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A Jobs and Infrastructure Program to Arrest Climate Change

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By David B. Goldstein

Electricity Policy – the website ElectricityPolicy.com and the newsletter Electricity Daily – together comprise an essential source of information about the forces driving change in the electric power industry.

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Part 1: Why limiting climate pollution is an economic development strategy

Most of us think of our electricity infrastructure as consisting of generating plants and power lines. But that leaves out *our* contribution—the consumer contribution—to the delicately balanced machine that is our power grid: the demand for energy we place on the grid. That's because our energy usage—our residences, businesses, grid-connected devices, and soon our cars as well—is part of the grid. There remain immense savings in that usage that can be achieved even while improving comfort—savings in energy use that make our economy more efficient and competitive, while reducing power bills for businesses and residences.

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The same is true for our transportation infrastructure: our energy usage is dependent on where our homes, jobs, shopping, entertainment, educational facilities, etc., are located. It depends too on whether alternatives to gas-fueled automobiles are available and convenient, as well as whether auto manufacturers offer us economical, or zero-emissions vehicles.

A commitment to making that energy use more efficient in all of these applications could achieve several goals at once—goals we all can support: employing more people in good jobs, stimulating the economy, and increasing economic competitiveness, while achieving cleaner air and reducing greenhouse gas emissions. It may turn out the key to making the decisions needed to put people back to work and increase economic growth are not economy-focused at all, but are based on protecting the world's climate.

The remarkable consensus agreement achieved at the United Nations Framework Convention on Climate Change meetings in Paris in December 2015 sets a two-fold goal for the world's nations: to hold the increase in global average temperature to below 2 degrees C above pre-industrial levels; and to pursue efforts to limit the increase in temperature to 1.5 C, "recognizing that this would significantly reduce the risks and impacts of climate change."

Numerous studies have provided blueprints on how to reach this goal painlessly. "Painlessly" may not mean that it will be easy politically, but that the changes are part of an infrastructure investment program that will reduce costs, create jobs, and help solve other economic, environmental, and health problems.

Limiting climate change to 1.5 C is a much-needed but previously unstated goal if the world is to avoid profound risks, costs and disruptions of severe climate change. Unfortunately, at current levels of improvement we will not achieve even the 2-degree goal. Perhaps the threat of climate change is the impetus we need to motivate action that we should be taking for these other reasons—for jobs, the economy, and cleaner air.

But what would it take to hold the line at 2 degrees? At 1.5 degrees? This essay shows: (1) policies needed to get there, including in six new areas where little or nothing has been done; (2) how these policies would produce new jobs, locally, and in the sectors that need the most help; and (3) how this would also improve economic justice.

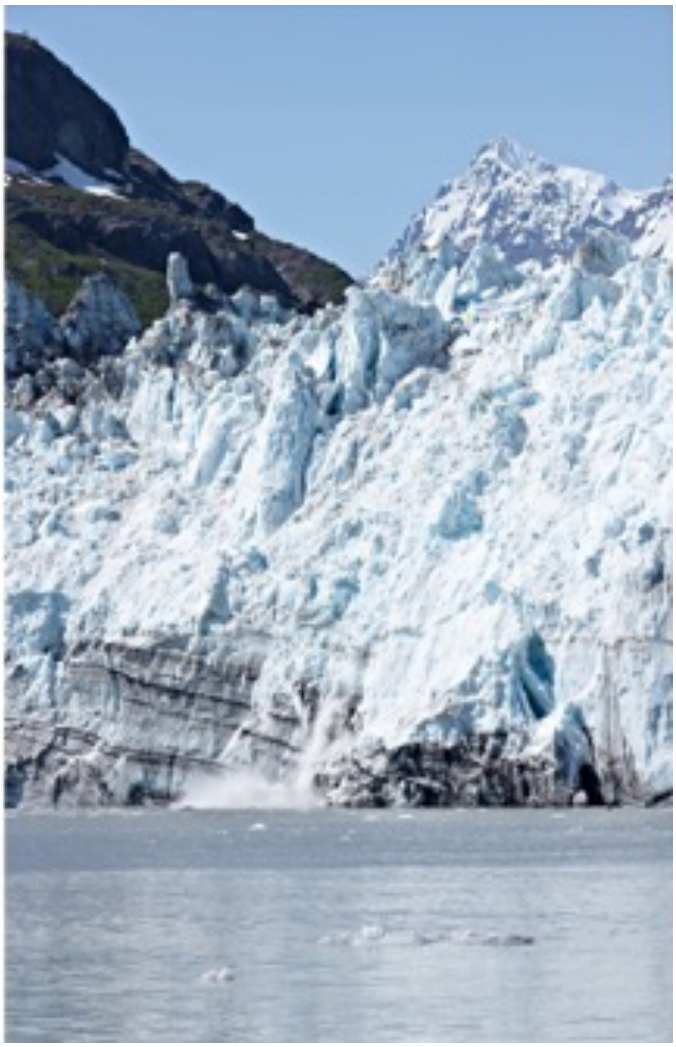
As of October 5, 2016, 72 countries, accounting for about 57% of the world's emissions, including the U.S., officially subscribed to the Paris Agreement, making it effective as of November 4, 2016.[1]

This essay has two goals:

- To inspire policymakers to adopt the goal of limiting climate change to 1.5 degrees and to take its implementation seriously, and to undertake the bold steps needed to do this immediately; and

[1] Jake Schmidt, "From Blueprint to Reality," October 5, 2016, NRDC, https://www.nrdc.org/experts/jake-schmidt/blueprint-reality (accessed November 22, 2016).

- To show that success is possible by explaining what it would *require* from a technological and behavioral point of view, and what it would *produce* in terms of economic development.



Melting and calving glaciers in the Arctic and Antarctic, along with a warming ocean, will contribute to sea rise.

These steps are interconnected. No one will undertake assertive new policies if they don't see convincing reasons why they will succeed. That's why this paper discusses what it would take to limit climate change, first to 2 degrees, which many studies address, and to 1.5 degrees, where much less work has been published.

This essay argues that the two goals adopted in the Paris Agreement—a firm goal of limiting climate change to 2 degrees and to "pursue efforts" to limit the change to 1.5 degrees make sense together. There is a broad base of work that gives decision-makers confidence that they can succeed in limiting warming to 2 degrees, at low or even negative cost, making it feasible as a policy goal. [2] That work provides a good beginning point for the additional proposals I suggest here. I will first discuss the content and consequences of policies needed to meet the 2-degree goal, and then move on to new ideas that are largely or completely missing from the 2 degree scenarios but will be needed to achieve the 1.5-degree goal.

What do the 2-degree scenarios show?

Two degree scenarios, both global and domestic, rely on an overarching strategy to improve the efficiency of energy use: better cars, refrigerators, and lighting, walkable neighborhoods that require less car use, buildings that require much less energy to heat and cool, etc. This is the conclusion that emerges from every study, whether it was done by the International Energy Agency, by

[2] See International Energy Agency, "Energy Technology Perspectives 2016," http://www.iea.org/etp/ (accessed November 22, 2016); see also note 1.

academic or environmental organizations, or by clean energy nonprofits.

The scenarios also feature greatly expanded reliance on renewable energy sources, primarily wind and solar, which, when integrated into the power grid, allow strong carbon reduction performance in one region to compensate for weaker performance elsewhere on the grid.

The overarching need for greater energy efficiency and cost savings

Energy efficiency pays for itself several times over, reducing energy bills and automobile expenses for families and businesses. These savings are particularly important for middle and lower income households, which spend a higher proportion of their income on energy. Efficiency also produces local jobs, both directly and indirectly from consumers spending money they previously wasted on energy on other things they want or need.

