Catalyzing Transformative Pathways to Decarbonization

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DRAFT (AND A VERY DRAFTY ONE AT THAT) – PLEASE DO NOT CITE WITHOUT PERMISSION

You're telling me what you need. I'm telling you what we have to work with at this point.

- Scene from *Apollo 13* (1995)—engineer speaking to an astronaut in the simulator

Ultimately solving climate change, or at least avoiding its most serious consequences, requires a widespread transformation in the world's economic, energy, and transportation systems away from fossil fuels. Put simply, we are currently locked in to carbon-based systems (Unruh 2000) and we need to disrupt that lock-in and build pathways to decarbonization. In the parlance of the epigram, this is what we *need*. The key questions, then, are what do we have to work with and how can we mold what we have to work with into pathways to decarbonization?

Traditionally, we turn to mega-multilateral treaty-making (Hoffmann 2011) for problems like climate change that have a global scope and require international cooperation. Unfortunately, the UN negotiating process over climate change has thus far faced insurmountable political obstacles and has failed to deliver an effective global response (see e.g. Victor 2011; Depledge 2006; Dimitrov 2002). Observers of that process know very well the obstacles that it faces and the reasons why there have been repeated failures. Since the early 1990s, neither the core set of interests around the bargaining table (which include North-North, North-South, and South-South cleavages) nor the structure of the negotiations themselves (universal negotiations aimed toward a legally binding agreement on emissions reductions) have changed in any substantial way.[1] Without a shift in the distribution of interests around the bargaining table and/or a change in the structure of the negotiations[2] (both relatively unlikely scenarios in the near term), achieving an effective multilateral solution that drives us towards decarbonization is likely to remain a significant challenge.[3]

Other factors and processes that we might think we have to work with to build pathways to decarbonization are also either relatively unlikely or entirely undesirable. A global social movement could emerge, rise up, and demand change. A breakthrough technology could alter the perceptions of costs of addressing climate change. The world could suffer one or more climate catastrophes that galvanize interests in acting quickly, overcoming the entrenched cleavages currently hamstringing the negotiations and moves towards

[1] The Copenhagen Accord of 2009, with its pledge and review approach to emissions reductions (rather than a common reduction target) is a slightly different approach, but in Durbin (2011) and Doha (2012), the international community appeared to move back to the central emissions target goal of earlier negotiations. Susan Sell's (1996) article examining the mix of interests in the climate regime is still relevant today precisely because the mix of interests have not changed.

[2] This is a baseline condition—obviously a change in interests around the table would go a long way to breaking the deadlock, but the distributional concerns at the heart of the North-South debates would also need to be addressed. Many of these concerns can be traced to a general lack of ambition amongst major players (e.g. US, China, Russia, Japan, Canada, India) so altering that baseline might also contribute to overcoming distributional debates.

[3] The necessity and desireability of such a governance model are open for debate (Hoffmann 2011; Prins and Rayner 2007)

transformation more generally. These are all possible futures, but none of them is available now to generate decarbonization pathways.

Fortunately, there are options. One thing *we have to work with* is an expanding universe of globally decentralized interventions. We are awash in multi-level (transnational, national, subnational, municipal, private), decentralized, often experimental, initiatives (e.g. Ostrom 2010; Hoffmann 2011; Bulkeley et al 2014; Andonova et al 2009; Rabe 2004; 2008; Selin and VanDeveer 2005) acting on climate change.[4] These range from international initiatives like the EU Emissions Trading System and the Clean Energy Ministerial, to national programs to pursue renewable energy (Germany and Denmark are two key examples), to subnational efforts at developing carbon markets and cities networking transnationally, to NGO-corporate alliances like The Climate Group, and to even very localized efforts in individual cities and communities.[5]

Conceiving of climate governance as a *collection* of globally decentralized interventions is a substantially different perspective than the dominant focus on multilateral treaty-making. It is just as global a perspective as multilateral climate governance, it is just global in a very different way. There are multiple actors and diverse rule-making practices as opposed to set actors (states) and an established, singular means of making rules (multilateral treaty negotiations). This is a perspective that climate change is a simultaneously global and local problem where negotiating emissions reductions is not the sole focus. The collection of globally decentralized interventions are, instead, pursuing multiple goals—changing infrastructure, promoting renewables, developing the green economy, emissions trading and carbon markets (as ends in themselves), and revolutionizing IT infrastructure—in specific places. The Climate Group is working to get LED lighting to be the norm for large municipalities across the world. Denmark aims to be fossil fuel free by 2035. The Voluntary Carbon Standard is working to improve the measurement and accounting of carbon offset credits. The C40 group of large cities is working on developing building standards and electric public transportation fleets.

How do we get to what we need (decarbonization) from what we have to work with (diverse interventions)? Can we? While there is an emerging body of scholarship that examines the origins of the polycentric, or experimental, or multilevel climate governance and seeks to understand the structure of it, less work has been dedicated to impact and pathways towards decarbonization.[6] We need to turn our attention to understanding if and how globally decentralized initiatives can contribute to decarbonization on broad scales—

[4] The regime complexes (Keohane and Victor 2010; Green 2013), new architecture (Aldy et al 2003) and governance fragmentation (Biermann et al 2011; Zelli 2010) literatures examine another thing we may have to work with—innovation/fragmentation at the multilateral level itself. Work in this area observes how climate governance has transitioned from a relatively unified process centered on the UN Framework Convention on Climate Change to a disjointed process that now includes multiple intergovernmental and non-governmental actors. In the very least different modes of multilateral governance are being envisioned.
[5] For more on the emergence and diversity of these interventions see Hoffmann 2011; Bulkeley et al 2014.
[6] The recent "Pathways to Decarbonization" project headed up by Jeffrey Sachs is both an exception to this, but also highlights the problem. Rather than conceptualizing pathways, that project conceptualizes endpoints with too little thought given to the conditions that make those endpoints possible or plausible.

how they can be catalytic of pathways to decarbonization. The socio-technical transitions and economics literatures have addressed transformation in technical and economic systems away from carbon lock-in, but to date both of these literatures have tended to neglect the political dynamics that make change possible. Decarbonization is a political challenge and we need to develop analytic frameworks that can help us to grasp and conceptualize political pathways to decarbonization.

