealth funds manage around USD2700bn. Green initiatives are already showing up. Dubai set up a green investment fund in 2015 (Reuters 2016) and Qatar Stock Exchange recently joined the UN Sustainable Stock Exchange initiative (Qatar Stock Exchange 2016). Further, we include the Chinese government sovereign wealth fund of about USD1500bn. Although there is no explicit Chinese statement on coal divestment, it seems that China's government runs its own coal divestment campaign because current policy strongly supports a transition from coal to low-carbon electricity production, in particular gas. New regulations on emissions of local air pollutants from power plants are strict and practically exclude coal power, which is far more polluting than gas power and emits twice as much CO₂. Hence, in addition to the divestment of the insurance industry we add USD710bn to the annual divestment flow from sovereign wealth funds in the Middle East and China. To sum up, the additional annual divestment flow in SN2 compared with SN1 amounts to USD4490bn (3780bn + 710bn).

Figure 2 shows the scenarios of green bonds and divestment implemented in SN1 and SN2. Notice that the labeled green bond path is the same in both scenarios, whereas the level of divestment in SN2 is around 7.5 times higher than in SN1. Figure 3 shows the regional allocation of green bonds in both scenarios. The coal divestment in SN2 follows the same regional allocation as in SN1 (Figure 4).

¹ Another estimate is: Insurers' total assets under management (AUM) reached \$13 trillion in 2013 (Risk&Insurance 2014). The difference might be that insurance companies increasingly do third party asset management.

