Low Emission Development Strategies: The Role of Networks and Knowledge Platforms

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NATIONAL RENEWABLE ENERGY LABORATORY

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Abstract

Considerable effort has been made to address the transition to a low-carbon economy. A key focus of these efforts has been on developing national low emissions development strategies (LEDS). Enabling these plans are well-functioning national, regional, and international low emission development networks and knowledge platforms. To better understand the role of LEDS, we examine them in relation to network theory. We present a review of strengths and weaknesses of existing LEDS networks that builds on the findings of a study conducted by the Coordinated Low Emission Assistance Network (CLEAN).[1] We identify opportunities for further refining LEDS networks based on the insights from theory and a mapping of the climate-related network space.

[1] As of April 2012, CLEAN has been merged with the Low Emissions Development Strategies Global Partnership (LEDS GP) in order to improve efficiency and enhance coordination of LEDS activities.

1 Introduction

Climate change has been widely recognized as a major global issue as it threatens to alter the natural environment, disrupt the well-being of society, and deter economic development (UNDP 2010; OECD 2011a; Mitchell and Tanner 2006; USAID 2012). Governments worldwide generally agree on the need to cut greenhouse gas (GHG) emissions over the coming decades and adapt to the impacts of climate change (e.g., UNFCCC 2009). Given the importance that governments place on economic growth and development, low emission development strategies (LEDS) are regarded as, "indispensable to sustainable development" (UNFCCC 2009).

LEDS[2] are described as "forward-looking national development plans or strategies that encompass low-emission and/or climate-resilient economic growth" (Clapp et al. 2010). For the purposes of this report, we consider LEDS-related activities to include efforts such as roadmaps, nationally appropriate mitigation actions (NAMAs), technology needs assessments (TNAs), and similar actions. Table B-1 compares some of the types of international instruments used to support low emission planning. Analysis of LEDS-related activities differs from the LEDS networks analysis. This report focuses on the latter.

Low emission planning processes consist of several stages[3] (EU-UNDP n.d.; Cox and Benioff 2011), and they are characterized by a substantial degree of complexity and cost. For this reason, there is a clear need for high-quality knowledge, extensive information sharing, and bold decision-making; yet, the experiential base for LEDS is thin. Faced with these issues, a diverse group of LEDS stakeholders have recognized the need to form regional and international networks and knowledge platforms (generally shortened to *networks* in the remainder of this report).

In this report, we focus on these networks. To understand why they are useful in the context of LEDS, and how their functioning might be enhanced, we examine aspects of network theory. Then, we review LEDS networks, highlighting both their strengths and weaknesses.[4] Based on this review and the insights from theory, we identify several[5] opportunities that could foster the improved performance of LEDS networks and platforms.

[2] LEDS has also been referred to as low carbon development strategies (LCDS), low carbon growth plans (LCGP) and climate resilient growth strategies (Clapp et al. 2010; Tilburg 2011). Climate compatible development (CCD) is another term often used along with LEDS. CCD, however, encompasses both low emission development and climate resilient development.

[3] The stages of LEDS vary by country and look different depending on national circumstances, readiness, purpose, and LEDS planning, for example. After the baseline analysis is conducted and projections are obtained, assessments regarding a country's energy and landscape resource availability and general market conditions are carried out. Future emissions scenarios and impact assessments are then developed, and are followed by policy and program design. Finally, plans are put into action by ensuring the necessary institutional infrastructure, catalyzing public and private sector investment and finance, as well as appropriate monitoring and evaluation of LED actions.

[4] We review only a partial data set. CLEAN suggests that the selected list of LEDS networks is not exhaustive, and it explains the existence of several data limitations, including incomplete data, potential errors in categorizing activities, potential for unbalanced representation of low emission planning activities across sectors, and problems with consistency and currency of data, for example (Cox and Benioff 2011, Table 1).

