

A POLYCENTRIC RESPONSE TO THE CLIMATE CHANGE CHALLENGE RELYING ON CREATIVITY, INNOVATION, AND LEADERSHIP

Job Taminiau & John Byrne

Position Paper Prepared for

UNFCCC COP-21

Paris, France

30 November - 11 December 2015

CENTER FOR ENERGY AND ENVIRONMENTAL POLICY

University of Delaware - 278 Graham Hall - Newark, Delaware 19716

Phone: (302) 831 - 8405

Facsimile: (302) 831 - 3098

Contact: jtam@udel.edu

DOI: 10.13140/RG.2.1.4447.3681

1.0. INTRODUCTION

The continuing upward climb of atmospheric CO₂ symbolizes society's apparent inability to redirect the 'Keeling Curve' despite more than two decades of international negotiation. The global economic crisis only temporarily slowed the global increase in greenhouse gas (GHG) emissions (Peters, et al., 2012) and emissions appear to have resumed their rapid march upwards resembling a 'worst case' scenario (Friedlingstein, et al., 2014). Indeed, atmospheric concentrations of carbon dioxide (CO₂) surpassed the 400 parts per million (ppm) milestone for the first time in 2013 (The Guardian, 2013) and a 400 ppm reality will become the 'new normal' in 2015 (NOAA, 2015). Weiss and Prinn show that global concentrations for all GHGs combined – so, not only carbon dioxide – were *already* at 450 parts per million (ppm) in 2014 (AGAGE, 2014; Weiss & Prinn, 2011). The corollary of this rising concentration is social and natural system structure and function degradation and associated unequal consequences. Moreover, thought experiments of what a substantially warmer world could look like convey dramatic potential consequences (New, Liverman, Schroder, & Anderson, 2011).

For most of the history of the climate change negotiations, proposed decarbonization strategies were formulated by nation states as the authorized representatives of the global community. This led to 'top down' strategy formulations and negotiation (Hare, Stockwell, Flachslan, & Oberthür, 2010). However, the long duration of negotiations without agreement at a sufficient level of stringency signals deep conflicts between and within negotiating nation-state parties. The 2009 Copenhagen collapse can be seen as an intensification of these conflicts (Bodansky, 2010). Recitation of problems like these has led to the characterization of the current

response strategy as insufficient and incapable of meaningful or transformative change (Prins & Rayner, 2007a; Prins & Rayner, 2007b; Leal-Arcas, 2011a; Tollefson, 2011; Victor, 2011). Looking forward to COP-21 and beyond, it is unlikely that a ‘top-down’ strategy can be maintained that focuses on establishing global targets and assigning national targets irrespective of what individual countries put forth (Morgan, Tirpak, Levin, & Dagnet, 2013). The climate diplomacy balance, what one observer calls the ‘New World (dis)Order’ (Roberts, 2011), is likely not there for this objective to materialize later this year.¹

As the negotiations mature into their third decade, a new strategy, first formulated in Copenhagen, has been proposed and will, in all likelihood, represent a key building block of the Paris negotiations this December (Grubb, 2015). This strategy revolves around a national self-determination of capability and ambition, formulated in what is currently called an ‘Intended Nationally Determined Contribution’ (INDC). At the moment, the United Nations Framework Convention on Climate Change’s (UNFCCC) INDC portal lists 140 submissions from Parties around the world.² For instance, the United States INDC puts forth a 26-28% emission reduction below 2005 levels by 2025 and expresses it will deploy “best efforts” to fulfill the full 28%. In light of climate diplomacy realities, this ‘pledge and review’ strategy currently represents the ‘only game in town’ that covers a broad range of Parties, including critical negotiating

¹ This position is shared by others: a Point Carbon (2013) survey of carbon market experts confirms ongoing disillusionment and dissatisfaction with multi-lateral climate negotiations and observes falling confidence in the likelihood that a global agreement along the lines of the top-down target-based approach will be realized. Instead, over a third of survey participants believe the current pledge-and-review architecture will be maintained until after 2020 (Point Carbon, 2013).

² INDCs communicate information on, among others, quantifiable targets and timetables, implementation periods or timeframes, scope and coverage, assumptions and methods, and a normative claim of how the submitting Party considers its INDC to be “fair and ambitious” in light of its national circumstances (Decision 1/CP.20). For a full overview of the INDCs submitted to the UNFCCC, please see:

<http://www4.unfccc.int/submissions/indc/Submission%20Pages/submissions.aspx>

Parties such as the United States, China, India, and Brazil. Indeed, as Grubb stresses, the INDC tool will play a central role in the Paris negotiations: “Do not underestimate their [i.e. INDCs] significance: all countries are expected to submit INDCs that represent a ‘progression’ from their current commitment [...]. This amounts to a significant shift from the original Convention, which placed the emphasis on industrialized country leadership, to a fully global process” (Grubb, 2015, p. 299).

However, it is largely unclear at this point whether the United Nations-based process will be able to amalgamate individual pledge-and-review components into a new strong, legally binding, top-down framework or whether the strategy will continue in its current form as a communication platform to the international community with national strategies providing the content, much of which is beyond international control.³

Impatience with the “painfully slow” process of establishing effective, top-down regimes (Neslen, 2015),⁴ has prompted the research community to ask “must we wait for global agreement?” (e.g., Ostrom, 2010b; Hoffmann, 2011). Such social inquiry has produced an alternative model relying instead on ‘adaptive’ or ‘polycentric’

³ Compliance has been a critical component of multilateral environmental agreements (MEAs), most notably evidenced by Canada’s public statement that it would pursue non-compliance, subsequent ineffective compliance enforcement by the Kyoto Protocol compliance committee, and eventual withdrawal from the Kyoto Protocol by Canada (Murtha, 2009; Oberthür, 2014). Recent, post-Cancun, discussions on the issue appear to have favored facilitative approaches as evidenced by the introduction of the international assessment and review (IAR) and international consultation and analysis (ICA) processes (Oberthür, 2014). Rather than relying on enforcement principles such as negative incentives, these processes rely on facilitative elements such as building transparency producing a “record of the facilitative sharing of views” (Oberthür, 2014).

⁴ Other concerns have also plagued the negotiations. For example, concerns remain about: a) the sustainability performance of negotiation outcomes (such as the ‘Kyoto Protocol’), b) the capability to meet justice demands such as removing the existential threat to the poor and c) the observance of a fairness principle to ensure that those responsible for the problem of global environmental change are the ones to lead the effort. In particular, the retreat by the United States from the negotiations in the early 2000s has plagued the negotiations for the better part of the last decade.

governance (Ostrom, 2010a; Galaz, Crona, Österblom, & Folke, 2012; Ostrom, 2014).⁵ The emerging governance model can be considered 'ecological', seeking to enhance institutional 'fit' with the complexity of Earth's social-ecological systems (Ostrom, 2014). The non-linear, uncertain, and unpredictable character of environmental degradation is thus answered with a dynamic, non-linear, and experimental strategy organized through 'polycentric' networks of creative innovation and leadership (Taminiau, 2015). Indeed, significant experimentation can be observed and one of the better known examples is the promulgation of city strategies (e.g., Broto & Bulkeley, 2013).⁶

This position paper builds the case that the 'polycentric' strategy of ecological governance holds promise and is in need of further development. Reconstructing urban energy economies to fit 'solar city' conceptualizations (Byrne, Taminiau, Kim, Seo, & Lee, 2015b; Byrne, Taminiau, Kurdgelashvili, & Kim, 2015a) is offered as an articulation of polycentric activity capable of offering transformative change.

2.0. EVALUATING PLEDGE AND REVIEW

The 2009 failure of the Copenhagen conference is often positioned as a return to 'realpolitik' where dominant domestic politics and material realities supersede commitments to international treaty-making resulting in an overall collapse of the talks (Carter, Clegg, & Wåhlin, 2011). The 'Copenhagen Accord', the main outcome document that emerged from the talks and constructed by several of the key

⁵ The polycentric model has been developed in the 1960s but has only recently been applied to address global environmental change, particularly climate change (Ostrom, 2014; Taminiau, 2015).

⁶ However, it is important to recognize that experimentation is occurring at all levels of government (see, e.g., Galaz, Crona, Österblom, & Folke, 2012)

negotiating Parties, has since been denounced as a ‘lowest common denominator’ outcome that is seen as inferior to the ultimate objective of a strong and legally binding ‘global deal’ (Falkner, Stephan, & Vogler, 2010; Egenhofer & Georgiev, 2009). Nonetheless, subsequent COP agreements have continually affirmed the importance of many of the elements of the Copenhagen Accord and new processes and mechanisms that align with the Copenhagen perspective on national contexts and national authorship.

In contrast to ‘top-down’ strategies, where international agreements like the Kyoto Protocol are the key measure of success (see Byrne & Taminiau, 2012), the pledge-and-review strategy accepts nationally determined strategies along a fragmented patchwork of submissions – as countries complete their nationally determined objectives, their submission becomes part of the global strategy.⁷ A previous CEEP position paper contrasted the ‘Kyoto era’ framework of action with that of the pledge-and-review approach (see Byrne & Taminiau, 2012; Taminiau & Byrne, 2012). These results are replicated in Table 1, supported by data from Stigson, Buhr, & Roth (2013).

Despite its initial characterization as a ‘lowest common denominator’ strategy, the Copenhagen Accord outlined a potential alternative for long-term shared action. How this will play out, however, remains to be seen. It appears that one possible and perhaps likely articulation of a future agreement is in line with the pledge and review approach and structured around a “dynamic agreement” where domestic mitigations

⁷ The space in which pledge-and-review has been able to move over the past couple of years has been substantiated by the effective dissolution of the Kyoto Protocol. Once touted as the cornerstone of the international climate change effort, the Kyoto Protocol is now essentially considered a remnant of times past as several major negotiating Parties refused to commit to a second commitment period leaving the agreement (even more) incapable of effecting transformative change.

are submitted to the international community and periodically reviewed and, where needed, strengthened (ENB, 2015).