This paper is a preliminary attempt to take up this challenge.[7] It begins by sketching out the nature of the challenge developing the argument that carbon lock-in is a fractal phenomenon—it is similar at multiple scales. This makes decarbonization a super-wicked problem (Levin et al 2009), but it also provides opportunities because we can study decarbonization efforts in specific places and understand how those decentralized efforts can potentially have broader consequences. The subsequent section introduces the analytic framework for conceptualizing pathways to decarbonization. A key aspect of getting from what we have to work with (globally decentralized interventions) to what we need is the scaling up and out of these interventions.[8] We need to understand how interventions grow and how they spread and/or catalyze change beyond their boundaries. The analytic framework both conceptualizes different classes of scaling dynamics and conceives of them as the observable result of three mechanisms of political transformation—normalization, capacity building, and coalition building. The fourth section offers a brief example of how the framework works to apprehend potential decarbonization pathways both internal to the intervention and on broader scales. We conclude with a discussion of the ongoing research agenda that seeks to both understand and conceptualize practical pathways to decarbonization.

Carbon Lock-in as a Fractal Phenomenon and Political Problem

Decarbonization is, in many ways, unlike any challenge that humanity has faced consciously and collectively. Whether it is described as wicked, super-wicked (Levin et al) or even diabolical (Steffen 2012), it is clear that moving away from fossil fuels is a complex, almost unbelievably difficult problem precisely because decarbonization ultimately requires a widespread transformation in the world's economic, energy, and transportation systems.

The challenge is disrupting, overcoming, and replacing carbon lock-in (Unruh 2000). This is not solely a technical challenge, or an economic challenge, or a social/cultural challenge, or a political challenge. Carbon lock-in results from the interplay of all of these domains and what we face are interlocking dynamics that all serve to make fossil fuel use the dominant and taken for granted default politically, economically, culturally, and technically. The carbon lock-in system is so difficult to disrupt precisely because there are so many

[7] This paper is drawn from a collaborative research project with Steven Bernstein, Michele Betsill, Matthew Paterson, Johannes Stripple, Harriet Bulkeley, Simon Pulver, Graeme Auld, Ben Cashore, and Kelly Levin. This paper also forms part of a larger framework paper that is also being co-authored with Steven Bernstein.
[8] A second key condition for catalyzing transformation is way interventions become entrenched in political and policy processes. Scaling is thus a necessary, but not sufficient, condition for developing transformative trajectories.

reinforcing dynamics that keep it stable. Take, for instance, driving cars fueled with gasoline (see Paterson 2007 on automobility). This is a default behavior in much of North America (and increasingly elsewhere) that is reinforced technically (significant road and fueling infrastructure), economically (entire industries dedicated to the development, manufacture, and sale of cars, car parts, fuel, experiences, and ancillary equipment), culturally (the growth and value of suburbia and the mythos of freedom associated with automobility), and politically (very few politicians win elections by building fewer roads or restricting the use of cars). And this is just one subset of one type of larger system (transportation) that will need to be disrupted on a large scale if we are to move to decarbonization.[9]

Conceptualizing pathways to decarbonization thus begins with the realization that carbon lock-in is not a single system that needs disruption. On the contrary, the carbon 'system' that we experience is the result of multiple, interlocking systems that exist at multiple levels. It is a fractal system. To be sure our global energy, transportation, and economic systems are locked-in to carbon, but that is because transportation, energy, and economic systems at the municipal, provincial, state, and regional level are locked-in to carbon. The canonical characteristic of fractal systems is self-similarity. From whatever scale the system is observed, the system looks the same. Carbon lock-in is fractal in just this way—carbon lock-in has similar reinforcing dynamics no matter what size of system (city, state, nation, global) one observes, and, further, those multiple systems reinforce one another.[10]

The end goal of avoiding the worst aspects of climate change is *global* decarbonization, but there is no global system to take direct action upon. Instead, there are multiple, interlocking systems that need decarbonization. This is both a challenge and an opportunity. Obviously, it is more complex to address a problem that is everywhere, and problems that are everywhere tend to be nowhere. However, because of the interlocking nature of the system, decarbonization anywhere, even at relatively small-scales, has the potential to catalyze decarbonization at broader levels. We have a dual challenge then. We must conceptualize how initiatives attempt to disrupt carbon lock-in in particular places and how those activities could come to catalyze disruption in broader systems.

We argue that politics and political dynamics are the lynchpin for conceptualizing the disruption of carbon lock-in (in particular places and more broadly) and fostering pathways to decarbonization. Clearly disrupting carbon lock-in and catalyzing decarbonization entails multiple changes in multiple processes (technological, economic, political, social) at multiple levels (local, regional, national, transnational, global) so ultimately understanding and achieving decarbonization will require pooling, integrating, and deploying knowledge from across multiple disciplines. Currently there is simply not enough intellectual effort on decarbonization and such efforts that do exist tend to be

[9] And this is even a relatively easy one because electric vehicles (assuming non-fossil fuel sources of electricity) could largely replace fossil fuel consuming cars with relatively modest changes in the supportive systems discussed above.

[10] Obviously we are using fractal metaphorically here. We have not modeled carbon lock-in or measured it to see if it conforms mathematically to the definition of a fractal system.

relatively siloed. The two most prominent perspectives are from the economics and socio-technical transitions literatures.

The economics literature, unsurprisingly, focuses on getting the prices and incentives right. The focus here has been on economic analysis and forecasting of the costs of decarbonization under different technological and policy scenarios. Essentially they start with the outcome (decarbonization) and then test the cost effectiveness of different pre-conceived solutions (e.g. Jagemann et al 2013; Shinnar 2012). The most significant and recent example may be the Jeffrey Sachs-led "Pathways to Deep Decarbonization" project that examines policy mixes for a number of states that could lead to decarbonization by 2050 (Pathways 2014). These are valuable analyses that provide a window on possible policy choices moving forward.

The literature on socio-technical transitions has examined the emergence and diffusion of specific new sustainable technologies (e.g. Geels 2002; Geels et al 2004; Meadowcroft 2007; 2009; 2011; Jordan 2009) both historically and currently. Much of this literature takes seriously the idea that socio-technical transitions involve interacting processes at multiple levels (landscape, regime, technological niche), which fits nicely with our understanding of climate governance as a multilevel phenomenon (Geels 2002). Further, the transitions management literature focuses on the role of government in steering the transitions process (Rotmans et al 2001). However, the transitions literature often focuses on single technologies or single political jurisdictions (e.g. Negro et al 2007; Vanderlaak et al 2007; Foxon et al 2010; Albrecht 2007).

