Will Innovation Save the Planet?

How the principles of successful innovation could slow global warming.

By Morten Olsen

"Combating climate change requires urgent and ambitious action," proclaimed the RIO+20 summit held in June 2012. Yet, strong commitments failed to materialize in Rio or in preceding climate meetings in Mexico City or Copenhagen, despite an increasing realization that greenhouse gas emissions must be reduced to prevent potentially catastrophic and irreversible climate change. In the absence of concrete solutions to the current business-as-usual policy, the Stern Review on the Economics of Climate Change assesses a 50% likelihood that global temperatures will rise by 5 degrees or more by the end of the century resulting in devastating consequences to weather, food production, human health, and the ecosystem at large[1].

That said, several measures are being pursued to address the problem. Recently, the U.S. government has begun supporting the cultivation of corn-based ethanol in the hope it may become the innovative biofuel source of the future. Unfortunately, careful examination of the large quantity of fossil fuel required during ethanol production has cast serious doubts on the environmental benefits of their multi-billion dollar corn-based ethanol subsidy program[2]. In Europe, several countries have experimented both mandating and subsidizing wind and solar power utilization. Although an increasing proportion of European energy is coming from these renewable sources, they are still very far from being economically viable.

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While there exists widespread agreement that climate change should be addressed, and that the pursuit of such solutions should involve the private sector, there is little agreement on the best way forward. This is because there is insufficient focus on the two key principles of 'how' and 'when' innovation works.

Let's start with the first principle: the 'how.' This principle of innovation states that most innovation is primarily directed at making a product either cheaper or more attractive to the consumer.

That is a good thing, you may say, pointing to a long and growing list of green innovation designed to improve our lives and world: hybrid cars, lighter, better and more efficient airplanes, increasingly efficient electricity production, virtual online meetings and so on. Surely with all these improvements, the energy consumption of the average human is bound to decrease and with it, harmful emissions. This sounds like a compelling argument. Unfortunately, it is likely to be wrong.

First, part of the savings from higher energy efficiency is lost to higher consumption. Consider aviation: in recent decades, huge improvements have been achieved not just in fuel efficiency, but also in comfort, speed and, above all, price – all of which increases the attractiveness, demand and thus incidence of flying. A higher consumption of fuel then follows these increases in flights. So while fuel consumption per passenger mile dropped more than 30% between 1975 and 2000 in the United States, the total miles traveled far outstripped those gains, leading to a more than doubling of fuel consumption during the same period. Furthermore, the rise of a new global middle class eager for energy intensive consumption, suggests an uphill battle in energy efficiency improving enough to keep global warming in check.

Paradoxically, not only do increases in energy efficiency encourage higher usage, they may also promote a migration towards less environmentally friendly products. Take cars for example. According to the Ford Motor Company, the Ford Model T introduced in 1908 boasted a fuel mileage of up to 21 miles a gallon (11 l/100 km.) While engine efficiency technology has improved substantially over the last century, much of that technological improvement has resulted in larger, heavier cars and not better mileage, epitomized by the popularity of SUVs in the U.S. which even almost a century later can rarely match the Model T in fuel efficiency. It is true that the range of car options have grown considerably since the Model T to include models that are considerably more fuel-efficient, but this great variety of choices further increases the desirability of a car such that many households today have two or more.

Successful innovation that leads to increased energy efficiency ultimately makes usage cheaper, which increases consumption and in turn reduces and may even reverse those original gains from higher efficiency. Unfortunately, there is little reason to expect this counter-balancing effect to abate in the future. Such insight dates back to the young British economist William Stanley Jevons of the late 19th century who observed that "[i]t is wholly a confusion of ideas to suppose that the economical use of fuel is equivalent to a diminished consumption. The very contrary is the truth," referring to the folly of the common presumption that increasing the efficiency of coal would reduce British coal use[3]. Jevons was largely right in his observation and the increased efficiency of British machinery only succeeded in making the use of energy cheaper and easier, encouraging further consumption. The effect was originally known as the "Jevons Paradox," though in its modern incarnation it is known as the "Rebound effect." Given its potential to paradoxically overturn the positive effects of energy efficiency, the Rebound Effect continues to be a source of great debate and research.

