CHAPTER 9

We Can Be Carbon Neutral

The great enemy of truth is very often not the lie – deliberate, contrived and dishonest – but the myth – persistent, persuasive and unrealistic.

John F. Kennedy

KNOWING THAT I DO CLIMATE-ENERGY RESEARCH, MY friend Gurmeet asked me about carbon offsets. His interest was spurred when booking online his vacation at a Caribbean 'eco-resort.' He recounted for me his dilemma.

"I was almost finished when it asked if I wanted to fly carbon-neutral. I wasn't keen, but I clicked to see the cost. You plug in your flight number, and it tells you the amount that will offset your share of your flight's emissions. It was about $20."

"That sounds cheap."

"I thought it would be more. I was going to skip past, but the low cost stopped me."

"What do you mean?"

"I'm an eco-resort kind of guy. I was feeling a bit guilty about flying, especially once the offset option popped up. Only $20 for a guilt-free vacation. On the other hand, I already do a lot for the environment, so why pay extra?"

"What did you do?"

"I thought about the other guests. What if I met an interesting woman who had bought offsets, and she asked about mine? What if everyone had offsets except me? After all, it *is* an eco-resort. Maybe other guests would

flaunt their receipts to show what good things they were funding. I bought the offset. Good thing too. As it turned out, everyone had purchased them, or so they claimed!"

It seems a simple concept. You pay someone to reduce their carbon pollution while you fly, as always, to your destination. The only difference is that you no longer feel responsible for global warming, no longer guilty about your lifestyle.

No wonder this industry is growing. Estimates suggest the global voluntary offset industry is above $10 billion in annual revenue. The industry feeds on image and guilt. Individuals keep it going. So do corporations, vying for a marketing edge as carbon neutral businesses. "For only $4.95 your website can be carbon neutral!" So do politicians. For his 2011 State of the Union Address, President Obama's motorcade traveled carbon neutral from the White House to the Capitol. (In 2017, Donald Trump did not.) Even some faith communities have gotten involved, with the US Presbyterian Church once urging its congregation to become carbon neutral.

Speaking of religion, offsetting will sound familiar to Christians. In the Middle Ages, the church sold indulgences to wealthy worshippers to expiate their sins. It rationalized this lucrative practice by claiming that its devout clergy, on a sure path to heaven, had done so many good deeds and acts of repentance that they had a surplus to sell to those less confident of their immortal prospects. The sins of the latter would be offset by purchasing the surplus good deeds from the clergy. Skeptics were ignored. The prospect of paying money to neutralize one's sins, without having to change one's lifestyle, was enticing.

Today, Christians no longer believe they can offset their sins by paying someone more pious. They see sin-offsetting as a delusion. But what about carbon offsets? Can we pay someone else to expiate our sins of emission? Can we buy our way to carbon neutrality? Or is this another myth that interferes with our ability to act effectively on the climate-energy challenge?

To address these questions, we should start by clarifying current and potential flows of carbon between the earth's crust (the 'lithosphere'), the atmosphere, and the biosphere. We extract fossil fuels from the lithosphere. We could capture the CO_2 emissions from burning these

fossil fuels before they reach the atmosphere. It would be difficult to have a CO_2 capture device on the tailpipe of every gasoline car, but coal- and natural gas-fired power plants could have equipment that captured CO_2 from exhaust gases 'post-combustion,' or that converted coal or natural gas into hydrogen (for combustion to generate electricity), in this case capturing the CO_2 'pre-combustion.' That zero-emission hydrogen and electricity could then be used in vehicles.

If these captured emissions were injected permanently into underground storage, the coal or natural gas plant would be effectively carbon neutral. It would return to the earth's crust almost the same amount of carbon it had removed. Atmospheric GHG concentrations would not increase in this process of using fossil fuels to produce zero-emission electricity or hydrogen for use in vehicles, buildings, and industry.

