Cap on Global Warming Emissions Most Effective Policy to Spur Clean Energy Growth[1]

A four year research study conducted at MIT found that a price on greenhouse gas emissions is the most effective policy to significantly accelerate the success and growth rate of innovative clean energy companies. Carbon policy such as that proposed in the MA Global Warming Solutions Act will help enable Massachusetts to lead the world in the clean energy economy of the 21st century.[1]

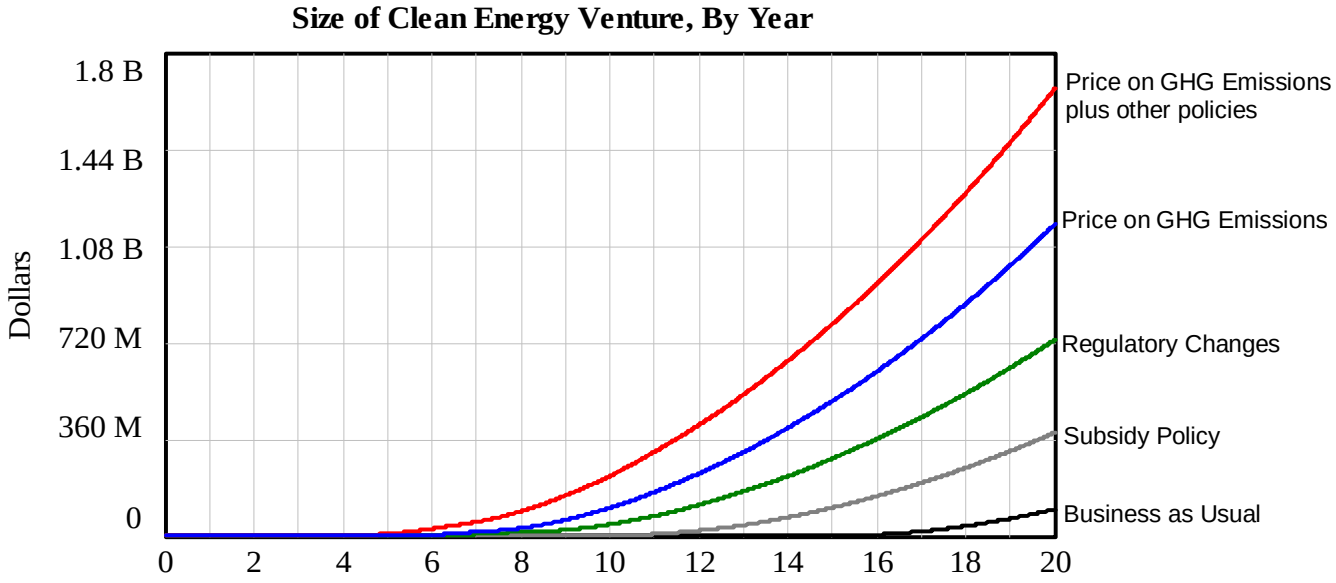

Figure 1: U.S. clean energy businesses grow sooner, faster and larger with a price on GHG emissions

Clean energy will be the foremost industry of the 21st century. In the U.S. alone, the clean energy sector could create 40 million new jobs and generate up to $4.5 trillion in revenue with a focused effort (Bedzik, 2007). And given that greenhouse gas (GHG) emissions must be dramatically reduced to avoid the most severe economic and environmental disruption due to climate change (Hansen 2008), the world will soon embrace sources of energy that decrease or do not produce harmful emissions. The U.S. can and should be the leading provider of these clean energy technologies, such as carbon capture and sequestration (CCS), renewable and/or efficient distributed generation (e.g. solar, wind, geothermal, fuel cells, cogeneration); energy efficiency technologies which enable the use of energy services at lower cost to users; intelligent energy management; and biofuels.

Unfortunately, the success of clean energy ventures has been stifled to date in the U.S. Over the last several decades as the importance of clean energy technologies has become widely accepted, new clean energy ventures have not been able to achieve success; even though many of these ventures have been very well managed and financed and offered breakthrough technologies that provide an extremely high return on investment.

To address the questions of why these businesses have been stifled, and what we can do to promote their success, we developed a sophisticated model of a prototypical clean energy business based on extensive interviews and data. The model takes into account capital flows, labor force, product and intellectual property development, market, competition, and government policies. The output of the model reflects the performance of real clean energy businesses with innovative technology and strong value propositions.

The model looked at a variety of policies including clean energy subsidies, improving regulations and putting a price on GHG emissions, such as proposed in the MA Global Warming Solutions Act. Putting a price on emissions had the greatest potential impact on the growth of clean energy businesses and jobs as demonstrated in Figure 1. [2] Naturally, combining the policies produced even better performance.

