Why Climate Policy needs long-term Deep Decarbonization Pathways

Working Paper

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Summary:
Long-term Deep Decarbonization Pathways, as developed under the Deep Decarbonization Pathway Project (DDPP, www.deepdecarbonization.org) are an essential tool for climate policy and the design of shorter-term climate strategies, such as the Intended Nationally-Determined Contributions (INDCs). Without such pathways it is impossible to know whether a country is moving towards deep decarbonization by 2050 to around 1.7tCO2 per capita in energy-related emissions or whether it is heading towards a "dead-end" from which it will be difficult to reduce emissions further after 2030. In addition to providing a framework for ensuring that short-term action is consistent with long-term emission reduction objectives, Deep Decarbonization Pathways (i) build a shared understanding of the three pillars of deep decarbonization (energy efficiency, low-carbon electricity generation, electrification of end uses and switch to low-carbon fuels); (ii) identify improvements in energy technologies needed to achieve deep decarbonization; (iii) identify investment needs and financing strategies; (iv) provide a shared framework for cumulative problem solving in each country; and (v) ensure transparency, build trust, and promote shared problem solving among countries. We propose four preliminary tests that INDCs need to meet in order to be consistent with 2°C in addition to reductions in headline emissions, as considered by the UNEP Gap Report 2015. First, every INDC must be based on a long-term pathway for deep decarbonization aiming to reduce net emissions to zero by 2070. Second, strategies need to fully address the three pillars of deep decarbonization with the DDPP reports providing valuable insights on technology benchmarks. Third, INDCs must include a strategy for accelerating the development and diffusion of low-emission energy technologies. And finally, national processes of developing and revising INDCs have to be consistent with long-term deep decarbonization. An international climate agreement consistent with 2°C should invite every country to prepare and make available a Deep Decarbonization Pathway by 2018 at the latest.

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As the COP21 begins in Paris, the 175+ submissions of Intended Nationally-Determined Contributions (INDCs) indicate a clear shift towards decarbonization. Almost every major economy now recognizes the need to reduce greenhouse gas (GHG) emissions by 2030. This is welcome news for COP21, which aims to produce an international agreement that limits global warming to less than 2°C above pre-industrial levels throughout the 21st century, as the signatories agreed in 2010.[2]

It is possible to limit the rise in global temperatures to less than 2°C, but the policy discussion often fails to appreciate the complexities and the scale of decarbonization this will require. To stay within the IPCC (AR5) carbon budget for 2°C, average energy-related per capita emissions of greenhouse gases need to fall from some 6.4tCO_2 today to around 1.7tCO_2 in 2050 and zero by 2070. With the world economy expected to grow 3-4 fold by 2050 this will require emissions per unit of world GDP to fall by a factor of 11-15 over the same period. This scale of emission reduction can only be achieved if every country's energy system undergoes a profound transformation between now and mid-century. We refer to this transformation as "deep decarbonization" – others use terms like "low-emission development pathways".

The INDCs aim to bend the emission curve downward to stay below the 2°C limit, yet they fall short in two serious ways. First, as demonstrated in the recent UNEP Emission Gap Report (Figure 1 on next page), the level of ambition through to 2030 is too low for a 2°C pathway. Second and less widely appreciated, INDCs consider emission reductions only through to 2030. Since every conventional power plant built over the next ten years will operate for some 30-40 years, its emissions need to be factored into projected emissions by 2050. A timeframe to 2030 is therefore much too short to ensure consistency with deep decarbonization by 2050 and zero emissions by around 2070.