Strong efficiency policies can correct several key economic imbalances that have plagued the American economy since 1973.[3] It is interesting to note that the median income of an American family had been rising steadily for decades until 1973, when oil prices tripled. Starting then, the trend went flat and median household income basically has not risen since. While other factors no doubt are also to blame, long-established trends such as growing median income do not just stop suddenly for no reason. The reason they stopped in 1973 cannot be unconnected from the rise in oil prices. The oil crises of the '70s triggered the highest U.S. inflation in a century, also leading to a trade deficit.

The continuing stagnation of median income after the effects of the second oil price rise in 1979 had faded also corresponds to a time of weakness in energy efficiency policy. After the bipartisan energy-saving laws of the '70s, America relaxed its commitment to fuel economy and efficiency standards, not only for cars but also for refrigerators, air conditioners, and buildings. Yet efficiency policies are still one of the few consensus steps we can take toward improving economic justice.

Renewable energy costs about the same as polluting energy—less if external environmental costs are considered—but it protects us from fluctuating fuel prices. It also produces jobs and reduces pollution. Clean energy is a growth industry worldwide, and policies to encourage efficiency and renewables give a nation or jurisdiction a competitive advantage over economies that are energy inefficient or more dependent on imported fuels whose prices may spike at any time.

These problems have become more urgent over time. One of the issues that came to the fore in the recent election was the worsening outcomes for the middle and lower middle class. Increasing economic growth and job generation are universally desired goals. If it were easy to realize these goals, every jurisdiction would achieve them.

[3] David B. Goldstein, *Invisible Energy: Strategies to Rescue the Economy and Save the Planet*. (Point Richmond, California: Bay Tree Publishing, 2010).

Efficiency is one of the very few policies with a track record of economic development success. There is a large and growing literature documenting the cost savings and job creation from existing efficiency policies and projecting the benefits from the expanded programs needed (and starting to be implemented) worldwide. In the U.S. alone, efficiency in buildings, equipment, and motor vehicles accounts for over 2 million jobs, while renewable energy provides over 400,000 additional jobs.[4]

These observations are relevant in the context of an incoming national administration that is both concerned about the loss of middle class jobs and skeptical of the value of meeting climate protection goals.

What is required to meet the 2-degree goal?

While the level of effort needed to reach the 2-degree goal is high, *most of the work is done by policy* changes—e.g., efficiency standards—or by a market in which clean energy businesses profit from their effort. Families will not notice much difference, most of which is beneficial: expanded mobility choices and greater availability of housing in walkable, transit-served areas, less air and water pollution, and lower utility bills. Businesses will see negligible change in their operations.

The difficulties will be borne by government and private sector organizations that implement energy policies, or by energy efficiency companies that will expand their scale of operation radically (with profits to match). The only businesses to be challenged in a major way will be traditional energy suppliers, which will need to diversify beyond many of their present service offerings.

Californians can take pride in the knowledge that their state is already on track to meet the 2-degree goal, while the state's economy hasn't experienced any negative consequences. But perhaps they have noticed that California's clean energy economy has helped it create more jobs than the rest of the country. The United States as a whole appears on track this year to hit its 2016 emissions target (based on actual emissions inventories from 2014), in large part because of actions taken by the Obama administration and by the states, even without a congressionally-approved climate goal. On the other hand, forecasts for the year 2025 all show the U.S. falling far short of meeting our goals for limiting climate change to 2 degrees unless we do much more with policies.

The last two observations—that we are on track for our 2-degree goal in terms of recorded emissions but also falling off the track for 2025—point out the dualism that runs throughout this essay:

- **There is confidence** that we can meet bold and aggressive goals because, in the times

[4] Environmental Entrepreneurs (2016). *Clean Jobs America: A comprehensive analysis of clean energy jobs in America*. Available at http://www.e2.org/wp-content/uploads/2016/03/CleanJobsAmerica_FINAL.pdf. (accessed December 13, 2016). Many of these jobs were created in a policy environment that was not always supportive of efficiency policies, and occasionally opposed them. With more consistent support for efficiency, the number would have been much higher. Also this tally included only direct jobs. Indirect jobs—those created when utility customers spend the money they would have wasted on other activities that generate employment—were not estimated, even though they may represent half of the efficiency jobs.

and places where we have tried to meet them, we are succeeding**;** *however*,

- **Far more needs to be done** with policies to reduce emissions, at the global, national, regional, state, local, and private-sector levels. These channels are largely interchangeable: less progress on one level can be overcome by more progress on others. This needs to be a process of continual improvement, as outlined in the Paris Agreement, in which initial goals are set, progress toward meeting them is tracked, and experience gained with what works and what falls short allows us to refine our policies and meet more aggressive goals in the next iteration. Thus, while state policies are making it profitable for utilities to encourage customer energy efficiency and customer-sited solar power in many states, these policies must be extended everywhere to meet climate goals. Stronger energy codes that focus on buildings that produce as much energy as they consume ("zero-net-energy buildings") are beginning to be adopted in leading states, counties, and cities, but they also need to reach everywhere.

Other policies that have yet to be adopted anywhere are reformed lending and appraisal rules for buildings, to allow greater ability to qualify for mortgages on energy- and location-efficient properties, both for homes and for commercial properties.

In summary, most of the things we need to do to meet the 2-degree target are things that we should do for other reasons, even if climate were not an issue. We would do them to create jobs, to save money and resources, clean the air, protect wild places, protect the poor and the middle class from high utility bills and high personal transportation expenses, and encourage competition and innovation in the economy.

Indeed, we are already doing them, to a greater or lesser extent, so meeting the 2-degree goal is merely an expansion and acceleration of existing efforts, or an extension of policies that are succeeding in some areas to additional areas.

Almost all the technology-based studies,[5] nationally and internationally, stop at the savings needed to meet the 2-degree goal. It is not difficult to identify the technical measures needed and explain how they would be deployed. These analyses do not rely on technological breakthroughs. Rather, they apply technologies already identified and in most cases even priced, sometimes with predictable incremental improvements over time. They are policies known to work.

These studies should be interpreted with a sense of optimism, because virtually all studies of efficiency potential contain *systematic biases* that underestimate the level of savings that can be achieved.[6] The most obvious of these is subjecting efficiency measures to a standard of

[5] These analyses are presented in a variety of forms, starting with the International Energy Agency's "Energy Technology Perspectives 2016," http://www.iea.org/etp/ (accessed Nov. 22, 2016), a technical/policy report that's updated annually. Many other such studies published by academic institutions and nonprofit organizations cover much of the same ground.

[6] Many of these are documented in Lester B. Lave, et. al., "Real Prospects for Energy Efficiency in the United States." Washington, D.C.: National Academies Press, 2009; others are discussed in Invisible Energy (see note 2).

proof beyond a reasonable doubt. Because efficiency is a relatively new concept and because the very idea of savings being possible may be controversial, researchers tend to choose levels of savings that are extremely safe. This is because a single error tending toward optimism on a single efficiency measure out of over a thousand could be career-threatening, whereas there is no downside to projecting savings very "conservatively."[7]

Thus, it is widely accepted that the world knows how to meet a 2-degree target with economically appropriate technologies and with policies that have a record of success.[8] Mobilizing these actions at scale and securing the political will to get it done will require sustained effort over many years.

Part 2: What initiatives will it take to halt warming at 1.5 degrees?

In Part 1, I discussed what it would take to stop climate change at 2 degrees, both in terms of technologies and policies. I noted that the most important overarching strategy, both in the U.S. and globally, would be energy efficiency, where policies will cut energy bills and prices, create millions of new jobs, and help overcome the economic downdrafts that led to the recession of 2007-09, from which half of Americans have never really recovered. Renewable energy also plays a dominant role.