A key missing factor in both the economic and socio-technical literatures is politics. A number of scholars have also highlighted its frequent omission of political variables from the transitions literature and why such variables matter for obtaining a more thorough understanding of technical transitions (Meadowcroft 2007; 2009; 2011; Shove 2010; Shove and Walker 2007; Jordan 2009). Whereas the transitions literature thus provides crucial insights on mechanisms of transition, it tends to underplay the complex role of politics and policy in constructing, altering, and ultimately transforming path dependencies, too often relying on untheorized exogenous shocks (e.g., an energy crisis or sudden, unexplained, massive policy shift) to explain change (Unruh 2006). In many cases this literature describes the steps that a technical transition might go through and provides historical descriptions of how transitions took place, but does not provide enough analysis of the political conditions that make transitions possible and shape how transitions unfold.

The economics literature focuses on outcomes to the detriment of understanding processes. There is not enough of the agency and activity in their accounts that we know must take place to catalyze pathways to decarbonization. It is a cliché, but nonetheless true that decarbonization is a journey not a destination. It is not even a defined end state beyond the banal and obvious vanishing use of fossil fuels. Decarbonization as a process could take almost any number of forms and the forms that it does take will be heavily influenced by political dynamics.

A number of interventions are under way that at least rhetorically aim for decarbonization. We need the conceptual apparatus to apprehend how they are developing and to what effect so that we can understand and even improve both the pathways that are developing and those that have not yet started. We contend that these pathways are fundamentally, though not solely, political. If we want to understand and facilitate transitions away from fossil fuels we have to go beyond disruptive technologies and beyond pricing dynamics and economic analysis of possible scenarios. These factors are important, but it is politics that makes transitions go and we need better political models for how that can take place. This is the task to which we now turn.

Conceptualizing Pathways to Decarbonization

For simplicity's sake we consider that any system (municipal, provincial, corporate, national, regional, global) moving forward in time can move towards a state of reinforced carbon lock-in, improved carbon lock-in (more efficient use of fossil fuels), or transformation (decarbonization). What we observe empirically is the emergence of a diverse array of interventions that seek to change the trajectory of the systems they are a part of. These include experimental interventions like C40 and its various projects, carbon labeling efforts, The Climate Group's smart 2020 project, and municipal carbon market pilot projects in China (Hoffmann 2011; Bulkeley et al 2014; Bulkeley and Broto 2012) as well as more traditional policy interventions like Colorado's new energy economy, the Danish policy to be fossil fuel free by 2035, and the new power plant regulations in the US. It even includes multilateral interventions like the Clean Energy Ministerial and the failed Asian Pacific Partnership.[11]

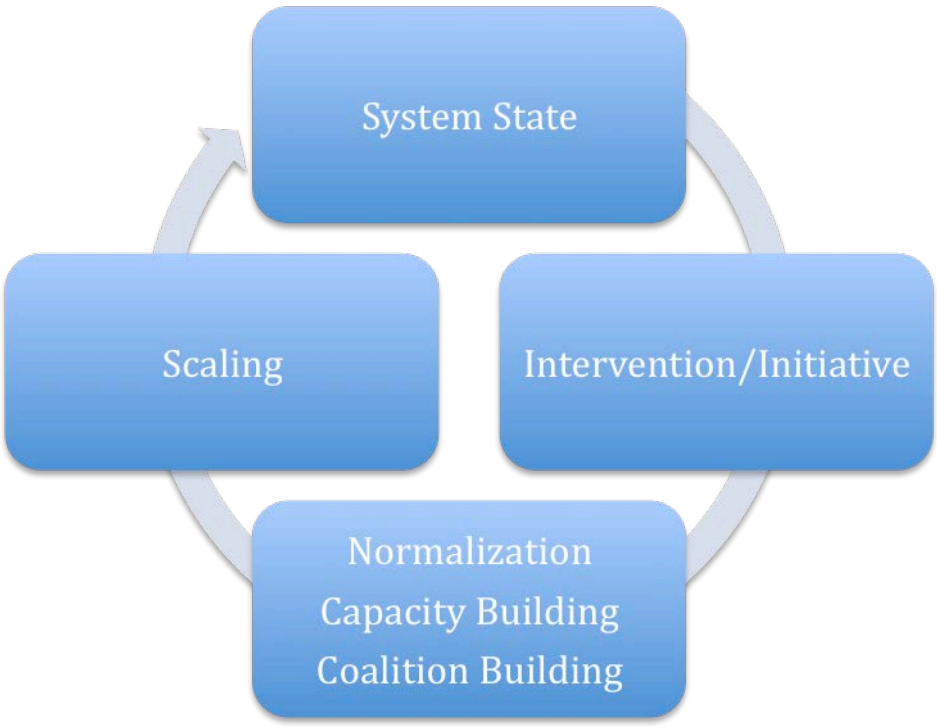
Our framework must be able to make sense of and explain the political trajectories that these diverse initiatives are on internally *and* whether and how they can catalyze broader trajectories towards decarbonization. Doing so requires two analytic developments—conceptualizing scaling and the political mechanisms that give rise to it. Figure one provides a visual representation of the framework. In any system we examine, it has an initial state of carbon lock-in—a specific socio-economic-political configuration. An intervention is a conscious attempt to disrupt the current system state (a new policy, a new municipal climate action plan, deployment of a new technology, etc). The intervention then has the potential to create and contribute to transformative political mechanisms of normalization, capacity building, and coalition building. These mechanisms help to determine if the intervention will scale up (grow larger) altering the system state and moving it towards reinforcement of carbon lock-in, improvement of carbon lock-in, or decarbonization.[12] This process also works externally, however, and the transformative political mechanisms can also contribute to how the intervention scales out (spreads) altering different or broader systems. So Figure one can be read as both an internal and

[11] With this conceptualization even the UNFCCC process would just be another intervention—at the global scale.

[12] As discussed below, the content or substance of the intervention will play a significant role in what direction the system moves as will opposition to the dynamics that the intervention engenders.

external cycle and the rest of this section provides more conceptual detail on the transformative mechanisms and scaling.