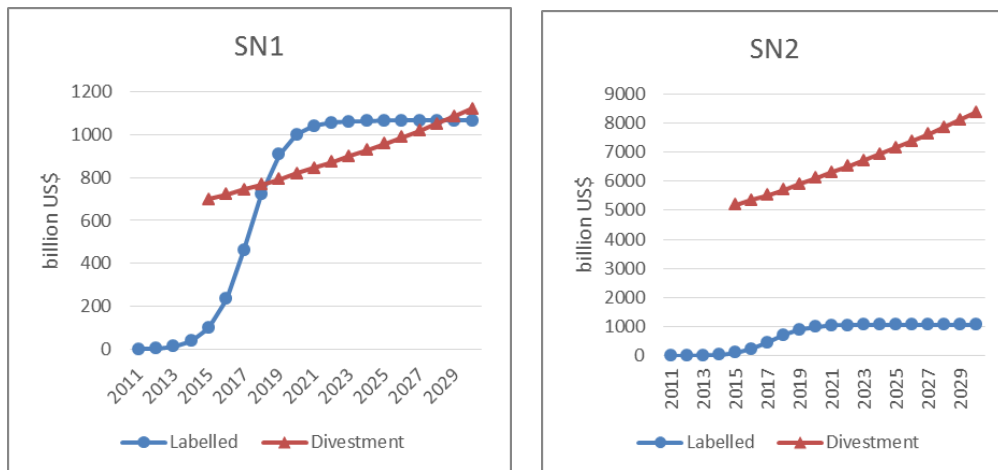


Figure 2. World fossil divestments in SN1 and SN2

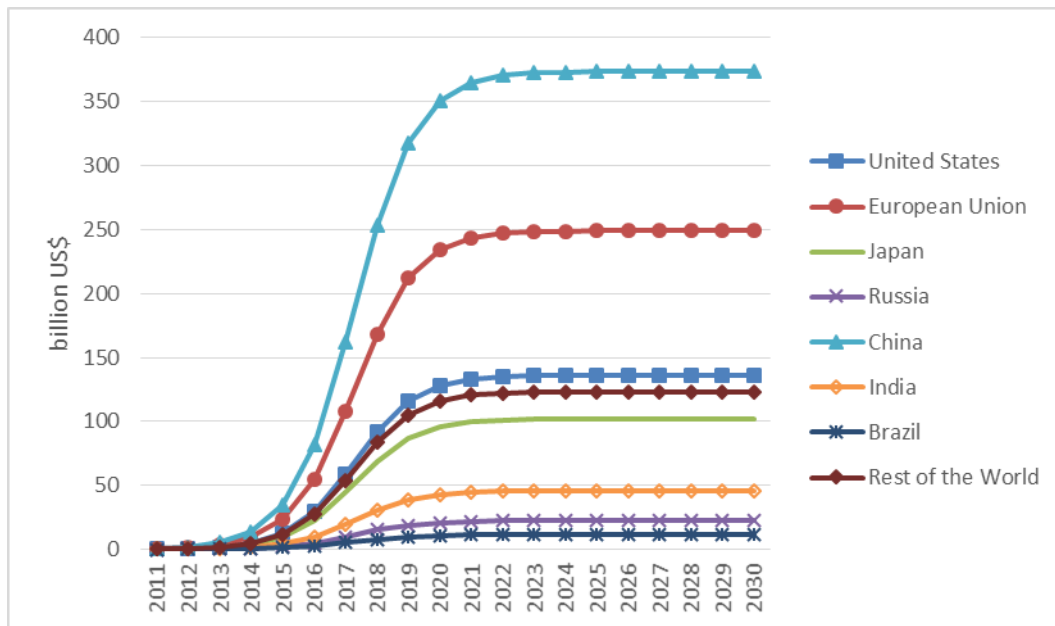


Figure 3. Regional allocation of labeled green bonds in SN1

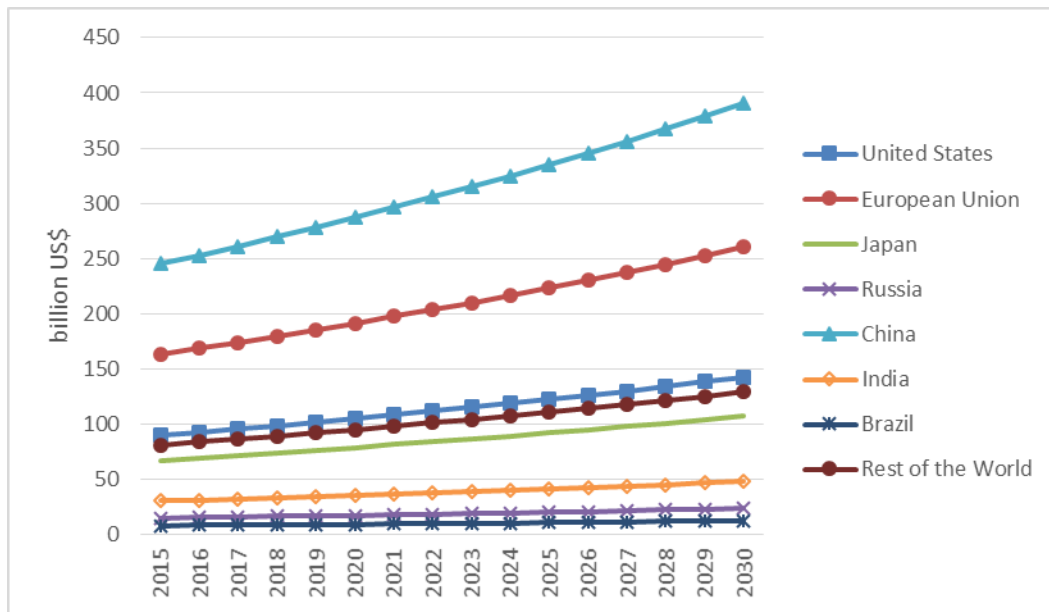


Figure 4. Regional allocation of fossil divestments in **SN1**

5 Simulation results

Below we present results for both scenarios as deviations from BAU level in 2030. Our comments only address results of SN2, which shows similar pattern as SN1, but markedly scaled up.

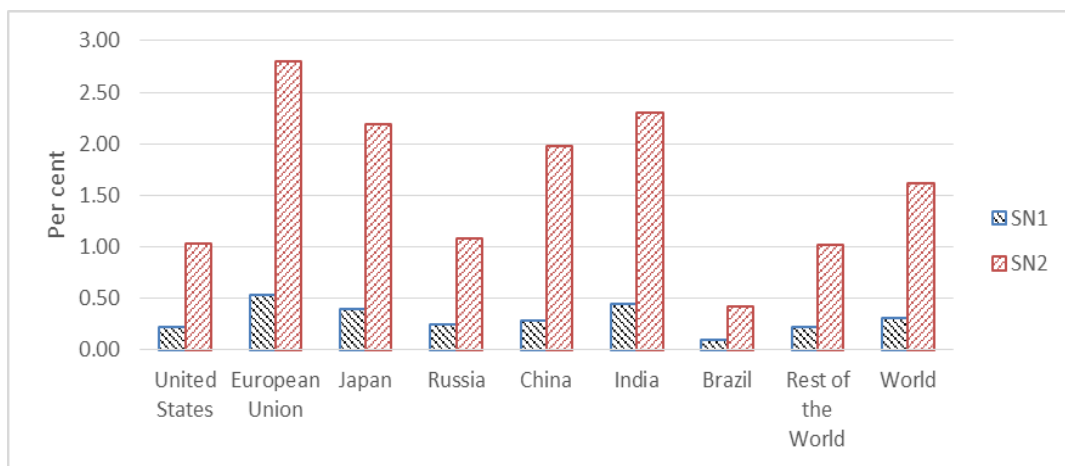


Figure 5. GDP. Deviation from BAU in 2030

When green finance is diverted from fossil industries, we find that GDP increases worldwide by 1.6 per cent (Figure 5). There is increase in every region but most pronounced in the European Union followed by India, Japan and China. Interestingly, the growth stimulation is less in United States and Russia with GDP only reaching about 1 per cent above BAU in 2030, whereas European Union, India and China raise GDP about 2-3 per cent. The effect is small, but after all, there is an increase in the reward to society from divestment rather than a cost.

The reason why the green finance tends to stimulate GDP growth is that coal industries, the dominant target of the divestment scenarios is a competitive industry in a global market and sensitive to the increase in capital costs generated by the higher cost of loan finance. Although minor, the additional cost of financing investments harms the coal industry and lowers its demand for finance. Hence, some investments shift towards other industries and regions with better prospects for finance. The coal industries generate low value added in all regions and the GDP growth mainly comes from value added growth in services, manufacturing, and from agriculture in the United States and European Union. The modest initial growth in GDP induces a re-enforcing effect in the coming years by generating somewhat higher savings and future investments, lifting the GDP growth path further.

