An Egalitarian Program for Building a Clean-Energy U.S. Economy

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As of 2010, total world greenhouse gas (GHG) emissions amounted to about 45,000 million metric tons (mmt) of CO_2 or its equivalent. In order to control climate change, the International Panel on Climate Change (IPCC) estimates that total GHG emissions will need to fall by about 40 percent as of 2030, to 27,000 mmt, and by 80 percent by 2050, to about 9,000 mmt.

About 82 percent of total emissions are generated by fossil fuel-based sources. This includes 33,615 mmt in carbon dioxide (CO_2) emissions, equaling about 75 percent of the world total, and emissions of methane and nitrous oxide.

The focus of this discussion paper is an agenda for reducing CO_2 emissions in the U.S economy over the next two decades. As of 2010, the U.S. economy produced about 5,600 mmt of CO_2 emissions from coal, oil and natural gas. This amounted to about 17 percent of total global CO_2 emissions. In order for the U.S. make its minimally fair contribution toward meeting the IPCC global emissions targets, it will be necessary for the U.S. to reduce its CO_2 emissions by at least 40 percent to no more than 3,200 mmt by 2030, and by 80 percent to about 1,100 mmt by 2050. Achieving these goals will be highly challenging, as we describe. Yet the goals are attainable. The Obama administration has consistently voiced its support for meeting these emissions targets.

This discussion paper describes a framework through which the U.S. economy can realistically achieve these targets. Our discussion draws from research projects in which the two of us have been engaged for several years. Parts 2 – 4 and 6 summarize previously published and ongoing work done by Pollin and collaborators, while Part 5 summarizes previously published and ongoing work done by Boyce and collaborators.

As a first order of business, reaching the 2030 emissions targets will require the U.S. to implement major improvements in energy efficiency, including in all three major areas of energy consumption—i.e. buildings, industry and transportation. No matter what other actions are taken, the U.S. will not achieve its 2030 emission targets unless overall energy consumption falls from its current level of about 98 quadrillion BTUs (Q-BTUs) to about 70 Q-BTUs, a decline of roughly 30 percent. This level of emissions reductions is achievable while the energy sector still supports a U.S. economy that is capable of growing at a healthy rate.

As a second order of business, the U.S. needs to undertake a rough doubling—from about 7.8 to over 15 Q-BTUs—in the amount of energy it consumes from clean renewable sources. These include wind, geothermal, solar power, clean biofuels and biomass, and hydro, including small-scale hydro projects. It does not include corn ethanol and other heavy carbon-emitting sources of biofuel/biomass energy. Achieving this level of clean renewable energy production by 2030 is also a highly challenging but realistic goal. Without major advances in the two critical areas of energy efficiency and renewables, the only other plausible path for significantly reducing greenhouse gas emissions in the U.S. would entail a major expansion in our reliance on nuclear energy. However the disaster the Fukushima nuclear power plant in Japan in 2011, as a result of a massive earthquake together with the failure to find a safe way to dispose of spent fuel, provided a dramatic and tragic reminder of the severe public safety risks associated with this approach.

Advancing the clean energy investment agenda—energy efficiency and clean renewable energy sources—will produce major additional benefits throughout the U.S. economy. In particular, these investments will generate a significant expansion in employment opportunities at all levels of the economy, including, among others, those for electrical engineers, operations managers, computer programmers, construction managers, farmers, accounting clerks, agricultural workers, carpenters, machinists, and roofers. That is, the project of building a clean energy economy will be a major new engine of job creation in the United States. The widely repeated claim that protecting the environment will be harmful to job creation is simply not consistent with the evidence. The weight of evidence also shows that the clean energy agenda is most likely to positively support GDP growth, if it has any effect on GDP at all. Among other factors here, achieving significant reductions in purchases of imported oil will, all else equal, enable the U.S. trade deficit to fall to its lowest level in 40 years.

Of course, dramatic improvement in energy efficiency and the expansion of clean renewable energy supplies will correspondingly entail a dramatic reduction in the consumption of fossil fuels in the U.S. Within the next 20 years, oil and natural gas consumption will need to decline by about 25 percent each relative to 2010 levels and coal will need to fall by about 50 percent. This will mean major job losses for workers who are connected to the oil, coal, and natural gas sectors. As such, to advance a successful clean energy agenda, it will be necessary to actively assist workers, their families and communities in transitional programs as the fossil fuel sectors experience retrenchments. The best single approach here would build from the idea of the late labor and environmental leader Tony Mazzocchi for a “superfund” to support workers and communities whose livelihoods will be significantly harmed by the transition from a high to low emissions economy.