[5] Fully integrating insights from the network theory remains difficult. We suggest a few insights that could be implemented, and we point out that the development of in-depth recommendations may emerge only after a case-by-case inquiry into LEDS networks.

2 Network Theory

Networks are regarded as crucial for creating knowledge, sharing information, and allowing different actions to co-exist in a harmonized environment (Marx and Soares 2011; Slaughter 2004; Martinez-Diaz and Woods 2009). Many perceive networks as a distinct form of governance, next to hierarchies and markets (Martinez-Diaz and Woods 2009; Podolny and Page 1998; Powell 1990; Börzel 2011; Torfing 2012; Scharpf 1993). Networks may provide more efficient delivery of benefits compared to hierarchies and markets according to some academics and practitioners (Ostrom 1990; Sabel and Zeitling 2012; Gilardi and Radaelli 2012; Uzzi et al.2007; Wienges 2010). Marx and Soares (2011) quantitatively analyzed the importance of networks for a country's development and revealed a strong positive correlation between its connectedness index and chosen policies and economy-related indicators. Although preliminary, this empirical exploration confirms the far-reaching benefits of effective networks in addressing policy issues and ensuring the delivery of public goods at all levels—local, regional, and international.

Several authors have emphasized the learning benefits of networks (Uzzi 1997; Hamel 1991; Powell 1990; Dore 1983), as they preserve greater diversity of search engines than hierarchies do, and they convey richer, more complex information than the market does (Podolny and Page 1998; Kaneko and Imai 1987). Networks can encourage learning by enhancing both the sharing of information (Podolny and Page 1998; Hamel 1991; Contractor and Lorange 1988; Root 1988; Kogut 1988) and the creation of new knowledge (Podolny and Page 1998; Powell and Brantley 1992). Personal and professional contacts established through networks allow experts and policymakers to share ideas, experience, and approaches more easily, bolstering their confidence and reducing their perceived risk of change (Radka and Aoki 1997).

The literature has also considered economic advantages of networks. While economists such as Williamson (1991) emphasize cost benefits of networks, laying out conditions under which networks lower transaction costs, sociologists stress advantages of quality[6] as the main economic benefit (Podolny and Page 1998; Uzzi 1997). Sociologists also regard adaptability of networks to unanticipated changes as another important economic benefit (Powell 1990; Kanter 1991). An additional benefit of networks is its adaptability to environmental changes. Because networks foster greater communication than the markets and have organizational boundaries that are easier to adjust in the face of change than hierarchies, they facilitate greater coordination among stakeholders and provide a greater flexibility to organizational modifications than other governance forms to respond to those changes (Sorenson 1997). In addition, some authors highlight the importance of networks in reducing intrinsic uncertainty and dealing with decision-making under bounded rationality (Haas and McCabe 2001; Ostrom 2001; Brousseau and Curien 2001; Pfeffer and Nowak 1976).

Since networks have many advantages, as stated earlier, network literature has sought to determine factors that maximize the performance of these networks. A distinction is drawn between embedded and autonomous networks based on the characteristics and functions of networks (Marx and Soares 2011; Baker 1990; Lie 1997; Powell 1990; Uzzi 1996, 1997).

[6] For example, Uzzi (1997) argues that a higher quality of product is derived in embedded networks because of improved communication along the supply chain.

Embedded networks are grounded in norms of trust and reciprocity, which increase as the duration of ties and diversity of relationships between actors increase, and as the size of the network is reduced (Uzzi and Gillespie 2002; Marx and Soares 2011). Embedded networks are characterized by repetitiveness of interactions, joint problem solving arrangements, and low information asymmetries, as well as the ability to transmit large amounts of information, enable knowledge creation, and improve the quality of performance (Uzzi and Gillespie 2002; Perrow 2002). For this reason, a network's "embeddedness" is particularly beneficial for quickening decision-making, adaptation, and coordination; reducing monitoring costs; and enhancing organizational learning (Uzzi 1996). Despite the advantages embedded networks offer, the inverted U relationship between embeddedness and performance suggests that too much embeddedness reduces a network's performance (Marx and Soares 2011). Essentially, an overly embedded network (i.e., one with too many strong ties and few weak ones) is an isolated "clique" (Uzzi 1996, 1997, 1999; Uzzi and Gillespie 2002; Granovetter 1973), which precludes an extensive flow of new information.

