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Can Technology Really Save Us from Climate Change?

by Alex Rau, Rob Toker, and Joanne Howard

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Entrepreneurs and investors are making the most of the world's excitement about clean technology, hammering out innovations in every energy-related field. Many of the projects show great promise for helping to meet the greenhouse-gas limits discussed at the recent UN climate summit in Copenhagen, but few people grasp this disturbing reality: Even if energy innovations have a lot of potential, they might not be deployable until it's too late. History shows that most of the technology breakthroughs need decades to make it to the mass market.

To cut global emissions in half over the next 40 years, as scientists recommend, clean technologies must be rolled out on a vast scale. In the past, they have taken 19 to 30 years to achieve wide use, say researchers at the UK think tank Chatham House and the patent-search firm CambridgeIP.

To be sure, powerful new market forces are at work: Governments beyond Europe are set to impose limits on greenhouse gases, and companies in a range of sectors are searching hard for ways to curb emissions. But technology deployment always takes time.

That is particularly true of energy-related inventions, which tend to get into big trouble on their way out of the incubator and into the marketplace. Entrepreneurs scrounge for capital, investors struggle to manage the risks of emerging technologies, patents get bought and sold but not necessarily used, and incumbent energy giants hesitate to give up their existing equipment.

Since irreversible climate change is already upon us, there isn't time to sit and wait years for great innovations to wend their way toward everyday use.

A Moore's Law for Clean Tech?

With the stakes this high and the outlook this unclear, businesses must begin making better clean-tech investments immediately, especially given the length of time before implementation. Looking at the slate of possible solutions, inventors and investors alike need to understand more quickly how much carbon emissions can really be abated and which innovations will be most effective at addressing the problem in the least amount of time.

In our work with an array of energy-related companies, we've become envious of the immense benefit the computer industry derives from a simple insight dating to 1965: Gordon Moore's conjecture that the number of transistors on a chip, and thus its processing speed, would double every 18 months. Moore's law, as it is known, is far more than an uncanny prediction. It is a pillar of high-tech industries, allowing entrepreneurs, investors, corporations, and governments to bank on the relentless acceleration of computing power. Microsoft, for example, factors in the arrival of next-generation processors when developing its ever more complex software. In other sectors, companies as diverse as Boeing, Pfizer, and Goldman Sachs rely on steadily advancing computer power when they develop new products and strategies.

That's exactly the confidence level that businesses and governments require to respond to global energy challenges. They need a conceptual framework that would predict the pace of clean-tech innovation and deployment—taking full account of the maddening lag between the two—as well as reveal which technologies promise to do the greatest good on the fastest schedule. A clean-tech equivalent of Moore's law could pave the way for more-focused innovation, more-efficient use of capital, and more-realistic regulations. It also could aid investors and governments in their efforts to decrease key technologies' time to market by spurring, for example, joint manufacturing initiatives, cross-licensing agreements, and tariff exemptions.

Gauging the Impact of New Energy Technologies

The lag between the invention and the full-scale adoption of clean technologies is one of the most frustrating unknowns in any calculation of how effectively humans will be able to curb carbon emissions. In the past, innovations' time to market has been decades long, for reasons ranging from investors' uncertainty about regulatory changes to incumbent energy companies' unwillingness to change their equipment.

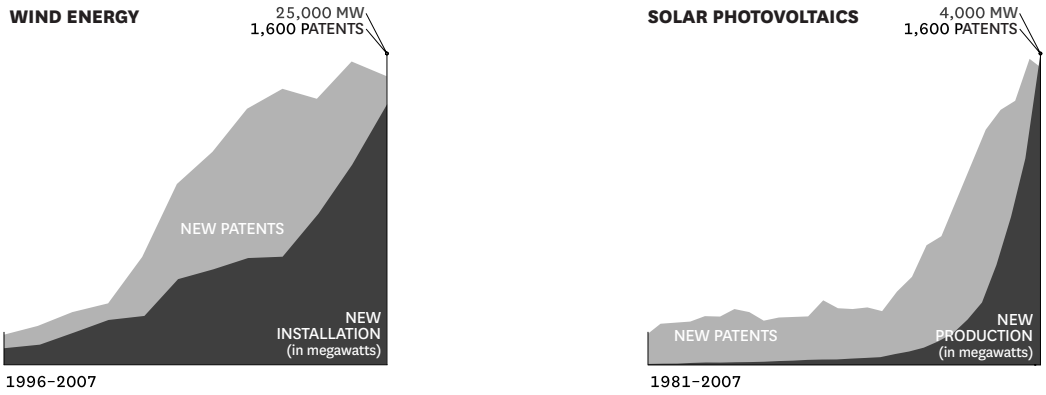
Narrowing the gap—and making it more predictable—is the key to meeting the carbon limits necessary to mitigate climate change. That's a tall order, but it's beginning to look doable.