As there is little doubt to the intellectual validity of this argument, researchers have sought to uncover its empirical validity[4]. In principle, all that is needed to assess the size of the rebound effect is to demand change from lower prices, i.e. the price elasticity. It is easy to see the empirical challenges: in the short run, more efficient air conditioners may lead to an increased use of AC, in the medium term this may result in additional consumer purchase and utilization, and in the long-run, perhaps even migrations of people to areas that were previously almost uninhabitable prior to the invention of AC systems. It is difficult to imagine the current modern day migration toward southern U.S. states without the convenience of air-conditioned houses, offices, cars and supermarkets. Though reasonable estimates in the short run imply a loss of 10-30 per cent of the original efficiency gains, it is practically impossible to estimate the (larger) long-run effects, which are likely sizeable[5]. The use of AC is just a case in point. Today the U.S. uses as much electricity to cool buildings as it did for all purposes in 1955[6].

Second, even if innovation were to reduce energy consumption from the usage of existing products, innovation does more than just improve the efficiency of existing products. From the advent of AC to the Internet of the present and possibly space tourism in the future, a stream of new highly energy-intensive products is constantly being introduced, along with new versions of existing products, such as the Tata Nano – the cheapest car in the world – targeted at a new global middle class in India. Although such products improve the lives of millions of people around the world, they raise an even higher bar on the necessary reduction of energy for the use of already existing products.

Third, successful innovation is not limited to consumer products. Deep-water drilling, liquid natural gas transport over long distances and shale gas extraction are examples of successful innovation that increases available energy. (The ability to drill for oil in deep water, transport liquid natural gas over long distances, and extract shale gas all make more energy available to us.) Though a global shift towards cleaner burning natural gas might reduce emissions on a per unit of energy basis, huge global reserves of shale gas will continue to provide access to vast amounts of fossil fuel.

The Jevons paradox need not imply that innovation is worthless, but rather that the anticipated environmental benefits of innovation may be limited. On the contrary; because innovation has allowed us to use energy and other resources far more efficiently, we have been able to improve our livelihoods. However, although the power of private innovation continues to amaze us all, there is no reason to suspect that this process will reduce our overall emissions.

Furthermore with a rapidly expanding global middle class the environmental

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impact of each person in the developed world will not only have to be monitored, but substantially reduced, suggesting that incremental improvements in energy efficiency may not be not enough to keep global warming in check.

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What are the reasons for this? As effective as private innovation can be, its goal is *not* necessarily to reduce energy consumption, but to reduce costs, improve customers' experience with existing products and introduce new ones. The fundamental problem underlying such innovations is that it often benefits the innovator and its customers, at the environmental expense of the whole planet, implying that the innovator bears only a part of the true cost of such innovation and the consumer only part of the full cost of consumption. This is a classic case of a market failure from an "externality," and as the Stern Review suggests it is "the greatest and widest-ranging market failure ever seen."

The immediate solution to this problem seems obvious. If private innovators do not fully account for the environmental impacts of their activities we have our governments to fix this. They must support new technologies, mandate the use of clean energy and better energy efficiency in general. Unfortunately, this approach runs afoul of the principle of 'when' innovation is successful: the person making the decisions and investments must have both specialized knowledge as well as a financial stake in the development and outcome. This ensures that she has both the ability as well as the incentive to make the best decisions. In the case of politicians, they generally have neither and the U.S. government's experience with corn ethanol is a case in point. The program was started for its political appeal, but few people had an economic interest in ensuring that emissions would in fact be reduced by the use of corn ethanol.

Another contentious U.S. policy is the mandate on fuel efficiency required by the Corporate Average Fuel Economy (CAFE), which fines carmakers for not meeting fuel efficiency standards. Unfortunately, whereas station cars are subject to strict requirements on fuel efficiency, SUVs are considered "light trucks" with correspondingly lower fuel requirements. This means that the U.S. legislation in effect ended up mandating the use of gas-guzzling SUVs over the previously popular station cars.

Other examples of governmentally mandated use of "green technologies" of little positive environmental impact are abundant and the reason is clear. The politicians reap all the political gains from appearing environmentally conscious, but bear none of the economic costs from forcing the use of these technologies. Further, whether the programs actually end up having a positive environmental impact 10 or 20 years later seemingly remains of little importance before the next election.

