CHAPTER 7

Public policy options

Public policy measures can do much to accelerate deployment of carbon mitigation measures, and there are basically three options. One approach is to put a price on emissions, which can be done through a cap-and-trade system or an outright tax. The approach is motivated by the following premise: if the goal is to put a large dent in GHG emissions, a price tag must be put on the emissions. A second approach is to mandate reductions through the regulatory process. Forms of government regulation could include corporate average fuel economy (CAFE) standards for automotive transportation, renewable portfolio standards (RPS) for power production, and efficiency standards for buildings and home appliances. The third approach is to provide financial incentives to ease the cost of mitigation. Incentives can be provided as outright grants, tax credits for producing carbon-free energy, or preferential treatment for sale of the energy.

In each of the three approaches, a critical issue, both politically and economically, is cost management. If costs are too high, economic growth is stifled; if they are too low, emission reductions and innovation are stifled.

7.1 Cap-and-trade

Lawmakers are generally averse to increasing taxes. Hence, if they believe that a price should be placed on carbon emissions, they're inclined to favor a cap-and-trade system, even though, like a tax, the cost of implementation is ultimately borne by the consumer. In principle, the system works as follows. Governments impose caps (limits) on GHG emissions from large central sources such as power plants, oil refineries, natural gas producers, and manufacturers of energy-intensive products such as concrete, steel, and glass. Initially, the caps are high to allow time for adjustment but are gradually reduced until atmospheric GHG concentrations drop to desired levels. Commensurate with a prescribed cap, permits (allowances) are granted and/or auctioned to the emitting entities, with one permit corresponding to a unit of annual emissions such as 1 t-CO_{2eq}.

Whether auctioned or granted, permits are traded on a market, which can be regional, national, or international. Permits are sold by those able to economically reduce emissions below their cap and bought by those finding such purchases to be a more cost-effective approach to compliance. If a company finds it too costly to meet its prescribed limit by reducing its emissions, it can purchase permits traded by a company that is within its cap. The system may include the use of offsets by companies unable to operate within their limits. A common offset involves reforestation or averted deforestation. Carbon credits would be provided according to the amount of atmospheric CO_2 assimilated by reforestation or the amount by which emissions are reduced by averting deforestation. If the cost of purchasing credits associated with reducing net GHG emissions by reforestation or averted deforestation is less than the cost of reducing the company's emissions, it can reduce the price of compliance by purchasing the credits. If applied in tropical regions of the world, costly emission reduction measures in developed nations could be supplanted by lower-cost programs in developing nations.

In principle, the cap-and-trade system provides a market-based approach to reducing emissions, with permit prices driven by the dynamics of supply and demand. Prices could increase over time, as the caps and the number of permits are progressively reduced, but would also depend on market conditions such as the relative cost of different energy sources and whether the global economy was experiencing growth or contraction. Market prices would also depend on the nature of allowable offsets and the extent to which technology and innovation made it easier for emitters to operate within their caps.

By invoking market principles, the cap-and-trade system ostensibly provides a mechanism for achieving emission reduction targets at the lowest possible cost. Ideally, entities would reduce their emissions only so far as the marginal costs of doing so did not exceed the market price of the permits (or offset credits). Above that threshold, additional permits would be purchased. Although emitting entities needing permits could purchase them directly from entities with excess permits, most transactions would be conducted on electronic exchanges involving third parties including banks and hedge funds. The system can take on layers of complexity that are susceptible to speculation and volatility.

To reach its full potential, a cap-and-trade system would have to be implemented globally. However, due to large disparities in per-capita energy consumption and economic growth between developed and developing nations, achieving global agreement on a system is difficult at best. To what degree should caps differ between developed and developing nations? Should allocations be weighted more heavily in accordance with emissions per capita or per GDP? Even if developing nations agreed to participate in a cap-and-trade system, they would likely insist on an allocation formula that provided allowances on a per-capita basis, which, in the face of a substantive cap on global emissions, would result in a huge unidirectional sale of allowances by developing nations to developed nations. Quoting Mankiw (2007), in the case of China, such a system "would amount to a massive foreign aid program to one of the world's most rapidly growing economies." Convincing developed economies to support such a program would be a nonstarter, even in good economic times.