Researchers at Chatham House and CambridgeIP analyzed six clean-tech sectors in 2009 and found that the pace of deployment is actually picking up. And the increases shown in the graphs below suggest that time to market may indeed be predictable for some technologies if you compare rates of technology rollout and patenting activity.

Implementation of wind-energy technology, for instance, rose sharply about five years after a boom in related patents. A similar pattern occurred in the photovoltaics sector, but the gap was closer to seven years.

Such data could help businesses and governments better anticipate how successfully—and, just as important, how quickly—various technologies will address the greenhouse-gas problem. The logical and necessary next step? Developing a framework that facilitates this kind of analysis.

—A.R., R.T., and J.H.



Source: Chatham House, CambridgeIP, with data from Global Wind Energy Council and Worldwatch Institute

Without the guidance that such a framework could provide, the clean-tech industry and governments are both flying blind. If it were clear that a particular technology—such as efficiency-boosting nanocrystal solar cells or the mineralization of carbon dioxide from flue gases at coal power plants—had the capacity to cost-effectively abate significant emissions and could be brought up to scale and implemented relatively quickly, then companies, investors, and governments would know where to concentrate their resources. If inventions turned out not to be scalable in a short enough period of time, then businesses and policy makers could shift resources into alternatives, such as adaptation efforts or strategies for taking greenhouse gases out of the atmosphere.

The Tale of the Patents

Of course, any emissions-abatement projection would be more complex than the elegant Moore's law, because clean tech is a burgeoning collection of technologies and processes, each with its own physics, risks, and investment cycles. A workable equivalent for energy would have to predict innovation cycles and rates of abatement for the most important sectors—wind, concentrated solar power, biomass fuels, carbon capture, and clean coal, to name a few.

Still, it must and, we believe, can be done. Several cost/benefit analyses, such as the carbon-abatement cost curve popularized by McKinsey, offer comprehensive views of major technologies' carbon-reducing capacities and thus seem like reasonable places to start. But they all suffer from two major shortcomings. They don't project technology development into the future, and they largely fail to account for the time-to-market problem.

A better starting place may be an examination of the relationship between patenting activity and technology implementation. The same researchers at Chatham House and CambridgeIP who found that clean tech's time to market can reach 30 years provide useful data that might point the way.

After looking at 57,000 patents and the implementation of various clean technologies, the analysts found an interesting correlation: In certain sectors, at least, deployment tends to skyrocket a few years after a steep increase in patenting. For example, prior to 1999, the number of patents issued annually for concentrated solar power technologies took a leisurely decade to double—and then abruptly doubled again in the next three years. That leap is expected to be followed by an even more dramatic jump in installed capacity from 2009 to 2011 (see the exhibit "Gauging the Impact of New Energy Technologies"). It might be possible to predict, on the basis of spikes in patenting rates, when deployment will take off for each of the main types of clean technologies. With such foresight, businesses would waste less money on technologies that ultimately won't have as much mitigating impact on climate change.

Now that the Copenhagen summit has concluded, here's a challenge to all the energy-minded quants out there: Develop a Moore's law equivalent for carbon reduction—a rule of thumb to give everyone the confidence that the technological pathways chosen to forestall climate change have a good chance of being the right ones. Whether it's based on patent data, as we've suggested, or some other source—and even if it's imperfect and imprecise—such a framework would focus both capital and innovation efforts. Just as important, it could decrease time to market for the most crucial and promising technologies and help the world move more quickly toward a stable climate.

The clean-tech industry and governments are flying blind. To effectively cut emissions, they need a framework for placing the right bets.

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