CHANGING BEHAVIORS TO REDUCE U.S. EMISSIONS: Seven Pathways to Achieve Climate Impact

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Changing Behaviors to Reduce U.S. Emissions: Seven Pathways to Achieve Climate Impact

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Executive Summary

Any solution to the climate crisis must involve the United States dramatically reducing its greenhouse gas emissions. Strong climate policies are an essential pathway to achieving necessary emissions reductions. However, a focus on policy alone ignores the breadth of available pathways for action and the urgency of acting on a faster timeline than the policy process often allows. Actions taken voluntarily at the individual and household level can significantly contribute to overall emissions reductions and can do so in the absence of policy. Here, we provide an accessible framework for prioritizing actions among the many options and apply behavioral science insights to identify effective pathways to individual action.

In this analysis, we identify the individual behaviors that have the greatest practical potential to reduce emissions in the U.S. These behaviors have a high impact on carbon emissions, are suitable for intervention focused on behavior change, and have significant potential for adoption.

Our results indicate that, without making dramatic lifestyle changes and in the absence of sweeping new policies, reasonable, individual actions by a small portion of Americans could nevertheless have a measurable, substantive impact on reducing national emissions through a suite of seven high-impact behaviors.

- Purchase Electric Vehicle
- Reduce Air Travel
- Eat a Plant-Rich Diet
- Offset Carbon
- Reduce Food Waste
- Tend Carbon-Sequestering Soil
- Purchase Green Energy

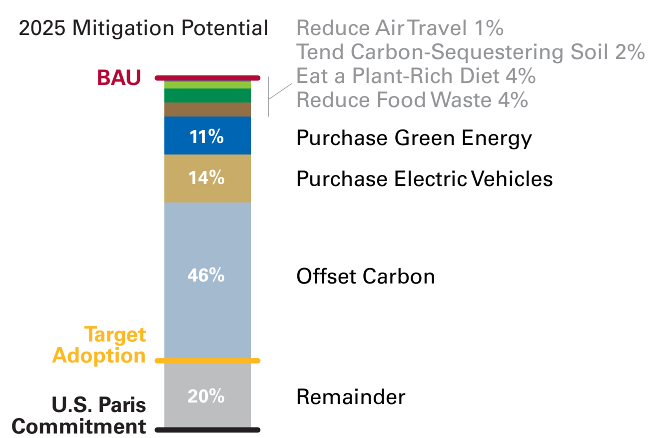
Modeling against a Business as Usual (BAU) scenario and using emissions reduction commitments under the Paris Agreement as a benchmark, we found that increasing national adoption of these seven behaviors by 10 percent of the addressable market of potential adopters would reduce total U.S. emissions across economic sectors by 8 percent. Calculated another way, if just one in every ten members of the relevant demographic for a given behavior in the U.S. was to adopt it, it could reduce the projected gap in delivering the U.S.'s commitment under the Paris Agreement by 80 percent. This adoption target would also achieve a total avoided cost to society of $22.1 billion USD per year.

To analyze the behavioral pathway for each of the seven behaviors, we undertook a landscape analysis and literature review in order to score them based on the feasibility of and momentum behind each behavior change solution. Our results show promising pathways for each of the seven behaviors. Promoting uptake of these behaviors will require further segmenting the target audiences for each and developing messaging and strategies tailored to each segment.

Our analysis indicates that individual behavior change is an integral, scalable component of achieving necessary emissions reductions in the near term.

Each Behavior's Contribution Toward Target Adoption Goal

Reducing emissions from a Business as Usual (BAU) scenario to a behavior change adoption scenario.



Introduction

Context

Reducing carbon emissions enough to avoid catastrophic warming requires multiple actions from multiple actors across sectors and geographies.

The scale of the problem is not trivial. Global net emissions were 36.2 gigatons in 2017.[1] To get on a trajectory that does not warm the planet by more than 1.5°C, we must somehow decrease annual global net emissions by about 50 percent between now and 2030, and reach net zero emissions by 2050.[2]

The U.S. emits 6.6 gigatons of carbon equivalent annually, which comprises 15 percent of global emissions. As a major emitter, the U.S. has an opportunity and a responsibility to make a real difference by decreasing its emissions.

As Rare explored in our recent report, *Climate Change Needs Behavior Change: Making the Case for Behavioral Solutions to Reduce Global Warming*, Project Drawdown's list of 80 global solutions contains 30 in which individual and household behavior changes play a significant role.[3]

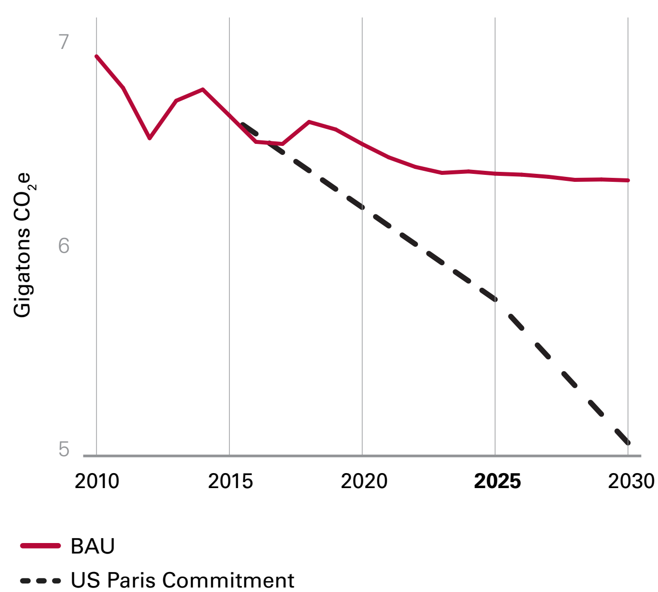
Although climate solutions rooted in behavior changes present an important opportunity to reduce emissions and behavioral science provides insights on the most effective available pathways for individual action, existing literature does not provide an accessible framework for prioritizing actions among the many that could be taken.

U.S. Paris Emissions Commitment

In 2015, Parties to the United Nations Framework Convention on Climate Change reached a landmark agreement to tackle climate change, enhance resilience and mobilize needed finance. For the first time, all countries pledged to reduce their emissions by a certain target amount, and each submitted a Nationally Determined Contribution (NDC). The U.S. signed the Paris Agreement in 2016 under President Obama and pledged to reduce economy-wide greenhouse gas emissions by 26-28 percent below 2005 levels by 2025. On June 1, 2017, President Trump declared that the U.S. would withdraw from the Agreement.

Figure 1: The U.S. Emissions Gap

Comparison of a BAU scenario with US Paris Agreement commitments scenario.



This Report

The amount of attention and energy any one individual can direct towards taking novel actions or building new habits is finite. To maximize emissions reductions we can strategically promote the highest impact behaviors, rather than presenting an overwhelming suite of options. **Our objective in conducting this analysis is to identify the behaviors that have the greatest practical potential to reduce emissions in the U.S. because they have both a high impact on carbon emissions and are suitable for intervention focused on behavior change.**

We prioritized behavioral solutions along three key dimensions — greenhouse gas (GHG) emissions mitigation potential, feasibility of behavior change, and momentum for a behavior change campaign. We modeled emissions reduction impact comparing a BAU scenario with a behavior change scenario.