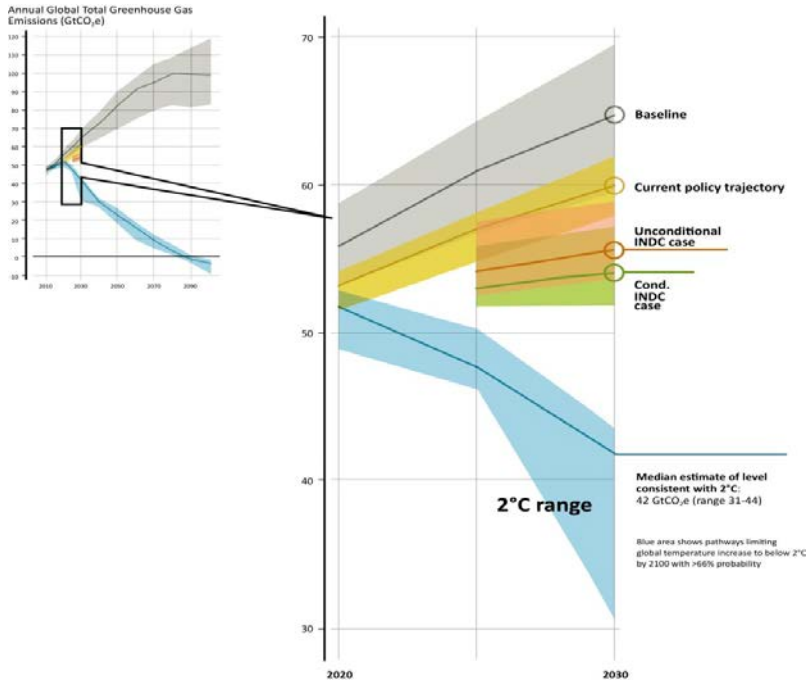
The need for long-term pathways for deep decarbonization

Consider as an illustration two alternative strategies for 2030 for a typical high-income country that should reduce net energy-related emissions from perhaps 10tCO2 per person in 2015 to around 1.7tCO2 in 2050, and zero in 2070 (Figure 2 on next page). Assume that both strategies aim for the same 2030 emission target of a one-third reduction of per capita emissions relative to 2015, as suggested by the IPCC emission ranges presented in the UNEP Emission Gap Report.

If policymaking focuses only on a 2030 target, then this target can be achieved by modest, relatively low-cost changes: replacing coal-fired power plants with natural gas and doubling average gasoline efficiency in automobiles. This could form the basis for an INDC announcing a one-third reduction of per capita emissions by 2030.

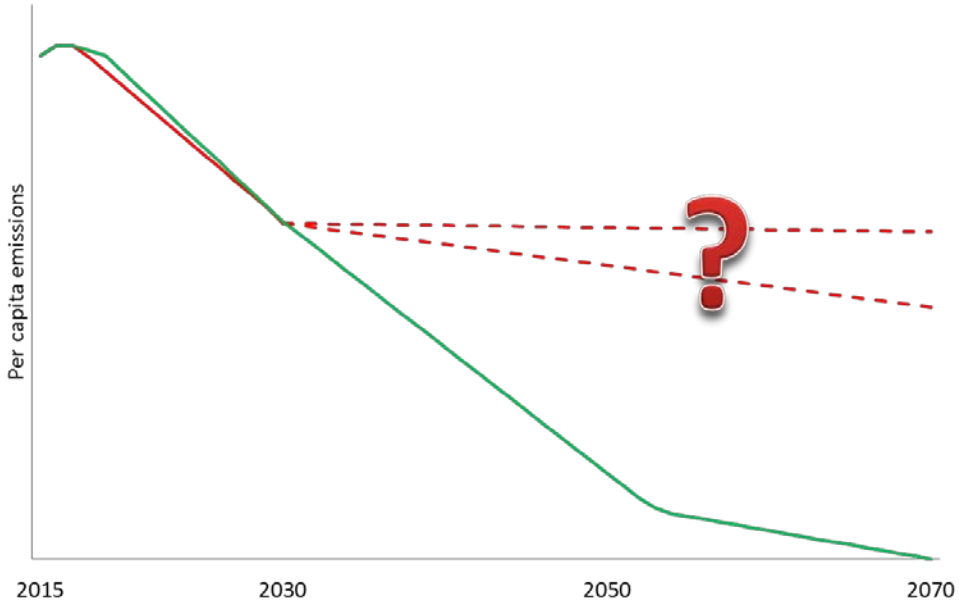
[2] Many scientists argue that even the 2°C limit may well prove dangerous for humanity, including the possibility of several-meter rise in sea level due to the loss of parts of the Antarctic and Greenland ice sheets.