Figure 1 – Decarbonization Pathway



Transformative Political Mechanisms

There is no shortage of ideas to draw upon when thinking about how globally decentralized interventions could catalyze broader transformation. Particularly salient for this paper, however, is the rich literature that specifically looks at diffusion or influence across political scales and jurisdictions.[13] Studies on the horizontal and vertical diffusion of subnational policies with the US (e.g. Rabe 2004; 2008; Graham, Shipan, and Volden 2006) have explained scaling up of local policies in many issue areas. A host of good work in this "laboratories of democracy" vein have examined how national policy (environmental or otherwise) in the U.S. bubbles up from innovations that take place subnationally in state capitols (Osborne 1990; Rabe 2004; 2008) through learning and coalition building. The salience of the state of California in these processes has even spawned a literature on the "California effect" whereby California sprints out ahead, teaching states and the federal government what is possible and catalyzing economic coalitions that push for national

[13] There is also significant literature on the general diffusion of innovations/policies and socio-technical systems (See e.g. Rotmans and Loorbach 2009; Bergek et al 2008) that we draw upon more tangentially for this discussion.

regulation to avoid having to deal with multiple sets of regulation. Wapner's (1996) complementary examination of the spread of ecological sensibility, provides an additional ideational mechanism for change generated by civil society. Normative change alters foundational understanding of interests in environmental protection and action.

Two specific works synthesize a great deal of these various mechanisms into specific pathways for non-state and subnational influence on state policy and interests. Bernstein and Cashore (2000) suggest that non-state actors seeking influence on national policy-making 1) exploit market dependencies, 2) pursue leverage to be found in international rules, 3) seek to alter (international) normative foundations of national policy, and 4) use direct access to domestic policy making to teach states how environmental protection can be done. Working on a similar problem, Selin and VanDeveer (2005) suggest that subnational initiatives like the climate plan adopted by New England governors can have influence through 1) demonstration effects, 2) policy learning, 3) market expansion, and 4) altering norms.

Looking across the literature, work coalesces around three general mechanisms of transformation—three types of mechanisms that interventions contribute to that could lead to scaling up and out. Interventions could contribute to norm change or the normalization of aggressive action on climate change, altering the underlying perspective through which climate policy/positions are viewed. They could enhance the capacity of actors to take aggressive action on climate change, thus lowering the barriers to a shift in policies/practices. They could catalyze the growth of coalitions of actors that want to see a shift in policies/practices.[14]

Normalization

Many analysts who seek to understand shifts in state policies and interests consider norm change to be a key ingredient. The logic, at the heart of constructivist approaches to politics, is relatively simple. Underlying ideas about appropriate actions constitute actors' interests and shape the kind of actions and bargaining positions that states consider to be necessary and plausible. As Selin and VanDeveer (2005: 371-372; see also Bernstein and Cashore 2000: 81-83) argue:

> If policy advocates succeed in generating a political and public expectation that GHG emissions should decline over time then policies and behaviors that further reduce GHG may be judged "better" and more appropriate than those that engender increases.

Constructivists have developed a number of ways that norm change can be brought about and while a full review of this literature is beyond the scope of this paper, two mechanisms

[14] Separating out these mechanisms is an analytic convenience. In reality, they interact—sometimes producing synergies (i.e. increasing normalization could alter coalition structures) and other times perhaps working at cross-purposes (i.e. if states learn to do certain kinds of climate practices from one set of interventions that do not mesh with the coalitions that other kinds of interventions generate).

are particularly salient. First, entrepreneurs can propose and advocate for new ways to look at the world and act on problems like climate change catalyzing norm change (Finnemore and Sikkink 1998). For instance, by framing climate change in different ways, entrepreneurs working from climate governance experiments can work to alter the perception of climate action from a question of whether to act to a question of how to act. Second, the build up of everyday action on climate change—practices —can shift how we perceive the necessity and appropriateness of climate action. As Vincent Pouliot (2011) argues, what people "do determines what they think." The practices that interventions entail can shape how society at large, and thus states understand climate change and their interests in taking aggressive action.

Climate governance interventions contribute to both of these mechanisms of norm change with the goal of normalizing aggressive action on climate change. Many extant interventions, and especially experimental initiatives (Hoffmann 2011) are, by their very nature, entrepreneurial efforts (whether consciously understood as such or not). Multiple cities, states, provinces, corporations, and environmental NGOs are not waiting for international negotiations to solve the problem, but are instead taking climate change actions themselves. Advocating not just for aggressive action, but also a different kind of climate response (as mentioned above).

Interventions are also working on developing new practices of climate response that could alter the commonsense around climate change in particular communities and more broadly. A key example of this comes from the Carbon Disclosure Project. This climate governance experiment, in part, advocates for companies to account for and disclose their carbon emissions and exposure to climate risk. In a recent report, CDP (https://www.cdp.net/CDPResults/companies-carbon-pricing-2013.pdf) highlighted how a number of heavy industry hitters are now including shadow carbon prices in their financial planning. Corporations like GE, Google, Microsoft, and even Exxon are assuming that there will be a carbon price in the future and are including the cost of carbon in their business planning. This kind of practice, treating climate action and a carbon price as inevitable, normalizes potential moves towards decarbonization in the corporate community. Similarly, transnational city networks like ICELEI's Cities for Climate Protection (Betsill and Bulkeley 2004) and the C40 group of large cities seek to normalize urban response to climate change, in some ways making climate action more directly visible and normal to people in their everyday lives (transportation options, energy distribution options, city planning rules, building codes).

The logic of norm change as a transformative mechanism is that broader policy change will follow changes in the commonsense that surrounds an issue. This is why Europe is far ahead of North America on national climate policies—there is underlying agreement that aggressive climate policy is normal. This normalcy shapes what decision-makers think is possible and appropriate. Climate interventions have the potential to normalize a more aggressive underlying understanding of the need for action.

Capacity Building

The second transformative mechanism is related to the practice path of normalization and sees change arising from an alteration of what actors do. In other words, if interventions can teach about how to act on climate change, this will potentially alter the way the development of climate policies, corporate practices, and even multilateral negotiations. Bernstein and Cashore (2000: 83-85) explicitly note how transnational actors can "infiltrate" domestic policy-making processes and, under certain conditions, use their knowledge and resources to effect change. Selin and VanDeveer (2005) discuss how this can occur via subnational initiatives when they provide demonstration effects and act as policy learning vehicles for states.

Climate governance interventions are engaged (again both consciously and unconsciously) with both demonstration effects and policy learning—both within individual systems and across systems. For instance, regional emissions trading systems in North America (Regional Greenhouse Gas Initiative (RGGI) in the northeast US and the Western Climate Initiative (WCI) in California, British Columbia, and Quebec) developed processes by which they learned from each other and attempted to coordinate their action on the role of carbon offsetting (Three Regions Offsets Working Group 2010). Standard setters that create the rules for making carbon offsets a legitimate commodity (Verified Carbon Standard, American Carbon Registry, The Climate Registry) share information on their methodologies and cross verify offset projects.