The results of the U.S. election suggest a new question that applies equally well to the 2-degree and the 1.5-degree scenarios: **How can the nation produce well-paying new jobs** that do not require graduate-degree skills and are well distributed across the country, including rural areas as well as cities?

Economic development using broad-brush measures such as tax or interest rate policy has not generally been successful: if it were, every country and political subdivision in the world would do it. But the economic policy community has not paid much attention to detailed, highly targeted approaches such as energy efficiency. As shown in Part 1, weak energy efficiency policy following the oil crises of the 1970s led to a sudden stagnation of median income. It is not unreasonable to believe that assertive energy efficiency policy can reverse that trend and restore the pattern of growing income—both from the consumer and a jobs perspective—such as characterized the American economy and most other advanced market economies prior to 1973. The jobs analysis cited above validates this hypothesis.

So, while what follows may be framed as an environmental protection initiative, it equally well describes a nationwide program of geographically distributed economic development and jobs creation.

[7] The very word "conservative" in this context is questionable. A conservative error is one whose adverse consequences are worse than those that would result from a non-conservative error. But in the context of climate studies of energy efficiency options, pessimism about efficiency makes the reader think we need more of the expensive options to mitigate climate change, and this error results in underfunding cheaper efficiency options and overspending on the expensive choices.

[8] "A Suite of Policies for Energy Efficiency in Buildings: Maximizing Synergies." David Goldstein, Proceedings of the 2016 ACEEE Summer Study on Energy Efficiency in Buildings. Washington D.C.: American Council for an Energy-Efficient Economy, 2016 http://aceee.org/files/proceedings/2016/data/papers/9_418.pdf

This program has a record of success at achieving its objectives, promoting innovation and enhancing American businesses' competitiveness as well as providing non-climate-related environmental benefits whose economic value is in the trillions of dollars.[9]

The Vermont Energy Investment Corporation works to apply cost-saving and energy-saving efficiency measures across the board.

It would require detailed analysis to identify quantitatively the exact pathway to limit warming to 1.5 degrees, but we can start by looking at the most challenging problems with the 2-degree scenario and identify how we would solve them. This simplified approach may be more valuable than a detailed analysis, since the energy modeling for such an ambitious scenario depends on assumptions that are based on judgments as to what is politically feasible and how fast decisions can be made and implemented at scale. These are not things that can be modeled or forecast: they are tough decisions that we will need to make.

The ideas explored next are discussed in a way that will allow an analyst to design quantitative scenarios. This essay does not undertake to do this, in part because a specific roadmap of what technologies need to be deployed in what areas is not necessary. If the policies are designed flexibly enough, they will allow markets to get us there more cheaply and easily, using a different mix of technologies.

This essay will map out the path to 1.5 degrees by starting with some major opportunities that were ignored or downplayed in essentially all the 2-degree scenarios. The first course of action is to simply accelerate deployment of the 2-degree scenario technologies: more efficient appliances and vehicles.

Sooner rather than later

A more stringent emissions target means that we need to look more closely at timing. These issues have not generally been addressed in 2-degree scenarios, either because of a perceived need to be "conservative" (the word is in

[9] David B. Goldstein, *Saving Energy, Growing Jobs: How Environmental Protection Promotes Economic Growth, Profitability, Innovation, and Competition*. (Point Richmond, California: Bay Tree Publishing, 2007.)

quotes here because allowing the climate to warm by as much as 2 degrees is a fundamentally risky, or non-conservative, goal), or simply by ignoring some of the opportunities due to a lack of research budget or due to gaps in the published literature.

Climate pollution is cumulative: it matters less how many tons of carbon equivalent we emit in 2050 than how much we will emit in the next 33 years, and how soon. An approach to 80% reduction along a straight-line path will lead to more cumulative emissions than front-loading the savings. A key to stopping at 1.5 degrees rather than 2 degrees is acting fast, since delaying action will be more-costly, both in terms of cumulative emissions and cost.

What about that last 20% of emissions?

For the 2-degree case, the goal for the U.S. is to reduce CO^2 emissions by 80% by 2050, as discussed above. What accounts for the remaining 20% that is still being emitted in 2050 in these scenarios? The answer to that question can provide an important tool in finding the most effective new policies to focus on. The key causes are natural gas use in industry and petroleum use in road and air transportation. There are also issues with reducing the emissions of non-carbon greenhouse gases. That is why these sectors are prominent among the new proposals being introduced.

Getting below the 2-degree case will also require an expanded effort to sequester carbon in natural systems. Reduced emissions and increased sequestration of emissions from soils and forests can significantly offset remaining emissions from combustion of fossil fuels, so these areas are areas where we focus. Although 1.5 degrees is much more of a challenge for energy planners than 2 degrees, it is still quite achievable. But achieving it will require ambitious policies like those discussed next.

What does the 1.5-degree goal mean in practice?

National goals for meeting the 2-degree C target were developed through global negotiation. For the U.S., the goal is to reduce emissions by some 80% by 2050. While there is no currently accepted approach to allocating emissions reductions to countries, this section offers a starting point for how to do this. It applies the methodology to the U.S., then uses it to prioritize new opportunities.

Since climate pollution is cumulative, and we are already slightly beyond 1 degree of warming, stopping warming at 1.5 degrees[10] means *reducing future cumulative global emissions by about one-half*, compared to 2 degrees. (If you want temperature increase to be only half a degree below the 2-degree level, that is half the emissions of a 1-degree rise.) This will be no small feat, given that global population by 2050 is projected to rise by about

[10] There has been some discussion about whether the world has ALREADY overshot 1.5 degrees. Such discussion is not relevant to this essay: it is an issue of calibration rather than goal setting. The 1.5 and 2 degree goals are premised on the assumption that the world is now committed to 1 (or 1.01 or 1.02) degrees. This essay—and all the analysis it cites focused on limiting climate change to 2 degrees—is best interpreted as analyzing the goals of limiting ADDITIONAL climate change to (about) 0.5 degrees (for the more ambitious goal) and 1 degree (for the less ambitious goal). The analysis is still self-consistent regardless how much the earth has warmed as of 2017.

25% to 9.7 billion people, most of them desiring a higher standard of living that is more energy intensive.

This reduction has not been allocated across countries, but one way to do it would be to start with national plans—INDCs[11]—to stop warming at 2 degrees and then cut the cumulative emissions by half. This is the argument with regard to the United States in the next section. It would be worthwhile to look at this idea in the context of other countries, particularly large developing countries, to see if it makes sense. In the case of the U.S. and other developed countries, cutting cumulative emissions that are on the 2-degree path to about 80% savings by 2050 will depend less on how much more than 80% we reach eventually than how quickly we can turn the curve down.

A key difference between the 1.5-degree scenario and the 2-degree scenario is that efficiency is even more important to limit warming to 1.5. That's because efficiency is generally cheaper—and, more importantly, can be deployed faster—than any other zero-emissions technology. In the 1.5-degree scenario, front-loading efficiency and automobile travel reduction policies is critical because the electricity and gasoline we avoid is dirtier than they will be in the future, when more renewables are developed and when fuel economy of cars is higher and fuels are cleaner.

