Economic Benefits of Carbon Fee & Dividend:

Good for the Economy, Good for People

Compiled summaries of recent research, articles, and the peer-reviewed literature
by Jerry Hinkle, CCL Research Coordinator

Citizens' Climate Lobby

Table of Contents

Table of Contents: Figures

Introduction

CCL asserts that a Carbon Fee and Dividend (CFD) policy is "good for the economy and good for people," but for some that assertion is not convincing because we are advocates for the policy. Our advocacy would be strengthened by fully understanding and being able to relay why there is such strong support among independent experts, as reflected in the peer-reviewed economic literature, for this general type of policy. For example, why does "the largest economist's statement in history," advocate for CFD as the best way to address climate change?

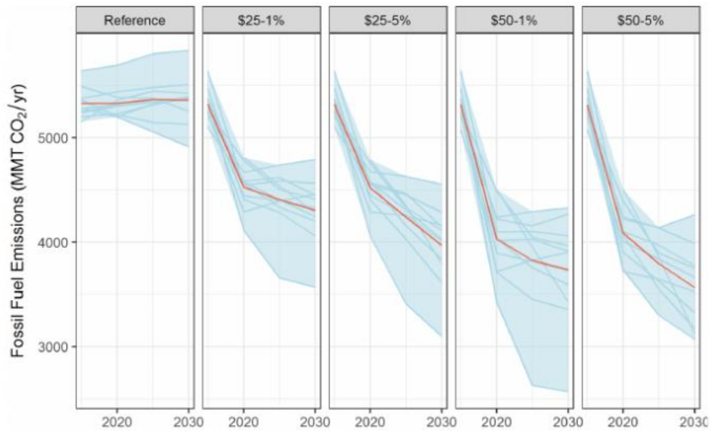
The purpose of this paper is to illuminate how the peer-reviewed literature supports carbon pricing generally and CFD in particular. This paper highlights the literature that shows revenue neutral carbon tax (RNCT) policies provide tremendous climate and health benefits at minimal to no economic cost, and a policy as ambitious as the Energy Innovation and Carbon Dividend Act (EICDA) in particular generates net benefits to the U.S. of roughly $1 trillion a year. Also, CFD, an RNCT policy that distributes all funds directly to households, is preferred by CCL because it provides a clear financial benefit to the most vulnerable in our society. Finally, though carbon pricing should be the backbone of an ambitious climate policy, certain regulations can be valuable complements to achieving science-based emission reduction targets. In sum, the peer-reviewed literature shows a policy like the EICDA can quickly and efficiently help stabilize climate risk, be clearly good for the economy, increase job opportunities, greatly improve our health, and provide a strong financial benefit to the most vulnerable.

Emission Reductions

According to scientists, temperatures will continue to rise until net emissions (emissions less carbon sinks and any carbon removal) reach zero on a global basis. Therefore, the most important thing the U.S. can do to stabilize climate risk is to pass a law that achieves net zero emissions by the 2050 target date suggested by the IPCC and to do it in a way that incentivizes other countries to follow in step.

What are the projected U.S. emission reductions from an RNCT policy? Likely the most comprehensive study on RNCT policy impacts, referred to as the EMF 32, showed results from 11 different peer-reviewed models on a variety of such policies (see chart, below, from page 10). Four carbon tax rates were modeled: starting at both $25/ton and $50/ton and increasing by both 1% and 5% a year. The results show significant variation in projected reductions from the models. For example, under the $50+1% policy (second column from right), after 15 years of the policy, reductions range from roughly 20% of reference scenario emissions to 50% across the 11 models. However, all show significant reductions from a carbon price over the 15-year time frame modeled.

Figure 1: Fossil Fuel Emissions



Annual fossil fuel emission levels (MMt CO_2) by year under the reference case and the four core carbon tax trajectories. For this and subsequent figures, the red lines show the average values across the models, the blue shaded area shows the range of model results, and the individual model trajectories appear in blue. For better readability, the vertical axis here does not start at zero. As mentioned in Sec. 1, model identity is generally not relevant to our conclusions here and so individual models are not identified. Note that the model with the most aggressive reductions did not report results for the $50-5% scenario, which explains the deeper maximum reductions in the $50-1% scenario. Figure from Climate Change Economics, "*Policy Insights from the EMF 32 Study on U.S. Carbon Tax Scenarios*" page 10.

A recent study from Columbia University looked explicitly at what carbon price trajectory would be sufficient to achieve net zero CO_2 emissions in the U.S. by three target years: 2040, 2050 and 2060 (see chart, below). As discussed here, the estimated price range required to meet the net zero 2050 objective is $34 to $64/ton in 2025 and $77 to $124/ton in 2030 (see blue bar in the graph). Note that if the EICDA carbon price began in 2021, it would reach $55/ton in 2025 and $105/ton in 2030, and these are right in the middle of the range of necessary prices, so that according to this very credible estimate, the EICDA's baseline carbon price path is well designed to achieve this science-based emission reduction target.

Figure 2: Net Zero CO_2 Emissions Pathways

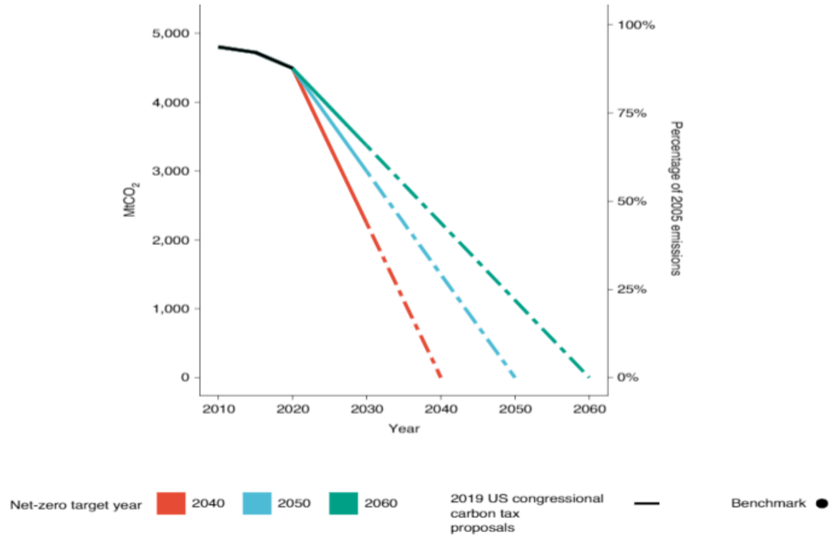


Figure from Nature Climate Change, "*A Near-Term to Net Zero Alternative to the Social Cost of Carbon for Setting Carbon Prices*" page 1012.

Figure 3: CO_2 Price Ranges

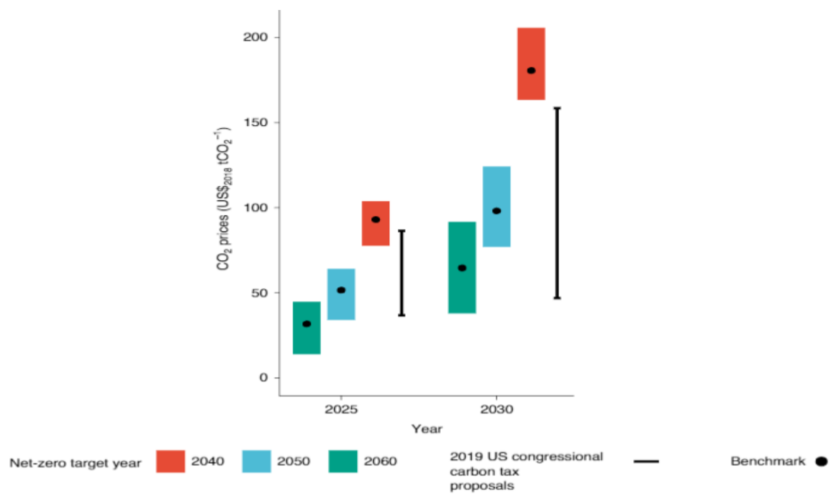
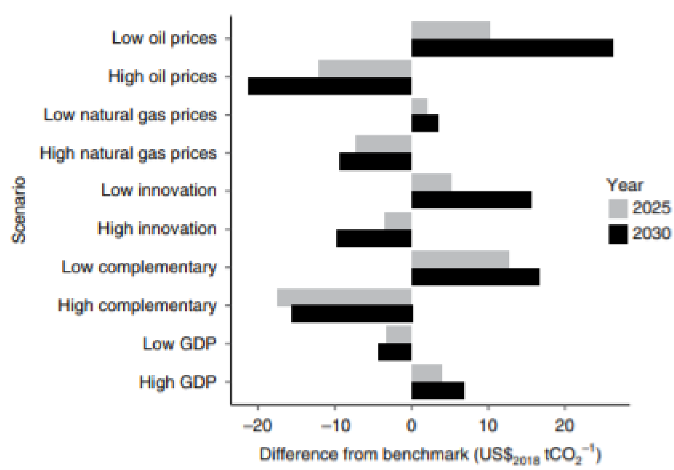