Our results indicate that, without making dramatic lifestyle changes and in the absence of sweeping new policies, a small portion of Americans can have a measurable, substantive impact on reducing national emissions.

Table 1: The Seven Behaviors

Each behavior was evaluated for GHG emissions mitigation potential ("impact"), feasibility of behavior change, and momentum for a behavior change campaign. Three stars is the highest evaluation outcome.

	IMPACT	FEASIBILITY	MOMENTUM
Purchase Electric Vehicle New car buyers opt for an electric vehicle [4]	★★★	★★	★★★
Reduce Air Travel High-frequency fliers fly one fewer time per year	★	★	★
Eat a Plant-Rich Diet Anyone who isn't already vegetarian eats a bit less meat	★	★★	★★
Offset Carbon Individuals offset their full annual emissions with verified carbon credits	★★★	★★	★
Reduce Food Waste Households waste a bit less from their plates, and compost the rest	★	★★★	★
Tend Carbon-Sequestering Soil Soy and corn farmers practice no-till agriculture	★	★★★	★★
Purchase Green Energy Households install solar and meet any additional energy needs with renewable energy	★★★	★	★★★

Summary Findings

Our analysis resulted in a list of seven behaviors that present the highest impact opportunities that individuals in the U.S. can reasonably take to significantly reduce their carbon emissions. These behaviors all have a high U.S. relevance, high carbon impact, and significant potential for adoption. (Table 1)

Despite current existing policy efforts, the U.S. is projected to miss its 2025 Paris commitment by 0.6 gigatons. National adoption of these seven behaviors can help to close the projected gap. Within the addressable market of potential adopters for each behavior, **if adoption increases by 10 percent, it would reduce that gap by 80 percent to 0.12 gigatons.**[5] (Figure 2 and 3)

Figure 2: Behavior Adoption Can Close the U.S. Paris Emissions Gap

Comparison of a BAU scenario with a behavior change adoption scenario.

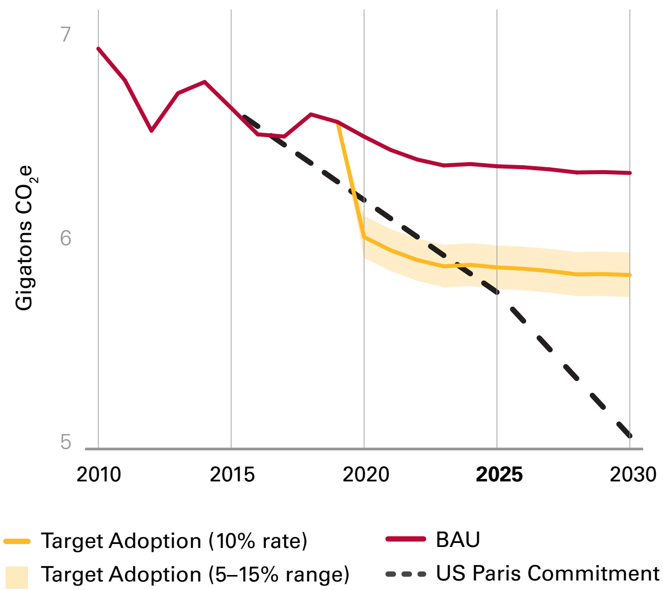
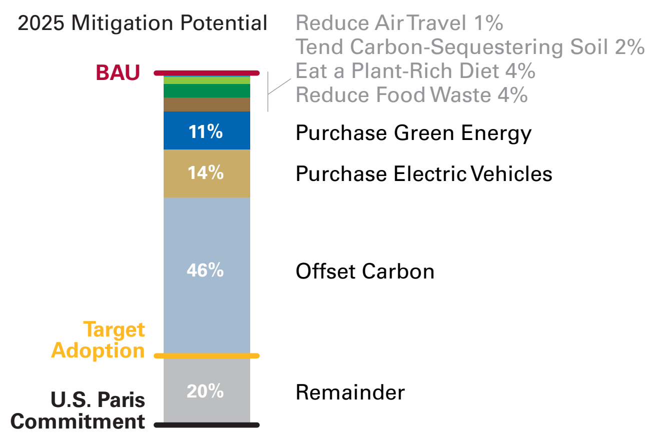


Figure 3: Each Behavior's Contribution to Emissions Reductions



Without making dramatic lifestyle changes and in the absence of sweeping new policies, a small portion of Americans can have a measurable, substantive impact on reducing national emissions.

These behaviors at our target adoption rate would close the Paris commitment gap by reducing total U.S. emissions across economic sectors by eight percent, or 0.48 gigatons. This figure is the GHG equivalent of a little over 27 million Americans emitting absolutely no carbon for a full year.[6] (Figure 4)

Finally, our behavioral adoption target would also result in substantial savings over time of $22.1 billion USD per year, measured as total avoided cost to society (Figure 5).

Figure 4: Reduction of U.S. Emissions Across Sectors

Overall 8% emissions reduction broken down by sector.

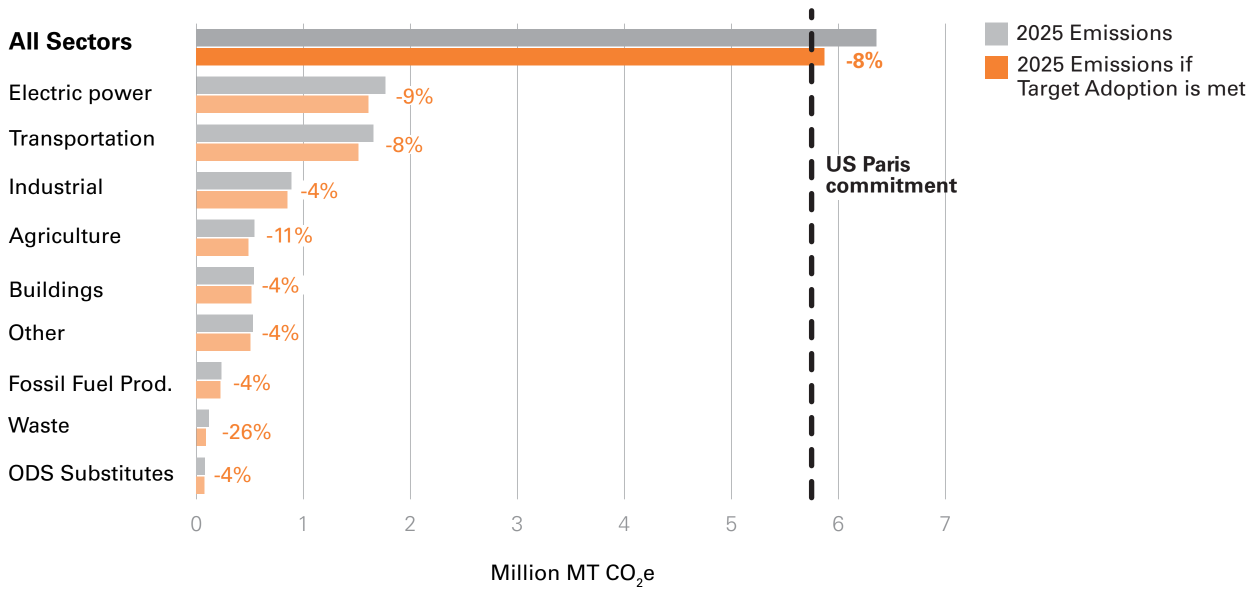
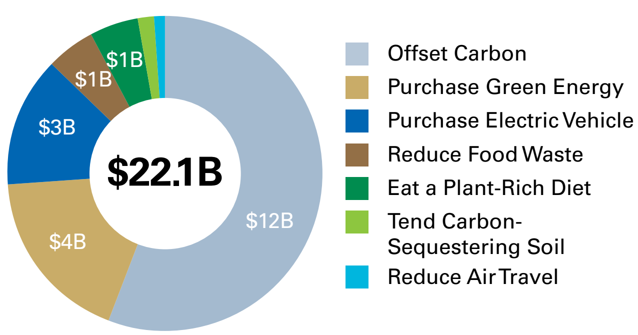