Additional opportunities: Six new programs to get us to 1.5 C

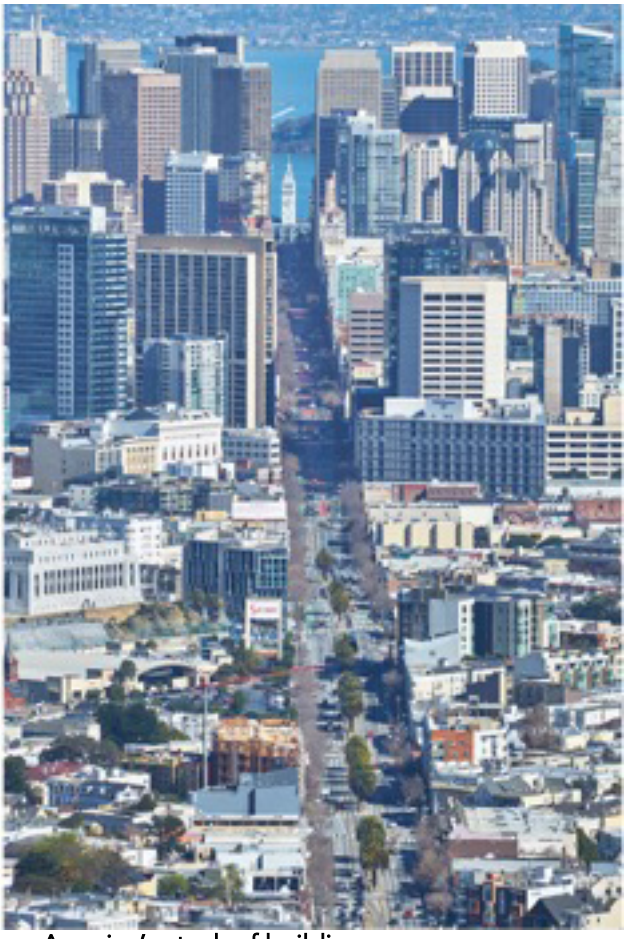
This essay suggests six areas where policies could be developed or strengthened and where potential savings are understated in current 2-degree scenarios. These new policies also turn out to be especially effective at advancing economic development and job creation, especially for the middle class. If we spent more time to look, we would find additional such opportunities.

The following programs focus on areas where the least analysis has been done, meaning that many opportunities for savings were left unanalyzed. They are also areas where emissions over the next 35 years are projected to be high. Emphasizing actions that can be taken promptly the discussion will show how these new initiatives complement policies needed to get to 2 degrees, as well as those that complement each other.

1. Fast, Deep Energy Retrofits of Buildings

Buildings' energy use accounts for more than 35% of climate pollution in the U.S. It is possible to cut energy consumption in buildings, typically by 50% for commercial space and 40-50% for residential units using moderate cost measures that pay for themselves even without considering their environmental and health benefits. Further savings—to the point of achieving net zero energy consumption—are technically feasible and financially reasonable in many cases. These savings have two independent components: physical upgrades to buildings ("retrofits") and behavioral savings.

[11] Intended Nationally Determined Contributions. See http://unfccc.int/focus/indc_portal/items/8766.php.



America's stock of buildings—even some recent ones—could really benefit from an efficiency upgrade.

We already know how to incentivize virtually all homes to undertake these deep retrofits, and to do it in just four years (one year for planning and three for implementation), through observation of successful pilot projects. [12] Virtually all existing homes could benefit from retrofitting: pilot programs achieved some 85% market share over three years, meaning that only 15% of homes were either unwilling to participate or incapable of being retrofit.

These pilot programs were operated on a small community scale, so it would require significant logistical efforts to scale them up to a national level. But the scale-up does not have to occur overnight. It should not take more than a few years to construct new insulation and window factories, to upgrade the efficiency of manufactured climate control equipment, etc., so that only the most efficient of the current product line are produced in numbers, and to train workers who built new homes ten years ago to retrofit existing homes next year.

These successful retrofit experiments involved very high levels of financial incentive, but those incentives could be reduced drastically over time.

This essay therefore proposes to retrofit all existing buildings by 2030, using market-based approaches that reward higher percentage savings more generously and that set minimum required levels of savings (say, 25-30%). The reason to choose a goal of 2030 is to create sustainable jobs for contractors performing the work and suppliers of efficiency products and solar energy. If we tried to remodel all buildings in five years, we might create a boom and bust cycle. But if we take 15 years, and have a market-enhancing structure, the level of savings will increase over time and we may have the opportunity to return to the first buildings after 2030 to find additional savings.

A 15-year program to retrofit all the homes in North America would be some 80 times larger than the pace of utility-administered home retrofit programs

[12] Lawrence Berkeley National Lab, "Driving Demand for Home Energy Improvements: Hood River Conservation Project," http://drivingdemand.lbl.gov/reports/lbnl-3960e-hrcp.pdf (accessed November 22, 2016).

currently underway. Similar conclusions were reached in Europe, where the budget for retrofit efficiency programs is consistent with the North American estimate. To put it another way, at current levels of expenditure, it would take managed incentive programs well into the fourth millennium before all existing homes were retrofit once.[13]

Raising the capital for this program would not be difficult, as one of the policies required—reforming lending to account for the cash-flow savings from energy (and location) efficiency[14]—would allow projects to be financed through conventional mortgages, and additionally with on-bill financing and Property-Assessed Clean Energy[15] (PACE) programs that can tap additional sources of capital beyond the traditional mortgage markets.

No other technical study, to our knowledge, has proposed such a fast or deep efficiency program. Many other analyses of this topic project only 15% savings by 2030—about one-third of what is proposed here. This roughly tripling of energy savings compared to other studies produces a disproportionately large reduction in emissions, since the electric grid will be much dirtier from now until 2030 than it is projected to be from 2030 to 2050. And if we are trying to limit concentrations of greenhouse gases, which are cumulative, fast reductions are especially important because we assure that the worst performing buildings will not continue their high level of emissions for more than 15 years.

This proposal has strong non-energy benefits as well: the worst-performing sector of the economy over the past decade in terms of growth has been housing.[16] Many jobs have been lost as the number of new homes constructed struggles to reach *one-half* the level it was at before the bubble and crash of 2008-09. We have the skill set in the labor force to do the work, and the economy would benefit from deploying it. The result would be about 500,000 net new jobs, disproportionately skilled blue collar jobs, which occur where people already live. Little or no geographic dislocation would be required.

This initiative would also offer the largest relative benefits to the middle class, renters, and the poor. These groups suffer more of the consequences of poor thermal comfort and poor indoor air quality, and pay a larger proportion of their incomes for utility services.

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[13] "A Suite of Policies for Energy Efficiency in Buildings: Maximizing Synergies." David Goldstein, Proceedings of the 2016 ACEEE Summer Study on Energy Efficiency in Buildings. Washington D.C.: American Council for an Energy-Efficient Economy, 2016 http://aceee.org/files/proceedings/2016/data/papers/9_418.pdf

[14] David B. Goldstein, "An Overlooked Way to Raise Trillions for Green Investments," September 23, 2016, NRDC. https://www.nrdc.org/experts/david-b-goldstein/overlooked-way-raise-trillions-green-investments. (Accessed 9 December 2016).

[15] https://energy.gov/eere/slsc/property-assessed-clean-energy-programs.

[16] David B. Goldstein, "Why Isn't America Doing More to Reinvigorate Housing by Supporting Energy & Location Efficient New Homes?" June 13, 2014, NRDC. https://www.nrdc.org/experts/david-b-goldstein/why-isnt-america-doing-more-reinvigorate-housing-supporting-energy. (Accessed 9 December 2016).

We can also find additional savings in buildings from better operations and maintenance and other behavioral programs, especially for commercial buildings. Immediate savings of from 15% to 30% *above and beyond those from physical upgrades* are easily and cheaply achievable.[17] Furthermore, these behavioral savings do not take 13 years to implement: most can be achieved in less than a year.