Figure from Nature Climate Change, "*A Near-Term to Net Zero Alternative to the Social Cost of Carbon for Setting Carbon Prices*" page 1012.

Two elements of this study bear special mention. First, it only discusses necessary carbon prices through 2030. The authors appropriately explain that estimated reductions from a strong carbon price are too uncertain beyond 10 or 15 years because it is not clear how the market will react to the price or what new low-carbon technologies will take hold. They recommend policymakers only set a price for the first ten years of the policy and then evaluate the level of emission reductions achieved from that before setting the price for the next period. At that point, the rate of carbon price increase can be raised if reductions are too low, and vice versa[1].

Second, the article quantified the sensitivity of model results to key assumptions required to perform the modeling. These assumptions are primary sources of uncertainty or potential error in the estimation process (see chart, below): if the assumptions turn out to be materially in error, the estimate of carbon prices required to achieve the net zero target will be off as well. Examples should help illustrate the point. The model must assume what fossil fuel prices will be in the future without a carbon fee. If they are lower than projected, more will be consumed, leading to higher baseline emissions, and vice versa. As the chart shows, future oil prices that are lower than expected (causing greater consumption and emissions) would mean the carbon price would need to be $27/ton higher in 2030 to stay on the path toward net zero emissions by 2050 (the base, high and low assumptions used are provided in the [paper's supplemental information, or SI](), appendices 1 and 5). Similarly, the degree to which innovation lowers the cost of clean energy in the future is quite uncertain and important for the estimates (see SI Table 3). Finally, the more that complementary policies, such as air pollution regulations and building and vehicle efficiency standards, assist in lower emissions, the lower the carbon price will need to be to achieve the interim goals.

Figure 4: US NT2NZ CO_2 Prices for a Net Zero by 2050 Pathway



Comparison of Sensitivity Scenarios to the Benchmark Scenario. The light and dark bars reflect the differences between the NT2NTZ CO_2 prices for a given sensitivity scenario compared with the benchmark scenario in 2025 and 2030, respectively. The complementary scenarios

---

[1] The authors of the Energy Innovation Act, in recognition of this same uncertainty, inserted two mechanisms in the policy to ensure target emission reductions were met. First, beginning in 2022, if specified targets are not met, the annual carbon price increase rises from $10 to $15 a year. Second, if by 2030, the higher price has still not resulted in sufficient reductions, the EPA is mandated to promulgate regulations ensuring reduction targets are met (see Section 8 330.f of the Act).

reflect proxies for policies that surround the CO_2 price and address non-price related market barriers. Figure from Nature Climate Change, "*A Near-Term to Net Zero Alternative to the Social Cost of Carbon for Setting Carbon Prices*" page 1013.

In sum, there is a clear consensus in the peer-reviewed economic literature that putting a price on carbon pollution will be effective in reducing emissions, and the higher the price, the more emissions will be reduced. There is some uncertainty as to just how great the reductions are, though a carbon price consistent with the baseline price within the EICDA is estimated to put the U.S. on track to achieve net zero emissions by 2050.

Policy Costs and Benefits

An RNCT will have a number of broad impacts on the overall economy. It will cause utilities to generate cleaner energy, businesses to reduce the carbon footprint in what they manufacture and sell, and consumers to reduce their carbon footprint in what they buy and do. Investment in cleaner technology and processes will increase while that in more polluting processes will decline. These shifts are estimated to have a small positive or negative impact on GDP, depending on the model used to do the analysis and what is done with the revenues raised. Importantly, the policy will also generate enormous climate and health benefits that are valuable both for the economy and society as a whole. *It's critical to understand that these policy benefits are not included in nearly all estimates of GDP impact: they are generated using very different estimation processes and so are evaluated separately.*[2] This section will first review estimates of the policies' impact on GDP. This impact reflects the predominant economic cost of the policy. Then, estimates of the value of climate benefits and health benefits will be explored. Finally, the costs and benefits are compared to derive approximate net benefits of the policy.

Impact on GDP

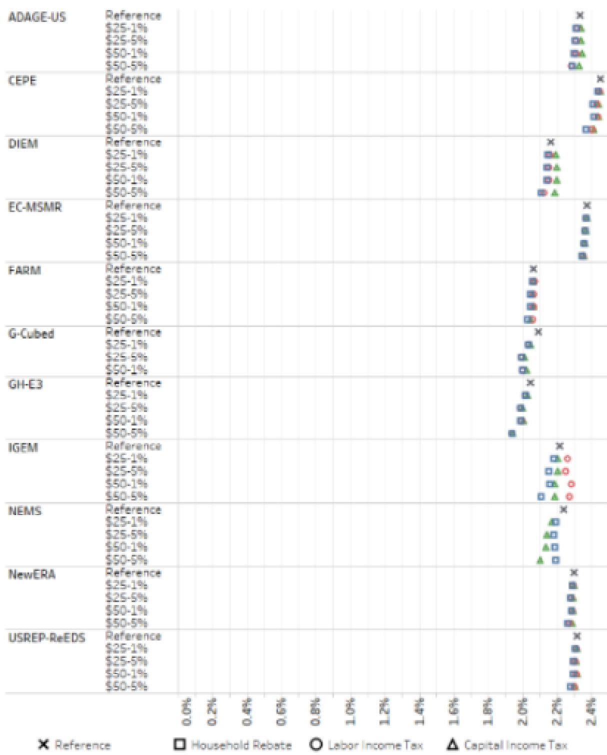
The Economic Cost of a RNCT: GDP Impact:

The EMF 32 study nicely summarized estimated GDP impacts from each of the 11 models across twelve different RNCT policies: the same four carbon price paths ($25+1%, $25+5%, $50+1%, and $50+5%) where the revenue has gone to either households (CFD), to reduce taxes on capital, or to reduce taxes on labor. The estimates are reflected in the Chart below (from page 26 of the Overview article). The columns (from left) show the different models, the

[2] One (rare) estimate from the IMF is discussed below in which the benefits are included in the economic analysis.

carbon price path, and the impact on GDP growth. Regarding GDP impact for each model (as noted below the chart), the “X” on top is GDP in the non-policy or Reference scenario, the square is CFD with funds returned to households, the circle reflects funds used to lower taxes on labor (e.g., payroll tax swap), and the triangle reflects funds used to lower taxes on capital (e.g., a capital gains tax cut).

Figure 5: Average Annual Percent Growth in GDP



Average annual percent growth in GDP from 2015 to 2040 under reference and core scenarios. Figure from Climate Change Economics, “*Overview of the EMF 32 Study on U.S. Carbon Tax Scenarios,*” page 26.