Instead of taking carbon from fossil fuels, to prevent its flow to the atmosphere, we could extract carbon from the atmosphere. Carbon Engineering is a company, partly funded by Bill Gates, that has developed such a 'direct air capture' technology. The concept originator is David Keith.[1] Because it is located north of Vancouver, I have visited the company's development plant several times with my students. As humanity's climate predicament worsens, the CO_2 from direct air capture could be shipped by pipeline to a favorable place for geological storage. If this occurred, the technology would be carbon negative rather than carbon neutral, physically reducing the atmospheric CO_2 concentration. Because of our climate-energy policy procrastination, we will need technologies like this in the future (we need them now actually) to reduce atmospheric CO_2. As the harms from CO_2 intensify, we will gladly pay their cost.

Until such time, new technology developers like Carbon Engineering need a revenue stream for their funders, which they hope to earn by using the extracted CO_2 to produce a valued hydrocarbon product, such as synthetic diesel for sale to diesel-fueled technologies, such as trucks, farm equipment, industrial equipment, trains, and ships. When burned, this diesel would release CO_2 into the atmosphere. But this would be equal to the CO_2 that was initially extracted from the atmosphere to produce the synthetic diesel, making the process as a whole carbon neutral. Under the low carbon fuel standard flex-regs of California, this

diesel would generate credits that Carbon Engineering could sell, meaning that it would earn the normal diesel wholesale price plus the low carbon intensity credits. And, of course, its product would be exempt from any carbon taxes. But a direct air capture system like that of Carbon Engineering needs energy to run its air capture process and its fuel production process. To benefit the atmosphere and earn credits under the low carbon fuel standard, that energy cannot be producing many GHG emissions, so it should come from wind, solar, hydropower, nuclear, or fossil fuels with carbon capture and storage.

Biomass energy is also a candidate for carbon neutrality. Except for the last 250 years, the human energy system has relied almost entirely on wood, brush, crop waste, and animal dung, and these have been essentially carbon neutral. As they grow via photosynthesis, trees, bushes, grasses, and crops extract CO_2 from the air to produce carbohydrates. When plants are burned or decay, this carbon is returned to the atmosphere, with no net increase in atmospheric GHG concentrations (although this is not precisely true if more of it returns as methane). Thus, with some caveats, the IPCC generally defines biomass energy as carbon neutral.[2]

If, however, the burning of wood and other forms of bioenergy at an electricity generation plant was combined with carbon capture and storage from the plant's flue gases, the underground storage of the resulting stream of CO_2 would cause the entire process to be carbon negative. This is referred to as 'bio-energy with carbon capture and storage' (BECCS). As with the direct air capture technology of Carbon Engineering, we may need a lot of BECCS in future to compensate for our procrastination on the GHG threat, as we desperately try to lower the atmospheric CO_2 concentration.[3]

Figure 9.1 summarizes these technologies and processes. On the left, it shows how our extraction and burning of fossil fuels emits CO_2 to the atmosphere, where its concentration increases. On the right, it shows how photosynthesis in growing plants extracts carbon from the atmosphere, but when those plants die and decay much of their embodied carbon returns to the atmosphere.

The figure also shows the options for preventing more CO_2 from getting to the atmosphere and for extracting it from the atmosphere. The thick dark line from 'combustion' down to underground carbon