Other issues relate to how caps should be set and whether emission allowances should be awarded or auctioned. Should limits be restricted to utilities, refineries, and other *concentrated sources* of emission, or should they be applied to a wider swath of economic sectors? If allowances are auctioned, how should the revenues be used? Since the costs are ultimately borne by the consumer, should the process be made revenue neutral, at least by providing tax relief for those of low and middle incomes? Should some of the revenues be used to accelerate development and implementation of GHG mitigation and adaptation measures?

The system has other issues. Prescription of specific caps would not occur without intense lobbying by special interests, while enforcement would require yet another government bureaucracy. Consider the intense lobbying and the political and corporate pressures that would precede establishment of a cap, an allocation formula, and permissible offsets. Then think about implementation and whether the rules could be manipulated by participants.

Despite its complexities, adherents of cap-and-trade believe it is the best way to capture free-market efficiencies. It is favored by politicians who are open to GHG curtailment measures, by a significant number of emitters (assuming generous caps and flexible trading arrangements), and by segments of the financial community that would benefit from a global permit-trading process. But, how does it compare with other options?

7.2 A carbon tax

Although carbon taxes do not impose specific emission caps, Economics 101 tells us that raising the price of a consumable is likely to do two things: reduce demand and encourage the pursuit of alternatives. By taxing GHG emissions from carbon-based fuels, society would be motivated to use them more efficiently, to capture and sequester emissions where feasible, and to advance the development and implementation of noncarbon energy sources.

Carbon taxes need not be viewed exclusively in terms of raising revenue for governments. As with revenues obtained by auctioning allowances in a cap-and-trade system, carbon taxes could be made revenue neutral by reducing other taxes. Since those most impacted by a carbon tax would be of low-to-moderate income, the impact could be mitigated by a graduated reduction in taxes paid on income below a certain level and/or a reduction in payroll taxes. As advocated in the early twentieth century by the British economist Arthur Pigou, taxes can also be used to remedy societal problems. A Pigovian tax would compensate for social costs not included in prices determined exclusively by supply and demand.

Pigou (2013) believed that when the interests of individuals (or corporations) harm the larger society, governments should intervene by imposing a tax commensurate with the harm. In the context of climate change, harm is associated with environmental degradation, resource depletion, and risks to human health and welfare. Although other issues have long contributed to divergence of individual and societal interests, climate change provides a more recent and intractable dimension.

Pigou was an advocate of market economies but believed they would only be sustainable if the full cost of goods and services was immediately recognized. Drawing from Pigou, Hawken (2005, p. 75) underscores the point with the statement that, "Today we have free markets that cause harm and suffering to both natural and human communities because the market does not reflect the true costs of products and services." Pigou and Hawken, along with many, largely heterodox economists, believe that external costs of the harm – those not otherwise included in the transaction between buyer and seller – must be internalized. But how are the costs to be determined, for future as well as current generations?

Models for estimating the economic impact of climate change must be superimposed on models used to predict global warming and its effects on climate. For extreme weather events or rising sea levels, how does one account for the loss of man-made and natural capital and the effect of the losses on current and future productivity? How does one deal with the effect of chronic drought on food production or the spread of vector diseases on human capital? Are common economic parameters such as discount and growth rates still useful when dealing with the vagaries of climate change?

In a report commissioned by the British government (Stern, 2006), an economic case was made for adopting strong and early action to reduce global warming by imposing a large enough tax on GHG emissions to stabilize atmospheric concentrations at no more than 550 ppm CO_{2e}. Absent such action, the Stern Review projected that climate change would provide a persistent drag on the global economy, reducing GWP by 5–20% per year. In contrast, the nominal cost of stabilization was predicted to be 1% of circa-2050 GWP within a –2% to +5% range.

The Stern Review did not go unchallenged and was criticized on three fronts: (1) for understating the real costs of reducing GHG emissions, (2) for using an unduly low discount rate to weigh the relative well-being of future and current generations, and (3) for discounting the role that adaptation measures, such as flood prevention, could play in reducing the economic costs of climate change (Lomborg, 2006; Nordhaus, 2007). Criticism of the manner in which the discount rate was treated illustrates how a seemingly arcane but important economic parameter can complicate the climate change debate.