Further savings come from improvements undertaken at the community level, such as replacement of dark roofs with reflective roofs, and planting more trees in suburban and urban areas. These types of measures reduce urban heat islands, lowering the temperature of the whole region in the summertime and improving outdoor comfort while reducing air conditioning needs.[18]

2. Smart Growth and Shared Mobility

Smart growth refers to the design of neighborhoods and transportation systems such that less driving is required. Smart growth neighborhoods can allow families often to get where they want to go with only one car, or with none, rather than needing to own two or three, so they save lots of money—around $10,000 per year.

Constructing new neighborhoods takes time, but adding infill development to existing neighborhoods is faster, and improving transportation infrastructure is still faster. New bus lines, pedestrian paths, bike lanes, etc., take only a few years. And one of the fastest opportunities, shared mobility, can be implemented almost immediately. In fact, it is beginning to happen just from market forces. What policies do we need to enhance it and how much could it save? (Would we want to require Uber, Lyft, etc., to offer carpool travel

Many modes of urban transportation other than the car—both personal and mass transit—will cut carbon and other emissions.

[17] This type of program is relatively new, and aggregate results do not seem to have been derived, but the California Commissioning Collaborative report "The Building Performance Tracking Handbook". Hannah Friedman, et. al., 2011. (http://www.cacx.org/PIER/handbook.html) (accessed November 22, 2016) and its references suggest 20% to 30% savings from operational tracking.

[18] These measures also increase heating needs, but by a lesser extent. The balance favors the heat island reduction virtually everywhere in the U.S., and in most of the world, especially the places with the greatest climate pollution emissions, such as China and India.

to all users, for example, or to make it the default choice on their apps?)

Smart growth and shared mobility can also reduce emissions that would otherwise occur as we don't need to build new highways, streets, parking spaces, etc., the need for which is obviated by smart growth planning. Parking infrastructure reductions alone (there are currently some 4-8 parking spaces in America for each car) would save as much in emissions as taking 10% of today's cars off the road. [19] These savings would show up as industrial energy use reductions, a major issue for emissions limits.

Most climate studies ignore smart growth and focus exclusively on better vehicles and cleaner fuels. The few that do consider smart growth make timid assumptions about how quickly and deeply urban designs can change. But market trends now favor smart growth, even as lending policy ("drive till you qualify") and zoning laws still encourage sprawl and require parking to be provided, generally for free. With workable policies like those already adopted with bipartisan support in California, it is reasonable to foresee a scenario in which essentially all net new housing is built in smart growth circumstances, either by adding density to older neighborhoods or developing new neighborhoods.

This essay does not attempt to estimate how much further we can go in travel demand reduction than previous studies, for many reasons. These include the unreliability of the models used to project "business as usual" and the problematic question of defining "as usual." Quantifying it would not be useful on a national level in any event, since related policy actions take place primarily at the local and metropolitan levels, where in some cases planners strive to meet quantitative targets on automobile vehicle miles traveled or on carbon emissions. But the additional resource savings are substantial.

These recommendations sound bolder than they are, primarily because the efficiency literature did not address location efficiency until very recently. In the past, policies that led to less driving were considered conservation behaviors rather than efficiency; policies that encouraged people to use alternative modes rather than driving, in a way that looked like "nanny state" interventions. But now we know that the amount people drive is mostly determined by infrastructure: Is the neighborhood dense enough to allow travel by foot or by transit or bikes, which is what the market increasingly prefers. Providing this infrastructure primarily involves relaxing formal regulation of land use and informal regulation of mortgage qualification,[20] allowing developers to build denser and more profitable buildings.

[19] David B. Goldstein, "Does Every Car Need 8 Parking Spaces? Ride-Sharing Can Save Emissions by Reducing Parking Too," March 9, 2016, NRDC, https://www.nrdc.org/experts/david-b-goldstein/does-every-car-need-8-parking-spaces-ride-sharing-can-save-emissions (accessed November 22, 2016).

[20] See, David B. Goldstein, "Why Conservatives Should Support Smart Growth" January 27, 2012, NRDC, https://www.nrdc.org/experts/david-b-goldstein/why-conservatives-should-support-smart-growth (accessed November 22, 2016) and David B. Goldstein, "Protecting the Environment by Reducing Regulatory Burden," September 27, 2013, NRDC, https://www.nrdc.org/experts/david-b-goldstein/protecting-environment-reducing-regulatory-burden (accessed November 22, 2016).

It also provides greater relative benefits to those not at the top of the income spectrum. Increased housing and transportation options offered under these policies will allow major savings in costs, expanded transportation and housing choices, and greater access to preferred lifestyles for those that are underserved or unfairly restricted today. But now we see that the primary trends we need to limit climate pollution are already happening *even in the face of contrary policies*. Millennials are increasingly choosing to live in walkable neighborhoods and are driving less than their parents did, even when policies still encourage car dependence. They are making these choices in cities that previously did not even offer such choices. Shared mobility is booming even where the companies providing it are restricted by regulation from expanding as much as they would like.

Typical 2-degree studies such as those of the International Energy Agency and the U.S. National Academy of Sciences also fail to account for potential reductions in intercity automobile and air travel by modal shifts. This represents another significant reservoir of additional savings that would become available by expanding rail service to become broadly competitive with air and auto travel, as is the case in most other advanced countries.

3. Strategic Management in Industry

Virtually all studies of industrial savings potential start at the level of widgets (better boilers, variable speed motors, etc.,) and work up. They fail to account for major changes in process, or for incremental improvements in O&M procedures. Strategic Energy Management (SEM)[21] is a standard for organizational management that promotes continual improvement in both facilities and O&M and directs management to provide sufficient resources to save ever more energy.

Since there is limited experience with this concept, it has not found its way into climate emissions mitigation studies. But in cases where it has been used, manufacturers achieved large savings in initial years; one company has reported 4.5%-6% annual gains for from 10 to 30 years. And these savings were achieved without:

Strategic Energy Management can yield great savings in industrial process, equipment, and O&M practices.

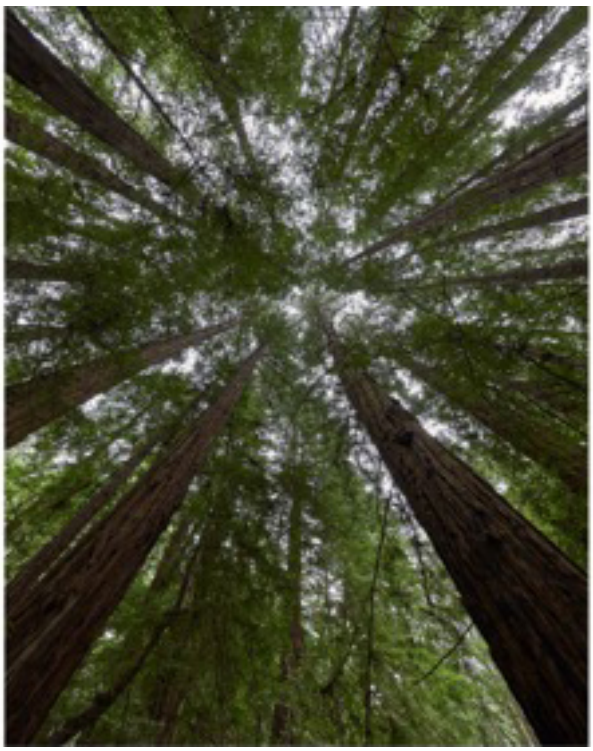
[21] Consortium for Energy Efficiency, "CEE[SM] Strategic Energy Management Minimum Elements," CEE, https://library.cee1.org/sites/default/files/library/11283/SEM_Minimum_Elements.pdf (accessed November 22, 2016).

- Looking at fundamental process changes (because of a lack of budget for such actions—something that would need to change under an SEM scenario),
- Considering savings in the supply chain, and
- Counting renewable energy production. (Several major companies have begun to purchase renewable energy sources to cover up to 100% of their energy loads.)