Figure 5: Total Avoided Cost to Society

Avoided cost by behavior at 10% target adoption. Source: EPA 2017



Prioritization Framework

Our methodology involved a two-step process of identifying priority behaviors and then estimating their carbon impact and their suitability for a behavior change intervention.

Step 1: Prioritization of Behaviors

Starting with the behavioral solutions in Rare's *Climate Change Needs Behavior Change* report, we reviewed several additional surveys of emissions-reducing activities to generate a long list of solutions.[7] To refine this long list, we ranked the solutions using a matrix model based first on emissions reduction potential and then on U.S. relevance. This initial evaluation quickly sorted out lower-emissions impact activities, like improved driving behavior and smart thermostats, and activities that were not relevant in the U.S., such as clean cookstoves and tropical staple trees.

After a review of the behavioral science literature for each solution and interviews with researchers, we further prioritized and arrived at our final list of seven behavioral pathways towards reducing emissions. We then assessed the seven based on three key dimensions: GHG emission mitigation, feasibility of behavior change, and momentum for a behavior change campaign.

This research explicitly prioritized individual and household actions in the U.S. with a feasible behavioral pathway. Selecting for other factors, such as high applicability outside of the U.S., could have resulted in a different outcome.

Step 2: Estimating Impact

Scenarios

To estimate the annual mitigation impact for each behavior, we built a simple model that compares BAU trajectories with a behavior change scenario. BAU scenarios are based on linear extrapolations of historic trends (i.e., 1990-2018), while behavior change scenarios assume immediate adoption of carbon-footprint reducing activities. The model's simplicity and linearity is well-suited for the degree of uncertainty that exists around key model assumptions and results must be understood as indicative.

Each solution modeled is treated as a single behavioral pathway. This includes two behaviors in our model that consist of more than one action. The model for reducing food waste includes decreasing plate size and increasing composting, and purchasing green energy consists of solar panels, solar water heating, and green energy purchasing. We combined these actions because they occupy the same decision and emissions pathway space.

Adoption Rates

A key variable in the model is the adoption rate of activities (i.e., the number of individuals who change their behavior). Our model takes a simple two-step approach. First, we estimated the addressable market, defined as the number of individuals or households that are in the position to, but have not yet adopted, a certain behavior, for each solution. Second, we assumed that 10 percent of this remaining addressable market adopts the behavior as a result of well-designed campaigns. To some, a 10 percent increase might seem low, but it actually represents an ambitious adoption rate when compared to what the literature considers a 'successful' behavior campaign (See Box). We assumed a ten percent adoption rate for all of the behaviors in our model except for purchasing carbon offsets, for which we assumed only a 5 percent adoption rate since offset markets are not mature enough to absorb the demand for carbon credits resulting from a 10 percent adoption rate.[8]

Feasibility and Momentum for Behavior Change

To assign an aggregate Feasibility score, we assessed nine potential barriers to adopting each behavior. To assign each a Momentum score, we assessed four momentum metrics. These scores were then used to plot the predicted ease or difficulty of adopting each behavior. (Table 1)

Adoption Rates in the Behavioral Literature

Meta-analysis on the effect of media-based campaigns on health behaviors found that campaign effect varies by the type of behavior:

- 15 percent for seat belt use,
- 13 percent for oral health,
- 9 percent for alcohol use reduction,
- 5 percent for heart disease prevention,
- 5 percent for smoking,
- 4 percent for mammography and cervical cancer screening,
- 4 percent for sexual behaviors.[9]

A literature review by the Nordic Council of Ministers suggests that adoption responses to informational and nudging campaigns for energy efficiency and improved waste management are very low, usually below 5 percent of the target audience.[10]

Adoption rates of heavily promoted and subsidized climate-smart agriculture practices are extremely low around the world, typically ranging from 5-20 percent.[11]

It took 40 years of government programs and NGO efforts to decrease littering in the U.S. by 60 percent.[12]

A 10 percent increase represents an ambitious adoption rate when compared to what the literature considers a successful behavioral campaign.

The Seven Behaviors

Our analysis shows that a small set of targeted actions can have significant climate impact at realistic rates of adoption. It represents findings about the specific individual actions that can most meaningfully curb carbon emissions and the opportunities that exist to apply behavioral insights to promote their adoption.

Momentum for Adoption

Since reducing emissions depends on people taking certain actions, we must have some insight into who will take those actions and how. Assessing the barriers to and momentum behind adoption of these behaviors provides insight into the likelihood of their adoption relative to their emissions impact. (Figure 6).

The portion of the U.S. population already engaged in each of these behaviors can be plotted along an adoption curve (Figure 7).[13] Most of the behaviors in this analysis are still in the 'Innovators' portion of the adoption curve, meaning very few people have adopted them. However, our feasibility and momentum analysis showed that several of these behaviors have significant momentum behind them. Importantly, two of the lowest-adopted behaviors — purchasing electric vehicles or solar and switching to a plant rich diet — scored the highest in our momentum analysis, indicating that a rapid move up the adoption curve is possible. Studies have shown evidence for the possibility of large and enduring behavioral shifts in short windows of time.[14]

No single individual needs to take on all seven of these behaviors to reach the target emissions reductions. The number of individuals that need to take on a given behavior to reach 10 percent of the addressable market varies by behavior. Promoting uptake of these behaviors will require defining specific target audiences within the addressable market for each behavior and developing messaging strategies tailored to each audience. Our discussion of behavioral pathways for each behavior includes evidence from the literature of what motivates people to adopt them, which is a step towards defining audiences.

Below, we provide details on each of the seven behaviors, including insights from the literature and the specific modeling parameters and impacts for each behavior.

Figure 6: Solutions Scored and Ranked by Feasibility and Momentum

Each behavior was assessed for behavioral barriers ("feasibility") and momentum on a scale of 1 to 10, with 10 as the highest score.