Table 1. Key differences between pledge and review architecture and the Kyoto era objective. Source: Taminiau & Byrne, 2012; Stigson, Buhr, & Roth, 2013.

Component	Kyoto era	Pledge and review
Compromise	Consensus	National considerations only
Rules	According to standards (MRV, etc.)	Flexibility in design
Commitment	Single-component	Multi-component
Conditionality	Conditionality not accepted	Conditionality accepted
Bindingness	Predominantly viewed as binding	Ambiguous
Stringency	Strict division according to capability	Continuum of stringency possible
Spatial focus	Global cap	National cap
Legal character	Predominantly seen as binding	Ambiguous, to be decided

Perhaps the key contribution from pledge and review is higher participation levels. In particular, the strategy has been able to extract commitments from key negotiating Parties that were previously reluctant to issue commitments or to generally participate in the process. A key example of this is the November 12th, 2014, U.S.-China joint announcement on climate change articulating their intention to cooperate bilaterally to advance the mandate of the Durban Platform for Enhanced Action and describing their respective post-2020 actions on climate change (The White House, 2014). The announcement has been hailed as a ‘historic breakthrough’ (Hoye & Yan, 2014).⁸

⁸ This development can be seen in light of the virtue of developing targets in the context of national circumstances as, for instance, China arguably moves forward with climate change mitigation and adaptation not because of carbon control aspirations but rather due to domestic policy priorities of energy security and clean technology market potential (Stigson, Buhr, & Roth, 2013). The consideration of national interests, values, and priorities offers the prospect of embedding climate protection measures in the wider context of sustainable development (Van Der Gaast & Begg, 2012). Considering the developing country perception of the climate policy issue as an inhibitor of overall development

However, similar to early findings that the Copenhagen Accord pledges were insufficient (e.g., Rogelj, et al., 2010), the Climate Action Tracker finds that only four INDCs out of 27 rate as ‘sufficient’ or ‘role model’ (Climate Action Tracker, 2015). All other INDCs rated by the Climate Action Tracker are either found to be ‘medium’ or ‘inadequate’. Effectively, the ‘deep’ (i.e. environmental integrity) versus ‘broad’ (i.e. high participation) tension has, since Copenhagen, consistently been geared towards the ‘broad’ perspective (Grubb, 2015). While ‘coalitions of the willing’ or ‘clubs of ambition’ can now breach least common denominator approaches prevalent in top-down discussions thus raising both urgency and ambition, unwilling nation-states could remain behind (Grubb, de Coninck, & Sagar, 2015). This structurally weak approach could elevate ambition levels as new participants are attracted or are convinced by the performance of others but, as signalled by the INDCs and earlier pledges, is challenged by commitments that fall short. These early indications lead Grubb to warn of a “Lima hangover” (Lima is the COP where the INDCs were introduced) as he believes it will become “plain that the ‘bottom-up’ intentions do not remotely match the ‘top-down’ ambitions” (Grubb, 2015, p. 301).⁹ Indeed, the most recent assessment by the United Nations Environment Program finds a 12-14 GtCO₂eq ‘ambition gap’ in the submitted INDCs (Figure 1).¹⁰

(Najam, Huq, & Sokona, 2003; Ockwell, Haum, Mallet, & Watson, 2010), such a reorientation of climate change action in line with wider objectives and priorities may prove significant.

⁹ Such findings lead some to argue the continued need for a stronger, top-down architecture (Hare, Stockwell, Flachslund, & Oberthür, 2010; Wiener, 2007).

¹⁰ This sustainability failure is compounded by several other limitations currently expressed by pledge and review. For one, unilateral pledges lack a harmonized character as assumptions related to baselines, land-use change, domestic and international offsets differ (Wada, Sano, Akimoto, & Homma, 2012) likely complicating future review. In addition, legitimacy concerns persist as the move away from a common emission reduction target effectively limits interstate influence to the yet-to-be-fleshed-out functioning of multilateral assessment. Also, the unilateral commitments will be domestically binding as they are to be grounded in domestic law but, as such, the international community will have limited

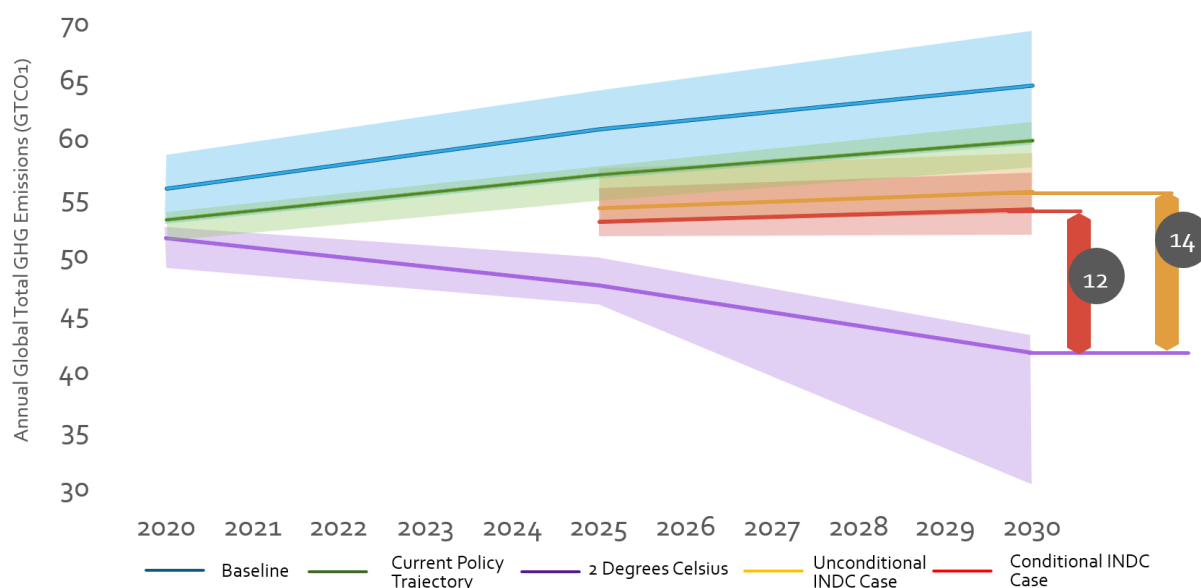


Figure 1. A 12-14 GtCO_{2eq} Emission Gap can be Observed from Submitted INDCs.
Source: UNEP, 2015

Ambition, as such, has become a key term in the international negotiations (Grubb, de Coninck, & Sagar, 2015). The need to do more is compounded by calls for equity and justice. For instance, to incorporate requirements stipulated by historical responsibility and equal cumulative emissions per capita, the U.S. INDC would have to be much more stringent and even push for negative emission (Climate Action Tracker, 2015). This is illustrated in Figure 2: ‘role model’ or ‘sufficient’ ratings would require fundamental reconfiguration of the U.S. economy. This line of argument can

influence. Facilitative processes to assist in the formulation of targets and pathways is one thing, enforcing the implementation of these plans is another. Especially when considered in the light of Canada’s public announcement that it would not comply with the Kyoto Protocol and the limited options for recourse of a top-down agreement (even though the Kyoto Protocol mechanisms are widely seen as having relatively advanced facilitation and enforcement capability (Murtha, 2009; Oberthür, 2014)), the capacity to elicit compliance in a pledge-and-review style approach can be called into question. Similarly, a continuing problem of ‘cherry picking’ can be observed – as evidenced, for instance, by the INDC of the Russian Federation limiting its attention to forest management and receiving an ‘inadequate’ verdict by the Climate Action Tracker – where attention would be directed towards potentially easier building blocks (the proverbial ‘low-hanging fruit’) while more complicated components of climate policy would be postponed. How pledge-and-review is to accelerate action remains a critical open question.

be extended to all parties to the negotiations, even non-Annex I members (Byrne, Kurdgelashvili, & Taminiau, 2012).

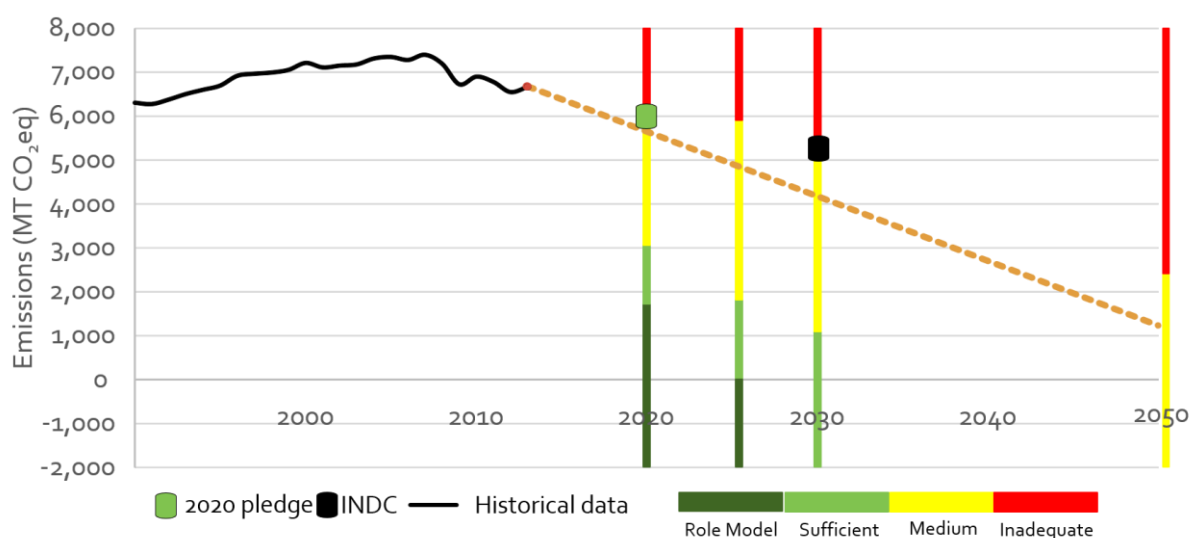


Figure 2 United States INDC Evaluation as per the Climate Action Tracker. It shows that substantially more effort will have to be taken by the United States to be considered 'sufficient' or 'role model' by the Climate Action Tracker method.