1. PROSPECTS FOR ENERGY EFFICIENCY

Reaching the 2030 emissions targets will require the U.S. to implement major improvements in energy efficiency, including in all three major areas of energy consumption—buildings, industry and transportation.

Overall U.S. energy consumption will need to fall from its 2010 level of about 98 Q-BTUs to about 70 Q-BTUs, a decline of roughly 30 percent. This 30 percent reduction in overall U.S. energy consumption will need to be accomplished without inhibiting economic growth, job opportunities or overall economic well-being. Forthcoming research by Pollin and co-authors provides a wide range of evidence on how this can be accomplished.[1] Pollin et al. examine in detail the types of investments that will be needed in these sectors of the economy to achieve the necessary gains in efficiency. They cost out those investments, in terms of gains in efficiency (measured in Q-BTUs) per $1 billion in expenditures.

Adding up all of our estimates of investment needs, we conclude that getting the U.S. economy to operate effectively at roughly 70 Q-BTUs in overall energy consumption will require overall investments in the range of $1.6 trillion over roughly 20 years, or about $80 billion per year over a 20-year period.

Note that such investments will save significant amounts of money for energy consumers. This makes energy efficiency investments self-financing, with typical payback periods between 3-5 years. The main requirement to mobilize energy efficiency projects in both the public and private sectors will be organizing the system of financing and risk-sharing, with a range of options available for both consumers and investors willing to underwrite such projects.

Finally, as regards energy efficiency investments, we need to consider the prospect that that the advances in efficiency may not end up yielding reductions in emissions at all. This could result through what is termed the "rebound effect," in which the efficiencies achieved in the use of energy then encourage consumers to expand their energy-using activities. But we conclude from reviewing the evidence that any rebound effect that is likely to emerge as a byproduct of economy-wide efficiency gains will not be large enough to significantly reduce the environmental benefits of the investments.

At the same time, the most effective way to limit any rebound effects is to combine efficiency investments with complementary measures to change the economy's overall energy mix. These would include measures such as a carbon cap or tax that would directly aim to reduce the use of fossil fuels; and policies to accelerate the integration of renewable energy sources into the economy. We discuss both these issues in what follows.

2. PROSPECTS FOR CLEAN RENEWABLE ENERGY

As of 2010, all renewable sources combined generated about 7.9 Q-BTUs of energy to the U.S. economy. This figure will need to roughly double by 2030-35 if the U.S. is reach the 20-year CO_2 emissions reduction target, since most renewable energy sources are emissions free.

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[1] Robert Pollin, Heidi Garrett-Peltier, James Heintz and Bracken Hendricks, *Green Growth* (working title), Center for American Progress, forthcoming 2014.

However, the challenge is greater than it appears, since at present most of renewable energy produced in the U.S. comes from bioenergy—biomass and biofuels—in which emission levels are roughly equivalent to those from fossil fuel sources. Corn ethanol is the primary case in point. Therefore, we need to focus on expanding the production of clean renewables, i.e. wind, solar, geothermal, small-scale hydro as well as bioenergy from cellulosic sources. Pollin et al. (2014) argue that a conservative estimate for what is possible by 2030 is to supply 15.4 Q-BTUs of energy in the U.S. from clean renewable sources. As of 2010, total supply of clean renewables was in the range of 3 Q-BTUs.

The main findings from the Pollin et al. research are as follows:

- We estimate that *total capital expenditures* to achieve 15.4 Q-BTUs of clean renewables within 20 years will be about $2.1 trillion, or $107 billion per year. The main areas of expansion will be clean bioenergy, small-scale hydro, wind, and solar PV.
- *Cost parity for some clean renewables.* Wind, hydro, geothermal and clean bioenergy sources—such as switchgrass-based ethanol and waste grease-based biodiesel fuel—are already close to achieving cost parity with most non-renewables in generating electricity under average conditions (natural gas through fracking being the one exception).
- *Solar costs declining rapidly.* Solar costs are still not likely to be at cost parity by 2017 under average conditions. But solar costs are coming down the most rapidly. Moreover, through technical innovations and expanded market opportunities over the next 1-2 decades, solar promises to become the cleanest, safest, and most abundant energy resource.