The discount rate is commonly used to assess the effect of today's actions on future benefits according to the time value of money and the belief that today's dollar is more valuable than a future dollar because of benefits derived from its investment. In the context of climate change, measures to reduce GHG emissions have present costs and future benefits. What is the present value of those benefits, and how does it compare with present costs? Does siphoning some of today's dollars away from other investments to fund mitigation measures reduce the benefits that would have otherwise accrued to future generations? Answers depend on many assumptions, including selection of the discount rate.

With adverse effects of climate change increasing over time, a low discount rate increases the present value of mitigation measures and benefits for future generations. Conversely, a high discount rate would reduce the present value of mitigation measures, tilting the argument in favor of a business-as-usual approach that foregoes mitigation measures and encourages economic growth. The implication is that returns on the growth would better enable future generations to deal with the effects of warming, as for example, by developing drought- and heat-resistant cereal grains, barriers to protect against rising seas, and medicines to protect against new diseases. Rather than devote today's resources to curb global warming, the argument calls for investment in measures that would enhance the resource base for future generations to deal with the effects of warming.

Jamieson (2014) compares approaches taken by Stern and Nordhaus in developing economic models of climate change. While Stern chose a discount rate of 1.4% – well below historic values and one that would not discriminate against future generations – Nordhaus chose a more representative value of 5.5% over fifty years and an average of 4% for the century. Stern and Nordhaus both support a global carbon tax but in different amounts. Stern advocates a steep tax of \$85/t-CO_2 to immediately and significantly curb emissions. In contrast, motivated by concern for the economic impairment that could accompany a large tax, Nordhaus recommends a tax that would begin at \$7/t-CO_2 and ramp to \$25/t-CO_2 by 2050. While Stern advocates an *all-in* approach to reducing emissions, Nordhaus recommends a conservative approach that reduces economic risks associated with the tax but only yields a 25% reduction in emissions by 2050 and 45% by 2100 – not enough to stabilize GHG concentrations below 550 ppm CO_{2e} – while projecting costs approaching 3% of GWP by 2100. It is not surprising to see such divergent results.

Climate change is the ultimate challenge for economic modeling. The models represent the climate system as a capital asset that is diminished by GHG emissions. A major objective is to determine an optimum cost (tax) for emissions, one that achieves a suitable trade-off between reducing degradation of the climate system and risks to the economic system. But the models involve many parameters and assumptions and allow for considerable latitude in specific choices. Add the large uncertainties associated with the choices to those of the climate models, and there is ample room for widely divergent results, as well as good reason for skepticism in the value of the models (Economist, 2013c; Nordhaus, 2013; Pindyck, 2013; Stern, 2013). Pindyck believes that results are so dependent on arbitrary assumptions as to be useless, while Stern feels that the models are biased toward underestimating economic impairment, which could be enormous in the case of abrupt climate change (Section 5.8). That said, many mainstream economists feel that a carbon tax is the best way to deal with climate change. So, how to proceed?

A carbon tax should be large enough to stimulate meaningful emission reductions, yet not so large as to inflict significant damage to the economy. Consider a tax of \$30/t-CO_2 (\$110/t-C), which corresponds to the low end of estimated costs for including CCS in a new, coal-fired power plant. The tax would add approximately \$60/tonne to the cost of coal and, if the plant were operated under supercritical conditions, approximately \$0.025/kWh_e to the cost of electricity. Although many would complain, the tax would not bring a developed economy to its knees. In contrast, if applied to gasoline, the same tax on emissions would only add about \$0.27 to the cost per gallon. A tax on coal comparable to the cost of CCS would have the intended effect of reducing emissions by encouraging CCS for coal-fired plants and by accelerating development of carbon-free sources of power. A 27 cent gasoline tax would have little effect on fuel consumption. The implication is that, if applied to emissions, taxes should be differentiated according to fuel source and application. Similar conclusions were reached in a study conducted by the MIT Joint Program on the Science and Technology of Climate Change (TR, 2009). If the goal is to reduce carbon emissions, a common tax would not fit all applications.