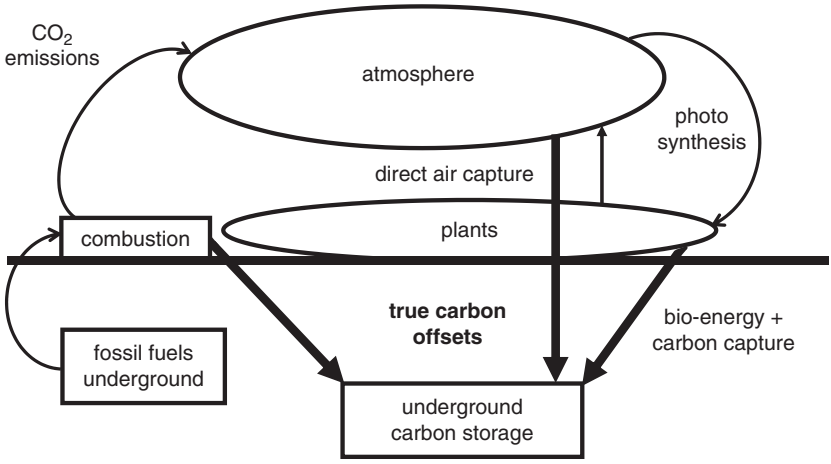

Figure 9.1 True carbon offsets

storage is a way of preventing CO_2 from reaching the atmosphere when using fossil fuels. As noted, this extraction of CO_2 is technologically feasible at large industrial plants burning fossil fuels, but not in smaller technologies like vehicles. The thick dark line in the middle from 'direct air capture' (DAC) down to underground carbon storage, as described above, is a way of reducing atmospheric CO_2 concentrations. If the energy used for DAC were zero-emission, this process would be carbon negative. The third option, the thick line on the right, denotes 'bio-energy with carbon capture,' which is also carbon negative if the CO_2 is returned to storage in the lithosphere.

In bold letters, Figure 9.1 associates 'true carbon offsets' with the box labeled 'underground carbon storage.' Since the CO_2 emissions we are trying to offset invariably come from the burning of fossil fuels extracted from the earth's crust, it stands to reason that the only way to *truly* offset them would be to put the equivalent amount of CO_2 back into the earth's crust that we removed when extracting fossil fuels. If we are to prevent atmospheric CO_2 concentrations from rising, we need to either prevent the emissions in the first place, via carbon capture and storage when we use fossil fuels, or capture CO_2 from the atmosphere and store it permanently underground using direct air capture technologies or biomass with carbon capture and storage.

Planting trees is not an offset for burning fossil fuels because when the trees die and decay (or are burned for energy), they release most of the carbon they extracted through photosynthesis back into the atmosphere, some of it as methane. Carbon flows between the atmosphere and the biosphere in an almost-closed loop. (Some carbon ends up in the oceans and soils, and some in sediments, to become fossil fuels after millions of years.) So it is incorrect to assume that planting trees somehow offsets the CO_2 released from extracting and burning fossil fuels.

The one exception is if we create a forest on barren land that would not have naturally returned to a forested state. And if that new forest became permanent (which we can never know for certain), it would represent an increase in carbon stored away from the atmosphere – in this case in the biosphere. But simply replanting trees on land that would eventually return to forest does not materially reduce atmospheric CO_2 concentrations. The carbon extracted from the atmosphere via photosynthesis returns with burning and decay of biomass, so it cannot be a legitimate offset for carbon that was extracted from the earth's crust and not returned.

In sum, for humanity to be truly carbon neutral, the carbon annually stored underground must equal the carbon the fossil fuel industry annually extracts from the earth's crust. For individuals, corporations, or government to be deemed carbon neutral, the carbon they return to the lithosphere must equal the carbon they extracted from it. We have all the technologies today to achieve this true carbon neutrality. But there's one catch. It doesn't cost $20 to truly offset Gurmeet's flight. It costs more like $100, or even $200.[4]

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The higher cost of truly offsetting GHG emissions explains why promoters of carbon neutrality have an alternative definition from the one I presented above. They say that an offset payment need not fund the actual extraction of carbon from the atmosphere and its burial. Instead, all the payment need do is "prevent emissions that would otherwise have occurred." Here are three examples of what they mean.