3. EMPLOYMENT IMPACTS OF CLEAN ENERGY INVESTMENTS

This section summarizes the estimates developed by Pollin et al. 2014 on employment changes in the United States from three sources:

1. Investing about $80 billion per year for 20 years in energy efficiency measures.
2. Investing about $110 billion per year for 20 years in clean renewable energy sources.
3. Contracting oil and natural gas consumption in the U.S. by about 25 percent each and coal consumption by about 50 percent.

Using the U.S. Department of Commerce input/output model, we estimate the employment requirements of implementing these features of the clean energy investment agenda: energy efficiency capital expenditures in building retrofits and industrial efficiency; capital expenditures in clean renewable energy; and operations and maintenance of clean renewable sectors.

We estimate the annual employment demand from these activities will be about 4.2 million jobs. We then estimate the contraction of employment that will result through retrenchment in the non-renewable sectors. For this exercise, we assume that all expansions in the clean energy sectors will be matched dollar-for-dollar by equal declines in spending in the non-renewable sectors.[2] We estimate the net job impact to be an increase of 2.7 million jobs.

There are two basic factors behind this net increase of 2.7 million jobs, with zero additional spending being injected into the economy:

- *Labor intensity*. Clean energy investments require more employment per unit of activity than the average level of spending within the non-renewable sectors.
- *Domestic content*. Clean energy investments entail a higher proportion of spending within the domestic U.S. economy than spending within the non-renewable sectors at roughly their current proportions.

What would be the impact of this net increase of 2.7 million jobs within the context of the 2030 U.S. labor market? One clear gauge of this impact is that, all else equal, it would mean a reduction in unemployment by about 1.5 percentage points. Thus, if the economy were otherwise operating at a 6.5 percent unemployment rate, operating under a clean energy framework as we have described would mean that the unemployment rate instead would be about 5 percent.

4. CARBON PRICING: FOLLOW THE MONEY

Pricing carbon emissions—instead of treating the planet's carbon absorption capacity as unlimited and free-of-charge—is an important element in climate policy. In the U.S., where private firms and households account for about three-quarters of total investment, a strong price signal is needed to steer private investment to energy efficiency and renewables.

Regulations, like power plant emissions standards and fuel efficiency standards for automobiles, are important, too. But without carbon pricing, regulation is like damming a river: it slows the flow, but investment still is drawn downhill towards lower costs and higher profits.

There are two ways to put a price on emissions: by setting an emissions cap or by creating a carbon tax. A cap sets the quantity of emissions and lets the price vary. A tax sets the price and lets the quantity vary. Because the exact relationship between price and quantity cannot be known in advance with certainty—this depends on the state of the economy and the

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[2] Note here that the "dollar-for-dollar" match refers to an expansion in *investment spending* in energy efficiency and clean renewables, the funds for which are matched with a decline in *operations* in the oil, coal and natural gas sectors. As noted above, the operational costs of producing energy with renewables, and even more so, saving on energy consumption through efficiency investments, are increasingly at parity with those of continuing to produce energy through our existing non-renewable sources, including nuclear power as well as oil, coal, and natural gas.

pace of technological change—and because the objective is a predictable time path of emission reductions, it arguably makes more sense to target the quantity via a cap. But apart from this difference, the effects of the two policies on emissions are equivalent.

Whatever the pricing mechanism, the easiest way to implement it is "upstream" rather than at the tailpipe. For each ton of carbon that a fossil fuel firm brings into the economy, it must surrender a permit (or equivalently, pay a tax). The Congressional Budget Office (CBO) estimates that such a system would require administrative compliance from about 2000 firms nationwide.[3] The added cost to fossil fuel firms will be passed to their customers, ultimately to consumers.

Carbon pricing does not mean that the environment is "for sale," any more than curbside parking meters mean that the city street is for sale. It just means that we're charging for use of a scarce resource. Much as we pay to park our cars, we'd pay to park fossil carbon in the Earth's biosphere.

The distributional impact of higher prices for gasoline, electricity and heating fuels will be regressive. As a percentage of income, the poor will be hit harder than middle class, and the middle class harder than the rich. This is because fuels in general are a necessity, not a luxury consumption item.