The results indicate the difference between the GDP growth rates over the 25-year period in the non-policy (Reference) scenario and the various policy scenarios. If the symbol for the particular policy (as denoted by the circle, square or triangle) is to the left of the “X,” the policy reduces the GDP growth rate, and, if to the right, it increases it. As expected, in the vast majority of instances, the policy has minimal impact on GDP. In two instances, the policy clearly causes GDP to increase: the DIEM model when revenues go to reduce taxes on capital, and the IGEM model when revenues go to reduce capital on labor. Again, when the climate and health benefits of the policy are not included, GDP is projected to decline slightly in most instances. This indicates the policy’s economic cost, and it is usually around 0.05% per year ($11 billion in today’s economy).

As demonstrated below, GDP clearly increases when climate benefits are considered, but why does GDP often decline when benefits are not included? Primarily, the carbon price causes producers to switch to cleaner sources of energy and other inputs that are more expensive on an "all-in" basis. For example, the fuel switch may require additional investment that comes at a cost. Within some models, if the revenues are used to reduce taxes on labor or capital, thereby stimulating hiring or investment, respectively, these positive impacts outweigh the cost of moving to cleaner energy, and GDP can increase.

This study from Columbia also evaluated the economic impacts of various RNCT policies (see chart, below). The estimate shows GDP rising slightly after 10 years if tax revenues are used to reduce labor taxes and declining slightly if they are rebated to households (CFD) or used to reduce the deficit. Based on this study, as well as the other peer-reviewed literature, the lead author testified before Congress that "studies suggest roughly zero impacts on the overall growth of the U.S. economy" from RNCT policies. The "equal rebates" to households' policy (second blue bar from right) does show a small economic cost of $98 billion (from $27,653 billion to $27,555 billion) after 10 years, and this is consistent with the EMF 32 results.

Figure 6: US Gross Domestic Product after 10 Years of Carbon Tax

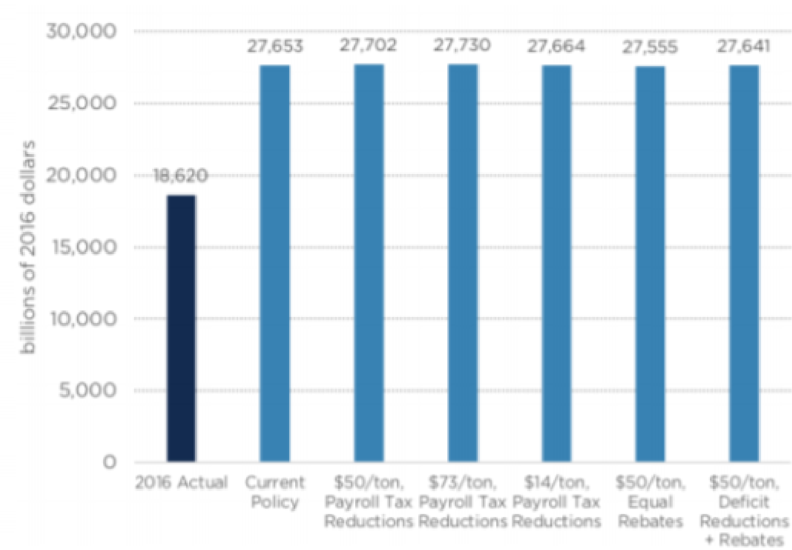
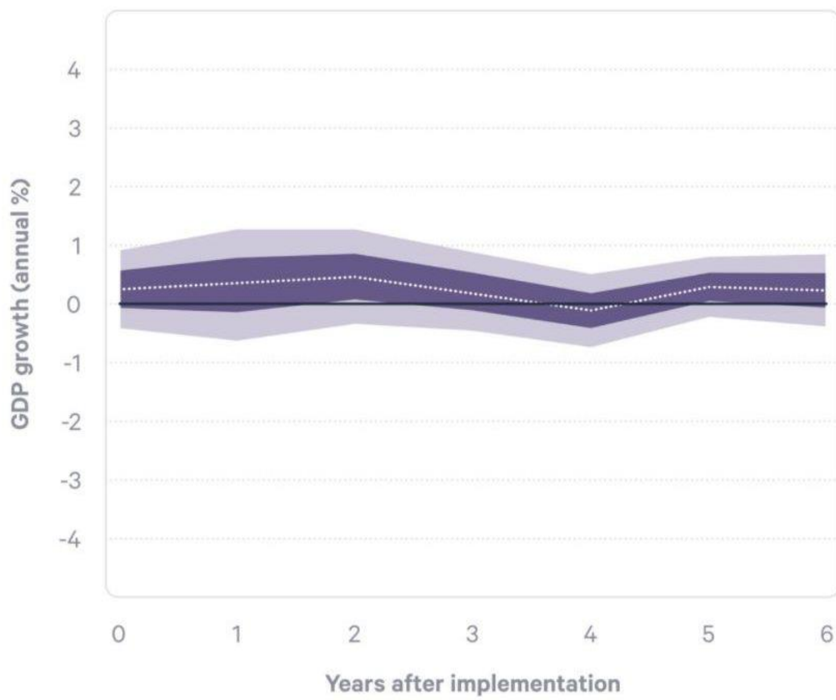


Figure from Columbia SIPA, Center on Global Energy Policy, "*The* Energy, Economic, and Emissions Impacts of a Federal US Carbon Tax," page 71.

A third study, discussed here, is unique and important because it assesses the actual impact carbon tax policies have had on GDP in a region where they have been in place. The analyses discussed above modeled the impact of a carbon tax with the use of significant assumptions that allow them to *forecast* the economy in policy (*i.e.*, with the carbon tax) and no-policy or reference scenarios to discern what impact the policy would have. The new study does not require these assumptions: it looks back over the last 30 years (1990 to 2019) at the policies that have been in place in 31 European countries to ascertain the policies' impact on GDP.

The study's results (see chart, below) show that the carbon tax policies have had a slight positive impact on GDP growth in the respective countries. This result is strong confirmation of the EMF and Columbia model forecasts that carbon tax policies do not adversely impact the economy. This is tremendously supportive of RNCT policies because it means the enormous climate and health benefits that would accrue to the U.S. from a RNCT policy like EICDA would come at no or little economic cost.

Figure 7: Estimated Annual GDP Growth in Response to a Carbon Tax



A typical impulse response function for the impact on the annual rate of growth of GDP in response to a permanent $40 increase in a carbon tax, estimated using a structural vector autoregression. The white dotted line indicates the point estimate, and the two shaded areas indicate 67 percent and 95 percent confidence bands. Figure from Resources Magazine, "*Carbon Taxes Do Not Harm Jobs or Economic Growth*."

Longer-term GDP Impacts

A different type of model, referred to as an Integrated Assessment Model (IAM), is able to incorporate the impact of some climate and health impacts on GDP or "output" over the longer-term. Two such studies are summarized by the IMF in the October 2020 issue of World

Economic Outlook (see Chapter 3). The studies, from Burke and Nordhaus, first show the impact on global GDP assuming little is done to reduce emissions. The two models generate significantly different results: whereas Burke (blue) shows Output declining by 25% by 2100, Nordhaus shows a decline of 7% (see chart, below). The IMF appears to favor the Burke results in stating *"… more recent studies that take account of the possibility of nonlinear effects and long-lasting reductions in economic growth (for example, Burke, Hsiang, and Miguel 2015) point to much higher damages than previously projected"* (Page 86).