Autonomous networks, on the other hand, are characterized by sporadic interactions between actors and disintegrated network structures, enabling access to non-redundant contacts to obtain novel information (Uzzi 1996, 1997, 1999; Burt 1992). For this reason, autonomous networks allow for an extensive amount of new information to be processed (Marx and Soares 2011; Granovetter 1973; Burt 1992). Research on inter-firm networks has found that having wide-ranging networks of relationships enhances the ability of firms to find valuable knowledge and increases their speed of learning (McEvily and Zaheer 1999; Reagans and McEvily 2003; Zahra et al. 2000). However, unless these structures subsequently develop in certain ways, they may be unable to implement new ideas effectively (Mariotti and Delbridge 2011; Marx and Soares 2011). A key problem in this respect is managing a large number of connections, a situation known as "network overload" (Steier and Greenwood 2000).

Academics have attempted to integrate these differing perspectives and have concluded that a theoretical optimum may be found only through a sufficiently fluid and flexible embedded network, i.e., one with a mix of strong and weak ties (Uzzi 1996; Helper 1991; Marx and Soares 2011). Much literature emphasizes the significance of clearly identifying members' common interests and the network's objective(s) (Wienges 2010; Nelson and Farrington 1994; Plucknett 1990; Bernard 1996; Ashman 2003). The different types of activities that networks seek to enhance raise demands for different types of organizational structures and levels of formalization of the network. A given organizational structure will allow the network to pursue certain activities more effectively than others. For example, a network will not likely have a loose and informal structure at the same time as it prioritizes fundraising, advocacy or lobbying activities (UNSO 2000). On the other hand, a centralized and highly formalized network will probably not effectively encourage mutual learning or information-sharing activities (UNSO 2000).

The literature seems to offer no definite superior solution regarding the "optimal" composition of any network. It is often suggested that a heterogeneous group enables more beneficial interaction among members (Stübing et al. 2004; Marsden 1987) because the network encompasses a larger variety of perceptions and ideas than it would if it were drawn from members with a common origin (Rodan and Galunic 2004). Others have emphasized the enhanced innovation aspects of heterogeneous networks (Wiesenthal 1995), while still others have stressed that more homogeneous groups involve greater levels of trust, and that "tighter" networks are thus faster in implementing new ideas (Powell 1990; Hess 2007). Because heterogeneity of ideas is desired in several situations, academics have sought factors that can enhance the work of heterogeneous networks. Reinicke et al. (2000) reveal that a key to success of these networks lies in the complementarity of resources that participants bring to the fore. Reinicke et al. (2000) suggest that a successful (global public policy) network combines the energy and legitimacy of civil-society groups; the financial "muscle" and interest of businesses; and the enforcement, rule-making power, coordination, and capacity building skills of states and international organizations.

3 Review of LEDS Networks and Platforms

In this section, we consider existing networks and collaborative initiatives, and their impact on low emission development planning within the context of network theory. In reviewing and mapping existing LEDS networks and knowledge platforms,[7] we consider the multitude of networks as a part of one "ecosystem" whose primary goal is to assist in creating and implementing LEDS. Within this framework, we identify strengths and weaknesses, drawing on the findings of the study performed by the Coordinated Low Emission Assistance Network (CLEAN 2011a) and results from a mapping activity performed in March 2012 (LEDS Global Partnership 2012).

