Green energy: a solution for climate change?

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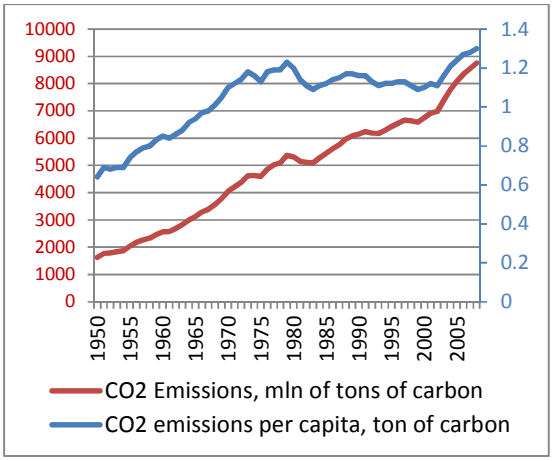
Abstract. This brief discusses the economic and political problems of so called green energy, a topic discussed at the 7th Energy Day recently organized by SITE. Green energy may be the only credible and feasible way to reduce carbon dioxide emission in the near future. However, a shift to a "greener" energy mix poses economic and political challenges which may impair the needed investments. This problem is further exacerbated by free-riding mechanisms associated with green energy investment. We suggest that investing and consuming renewable energies at the local level may be a way to internalize some the costs of the green energy.

There is a pressing need to cut pollution and the emission of greenhouse gases in the face of climate change and environmental damage. Since 1950s, global greenhouse gas emissions grew more than 5 times, and per capita emissions more than doubled.

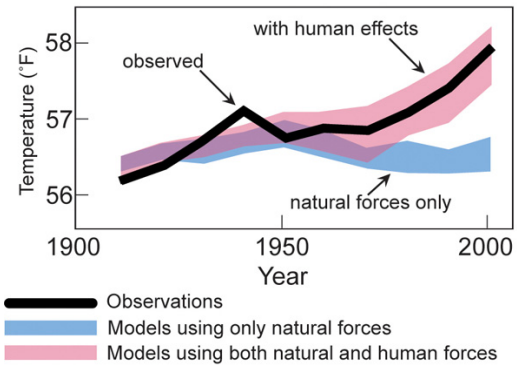
Figure 1. Global CO_2 Emissions from Fossil-Fuel Burning, Cement Manufacture, and Gas Flaring.



Source: Boden, T.A., G. Marland, and R.J. Andres. 2010. Global, Regional, and National Fossil-Fuel CO2 Emissions. Carbon Dioxide Information Analysis Center, Oak Ridge

A substantial part of this growth in emissions, and associated global warming, is driven by human activity. In particular, the model experiments aimed at reproducing the dynamics of temperature change fail to consistently predict the recent years of temperature increase unless anthropogenic influence on the greenhouse emissions is taken into account.

Figure 2. Separating Human and Natural Influences on Climate.



The blue band shows how global average temperatures would have changed due to natural forces only, as simulated by climate models. The red band shows model projections of the effects of human and natural forces combined. The black line shows actual observed global average temperatures

Source: Global Climate Change Impacts in the United States, Thomas R. Karl, Jerry M. Melillo, and Thomas C. Peterson (eds.). Cambridge University Press, 2009.

With this perspective, it is not surprising that in the last decades investment in environmentally friendly energy has become one of the most common ways to address this issue around the world. However a shift to a "greener" energy mix is inevitably costly. The objective of this brief is to discuss economic as well as political costs of green energy. We do so by summarizing and extending the discussion that took place during the 7th SITE Energy Day which took place in November 2013 and was devoted to the challenges of green energy.

The Kaya Identity: Green energy, one of many possibilities.

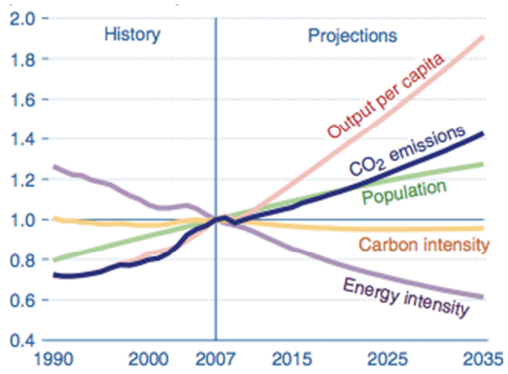
A frequently used approach when analyzing drivers of emissions is the so called *Kaya Identity*, originally developed by energy economist Yoichi Kaya. It relates global carbon dioxide emissions (CO2) from human activity to the level of economic activity (GDP), total world population (Pop), the energy intensity of economic activity and the carbon intensity of that energy use. The relationship can be summarized as the following identity (see Global Energy Dilemmas, Bradshaw 2013, for a detailed discussion on this topic):

CO2 emission = carbon intensity (CO2/E) * energy intensity (E/GDP) * GDP per capita (GDP/Pop) * Pop

The impact of these "Kaya" factors on the world carbon dioxide emissions varies, both across factors and over time. Figure 3 gives the International Energy Agency's estimates for the period 1990-2035.