By assumption, China receives a high share of the green finance (35 per cent) in our scenarios, India only 4 per cent, but the reallocation of investments raise GDP of India markedly more in relative terms than in China. Annual investments in India are much smaller, only 11 per cent of that in China in 2030. Figure 6 shows the relative share of green finance in annual investments in 2030 by region. The green finance accounts for 27 per cent of total investments in India versus 24 per cent in China, hence the green finance incurs a somewhat stronger incentive for transition in India than in China. The share of green finance in annual investments is particularly high in Japan (35 per cent) and European Union (34 per cent) followed by India (27 per cent) and China (24 per cent). Russia and United States have relatively high shares of green finance in their investments, but achieve only moderate increases in GDP.

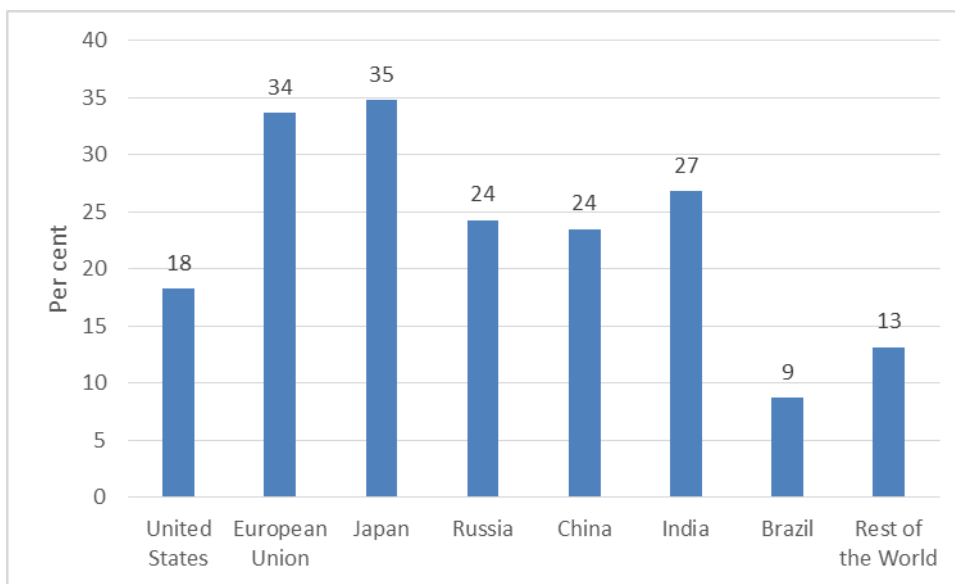


Figure 6 Shares of green finance in total investment in SN2. 2030

The reallocation of investments associated with green finance increases value added at national/regional level and benefits the society. However, the structure of the economy will be affected, leading to distributional impacts associated with the transition. As shown in Figure 7 there is a general decline of 2-4 per cent in rates of return to capital in most regions. China and India see the largest reductions by far, at 16 and 12 per cent respectively. This means for example that with a (hypothetical) 10 per cent return to capital in China in BAU in 2030, the rate of return would fall to 8.4 per cent in SN2.