3.0. MOVING BEYOND PLEDGE AND REVIEW AND TOWARDS POLYCENTRICITY

The 'Kyoto era' can be characterized as an attempt at uniform and universal action – natural virtues were to be translated into globally fungible units for exchange and stripped from their specific contexts (Newell & Bumpus, 2012, p. 63; Paterson & Stripple, 2012; Paterson, Dryzek, Norgaard, & Schlosberg, 2011). This global character of the approach could be ascribed with 'virtual' emission reductions as counterfactual emission baselines of developing countries were influenced through carbon control measures and counted towards the efforts of developed countries (i.e. Annex I of the Kyoto Protocol) (Byrne & Glover, 2001). As findings by the Intergovernmental Panel on Climate Change (IPCC) demonstrate, however, the world struggles with the notion of absolute emission reductions.

The ‘pledge and review’ approach reintroduces the importance of context and differentiation. However, as discussed in the previous sections, the strategy could have difficulty raising ambition levels of unambitious parties. This difficulty is captured by Grubb et al.: “an effective approach must support those with ambition, not be constrained by those without it” (Grubb, de Coninck, & Sagar, 2015, p. 414). Importantly, the dynamics of pledge and review continue to largely revolve around nation-states and their interests and negotiation positions which are subject to domestic political disagreement and heavy lobbying which fosters delay (e.g., Brulle, 2014). In effect, this observation drives a need to review and retest assumed linkages between a global problem on the one hand and a global solution on the other hand.

Energy poverty, energy justice, and climate justice are intrinsic dimensions of a transition to new energy trajectories (Newell & Mulvaney, 2013). With nation-states neglecting justice implications of energy access and the linkages between climate and energy justice – due to, among others, geopolitical sensitivities, strategic importance associated with energy resources, and prioritization of economic considerations – efforts to advance all three of these dimensions will need to be cognizant of the social context in order to avoid falling in the pit fall of carbon reductionism (Newell & Mulvaney, 2013).

A context-sensitive strategy capable of reducing absolute emission levels is therefore required. As briefly described in the introduction, a separate development in the climate change space is the fragmentation of decision-making authority and legitimacy as new actors experiment with climate change mitigation and adaptation (e.g., Hoffman, 2011). Cities, in particular, have been cited as a prominent actor in the

climate change arena (e.g., Aylett, 2014). A strategy of 'new governance', 'polycentricity', or 'adaptive governance' can be observed to shape perhaps a viable alternative to both pledge and review and Kyoto era style solution-making. New governance strategies depart from the statist focus of the other two strategies and, instead, position the importance of the 'polycentric' network (Ostrom, 2012; Ostrom, 2010). The strategy is characterized by experimentation, local context-based solutions, and reiterative reconfiguration.

Formulated under the rubric of 'new governance' or 'polycentricity' (Ostrom, 2010), efforts implemented by sub-national actors essentially challenge the legitimacy of collective action theory and the singular focus on (inter)state action (Scott & Trubek, 2002). The emergence of hybrid governance structures (Karkainen, 2004) that actively reconfigure and redistribute authority to articulate processes of change (Bulkeley & Betsill, 2013) cause exclusively statist explanations of change to lose ground and highlight that the theory of collective action apparently insufficiently deciphers such processes of change (Ostrom, 2010; Ostrom, 2012). Moving away from traditional conceptualizations of action and governing, the alternative conceptualization finds expression in poly-centric networks of municipal, state, civil society, and transnational action (Ostrom, 2012).

This 'neural' network strategy is motivated by observations of the increased complexity and associated uncertainties with the problem at hand, the irreducible diversity (i.e. the unavailability to uniformity due to the wide range of contexts involved), the realization of the limits of traditional top-down regulation in terms of, among others, legitimacy, and the principle of subsidiarity (Scott & Trubek, 2002). As

authority is dispersed and fragmented away from the singular statist perspective and heterarchical chains of command are formed, this strategy takes on a variety of forms and seeks accountability in the public realm, emphasizes adaptability and flexibility to meet new challenges, and continuously creates new knowledge (Scott & Trubek, 2002, p. 8). As such, a new paradigm of how to formulate and implement climate change mitigation and adaptation could be seen to emerge (van der Heijden, 2013). The polycentric application of climate change action is associated with policy virtues that are often promoted as delivering crucial normative benefits (Ostrom, 2010, 2012; Van der Heijden, 2013):

- *Collaboration*: The collaborative nature of the strategy allows for public and private stakeholders to engage in consensus-oriented decision-making (Ansell & Gash, 2008). By bringing in multiple stakeholders together, including stakeholders that previously faced marginalization or exclusion when action was formulated ‘top-down’, such collaborative governance can be seen as a counterforce to the apparent failure of downstream regulation, the adversarialism of interest groups, and the managerialism by experts as arguably found in the other two strategies of change discussed above (see also Byrne & Taminiau, 2012).
- *Inclusion and power sharing*: related to the previous contribution, the strategy is argued to allow for broader inclusion of stakeholders. Unlike other routes for non-elite participation (e.g., resistance, mobilized social disobedience, formal representation), non-elite citizens can be included in the planning process. Holmes & Scoones (2000, p. 43) offer that a critical contribution of non-elite collaboration in participatory environmental policy processes is “that they bring

into the debate wider questions of ethics and values, linked to debates about rights, justice, and morality". Deliberation, as such, produces a sharing of power and responsibility between elite and non-elite participants (Ansell & Gash, 2008).

- *Experimentalism and knowledge creation:* Hoffmann (2011), in his account on sub-national climate change action, heavily emphasizes the importance and benefits of climate change experimentation. Others follow suit (Castán Broto & Bulkeley, 2013). The strategy is argued to recognize that solution searching is time and space contingent and, as such, the approach should not follow a 'one way street' towards global agreement but rather "demands constant revisability of ends as these are rethought and adjusted or altered in the course of experimentation and mutual learning" (Wilkinson, 2010, p. 679). Public problems, therefore, are approached pragmatically (Karkainen, 2004) and this experimentalism goes beyond simple trial and error as ends are reflexively re-determined. Seeing solutions as a 'step along the way' is argued to enable a flexible and adaptive approach to public problems. Evidence of experimentation and social learning are positioned as critical indicators of such processes of change (Nevens, Frantzeskaki, Gorissen, & Loorbach, 2012; Bos & Brown, 2012; Bos, Brown, & Farrelly, 2013; Hoffman, 2011; Castán Broto & Bulkeley, 2013; Bulkeley & Castán Broto, 2012). Whereas the managerial, commodity-based strategy of top-down negotiations can be argued to have favored *technical* innovation and learning (Byrne & Taminiau, 2012), this new strategy can expand learning towards society-wide *social* learning through such processes (Bos & Brown, 2012, p. 1341).

- *Localism and improved democratic legitimacy*: the strategy champions decentralization, fragmentation, and heterarchy (Wilkinson, 2010). Positioning decision-making closer to the stakeholders experiencing the problem is thought to enhance the quality of the outcome (Adger, Benjaminsen, Brown, & Svarstad, 2001; Plumwood, 2002). The disaggregation of complex global problems into bite-size local chunks leads to a wider diversity of solutions that are fitted to local context and social learning and rigorous peer-review provides transparency which can strengthen accountability (Van der Heijden, 2013). Furthermore, political economy critiques of top-down architectures show that interstate interaction oftentimes leads to the prioritization of interests over values (Eckersley, 2004; Brüttsch, 2012; Newell & Paterson, 1998; MacNeil & Paterson, 2012; Newell & Mulvaney, 2013; Paterson & Strippel, 2012). In contrast, the polycentric strategy can be argued to advance values-based prioritization as, for instance, foreign engagements by metropolitan agents are oftentimes constructed based on a recognition of common values, potentially supported by common interests (Brüttsch, 2012; Engel, 2009). National political economy interests and architectures, as such, could be circumvented through neural network applications of action (Byrne, Wang, Taminiau, & Mach, 2013; Engel, 2009). Indeed, polycentric cooperation along a network of many nodes, supported by the digitization of so many components of day-to-day life and interaction through the internet, breaks the congruence that now exists between sovereignty, nationality, citizenship, and territoriality (Eckersley, 2004, p. 46).

All these characteristics contribute to the perception of new governance as a 'good thing' (Van der Heijden, 2013). Indeed, initial investigations of such action find that this 'neural' network approach undermines empirical support for collective action theory as they only limitedly display expected short-comings such as free-ridership, leakage, and inconsistency (Ostrom, 2012; Poteete, Janssen, & Ostrom, 2010; Okereke & McDaniels, 2012).

4.0. ADVANCING POLYCENTRICITY BY FOCUSING ON INNOVATION, CREATIVITY, AND LEADERSHIP

The dominant concern associated with fragmented action is the prospect of a 'patchwork' of inconsistent initiatives that is unable to realize a significant collective reduction in emissions (Wiener, 2007; Hare, Stockwell, Flachslan, & Oberthür, 2010). The character of allowing a broad range of actors to work independently or together on climate change through polycentric networks is argued to result in a state of chaos (Wiener, 2007; Hare, Stockwell, Flachslan, & Oberthür, 2010). However, while experimentation with such new processes of change is relatively new within the climate change context (Hoffman, 2011; Bulkeley & Castán Broto, 2012) and, as such, it is difficult to determine their exact contribution, sub-national actions have been shown to produce significant impacts (Byrne, Hughes, Rickerson, & Kurdgelashvili, 2007; Carley & Browne, 2012; Rabe, 2006; ARUP, 2014). In addition, local action levels appear to be intensifying (Bulkeley & Betsill, 2013).