CLEAN (2011b) shows the existence of a broad array of networks and platforms supporting low emission and climate-compatible development planning (Appendix A). Most of these networks were created recently. The majority of LEDS networks and platforms—e.g., the International Renewable Energy Agency (IRENA), CLEAN, the Climate and Development Knowledge Network (CDKN), and the Global Green Growth Institute (GGGI)—operate at a global level. Other networks—e.g., Institute of Global Environment and Society (IGES) and the Energy, Environment and Development Network for Africa (AFREPREN)—have a regional focus, which has led to the emergence of regional clusters of LEDS support in Latin America, West Africa, Southern Africa, and Southeast Asia. Evidence suggests that at least 80 countries have been working on LEDS related activities and that more than 73 international programs support these efforts (LEDS GP 2012). Certain countries[8] have a considerable number of LEDS support activities underway that can be strengthened through efficient donor coordination. Preparing and implementing LEDS requires significant financial resources[9] (Clapp et al. 2010). The fact that during the last three years the number of donor-supported LEDS activities at the regional and national level reached 257[10] (LEDS GP 2012), implies that LEDS networks have better means to reach their goals.

[7] Knowledge platforms are defined here as centralized forums (e.g., websites) for sharing information and technical resources and fostering peer-to-peer exchange of ideas and experiences.
[8] These countries include Brazil, China, Colombia, Ethiopia, India, Indonesia, Kenya, Mexico, Philippines, South Africa, Thailand, Vietnam (CLEAN 2011a).
[9] In one estimate, costs for preparing low-carbon growth studies (ESMAP 2009) ranged from 0.5 USD to 1.5 million USD (OECD 2010).
[10] These data represent organizations that responded to a survey conducted by CLEAN and LEDS GP (see LEDS GP 2012), including CDKN, United Kingdom Department for International Development (DFID), the United States Agency for International Development (USAID), the U.S. State Department, the United Nations Development Programme (UNDP), the U.S. Department of Agriculture (USDA), the United Nations Environment Programme (UNEP), Center for Clean Air Policy (CCAP), and Worldwatch Institute (WWI).

Despite the worldwide proliferation of LEDS networks, certain regions (e.g., Central Africa, Middle East, and Central Asia) still have few networks. The Middle East, however, has seen continued rapid growth of GHG emissions, and it is the region with the highest levels of emissions per GDP (IEA 2011). Central Africa[11] is particularly vulnerable to climate variability because of its limited economic development and constrained capacity to adapt and protect itself from the impacts of climate change (The Global Mechanism 2009; Boko et al. 2007). In Central Asia,[12] where almost half of the population lives in poverty and lacks access to sufficient natural resources to sustain their livelihoods, global climate change poses serious threats (Perelet 2007). Hence, more LEDS networks that focus on these regions are likely needed.

LEDS networks and platforms focused on the energy sector networks show a significant presence worldwide because the energy sector accounts for about two-thirds of total GHG emissions[13] (IEA 2011; Blodget and Parker 2010; Rogner et al. 2007), thus a strong focus on energy-related issues within climate change considerations is warranted (Bazilian et al. 2010). With objectives of reducing GHG emissions while ensuring energy security and expanding access, LEDS energy networks address topics ranging from the general (renewable energy,[14] energy efficiency,[15] and policy and finance[16]) to the more specific (such as biofuels,[17] hydropower[18] and solar energy[19] development). Developed countries (i.e., United Nations Framework Convention on Climate Change Annex I countries) are strongly represented in energy networks. While they were a source of most emissions of GHGs in the past (IEA 2011), many are now making technological, policy and financial efforts to reduce emissions and achieve sustainable development[20]. Their knowledge and expertise could enable developing countries to adopt different energy development paths.