Carbon pricing means paying for emissions that are *not* prevented. This is quite different from the cost of *preventing* emissions—for example, by insulating buildings or switching to clean energy, discussed above—although they're often confused. The cost of preventing emissions is modest compared to what carbon pricing would make households pay for emissions that aren't prevented. A useful estimate of the relative magnitudes was produced by the CBO as part of its assessment of the 2009 American Clean Energy and Security Act (ACESA) cap-and-trade bill, otherwise known as the Waxman-Markey bill, named for its two sponsors in the House of Representatives. Waxman-Markey passed in the House in May 2009, but failed to pass in the Senate. The CBO estimated that the cost of emissions prevention under Waxman-Markey would have been about 18 cents per household per day. The costs to households resulting from fuel price increases under the bill's cap-and-trade program would have been more than ten times higher – closer to $1000/year, and increasing over time as the cap tightens and prices rise further.[4]

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[3] CBO, *An Evaluation of Cap-and-Trade Programs for Reducing U.S. Carbon Emissions.* June 2001.

[4] CBO, "The Estimated Costs to Households from the Cap-and-Trade Provisions of H.R. 2454," June 19, 2009. James K. Boyce and Matthew Riddle, *Cap and Dividend: A State-by-State Analysis.* Amherst, MA: PERI, November 2010.

Whereas preventing emissions requires spending real resources, the increase in fuel prices does not involve a resource cost: it's what economists call a "transfer." This money is not spent on labor and materials. It isn't sent to the moon or shipped to Saudi Arabia. Instead it's recycled, one way or another, within our economy.

A key question therefore is *who will get this money?* In other words, who will receive the "parking fees" that consumers pay for their carbon emissions? The answer depends on the policy. Five options are shown in Table 1 (tables appear at end of this document).

Cap and dividend policies were proposed in two 2009 bills in Washington, one by Congressman Chris Van Hollen (D-MD) and another by Senators Maria Cantwell (D-WA) and Susan Collins (R-ME). New versions of these bills are now in the works. Both would cap emissions, auction all of the permits to fossil fuel firms, and return all or most of the revenue to the people in the form of equal dividends for every woman, man and child (100% dividends under Van Hollen; 75% dividends under Cantwell-Collins with the remaining 25% allocated to a fund for public investments). These dividends would transform the policy's net distributional impact from regressive to progressive. This is because high-income households generally consume above-average amounts of fossil fuels (even though these represent a smaller percentage of their income), so they would pay more as a result of higher fossil fuel prices than they get back as dividends; low-income households would get back more than they pay; middle-income households would come out in between. Because the U.S. income distribution is highly concentrated at the top, the majority of households nationwide and in every state would come out ahead.[5] This means that in sheer pocketbook terms—not even counting the benefits of climate protection—most Americans stand to benefit from such a policy.

Fee and dividend differs from cap and dividend in that it relies on a tax (or "fee") rather than permit auctions to generate the revenue. The prominent climate scientist James Hansen has endorsed this policy.

Cap and spend policies again auction all the permits, but in this option the government keeps the revenue. The money can then be used for expenditures, as is currently done under the Regional Greenhouse Gas Initiative (RGGI) for power plants in the northeastern states, or it can be used to offset cuts in other taxes.

A *carbon tax* differs from cap and spend in that it takes the form of a tax rather than permit auctions. Again, the revenue goes to the government, which puts the money to whatever use Congress chooses.

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[5] For net impacts of the Cantwell-Collins bill, see James K. Boyce and Matthew Riddle, CLEAR Economics: State-Level Impacts of the Carbon Limits and Energy for America's Renewal Act on Family Incomes and Jobs. Amherst, MA: PERI, July 2011.

Cap and trade gives the permits to the firms free of charge, based on a legislated formula that takes into account their historic emissions. (This giveaway is sometimes called "grandfathering," a term we regard as an insult to grandfathers.) Firms receive windfall profits, much as OPEC profits by restricting oil supplies. The money goes to the shareholders and executives of the firms that get free permits. Because the permits are given away to firms, rather than being auctioned to the highest bidder, some get more than they need, and others need more than they get. For this reason, permit trading is part of the policy, while in the other four options there is no need for permit trading and no scope for speculators to game the system. The U.S. established a cap and trade system for sulfur dioxide emissions from power plants under the 1990 Clean Air Act amendments, and more recently the European Union implemented one for carbon dioxide emissions from power plants.

Politically, cap and dividend (and its cousin, fee and dividend) have the great advantage of providing a clear monetary payback to the American people, a feature that could prove crucial is sustaining support for the policy as fuel prices rise over the decades needed to complete the clean energy transition. The political appeal of cap and trade, on the other hand, rests on its potential to neutralize opposition from fossil fuel lobbyists in exchange for windfall profits.