Another recurring and similar concern related to neural network action is the issue of 'leakage' (Adelman & Engel, 2008; Wiener, 2007): sub-global regulation efforts could simply lead to the relocation of emission intensive activity towards non-

regulated areas. However, climate change concerns such as carbon control are often tied in with a range of other concerns such as resource scarcity, resilience, security, capitalizing on market potential (Matisoff, 2008), policy entrepreneurship, networking, and other co-benefits (Engel, 2008). Urban resilience, for instance, is degraded on a variety of levels and dimensions by climatic change leading urban resilience improvement strategies to emphasize diversity, flexibility, adaptive governance, and learning and innovation in relation to climate change in their broader development policy framework (Leichenko, 2011). These ‘co-benefits’ serve as one component of the answer to climate change leakage.¹¹

Another element of the answer is shaped by the potential for disruption: sub-national action, when properly structured and deploying infrastructure-level strategies of change, can deliver transformative change that is likely beyond the capacity to ‘leak away’ (Byrne, Taminiau, Kurdgelashvili, & Kim, 2015; Byrne, Taminiau, Kim, Seo, & Lee, 2015; Byrne & Taminiau, 2015).

To advance polycentricity, therefore, it is critical to identify innovation opportunities capable of overcoming the potential shortcomings of ‘chaotic’ action due to their transformative, infrastructure-scale, and context-based character. The creativity espoused within the polycentric strategy can become fertile ground for transformative innovation and leadership.

¹¹ Urban climate change experimentation tends to spend little attention to adaptation (Castán Broto & Bulkeley, 2013; Carter J. , 2011; Zimmerman & Faris, 2011; Kithiia, 2011; Liu & Deng, 2011). To capitalize on the potential of local narratives to incorporate adaptation (Adger, Benjaminsen, Brown, & Svarstad, 2001), the interlocking characteristics of adaptation with other agendas will need to be addressed through the integration of sectoral, spatial and temporal scales.

5.0. INNOVATIVE OPTIONS FOR CITIES IN A POLYCENTRIC WORLD

New governance experimentation takes place across the different world regions (Bulkeley & Castán Broto, 2012; Castán Broto & Bulkeley, 2013). Cities, in particular, have actively engaged the issue of climate change (ARUP, 2014; ICLEI, 2014; Aylett, 2014). For instance, the Urban Climate Change Governance Survey (UCGS) notes how 75% of cities globally now seek to actively address climate change issues (Aylett, 2014). Indeed, many hundreds of cities – large and small – have embarked on climate change action (Aylett, 2014; Hoffmann, 2011; Ostrom, 2010; ARUP, 2014; Figure 3). In the U.S., the Conference of Mayors Climate Protection Agreement, for example, represents about 90 million people across over one thousand cities, towns, and villages. Similarly impressive networks of local climate action have been constructed across the world (e.g., Climate Alliance, 2015). In fact, the commitment by non-state actors has deepened and strengthened over time (Bulkeley & Betsill, 2013) in part due to the realization of interstate negotiation ineffectiveness (Hoffman, 2011).

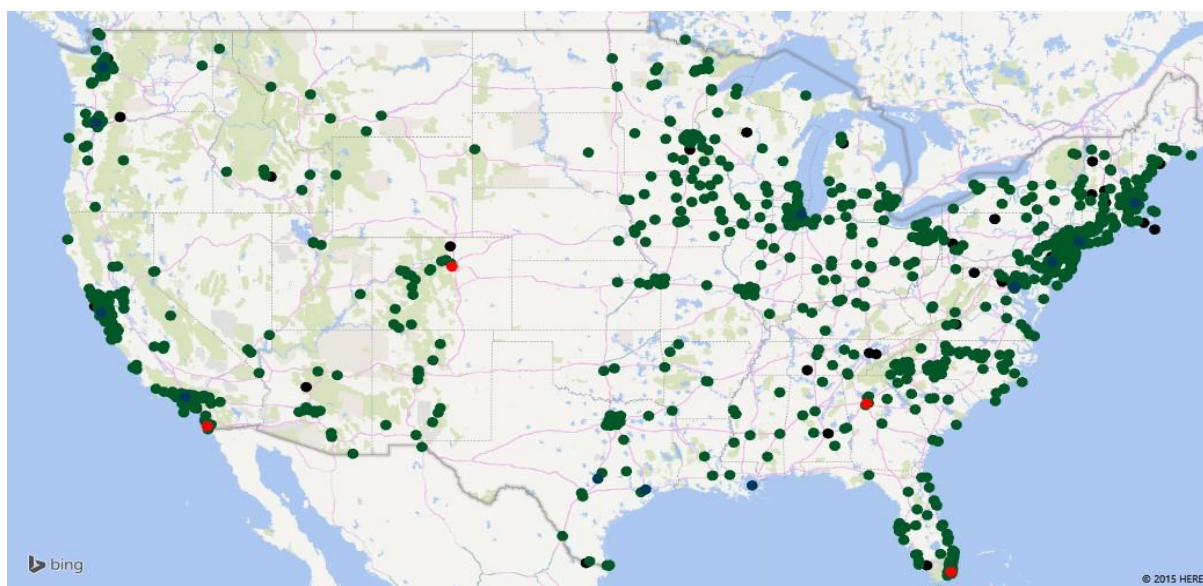


Figure 3. *U.S. Cities, Towns, and Villages Engaged in Climate Change Mitigation and Adaptation Under the Networks of the U.S. Conference of Mayors, ICLEI, C40, and the Carbon Disclosure Project (CDP).*

Urban economic mitigation potential appears to be significant. For instance, an investigation into four developing country cities (representing 27.5 million people) finds total cost-effective abatement NPV of \$4.3 billion (Sudmant, et al., 2015) and similar results have been found for other cities (Colenbrander, Gouldson, Sudmant, & Papargyropoulou, 2015; Gouldson, et al., 2015). Importantly, capitalizing on such sustainable energy opportunities can yield critical benefits. The International Energy Agency (IEA), for instance, notes how fuel savings more than compensate for energy infrastructure investments to stay within 2 degrees Celsius (IEA, 2015a). Similarly, a recent report put the global economic opportunity for low-carbon urban actions at \$16.6 trillion over the 2015-2050 period (New Climate Economy, 2015).

However, cities face a range of barriers that could limit their effective action such as political and institutional barriers, information and knowledge barriers, and capacity and skills barriers (LEDS Global Partnership, 2014; Aylett, 2014). A particular barrier for urban climate change action, however, is lack of capital (Aylett, 2014). Climate change mitigation and adaptation projects can be very expensive and dwarf city budgets. Multiple strategies to overcome these shortages have been proposed. Recent work by the Center for Energy & Environmental Policy (CEEP) directs attention to the option of using the capital markets as a vehicle for urban energy economy transformation (Byrne, Taminiau, Kurdgelashvili, & Kim, 2015a; Byrne, Taminiau, Kim, Seo, & Lee, 2015b).¹²

¹² Another strategy discussed in the extant literature is the deployment of city-wide Clean Development Mechanism (CDM) projects (Marr & Wehner, 2012; Clapp, Leseur, Sartor, Briner, & Corfee-Morlot, 2010; The World Bank, 2010).

5.1. Green Bonds as a Vehicle to Redirect Infrastructure-Scale Investment to Sustainable Energy Implementation

Current momentum in emission trajectories and investments makes clear that architectural decisions made now will be determinative whether the worst consequences of climatic change will be avoided (e.g., IEA, 2014 and Erickson & Lazarus, 2015). This realization is particularly significant in light of the globally relevant ‘investment gap’ that will need to be filled to reach stated targets and ambitions (e.g., Jacobsson & Jacobsson, 2012 and Dobbs et al., 2013). This perspective agrees with Wüstenhagen and Menichetti: “while mobilizing private investment is obviously not trivial, the true challenge policy makers are facing is not primarily about ‘paying a green premium’, but one of influencing strategic choices of those investors who will deploy capital anyway, and are selecting between opportunities in conventional and renewable energy projects” (Wüstenhagen & Menichetti, 2012, p. 3). However, the investment gap, as estimated by McKinsey Global Institute (Figure 4), can also be positioned as an opportunity: guiding investment flows towards long-term systemic change through infrastructure-scale programming for sustainable energy (as opposed to project-to-project based policy) could avoid carbon ‘lock-in’ and advance energy transition (Byrne, Taminiau, Kim, Seo, & Lee, 2015b). Byrne, Taminiau, Kim, Seo & Lee (2015b) propose the use of green bonds as an investment vehicle capable of doing just that.¹³

¹³ For a detailed discussion on the green bonds market, see Byrne et al. (2015b).

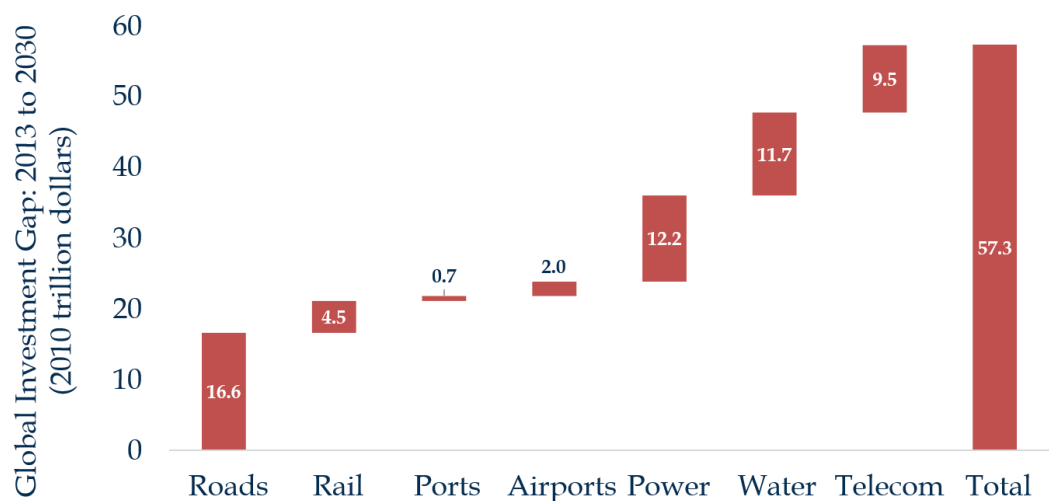


Figure 4. *Investment gap and opportunity for various sectors of the economy (Source: Dobbs et al., 2013, p. 14).*

5.2. Financing Solar Cities Using the Capital Markets

Positioning renewable energy as an infrastructure for social progress – as opposed to the often ‘add-on’ conceptualization of especially customer-sided renewable energy such as photovoltaics – together with infrastructure-level investments guided by new governance models allows for renewables-based social development. One practical expression put forth by Byrne et al. (2015a, 2015b) of such an approach is the public-sector led, infrastructure-scale design and investment of ‘solar cities’. Byrne et al. (2015a, 2015b) illustrate the potential of solar energy in the urban context and outline a financing strategy using green bonds for such city-wide programming: an investment potential of just under \$10 billion is available in the six cities studied by Byrne et al. (2015b), together capable of generating a net benefit of about \$25 billion. To bring such an investment potential to market, however, requires careful and strategic consideration of available options and Byrne et al. (2015b) propose to use the Sustainable Energy Utility (SEU) model as the special purpose vehicle capable of fulfilling such a role (Byrne & Taminiau, 2015).