If someone intended to purchase a standard efficiency car but accepted an offset payment to purchase an electric vehicle instead, proponents claim that the alternative vehicle choice reduced emissions that would otherwise have occurred. The offset payment to the electric vehicle purchaser allows someone else to claim carbon neutrality without reducing their own emissions. If an electricity supplier intended to build a natural gas plant but accepted a payment to build a hydropower plant instead, carbon neutrality proponents argue again that this reduced emissions that would otherwise have occurred. If an owner of forested land intended to log some of it but was paid to keep it forested instead, carbon neutrality advocates argue that keeping carbon stored as biomass reduced emissions that would otherwise have occurred.

Note that in each example the concept of carbon neutrality depends on the assumed intended action: what would have occurred if the seller of the offset had acted as they apparently intended. This is critical. Presumably, *they* know what they intend to do now and in future with their choice of car or power plant or land. But we don't know. Thus, the carbon offset industry needs to build a hypothetical future that would otherwise have occurred in order to determine if the emissions reductions were truly 'additional' to that future. That future depends on intentions.

Enter the 'offset verification' industry. These are companies paid to verify that an offset is additional. In the early years of offsetting, they simply verified that what was claimed actually occurred: someone bought an electric vehicle, the electric company built a hydropower plant, and the forest was not logged. This was the full extent of offset verification.

Soon, however, skeptics noted that confirmation of the action (or non-action in the case of not logging) does not prove it was additional. Offset verifiers need to also prove that what happened when the offset payment occurred is different from what otherwise would have happened. But since they can't know the true intention of the offset seller, their best hope, 'gold standard verification,' is to gather evidence showing that the car buyer's cheapest option was a gasoline vehicle, the utility's best option was a natural gas plant, and the forest owner's most profitable option was to log the forest. They then presume that these

agents would have taken these financially superior actions, if not for the offset payment.

But from whom does the offset verifier obtain cost and profit estimates? You guessed it, the offset seller. Of course, some information is publicly available: the cost of the electric vehicle, the cost of hydropower turbines, the market price for timber. But every economic decision has unique aspects. There will be cost and benefit information that only the seller knows: the use rate of the electric vehicle, future payments for flood control to the hydropower plant owner, future payments for forest use by local hunters. But we can only really know what the offset seller intended to do if he or she provides an honest disclosure of all possible decision factors. Full disclosure is not, however, in the offset seller's interest, since he or she would like the offset money regardless of original intent.

This self-serving bias of the offset seller is not the only problem. The incentives facing verifiers also favor distortion, since their income depends on the development of a thriving offset industry, with lots of offset payments to be verified. They have no incentive to question the offset seller's decision too deeply lest they dramatically reduce the likelihood that offset buyers and sellers will be active. And because we cannot ever know the true intent of the offset seller, no one can prove that the verifiers did a bad job.

What about the brokers who bring together offset buyers, sellers, and verifiers? No help here either. Since they get a commission on the transaction, their income too depends on the development of a thriving offset industry. The broker would be smart not to question too deeply the relevant decision information used by the offset seller lest they reduce offset sales.

What about the offset purchaser, like Gurmeet? Surely he is the one party to the transaction who wants certainty that his payment actually reduced emissions, that he has not wasted his money on a delusion. Or are his motives so simple? Christians purchasing indulgences from the church wanted to feel less guilty about their lifestyle. Gurmeet now feels less guilty about his lifestyle. And that good feeling was cheaply acquired.

* * *

Economists refer to Gurmeet's dilemma as an 'asymmetric information problem.' Gurmeet and everyone else has less information than offset sellers about their costs and benefits. Because of this, he risks paying excessively for a legitimate offset or, even worse, one that doesn't reduce GHGs.