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[1]Based on, Miller, David S. (2007), New Venture Commercialization of Clean Energy Technologies. PhD Dissertation, Massachusetts Institute of Technology, Cambridge, MA. The author is a research affiliate at MIT's Sloan School of Management, and can be reached at (877)531-9017 or dsmiller@mit.edu.

[2] Based on data from EPA Analysis of the federal Lieberman-Warner Climate Security Act

Barriers to growing a new industry

New ventures are the growth engine for any major new industry. Throughout American history, only new ventures have been able to effectively commercialize disruptive new technologies (i.e. technologies that break through problematic old paradigms and change the playing field for the better, such as when electricity replaced gas lighting). In the energy sector, disruptive technologies already exist that produce energy with no emissions, or limit the emissions of existing systems, and these technologies and others yet to develop will dominate the global energy industry over the next century. There are many new ventures commercializing these technologies, and supporting the growth of these businesses is the key to U.S. economic leadership of the 21st century.

Unfortunately, government policy is hindering the success of new clean energy ventures. Under the "business as usual" scenario these innovative companies are more likely to grow very slowly and many will fail due to current federal policy. Extensive subsidies, tax incentives and regulations support the fossil fuel industry and thus, albeit unintentionally, help stifle clean energy ventures. Decades of these subsidies, during which fossil fuel industries have received hundreds of billions of dollars of government support, and the accompanying infrastructure development, have created an uneven playing field that impedes clean energy technologies from entering the U.S. market. Government support of fossil fuel production and use, combined with a complete absence of controls on greenhouse gasses and their extremely high cost to society, has severely distorted the energy market. [3]

Development of a model of a clean energy venture

Over the course of four and a half years, we collected data on thousands of clean energy ventures and conducted over a hundred interviews with clean energy entrepreneurs and a variety of stakeholders related to clean energy ventures. The stakeholders include the customers of clean energy technology, energy service providers, investors in the ventures, and participants in policy-making processes related to clean energy technologies. Interviewees were selected from both established and newly created clean energy technology ventures; from large and small customers of these products and technologies; and from a wide variety of sectors of the industry, including distributed generation, demand side management, renewable energy generation, energy efficient building technologies, and energy equipment maintenance.

The data collected in this study was used to create a model of a prototypical clean energy venture in order to better understand what policies would most help it to succeed. The model contains hundred of parameters and equations which relate to the performance of a new venture over time. Specifically, the model takes into account capital flows, labor force, product and intellectual property development, market, competition, and government policies. An indication of the model's validity is that the output of the model reflects the performance of real clean energy businesses.

Why the modeling is useful

The strength of the model is that it can help us learn the effect of different strategies and policies on the performance of a clean energy venture. It's obvious that putting a price on GHG emissions will be helpful to businesses selling clean energy alternatives. But it is not obvious how much of an effect that would have. Would it only help marginal businesses (businesses that wouldn't succeed otherwise)? Would it help clean energy businesses that have a strong value proposition without the policy in effect? And what would be the comparative effects of various policies? We have no historical data on the effect of carbon prices on US businesses. And given the initial problems with the EU carbon trading scheme, their data are not very useful.[4] So how do we gain insights beyond the obvious on what the effect of these policies will be? One way is to create a model of a business that takes into account the important attributes of the business and its market, and that performs similarly to the way real world businesses perform. Then we can test the effect of various decisions and policies on the performance of the business. In summary, the model:

- Tells us the degree/strength of the effect of policies
- Tells us which policies are most effective

[3] Former World Bank chief economist Sir Nicholas Stern estimates the cost of climate change due to GHG emissions under business as usual to be between 5% and 20% of world economic output

[4] Since permits were allocated at no cost and too many were allocated, there was no significant price to emissions