In Byrne et al.'s (2015b) assessment of solar city bond financing potential, several cities will need to modify their existing enabling market conditions to attract investments. For instance, to allow for a ten-year financing of the solar city program, only New York City is calculated as a viable project. Here, we re-visualize the results obtained by Byrne et al. (2015b) and calculate program viability for ten-year financing under the condition that surplus revenue of early years of program operation is used to cover potential cost shortfalls in later years of the program. Effectively, the results shown in this position paper spreads the cash flow across the years of the program. The application of this new condition makes solar city program financing much more feasible for most cities (Figure 4). While NYC is still the main candidate for a ten year financing, Amsterdam, London, and Munich come much closer to a viable program and are able to finance a solar city program when maturity is extended to 11 or 12 years. Seoul and Tokyo, however, due to existing conditions such as PV system cost and retail electricity prices, could successfully complete a 13-year financing term. Figure 5 captures a more detailed assessment of a 10-year financing for the six cities and outlines several reasons why the cities have difficulty bringing a 10-year program to market. In particular, Seoul faces a challenging enabling context as the low retail electricity price – the primary source of revenue under the power purchase construct envisioned by Byrne et al. (2015b) – slows debt service repayment.

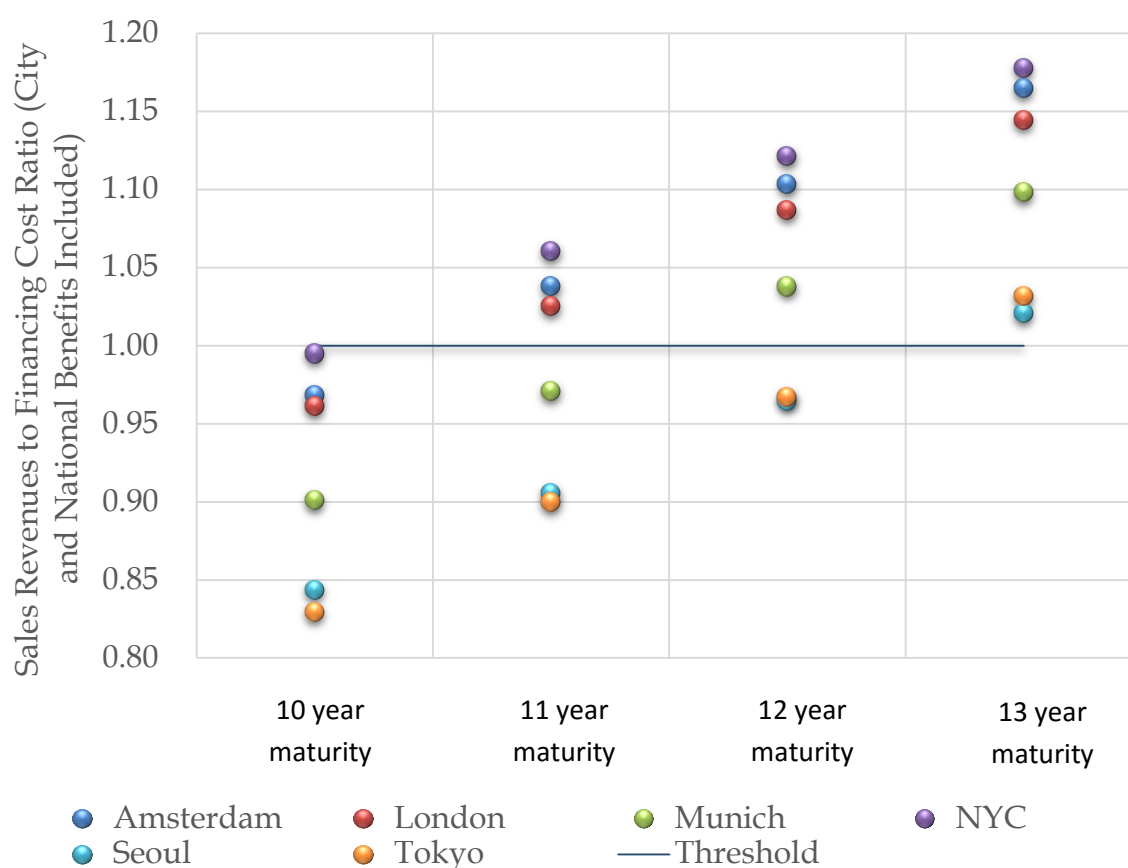


Figure 5. *Solar City Financing Conditions for a Selection of Maturities for the Six Cities Studied by Byrne et al. (2015b).*

Modifying the existing conditions can help bring the municipalities over the threshold line where sales revenues (including policy benefits) exceed financing and operation and maintenance costs. An early attempt at this was performed by Byrne et al. (2015b) looking into the changes required to individual conditions separately (see Table 9 in Byrne et al. 2015b). When only modifying one parameter at a time, substantial shifts are required in several of the cities (in particular Seoul and Tokyo). However, future research will demonstrate how a bundled approach – modifying multiple parameters at the same time – will affect the solar city opportunity. An initial attempt at such a strategy is made for Seoul in this position paper. Indeed, modifying

three parameters by a relatively small amount instead of one parameter by a large amount can bring Seoul to a 10 year maturity (Figure 6).

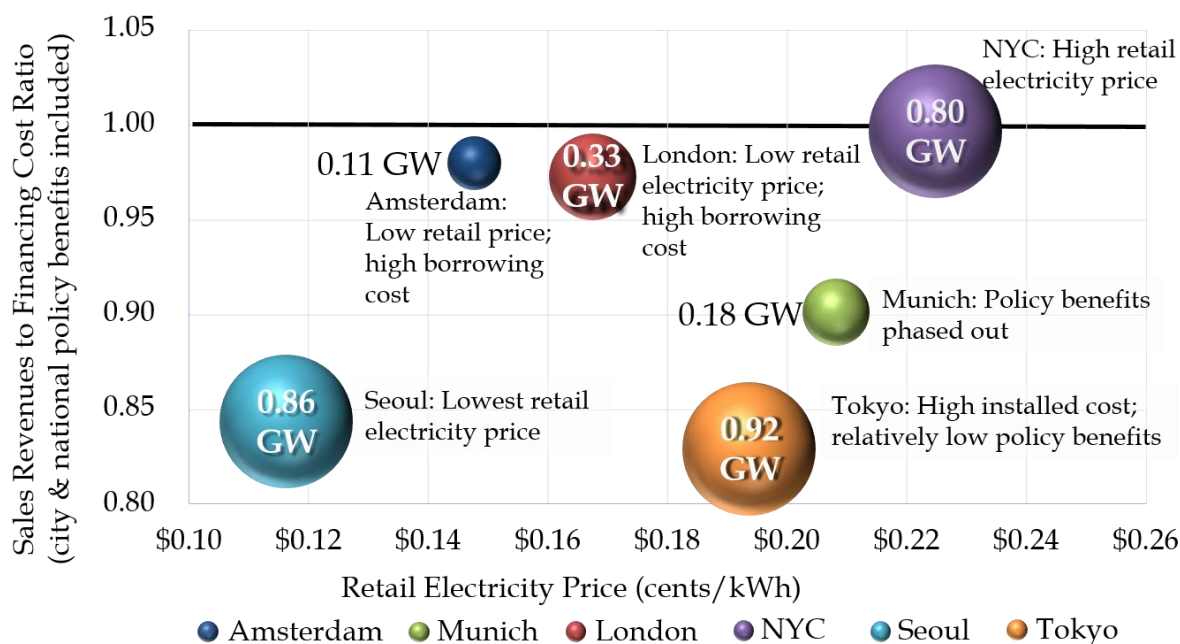


Figure 6. Solar City Conditions in the Six Municipalities for a Ten Year Maturity.

- *Option 1: restructure the debt financing by relying on the country's socially responsible investment (SRI) base.* Including the SRI base into the financing at more favorable conditions compared to private investors can improve the financing model by 6% when SRI investors provide capital at 20% below market rates.
- *Option 2: Lower debt service through phased installment, soft cost learning effects, and bulk purchase negotiation.* There are a variety of ongoing processes that bring down PV system costs. First, the strong decline of PV prices observed in the world markets is expected to continue (e.g., Feldman, et al., 2014). With prices falling roughly at 6% per year, a phased installment over five years could benefit from this downward price trajectory. Second, Seoul could learn from Germany's example and adopt an aggressive soft-cost reduction strategy (e.g.,

Seel, Barbose, & Wiser, 2014). Finally, Byrne et al. (2015b) only limitedly include the benefits from the bulk purchase of solar panels at the scale envisioned under the solar city strategy. The combination of these effects could lower system costs of the project by 6% which translates into a 4% improvement in the financing model.

- *Option 3: Implement an energy savings strategy in conjunction with the solar city energy supply strategy.* Energy savings measures typically have a more favorable return on investment and surplus savings can be used to improve the financing model. Assuming an aggressive energy savings strategy can improve building efficiency by 20%, the financing model improves by another 5%.