Tax revenues could be used in several ways: (1) to reduce other taxes, making the carbon tax revenue neutral; (2) to accelerate progress toward a sustainable, decarbonized energy future by investments in public transportation, the electric grid, and technologies that increase energy efficiency and the use of renewable energy; and/or (3) to reduce federal budget deficits. In a survey of the U.S. public (NSEE, 2014), only 34% of the respondents supported a tax with unspecified use of the revenue and only 38% supported using it to reduce the budget deficit. However, 56% supported the tax if it is revenue neutral and 60% supported it if revenues are used to support renewable energy. An argument against any tax is that money is withdrawn from the economy, slowing economic growth. But if a carbon tax is revenue neutral, money would not be withdrawn from the economy. If the tax is used to support mitigation measures, it would contribute to economic development through manufacturing and service industries built around energy efficiency and carbon-free energy sources.

7.3 Cap-and-trade or a carbon tax?

If a price is placed on carbon, would it be better to implement a cap-and-trade system or to simply impose the tax? In a study conducted by the U.S. Congressional Budget Office (CBO, 2008), a carbon tax was determined to be the most efficient of several incentive-based options for reducing CO_2 emissions. Defining the most efficient option as one that "can best balance the costs and benefits of the reductions," a steadily rising carbon tax would eliminate fluctuations in the cost of emissions and allow both producers and consumers of energy to more confidently determine when and to what extent emissions should be reduced. Of variants on the cap-and-trade option, imposition of an inflexible annual cap on emissions was the least efficient approach. Preferable options were those that provided flexibility in the form of a *safety valve* (a ceiling on the price of emission allowances), a *circuit breaker* (an adjustment to the cap), and either *banking provisions* or a *price floor* to prevent the cost of emission allowances from dropping too low. Banking would allow firms to defer the use of allowances when costs of meeting emission requirements are low and draw on them when costs are high. However, even with such flexibility, an outright tax on emissions was deemed to be the most efficient approach. From a broad range of 103 options, a tax of \$25 per ton of CO_{2eq} was determined to be the most effective means of reducing the U.S. budget deficit (CBO, 2013). With a 2% annual increase, the tax could raise \$1 trillion over a ten-year period while encouraging efficiency and conservation measures that reduce emissions by 10%.

One advantage of a carbon tax is the certainty of related costs. Assuming implementation over an extended period, energy providers would be able to more effectively make long-term investments in energy systems. The tax would send the clearest possible signal to energy markets and would encourage market-based solutions by stimulating the development of improved and innovative energy technologies. The tax could start low and be incremented gradually to provide time for adaptation by energy producers and consumers. Although a carbon tax does not explicitly cap emissions, annual increments could be fine-tuned to achieve the desired emissions trajectory.

A tax would also be simpler to administer, particularly if it were applied at a limited number of sources, such as coal mine heads, gas pipelines, and oil refineries. Once implemented, it would be less vulnerable to political manipulation and lobbying by special interests. Although conventional wisdom suggests that it would be more difficult to implement globally than a cap-and-trade system, suitable mechanisms have yet to be vetted. Taxes could initially be varied across developed and developing nations, larger for the former and smaller for the latter. Differences could be reduced over time, as developing economies mature.

The single most important barrier to prescribing ambitious targets for reducing GHG emissions is the cost of implementation and its impact on business and the consumer. For cap-and-trade, it is cost containment that drives caveats such as offsets and ceilings on the market price of an emission credit. If offset allowances are too generous and/or the ceiling on the price of an emission credit is set too low, prospects for maintaining the cap are diminished. In principle, a cap provides emissions certainty, but if trade is regulated by limiting the price of emission credits and/or providing generous offsets, achieving the cap becomes problematic. Ideally, one would like to find a sweet spot that provides a good mix of emissions certainty and price certainty. A carbon tax would achieve price certainty and, if high enough, would bring down emissions. An outright carbon tax provides the simplest and most efficient means of reducing emissions, with recent studies pointing to negligible adverse effects on the economy (GCEC, 2014; IMF, 2014).

7.4 Regulatory options

In the 1970s and early 1980s, the world's supply of petroleum was sharply curtailed by conflicts involving embargos imposed by producing nations. The United States needed to respond by discouraging domestic consumption of transportation fuels, but it was reluctant to do so by increasing fuel taxes. Instead, it chose to implement CAFE standards for LDVs. Enacted by the Nixon administration and to be achieved by 1985, the standards prescribed separate fleet averages of 27.5 mpg and 19.5 mpg for cars and light trucks (minivans, pickups, and SUVs), respectively. The target for light trucks was subsequently raised to 22.2 mpg, with a recommendation by the G.W. Bush administration that it be raised again to 23.5 mpg by 2010. However, over a thirty-five-year period since their inception, CAFE standards had failed to adequately curb fuel consumption, and by extension carbon emissions. In 2005, average U.S. fuel economy was actually 22.2 mpg for cars and 16.9 mpg for light trucks, well below the mandated values.