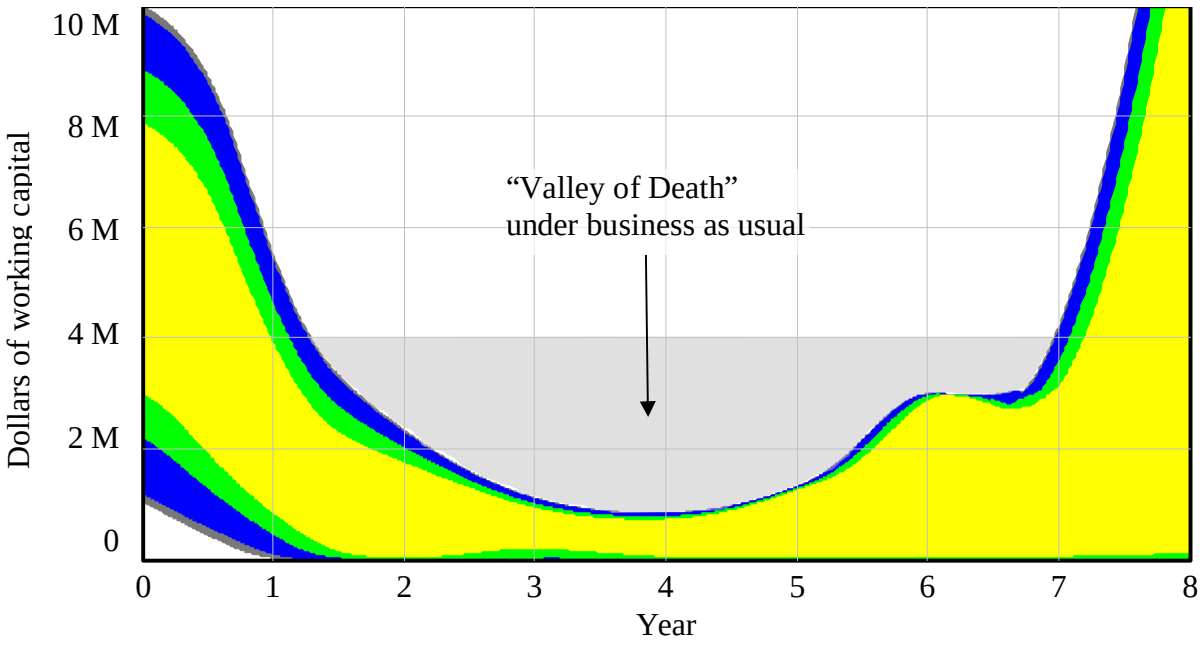

Figure 2: Results of 200 simulations varying the initial investment under business as usual: ***Regardless of capital invested, businesses take an excessive amount of time before they will succeed. Note: Yellow is the middle 50% of ventures, with green and blue showing the ventures with the highest and lowest initial investments.***

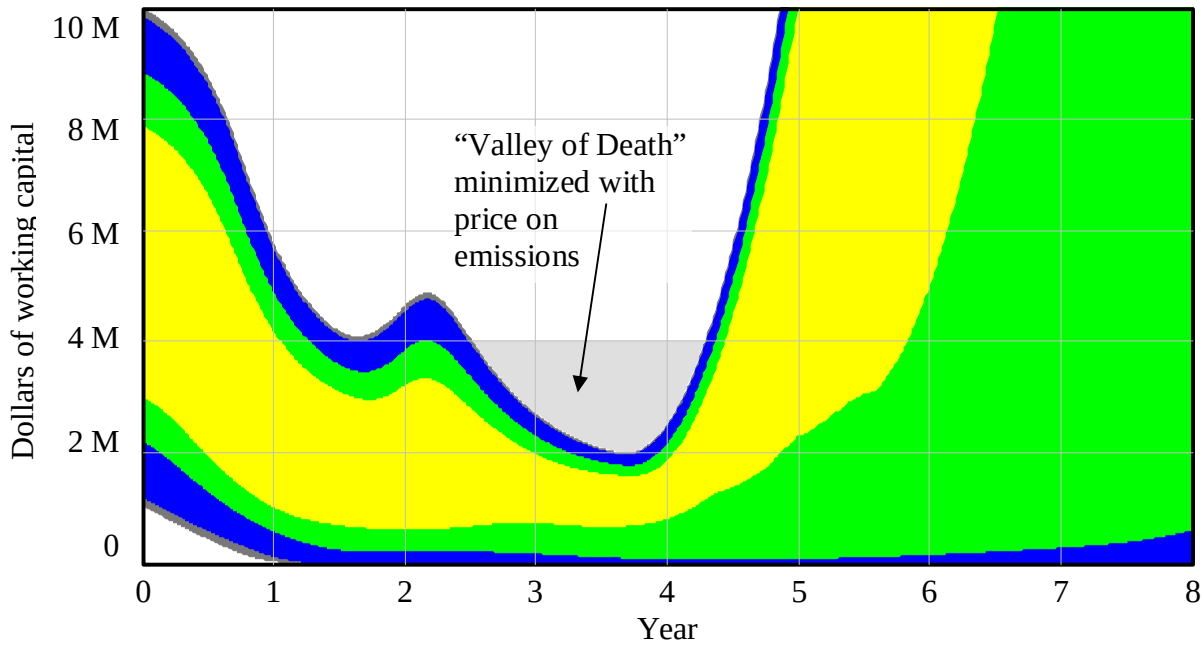

Figure 3: Results of 200 simulations varying the initial investment with a price on emissions: ***Businesses with less of an initial capital investment succeed much sooner and to a much greater degree with a price on emissions. Note: as per above, yellow is the middle 50% of ventures, green is the next 25% of ventures, and blue is the next 20% of ventures.***