Figure 8: Output Losses of Climate Change (Percent)

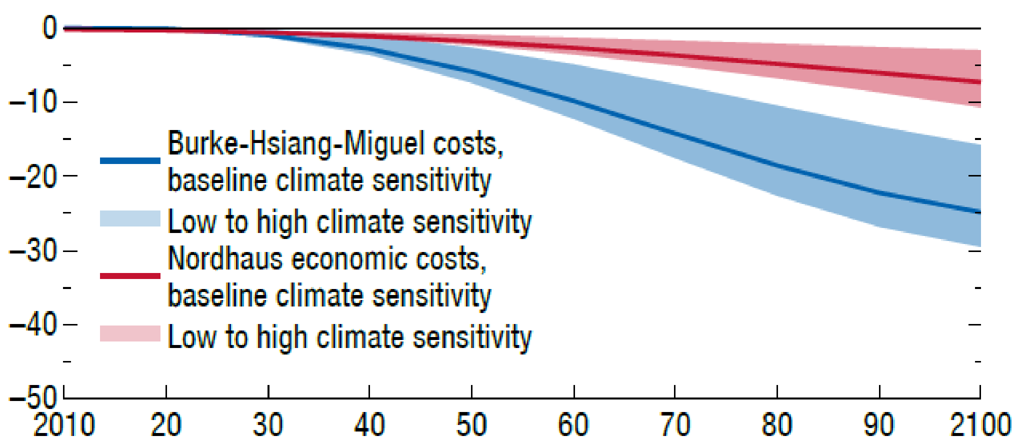
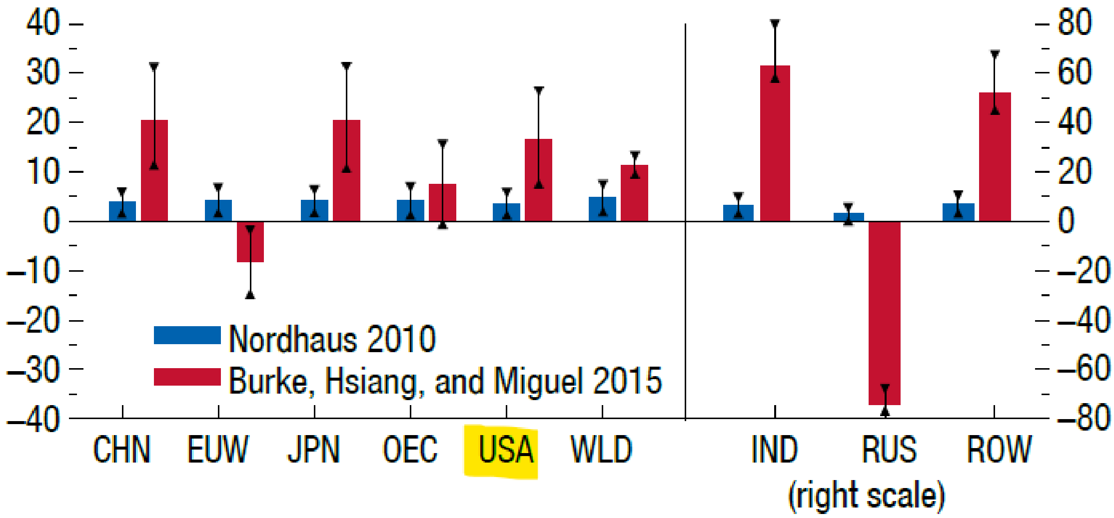


Figure from International Monetary Fund, "*World Economic Outlook, October 2020: A Long and Difficult Ascent,*" page 86.

More importantly, the models then estimate the difference in GDP should a carbon tax policy (with some initial green investment) be implemented that would reduce global emissions 80% by 2050, and the results are noteworthy (see chart, below). The Burke results show World GDP being about 10% higher (WLD in the chart below), and U.S. GDP being about 15% higher in 2100 with the carbon tax policy. Nordhaus shows weaker results, but the IMF makes clear Burke is likely more credible, stating "The more recent studies (for example, Burke, Hsiang, and Miguel 2015) point to much larger damages than previously estimated and are more in line with the substantial risks scientists have warned about the projected net output gains from mitigating climate change increase rapidly after 2050, reaching up to 13 percent of global GDP by 2100 (Figure 3.7). However, even these estimates are likely to understate benefits from mitigating climate change as they imperfectly take account of—or do not incorporate—some of the damages related to temperature increases, such as a higher frequency and severity of natural disasters, a rise in sea levels, and the risk of more catastrophic climate change."

Figure 9: Long-Term Output Gains from Climate Change Mitigation



Percent deviation from 2100 real GDP. Figure from International Monetary Fund, "*World Economic Outlook, October 2020: A Long and Difficult Ascent*" page 100.

To summarize the impacts to GDP, when valuable climate and health benefits are not included, the impact to GDP is minimal in the shorter-term and could be slightly positive or negative. CFD tends to have a slightly negative impact on GDP, though is unique in providing significant financial benefits to low-income and minority households. In the longer term, when some of the climate benefits are included in the modeling, strong market-based climate policy significantly increases GDP. These policies are unquestionably good for the economy, and that is why they are so fully supported by economists.

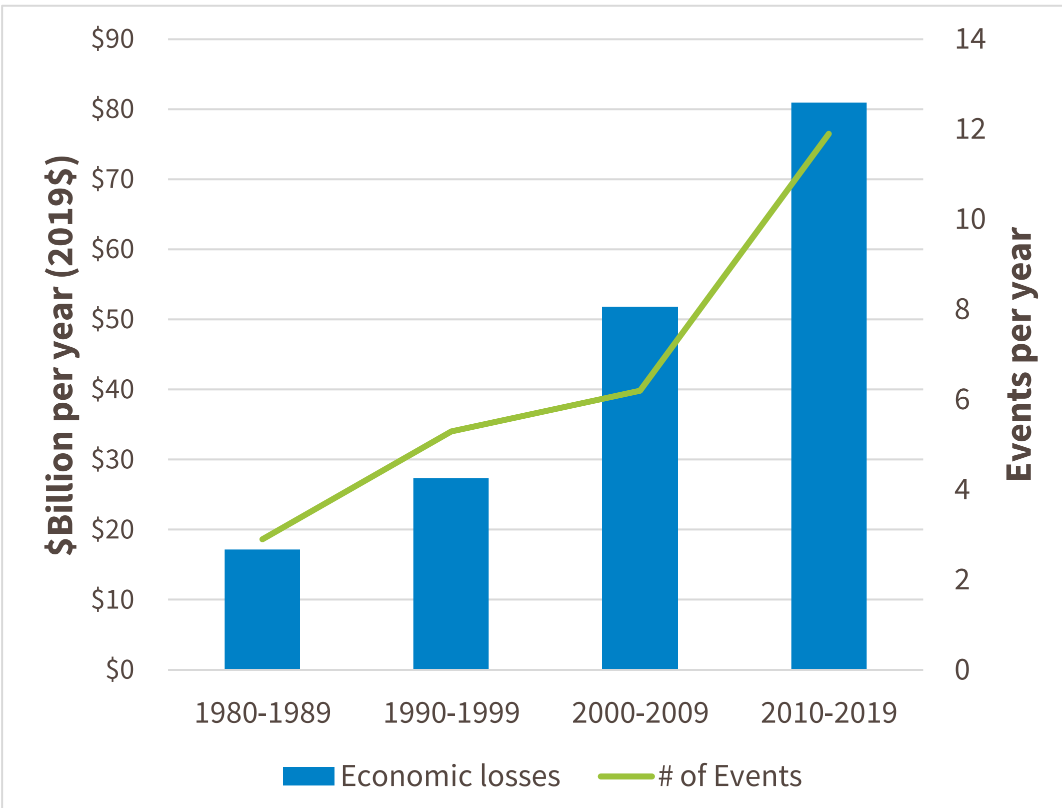
Climate and Health Benefits

Stabilizing Climate Risk

The economic value of the reduced emissions from any policy reflects the value of avoided climate damages, and these are exceedingly difficult to measure. Columbia's Dr. Noah Kaufman recently commented to CCL that published analysis shows this value could be anywhere from $0 to $1,000 per ton of CO_2 emitted. We first show a simple view of how certain climate damages have increased in the US. We then look at official estimates of climate damage called the Social Cost of Carbon (SCC) in order to approximate the value of climate benefits in a policy like EICDA.