Figure 1: INDCs are not yet consistent with 2°C upper limit



Source: UNEP Emissions Gap Report 2015

Figure 2: Illustrative emission-reduction pathways for hypothetical INDCs aiming for the same 2030 target: INDC based on Deep Decarbonization Pathway (green) and conventional INDC (red)



Source: Authors' analysis

Based on the headline reduction in per capita emissions generated under such an INDC, the strategy could be considered "consistent with 2°C", but in reality its emission reductions would be an effective dead end: once they have been achieved, the economy remains stuck with gas-fired power plants and a vehicle fleet with internal combustion engines, leaving insufficient prospects for reaching deep decarbonization by 2050. Such a strategy, albeit low cost to 2030, does not prepare the economy for the post-2030 transformation to deep decarbonization.

Compare this with an INDC based on a Deep Decarbonization Pathway that is consistent with net-zero emissions by 2070. Such a strategy for 2030 would use very different approaches, e.g. retiring a fraction of the coal-fired power plants and replacing them with zero-carbon power generation (e.g. through wind or solar), and replacing the aging vehicle fleet with new all-electric vehicles that charge on the clean power grid. Such an INDC would need to consider a deep transformation to zero-carbon electricity generation and vehicles with zero tailpipe emissions, as well as deep changes in virtually every other sector. It will take time and might provide a one-third reduction by 2030, though it could conceivably result in higher emissions over the short-term compared with a strategy focusing only on low-hanging fruits. An INDC based on a long-term pathway does, however, leave open the path to deep decarbonization by 2050 and zero net emissions by 2070. Through to 2030 this strategy might be more expensive than the previous, but it will be much less expensive in order to arrive at deep decarbonization by 2050.

The Deep Decarbonization Pathway Project

In 2013 the UN Sustainable Development Solutions Network (SDSN) and the Institute for Sustainable Development and International Relations (IDDRI) launched the Deep Decarbonization Pathways Project (DDPP, www.deepdecarbonization.org) involving leading research institutions from 16 of the world's largest emitters of greenhouse gases. The project has issued a second set of national Deep Decarbonization Pathways for energy systems[3] that in aggregate are consistent with 2°C. They are summarized in the 2015 DDPP Synthesis Report.

The DDPP focuses on the technical and technological challenges of long-term deep decarbonization, which is defined as moving towards a global average of 1.7tCO_2 per capita by mid-century. The project does not propose country emission targets by mid-century, but it concludes that emission-reduction technologies that are available today or are likely to become available in coming decades do not permit net-negative emissions in any large country by mid-century. If no large country can be significantly below the global average, then arithmetic requires that no large country be far above the average if the world is to stay within the 2°C limit. For this reason 1.7tCO_2 by 2050 is a useful benchmark for deep decarbonization in all major greenhouse gas emitters. It does require high-emitting countries, such as Australia, Canada, and the US to reduce per capita emissions much faster than others. Poorer countries will require technical and financial support to achieve deep decarbonization by mid-century.

The DDPP shows that deep decarbonization consistent with 2°C is feasible, but pathways prepared to 2050 would look very different from pathways prepared only to 2030 that make incremental changes to the energy system. Moreover, current technologies can sustain the 2°C upper limit but they will need

[3] Most national pathways under the project do not consider greenhouse gas emissions from land-use change in any detail. This important gap will need to be closed in future work.

significant improvements in performance in order to do so at low cost. Therefore, a COP21 agreement should put in place policies and financing to speed improvements in low-carbon energy technologies.