Governments face a somewhat similar challenge when they want a private company to provide a public good or service. The company, being privy to details about costs and benefits, might pad its cost estimate to extract additional funds from government. In most situations, however, what is provided is tangible – a fighter jet, a bridge, food delivered to the elderly. Government can ask for competing bids so it can compare the offers of firms vying to provide a tangible good or service. But with offsets, what is provided is hypothetical. There is no physical product or service for comparison, so the information asymmetry persists. As Mark Schapiro said in a 2010 *Harper's* article, "the offset market is based on the lack of delivery of an invisible substance to no one."[5]

The offset purchaser cannot know all the decision factors considered by offset sellers. Perhaps the seller likes the eco-status of owning an electric car and would have paid extra to get one, without the benefit of the offset payment. Perhaps the electricity supplier was intending to build the hydropower plant, which would cost more but earn extra revenue by timing water releases to benefit downstream irrigation users. This information asymmetry is a fundamental problem with carbon offsetting. And, contrary to offset industry talk of 'rigorous verification,' it can't be completely eliminated. Uncertainty is *unavoidable* in a verification process that requires assumptions about a hypothetical future that never happens.

To illustrate with a racy analogy, some skeptics once created a (presumably) mock internet service where you could purchase offsets for sexual infidelity. They claimed that if you have a secret affair, your feelings of guilt increase the "concentration of sexual guilt in the atmosphere." These high concentrations are bad for the planet, "raising temperatures with unhealthy clouds of suspicion and regret." While the website was still live, you could log in to Cheat-Neutral and pay someone not to have an affair, so that their fidelity offsets your infidelity. The motto said it all: "helping you, because you can't help yourself."[6]

For a small commission, Cheat-Neutral would help you find the offset seller who makes a fidelity commitment and receives your payment. You pick them from a catalog of cheery, innocent-looking individuals and couples eager to accept money for not having an affair. Bob and Pria are one such couple. An accountant, Bob admits that the word sheets makes him think of spreadsheets. Pria dotes on her four cats. If you're worried these people might take your offset payment and then secretly renege, you can pay extra for "gold standard verification" – 24-hour video-surveillance.

Why are you suspicious? Cheat-Neutral and carbon neutral both depend on something we can't prove. It does no good to pay people who are celibate, and will remain so in future, so you must find someone in a relationship who was about to have an affair, an outcome that changed only because of your payment. But you can't be sure the person you paid would have had an affair were it not for your payment. You can't be sure of their initial intention, although you might gather information to help you guess. (Bob and Pria look suspiciously like people who don't have affairs, but looks can be deceiving.)

Perhaps you learn that one was previously a compulsive adulterer. This improves the chances that your offset payment (in concert with 24-hour surveillance!) will reduce the global total of infidelity-guilt. But perhaps they recently experienced a spiritual awakening, and renounced forever their promiscuous lifestyle. All you can do is hope that they would have secretly broken their vow and continued to cheat (a warped thought), just as we must hope that the electric vehicle purchaser would have bought another gas-guzzler, the electric company would have built another natural gas plant, and the forest owner would have clear-cut her land.

We can extend this analogy to the entire verification apparatus. As with carbon neutrality, all parties in the Cheat-Neutral transaction have an incentive to argue or believe that the offset payment caused the future to unfold differently than it otherwise would have. Offset sellers like Bob and Pria only make money if they can convince someone they were sure to have an affair, regardless of the truth. Cheat-Neutral only makes money if transactions occur, so it needs to find people claiming to be imminent cheaters, even if uncertain of their true intentions. Finally, the offset purchaser wants

to avoid guilt as cheaply as possible, but lacks the time and motivation to investigate the likelihood that the offset seller was going to cheat.

Claiming to neutralize atmospheric guilt from sexual infidelity may sound bizarre, but it is no different than claiming to neutralize our emissions without returning to underground storage the carbon we removed from the earth's crust. In both cases, we cannot be certain a given offset-funded project is additional, since we cannot verify a hypothetical future that never happens.