These examples – and many others – are mandated requirements. An alternative approach, taken by many European governments, is subsidizing the use of green technologies. Spain, Germany and Denmark have all subsidized the use of wind and solar power, although the programs also feature complicated floor price systems for renewable energy sales. Although the program in Spain was originally hailed as the "energy system of the future" and the source of green jobs by former prime minister Zapatero, following analysis, serious doubts have been cast on the effectiveness of the subsidy program, which has since been cancelled as a result of the subsequent economic crisis[7]. In Germany, the price of electricity produced by solar power is estimated to be 8 times higher than the wholesale price of electricity[8]. In Denmark – not known for sunny weather – subsidies and tax breaks encourage the installation of small-scale solar panels in private homes, a very cost-ineffective way of generating green electricity. All of these programs encourage production of renewable energy that is far from economically viable. Moreover fleeting political will remains a risk as politicians may cancel successful subsidy programs when surprised by its expense. This makes long-term planning of these inherently long-term projects difficult, thus reducing private engagement.

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If private innovation is effective, although not automatically directed at reducing emissions of green house gasses and governments end up supporting ineffective and costly technologies, how will we overcome the environmental challenges we are facing? The answer is to combine these two principles of successful innovation and thus ensure that innovation is both successful and is directed at reducing environmental impacts.

A first step must be to align the interests of innovators with those of society at large by making the environmental costs explicit. This could happen through a price on carbon, achieved by either taxes or quotas on green house gas emissions, which would require companies to "buy" the right to pollute. Such a price would push innovation towards less energy intensive goods, it would ensure that the costs of extracting fossil fuels includes the environmental consequences, while at the same time making it clear to all of us that there is an environmental cost to a lot of our daily consumption. Such a scheme would have avoided many of the unintended consequences of the aforementioned government programs. The corn ethanol program in the U.S. would likely have been unprofitable, as the true cost of fossil fuel used in production would have become

apparent. At the same time, such a scheme would impose a lower tax on the production of bio-fuel in Brazil, as the alternative use of sugarcane requires only around 15 per cent of energy produced as fossil fuel. In addition, an emission price would have avoided the 'loop holes' in the CAFE system that originally encouraged the use of SUVs and inefficient green technologies across Europe[9]. The criteria of which technologies to adopt would be the one used by private innovators in their search for technologies to most cheaply reduce emissions, and not what sounds best in political speeches. Not only would this be better for the planet, it would also be positive for the consumer who eventually has to pay the bill.

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Given the uncertainties inherent in predicting climate change, designing a well-defined emissions price scheme is not a trivial matter. One thing is clear, though, the price has to be sizeable. The Stern Review estimates an appropriate price of around \$85 per ton of CO_2 equivalent emission, equal to a return flight from Europe to the U.S. East Coast. EU's Emission Trading System (EU ETS) is a small step in the right direction with around €15 per ton and also covers power production and other energy intensive industries[10]. Many will doubtless argue that such additional costs will be harmful to the aviation industry and will reduce flying. But that is the point! We must get used to the idea, that although more energy efficient planes reduce emissions per flight, no flight emits as little CO_2 as the one we do not take. Most European countries have been taxing gasoline for decades, and although the system might not have been put in place by environmental concerns, the effect is still clear: Europeans drive less and in smaller cars.

To maximize effectiveness, such a system must be global. This will be the best way of ensuring production does not reallocate to places where polluting is free. Until such a system is in place, tariffs on imports of energy-intensive goods can do something to prevent "polluting haven" effects.

Naturally, some developing countries will argue that they should not bear these costs, as presently developed countries did not have to limit their emissions in the past. With billions of people ascending into the middle class, the planet cannot bear for this prevailing argument to hold. For this reason, revenues from a tax on emissions must partly be used in developing countries, for example for reforestation projects, to assist them in forestalling the now seemingly inevitable consequences of climate change. Other parts of the revenue must be spent on general research in green technology, where crucially the government must get out of the business of "picking winners," which history has repeatedly demonstrated them as incapable of doing.

While human innovation has and should continue to improve living standards, in order to prevent potentially devastating climate change, it is important to realize that although effective, private innovation will not automatically result in lower emissions. At the same time it is doubtful that direct government initiatives will be effective. The solution is to ensure that private enterprises incorporate the environmental costs of their actions and that can be done only through a global price on emissions.

About the Author

Morten Olsen is an assistant professor in the Department of Economics at IESE Business School. He earned his Ph.D. and M.A. in economics at Harvard University and holds an undergraduate degree in economics from the University of Copenhagen. His areas of specialization include international economics, banking, contract theory, growth theory.

Prof. Olsen's research interests center on international trade patterns with an emphasis on the importance of international financial institutions. He also analyzes labor adjustments to international competition and the importance of legal institutions for long-term growth.

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