This learning through capacity building can move across scales as well. When the US Congress was considering legislation for a federal cap and trade system it used ideas and mechanisms that had been developed in the regional cap and trade systems to design the ill-fated national cap and trade program. In fact, part of the original motivation for RGGI and the Chicago Climate Exchange was expressly to demonstrate how cap and trade could work to make it easier for national politicians to move forward. Further, when the US EPA devised mandatory reporting standards for carbon dioxide, it used ideas developed by the Carbon Registry, learning how to regulate carbon accounting by turning to an experiment that was already doing so.

Coalition Building

Finally, interventions can potentially spur the emergence and strengthening of economic and political coalitions that back strong climate action. Climate governance interventions can catalyze coalitions by creating friction that alters how actors make political and economic calculations. This entails empowering actors who have an interest in climate change, building constituencies, and utilizing larger market forces. The last of these has garnered the most attention in the literature and is a well understood dynamic in environmental politics. Wapner (1996) described how transnational environmental activist groups could 'govern' environmental problems by exploiting economic networks. By targeting high-profile companies (i.e. McDonald's and its styrofoam packaging and Star-Kist with its dolphin-unsafe tuna) and getting them to change their behavior, NGOs are able to set into motion coalitions that alter supply chains and push for regulations at broader jurisdictional levels that institutionalize their practices. The push for and politics of environmental standard setting follows this same logic (Bernstein and Cashore 2007;

Dauvergne 2008; Tollefson et al 2008). By changing the nature and sustainability of supply chains, efforts like the FSC and various fair trade, organic, and other standards create coalitions committed to transformation in production that has the potential to alter national policy-making (Dauvergne and Lister 2013).

Of course leveraging market dynamics can be a fraught and is far from simple process (Dauvergne and Lister 2013; Bernstein and Cashore 2007). However, a number of climate governance interventions seek to do precisely this. The Investor Network on Climate Risk and Climate Wise both target the financial and insurance industries to get sustainable principles ingrained into investment decisions. These interventions work at a particular node (capital investment) in economic networks to try and leverage transformation.

Other interventions build markets from the ground up, engaging in what Selin and VanDeveer (2005) call market expansion strategies. The development of voluntary carbon markets is a quintessential example of this dynamic. Climate registries or disclosure initiatives (the Climate Registry, the Carbon Disclosure Project) and offset standard setters (the Climate Action Reserve, the American Climate Registry) are crucial parts of the infrastructure necessary for carbon markets and emissions trading systems to function. A whole ecosystem of climate governance interventions has emerged that enables actors to measure, account for, offset, and trade emissions. These activities have the potential to do is expand the number of actors who see an interest in national climate policy and global climate agreements. Interventions can generates new winners (and losers) and create new possibilities for heretofore unheard of partnerships (like environmentalists and high finance that back emissions trading policies). The friction that interventions generate can produce political advocacy that alters how multiple levels of politics take up climate policy.

Scaling Up and Out

One of the observable implications of interventions contributing to transformative mechanisms is that interventions scale up and out and we contend that scaling is a necessary condition for an intervention to contribute to pathways to decarbonization.[15] When interventions are successful in contributing to normalization, capacity building, and/or coalition there is the possibility of achieving scaling internally and externally.[16] Recall that Figure 1 can be used to trace a double cycle—one internal to the locus of the experiment and one that is broader. For example the City of Copenhagen has an ambitious plan to become carbon neutral by 2025. The activities associated with achieving this goal can contribute to transformation mechanisms within the city and beyond the city. Take the

[15] Entrenchment is another necessary condition as is favorable content (i.e. there are some interventions that may never catalyze decarbonization because the substance of what the intervention does cannot produce that kind of outcome).

[16] Determining the conditions for 'successul' contribution to transformative mechanisms is clearly a crucial concern and it is one being pursued in ongoing empirical research. As discussed below, this framework provides a way to make sense of the potential catalytic impact of an intervention and to inform an understanding of the trajectories that interventions are on and create. It may not be possible to define, a priori (or even inductively) all the boundary conditions that link the transformative mechanisms, scaling, and decarbonization.

building retrofit pilot projects that are being developed. Internally to Copenhagen, these measures can contribute to normalizing a new level of energy efficiency in buildings in Copenhagen, to increasing the capacity of construction companies in Copenhagen to build in a green manner (and city officials to develop policies on energy efficiency that work), and to building coalitions that support further energy efficiency measures (both citizens and building companies) if they generate benefits. The experiment can thus generate internal momentum towards decarbonization in Copenhagen and for further experimental activity. Externally, the pursuit of carbon neutrality in Copenhagen can normalize ideas about municipal sustainability through the spreading of best practices in city networks (Copenhagen is a leader in C40), build capacity of companies working not only in Copenhagen, but globally, and build coalitions that seek continued ambition at the national level in Denmark.

Scaling is thus not a simple result and can occur in multiple scales and pathways. Very simply, scaling up is the key for interventions to succeed within their own boundaries (geographic or otherwise). They need to grow in order to reach their goals and to become entrenched. The City of Copenhagen needs to move from pilot projects to full scale implementation of its programs if the intervention of pursuing carbon neutrality by 2025 is to succeed. The C40 group of large cities needs to expand its activities and membership if it is to succeed in transforming urban sustainability in the world's most populous cities. Scaling out occurs when intervention contributes to normalization, capacity building and coalition building outside their boundaries.

Scaling up and scaling out can be more precisely discussed as three categories of outcomes:

- **Simple Scaling** Individual interventions grow larger within their original boundaries or beyond.
- **Self-organized Scaling** Intervention begets intervention as the activities of extant initiatives open up niches or political/economic/technological spaces that other emerge to fill.
- **Modular/Isomorphic Scaling** Similar types of interventions multiply as either the model of an interventional is copied elsewhere (modular)[17] or similar, but unrelated, interventions emerge in new areas (isomorphic).

<u>Simple Scaling</u>

Most basically, climate governance interventions that contribute to normalization, capacity building and coalition building can grow. This is what is classically considered scaling up—initiatives start small and then grow. Growth, in this conception, can be in terms of size and/or range of activities.

The growth imperative is as evident in climate governance interventions as in any other kind of organization. Over time one way of conceiving of success for climate governance

[17] We want to thank and acknowledge Hamish van der Ven (2014) for coining the term modular scaling and discussing how it is different than simple scaling.

interventions is that they grow—they attract more members and resources, they expand their geographic scope, they begin to undertake different types of activities. This has clearly been the case for a number of climate governance experiments. The C40 Cities Climate Leadership Group began as the C20, an ironic homage to the G20. Not only has the C40 Cities Climate Leadership Group grown larger, many would argue that it has also grown stronger—learning and demonstration effects within the network have enabled C40 cities to take the lead on climate change in a number of ways (Gordon 2013).