When we mix together the ubiquitous nature of GHG emissions, financial self-interest, human imagination, and the propensity to delude, we have a potent cocktail. Little wonder that today you can pay to offset your emissions from drinking a beer, racing Formula 1, or changing diapers. And you can do this by paying someone to capture cow farts in Montana, plant trees in the Sahara, or shoot camels in Australia. As actor Ed Begley Jr. put it, "If you're going to drive around in a big old Hummer and then buy carbon offsets to mitigate that, that's like getting drunk and throwing some money through the window of an AA meeting."[7]

Figure 9.2 Cartoon by Jacob Fox

But should we write off the entire offsetting business? Are all carbon offsets a sham? Perhaps there is a way to estimate the percentage of offsets likely to be additional.

While carbon offsets are relatively new, offset-like schemes have a long history. For decades, researchers have assessed the effectiveness of government and voluntary programs that pay people to provide something of public value, many with strong similarities to offset payments. These include payments by electric utilities for improved energy efficiency and payments by governments and charitable organizations for reforestation, forest conservation, and afforestation (foresting an area that never was forested). I and my research team have contributed to assessments of electric utility efficiency payments and forest payments.[8]

From 1985 to 2000, US electric utilities spent over $20 billion in subsidies and information programs to induce consumers and businesses to acquire energy-efficient devices. These subsidies are effectively the same as offset payments. The utility pays someone to buy an efficient device who otherwise, presumably, was going to buy an inefficient device. Because some jurisdictions had subsidy programs while others didn't, this provided an opportunity to estimate if the offset-like payments made a difference, by comparing the two jurisdictions.

The challenge is illustrated by the following example. At any given time, some consumers buy high-efficiency fridges, while others buy medium- and low-efficiency models. When a utility offers a $50 rebate to purchasers of the efficient models, its program would be completely successful if all subsidies went to people who were not intending to buy these. If, in contrast, all subsidies went to people who would have bought the efficient models anyway, this program would be a complete failure, with zero additionality. (Economists call it 'adverse selection' when a program benefits the wrong people because only they possess information on their true intentions.)

Researchers have tried to detect an efficiency improvement in those jurisdictions with subsidy programs compared to those without. As it turns out, the last two decades have witnessed many of these studies on electric utility efficiency programs. While there is not complete agreement on the rates of additionality, there is agreement that it is rarely

above 50%. In other words, at least half of the offset-like subsidy payments did not increase efficiency, instead going to people for buying what they would have bought anyway.[9]

Another offset-like subsidy with a long history is the practice of paying for forest conservation and reforestation, especially payments from governments and private donors to conserve forest land in developing countries. Independent research has generated results the offset industry would not want widely known. Researchers at *Resources for the Future* noted that in some cases, such as a program in Costa Rica, offset-like payments were less than 10% effective because almost all the land receiving money was ill suited for other uses.[10] Thus, forest land owners received money for not cutting down forests they weren't going to cut down anyway.

The Kyoto Protocol in 1997 created two offset mechanisms. One of these, called Joint Implementation, allows companies in developed countries to subsidize GHG-reducing investments in other developed countries. A 2015 hindsight analysis by the Stockholm Environment Institute estimated that 75% of the funding paid for actions that would have happened anyway.[11] The other Kyoto offset program is called the Clean Development Mechanism, which allows companies in developed countries to subsidize reductions in developing countries. A popular offset is to pay for 'reduced emissions from deforestation and forest degradation' (REDD). Hindsight research has shown that it too is much less effective than its promoters promised, with 85% of funded projects unlikely to be additional.[12] To Lisa Song, the reduced effect of forest preservation offsets is "an even more inconvenient truth."[13]

These are a few examples of independent research that assesses the likely additionality of offset-like mechanisms, whether private or institutional. Such research finds, unsurprisingly, that offsets are vulnerable to the same flaws found with previous subsidy programs for energy efficiency and forest conservation: additionality is almost impossible to prove with individual projects, while the aggregate effect is less than claimed. This is bad news for the offset industry – although only if widely publicized and understood.