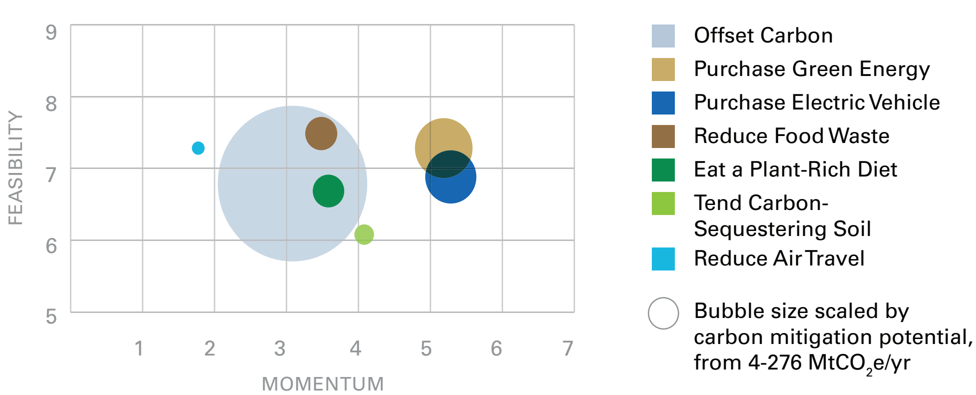
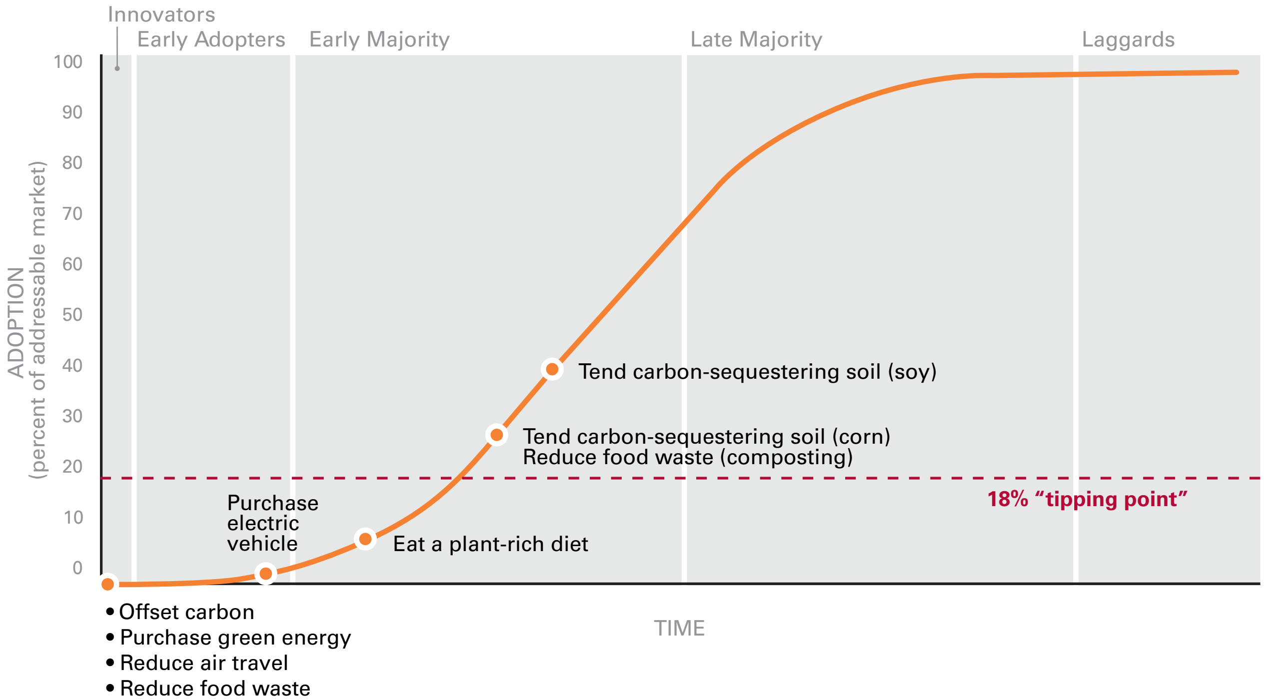


Figure 7: Adoption Baseline Curve

The portion of addressable market already engaged in each of the seven behaviors, plotted along adoption curve. Curve and market segments drawn from "Diffusion of Innovation" model.

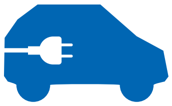


Tend carbon-sequestering soil' is treated as one behavior in our emissions model. Since we have enough data to know that adoption rates for this behavior differ between corn and soy farming, we have separated it by crop here in order to provide more accurate information.

Carbon Sequestering Soil

Carbon-sequestering agriculture is the one productive-sector strategy in our final prioritization. While this behavior does not fit neatly with the others in terms of addressable audience, it fully performs within the core criteria of our prioritization. Addressing farming behavior has a high emissions reduction potential, is U.S. relevant, and is backed by sufficient evidence from behavioral science. Although the audience for this behavior, farmers, is a specialized demographic, we nevertheless consider a switch to carbon-sequestering soil practices an individual behavior, as farmers are individual actors and the decisions they make about their practices follow the same behavioral mechanisms as other behaviors on this list.

Purchase an Electric Vehicle



By the most recent available figures, the U.S. consumes more refined petroleum than any other country in the world, the majority of which goes to transportation.[15] Given that much of existing U.S. infrastructure is built around passenger vehicle use, improvements to public transportation alone will not decarbonize the transportation sector. Transitioning new car purchases to electric vehicles (EV's), in tandem with decarbonization of the energy grid, is one important pathway to reduce passenger vehicle emissions.

BEHAVIORAL PATHWAYS

Price incentives are an important component of easing this expensive purchase, especially because studies have shown that people are not good at estimating long-term cost savings associated with EV's.[16] However, subsidies alone will not increase EV drivership. Car purchasing decisions involve a combination of psychological, political, and situational decision-making.[17] While early adopters with a strong environmental ethos are currently the group most likely to purchase EV's, studies have shown that various methods of priming individuals can substantially increase their purchasing of EV's, both by dispelling biases against EV's (i.e. they have range issues, they are only for rich people) and by increasing interest in them (i.e. they are fun to drive, subsidies are available, they cost less over time).[18] Pilot programs have found that the opportunity to test drive an EV, the ability to talk to a current owner, or even the mere presence of observable charging infrastructure in a person's daily routine, all contribute positively to a person's likelihood of purchasing an EV.[19]

MODELING

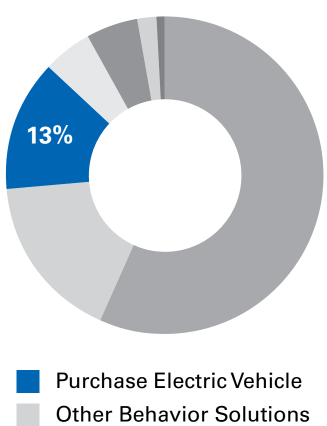
We modeled Vehicle Miles Traveled (VMT) in EV's when the share of passenger vehicular travel completed in EV's was increased by 10 percent. Though gains in the U.S. grid mix could vary significantly, for modeling purposes we projected linear gains after 2017 based on a 10 year average. Wheel-to-well emission factors for gasoline were assumed to remain static.