SEM creates jobs in several different ways. *First*, the process of implementing it requires energy management professionals, both in-house and often consultants, and entails more jobs for operators doing more effective O&M. It also involves purchasing new efficient equipment and controls, which creates jobs for the suppliers and installers. *Second*, companies that engage in SEM become more competitive globally because their cost structure in lower and because SEM helps management to deploy innovative methods and new technologies that increase productivity even in non-energy-related ways. A globally competitive facility is more likely to expand in the future, and much less likely to close its doors.

Third, since energy efficiency is a great investment, efficient plants make more money, allowing the owners or investors to buy other things whose production creates jobs.

To reduce industrial emissions proportionally to those expected in other sectors would require a rate of improvement of almost 7% annually—a challenging goal. But when even the leading companies refuse to invest in improvements that pay back their costs in three years, there is a lot of profitable slack in the system that could be addressed by policy changes, including utility programs for SEM, changes in financial rating criteria to allow companies to borrow and invest in profitable efficiency upgrades, and simply setting goals and tracking progress. That is why the typical large company engaging in SEM finds that the improvements not undertaken before pay back in 1.5 years.[22]



Improved forestry practices and management—along with reduced deforestation and afforestation—can reduce CO_2 emissions.

[22] U.S. Department of Energy, "Revolution, now… The Future Arrives for Five Clean Energy Technologies – 2016 Update" September 2016. http://energy.gov/sites/prod/files/2016/09/f33/Revolutiona%CC%82%E2%82%ACNow%202016%20Report_2.pdf (accessed December 13, 2016).

Purely voluntary SEM programs are attracting significant interest in and participation from leading industries.[23] But the nation (and the world) need to do more. So far, the extent of incentivized SEM programs has been minimal: generally small-budget programs in only a few regions. Without financial incentives, SEM participation has not been sustained.[24] Incentive programs are needed for existing efforts to be rapidly expanded and to target more ambitious goals.

A policy option to promote SEM would encourage businesses to set goals for continual improvement in energy performance, counting both efficiency and non-emitting energy supply, and to make their metrics and results publicly available. The author has developed a straw man tax incentive proposal to encourage businesses to do this. The tax incentive pays for itself, because the energy savings that result reduce tax-deductible energy expenses—deductions the participating company would otherwise have taken.

Many large companies already publish annual sustainability reports, and this dataset could be the central component of their analytics. Also, SEM is applicable not only to industry. It can be used by building operators, even single families, where it will promote not only physical retrofits but emissions-reducing behaviors.

Financing the improvements should not be difficult, since they are all very cost effective. An example of this would be to change lending or financial rating methods, analogously to what is recommended for the buildings sector, so that energy efficiency in a given building is considered on a level playing field with other measures that can increase net operating income by the same dollar amount. Thus, if building A has an expected energy bill that is $50,000 less than an otherwise comparable building B, it would appraise for about $1,000,000 more than B would, and would qualify for a commensurately larger loan.

4. Saving Emissions in the Supply Chain

Most industrial emissions are caused by a very small number of industrial categories, such as steel, chemicals, cement, etc. No systematic analysis has yet been undertaken of where all these energy intensive products are used, and whether there are alternatives. Yet a growing number of businesses are starting to track the upstream emissions consequences of their activities, and in the process discovering savings opportunities that no one knew were there.

As more companies undertake SEM and look at the supply chain, new emissions savings opportunities will emerge in areas that no one anticipated.[25] For example, NRDC has shown that 40% of food is wasted.[26] Food supply and

[23] David B. Goldstein, "Businesses Show the Way in Fight against Climate Change by Embracing Energy Standard as Good for the Bottom Line," May 16, 2016, NRDC, https://www.nrdc.org/experts/david-b-goldstein/businesses-show-way-fight-against-climate-change-embracing-energy-standard (accessed November 22, 2016).

[24] Julia Vetromile and Steve Phoutrides. "What Gives SEM Staying Power?" American Council for an Energy-Efficient Economy, "2015 ACEEE Summer Study on Energy Efficiency in Industry." http://aceee.org/files/proceedings/2015/data/index.htm (accessed November 22, 2016).

[25] David B. Goldstein, "Saving Energy in the Supply Chain." August 24, 2015. NRDC. https://www.nrdc.org/experts/david-b-goldstein/saving-energy-supply-chain. (Accessed 9 December 2016).

[26] Dana Gunders. "Wasted: How America is Losing up to 40% of its Food from Farm to Fork to Landfill." Natural Resources Defense Council Issue Paper 12-06-B, 2012.

preparation account for some 25% of climate pollution. If we could cut food waste by half, we could save an additional 5% of emissions. NRDC also estimated that reduced parking needs—the need to construct new parking facilities—could cut emissions by some 100 million metric tons of CO_2 annually, about 10% of the residual emissions for 2050 in the 2-degree scenario. This potential is also entirely absent from any climate studies I have seen.

5. Improved Forestry

Most analyses of emission reduction potential focus on opportunities to reduce emissions from combustion of fossil fuels. Expanding that focus to include forestry management provides additional opportunities. The past few decades have seen a significant loss of forests, primarily in the tropics. As these forests are cleared, the stored carbon that had been in the trees and forest soil is released into the atmosphere. Emissions from this deforestation accounts for approximately one-quarter of the total climate impact over the past few decades.[27]

Reducing the rate of deforestation will lower emissions and contribute to meeting a 1.5-degree target. Additionally, restoring forests, planting new forests, and increasing forest growth can sequester carbon that has already been released and lower CO_2 concentrations in the atmosphere. CO_2 concentrations are also lowered by the absorption into the oceans, but this results in acidification and higher ocean temperatures, with increasingly dangerous implications for ocean ecosystems. Importantly, restoring and expanding forests is a labor-intensive activity that can provide well-paying jobs in rural communities that often suffer from high levels of unemployment and economic stagnation.

Forests are cut down for a variety of reasons, including the need for forest products such as paper, wood, and fuel, and to make land available for agriculture and development. Much of the added emissions occur rapidly through losses in conversion into wood products, direct combustion of wood for fuel, or decomposition of short-lived wood products such as paper and packaging. Forest soils often also contain significant amounts of carbon which escapes to the atmosphere when forests are cleared. In the case of peat soils, the amount of soil carbon can exceed the amount of carbon in aboveground biomass.

Strategies to reduce forest emissions and increase sequestration need to include measures that protect forests and focus development on already-cleared lands as well as efforts to reduce the demand for forest products through increased efficiency and use of recycled products.

Forest protection is necessary to reduce the huge emissions additions that occur when existing forests are cleared. Protection of existing forests is also critical to protect the many co-benefits that they provide, including species habitat, forest products for local communities, and soil carbon. Once an old-growth forest is cleared, it can take decades to

https://www.nrdc.org/sites/default/files/wasted-food-IP.pdfan. (Accessed 9 December 2016).

[27] IPCC, *Land Use, Land-Use Change and Forestry* (Cambridge, England: Cambridge University Press, 2000) http://www.ipcc.ch/ipccreports/sres/land_use/index.php?idp=0 (accessed December 13, 2016).

centuries to restore the full range of benefits that the forest provided.

Reduced demand for forest products is also essential. If demand continues to grow, the pressure for forest clearing will overwhelm site-specific efforts to prevent clearing. (The problem of reduced emissions in one place being replaced by emissions elsewhere is known as "leakage.") Demand for forest products can be reduced through a variety of strategies, including improved efficiency and increased use of recycled products. For example, we can reduce the need for virgin paper by double-sided printing and by increasing the use of recycled paper.