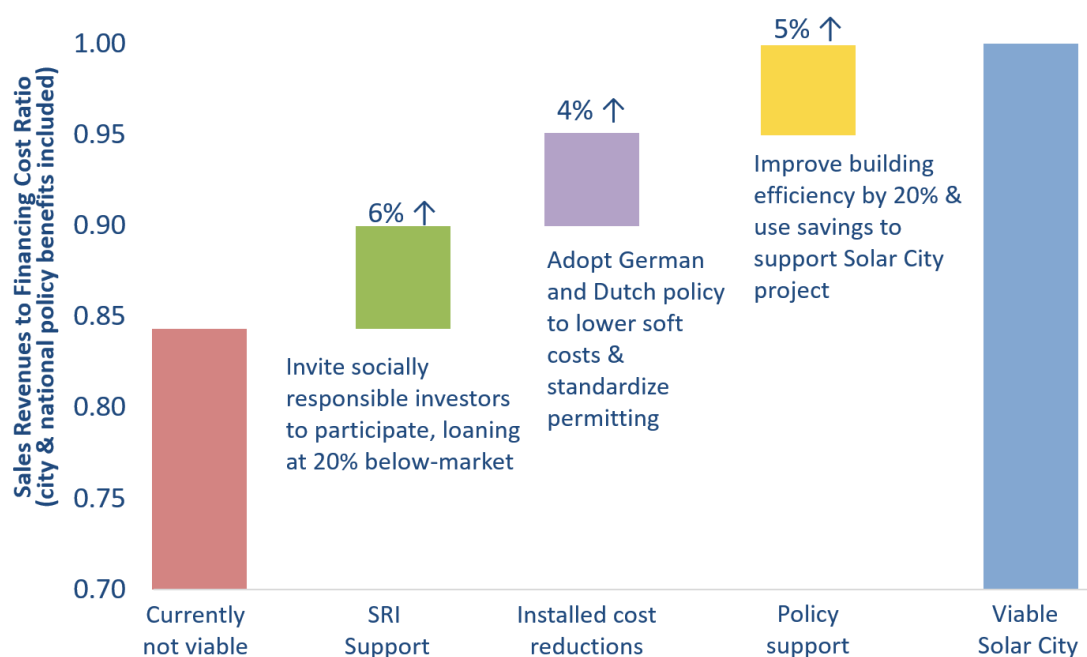


Figure 7. *Closing the Finance Gap: Options for Seoul to Operate a 10-Year Solar City Program.*

6.0. CONCLUDING REMARKS

The move of authority away from the singular and statist perspective and into the fray of the larger constellation of social actors should be particularly well-suited to avoid reductionism as it militates against uniformity. Driven by the twin pressure of disillusionment with lack of progress and the fragmentation of political authority, polycentric governance is a strategy that could offer a viable way forward in the absence of global agreement (Hoffmann, 2011; Sovacool & Brown, 2009; Ostrom, 2012). The unjust distribution of climate change consequences (Douglas, et al., 2008), the differing nature-society relationships (Guha & Martinez-Allier, 1997), and different drivers for change (Taminiau, Wang, & Byrne, 2014) can be seen as motivating factors for a pluralistic response to climate change along the lines offered by the polycentric strategy.

The governance of carbon and climate change is already increasingly positioned within a multi-level, multi-faceted governance context as authority has been reconfigured upwards to international and transnational organizations and institutions, downwards to states, regions, cities, and communities, and outwards to non-governmental organizations (NGOs), civil society and other non-state actors. Moving forward, two pathways appear to emerge. One, nation-states could perceive such polycentric action, in particular transnational collaboration between sub-national governments, as a challenge to sovereignty and, as a result, attempt to deny authority to, for instance, metropolitan rule (e.g., Brütsch, 2012). This can be characterized as a perception of the 'demise of the state' which motivates resistance by decision-makers at the national level.

However, it can be argued that this perspective maintains a reductive dichotomy of public/private and state/non-state that has limited explanatory power in the fragmented post-Kyoto era (Bernstein, Betsill, Hoffman, & Paterson, 2010; Bulkeley & Schroeder, 2012). For instance, the reconfiguration of authority to govern and steer societal activity into new configurations of action allows for both the delegation of work and authority in a way that the state can benefit. A second pathway of a state of 'co-creation' or 'co-governance' through non-state – state actor partnerships and collaboration is possible (Bulkeley & Schroeder, 2012). The challenge thus becomes to incorporate transnationalist concerns associated with climate change into the conceptualization of legitimacy while also accepting the apparent failure of state-based models to provide legitimate confidence to address the problem at hand (Scott & Trubek, 2002, p. 17). One potential way forward is to rely on diversity and creativity – hallmarks of maturing bottom-up frameworks like the EU's Climate Alliance Covenant of Mayors (Climate Alliance, 2015), the Sustainable Energy Utility movement (Byrne & Taminiau, 2015), and the American Energy Efficiency Resource Standard (EERS) strategy (Brennan & Palmer, 2013) which prioritizes 'direction of travel' (Rayner, 2010; Verweij, et al., 2006) over any specific targets or timetables. This approach facilitates innovative expressions of leadership and creativity. Harnessing the chaotic nature of polycentricity in this way could establish a 'race to the top' mentality (Morgan, Dagnet, Hohne, Oberthur, & Li, 2014) that evades capture by unambitious states and, instead, celebrates diversity and fundamental re-dimensioning of the approach. The solar city analyzed in this position paper is a case in point: large cities are often positioned as high-energy conglomerations of built

environment that will take decades to reconfigure as low-carbon communities. However, strategic application of market, policy, and finance conditions shows that cities have options available to overcome such a gloomy forecast.

The current arena offers an outgrowth of opportunities to engage in climate change action. The simultaneous development of pledge and review and neural network applications of action offers a promise of positioning self-governing and self-directed action at the core of governance within a wider 'publics' (Mason, 2008) in which communities can articulate change based upon own knowledge and lessons learned from other experiments around the world. Communities, thus, can advance their values and interests through the public space of contestation, discourse, and action that is the publics.

No matter the course, it has become clear that the original narrow focus on interstate interaction and global agreements as the 'formula for success' is now outdated as an outgrowth of governance opportunities has presented itself. In fact, national, transnational, and sub-national activity already surpasses (and will likely continue to surpass), in both quantitative and qualitative terms, the commitments adopted by the COP process.

Works Cited

- Adelman, D., & Engel, K. (2008). Reorienting State Climate Change Policies to Induce Technological Change. *Arizona Law Review*, 835-879.
- Adger, W., Benjaminsen, T., Brown, K., & Svarstad, H. (2001). Advancing a Political Ecology of Global Environmental Discourses. *Development and Change* 32, 681-715.
- AGAGE. (2014, November 18). *Advanced Global Atmospheric Gases Experiment*.
Opgehaald van <http://agage.eas.gatech.edu/index.htm>
- Ansell, C., & Gash, A. (2008). Collaborative Governance in Theory and Practice. *Journal of Public Administration Research and Theory*, 18(4), 543-571.

- Bernstein, S., Betsill, M., Hoffman, M., & Paterson, M. (2010). A Tale of Two Copenhagen: Carbon Markets and Climate Governance. *Millenium - Journal of International Studies*, 39(1), 161-173.
- Bodansky, D. (2010). The Copenhagen Climate Change Conference: A Postmortem. *The American Journal of International Law*, 104, 230-240.
- Bodansky, D., & Diringer, E. (2010). *The Evolution of Multilateral Regimes: Implications for Climate Change*. Pew Center on Global Climate Change.
- Bos, J., & Brown, R. (2012). Governance Experimentation and Factors of Success in Socio-Technical Transitions in the Urban Water Sector. *Technological Forecasting and Social Change*, 79, 1340-1353.
- Bos, J., Brown, R., & Farrelly, M. (2013). A Design Framework for Creating Social Learning Situations. *Global Environmental Change*, 23, 398-412.
- Brennan, R., & Palmer, K. (2013). Energy Efficiency Resource Standards: Economics and Policy. *Utilities Policy*, 25, 58-68.
doi:<http://dx.doi.org/10.1016/j.jup.2013.02.001>
- Brulle, R. J. (2013). Institutionalizing delay: foundation funding and the creation of U.S. climate change counter-movement organizations. *Climatic Change*, 122, 681-694. doi:10.1007/s10584-013-1018-7
- Brütsch, C. (2012). From Sovereign Prerogatives to Metropolitan Rule? The Anarchical Society in the Urban Age. *International Studies Perspectives*, 1-18.
- Bulkeley, H., & Betsill, M. (2013). Revisiting the Urban Politics of Climate Change. *Environmental Politics*, 22(1), 136-154.
- Bulkeley, H., & Castán Broto, V. (2012). Government by Experiment? Global Cities and the Governing of Climate Change. *Transactions of the Institute of British Geographers*, 23, 1-15.
- Bulkeley, H., & Schroeder, H. (2012). Beyond State/non-State Divides: Global Cities and the Governing of Climate Change. *European Journal of International Relations*, 18(4), 743-766.
- Bumpus, A., & Liverman, D. (2008). Accumulation by Decarbonization and the Governance of Carbon Offsets. *Economic Geography*, 84(2), 127-155.
- Byrne, J., & Taminiau, J. (2015). A review of sustainable energy utility and energy service utility concepts and applications: realizing ecological and social sustainability with a community utility. *WIREs Energy Environ.*
- Byrne, J., Hughes, K., Rickerson, W., & Kurdgelashvili, L. (2007). American Policy Conflict in the Greenhouse: Divergent Trends in Federal, Regional, State and Local Green Energy and Climate Change Policy. *Energy Policy* 35, 4555-4573.
- Byrne, J., Kurdgelashvili, L., & Taminiau, J. (2012). Social Change to Avert Further Climate Change: Defining the Scale of Change and Principles to Guide a new Strategy. *WIRE's Energy and Environment*, 17-40.