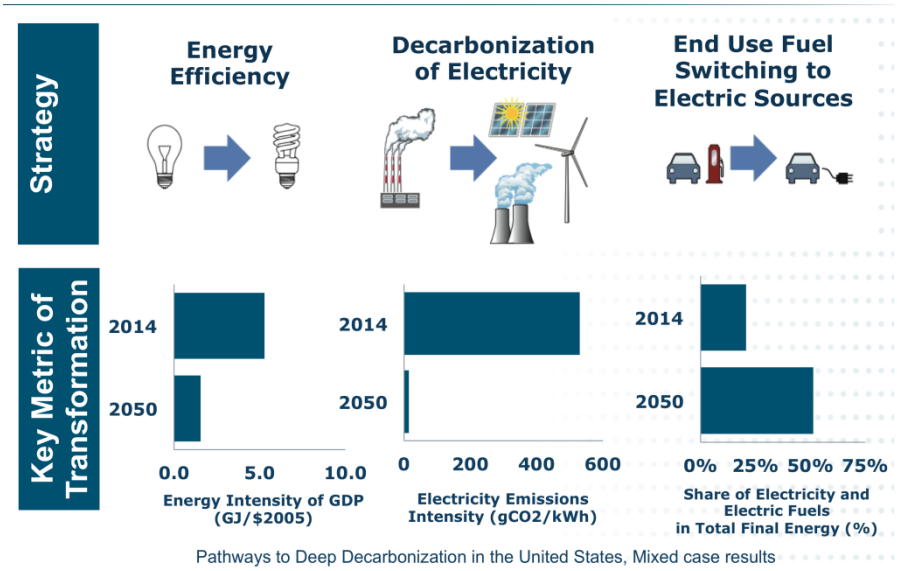
Deep Decarbonization Pathways as a method for national and international problem solving

Deep Decarbonization Pathways are key tools for national climate policy as well as a method of international problem solving. We see six major contributions emerging from long-term pathways, including the ones developed under the DDPP:

1. **Provide a framework for ensuring that short-term action is consistent with long-term emission reduction objectives:** Without long-term pathways it is impossible to know whether a country is on track towards deep decarbonization or whether it might be heading for an emissions "dead end". INDC and short-term policy measures need to be nested in long-term pathways so that action taken till 2030 indeed marks the beginning of the path towards deep decarbonization by mid-century. Long-term pathways are of course uncertain and will need to undergo continuous revision as we learn how to achieve deep decarbonization, but they do – at any point in time – summarize a country's best understanding of its options for how deep decarbonization can be achieved and what steps must be taken now to make this possible.

2. **Build a shared understanding of the three pillars of deep decarbonization:** The national Deep Decarbonization Pathways developed by the DDPP country teams vary in terms of technology choices, investments, and policies that are reflective of national circumstances and choices. Yet, all are underpinned by the same three pillars of deep decarbonization: (i) high levels of energy efficiency; (ii) nearly complete decarbonization of power generation; and (iii) switching end-use equipment, such as vehicles or space heating, to electricity where feasible and otherwise to lower-emission fuels (Figure 3). To achieve deep decarbonization, every country needs to pursue all three pillars simultaneously.

Figure 3: Three pillars of deep decarbonization (illustrated for the case of the United States)