Another example is Carbon Disclosure Project, an initiative that works to get corporations to disclose their climate change risk so that institutional investors will take this information into account. In 2003 it had 35 members (investor signators) with $4.5 trillion in assets (Kolk, Levy, and Pinske 2008: 724). By 2007 these numbers had grown to 385 investor members worth $40 trillion (ibid). Today, CDP boasts 722 members with $87 trillion in assets (https://www.cdproject.net/en-US/Pages/About-Us.aspx). Ten years has seen a 20 fold increase in membership numbers and assets covered.

Self-organized Scaling

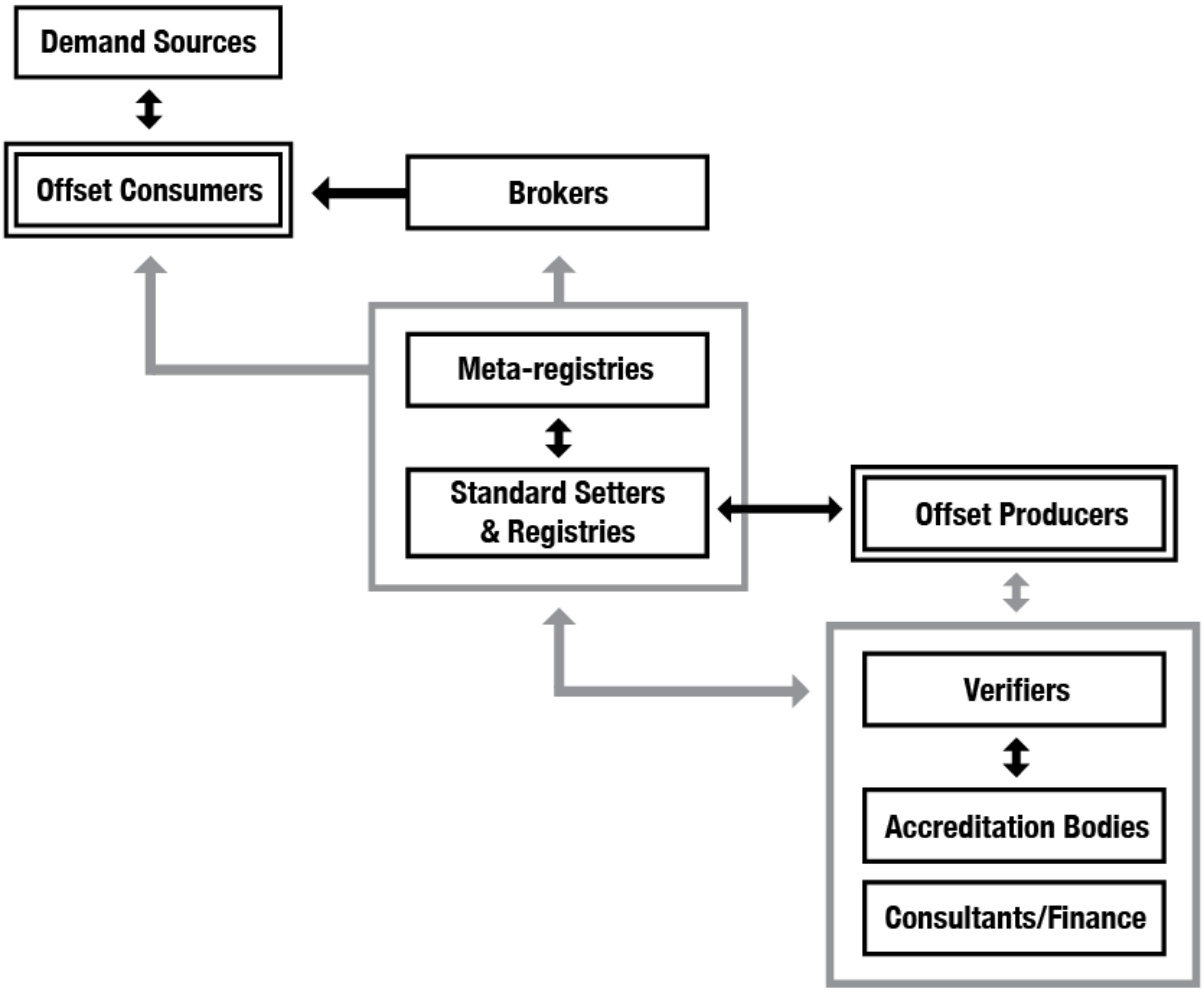
Scaling up through growth in individual interventions is occurring in some areas, but this relatively simple kind of linear expansion is not the only kind of observable scaling. Ecosystems of interventions can also emerge and expand because interventions open up political and economic space for further activty. Intervention begets intervention in important ways.

Experimental climate governance systems (Hoffmann 2011) are self-organized in the sense that structure and patterns have emerged in this system without their being centralized direction setting up the system. An important characteristic of self-organized systems is that they are, for lack of a better word, clumpy. Rather than being randomly distributed or independent, components of self-organized systems will group together, "clustering around points of energy" or creating a "basin of attraction" around a particular function or activity (Comfort 1994: 397). Without external design, we see "different components perform[ing] different functions simultaneously" in the experimental system, a hallmark of self-organization (ibid: 397).

This kind of clustering effect facilitates self-organized scaling and has the potential to engender increasing returns to interventions—a dynamic whereby adding interventions reduces the barriers to further experimentation and actually encourages the expansion of complementary activity. Clustering produces new niches that additional interventions can fill and it opens up opportunities for cooperation and competition that produces more interventions. The voluntary carbon market is a quintessential example of this effect. Once carbon offsets producers emerged (a particular kind of climate governance experiment like CarbonFix) this opened up room for additional experimentation to make the market work—offset and carbon credit registries, carbon standard-setters, carbon accounting. The entire voluntary carbon market is an ecosystem of climate governance interventions, each of whose functions (and existence really) are made relevant by the functioning of others

(See Figure 2). Each box in the figure is populated by initiatives that emerged to fill a niche created by other initiatives.