As is evident from the Kaya identity, greener energy represents only one possible solution to tackle environmental damage. The decomposition of the different components shown in figure 3 suggests that most of the future growth of emissions is predicted to come from increased output per capita and an increasing population. But taking actions to reduce these are not on the policy agenda in most countries. The two remaining alternatives then seem to be reducing energy intensity or the carbon content of economic activity.

Figure 3. Impacts of four Kaya factors on world carbon dioxide emissions, 1990-2035 (index: 2007 = 1.0)



Source: International Energy Outlook IEA 2010.

Reducing energy intensity is often prescribed as the key solution and it is easy to see why this would be a preferred alternative for policy makers. It suggests that we need not cut back on standard and at the same time we would not have to alter the energy mix because increased efficiency in energy use will take care the needed reductions. It does indeed seem plausible that energy efficiency will continue to develop, in particular based on technological innovation, but there are problems with relying on this solution alone. First, as can be seen in figure 3, projections already include an optimistic development for this factor. Second, reducing energy intensity requires changing consumer behavior. Research suggests both that inducing such change is surprisingly difficult and also that changed behavior has a tendency of not lasting in the longer term (see for example Hunt and Rogers, 2013).

Taken together this suggests that reducing carbon intensity, that is, investing in "green energy",

may be the most important change when trying to cut CO2 emissions in the near future. This solution may also bring additional benefits. For example, once up and running, renewable energy production would not require a supply of inputs, thereby ensuring long-term sustainability. Renewable energy would allow the countries to diversify their energy portfolio, positively contributing to their energy security. Finally, renewables are geographically more dispersed than carbon-based fuels. This could contribute to strengthening user countries' energy security.

The multiple dimensions of the green energy costs

There are, however, various costs associated with green energy. These are direct and indirect as well as economic and political. An obvious direct cost comes from the installment of a new technology, and modification of the existing network. In addition, investing in green energy is usually considered riskier than investing in conventional energy. As a consequence, government subsidies or guaranties to attract private investors (such as a feed-in tariff for the wind energy providers) have to be (and have been) provided by the state. Another concern with many types of green energy, especially wind power, is that the power generation can be highly intermittent. As a result, such renewable power generation requires backup technologies (such as open-cycle gas generation which have high carbon emissions), to be on stand-by to real-time match demand and supply. All of this may contribute to an energy price increase for the final consumers. Another component of massive green energy promotion and subsidization by the state is that it lowers the market share of the traditional energy providers, leading to costly (and likely unpopular) reallocation of labor and capital.

All of the above suggests that costly green energy decisions are difficult to "sell" to voters who face substantial instantaneous costs of green energy transition, but do not (immediately) enjoy future benefits of cleaner environment. This, coupled with the potentially short horizon of politicians (as compared to the horizon for the green energy benefits), risks undermining the political incentives to invest in the green alternatives. Moreover, green-motivated politicians are likely to face resistance from significant counter-lobbying by affected energy-intensive industries as well as by incumbent energy providers, which further increases the direct political costs of green energy.

There are also some indirect costs, or negative externalities, associated with green energy, some of which are not immediately obvious. For example, due to electricity network interconnection across countries, the intermittency of wind power affects the energy supply security not only locally but also at the regional level. A local congestion problem may thus become a regional costly problem. Furthermore, it is not obvious that investing in greener energy in some parts of the world, such as EU, would reduce aggregate world carbon dioxide emissions. Indeed the reduced demand for "dirty" carbon energy in Europe would reduce its world price, making it more affordable for countries with weaker environmental standards, which may respond by increasing their "dirty" energy consumption. Last, but not least, adopting a green policy may also have indirect political costs at intergovernmental level. For example, recent research shows that being the first country to adopt green energy policy may weaken its position in case of a collective agreement to reduce pollution (see Harstad, 2012).

The local solution

Summing up, lowering carbon intensity seems like an important component in reducing CO2 emissions with large benefits in terms of being long-run sustainable and low cost once the initial investments have been made. But there are also clear costs to governments, especially in the short-run, and also technological constraints with integrating green alternatives into a centralized

electricity grid. Some of these problems make it especially difficult to agree on governmental and intergovernmental levels.
An interesting alternative possibility comes from facilitating the introduction of green alternatives on a smaller scale and on a more local level. It may seem paradoxical but the easiest way of introducing green alternatives may be in places that for various reasons are not yet connected to a centralized system or where gradual, initially small scale, introduction is possible. There are several examples of successful projects of this type (e.g., at SITE 7th Energy Day such projects were discussed by Fredrik Svinhufvud, in case of Ukraine, and Grigory Dudarev, in case of Russia).

The main challenge seems to be how to deal with the unevenness of energy production from sources such as wind or solar. In general, development of storage capacity seems to be of crucial importance, but this does not necessarily need to rely on advancements of battery technology. There are other ingenious examples of green storage technologies that have successfully been tried out in small scale. One such solution is using excess capacity when conditions are good to pump water into an elevated basin that acts as a reserve hydro-source of energy when wind or solar do not produce enough. The extent of the impact of such local solutions on reducing CO2 emissions is yet to be investigated.

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