IMPACTS

Our model projected an annual emissions savings of 65 million tons of carbon dioxide equivalent ($MtCO_2e$) and a social value of mitigation of between $2.9 and $33.4 billion per year.

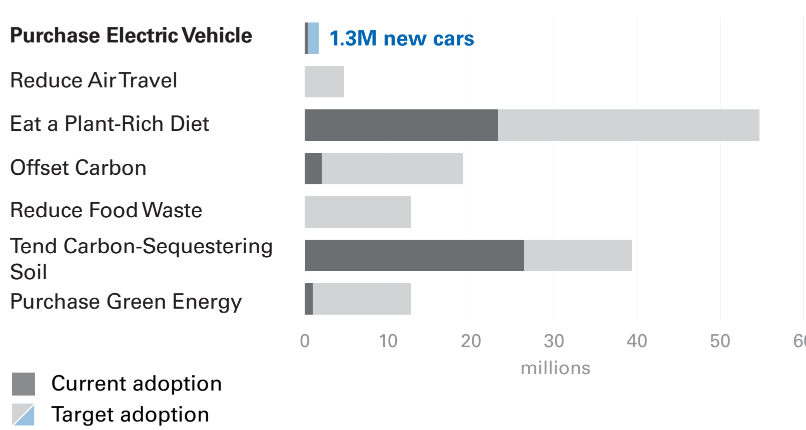
Emissions Impact

New car purchases make up 13% of the carbon emissions reduction attributable to the target adoption.



Human Behavior Angle: Behavior Changes Needed for Target Adoption

2.4% of new car purchases are already electric vehicles. 1.3M behavior changes are needed to increase target adoption by 10% of new car buyers.



Reduce Air Travel

Per passenger-hour, the climate impact of air travel is a factor 6 to 47 times higher than the impact of car travel.[20] Emissions from aviation have a climate forcing impact beyond carbon dioxide, since other emissions such as water vapor and nitrogen oxides have additional warming effects.[21] While the International Civil Aviation Organization (ICAO) has committed to carbon neutral growth by 2020, primarily via increased fuel and flight efficiency, we will need to curtail demand to reduce overall emissions from air travel.

BEHAVIORAL PATHWAYS

The U.S. is home to the busiest airlines and the passengers who fly the most in the world, representing nearly a fifth of total air traffic.[22] The amount that average U.S. citizens fly is highly segmented, with more than half of people not having flown at all last year, and with top fliers flying 9 or more times per year.[23] Unlike other groups, these high emitters are also often those who have the strongest stated values about mitigating climate change.[24] If top fliers reduce their air travel by just one international flight per year, it could have a significant emissions impact. About a third of total flights taken by Americans are for business, representing an opportunity to sub out in-person meetings for teleconferences or other remote engagement.[25]

MODELING

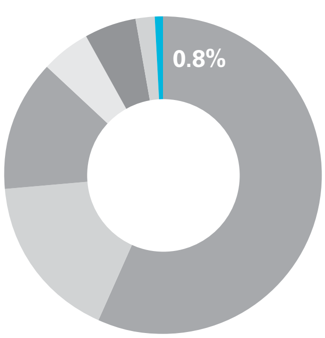
We defined frequent fliers as those U.S. residents that take 5 or more flights per year and assumed that individuals in this segment of frequent fliers drop one transnational or transatlantic flight from their list per year (~2,550 miles equivalent to 0.9 $MtCO_2$).[26] Importantly, the business as usual scenario assumes a decreasing industry-wide emissions intensity from 0.39 kg CO_2 / billion passenger km in 1990 to 0.15 in 2015 to 0.09 in 2040.[27]

IMPACTS

Our model projected an annual emissions savings of 4 $MtCO_2e$ and a social value of mitigation of between $0.2 and $2.1 billion per year.

Emissions Impact

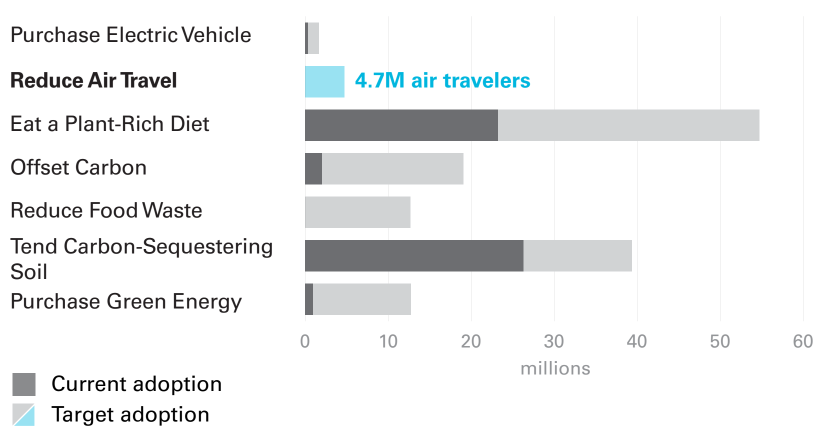
Reduced air travel make up less than 1% of the carbon emissions reduction attributable to the target adoption.



Reduce Air Travel
Other Behavior Solutions

Human Behavior Angle: Behavior Changes Needed for Target Adoption

Zero air travel reductions represent current adoption in the model. 4.7M behavior changes are needed to increase target adoption by 10% of air travelers.



Eat a Plant-Rich Diet

U.S. residents consume almost four times the beef per capita as the global average.[28] As beef is the most greenhouse gas (GHG) intensive protein in the world (with, for example, 20 times the impact on land use and GHG emissions of beans), this behaviour is as unsustainable as it is unhealthy.[29] While Americans have been switching to consuming more chicken, which is much less GHG intensive, overall meat consumption in the U.S. is rising.[30] Meanwhile, the proportion of vegetarians and vegans in the U.S. has not shifted in 20 years. More people do not need to be vegetarian to reduce the overall GHG impact of U.S. diets. More people simply need to eat less meat than they currently do.

BEHAVIORAL PATHWAYS

Many of the major barriers to reducing meat consumption and eating more plant-based meals are social norms, making this pathway fertile ground for behavioral intervention. Consumers often report feeling that vegetarian food is less tasty, filling, or nutritious and many people carry norms around eating meat, such as associating it with masculinity.[31]
At the same time, we know that consumers are unconsciously influenced by multiple cues, such as what we notice first, meal descriptions, and availability.[32] Taken together, these factors indicate multiple potentially effective avenues for changing meat preferences and consumption, many of which are already being explored.[33]

Importantly, research suggests that promoting a reduction in meat consumption rather than elimination is more viable for long-term adoption, since 84 percent of vegetarians revert to eating at least some meat.[34]

MODELING

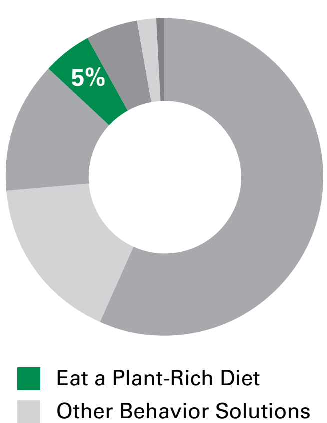
In order to estimate a realistic GHG impact of a behavior change campaign, we first broke U.S. residents into five groups (quintiles) with increasing levels of meat consumption.[35] We then assumed that 10 percent of people in each but the last of these quintiles switched to the diet of the next less meat-heavy quintile. Since the lowest quintile has already adopted a primarily plant-based diet, we did not assume any change for them. The biggest impact in reductions came from people in the highest consumption group moving down a quintile, as they eat disproportionately more (red) meat than all the other quintiles. However, as this is likely the hardest group to budge, we decided it was more realistic to model impact across quintiles, rather than to concentrate on the high-consuming segment. To calculate GHG emissions reductions, we used the midpoint GHG emissions factor of each quintile.