Crosscutting networks and knowledge platforms are also widely diffused. Some analysts (Venema and Cisse 2004; Goklany 2007) have recognized potential for creating synergies between adaptation and mitigation (Klein et al. 2007), which explains the proliferation of crosscutting networks. This trend is welcomed by many developing countries, which during the 2012 and 2013 LEDS Global Partnership annual global and regional workshops, noted the need to create stronger connections between adaptation and mitigation activities, as well as the need to place development priorities first (LEDS Collaboration in Action Workshop Report 2012). When looking at the specific subtopics addressed by these networks, it may be observed that mitigation

[11] The Central Africa sub-region consists of Burundi, Cameroon, Central African Republic, Chad, Congo, Democratic Republic of Congo, Equatorial Guinea, Gabon, Rwanda, and Sao Tome and Principe (The Global Mechanism 2009).
[12] Central Asia encompasses Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, and Uzbekistan (UNDP 2007).
[13] In 2009, electricity and heat generation along with transport produced nearly two-thirds of global CO2 emissions (IEA 2011). In 2005, the energy sector accounted for almost 70% of total GHG emissions (Blodget and Parker 2010).
[14] For example, IRENA, the Renewable Energy Policy Network for the 21st Century (REN21), and Open Energy Information, the online knowledge-sharing community
[15] For example, the International Partnership for Energy Efficiency Cooperation (IPEEC) and UNEP-en.lighten
[16] For example, the Africa-EU Energy Partnership (AEEP), the Clean Energy Solutions Center, and the Global Village Energy Partnership (GVEP)
[17] For example, Africa Biofuel Network
[18] For example, the Sustainable Development of Hydropower Institute of the Clean Energy Ministerial (CEM)
[19] For example, the Solar and LED Energy Access Program of the CEM
[20] In 2009, the emissions of developed countries (UNFCCC Annex I) fell sharply (6.5%), putting them 6.4% below their 1990 collective level. Consequently, they accounted for 46% of total world emissions (IEA 2011).

issues, required to avoid dangerous and irreversible changes to the climate system, generally prevail.

At the 16th session of the Conference of the Parties to the United Nations Framework Convention on Climate Change (UNFCCC) in Cancun in December 2010, governments decided to create a new crosscutting network and an associated "centre" that will in part address LEDS issues. The mission of the so-called Climate Technology Centre and Network (CTCN) is to stimulate technology cooperation and enhance the development and transfer of technologies to developing country parties at their request. The centre is to "build or strengthen [developing country] capacity to identify technology needs, to facilitate the preparation and implementation of technology projects and strategies … to support action on mitigation and adaptation and enhance low emissions and climate-resilient development." An advisory board that answers to parties will govern the centre, which is expected to become operational in late 2013.

Despite their relevance, land use (i.e., agriculture and forestry) issues have been covered by only a few LEDS networks and platforms (CLEAN 2011a). Agriculture releases to the atmosphere significant amounts of carbon dioxide (CO2), methane (CH4), and nitrous oxide (N2O) (Klein et al. 2007; Cole et al. 1997; IPCC 2001; Paustian et al. 2004), and annual GHG emissions from agriculture are expected to increase in coming decades due to escalating demands for food and shifts in diet as well as the increasing demand for biofuels in some countries. Some have suggested that improved management practices and emerging technologies could permit a reduction in emissions per unit of food (or of protein) produced. Given their importance, land use issues certainly deserve more attention by LEDS networks (Smith et al. 2007a)[21]. The LEDS Global Partnership has recently launched a working group on Agriculture, Forestry and Land Use that plans to address these issues and collaborate on best practices for promoting the development of the sector while reducing GHG emissions.[22]

Many of the existing LEDS networks specialize in a few topics[23], which is often appropriate for efficacy and effectiveness. This is not necessarily a fault, as in some cases, specialization is appropriate for efficacy and effectiveness. The type and the direction of information exchanged between members of the network are very important (Marx and Soares 2011). Ideally, a network should have a two-way flow of information and enable both information sharing and knowledge creation. LEDS networks largely facilitate the transmission and sharing of information. Providing data and tools is a common area of focus across LEDS networks and platforms. Many networks also concentrate on developing best practice resources, reports facilitating peer-to-peer learning forums, or both. Knowledge creation, however, is not as dispersed as it should be. Some networks and platforms (such as the Renewable Energy and Energy Efficiency Partnership, the LEDS Global Partnership, and the Clean Energy Solutions Center (CESC)) are now focusing on knowledge creation. Launched in September of 2011, the CESC has responded to 83 questions from policymakers in 44 countries and provided 36 online trainings to 3,916 international organizations, governments and technical experts. Yet, in-depth and long-term training activities are limited, perhaps because they are more labor intensive and require greater time commitment,