The prototypical clean energy venture – and the "Valley of Death"

The model is set up to simulate the performance of a clean energy technology business that *should* succeed. The modeled venture starts out with a product that has better features at lower cost than competitors, with the bulk of its feature advantage non-appropriable (e.g. protected by patents). Furthermore, the new venture starts out with millions of dollars of investment capital. The management team of this hypothetical venture does not make mistakes, and the employees all have very high productivity and performance. Furthermore, the venture has many prospective customers who value the products and services the venture is providing and are willing and able to pay for them.

However, due to the lack of a level playing field, the venture takes a long time to succeed and experiences what we call the "valley of death." This refers to a period of time during which a startup company may not have sufficient capital to grow and is not able to attract new investments, and appears over a wide range of scenarios for clean energy technology companies. With clean energy technology, unlike other technologies which have created new industries such as software and the internet, this gestation period can take several years even under the best of circumstances.

Based on hundreds of simulations of the model, putting a price on GHG emissions leads to far more clean energy companies successfully crossing over the valley of death regardless of the amount of capital invested in them. Figure 2 shows a sensitivity analysis of working capital over the first eight years of a clean energy venture's existence. To create this graph, 200 simulations were run with a uniform distribution of initial investments between $1M and $10M. The middle 50% simulation results are shown in yellow and the more extreme cases are shown in green and blue respectively. Note that regardless of the amount of capital invested in the business, the capital is mostly spent down, and it take nearly eight years before the most successful version of the business becomes profitable and recoups its original loss of capital.

However, when there is a price on greenhouse emissions, the "valley of death" is considerably reduced. See Figure 3, which shows that with a price on GHG emissions, almost all of the businesses more than recoup the initial investment in less than half the time as the "business as usual" case. Note that even businesses with a smaller capital investment (the green area on the bottom) which all have no capital after 8 years in the "business as usual" case succeed to a much higher degree with a price on emissions.

Overview of effect of policies

Under almost all scenarios, a price on emissions is the most effective policy to stimulate rapid growth of clean energy ventures. Many policies have been proposed to encourage the development and adoption of clean energy technologies, and these policies generally fall into three categories:

Price on Emissions: Most climate change or global warming legislation attempts to impose a price on emissions of GHG. The Kyoto Protocol, California's global warming bill, the Northeastern states' Regional Greenhouse Gas Initiative (RGGI), and the MA Global Warming Solutions Act all envision creating GHG emissions trading systems that would require entities emitting GHG pollution to pay for permits. These types of policies create a level playing field for clean energy businesses that internalizes the cost of emissions.

Subsidy Policy: Another common type of policy is to subsidize the development or purchase of clean energy technologies. For example, the federal government provides grants to cover a portion of the research and development costs for some clean energy technologies. An example is the Small Business Innovation Research Program (SBIR). The result of this policy is to lower the cost of providing the clean energy technology, enabling higher profits for the firm without raising the price to the consumer.

Removing regulatory barriers and adding incentives: The final group of policies considered either remove regulatory barriers or provide regulatory incentives for the adoption of clean energy technologies. Examples of regulatory barriers that can be removed are those that impose high additional costs on companies that connect and utilize distributed generation. Regulatory incentives provide tax breaks for companies that implement energy efficiency measures, or tax credits for the development of, for example, wind farms. An effective policy in Europe has been feed-in tariffs, which require utilities to buy renewable electricity at pre-determined rates. These policies increase the number of customers that are capable of adopting clean energy technologies and therefore increase the rate at which the size of the market increases. Next to a price on emissions, these are the most effective policies at promoting growth in the clean energy sector.