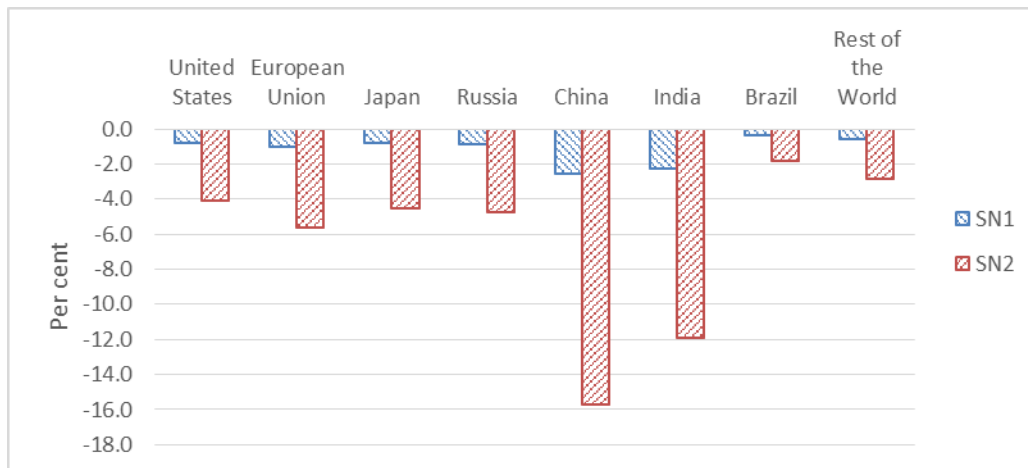


Figure 7. Rates of return to capital. Deviations from BAU 2030

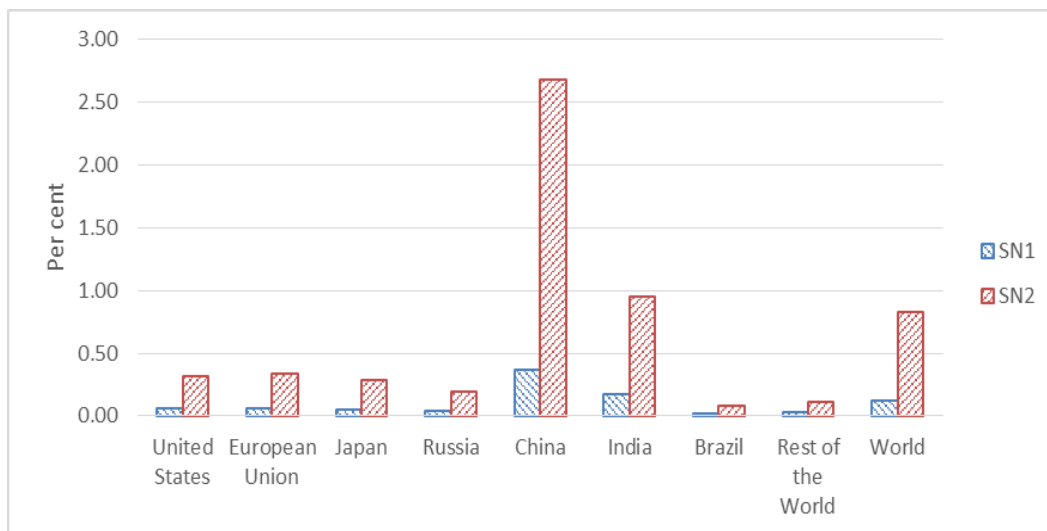


Figure 8. Produced capital stock. Deviation from BAU. 2030

The green finance enters the regional loan markets as a fixed inflow of capital. This reallocation of investments represents a deviation from the optimal solution as depicted within the CGE-model in BAU. By necessity the rate of return to investments will decline somewhat, all other equal. The rates will fall the most in regions with the largest shares of green finance in investments.

Figure 8 shows the development in produced capital stock by region in 2030. The green finance leads to a modest build-up of produced capital of 0.8 per cent at the global level, less than proportional to GDP increase of 1.6 per cent. China is the region with the largest increase in production capital stock of 2.7 per cent, making China slightly more capital intensive as GDP increase by 2 per cent only. Besides China, India is the only region where investment in produced capital is markedly encouraged (1 per cent above BAU), however, all regions invest more, but far from proportional to their GDP growth. Figure 9 illustrates the development in return to capital by regions as deviations from BAU over time.

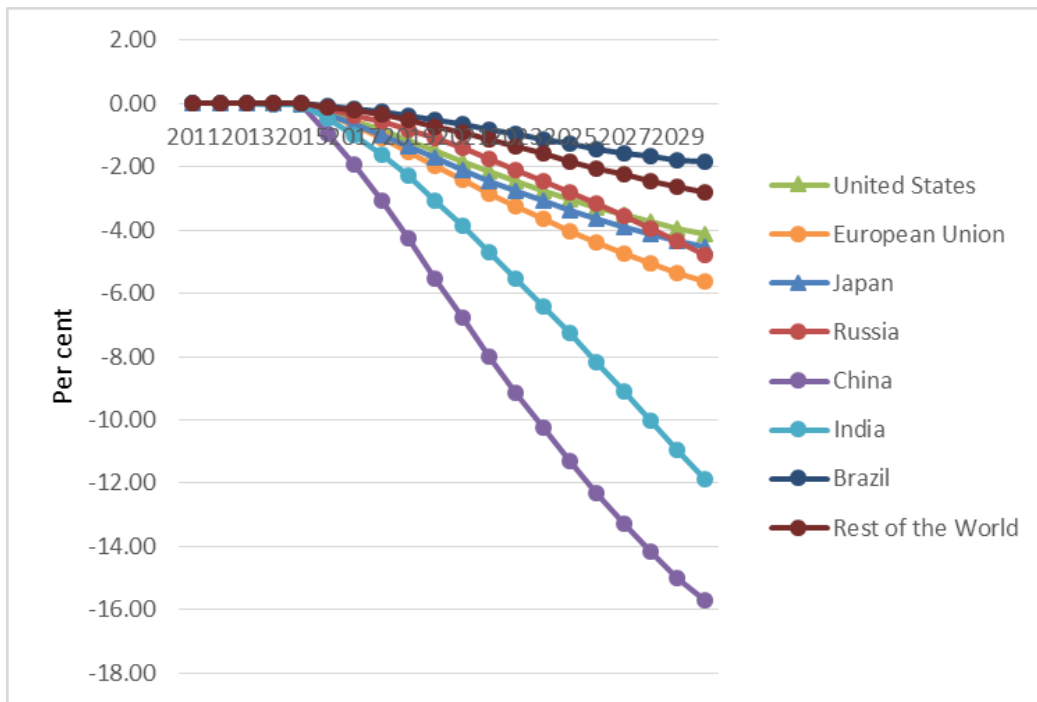


Figure 9. Rates of return to capital in SN2 Deviations from BAU

Table 1 shows the level of wage income and profit at the regional level, whereas table 2 shows the redistribution taking place as a result of the green finance. In all regions there is a shift from profit to wage income. Wage income increases the most in European Union (9.7 per cent) and Japan (9.0 per cent) followed by Russia (5.6 per cent). The labour intensive economies of China and India had the highest reduction in profits (13.8 per cent and 11.8 per cent respectively) – and 4.4 per cent and 4.2 per cent increase in wage remuneration. Hence, the green finance would support the Chinese policy to move towards a more consumption based economy, less dependent on exports and domestic investments programs.