- Byrne, J., Taminiau, J., Kim, K., Seo, J., & Lee, J. (2015b). A solar city strategy applied to six municipalities: integrating market, finance, and policy factors for infrastructure-scale development in Amsterdam, London, Munich, New York, Seoul, and Tokyo. *WIREs Energy and Environment*.
- Byrne, J., Taminiau, J., Kurdgelashvili, L., & Kim, K. (2015a). A review of the solar city concept and methods to assess rooftop solar electric potential, with an illustrative application to the city of Seoul. *Renewable and Sustainable Energy Reviews*, 41, 830-844.
- Byrne, J., Wang, Y.-D., Taminiau, J., & Mach, L. (2013). The Promise of the Green Energy Economy. In J. Byrne, & Young-Doo, *Secure and Green Economies*. New Brunswick, New Jersey: Transaction Publisher.
- Carley, S., & Browne, T. (2012). Innovative U.S. Energy Policy: a Review of States' Policy Experiences. *WIREs Energy & Environment*.
- Carter, C., Clegg, S., & Wåhlin, N. (2011). When Science Meets Strategic Realpolitik: The Case of the Copenhagen UN Climate Change Summit. *Critical Perspectives on Accounting*, 22(7), 682-697.
- Carter, J. (2011). Climate Change Adaptation in European Cities. *Current Opinion in Environmental Sustainability*, 193-198.
- Castán Broto, V., & Bulkeley, H. (2013). A Survey of Urban Climate Change Experiments in 100 Cities. *Global Environmental Change*, 92-102.
- Clapp, C., Leseur, A., Sartor, O., Briner, G., & Corfee-Morlot, J. (2010). *Cities and Carbon Market Finance: Taking Stock of Cities' Experience with Clean Development Mechanism (CDM) and Joint Implementation (JI)*. OECD Environmental Working Paper No. 29. Opgehaald van http://www.dev-practitioners.eu/fileadmin/user_upload/10-11-24_OECD_CDM_Climat_Cities_and_carbon_finance_CDM_JI.pdf
- Climate Action Tracker. (2015, November 19). *Tracking INDCs*. Opgeroepen op April 28, 2015, van Climate Action Tracker: <http://climateactiontracker.org/indcs.html>
- Climate Alliance. (2015). *Climate Alliance - Position on the Energy Union*. Frankfurt am Main, Germany: Climate Alliance.
- Colenbrander, S., Gouldson, A., Sudmant, A., & Papargyropoulou, E. (2015). The economic case for low-carbon development in rapidly growing developing world cities: a case study of Palembang, Indonesia. *Energy Policy*, 80, 24-35.
- Diringer, E. (2011). Letting go of Kyoto. *Nature*, 479, 291-292.
- Dobbs, R., Pohl, H., Lin, D.-Y., Mischke, J., Garemo, N., Hexter, J., . . . Nanavatty, R. (2013). *Infrastructure productivity: how to save \$1 trillion a year*. McKinsey Global Institute.

- Douglas, I., Alam, K., Maghenda, M., McDonnell, Y., McLean, L., & Campbell, J. (2008). Unjust waters: Climate Change, Flooding and the Urban Poor in Africa. *Environment and Urbanization*, 20(1), 187-205.
- Eckersley, R. (2004). *The Green State: Rethinking Democracy and Sovereignty*. Cambridge, MA: Massachusetts Institute of Technology (MIT) Press.
- Egenhofer, C., & Georgiev, A. (2009). *The Copenhagen Accord: A First Stab at Deciphering the Implications for the EU*. Brussels, Belgium: Centre for European Policy Studies [CEPS].
- Engel, K. (2009). Whither Subnational Climate Change Initiatives in the Wake of Federal Climate Legislation? *Publius: The Journal of Federalism*, 39(3), 432-454.
- Erickson, P., & Lazarus, M. (2015). Global emissions: New oil investments boost carbon lock-in. *Nature*, 526, 43.
- Falkner, R., Stephan, H., & Vogler, J. (2010). International Climate Policy after Copenhagen: Towards a 'Building Blocks' Approach. *Global Policy*, 1(3), 252-262.
- Feldman, D., Barbose, G., Margolis, R., James, T., Weaver, S., Darghouth, N., . . . Wiser, R. (2014). *Photovoltaic system pricing trends - historical, recent, and near-term projections 2014 edition*. U.S. Department of Energy SunShot / National Renewable Energy Laboratory (NREL).
- Friedlingstein, P., Andrew, R., Rogelj, J., Peters, G., Canadell, J., Knutti, R., . . . Le Quéré, C. (2014). Persistent growth of CO₂ emissions and implications for reaching climate targets. *Nature Geoscience*, 7, 709-715. doi:10.1038/ngeo2248
- Gouldson, A., Colenbrander, S., Sudmant, A., McAnulla, F., Kerr, N., Sakai, P., . . . Kylvénstierna, J. (2015). Exploring the economic case for climate action in cities. *Global Environmental Change*, 35, 93-105.
- Grubb, M. (2015). From Lima to Paris, Part 1: The Lima Hangover. *Climate Policy*, 15(3), 299-301. doi:10.1080/14693062.2015.1029767
- Grubb, M., de Coninck, H., & Sagar, A. (2015). From Lima to Paris, Part 2: Injecting Ambition. *Climate Policy*, 15(4), 413-416.
- Guha, R., & Martinez-Allier, J. (1997). *Varieties of Environmentalism: Essays North and South*. London: Earthscan Publications.
- Hare, W., Stockwell, C., Flachsland, C., & Oberthür, S. (2010). The Architecture of the Global Climate Regime: A Top-Down Perspective. *Climate Policy*, 10(6), 600-614.
- Helm, D. (2009). Climate-Change Policy: Why has so Little Been Achieved? In D. Helm, & C. Hepburn, *The Economics and Politics of Climate Change* (pp. 9-35). Oxford: Oxford University Press.
- Hoffman, M. (2011). *Climate Governance at the Crossroads: Experimenting with a Global Response after Kyoto*. Oxford, U.K.: Oxford University Press.

- Holmes, T., & Scoones, I. (2000). *Participatory environmental policy processes: experiences from north and south*. Institute of Development Studies .
- Hoye, M., & Yan, H. (2014, November 12). *U.S. and China reach historic climate change deal, vow to cut emissions*. Opgeroepen op April 28, 2015, van CNN: <http://www.cnn.com/2014/11/12/world/us-china-climate-change-agreement/>
- IEA. (2015a). *Energy Technology Perspectives 2015 - mobilising innovation to accelerate climate action*. Paris, France: International Energy Agency.
- International Energy Agency [IEA]. (2011). *World Energy Outlook 2011: Executive Summary*. Paris, France: International Energy Agency.
- International Energy Agency. (2014). *World Energy Investment Outlook 2014: Special Report*. Paris: International Energy Agency.
- Jacobsson, R., & Jacobsson, S. (2012). The emerging funding gap for the European energy sector - will the financial sector deliver? *Environmental Innovation and Societal Transitions*, 5, 49-59. doi:10.1016/j.eist.2012.10.002
- Karkainen, B. C. (2004). Post-sovereign Environmental Governance. *Global Environmental Politics* Vol 4, No. 1, 72-96.
- Kithia, J. (2011). Climate Risk Responses in East African Cities: Need, Barriers, and Opportunities. *Current Opinion in Environmental Sustainability*, 176-180.
- Leal-Arcas, R. (2011a). Kyoto and the COPs: Lessons Learned and Looking Ahead. In N. Lavranos, & R. Kok, *Hague Yearbook of International Law* 2010 (pp. 17-90). Koninklijke Brill NV.
- Leal-Arcas, R. (2011b). Top-Down Versus Bottom-Up Approaches for Climate Change Negotiations: An Analysis. *The IUP Journal of Governance and Public Policy*, 6(4), 7-52.
- Leal-Arcas, R., & Carafa, L. (2014). Road to Paris COP21: Towards Soft Global Governance for Climate Change? *Renewable Energy Law and Policy Review*, 5(2), 130-135.
- Leichenko, R. (2011). Climate Change and Urban Resilience. *Current Opinion in Environmental Sustainability*, 3(3), 164-168.
- Liu, J., & Deng, X. (2011). Impacts and Mitigation of Climate Change on Chinese Cities. *Current Opinion in Environmental Sustainability*, 188-192.
- Lobel, O. (2004). The Renew Deal: the Fall of Regulation and the Rise of Governance in Contemporary Legal Thought. *Minnesota Law Review*, 263-293.
- MacNeil, R., & Paterson, M. (2012). Neoliberal Climate Policy: From Market Fetishism to the Developmental State. *Environmental Politics*, 21(2), 230-247.
- Marr, M., & Wehner, S. (2012). *Cities and carbon finance: a feasibility study on urban CDM*. United Nations Environment Program.

- Mason, M. (2008). The Governance of Transnational Environmental Harm: Addressing New Modes of Accountability/Responsibility. *Global Environmental Politics* Vol 8, No. 3, 8-24.
- Matisoff, D. (2008). The Adoption of State Climate Change Policies and Renewable Portfolio Standards: Regional Diffusion or Internal Determinants? *Review of Policy Research*, 527-546.
- McCarthy, J. (2005). Scale, Sovereignty, and Strategy in Environmental Governance. *Antipode* Vol 37, No. 4, 731-753.
- Morgan, J., Dagnet, Y., Hohne, N., Oberthur, S., & Li, L. (2014). *Race to the top: driving ambition in the post-2020 international climate agreement*. Washington, DC: Agreement for Climate Transformation 2015 (ACT 2015).
- Morgan, J., Tirpak, D., Levin, K., & Dagnet, Y. (2013). *A Pathway to a Climate Change Agreement in 2015: Options for Setting and Reviewing GHG Emission Reduction Offers*. Washington, DC: World Resources Institute (WRI).
- Murtha, P. J. (2009). Effective international compliance is needed to avoid 'dangerous anthropogenic interference' with the climate system. *International Network for Environmental Compliance and Enforcement (INECE)*, 8-9. Opgehaald van <http://inece.org/resource/inece-special-report-on-climate-compliance/>
- Najam, A., Huq, S., & Sokona, Y. (2003). Climate negotiations beyond Kyoto: developing countries concerns and interests. *Climate Policy* 3, 221-231.
- Neslen, A. (2015, August 20). *EU calls for urgency in 'seriously lagging' Paris climate talks*. Opgehaald van The Guardian: <http://www.theguardian.com/environment/2015/aug/20/paris-climate-talks-seriously-lagging-eu-calls-urgency>
- Nevens, F., Frantzeskaki, N., Gorissen, L., & Loorbach, D. (2012). Urban Transition Labs: Co-Creating Transformative Action for Sustainable Cities. *Journal of Cleaner Production* (article in press), 1-12.
- New Climate Economy. (2015). *Seizing the global opportunity: partnerships for better growth and a better climate*. Washington, DC: New Climate Economy.
- New, M., Liverman, D., Schroder, H., & Anderson, K. (2011). Four degrees and beyond: the potential for a global temperature increase of four degrees and its implications. *Philosophical Transactions of the Royal Society*, 369, 6-19.
- Newell, P. (2008). The Political Economy of Global Environmental Governance. *Review of International Studies* 34, 507-529.
- Newell, P., & Bumpus, A. (2012). The Global Political Ecology of the Clean Development Mechanism. *Global Environmental Politics*, 12(4), 49-67.
- Newell, P., & Mulvaney, D. (2013). The Political Economy of the "Just Transition". *The Geographical Journal*, 1-9.
- Newell, P., & Paterson, M. (1998). A Climate for Business: Global Warming, the State, and Capital. *Review of International Political Economy*, 5(4), 679-703.