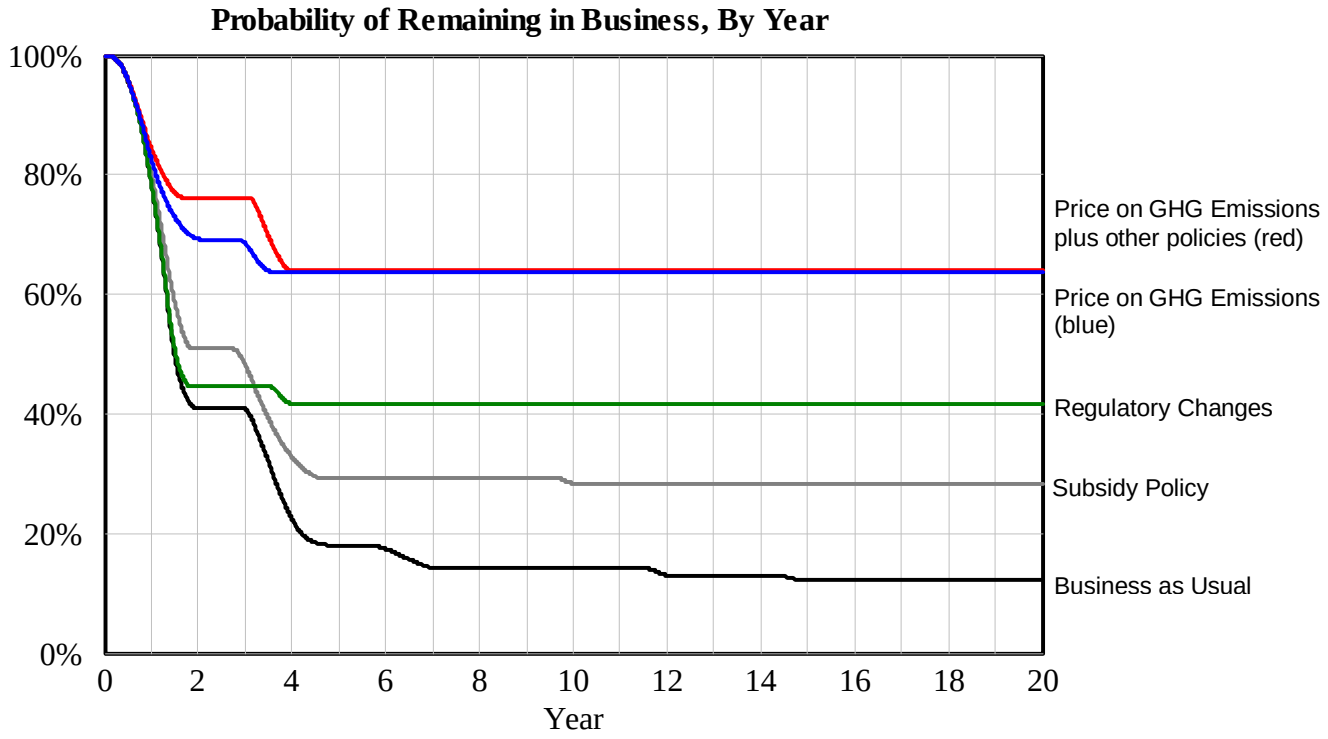

Figure 4: Effect of policies on success rate of clean energy ventures

Figure 1 showed the effect of each of the policies, as well as the effect of no policy ("business as usual"), or all the policies combined, on the performance of the prototypical clean energy venture modeled. Note that any of the policy options had a significant effect on the performance of the prototypical clean energy venture which has all the attributes for success, but that a price on GHG emissions had the most pronounced effect by far. Clean energy businesses grow sooner; faster and larger with a price on GHG emissions compared to any other class of policy (of course, putting *all* the policies in place has an even better effect).

Another very important metric is the success rate of new clean energy ventures. A venture that does not grow fast and that experiences a long "valley of death" will not likely succeed. The investors will pull the plug and the entrepreneurs will give up. Figure 4 shows the probability of the venture remaining in business under each of the policy scenarios. Note that under business as usual, the prototypical clean energy venture only stays in business about 10% of the time. It is important to keep in mind that this prototypical business *should* succeed; it has excellent technology, professional management and a motivated workforce. However, given the current U.S. energy legal and regulatory landscape, it probably will not. But with a price on GHG emissions, that same venture has over a 60% chance of succeeding. Six times as many innovative and well-run clean energy companies will succeed with a price on GHG emissions, leading to the pronounced growth of a new industry.

Conclusion

Current U.S. policy favors fossil fuel businesses of the last century over the innovations of the next century. As a result Europe, Japan and other countries are currently the leaders in many of the most important technologies and industries of the next century. The U.S. does not have the world's largest reserves of fossil fuels, but does have the world's largest reserve of innovation and entrepreneurial talent. Putting a price on GHG emissions, such as proposed in the MA Global Warming Solutions Act, will leverage those reserves and enable the U.S. to lead the world in the clean energy economy of the 21st century.

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