IMPACTS

Our model projected an annual emissions savings of 25 MtCO_2e and a social value of mitigation of between $1.1 and $12.7 billion per year.

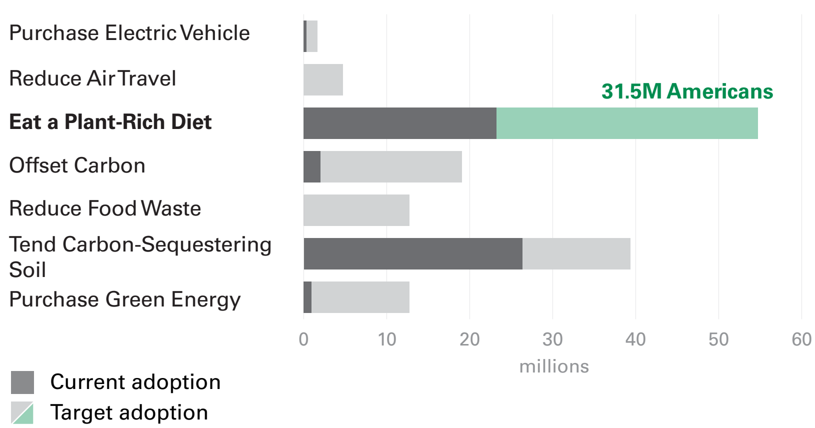
Emissions Impact

Eat a Plant-Rich Diet makes up 5% of the carbon emissions reduction attributable to the target adoption.



Human Behavior Angle: Behavior Changes Needed for Target Adoption

8% of Americans are already vegetarian or vegan. 29M behavior changes are needed to increase target adoption by 10% of non-vegetarians.



7 BEHAVIORS

Offset Carbon

U.S. consumers have one of the highest per capita GHG footprints at around 15 $MtCO_2e$ annually.[36] Though a high proportion of personal emissions can be reduced or eliminated with lifestyle changes, many of which are outlined here, some personal emissions present too high a barrier to eliminate or reduce. Purchasing third-party verified carbon credits can help offset one's carbon footprint by financing the reduction or sequestration of GHGs in another sector of the global economy. With vetted carbon credits as a comparable alternative to emissions reductions, individuals offsetting their personal emissions could result in a very large overall decrease in net global emissions. Even among U.S. residents who believe that their personal emissions have an impact on climate change, only 1 in 10 have purchased a carbon credit, making this a good candidate avenue for increased engagement.[37]

BEHAVIORAL PATHWAYS

Worldwide, voluntary carbon offsets are primarily purchased by companies and institutions, rather than individuals. Motivations for purchasing voluntary offsets are complex, ranging from companies seeking to improve their image or supply chain, to non-profits or individuals purchasing for social capital or altruistic reasons. [38] Most credit-purchasing platforms cater to businesses and are therefore not as user-friendly for individuals. Studies show that even consumers with high levels of knowledge about carbon emissions don't usually translate that into action via purchasing offsets. [39] However, carbon offset matching between a company and individual customers has been documented as an effective way to sustain individual purchases over time.[40] Offsets are a contentious but potentially necessary component of reaching national and industrial commitments to emissions reductions.[41]

MODELING

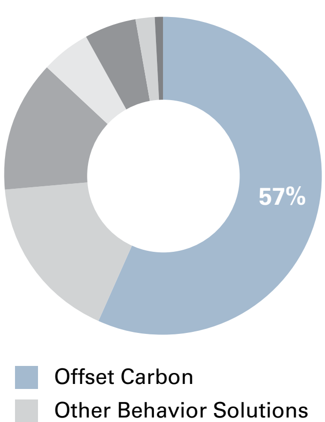
Our model assumed that purchasing offsets is equivalent to eliminating emissions. It assumed that individuals who purchase offsets opt to offset their entire carbon footprints and that their footprint is the U.S. average emission intensity. Since voluntary markets are not mature enough to absorb a large demand for carbon credits, we assumed that only 5 percent of U.S. residents offset their emissions.

IMPACTS

Our model projected an annual emissions savings of 276 $MtCO_2e$ and a social value of mitigation of between \$12.4 and \$142.6 billion per year.

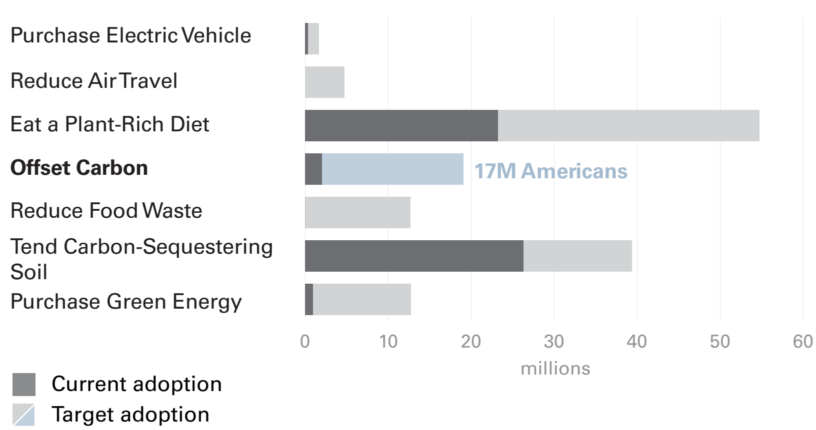
Emissions Impact

Purchasing carbon offsets makes up 57% of the carbon emissions reduction attributable to the target adoption.



Human Behavior Angle: Behavior Changes Needed for Target Adoption

Zero carbon offset purchasers represent current adoption in the model. 17M behavior changes are needed to increase target adoption by 5% of potential carbon offset purchasers.



Reduce Food Waste

Around one third of food produced is never eaten as a result of food loss and waste.[42] Food loss and waste contribute to GHG emissions at every stage of the food cycle, from emissions caused by fertilizing and transporting food that is never eaten, to emissions from wasted food if it ends up in a landfill rather than being composted, not to mention packaging and water waste. In the U. S., the problem is primarily one of waste, which is concentrated in retail and consumption.[43] Overall average food waste in the U.S. is estimated at 400 pounds per person, per year.[44] Since our assessment is of individual and household behaviors, we elected to focus on reducing household food waste and increasing composting.