Figure 2 – Ecosystem of Voluntary Carbon Markets



Source: Hoffmann 2011

Cisco's recent experience with the Connected Urban Development program[18] is another example of the self-organized scaling effect. Cisco experimented with introducing pilot ICT projects in a few cities to demonstrate how they could reduce emissions and produce economic and other co-benefits for municipalities. This experiment opened up the possibility for expansion through cooperation with The Climate Group. Getting The Climate Group's larger network of cities involved in order to expand the pilot projects and make the demand case for their smart grid technology. In both of these instances, the effect of clustering around a particular substantive issue (carbon offsets and technology

[18] www.theclimategroup.org/our-news/news/2009/9/28/cisco-and-the-climate-group-to-develop-new-connected-urban-development-alliance/.

implementation in cities) produced increasing returns to experimentation and expansion of the experimental ecosystem. The substantive clusters that have already emerged in the experimental system provide specific sites of interaction that draw experimental activity and are the specific areas where experiments actually function and work to respond to climate change. The result of clustering is the opening of functional and political space for additional experimentation.

Modular and Isomorphic Scaling

Scaling can also take place when similar models emerge in multiple contexts (DiMaggio and Powell 1983). When this is conscious borrowing of ideas developed in a particular intervention we have modular scaling. This looks like some classic versions of diffusion (e.g. Graham, Shipan, and Volden 2012; Busch and Jorgens 2005) or what Dimaggio and Powell (1983) call mimetic scaling. When similar models emerge independently we have isomorphic scaling—similar innovations arises in different places because organizations face similar constraints. In practice, these two means of scaling up are rarely mutually exclusive, and in both cases, the result is more of the same type of activity being done in more places.

Two key examples of this are the proliferation of transnational city networks (Betsill and Bulkeley 2004) and regional emissions trading systems (Betsill and Hoffmann 2011; Paterson et al 2014). City networks, experiments that bring municipalities together to work on climate change at the local level, have emerged in large numbers in the last decade and their numbers continue to grow as city networks are now emerging in China. Regional emissions trading systems have also proliferated. In the aftermath of the collapse of a Kyoto Protocol-centered global trading system, multiple carbon markets have been considered, designed, and implemented in Europe (the EU ETS which incorporated the experience of markets developed in the UK, Denmark, and Norway), North America (three regional systems were considered while the Western Climate Initiative and Regional Greenhouse Gas Initiative are functioning markets—the Chicago Climate Exchange was a functioning carbon market for firms as well), and beyond. Australia and Japan were also early designers and markets are being developed in Russia and China as well (Paterson et al 2014).

Forward Theorizing

This framework is an attempt to build a conceptual framework that makes sense of the trajectories and catalytic potential of individual interventions. It provides a way to conceive of the political dynamics that unfold over time after an intervention emerges and is a way to conceptualize paths forward whereby disruption of one aspect of a larger interlocking fractal system can potentially catalyze broader transformation. It is not a theory of decarbonization that specifies the conditions under which normalization, capacity building, and coalition building engender scaling up and out, or the conditions under which scaled up interventions lead to decarbonization outcomes.

A fully theory of decarbonization pathways is not currently possible because we have no (or only limited) cases of decarbonization. What we have to study are diverse cases of interventions that that aim to disrupt various aspects of carbon lock-in in particular systems. This framework is a recipe for decarbonization, but rather a conceptual approach that provides a way to organize analysis of diverse cases so that we can learn about how the politics of decarbonization function.

Bringing the Framework to Life

The strategy for bringing this forward looking theorizing to life is to analyze a relatively large set of diverse initiatives in a long-term research project (25-30 over the six years of the project—we're in year two). The interventions vary in scale (level of political activity of the initial intervention), scope (the kind of disruption that the intervention seeks), and trajectory (where the intervention is in time). Thus far we are engaged in cases on:

- IISD's campaign to get rid of fossil fuel subsidies
- C40's electric vehicle network project
- Copenhagen's municipal climate action plan
- Denmark's national climate action plan
- The Carbon Trust's carbon labeling initiative
- The Climate Group's Smart 2020 project
- The Clean Energy Ministerial
- Colorado's Clean Energy Economy Policy
- Provincial Carbon Market efforts in Canada
- The Germany suite of Renewable Energy Policies

For each case, we analyze the trajectory of the intervention, identifying ways that the intervention contributes to normalization, capacity building, coalition building, and looking for evidence of scaling up and out. Of course, the political of decarbonization are contested politics, so much of the analysis concerns the obstacles to transformation—entrenched interests and coalitions, the capacity to perform practices associated with carbon lock-in, and the common sense around carbon lock-in. In this section we provide two brief vignettes (the Carbon Trust, and the municipal plan in Copenhagen) to show how the conceptual framework can organize and make sense of the trajectory of interventions and what we can learn by viewing interventions through this lens.

The Carbon Trust[19]
This initiative started as a partnership between civil society groups and the UK government. It sought to develop and disseminate product-level carbon labeling standards and so companies would carbon footprint their products and report the results to consumers on the labels. The idea was to move towards decarbonization (or at least improve the efficiency of carbon lock-in) by promoting consumer awareness of the carbon footprint of the products that they bought and therefore generate demand for lower-carbon intensive products.

[19] Draws on van der Ven 2014—who developed this case for our project.

After initial success getting corporations to participate (e.g. Tesco and Pepsi), the Carbon Trust rapidly ran into problems. It turns out that doing product level carbon footprinting is complex and expensive, so the corporate supply of footprinting information was limited and early corporate participation faltered. It also turned out that consumer recognition of the labeling was very low, so the initiative had difficultly generating demand for both the footprinting information and low carbon products.

Initially then, this looks like a case of the internal scaling cycle getting stuck and a failed pathway to decarbonization. The experiment did not scale up rapidly as it failed to normalize the demand for footprinting information amongst consumers and coalitions backing an expanded and required use of product level labeling failed to materialize as corporations backed out of the program. However, the Carbon Trust initiative did build internal capacity to develop methodologies for product-level footprinting and corporate capacity to actually carry out the methodologies. This latter piece would be the key for the modified success of the Carbon Trust initiative in potentially generating pathways to decarbonization.

The external cycle—beyond the Carbon Trust and beyond the UK—was, however, driven by unintended consequences that arose from the initiative. This happened in two ways. First, the capacity building amongst corporations—carrying out footprinting methodologies—began to normalize the idea of product level measurements within corporations. Not to drive consumer demand or even for reputational purposes, but because through the process of carrying out the methodologies, corporations found 'hidden' emissions in their processes and supply chains and further found ways to save money by eliminating them. For instance, a potato chip company found, to its surprise, that its most significant emissions came from the frying of the potato chips themselves. A simple switch from purchasing potatoes on the basis of wet weight (which gave farmers an incentive to supply potatoes with higher water content and made frying times longer) to dry weight saved the company significant energy costs and emissions. This kind of discovery in the process of carrying out the Carbon Trust methodology has contributed to[20] normalizing carbon footprinting beyond the initiative itself scaling out the community of corporate actors who accept this kind of activity.