5. ENVIRONMENTAL REGULATIONS AND GDP GROWTH

What is likely to be the impact of a carbon cap or carbon tax on economic activity in the United States? Of course, coming up with reliable forecasts of the impact of such measures is notoriously unreliable, especially if one is considering impacts over an extended period of time. Nevertheless, it is useful to look at the forecasting exercises that have been undertaken specifically with respect to cap-and-trade legislation to obtain a sense of the range of effects that researchers anticipate.

With this limited ambition in mind—and without presuming that one can accurately forecast the future growth rate of the economy over the next generation—let us consider now the various forecasts that were generated to estimate the effects on long-term GDP growth of the most recent piece of federal cap-and-trade legislation that was voted upon in Congress, i.e. the Waxman-Markey bill.

In Table 2, we show the results of alternative forecasts generated by the Energy Information Administration (EIA), the Environmental Protection Agency (EPA) and the American Council on Capital Formation/National Association of Manufacturers (ACCF/NAM), a business lobbying group that was strongly opposed to Waxman-Markey. We present in Table 2 only the worst-case scenario generated by the ACCF/NAM model, their "high cost case."

The results of these modeling exercises can be readily summarized. With the two sets of models produced by the EIA and EPA, the effects of Waxman-Markey would be virtually indiscernible statistically. That is, the difference between their baseline GDP forecast and that in which cap-and-trade legislation was in effect is in the range of 1/20th of one percentage point of GDP growth. For example, in the first case shown in Table 1, the EIA reference case, the difference is between a 2.71 and a 2.67 average annual growth rate from 2010 to 2030.

What is equally if not more remarkable with these model results is that the worst-case scenario from ACCF/NAM—i.e. strong opponents of cap-and-trade legislation—reaches basically the same conclusion as the EIA and EPA models. Under their *worst-case scenario*, cap-and-trade legislation would reduce average GDP growth by only 1/10th of a percentage point.

This basic finding is even more notable, given that these models all leave out significant considerations that would tend to encourage the long-term growth rate to rise. These basic considerations include: 1) the positive effects of higher employment; 2) the benefits of a higher level of domestic content and thus a reduced trade deficit; and 3) the economic benefits of reducing greenhouse gas emissions.[6]

6. CONCLUSION

In this brief overview of some of the main themes of our recent and current research, we have shown how the U.S. can achieve its carbon emission reduction goals over the next 20 years. Crucially, we also show how this fundamental challenge can be met while also promoting an expansion of job opportunities and a more equal distribution of income. We also show that there is no credible evidence—even from vehement opponents an effective climate change control agenda such as the American Council on Capital Formation—that advancing a clean energy agenda in the U.S. will generate any discernable negative effects on economic growth as conventionally measured.

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[6] These models also omit the public health co-benefits of improved air quality as a consequence of reduced use of fossil fuels. Though often neglected in discussion of climate policy, these co-benefits would be substantial; indeed a number of valuation studies have concluded that they would be comparable to the climatic benefits. For discussion, see James Boyce and Manuel Pastor, ‘Clearing the Air: Incorporating Air Quality and Environmental Justice into Climate Policy, ’*Climatic Change* 102(4), 2013.

TABLE 1.
Carbon pricing policy options

Policy	*Fix emissions quantity or price?*	*Who gets the money?*	*Distributional impact*	*Trading?*
Cap and dividend	Quantity	The people	Progressive	No
Fee and dividend	Price	The people	Progressive	No
Cap and spend	Quantity	Government	Regressive	No
Carbon tax	Price	Government	Regressive	No
Cap and trade	Quantity	Corporations	Highly regressive	Yes

TABLE 2.
Comparison of Alternative U.S. GDP Growth Forecasts under Baseline and with Cap-and-Trade Legislation
(figures are average annual growth rate forecasts for specified time periods)

	1) Baseline GDP Forecast	*2) GDP Forecast under Waxman-Markey Cap and Trade*	*3) Difference between Baseline and Cap-and-Trade Growth Forecasts (columns 1-2)*
Energy Information Admin. (basic scenario 2010-2030)	2.71	2.67	0.04
Energy Information Admin. (high-cost scenario 2010-2030)	2.71	2.66	0.05
Environmental Protection Agency-1 (ADAGE model—2015-50)	2.41	2.36	0.05
Environmental Protection Agency-2 (IGEM model—2015-50)	2.38	2.32	0.06
ACCF/NAM—“High Cost Case” (2007-30)	2.31	2.21	0.11

Sources: Energy Information Administration (2009); Environmental Protection Agency (2009); American Council on Capital Formation/National Association of Manufacturers (2009). Full references in Pollin et al. (2014 forthcoming)