In an economy that is demand constrained, as is the case in the current global economic crisis, the shift in income distribution might enhance demand and stimulate growth. However, this is not visible in our analysis, which generally assumes markets in equilibrium and has a longer term perspective. The increases in potential consumer demand in European Union and Japan are particularly high.

	BAU		SN2	
	Labor	Capital	Labor	Capital
United States	13781	6610	14187	6360
European Union	9928	9147	10890	8665
Japan	2994	3357	3262	3214
Russia	979	1058	1034	999
China	10404	2645	10865	2280
India	2678	752	2790	664
Brazil	2212	1512	2231	1486
Rest of the World	14915	11757	15328	11409

Table 1 Profit and wage compensation in 2030. Unit: USD 201bn

	Labor	Capital
United States	2.94	-3.80
European Union	9.69	-5.27
Japan	8.95	-4.24
Russia	5.59	-5.60
China	4.44	-13.81
India	4.19	-11.76
Brazil	0.83	-1.72
Rest of the World	2.77	-2.96

Table 2 Changes in profit and wage compensation in SN2 from BAU in 2030. Per cent.

Figure 10 shows the additional costs of investment finance imposed on the coal industry by region. This divestment premium reflects the ability of the coal industry to stand up against the closed doors of some financial investors, i.e. what they are able to pay extra in terms of higher cost of finance from the limited source of funding for fossil industries.

The highest divestment premium to the coal industry falls on Russia, amounting to 8 per cent additional cost of finance in 2030. China follows with 7.2 per cent. Notably, Rest of the World comes next with as much as 3.4 per cent. For European Union there is hardly any coal premium at all, as green finance is in high supply and the electricity market shows limited growth potential (Glomsrød and Wei 2016). By 2030, the European Union has already about 60 per cent non-fossil electricity production in BAU (Figure 13) and increase this further through the divestment initiatives, hence the attraction of investing in additional coal capacity is limited in the European Union, being the highest receiver of divestment and green bonds (23 per cent) after China (34 per cent).

In Russia the coal industry is little affected but the hydro power production increases markedly. The BAU growth rate of Russia is relatively high and hydro fills some of the energy gap while there is limited competition from inflow of finance for non-fossil targets. In contrast, China has

a big inflow of non-fossil finance, which keeps down the cost of finance and modifies the fall in rate of return to capital at a regional level.