Second, developing the methodology for product level footprinting within the Carbon Trust, has provided significant capacity building externally. Doing the complex work of setting initial standards and methodologies has made it easier for jurisdictions outside the UK to consider and adopt similar programs. For instance, France, Quebec, Japan, and Korea are all developing product level carbon footprinting standards and policies that explicitly draw on and adapt the original Carbon Trust standards. These standards have also informed the development of transnational methodologies put together by the World Business Commission on Sustainable Development and the International Standards

[20] This is also in line with other supply chain management norms that are developing. See Dauvergne and Lister 2013.

Organization. So external capacity building has contributed to the modular scaling of carbon labeling as this kind of initiative is emerging in multiple jurisdictions.

Whether the modular scaling of this initiative is helping to catalyze a pathway to decarbonization or to improving the efficiency of carbon lock-in is an open question. Dauvergne and Lister (2013) urge caution in pinning hopes for sustainability transitions on this kind of supply chain management and greening of corporate activities. The Carbon Trust initiative is contributing to larger system change around labeling and standard setting around business practices, but the transformative effect of this new normal will depend significantly on whether it stimulates demand for low and non carbon products and in how generating corporate self-interest in paying attention to emissions reductions translates into political coalitions that back actions that go beyond efficiency improvements.

This brief vignette does, however, demonstrate the utility of the framework for making sense of what the Carbon Trust initiative is doing and the possible impacts it might have as well as indicating what needs to be done with the framework to more fully conceptualize pathways to decarbonization. In particular, the role of unintended consequences was very significant. We cannot base our analyses of the trajectories and impact of initiatives solely on what they are explicitly attempting to do, rather we need to trace the impacts, internally and externally, from both intended and unintended consequences. [21]

Copenhagen's Plan to be Carbon Neutral by 2025[22]

In 200X, the city of Copenhagen adopted a goal of carbon neutrality and a plan designed to help them achieve that goal. The plan (the intervention for this case) includes initiatives in energy, buildings, transportation, and public outreach. The city has put into place a process of pre-analysis, pilot/demonstration projects, and city-wide implementation and different parts of the plan are currently in different phases. This intervention is of interest for multiple reasons. It is one of the few interventions of this scale to aim directly for decarbonization. The initiative also has explicit aims at internal scaling and external influence (scaling out), so it offers a way to observe how the transformation mechanisms discussed above connect to scaling dynamics.

If we begin with the internal cycle of the conceptual framework, explicit attempts at normalization are accompanying the municipal plan. The city has outreach plans for both citizens and corporations, selling the idea of a sustainable city and a green economy. Capacity building efforts are even more directly observable. In each sector, capacity building efforts differ, but across sectors, the city of Copenhagen is attempting to develop pilot projects to build capacity for both city actors and corporate actors. For instance, in the building sector, retrofit pilots are being undertaken to learn how to bundle project, map the

[21] We, of course, realize that this makes the development of clear a priori conditions for the development of pathways to decarbonization difficult, if not impossible. It will, however, make the process of analyzing initiatives' trajectories more accurate and useful.

[22] In this brief sketch, we do not analyze the opposition and obstacles to the plan and its implementation. That is part of ongoing research.

city by building types, and increase the experience of construction companies in Copenhagen to build in a green manner (and city officials to develop policies on energy efficiency that work). Coalition building is evident in the development of the Copenhagen Cleantech Cluster which brings together Danish corporations, the city, and universities in partnership to develop the green economy. They are actively developing a new model for Copenhagen's economic foundation and using green growth as a strategy for building public and corporate support for the municipal plan.[23]

Attempts to scale up Copenhagen's municipal efforts (simple scaling and ecosystem scaling) are accompanied by efforts and dynamics that are scaling out (simple scaling beyond Copenhagen and modular scaling) the disruption. There is a conscious outreach effort beyond Copenhagen through the city's engagement with C40. This is contributing to the normalization of the idea of the sustainable city more broadly. As their promotion material says "Copenhagen is unique…large enough for its climate solutions to be interesting in an international context" (Copenhagen 2013). The city is also selling the greening of the Danish and Copenhagen economy internationally. The result is modular scaling as Danish corporations build capacity to act on climate change and then sell that capacity abroad, generating clean teach clusters elsewhere. Recently Copenhagen and New York City announced a C40 facilitated partnership. The Danish cleantech hub in New York will "help New York City capitalize on Danish tech savy…while providing Danish companies access to the New York marketplace" (C40 2014).

The story that is emerging in Copenhagen is thus one of internal scaling of activities also contributing to modular scaling beyond Copenhagen. Again, time will tell as to whether the Copenhagen model is the appropriate one to scale up and out if we want to move towards decarbonization.

Moving Forward

The impact of the myriad climate activities already identified in the literature and their significance for moving beyond multilateral stalemate and the broader global response to climate change are relatively unknown commodities. The temptation is to dismiss this kind of activity as irrelevant—too small to matter (Wiener 2010). Contrary to that position, this paper considers that relatively small scale initiatives may be an effective part of the global response to climate change because of their potential to have catalytic impact on the development of decarbonization pathways.

This is the beginning of the work needed to understand the potential to disrupt carbon lock-in and build new path dependencies. The way forward is both abductive and, frankly, imaginative. The work involves analyzing a large number of cases through this framework in an attempt to understand and uncover the conditions that drive decarbonization trajectories in different directions. In other words it is possible that even if norm change is at least partially achieved, capacity is built, and coalitions are amassed, scaling and transformation is still not forthcoming. The transformation mechanisms discussed above

[23] It is also a strategy for economic development in Copenhagen in general.

will interact with a number of other factors and dynamics that ultimately determine whether we see transformation or not. The strength of counter coalitions, distributional issues, the technological context, and climate events are all likely to play a role.

The work ahead is also imaginative because this paper and research agenda is ultimately less an analysis of what has happened and more an inquiry into what could be. Pathways to decarbonization will need to be developed rather than uncovered. Explaining trajectories towards decarbonization must give way and speak to extrapolating trajectories into an unknown future.

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