Trends in US Climate and Weather-Related Disasters - Economic damages from climate and extreme weather events, one small part of overall climate damages, are charted each year by NOAA[3]. Below is a graph of both the number of events and total annual damages caused by the events. To smooth out the annual variation, the annual number of events (green line) and total damages (blue bar) per year are averaged over the course of the corresponding decade: the 1980s (1980-89), 90's, etc. Its critical to understand the data is inflation-adjusted: all damages are in 2019 dollars so that inflation is not a factor in the trend.

Figure 10: Losses from Climate & Extreme Weather



Source: graph compiled by CCL Research from NOAA data.

The results are stunning yet should not be a surprise. The economic losses from climate and weather-related damages grew from an average of $17 billion per year in the 80s to $81 billion per year last decade, an increase of almost fivefold (471% increase). And again, inflation was completely taken out of the equation. Similarly, the number of events that cost at least $1 billion grew from an average of 2.9 per year in the 80s to 11.9 last decade, a fourfold increase. These numbers confirm our intuition: we are unquestionably seeing a steady but dramatic increase in the cost of extreme weather events. If the annual averages are taken from only the

[3] This chart was produced by CCL's Research group from NOAA data (see link). NOAA only aggregates the events that cost at least $1 billion. These cover roughly 80% of total damages each year.

last five years of the last decade, 2015 to 2019, the average losses and events increase to $107 billion and 13.8, respectively, indicating that the trend toward increased damages may be accelerating.

How much of the increase in losses are due to climate change? We can't know with certainty, but we can derive an indication. NOAA states that the increase is due to climate change and increased vulnerability and exposure. The increase in vulnerability and exposure reflects that there are simply more valuable assets in harm's way in the last decade relative to the 1980s, but how much more? U.S. population growth is about one-third in that time as is the value of the average home. Though these are significant, they come nowhere near explaining a 470% increase in average annual damages. Climate change, as long predicted by a strong majority of climate scientists, is the primary driver behind this dramatic and costly trend.

The Social Cost of Carbon (SCC)

While the above chart provides a clear picture of how one small element of climate damages is increasing, to estimate the climate benefits of a particular policy, we need an estimate of the total value of the damages avoided over time. The SCC is designed to provide exactly this[4] (page 1): it is an estimate of the economic value of avoided damages per ton of CO_2 emissions. The SCC is derived in two parts: the value of damages from climate change over forthcoming decades are projected with a "damage function," and these values are discounted back using an appropriate discount rate.

Most damage functions are quite limited in that they only include those climate impacts that we know will occur as a result of climate change and can be readily quantified. Therefore, they exclude what we cannot readily quantify or do not know will occur[5]. The damage function may include at least portions of "mortality and other health effects from excess heat and natural disasters, depressed agricultural production, reductions in labor productivity, disruption of energy systems…property damage from hurricanes and floods" (page 2 of the above link). However, they do not include damages to ecosystems and the services they provide (*e.g.*, natural capital), wildfires, species extinction, slower economic growth from higher temperatures, mass migration out of affected regions, increased risk of violent conflict, tipping points, morbidity, and impacts from catastrophic events. As a result of what is not included in the estimate as well as other factors, current SCC estimates significantly underestimate total damage from climate change.

[4] This paper will be used for much of the SCC discussion.
[5] This assessment is from the book *Climate Shock*, by Weitzman and Gernot.

As difficult as estimating the value of damages over forthcoming decades is, the challenge is compounded by the need to appropriately discount those values over time to derive a single current SCC estimate. The discount rate is incredibly impactful because the worst damages from climate change are expected to occur far into the future. As an example of its importance, whereas the discounted value of a dollar of damages in 2100 is worth 20 cents using a 3% discount rate, it is worth only nine cents using a 2% discount rate, so the discount rate used will greatly alter the SCC. It is beyond the scope of this paper to delve into the appropriate discount rate to use here, but the above linked paper (see page 21) is comprehensive and guides us to the rate used for this analysis.

What is a reasonable value or range of values for the SCC? Under the Obama Administration, the EPA formed an interagency working group (IWG) to derive an estimate of the SCC. An initial estimate was derived in 2013 and partially revised in 2016. The estimate was an average of results from three Integrated Assessment Models (IAM's)[6], utilizing scientific data generally from 2009 or before, and the resulting SCC was used by the federal government as a shadow price to ensure the cost of carbon pollution was considered in investment and purchase decisions. According to that estimate, if using a suggested constant discount rate of 3%, the SCC would be $52/ton as of 2020 and would continue to rise gradually every year. The IWG was essentially abandoned under the Trump Administration but has been reformed and has been charged with revising this estimate both in the short-term and again by January 2022.

In 2017, the National Academy of Sciences (NAS) published an in-depth study of the SCC and how it could be improved. A consortium led by the University of Chicago, the Climate Impact Lab (CIL), set about constructing a process to generate an SCC that complied with the NAS recommendations and utilizing the latest and far more abundant climate science, utilizing more granular data and improved methodologies. Though the final estimate is not expected until the Spring of 2021, the Director of the CIL published a working paper recommending that, until the new estimate is ready, the Biden Administration use the prior IWG estimate but with a discount rate of at most 2%, owing to the fact that real (inflation adjusted) long-term risk free interest rates (i.e., yields on 10-year U.S. Treasuries) on which the discount rate may be based have declined significantly. Just using the lower discount rate, the SCC increases

[6] This estimate was an average of the results of three integrated assessment models widely used to produce estimates of the SC-CO_2: the Dynamic Integrated Climate-Economy (DICE) model, the Framework for Uncertainty, Negotiation and Distribution (FUND) model, and the Policy Analysis of the Greenhouse Effect (PAGE) model. For information on them, see this discussion.

from $52/ton to $125/ton. However, this figure still understates the value of damages because 1) the upcoming revisions using better data will likely increase it further, 2) it still does not include the categories of climate damages noted above, and 3) as the paper indicates, a 2% discount rate is a conservative upper limit given current long-term interest rates.

Very recent analysis in a top journal, as discussed here, attempts to incorporate one missing source of climate damages: those to "natural capital." "Natural capital includes elements of nature that produce value to people either directly or indirectly." One author provides an analogy: "The standard approach [to estimating SCC] looks at how climate change is damaging 'the fruit of the tree' (market goods); we are looking at how climate change is damaging the 'tree' itself (natural capital)." According to this analysis, just by including the "direct" damage to industries like timber, agriculture and fisheries, the total damages from climate change increase by $44/ton. Including all direct and indirect damages from impacts to natural capital increases damages by $132/ton.

From this data, a reasonable but still conservative estimate of the SCC can be derived for our purposes. The $125/ton recently suggested by the CIL to the Biden Administration plus only direct damages to natural capital of $44 yields a reasonable, yet still conservative $169/ton. A more credible number can be derived as revisions are made, and the estimates will almost certainly increase.

From this, estimates of the climate benefits of a particular policy can be derived. The value of climate benefits in a given year are the product of the SCC and the number of tons of emissions reduced by the policy in that year. For example, using net zero by 2050 path (see Source Data, Fig. S1), the EICDA would reduce emissions by 1.5 billion tons in the 10th year after enactment[7]. Using $169 as our SCC, this would indicate the value of climate benefits derived in that year to be $254 billion (1.5 billion X $169).

Health Co-Benefits:

Greenhouse gas emissions that cause climate change are also a significant source of air pollution that greatly degrades our health. Though climate change brings about its own health issues, such as heat stress, that are already included in the SCC estimates, health costs from air pollution are separate, and are substantial. The value of these benefits are referred to as health co-benefits of climate policy.

[7] Because this calculator has policy implementation in 2020, 2029 and 2034 were used to estimate reductions 10 and 15 years out, respectively.

Though there is substantial research on health co-benefits from climate policy for both the U.S. and globally, the focus in this section will be on the work of a team at Duke University led by Dr. Drew Shindell. The reason is that, though work is completely in line with the literature, they focus on estimating co-benefits from a level of emission reductions consistent with the EICDA. Specifically, they evaluate U.S. health co-benefits under a policy that yields reductions consistent with a 2°C target for global temperature increase.[8] This allows for an explicit but conservative dollar estimate of the co-benefits from this policy.