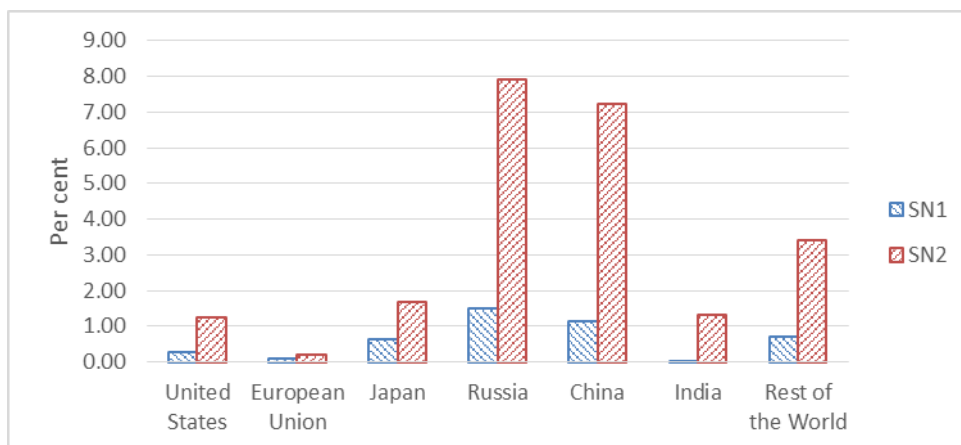


Figure 10. Divestment premium in the coal industry finance in 2030

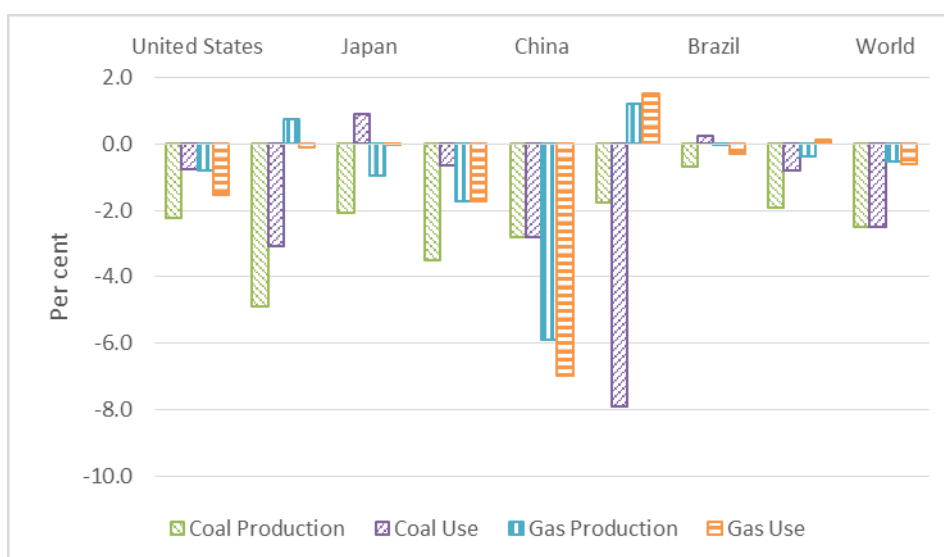


Figure 11. Coal and gas production and use. SN2. Deviations from BAU in 2030

Figure 11 shows the impact of green finance on coal and gas production and consumption by region. Focusing on coal, India is reducing coal consumption by as much as 8 per cent, considerably more than in European Union (3.1 per cent) and China (2.8 per cent). Hence, the divestment pledged so far already serves as brakes on the expected upward boost of coal use in India. European Union gets the modest investments its coal industry needs without bidding high for it, being crowded out by the renewable energy expansion. Globally there is a decline of 2.5 per cent in coal.

Production of coal changes in a different pattern than consumption, and India is only lowering production to 1.8 per cent below BAU. China's production of coal falls like production by 2.8 per cent, considerable when taking into account that GDP actually is 2 per cent above the BAU

level in 2030. It seems that the growth in renewables and nuclear power manage to hold back growth in gas consumption, being more costly than coal. Only India increases production and consumption of gas, hence gas consumption is not generally replacing coal. All regions reduce coal use, except for a minor increase in Japan (0.7 per cent) and a negligible increase in Brazil.

The trade in coal is not changing markedly, however, trade is somewhat reduced, and most markedly in India, where net import is lowered by almost 5 percentage points in 2030 (Figure 12).