- NOAA. (2015, May Wednesday). *Greenhouse gas benchmark reached*. Opgehaald van National Oceanic and Atmospheric Administration (NOAA): <http://research.noaa.gov/News/NewsArchive/LatestNews/TabId/684/ArtMID/1768/ArticleID/11153/Greenhouse-gas-benchmark-reached-.aspx>
- Oberthür, S. (2014). *Options for a compliance mechanism in a 2015 climate agreement*. Washington, DC: Agreement for Climate Transformation 2015 (ACT 2015). Opgehaald van www.wri.org/our-work/project/act-2015/publications
- Ockwell, D., Haum, R., Mallet, A., & Watson, J. (2010). Intellectual Property Rights and Low Carbon Technology Transfer: Conflicting Discourses of Diffusion and Development. *Global Environmental Change* 20, 729-738.
- Okereke, C., & McDaniels, D. (2012). To What Extent are EU Steel Companies Susceptible to Competitive Loss due to Climate Policy? *Energy Policy*, 46, 203-215.
- Ostrom, E. (2010). Polycentric Systems for Coping with Collective Action and Global Environmental Change. *Global Environmental Change*, 20(4), 550-557.
- Ostrom, E. (2012). Nested Externalities and Polycentric Institutions: Must we Wait for Global Solutions to Climate Change Before Taking Action at Other Scales? *Economic Theory*, 49(2), 353-369.
- Paterson, M., & Stripple, J. (2012). Virtuous carbon. *Environmental Politics*, 21(4), 563-582.
- Paterson, M., Dryzek, J., Norgaard, R., & Schlosberg, D. (2011). Selling Carbon: From International Climate Regime to Global Carbon Market. *The Oxford Handbook of Climate Change and Society*, 611-624.
- Peters, G. P., Marland, G., Le Quere, C., Boden, T., Canadell, J. G., & Raupach, M. R. (2012). Rapid growth in CO₂ emissions after the 2008-2009 global financial crisis. *Nature Clim. Change*, 2-4.
- Plumwood, V. (2002). The Politics of Ecological Rationality. In V. Plumwood, *Environmental Culture: The Ecological Crisis of Reason* (pp. 62-80). Routledge.
- Point Carbon. (2013). *Carbon 2013 - At a Tipping Point*. Thompson Reuters Point Carbon.
- Poteete, A., Janssen, M., & Ostrom, E. (2010). *Working Together: Collective Action, the Commons, and Multiple Methods in Practice*. Princeton, NJ: Princeton University Press.
- Prins, G., & Rayner, S. (2007). Time to Ditch Kyoto. *Nature*, 449, 973-975.
- Prins, G., & Rayner, S. (2007b). The Wrong Trousers: Radically Rethinking Climate Policy. *Joint Discussion Paper of the James Martin Institute for Science and Civilization, University of Oxford, and the MacKinder Centre for the Study of Long-Wave Events*.
- Purvis, N., & Stevenson, A. (2010). *Rethinking Climate Diplomacy*. Washington, DC: German Marshall Fund.

- Rabe, B. G. (2006). *Race to the Top: the Expanding Role of US state Renewable Portfolio Standards*. Pew Center on Global Climate Change.
- Rayner, S. (2010). How to Eat an Elephant: A Bottom-up Approach to Climate Policy. *Climate Policy*, 10(6), 615-621.
- Roberts, J. (2011). Multipolarity and the new world (dis)order: US hegemonic decline and the fragmentation of the global climate regime. *Global Environmental Change*, 21(3), 776-784. doi:<http://dx.doi.org/10.1016/j.gloenvcha.2011.03.017>
- Rogelj, J., Nabel, J., Chen, C., Hare, W., Markmann, K., Meinshausen, M., . . . Hohne, N. (2010). Copenhagen Accord pledges are paltry. *Nature*, 464, 1126-1128. doi:10.1038/4641126a
- Scott, J., & Trubek, D. (2002). Mind the Gap: Law and New Approaches to Governance in the European Union. *European Law Journal*, 8(1), 1-18.
- Seel, J., Barbose, G., & Wiser, R. (2014). An analysis of residential PV system price differences between the United States and Germany. *Energy Policy*, 69, 216-226.
- Sovacool, B., & Brown, M. (2009). Scaling the Policy Response to Climate Change. *Policy and Society*, 27(4), 317-328.
- Stigson, P., Buhr, K., & Roth, S. (2013). The Ambitions in Copenhagen Pledges: Country Case Studies of Drivers and Barriers. *Greenhouse Gas Measurement and Management*, 3(1-2), 21-36.
- Sudmant, A., Gouldson, A., Colenbrander, S., Sullivan, R., McAnulla, F., & Kerr, N. (2015). Understanding the case for low-carbon investment through bottom-up assessments of city-scale opportunities. *Climate Policy*.
- Taminiau, J. (2015). *A paradigm analysis of ecological sustainability*. Newark, DE: University of Delaware.
- Taminiau, J., & Byrne, J. (2012). A Reformulation of 'Success' in the Climate Change Negotiations. *Joint Implementation Quarterly (JIQ)*, 18(1), 11-14.
- Taminiau, J., Wang, Y.-D., & Byrne, J. (2014). Drivers for Change. In J. Byrne, & Y.-D. Wang, *Green Energy Economies: the Search for Clean and Renewable Energy* (pp. 349-360). London & New Brunswick, NJ: Transaction Publishers.
- The Guardian. (2013, May 14). *Record 400 ppm CO2 milestone 'feels like we're moving into another era'*. Opgehaald van The Guardian - Guardian Environment Network: <http://www.theguardian.com/environment/2013/may/14/record-400ppm-co2-carbon-emissions>
- The White House. (2014, November 11). *FACT SHEET: U.S.-China Joint Announcement on Climate Change and Clean Energy Cooperation*. Opgehaald van The White House Office of the Press Secretary: <https://www.whitehouse.gov/the-press-office/2014/11/11/fact-sheet-us-china-joint-announcement-climate-change-and-clean-energy-c>

- The White House. (2014, November 12). *U.S.-China Joint Announcement on Climate Change*. Opgeroepen op April 28, 2015, van The White House - Office of the Press Secretary: <https://www.whitehouse.gov/the-press-office/2014/11/11/us-china-joint-announcement-climate-change>
- The World Bank. (2010). *A city-wide approach to carbon finance*. The World Bank. Opgehaald van http://www.citiesalliance.org/sites/citiesalliance.org/files/A_city-wide_approach_to_carbon_finance.pdf
- Tollefson, J. (2011). Durban Maps Path to Climate Treaty. *Nature*, 480, 299-300.
- UNEP. (2015). *The Emissions Gap Report 2015 - A UNEP Synthesis Report*. Nairobi: United Nations Environment Programme (UNEP).
- Van Der Gaast, W., & Begg, K. (2012). *Challenges and Solutions for Climate Change*. London: Springer-Verlag.
- van der Heijden, J. (2013). *Looking Forward and Sideways: Trajectories of New Governance Theory*. Amsterdam, The Netherlands: University of Amsterdam General Subserie Research Paper No. 2013-01.
- Verweij, M. D., Ellis, R., Engel, C., Hendriks, F., Lohmann, S., Ney, S., & al., e. (2006). Clumsy Solutions for a Complex World: the Case of Climate Change. *Public Administration*, 84(4), 817-843.
- Victor, D. (2001). *The Collapse of the Kyoto Protocol and the Struggle to Slow Global Warming*. Princeton, NJ: Princeton University Press.
- Victor, D. (2009). Plan B for Copenhagen. *Nature*, 461, 342-344.
- Victor, D. G. (2011). *Global Warming Gridlock : Creating More Effective Strategies for Protecting the Planet*. Cambridge, UK: Cambridge University Press.
- Wada, K., Sano, F., Akimoto, K., & Homma, T. (2012). Assessment of Copenhagen Pledges with Long-term Implications. *Energy Economics*, 34, S481-S486.
- Weiss, R., & Prinn, R. (2011). Quantifying greenhouse-gas emissions from atmospheric measurements: a critical reality check for climate legislation. *Phil. Trans. R. Soc. A*, 369, 1925-1942. doi:10.1098/rsta.2011.0006
- Wiener, J. (2007). Think Globally, Act Locally: The Limits of Local Climate Policies. *University of Pennsylvania Law Review*, 155(6), 1961-1979.
- Wilkinson, M. (2010). Three Conceptions of Law: Towards a Jurisprudence of Democratic Experimentalism. *Wisconsin Law Review*, 673-718.
- Wüstenhagen, R., & Menichetti, E. (2012). Strategic choices for renewable energy investment: conceptual framework and opportunities for further research. *Energy Policy*, 40, 1-10.
- Zimmerman, R., & Faris, C. (2011). Climate Change Mitigation and Adaptation in North American Cities. *Current Opinion in Environmental Sustainability*, 181-187.