Initial research was published on the value of U.S. health co-benefits in 2016, and they were estimated at $250 billion a year. As discussed here, Dr. Shindell presented updated research[9] to the House Oversight Committee in August 2020 that utilized far more granular data. The revision found that over 50 years a 2°C policy would prevent, on average, 90,000 premature deaths, 70,000 hospitalizations, and six million lost workdays each year, as well as other health benefits. The value of these benefits was estimated at an average of $700 billion per year over the 50-year period. This reflects tremendous value! In other words, we could take climate damages completely out of the equation, and the health benefits from reduced air pollution would pay for a policy like EICDA many times over.

Total Net Benefits:

Clearly, the climate and health benefits of RNCT policies will greatly outweigh the costs, and this is a key reason they have nearly universal support among economists. As to the EICDA specifically, we can derive a rough but conservative estimate of net benefits: t*en years after policy implementation*[10]*, we conservatively estimate benefits at $952 billion ($252 + $700) and costs at $98 billion for net benefits of approximately $854 billion per year. Again, this is a conservative estimate because the SCC is understated for the three reasons noted above.*

Fairness

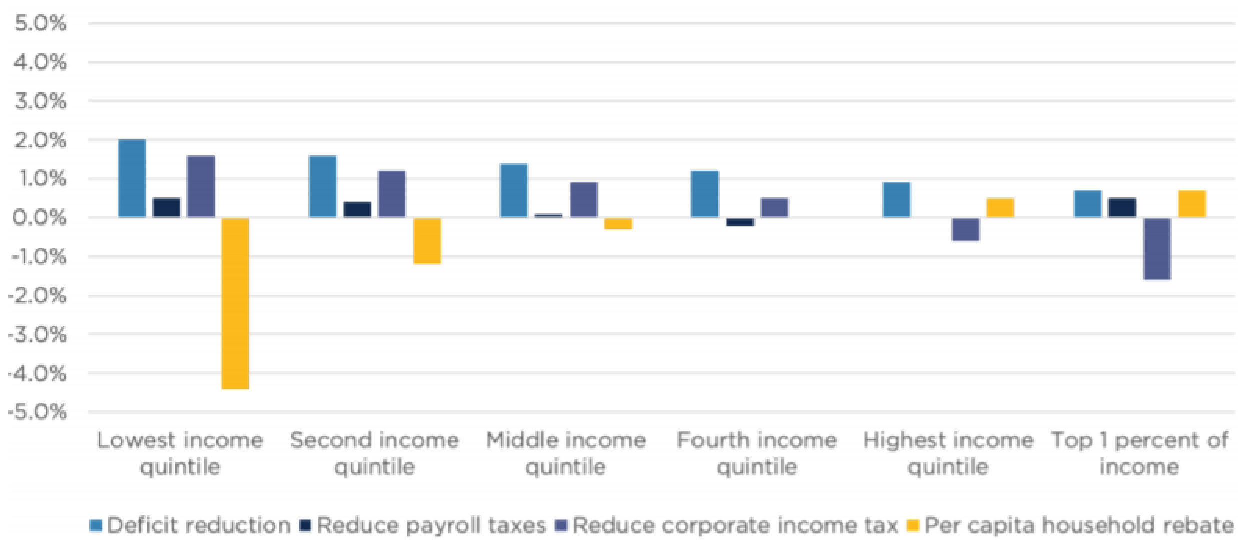
[8] CCL Research estimates that if the estimated reductions from EIA were achieved by all emitters, global temperatures would rise roughly 1.8°C.

[9] This research was quite new at the time of the hearing and had not yet been published. However, Dr Shindell assures us that the methods used to derive the results had previously gone through peer review.

[10] Benefits and costs will grow over time as emissions are reduced.

This study from Columbia that evaluated the GDP impacts of various RNCT policies also assessed their distributional impacts, and this nicely illustrates a key reason why CCL favors returning all funds to households (CFD). The chart below estimates the "change in tax burden" from a set of RNCT, including CFD, across income quintiles, each of which represents 20% of the population. A decline in tax burden from the policy reflects a financial benefit to the quintile. The chart makes clear that when funds are used to reduce the deficit (light blue), labor taxes (dark blue) or corporate taxes (medium blue), the lowest (poorest) quintiles are harmed financially as their net cost burden rises. CFD is unique in providing a clear financial benefit to the poor, and the Household Impact Study, which is specific to the EICDA, makes clear the bottom three quintiles benefit handsomely. This helps explain why, though using the funds to reduce other taxes may be slightly more beneficial to GDP, distributing the funds directly to households addresses deep economic inequities that have been growing worse in recent decades.

Figure 11: Change in Tax Burden as a Percent of Pre-Tax Income in 2025 for a $50/Ton Carbon Tax Scenario



Notes: Assumes a carbon tax of $50 per metric ton (in 2016 dollars) is implemented in 2020 and increases by 2 percent annually (above inflation). Each bar in the figure reflects a different assumption about how 100 percent of the carbon tax is used. The "per capita household rebate" scenario assumes all revenues are used for carbon dividends. The analysis was conducted by the Urban-Brookings Tax Policy Center. Source: Kaufman N. & Gordon K. "The Energy, Economic & Emissions Impacts of a Federal US Carbon Tax." Columbia University Center on Global Energy Policy. July 2018. Figure from Columbia SIPA, Center on Global Energy Policy, "*The Energy, Economic and Emissions Impacts of a Federal US Carbon Tax*"

Job Impacts

The models that evaluate economic impacts of an RNCT policy cannot readily evaluate the economy-wide impact on employment. As a demonstration of this, none of the ten carbon pricing proposals introduced in the last Congress had an evaluation of the impact on jobs, including EICDA. The reason is that peer-reviewed analysis of these policies is done by Computable General Equilibrium (CGE) models. They start with the assumption that all markets are in equilibrium: all goods are priced so that all produced are sold, and markets "clear," in both the non-policy (reference) scenario and in the RNCT policy scenario. Labor (the job market) is one such market: it starts at a condition of equilibrium (everyone has a job who wants one at prevailing wages) and ends at equilibrium in both non-policy and policy scenarios, so it is not useful to calculate the change in employment between the two scenarios. This makes it difficult for an assessment of job impacts within the peer-reviewed literature.

Though we cannot readily project what the economy-wide impact on jobs will be of a specific policy, the peer-reviewed literature does tell us that job opportunities will increase significantly. First, within the energy sector, job opportunities will clearly rise. Impacts on the energy sector are critical because, in model after model, the clearest result of a carbon price is a shift from fossil fuel energy to renewables and energy efficiency. And as discussed here and here, two to five times more jobs are required to produce clean energy than to produce that energy from fossil fuels.

This research looked at the jobs created from a set dollar investment in fossil fuels versus renewables and energy efficiency. This is pertinent because the result of the carbon price will be to shift future investment. The results are similar to the production numbers above. Their summary conclusion is that "*Spending a given amount of money on a clean-energy investment agenda generates approximately 3.2 times the number of jobs within the United States as does spending the same amount of money within the fossil fuel sectors*" (see chart, below). The fundamental explanation for this is that, whereas fossil fuels are more "capital intensive," requiring heavy investments in machinery and systems to extract, process and burn the fuel, clean energy is more "labor intensive," with little or no cost for fuel, but more of the revenue supporting workers' wages for functions such as installation, control and maintenance.