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Maybe it doesn't matter if some people are misled about carbon neutrality. Why should Gurmeet be prevented, even if there is little effect, from voluntarily increasing his airfare by $20 to transfer money to a forest owner in Costa Rica? One can hardly prohibit offsetting just because it's not all additional. And we don't want government, in a bizarre perversion of roles, to stop people from voluntarily taxing themselves for the environmental harm they cause, just because the tax is too low.

But the point of carbon offsets and carbon neutrality is to effectively address the climate-energy challenge. If offsets are often ineffective, yet its proponents convince themselves and others that they are effective, we have a problem. We risk further delaying a truly effective effort if claims of carbon neutrality enable insincere politicians to delay the essential but difficult regulatory and pricing policies. This concern explains why Kevin Anderson, a leading researcher at the UK Tyndall Centre, claims that, "offsetting is worse than doing nothing."[14]

If we are to get past carbon offsetting, we should understand why it emerged. I've described previously the successes we've had in addressing environmental threats from acid, lead, smog, and ozone-depleting emissions. We succeeded because we implemented regulations and sometimes pricing. Never have we pursued acid offsets, lead offsets, smog offsets, or ozone-depletion offsets. The terms sound fanciful.

The carbon emissions story is different. For reasons I've described in previous chapters, national governments have been far too slow in implementing effective climate-energy policies, which is why individuals, groups, organizations, and businesses are exploring voluntary actions, like the behavioral change I described in Chapter 8. Carbon offsetting has emerged in this context. Even those who understand that strong national policies are essential may look to carbon offsetting to show that immediate action is possible as an alternative to only railing about government.

There is also the 'glass half-full' argument. If 50% of offset recipients are not additional, this means that 50% are. If their actions accelerate the market penetration of low-emission technologies, like wind turbines, solar panels, and electric cars, the costs of these technologies may fall faster thanks to greater economies of scale from mass production. From

this perspective, even partially effective carbon offsetting may contribute to the solution.

Also, not all offsets are equally bad. Some subsidies to afforestation might develop a vibrant forest on land that would have remained barren indefinitely, storing carbon on the earth's surface that would otherwise be in the atmosphere.

Proponents also point out that offsetting provides a means of reaching GHG emissions that are difficult to regulate or price. In agriculture, changes in tilling practices, animal feed, and the storing and treating of animal waste can reduce GHG emissions. Imagine the reaction of farmers to an onslaught of regulations and taxes on these activities. Offset payments, so the argument goes, increase farmer awareness of the climate-energy challenge, preparing them for more exacting policies in future.

Thus, advocates sometimes argue that carbon offsetting complements and facilitates the compulsory pricing and regulatory policies that governments must enact. This sounds good. But the experience doesn't match this image. To understand why, we must distinguish between the trading of carbon offsets, and the trading of carbon permits in a comprehensive cap-and-trade system. These two forms of carbon trading differ fundamentally, yet are often conflated in the eyes of proponents, the public, politicians, and the media.[15]

In a comprehensive emissions cap-and-trade policy, all emissions would require a permit and all permits would sum to the total allowed emissions. Under this policy, there would be no such thing as carbon offsets, no such thing as carbon neutrality. Some people might have high emissions. Some might have low or even zero emissions. But no one would pretend that buying someone's permits makes them carbon neutral. This is why no one promoted 'acid offsets' when the US government implemented its ambitious acid emissions cap-and-trade program in 1990. Nor would anyone promote 'carbon offsets' if government implemented a similar policy for reducing carbon emissions.

Or so one might think. However, carbon offsetting has inculcated itself into the very design of climate cap-and-trade policies. Lobbyists have convinced politicians that difficult-to-regulate emissions in farming and forestry can be addressed in the cap-and-trade system with a win-win mechanism that lowers the cost of emissions reduction and induces

climate policy buy-in from farmers and forest land owners. Under this approach, those whose emissions are capped would have the option to buy offsets from those whose emissions are not. A factory that has permits for only 80% of its current emissions would now have three options instead of two. Initially, its two options for achieving the 20% reduction were to reduce its own emissions or buy permits in the permit trading market. Now, its third option is to buy offsets from a farmer or other entity whose emissions are not capped.