Motivated by a desire to reduce emissions and viewing existing CAFE standards as inadequate, thirteen states and cities challenged the status quo in court, advocating for stricter standards. The Ninth Circuit Court of Appeals in San Francisco agreed and ruled that the federal government had undervalued the benefits associated with reducing GHG emissions and had overestimated the costs associated with imposing higher standards (Ball, 2007b). The court rejected existing standards, and the government was expected to revise them. Although the Bush administration did not act on the ruling, things changed in 2009 when the Obama administration secured an agreement for a standard of 34.5 mpg across all LDVs by 2016. In 2011, the bar was set higher, with a standard of 54.5 mpg prescribed for 2025. For the first time, standards were also prescribed for larger trucks, with improvements in fuel economy ranging from 10% to 23% based on the size of the truck.

It remains to be seen whether the foregoing objectives will be achieved, and at this point it is highly unlikely.[1] Even if they are met, it is sobering to note that the United States will continue to lag behind many nations in which stricter standards and high fuel taxes have shaped consumer preferences for fuel-efficient vehicles and manufacturers have responded accordingly. In the European Union, standards are based on vehicle (tailpipe) CO_2 emissions. From a 1995 average of 186 grams of carbon dioxide per kilometer (g-CO_2/km), standards for 2008 and 2012 were reduced to 140 and 120 grams, respectively. The 2012 standard is approximately equivalent to 50 mpg. In Japan and China, fuel economy standards are couched in terms of vehicle weight, with circa-2007 standards equating to 46 mpg and 36 mpg, respectively (Gallagher et al., 2007). Although CAFE standards provide an instrument for reducing carbon emissions in the transportation sector, a meaningful carbon tax of $1 or more per gallon would do far more to drive consumer preferences for fuel economy.

In the electric power sector, renewable portfolio standards (RPS) dictate production of a certain amount or fraction of energy from renewable sources (solar, wind, biomass, hydro, and/or geothermal). Germany, which has ambitious 2020 targets of obtaining 35% of its electricity and 18% of its total energy from renewable sources, is well on its way to meeting its goals. Although similar targets have been established by the European Union, it is problematic whether they will be met by all members, particularly in the face of weak economic growth and the debt-driven financial difficulties experienced by some nations. Although generally less aggressive, renewable portfolio standards are being established in other regions of the world.

Out of concern for its impact on consumer energy prices, the U.S. Congress has not enacted a national RPS and is not likely to do so. However, many states have adopted their own standards, which typically take the form of achieving a certain percentage (10% to 40%) of power production from renewables by a certain year (2015 to 2030). As of 2014, thirty-one states and the District of Columbia had established standards, with seven more having established aspirational targets (C2ES, 2014). Aggressive standards have been set by Maine (40% by 2017) and California (33% by 2020), with other states seeking to achieve 20% or more. In many states the ability to meet prescribed standards is enhanced by financial incentives, trading of *renewable-energy credits* (RECs), and/or receiving credit for improved energy efficiency.

State renewable portfolio standards have been a major contributor to rapid growth in large-scale wind and solar power systems. However, siting issues, including NIMBY (*not in my back yard*) considerations, and transmission bottlenecks are looming impediments to sustained growth. From large solar farms in Sun-rich regions of the Southwest to wind farms in the Northeast, NIMBY has become a formidable obstacle to securing site permits. Transmission bottlenecks exist between regions of the United States with the greatest potential for wind and solar energy, such as the Upper Midwest, Southwest, and population centers with large demand. To reduce the bottlenecks, there is a growing need for cooperation between states in transmitting and sharing renewable energy and in issuing and tracking RECs. The federal government could play an important role by coordinating state initiatives, supporting expansion of the grid, and adopting consistent, long-term approaches to maintaining tax credits for renewable energy.