Figure 12: Total Employment Creation Through Alternative Energy Sources

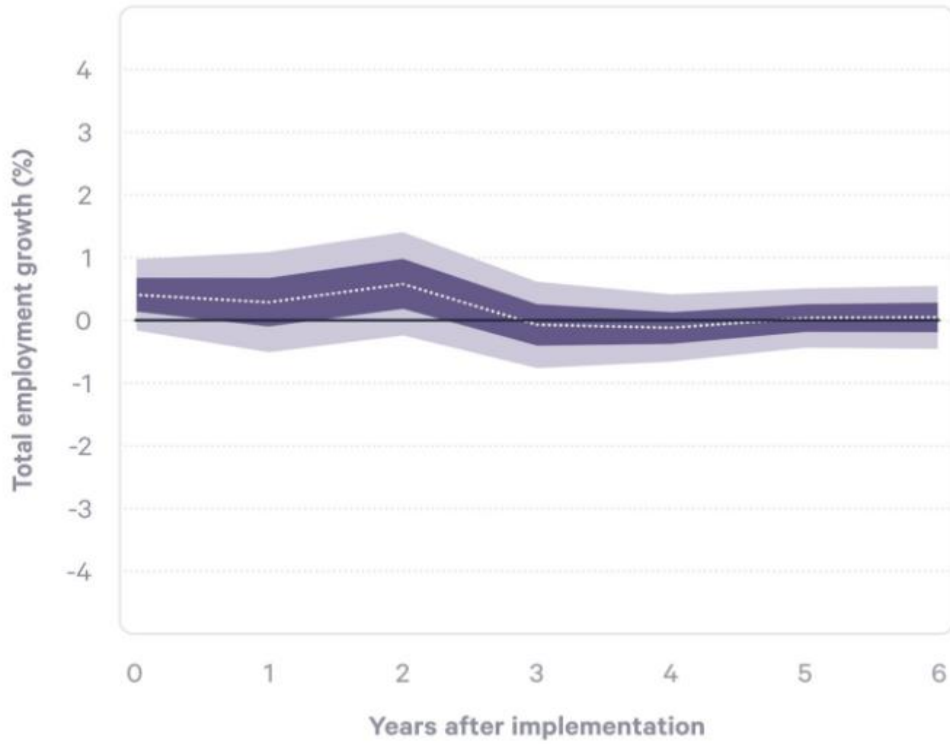
Energy source	Total job creation	Total job creation relative to oil
Fossil fuels		
Oil and natural gas	5.2	---
Coal	6.9	+32.7%
Energy efficiency		
Building retrofits	16.7	+221.2%
Mass transit/freight rail (90% MT, 10% FR)	22.3	+328.8%
Smart grid	12.5	+140.4%
Renewables		
Wind	13.3	+155.8%
Solar	13.7	+163.5 %
Biomass	17.4	+234.6%

Direct, indirect and induced effects for $1 million in spending (induced jobs =0.4(direct + indirect jobs)) Figure from Center for American Progress, "*The Economic Benefits of Investing in Clean Energy,*" page 29.

Regarding the economy-wide impact of an RNCT on jobs, the same study that evaluated the impact on GDP of carbon taxes in 31 European countries over 30 years also evaluated the impact on jobs.[11] As the chart below indicates, the policies, on average, had a slight positive impact on employment for the first few years. In the longer-term, no discernable impact could be found. The authors concluded that "our point estimates suggest a zero to modest positive impact on GDP and total employment growth rates" from the policies.

[11] While a CGE model cannot readily project job impacts, an econometric analysis, as was done here, can assess the impact a tax actually had on employment.

Figure 13: Estimated Total Employment Growth in Response to a Carbon Tax



A typical impulse response function for annual rate of growth of employment in response to a permanent $40 increase in a carbon tax, estimated using a structural vector autoregression. The red line indicates the point estimate, and the two shaded areas indicate 67 percent and 95 percent confidence bands. Figure from Resources Magazine, "*Carbon Taxes Do Not Harm Jobs or Economic Growth*."

The Clean Jobs are Good Jobs

A concern that has stemmed from the evidence of job increases in new industries is whether they will be "good jobs" or comparable in compensation to those that they replace. A study[12] evaluates the quality of clean energy jobs in the U.S. by comparing the wages and benefits of these jobs—clean energy generation, energy efficiency, clean grid and storage, clean fuels, and clean vehicles—to the national average as well as to those in the fossil fuel industry. The summary results are as follows:

- Median hourly wages for clean energy jobs are 25% higher than the national median wage. Further, clean energy jobs are more likely to come with health and retirement benefits than the rest of the private sector. And generally, unionization rates for clean energy jobs are slightly higher than the rest of the private sector.

[12] Though this study is not peer-reviewed, it's a simple aggregation of data largely from the U.S. Bureau of Labor Statistics. CCL volunteers on the Labor Action Team performed a similar analysis and generated similar results. As a result, it's included here.

- Clean energy job salaries are comparable to fossil fuel job salaries. For instance, jobs in coal, natural gas and petroleum fuels pay about $24.37 an hour, while jobs in solar and wind pay about $24.85 an hour. Similarly, jobs in energy efficiency come with median salaries of about $24.44.
- Even without a charge for pollution, U.S. clean energy employment has grown 6.0%, more than twice the national average, for the last three years (2017-2019). In contrast, employment has fallen in the natural gas (-5.3%) and coal (-7.1%) businesses.

In summary, an RNCT will clearly cause a shift in jobs and resources from more polluting industries to cleaner industries. Though this transition must occur to stabilize climate risk, we understand the hardships that result are real and transition assistance is important. However, the evidence indicates more jobs will be created than eliminated, and that compensation in the new jobs will be comparable to the old. An RNCT will bring a stronger, cleaner economy that is a clear job creator.

A Clear Role for Regulations

Can a carbon price achieve the necessary emission reductions by itself, or is there a role for regulations that complement the price? Economists agree that having an RNCT be the backbone of the policy is best for the economy and distributing the revenues to households (CFD) helps promote economic equity, but that achieving an objective as stringent as net zero by 2050 requires regulations to source reductions where a carbon price is less effective[13]. This section first describes the key advantages of a carbon price versus regulations to motivate the vast majority of reductions. Next, the regulations are discussed that are most complementary to a carbon price, and so clearly will increase the total reductions from the policy in as efficient and effective manner as possible.

Preference for a Carbon Price - CCL believes a carbon price should be the backbone of ambitious climate policy, and economists, the IMF, World Bank, the IPCC, UN and many others agree. Below is a list of key reasons why.

- Efficiency - With an economy-wide carbon price, emission reductions are achieved in a least cost manner, so an RNCT is significantly better for the economy. A price allows producers and consumers flexibility (see section on page 12) to reduce emissions in the least-cost manner, whereas regulations tend to dictate how the

[13] The supplementary information of the net zero paper indicates the complementary policies required to reach the objective. This paper by Columbia describes how regulations can integrate with a price to reduce emissions.

reductions will be made without tapping the huge pool of expertise available throughout the private economy. So, for example, a clean energy standard (CES) in the power sector does not incentivize energy efficiency as transparently as a price does, and a fuel economy standard does not incentivize driving fewer miles or taking the bus. A study compared the impact on GDP of a CFD policy starting at just over $40/ton and rising at 5% per year to a reasonably efficient regulatory approach that generated the same level of emission reductions. The CFD policy averaged $190 billion higher GDP per year, and this figure grows over time. By 2036, the GDP was $420 billion higher, and average household consumption was $1,260 higher under the CFD policy. Arguing that climate policy is “good for the economy” is more problematic under a predominantly regulatory approach.