From a political perspective, allowing offsets in a cap-and-trade system is attractive. By lowering the cost of achieving the government's emissions target, offsets increase political acceptability. The factory is better off if offsets are cheaper than buying permits or reducing plant emissions. The farmer is happy to get paid for something that she was perhaps going to do anyway, and to avoid new complicated regulations. For the whole economy, offsets add another low-cost option, which decreases the permit trading price and thus everyone's compliance costs. (Of course, if the offsets are not additional, the low compliance cost is explained by the fact that emissions are not actually declining.)

With these apparent cost advantages, political negotiations to develop cap-and-trade regulations in a given jurisdiction tend to expand the role of offsets to overcome stalemates. The various interests clamoring for offsets drown out the few economists and environmentalists frantically arguing that including offsets increases the likelihood of replacing real with fictive reductions.

This is the dilemma for climate policy, both within and between countries. Even if governments one day acknowledge that carbon neutrality is a myth, the practice of carbon offsetting is not easily expunged. This does not mean we must resign ourselves to perpetual climate policy failure. But we do need to severely restrict the offset loophole. Here's how.

First, governments should only recognize a strict definition of carbon neutrality. A carbon offset must physically remove carbon from the atmosphere and store it, preferably underground, as I showed in Figure 9.1.

Second, governments should not allow carbon offsetting to undermine their compulsory climate-energy policies. Whether using flex-

regs, carbon pricing, or a combination of these, government should restrict the contribution of offsets to 10% of total reductions. And the claimed quantities of 'permitted' offsets should be discounted by 50% to reflect their likely additionality flaws. Thus, a factory would have to hold 200 tons of carbon offsets to get credited for 100. This is not a new idea; some early drafts of US cap-and-trade bills discounted offsets by 25%.

Third, governments should assign sunset clauses to offset provisions in their cap-and-trade policies. While agricultural emissions might initially be exempt from an emissions cap, but available for offsets, the cap would gradually extend to tillage practice, animal waste handling, and so on, while gradually diminishing the offset contribution.

Fourth, at the international level, developing countries would be eligible for offsets from developed countries, but their eligibility would be tied to domestic implementation of effective climate-energy policies – either stringent regulations or a rising carbon price or both that were guaranteed to phase-out coal plants in electricity and gasoline and diesel in transportation.

With these four conditions, governments would undermine the myth that one can achieve carbon neutrality by buying offsets and would prevent offset programs from weakening otherwise effective climate-energy policies. But the offset problem started because most governments are unwilling to implement effective policies. The carbon neutral delusion suits many political leaders just fine, which returns us to where we started, trying to help Gurmeet decide what to do.

At least by now it's obvious Gurmeet is not helping anybody by sustaining the myth of carbon neutrality. He needs to do something else. He could use the funds he would have spent for offsets to directly reduce his own emissions, especially by an action he would otherwise not yet have taken. Thus, he might put the money toward an electric car or electric heat pump or solar panels.

Perhaps he could use offset money to pay extra for goods and services in order to reward companies that commit to use these funds for additional emissions reductions, without buying and selling offsets. An example is to pay a higher rate to a natural gas supplier for blending more biomethane into its gas supply. If this is a high-cost option, Gurmeet can

be confident that it would not have occurred without his offset payment, potentially meeting the additionality test.

Finally, Gurmeet needs to recognize that if his fellow citizens are not also reducing emissions, his individual efforts don't mean much. He might take the money he would spend on offsets and instead donate it to organizations and politicians pursuing the essential compulsory policies that regulate energy and technologies or price carbon emissions. If he finds climate-sincere politicians willing to champion and implement these strategies, helping elect them is the best use of his offset money. Success with the climate-energy challenge requires action from everyone, not just the small number of people willing to voluntarily tax their pollution.