Finally, planting new trees and allowing them longer to grow before harvest offers a significant opportunity to increase the amount of carbon dioxide that is removed from the atmosphere. Over the past few decades, terrestrial ecosystems have sequestered large amounts of CO_2, largely offsetting emissions from land-use change. Afforestation on degraded and/or deforested lands can supplement this important carbon sink.

It typically takes decades before newly planted forests sequester carbon at high rates, so early action to plant trees now is essential to provide benefits in the middle years of this century. Afforestation can also provide many co-benefits, including water retention, flood protection, and ecosystem benefits to justify a significantly increased level of investment. Urban forestry offers a particularly large array of co-benefits in addition to the direct benefit of carbon sequestration: improved air quality, reduced summer temperatures (which reduces the need for air conditioning), and improved property values.

Controlling emissions makes economic sense for industry because methane not leaked is methane that can be sold.

Significant progress has already been made in reducing emissions from deforestation. The United Nations Food and Agriculture Organization (FAO) estimates that global emissions resulting from deforestation have decreased by 25% from 2001-2015.[28] But many analyses find that further reduced deforestation, improved forest management, and afforestation offer further large cost-effective options for emissions reductions. One study estimates the potential for emission reductions from reduced deforestation of up to 2.7 GtC/year.[29] Increased

[28] UN Food and Agriculture Organization. "Carbon emissions from forests down by 25% between 2001-2015. http://www.fao.org/news/story/en/item/281182/icode/ (accessed November 22, 2016).

[29] Georg Kindermann et al., "Global cost estimates of reducing carbon emissions through avoided deforestation" PNAS, "2008 Proceedings of the National Academy of Sciences of the United States of America." http://www.pnas.org/content/105/30/10302.full (accessed December 12, 2016).

afforestation and improved forest management could add significantly to this total.

6. Reducing Methane Leaks

There are two types of policies that can reduce methane leaks, which currently account for about 15% of U.S. greenhouse gas emissions, on a weighted basis.

The first is to swiftly and significantly reduce methane emissions from all sectors of the natural gas and petroleum industries, from production through distribution. According to the EPA's most recent Inventory of U.S. Greenhouse Gas Emissions, the oil and gas industry emits nearly 30% of total U.S. methane emissions, making it the largest industrial source of methane emissions in the nation. Pound for pound, methane can cause over 80 times more warming than carbon dioxide over the first 20 years of its release. Reducing emissions of this short-lived but powerful greenhouse gas is crucial to fighting climate change.

Electrification of buildings often will be cheaper than replacing gas pipes, and will eliminate methane leaks permanently.

Given that methane is the primary component of natural gas, controlling emissions also makes economic sense for industry because methane that is not leaked is methane that can be sold. Technologies for reducing methane emissions are readily available and low cost. Despite this, voluntary emissions reductions by the oil and gas industry fall far short of what is necessary to meet climate goals, due at least in part to the fact that projects to reduce emissions may yield a lower rate of return than, for example, drilling new wells and therefore have a hard time competing for capital. Federal and state policies to reduce emissions are therefore crucial.

Leading states such as Colorado and Wyoming have strong and sensible rules to control methane across the oil and gas supply chain. At the federal level, in 2016 EPA put in place important rules that will apply to new sources of methane emissions and has begun the process of planning to regulate existing sources. Oil and gas equipment and facilities already in operation will be responsible for the vast majority of future methane emissions. One study found that by 2018 almost 90% of methane emissions from the oil and gas sector will come from sources that were already in operation in 2011.[30]

Particularly to meet near term climate goals, it is critical that comprehensive policies be developed and implemented to control methane emissions from existing sources. The U.S., Canada and Mexico recently committed to reduce methane emissions from their oil and gas sectors by 40-45% below 2012 levels by 2025, and explore new opportunities for additional methane reductions. These goals will

[30] "Economic Analysis of Methane Emission Reduction Opportunities in the U.S. Onshore Oil and Natural Gas Industries". ICF International, Fairfax, VA, 2014. https://www.edf.org/energy/icf-methane-cost-curve-report. (Accessed 3 January 2017).

only be reached if the countries move swiftly to control existing sources of methane pollution.

Mitigating methane emissions will create high-value jobs at the dozens of firms that manufacture mitigation equipment and/or provide emissions reduction services. These firms provide high-paying U.S. jobs in at least 531 locations across 46 states.[31]

The second set of policies for reducing methane emissions is to look for places where the existing gas distribution system is aging and leaky to the extent that expensive replacement is needed, and to shut these systems down and electrify the buildings that are currently served by natural gas. Electrification of buildings in many cases will be cheaper than replacing the gas pipes, and will not only eliminate the methane leaks permanently but also reduce emissions because electrification of low temperature heating is already part of 2-degree scenarios. These opportunities can be pursued immediately. Other more expensive replacements of electricity for gas should be done later and planned in advance to minimize economic losses.

While 20 years ago the most efficient way to provide space heating and water heating was to burn gas at the building site, today's electric generators and heat pumps are more efficient, such that a unit of gas burned at a power plant produces more heat and energy—and fewer emissions—than it would if burned at the building. Electricity suppliers also are increasingly relying on low-cost wind and solar energy; accelerating this trend is part of the low-emissions scenarios. California, the nation's most populous state, and New York, with the third largest population, have already committed to 50% renewables by 2030; [32] Hawaii and Vermont have set even higher renewables goals.

Summary of New Programs for Dramatic Emissions Reductions

This essay has suggested six new programs that go beyond most of the savings in greenhouse gas emissions that have been included in studies focused on meeting the 2-degree goal. While there are good reasons to limit a short essay to only six new ideas, in the real world there are dozens of other policies and plans that can further reduce emissions beyond those that have been analyzed. Some of them are new approaches, while others involve trying to quantify emissions savings that will occur from programs whose impacts are indirect or which have never been studied quantitatively.

Part 3: What will it take to achieve the 1.5-degree scenario?

> "It always seems impossible until it's done."
> —Nelson Mandela

Parts 1 and 2 discussed what a 1.5-degree scenario would look like. Part 1 summarized why a 2-degree scenario would rely most heavily on energy efficiency programs that accelerate economic development. Part 2

[31] Shawn Stokes, Monica La, and Marcy Lowe, "The Emerging U.S. Methane Mitigation Industry". Datu Research, 2014. https://www.edf.org/energy/us-methane-mitigation-industry. (Accessed 9 December 2016).

[32] Kit Kennedy, "New York Adopts Historic '50 by '30' Renewables Goal," August 1, 2016, NRDC https://www.nrdc.org/experts/kit-kennedy/new-york-adopts-historic-50-30-renewables-goal (accessed November 22, 2016).

addressed six additional areas not usually included in 2-degree studies and discussed how they make achieving the 1.5-degree scenario more practical, while also making a major new contribution to creating middle class jobs, saving money across the income spectrum, and accelerating innovation and economic growth that will keep American companies in the forefront.

What does it take?

If the nation and the world realized the enormity of the climate change threat and the fact that averting it is possible and even attractive economically, we could adopt and refine the policies needed to get there. But it won't happen without understanding and motivation.

Much of the political controversy around climate change seems to stem from three misconceptions: [33]

- That there is doubt about whether human activity causes climate change;
- That proponents of limiting climate pollution have a hidden agenda: promoting global government control;
- That it would require unreasonably intrusive government regulation to solve the problem, if it exists.

This essay, as well as the blog at note 33, demonstrates that these ideas are mistaken. Even if one doubted whether science has established that past warming was caused by human intervention, there is no denying that future emissions could cause climate disruption. A conservative approach to a risk is to mitigate it. The solutions to controlling emissions discussed here are all market-based: they encourage competition and innovation.[34] They involve reducing regulation more than adding regulation. And they address economic needs that no other program under discussion seems capable of meeting.