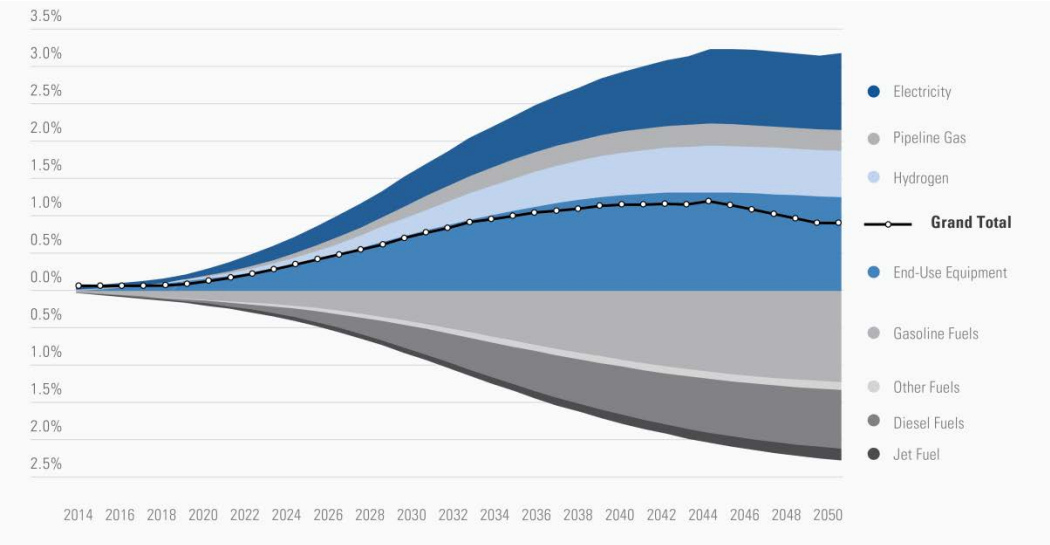


Source: 2014 US Deep Decarbonization Pathway Report.

3. **Put focus on low-emission technology development:** A central finding of the DDPP is that the pace of development and diffusion of low-emission technologies must pick up significantly if the world is to stay within the 2°C limit. The country pathways provide transparent technology benchmarks – such as minimum penetration rates of zero-tailpipe emission light-duty vehicles and the carbon intensity of electricity from newly constructed power plants – that must be met over time to respect the world's carbon budget for 2°C. The Deep Decarbonization Pathways therefore will help governments and businesses to adopt effective strategies of technology development and diffusion.

4. **Identify investment needs and financing strategies for deep decarbonization:** Available Deep Decarbonization Pathways quantify investment needs and provide a basis for understanding how they can be financed. For the US, for example (Figure 4), net costs are estimated to peak at around 1% of GDP per year during the 2030s. For low-income countries, pathways spell out the long-term support required in terms of financing and technology access to make deep decarbonization possible.

Figure 4: Net energy system costs of deep decarbonization in the United States (%GDP)



Source: 2015 Synthesis Report of the DDPP

5. **Provide a shared framework for cumulative problem solving in every country:** Transparent national deep decarbonization pathways provide a framework for engaging all key stakeholders – governments (national and subnational), business (e.g. power utilities, infrastructure companies, car manufacturers, finance and insurance companies), civil society, and the scientific community around the practical questions of deep decarbonization. The process of developing pathways allows all stakeholders an opportunity to review, pose questions, and suggests improvements that may lower the cost, improve the feasibility, and increase the buy-in of deep decarbonization in the country. This is indeed how California has succeeded in building broad support for its commitment to reduce greenhouse gas emissions by over 80 percent by 2050.

6. **Ensure transparency, build trust, and promote joint problem-solving among countries:** Deep Decarbonization Pathways are also a method for problem solving at the international level that

fills a critical gap in the current policy dialogue. By focusing on long-term emission reduction objectives they remove some of the short-term political excuses that prevent action and bedevil the climate negotiations. The absence of a long-term pathway in a country demonstrates plainly to everyone that this country is not serious about deep decarbonization. As the world learns how to undertake deep decarbonization, national pathways can be compared and updated – providing a continuous and fair ratchet mechanism for international climate action.

What INDCs might look like if based on Deep Decarbonization Pathways

The work of the DDPP shows that strategies through to 2030 that are not nested in a long-term Deep Decarbonization Pathway to 2050 are likely to be inconsistent with deep decarbonization even if they reach acceptable numerical emission targets for 2030. Analyses that consider only headline emission reductions by 2030 and extrapolate them to mid-century cannot ascertain whether a national strategy (such as an INDC) opens a pathway to deep decarbonization or whether it leads into a dead end.