Although policy makers have given far more attention to renewable power, targets and support policies also exist for the heating and cooling sector. By 2014, at least twenty-four countries had adopted heating (and cooling) targets through building codes, financial incentives, and other measures (REN, 2014).

7.5 Financial incentives

Financial incentives come in different forms, two of which are tied to the tax code. One involves the amount of electricity produced from renewable energy. In the United States, the subsidy is termed a production tax credit (PTC). For each unit of energy, the federal tax liability of the producer is reduced by about \$0.02 per kWh_e. The other incentive involves an investment tax credit (ITC). Depending on the type of renewable energy, credit for up to 30% of the cost of development is provided when the facility becomes operational. Although the economics of wind and solar power are becoming more competitive with fossil and nuclear energy, retention of the credits would do much to sustain a strong trajectory of growth for the renewables.

In Europe, production subsidies are more commonly provided in the form of feed-in tariffs (FIT), which obligate utilities to purchase renewable energy at a set price over a prescribed duration. To encourage development of renewable sources, prices are typically set at a premium, no more so than in Germany, which mandated prices of approximately \$0.55/kWh_e and \$0.084/kWh_e over twenty years for solar and wind energy, respectively. The utilities, in turn, are allowed to pass the increased cost of electricity to the consumer. While the costs are high per unit of renewable energy, adverse economic effects are mitigated if the energy makes a comparatively small contribution (e.g., less than 20%) to the total energy portfolio. Led by Germany and Spain, European countries that have adopted FITs have experienced the largest growth rate in using renewables for power generation, with concomitant development of renewable energy industries that have stimulated job growth and technology export opportunities.

Financial incentives in the form of loan guarantees or outright cash awards can also be used to encourage the development of related infrastructure. Such incentives are being used worldwide, driven in part by the goal of reducing GHG emissions but also by the desire to gain competitive advantage in emerging clean energy industries. In the United States, the Energy Policy Act of 2005 authorized the Secretary of Energy to provide loan guarantees for projects whose accelerated development would provide a more secure energy supply. Under the American Recovery and Reinvestment Act of 2009, guarantees and grants were used to enable large solar and clean coal initiatives.

7.6 Summary

If energy efficiency and renewable energy are to have a growing and significant impact on reducing GHG emissions, public policy must play a prominent role and policy instruments must continue to evolve. In the heating/cooling and transportation sectors, policy instruments must do more to reduce the use of fossil fuels. In the power sector, new measures are needed for adapting the grid to deal with increasing levels of renewable electricity, including support for development and installation of large-scale energy storage systems as well as net metering and demand control technologies.

Moving forward, it will be important to retain a mix of regulatory and financial measures, but one point cannot be emphasized too strongly. Putting a price on carbon emissions is the best way to stimulate adjustments in energy consumption patterns and to trigger appropriate market responses. This view is shared by many mainstream economists and members of the business community. Quoting Jeffrey Immelt, CEO of General Electric (Friedman, 2007), "the multi-billion dollar scale of investment that a company like GE is being asked to make in new clean-power technologies or that a utility is being asked to make in order to build coal sequestration facilities or nuclear power plants is not going to happen at scale – unless they know that coal and oil are going to be priced high enough for long enough that new investments will not be undercut in a few years by falling fossil fuel prices." And, quoting from an assessment of climate change and fiscal policy made by the International Monetary Fund (IMF, 2014),

Stabilizing atmospheric concentrations of greenhouse gases will require a radical transformation of the global energy system over coming decades. Fiscal instruments (carbon taxes or similar) are the most effective policies for reflecting environmental costs in energy prices and promoting development of cleaner technologies, while also providing a valuable source of revenue (including, not least, for lowering other tax burdens). The message is that carbon emissions must be monetized.

At the end of the day, the extent to which mitigation measures are implemented at meaningful scales depends a good deal on political considerations – global, national, and regional. An argument made against strong mitigation measures is that they are too costly and impede economic growth. There is no better testimony to the fact that the argument is overstated than the economic prowess of Germany. Energy efficiency and conservation are ingrained in the German culture and mindset, and no nation has invested more in developing its renewable energy portfolio. Despite the increased costs associated with very generous FITs, the nation remains an industrial juggernaut, the world's leading exporter of manufactured goods, and a leader in developing future energy technologies.