- Fairness – We discussed in the Fairness section, above, how CFD generally, and EICDA in particular, provides a significant financial benefit to the most vulnerable in society. As discussed here, regulations that reduce carbon emissions tend to be neutral to slightly regressive, actually making life harder for the poor, even though those costs tend to be hidden. But more importantly, they will raise the cost of essential products like energy and energy-intensive products without any offsetting compensation and, unless the policy explicitly addresses this, it will place a financial burden on the poor and middle classes.
- Durability - CCL's objective is to help pass strong climate legislation with bipartisan support. Policy that can attract broader support stands a better chance of passage in the Senate and will provide an essential message to the global climate community that the U.S. is "in it for the long haul," allowing them to take stronger action. At this point in time, our understanding is that, as it pertains to truly ambitious climate policy, a market-based policy that does not increase national debt has the best chance of attracting Republican support[14].
- Urgency - It's important that reductions begin as soon as possible. As discussed here, there is good evidence that "well-designed carbon price legislation is forecast to work very quickly, while regulatory action can be stalled for years by procedural obstacles and court challenges." There are many examples of large-scale regulatory policy initiatives that have taken years or even decades to bring to fruition. In contrast, all of the models of RNCT proposals show rapid emissions cuts occurring immediately upon enactment.
- Competitiveness and the BCA - A carbon tax increases the production costs of U.S. producers, potentially diminishing their competitiveness relative to foreign

[14] See, for example, the recent statement by the U.S. Chamber of Commerce in support of market-based climate solutions.

producers. A Border Carbon Adjustment (BCA) will level the playing field by reversing this charge for U.S. exporters and applying a like charge on those importing to the U.S. This is permissible under WTO trade rules, in part because the additional cost of production owing to the environmental policy is clear. Under regulations, production costs will rise, but it's very unlikely a BCA would be compatible with regulations under WTO rules, so that the corresponding competitiveness issues cannot be readily mitigated.

Complementary Policies

So, though CCL's objectives are to pass a policy that greatly reduces emissions without burdening the most vulnerable, we and others believe it's best that carbon pricing is the backbone of ambitious climate policy. However, there are sources of emissions that a price will not quickly or efficiently mitigate and which would be better addressed with well-designed regulations, so such complementary policies should be encouraged. Columbia lists six climate policies that are "complementary" to a carbon price (left column of the chart, below), as well as several that are made somewhat or fully redundant by the carbon price. Complementary policy is defined as one that "enables more cost-effective reductions of carbon dioxide emissions than a carbon tax would achieve on its own; or reduces GHG emissions and achieves a separate policy objective more cost-effectively than a federal carbon tax would on its own." If these are enacted or strengthened, the overall policy is clearly made more effective. Those six are described briefly below.

Figure 14: The Compatibility of a Federal Carbon Tax and Other Policies that Reduce Emissions

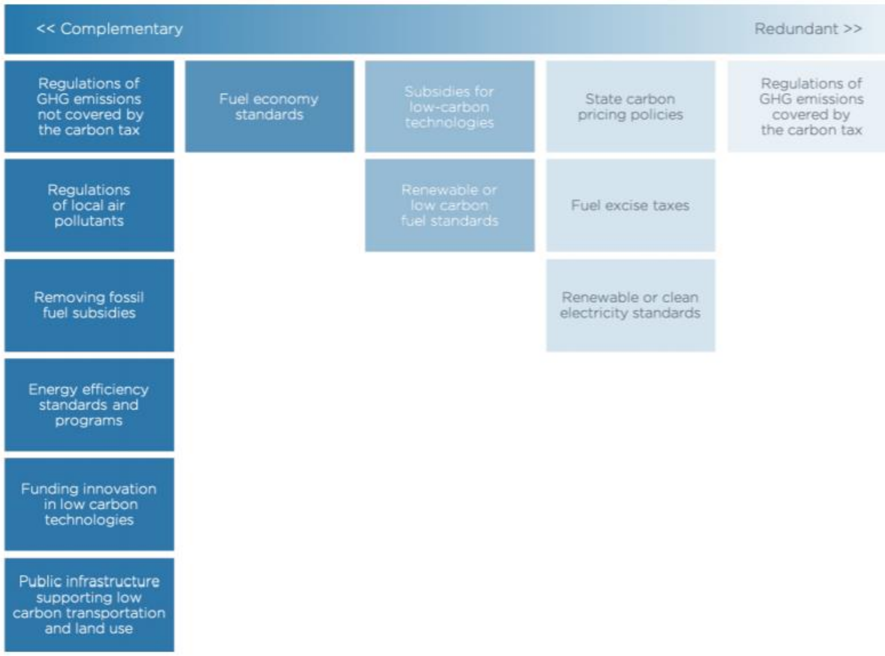


Figure from Columbia SIPA, Center on Global Energy Policy, *"Interactions Between a Federal Carbon Tax and Other Climate Policies"* page 8.

- Regulation of Greenhouse Gas (GHG) Emissions Not Covered by the Carbon Tax (Page 29) - The Clean Air Act (CAA) regulates pollutants such as particulate matter, sulfur dioxide and mercury. These regulations also lower CO_2 by reducing coal use. Further, the CAA also regulates methane, a powerful GHG. Stronger regulation of these pollutants would likely reduce GHGs in a manner complimentary to the carbon tax.
- Regulations of Local Air Pollution – These regulations play a critical role in reducing harmful air pollution in local communities. Though a carbon tax will significantly reduce air pollution generally, it will not reduce it in all communities, so that maintaining or strengthening these regulations remains important.
- Removing Fossil Fuel Subsidies (page 30) - Simply stated, "Continued existence of tax credits intended to lower the cost of fossil fuel production undermines a carbon tax, and eliminating them complements a carbon tax." Eliminating tax expenditures alone would increase federal revenue by $4 billion annually and "the elimination of the three largest tax preferences for oil and gas production … would have material effects on drilling but only modest effects on production, prices, and consumption."
- Energy Efficiency Standards and Programs (page 34) - According to the International Energy Agency, energy efficiency policies, such as labeling requirements, informational tools, and performance standards for appliances and buildings, overlap little with carbon pricing and can be highly effective in tandem. They "address

problems that cannot be addressed sufficiently by shifting market prices, such as principal-agent problems, unavailable energy performance information, and bounded rationality."

- Funding Innovation in Low Carbon Technologies (page 34) - "While a carbon tax encourages private sector investments in low carbon technologies, a carbon tax by itself is insufficient to address the underinvestment in R&D resulting from the market failure of private entities not capturing the full benefits of their R&D spending." Further, "A carbon tax is most complementary with early-stage research, development, and demonstration of new technologies, where the private sector is unlikely to make sufficient investments due to long time horizons and risks. Support for R&D can come in the form of government programs, direct spending, public-private partnerships, tax credits, or other forms."
- Public Infrastructure Supporting Low Carbon Transportation and Land Use (page 35) - "Certain types of improvements in public infrastructure can enable more cost-effective GHG emissions reductions alongside a carbon tax. For example, with better mass transit systems or urban planning that enables more walkable or bikeable urban areas, households will be more likely to take advantage of financial incentives to reduce vehicle travel." Further, "land use policies, including improved forest management practices, tree planting in urban areas, and the management of agricultural soils, landfilling of yard trimmings and food scraps, reduce GHG emissions and serve as a sink that removes GHGs from the atmosphere."

Summary

What do the independent experts, as reflected in the peer-reviewed literature, say about the impacts of an RNCT generally, and EICDA in particular? The following are summary conclusions:

- **Emissions -** Carbon taxes are effective at significantly reducing emissions, and the EICDA baseline carbon price should put the U.S. on a path to achieve net zero emissions by 2050.
- **GDP** - When valuable climate and health benefits are not included, the impact to GDP is minimal in the shorter-term and could be slightly positive or negative. In the longer-term, GDP is significantly enhanced by carbon tax policies. These policies are unquestionably good for the economy, and that is why they are so fully supported by economists.
- **Net Benefits –** The net benefits to the economy and society, defined here as climate and health benefits less any economic cost (reduction to GDP) are substantial. A policy like EICDA would generate nearly $1 trillion of net benefits to the U.S. each year within 10 years of enactment.
- **Job Growth** - Net job opportunities will grow significantly under an RNCT. As resources shift from fossil fuels to renewables and energy efficiency, roughly three jobs will be created for every one lost. Still, transition assistance to those in disadvantaged industries should be considered.
- **Fairness** - CFD is unique in providing significant financial benefits to low income and minority households.
- **Role for Regulations -** Finally, CCL strongly believes a carbon price should be the backbone of any ambitious U.S. climate policy. It will be far better for the economy, is more likely to achieve bipartisan support and so be durable, and will reduce emissions more quickly once implemented. However, certain regulations can play a very valuable complementary role, and their enactment should be encouraged.