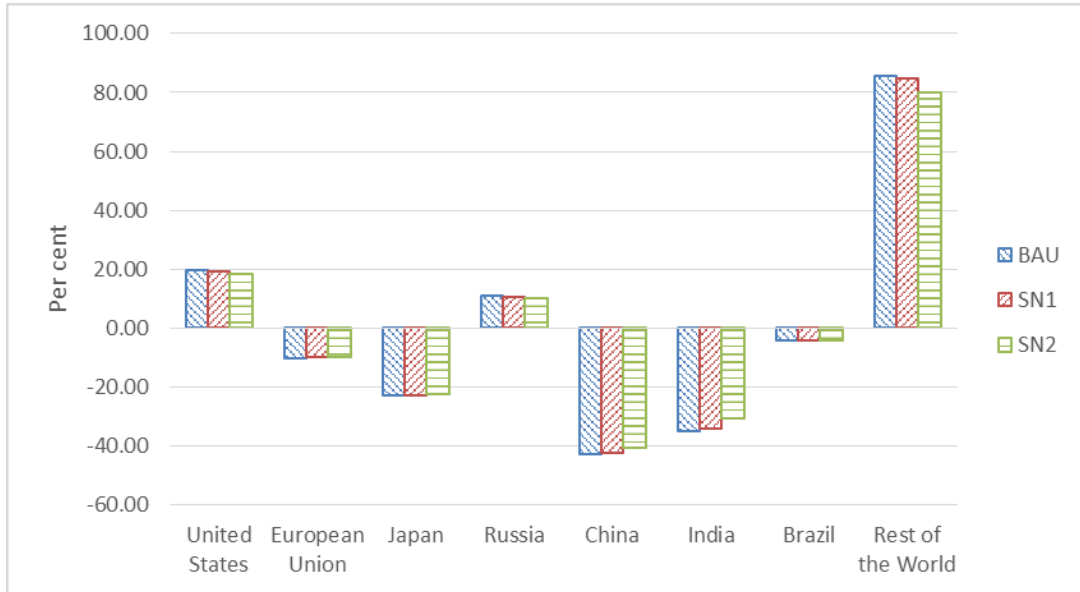


Figure 12. Net export of coal in 2030. Share of domestic consumption

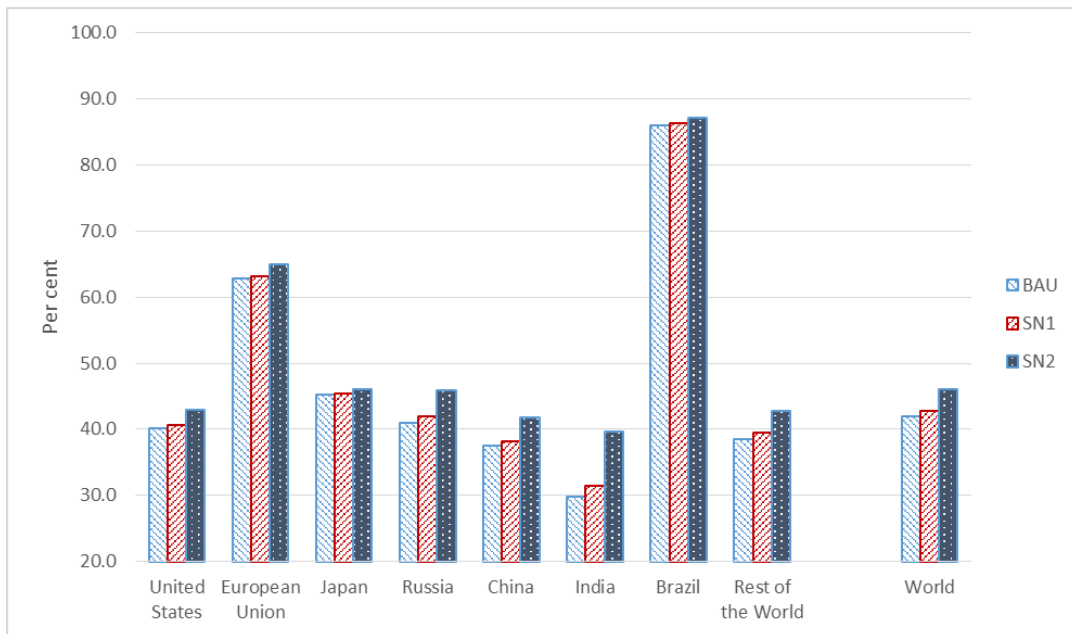


Figure 13. Shares of non-fossil electricity generation in 2030

Coal is feedstock in 40 per cent of global electricity production and the reduction in coal use is followed by an increase in the share of non-fossil electricity generation, globally and in every region (Figure 13). In particular, India makes a jump from a coal share of 30 per cent in BAU to 40 per cent by 2030. Russia is also taking a clear step away from fossil based power production, going from 41 per cent to 46 per cent. At the global level, the change is rather significant, from 42 per cent to 46 per cent non-fossil electricity generation.

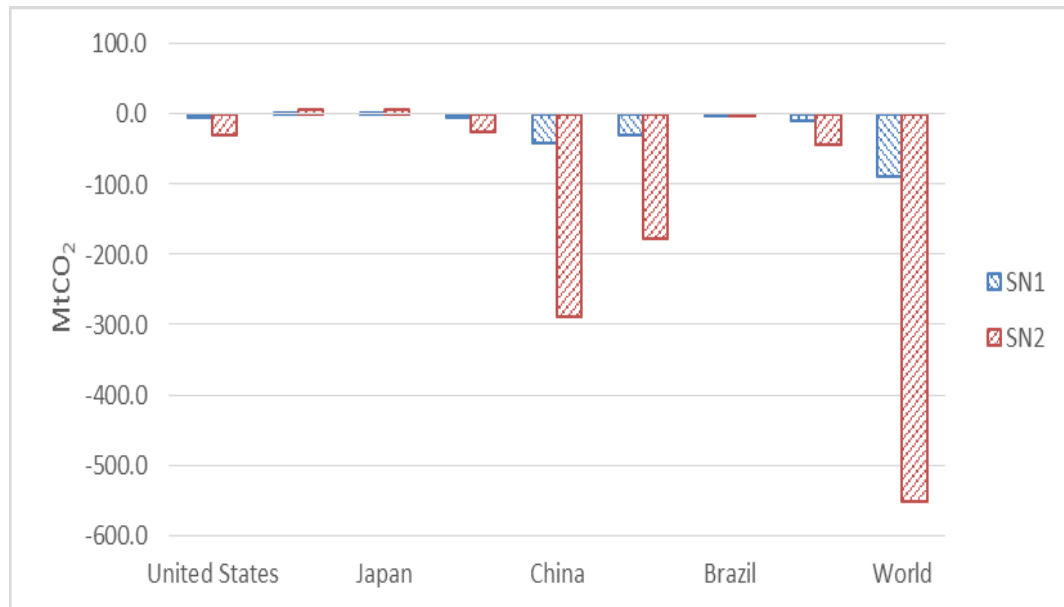


Figure 14. Emissions of CO₂. Deviations from BAU in 2030

Tables 3a and 3b show how low carbon energy sources drive the transition from fossil to non-fossil electricity. China replaces coal and some gas with hydro and solar power, whereas wind is slightly discouraged. India turns towards hydro and solar, but also towards wind power. Russia totally leans on hydro to make the transition, Japan on hydro and solar, while reducing the reliance on nuclear power somewhat. European Union's capacity reduction in coal and gas is largely compensated by growth in hydro and solar energy. United States limits its expansion in power based on gas while adding wind, hydro, solar and nuclear.

United States, India and Rest of the World are the only regions that turn to wind power. Among the new renewables, China's priority seems to be solar power rather than more wind power.

Green bonds and divestment in SN2 reduces global CO₂ emissions to 550 Mt below BAU in 2030 (Figure 12), a reduction of 1.6 per cent, achieved while global GDP is raised 1.6 per cent above BAU. Emissions reductions almost exclusively take place in China and India. Over the whole period 2011-2030, the reduction in global CO₂ emissions amounts to 4723 Mt, roughly corresponding to the sum of emissions of the European Union and Japan in a recent year.