Stopping climate change can proceed more easily, rapidly, and cost-effectively if the public and decision-makers look carefully at what is involved and see that the changes needed will lead to a stronger economy and greater equity. They will also help to reverse long-term elements of decline in the American economy related to failure to innovate in our industries, causing them sometimes to lose out to more up-to-date companies abroad.

It takes the type of programs outlined here, along with a scaling up of policies that advanced states and regions are already undertaking—policies and programs that require no sacrifice, no burdensome regulations or limits, no rationing or large energy price increases—virtually nothing that makes day-to-day life more challenging. But it will require political support for ambitious expansion of existing programs and funding to allow them to realize their fullest potentials.

There are plenty of examples of people or organizations setting ambitious goals whose

[33] David B. Goldstein, "'Merchants of Doubt': More than just a movie review--a challenge to conservatives on climate change," April 20, 2015, NRDC, https://www.nrdc.org/experts/david-b-goldstein/merchants-doubt-more-just-movie-review-challenge-conservatives-climate (accessed November 22, 2016).

[34] David B. Goldstein, *Saving Energy, Growing Jobs: How Environmental Protection Promotes Economic Growth, Profitability, Innovation, and Competition*. (Point Richmond, California: Bay Tree Publishing, 2007.)

means of achievement were beyond the ability of anyone to predict. Occasionally this happens without even trying, such as the creation of mass markets in portable internet-connected computers that work even in remote villages. Sometimes it comes about because leadership asks its staff for the impossible and they deliver: the Toyota Prius or the iPhone for example.

> *If we learned tomorrow that there would be dire consequences of warming beyond 1.5 degree, we would solve the problem because there was no choice.*

Some may argue that such ambitious proposals are unrealistic. But this is a circular argument: If the public and their representatives believe that meeting climate goals is important, they would certainly adopt the needed policies. And if they realized that meeting climate goals is the most effective program of middle-class economic development we know how to implement, rather than being a constraint on growth or jobs, we make much more progress. The problem is that these policies have seldom been persuasively laid out before the American public and shown to be technically and economically feasible and beneficial. This essay aims to demonstrate the need for and benefits of these policies.

The practice of setting performance goals is fundamental to how American business has worked for generations. While we talk in theory about companies maximizing profits, the *way* they do it typically is by setting goals—sales increases, cost reductions, production levels, etc. Adding a climate goal to the mix, especially if it can be company-specific and integrated into management procedures such as is done in Strategic Energy Management (SEM), can itself be a key part of the solution.

Perhaps the strongest example of this in American history is World War II. The bombing of Pearl Harbor came at a time when the U.S. was utterly unprepared to fight a war. Yet starting the very next morning, President Roosevelt committed the nation to fighting and winning the war. This fight disrupted the lives of millions and involved the government essentially taking over large industries such as automobile production and rationing civilian use of gasoline. Limiting climate change will be nowhere near as disruptive but the fact that we could prepare for war and wage battles on and across oceans in just 2½ years shows that we can change our economy quickly when we realize the importance of doing so.

A global perspective

Much of the world is still mired in poverty. There is an argument that emissions must grow in order to provide a middle-class lifestyle to citizens who are now poor. But this argument is based on the false assumption that energy use must grow in proportion to income. In fact, the contrary has been shown to be true in the U.S. and other developed countries. If richer countries are to reduce emissions, requiring even greater reductions in per-capita emissions, the level of energy that an aspiring middle class African must reach is much lower than

conventional wisdom suggests.[35] Already we are seeing high-end buildings being built at little or no extra cost that consume zero net energy. If we can do this for office workers in Seattle and wealthy homeowners in Austria we assuredly can do it for formerly poor families in Africa or India or China.

When we look at industrial energy in other countries, we should recall that it is consumed mainly to produce products that serve consumer needs: housing, shopping, schools, etc. In fast-urbanizing China, over 20% of industrial energy goes to provide materials such as concrete, glass, and steel to the home and commercial buildings sector. As China's population stabilizes, the need for new construction will drop dramatically. These emissions reductions will occur automatically, even without policy action, but they are not accounted for in most 2-degree scenarios.

The process can be enhanced by making choices to reduce supply chain energy[36] as part of SEM efforts. These are global efforts: Indeed, the U.S. is not the farthest along in implementing the International Standards for SEM.[37] Developing countries can reduce emissions by using cleaner fuels, more efficient (and thus more productive and competitive) industrial processes and operating protocols, and by making design choices that rely on less emissions-intensive materials. Developed countries, either acting as national or regional governments or through major business organizations that purchase the materials they manufacture, can help them do this.

We also must note the globalization of business and its consequences on other countries if the United States meets an advanced emissions reduction goal. Most energy-using products are sold into global markets: air conditioners, motors, pumps, fans, light bulbs, TVs, etc. Efficiency in one country tends to spread globally, reducing the difficulty of making different products for different regions. In any given country, many buildings are owned by real estate firms with properties around the world; good experience with deep retrofits or zero-net energy buildings in one country will tend to spread to others.

One of the biggest problems faced by many developing countries is weak rule of law: the government may try to require efficient products and clean energy sources, but the government may be too weak to assure that requirements are implemented. Some of this may be overcome as global markets harmonize on more efficient and cleaner products. Many countries have non-governmental organizations that work to strengthen rule of law, or to implement standards and policies in collaboration with government. The climate imperative may add to their success, especially

[35] Conventional wisdom asserts that if an American or European middle class household accounts for 100 units of emissions, then an aspiring middle class household in Africa might need 25 or 50. But if the rich country households can use advanced efficiency to get by with only 20 or less, then the need to accommodate middle class development goals has far lower consequences on emissions.

[36] "Adding Energy Savings in the Supply Chain." Pierre Delforge, David B. Goldstein. Proceedings of the 2015 ACEEE Summer Study on Energy Efficiency in Industry. Washington, D.C.: American Council for an Energy-Efficient Economy, 2015. Summarized in David B. Goldstein, "Saving Energy in the Supply Chain," August 24, 2015, NRDC, https://www.nrdc.org/experts/david-b-goldstein/saving-energy-supply-chain (accessed Nov. 22, 2016).

[37] International Organization for Standardization, "ISO 50001: Energy management systems," 2011, ISO, http://www.iso.org/iso/iso_50001_energy.pdf (accessed Nov. 22, 2016).

as less-developed countries recognize that their people and prospects will suffer disproportionately from climate change as some are already doing.

Closing Observations

Suppose we learned tomorrow that there were previously unsuspected and dire consequences of warming beyond 1.5 degrees. We would solve the problem because there was no choice, by whatever lawful means necessary, even if the measures were draconian. Fortunately, the actions needed are not that severe. If we simply take action soon we will have more time and can encourage more moderate measures through the use more of carrots than sticks.

Can we really limit climate change to 1.5 degrees? The real answer to this question has three parts:

1. If we DON'T set a goal this ambitious, we surely WON'T meet it because we won't have allocated the budgets needed to meet it.
2. If we DO set the goal, we just might meet it. It is technically possible. And where we have tried to meet ambitious goals with serious policies, we have succeeded. At worst, we may find that some of the final pieces are too expensive or will not be done for political reasons, so we delay them. Or we might find alternative emission savings that we hadn't planned for.
3. If we DON'T meet the goal, we will come far closer to it than had we not set the goal.

Let's make climate change a focus of American global leadership and renewed patriotic commitment—a commitment that brings the world together to focus on constructive competition for mutual benefit. We can meet the most ambitious climate goals in a way that strengthens our country and any other country that does so, in ways that offer economic opportunity to everyone, including those left behind in the last 45 years. In the process, we will be leaving our children and grandchildren a more secure, prosperous, sustainable, and equitable world. ■

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