BEHAVIORAL PATHWAYS

Research has shown that many non-cognitive behaviors, such as emotions and habits, play important positive and negative roles in food waste behavior.[45] Wasting food is one of the more complex behaviors examined in this study. It has multiple antecedents often not directly related to the food itself, such as overambitious forecasting about having time to cook when purchasing. It can also involve many ingrained habits, such as a personal aversion to eating leftovers, or cultural components, such as food being associated with abundance, generosity, or displays of wealth. On the consumer side, we know that over-purchasing and over-plating can lead to waste. Interventions like reducing plate size and normative cues from chefs have been shown to reduce food waste in hotel restaurants by 20 percent.[46]

MODELING

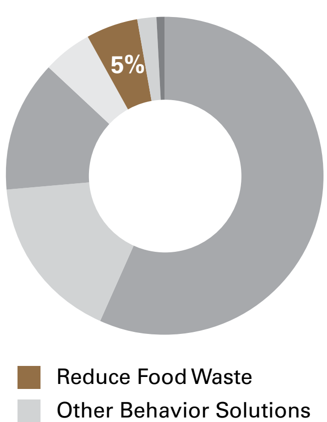
We modeled emissions reductions associated with a 20 percent reduction in per-person household food waste. We assumed a reduction in plate size, leading to emissions reductions across the food supply chain. We combined this metric with an increase in composting of 100 percent of compostable material in the target population. To calculate emissions reductions from composting, we assumed a 50-year emissions factor for uncomposted waste decomposing anaerobically in a landfill.

IMPACTS

Our model projected an annual emissions savings of 25 $MtCO_2e$ and a social value of mitigation of between $1.1 and $13.1 billion per year.

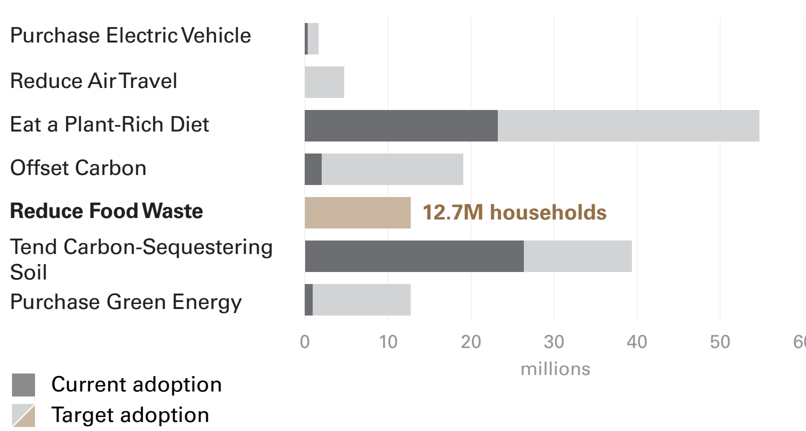
Emissions Impact

Reducing Food Waste makes up 5% of the carbon emissions reduction attributable to the target adoption.

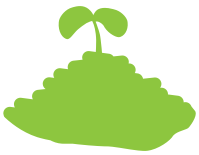


Human Behavior Angle: Behavior Changes Needed for Target Adoption

Zero households represent current adoption in the model. 12.7M behavior changes are needed to increase target adoption by 10% of households.



Tend Carbon-Sequestering Soil



The top meter of the world's soil contains, on average, three times as much carbon as is in the entire atmosphere, but over the last 50 years conventional agriculture practices have almost halved soil organic matter in the U.S.[47] In 2015, about 240 million acres of U.S. soil were under conventional agricultural management for corn, wheat, soybeans, and upland cotton.[48] Agricultural practices that improve the ability of topsoil to serve as a carbon sink also improve soil quality, health, and productivity. A suite of restoration and conservation agricultural practices can reverse soil degradation and draw down carbon.

BEHAVIORAL PATHWAYS

Appealing to the norms and values of farmers, which usually center on land stewardship rather than generalized environmentalism, has had the highest rate of past success in farmers switching their practices.[49] Farming practices in the U.S. are subject to myriad social, political, financial, and regional factors, making them resistant to change.[50] Farmers can also perceive that sustainable practices interfere with cash crops. However, appealing to the agronomic benefits of such practices, such as the potential to reduce erosion, control weeds, and reduce soil compaction, has had positive results.[51] Regardless of intervention, studies point to the heterogeneity of farmers across contexts and the high importance of regional conditions.[52]

MODELING

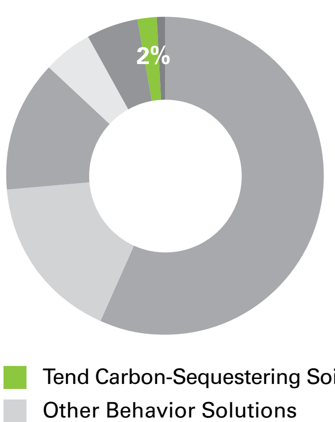
Carbon fluxes in agricultural soils are some of the least well-understood, but several studies have shown that practices such as no-till agriculture, in which farmers don't turn over topsoil before planting seeds, can dramatically increase the amount of carbon sequestered in soils. Since soil can reach carbon saturation, no-till agriculture can be considered the most significant single soil practice among those available. Our model assumed full adoption of no-till agriculture on impacted land area, which includes all land in the U.S. currently under corn and soy production.

IMPACTS

Our model projected an annual emissions savings of 9 $MtCO_2e$ and a social value of mitigation of between $0.4 and $4.9 billion per year.

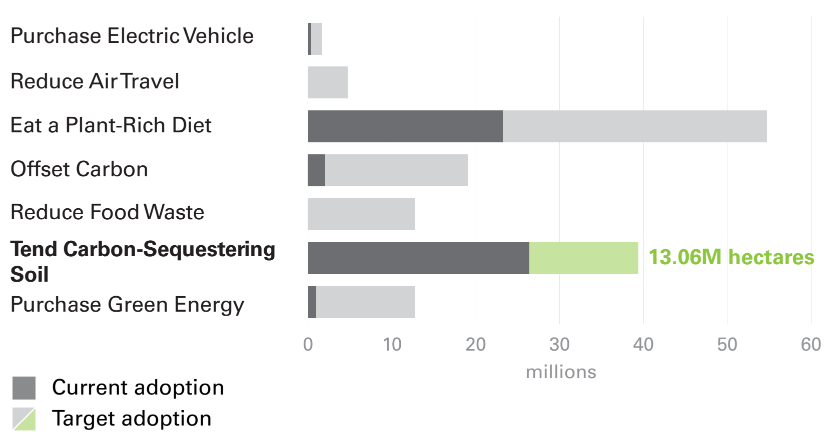
Emissions Impact

Tending carbon-sequestering crops makes up 2% of the carbon emissions reduction attributable to the target adoption.

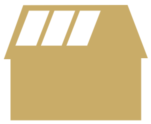


Human Behavior Angle: Behavior Changes Needed for Target Adoption

28% of corn farms have already switched to no-till agriculture. 13.06M hectares must switch to increase target adoption by 10% of farmland.