	United States	European Union	Japan	Russia	China	India	Brazil	Rest of the World
Coal-fueled	-12.7	-30.4	-2.9	-3.5	-268.4	-160.6	-1.9	-78.6
Gas-fueled	-108.9	-51.9	-6.3	-24.2	-133.0	4.5	-3.4	-30.5
Oil-fueled	-2.6	-1.6	-4.5	-0.7	-1.3	-1.8	-0.7	-62.1
Hydropower	40.6	68.0	14.8	88.0	416.3	232.1	41.5	504.1
Nuclear	18.9	-6.5	-14.4	7.5	-124.0	15.7	-0.1	50.5
Biomass power	-8.6	-26.7	-4.8	0.3	-46.3	0.2	-3.7	-9.0
Solar power	32.7	38.9	14.5	0.0	169.9	67.4	0.7	37.1
Wind power	60.0	0.6	0.6	2.9	-19.0	15.3	0.4	29.6
Other renewable power	-3.9	-12.6	-4.9	0.1	-8.2	-1.4	0.0	-6.4

Table 3a. Electricity generation in **SN2**. Deviation from BAU in 2030 (GWh)

	United States	European Union	Japan	Russia	China	India	Brazil	Rest of the World
Coal-fueled	-1.03	-5.63	-0.99	-1.83	-5.14	-10.27	-8.04	-3.71
Gas-fueled	-6.49	-6.76	-2.17	-4.13	-22.57	1.61	-3.44	-0.85
Oil-fueled	-13.68	-9.06	-18.51	-13.65	-32.29	-12.92	-7.59	-12.71
Hydropower	12.91	17.04	15.13	38.49	30.35	76.68	6.61	23.92
Nuclear	2.12	-0.82	-6.61	2.77	-14.61	9.51	-0.43	6.28
Biomass power	-5.24	-10.76	-7.95	1.64	-16.20	0.31	-5.32	-3.86
Solar power	26.72	23.71	20.18		72.58	74.23	7.29	23.52
Wind power	14.59	0.11	1.66	27.31	-2.60	10.86	0.63	7.93
Other renewable power	-5.66	-28.57	-22.87	0.84	-31.29	-18.01		-3.01

Table 3b. Electricity generation in **SN2**. Deviation from BAU in 2030 (Per cent)

6 Final comments

The global carbon budget tells the world how much carbon emissions have to be reduced to limit the risk of global warming above 2 degrees to 50 per cent. Many different policies and initiatives are needed to deal with this challenge, and the divestment movement has initiated substantial efforts within the business community to decouple economic growth from carbon emissions.

We find that green bonds and divestment along reasonable trajectories avoids CO₂-emissions corresponding to the total emissions of European Union and Japan in a recent year. This is far from a trivial result of a campaign that is only at its beginning stage. Further, it is noteworthy that GDP is increasing as a result of divestment, in itself a factor that keeps up CO₂-emissions and counters the effect of the divestment. Hence, the carbon intensity is reduced more than emissions, and higher income bears the potential of increased welfare.

The results might be underestimates, as divestment is only represented as avoided investment in coal or fossil based industries in general, but hardly captures the fact that many investors also pledge to increase investments in renewables in addition to or as main commitment to climate change mitigation. In our study the activity level in the renewable energy sectors is market determined. Taking into account that finance directly might target renewable energy would increase the capacity of renewables to compete with fossil energy, thus strengthening our results.

The divestment movement tends to measure their achievements by counting the amounts of fossil shares that investor groups will sell out of. This signal effect is important. However, the larger effects come when investors continue a fossil free investment profile for all their assets under management in the future. The scale of green finance has been increasing rapidly. Our study deals with annual divestment of USD 5trillion, whereas the global investment in produced capital in the year 2015 amounts to 20 trillion USD.

Pricing carbon emissions through a tax or an emissions cap and trade system has long been seen by economists as the preferred climate policy, however, the political barriers have led to other solutions. Tax schemes are implemented or planned by 38 national and 21 subnational jurisdictions. Only half of them are operating, but activating all of them would only reduce global GHG emissions by 12 per cent (Meckling et al. 2015). Green finance emerged as a bottom up-initiative from the private investors in response to this political deadlock. We have illustrated that the effect of green finance can be significant.

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Appendix

Region in GRACE	Region in Climate Bonds Initiative (2015)	Original Share	Share in GRACE
United States	US	12	12.8
European Union	UK, France, and Austria	22	23.4
Japan	Assuming equivalent to France	9	9.6
Russia	Russia	2	2.1
China	China	33	35.1
India	India	4	4.3
Brazil	Brazil	1	1.1
Rest of the World	Others	17	11.6
Supranational	Supranational	6	—
Total	Total	100	100

Table A1. Regional shares of global climate-aligned bonds in 2015 (per cent)

CICERO (Center for International Climate and Environmental Research - Oslo)

CICERO (Center for International Climate and Environmental Research - Oslo) was established by the Norwegian government in 1990 as a policy research foundation associated with the University of Oslo. CICERO's research and information helps to keep the Norwegian public informed about developments in climate change and climate policy.

The complexity of climate and environment problems requires global solutions and international cooperation. CICERO's multi-disciplinary research in the areas of the natural sciences, economics and politics is needed to give policy-makers the best possible information on which to base decisions affecting the Earth's climate.

The research at CICERO concentrates on:

- Chemical processes in the atmosphere
- Impacts of climate change on human society and the natural environment caused by emissions of greenhouse gases
- Domestic and international climate policy instruments
- International negotiations on environmental agreements

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