If, however, INDCs were based on long-term Deep Decarbonization Pathways they would need to consider at least four dimensions:

1. **Nest the INDC in a long-term emission reduction pathway.** Unless national strategies are informed by a long-term pathway – at least to mid-century – it is impossible to tell whether the INDC is consistent with 2°C. On average, countries will need to converge on energy-related emissions of about 1.7tCO_2 per capita by 2050.

2. **Address all three pillars of deep decarbonization.** Only if country strategies include aggressive action in all three pillars is it possible to transform energy systems to achieve deep decarbonization by mid-century. Key dimensions for each pillar might include the following:

    - Energy efficiency: E.g. inventory and project energy efficiency improvement for all building stock (residential and commercial), transport modes (light-duty vehicles, heavy-duty freight, rail, shipping, aviation), and major industrial sectors (cement, steel, aluminum); mandate energy efficiency standards for all these applications that are consistent with international best practice; and propose mid- to long-term energy efficiency benchmarks that must be met across the demand and supply side.

    - Decarbonization of power generation: E.g. project maximum emission standards and other technology benchmarks for new power plants built over the coming decades; project a schedule for phasing-out high-emission technologies, such as coal-fired power plants that are not equipped with carbon capture and storage; and underpin the INDC by a detailed modeling of the country's power grid to understand how rising shares of renewable power and changes on the demand side can be accommodated.

    - Electrification and fuel switching: E.g. lay out a strategy for promoting zero-emission transport technologies, such as electric vehicles; propose building standards for shifting towards zero-carbon space heating in existing and newly constructed buildings; and integrate strategies for the electrification of end uses and low-carbon power generation to generate emission reductions that are greater than the sum of the parts.

These issues cover only a subset of the technical and policy questions that INDCs need to provide answers to. The 16 Deep Decarbonization Pathways published under the DDPP explore these issues in much greater detail.

3. **Include a strategy for low-emission technology development and diffusion.** Since the pace of low-carbon technology development must accelerate substantially, all INDCs – particularly from industrialized countries with strong national innovation systems – must spell out how the development and diffusion of new technologies can be accelerated over time with regards to renewables (e.g. wind, solar, geothermal), carbon capture and storage (CCS), energy efficiency, electric and fuel cell vehicle technologies, biofuels, smart grids, advanced nuclear power, etc. To this end we must learn from the success stories where low-carbon technologies, such as solar and wind, have moved quickly from R&D to large-scale diffusion, and the resulting production volumes have led to sustained reductions in costs.

4. **Ensure the national process of developing and revising the INDC is consistent with deep decarbonization.** To be effective INDCs must guide national policymaking across a broad range of sectors that traditionally do not coordinate closely, such as electricity and transportation; assign clear responsibilities for implementation and monitoring to the competent public authorities; mobilize actions by private investors and the business community; and – critically – enjoy widespread support among the public. To generate the required buy-in from all stakeholders it is critical that the INDCs be reviewed, discussed, and revised by relevant parts of government, business and civil society.

Agreement on Deep Decarbonization Pathways at COP21

At COP21 governments should agree that all countries prepare and make available Deep Decarbonization Pathways in conjunction with their INDCs. These pathways could be submitted, for example, by 2018 or even earlier in some cases. They would not be legally binding, but merely indicative of country strategies towards deep decarbonization by mid-century.

The US and China, the two largest emitting countries, have recently signaled their interest in such an approach. On 25 September 2015 U.S. President Barack Obama and Chinese President Xi Jinping made the following statement:

> *Further, the United States and China underscore the importance of formulating and making available mid-century strategies for the transition to low-carbon economies, mindful of the below 2 degree C global temperature goal. Both sides also emphasize the importance of global low-carbon transformation during the course of this century. (Paragraph 6)*

More than 40 other heads of state gathered at the UN General Assembly in September joined this call for emission reduction pathways till mid-century, which has also been reflected in the recent France-China Joint Presidential Statement and other declarations by heads of states. This growing consensus augurs well for including Deep Decarbonization Pathways in the final agreement at COP21 and for ensuring that shorter-term climate policies become aligned with long-term goals.