Purchase Green Energy



In 2018, about 60 percent of the electricity generated in the U.S. was from fossil fuels, primarily natural gas and coal.[53] Electricity generation represents around 30 percent of U.S emissions, on par with transportation. Meanwhile, the costs to install rooftop solar panels have fallen by around 70 percent since 2010.[54] Rooftop solar, solar heating, and green energy purchasing can significantly decrease household GHG emissions and potentially alleviate energy insecurity.

BEHAVIORAL PATHWAYS

Though numerous options exist and a myriad of state rebates are often available, consumer awareness of renewable energy purchase options is often relatively low.[55] This awareness gap presents an opportunity to combine education with social nudges to promote green energy purchasing. Functional, social, and emotional value dimensions all play a role in consumer valuation of green energy, indicating an opportunity for messaging that goes beyond financial considerations, and into considerations of independence, environmental identity, or innovative technology.[56] Free, independent energy audits seem to increase green energy investment in both homes and businesses.[57]

For rooftop solar, talking to trusted neighbors or social networks can increase uptake and shorten people's pre-purchase decision making time.[58] In general, people who live in communities in which their neighbors are already using green energy are those most likely to purchase it themselves.[59]

MODELING

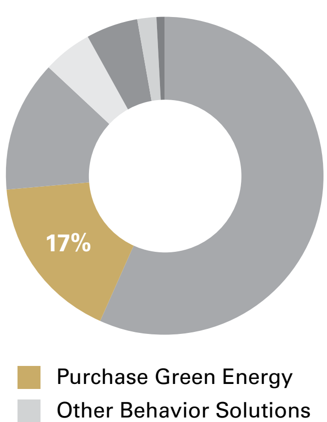
We modeled a fully emission neutral energy mix through a combination of rooftop solar purchasing, solar water heating, and green energy purchasing. Our model assumed independent adoption between these interventions – that is to say that our model did not assume that the population of rooftop solar adopters was more likely to be the population purchasing green energy. Energy consumption emissions capture residential space heating and cooling, lighting, water heating, cooking, and appliances. For water heating, the model assumed that 100 percent can be offset with solar. Our business as usual scenario assumed normal improved efficiency of residential energy use, in accordance with the IECC code for new buildings. Our model held constant the share of buildings eligible for rooftop solar (75 percent) and the percentage of energy displaced through 2040.

IMPACTS

Our model projected an annual emissions savings of 82 $MtCO_2e$ and a social value of mitigation of between $4 and $42 billion per year.

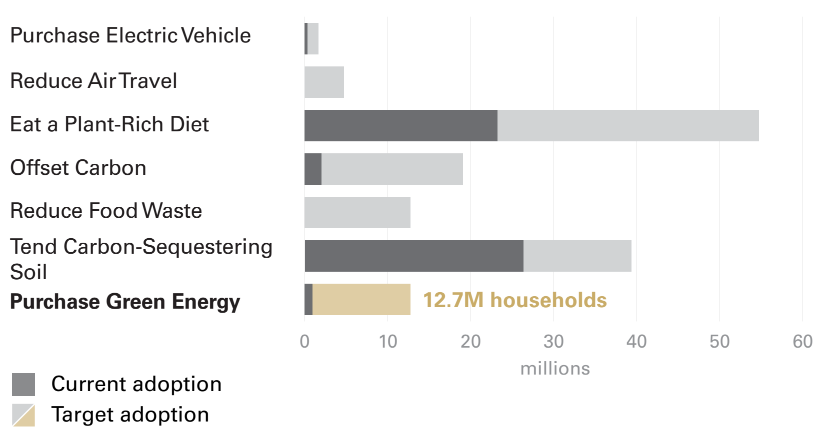
Emissions Impact

Households that purchase green energy make up 17% of the carbon emissions reduction attributable to the target adoption.



Human Behavior Angle: Behavior Changes Needed for Target Adoption

In the model, less than 1% of households are purchasing green energy. 12.7M behavior changes are needed to increase target adoption by 10% of households.



Considerations & Future Avenues

Considerations

Though we have divided emissions reduction behaviors into discrete categories, in application, many of these behaviors are likely to overlap. In particular, this study does not consider the potential for spillover effects. Recent research has explored how some pro-environmental behaviors can "spill over" to encourage (or discourage) other pro-environmental behaviors, depending on factors like external motivations such as price signals or internal motivations such as self-identity, decision modes such as calculation vs. affect-based, causal attribution, or behavioral difficulty.[60] These indirect effects could increase or decrease the carbon impact of actions taken. Relatedly, several of the behavioral pathways examined here, such as eating a plant-based diet or choosing to fly less, can be habit forming. Habits have been shown to inform identity once they are formed, which can have powerful tack on effects.[61] Though habit formation may be the most challenging type of behavioral intervention, it may also have the greatest transformational potential.

One already mentioned consideration in terms of target audiences is that while most of the seven behaviors lend themselves to audiences across urban, suburban, or rural settings, behaviors around carbon sequestering agriculture can only be undertaken by individuals who are farmers. A larger consideration, not addressed in this exercise, is people's relative ability to access and/or enact these recommended changes. Although solar panels and electric vehicles provide cost savings over the long run, purchasing them requires substantial up-front financial investment that many people will not be able to afford or will not easily prioritize among their expenses. Changing one's diet to eat more plants may depend on reliable access to produce. Lower-income people can and should be supported in taking these actions, particularly those that provide a return on investment, in a number of ways, such as through collective purchasing arrangements or policies that provide targeted subsidies that are then supplemented by behavioral campaigns to encourage adoption.

Future Avenues

Though we have focused on individual and household behaviors, recent research has started to take the same behavioral principles and apply them to actors at different scales, where individual choice may be both mediated by and able to influence broader social, institutional, or political dynamics. Much of this research examines how people adhere to familiar behavioral principles even in their professional capacities, such as architects or engineers making decisions about the built environment or executives making decisions about corporate social responsibility. These arenas present emerging opportunities to apply behavioral science towards climate mitigation, with the potential that individual choices made at these 'upstream' decision points can 'lock in' certain pro-environmental behaviors in larger groups of people, thus scaling the influence of the individual behavioral decision.

Given our current carbon emissions trajectory, we need to invest in solutions across the board, from the political to the personal. Shifting individual behaviors is an integral, scalable component of achieving necessary emissions reductions. Almost a century of research has shown us that people are influenced by the behaviors of others.[62] Thus, engaging some people in individual action, such as the behaviors outlined here, can lead to many more people engaging in those actions. Counterintuitively, behavior can also actually drive attitudes, which inform cultural norms.[63] Taken together, this evidence indicates that increasing adoption of behaviors that reduce carbon emissions is one potent component of scaling emissions reductions in the United States.

Shifting individual behaviors is an integral, scalable component of achieving necessary emissions reductions.

Endnotes

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Rare inspires change so people and nature thrive. Conservation ultimately comes down to people – their behaviors toward nature, their beliefs about its value, and their ability to protect it without sacrificing basic life needs. And so, conservationists must become as skilled in social change as in science; as committed to community-based solutions as national and international policymaking.

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