[21] Smith et al. (2007b) estimated a global potential mitigation of 770 metric tons of carbon dioxide equivalent by 2030 from improved energy efficiency in agriculture (i.e., through reduced use of fossil fuels).
[22] http://ledsgp.org/
[23] Common LEDS network topics of focus are included in Appendix A.

and hence are more expensive. Only 30% of these networks and platforms are involved in training activities, and few activities are sustained over long periods (CLEAN 2011a).

Activities provided by LEDS networks are considered invaluable for both adaptation and mitigation efforts. Adaptation to, and mitigation of, climate change are subject to a cascade of barriers,[24] including incomplete and imperfect information, high transaction costs, and risk aversion in financial institutions and donors. Yet, staff in resource-constrained countries often lacks education and training to manage such issues (CLEAN 2011b). LEDS networks greatly reduce these problems by providing needed information and assistance, and facilitating decision making by relevant stakeholders. Still, more can be done if expert assistance, peer-to-peer learning and training activities are given greater emphasis.

Enhanced collaboration and cooperation of relevant stakeholders is fundamental to an effective response to climate change (PwC 2010). To ensure involvement of stakeholders, LEDS networks should provide the needed incentives, which differ according to the type of the stakeholder involved. Developing countries are interested in obtaining information, tools, resources, and capacity to embark on low emission development paths, as well as to maintain ownership of the development plans being created. Developing countries have also shown interest in intra regional and cross regional learning. Developed countries and multilateral organizations gain from participating in a LEDS network by better using their aid resources, avoiding duplication of work, and optimizing the development cooperation efforts. In addition, the knowledge, information, and best practices that LEDS networks identify, share, and foster may prove useful for the sustainable development plans of developed countries. The private sector benefits from participating in the policy design stage, as well as from the opportunity to foster innovation. By participating in networks, research and technical institutions raise their visibility, hence increasing their access to funding for their operations and improving the options for applying their research. Finally, through LEDS networks, non-governmental organizations (NGOs) and civil society might participate as consulted stakeholders in low emission development planning, and hence have an opportunity to influence such processes.

Multilateral institutions, NGOs, and technical institutions are the main actors engaged with low emission and climate-compatible development planning activities. They make vital contributions to LEDS formulation and implementation by providing technical and intellectual leadership. Evidence suggests, however, that other key stakeholders are still insufficiently engaged in LEDS networks (CLEAN 2011a), including developing country officials, high-level political leaders, and the private sector. The best interactions with these stakeholders seem to be at workshop style engagements (CLEAN 2011a). Reasons for their absence are 1) lack of awareness on the meaning of low emission development, 2) lack of effective communication on opportunities for private sector stakeholders to engage in low emission development, 3) lack of awareness on the strong linkages between low emission development and domestic development goals, and 4) the lack of awareness of the benefits of participating in LEDS networks (see CLEAN 2011b).

Political leaders often have an unclear vision of the relation between low emission development and domestic development goals. Thus, they require tools that (1) illustrate how LEDS can help

[24] See for example, Adger et al. (2007); OECD (2006); Lu (n.d.); ORNL (2008); Sathaye (2002); Davidson (2000); UNFCCC (2005).

achieve national goals, such as energy and food security and economic growth, but (2) do not retard development (CLEAN 2011b). Despite the criticism marginal abatement cost (MAC) curves receive for their cost and carbon focus, and their omission of development goals (CLEAN 2011b; CLEAN 2011c), these curves have helped decision makers understand the costs and opportunities of different GHG mitigation options. Nevertheless, it might prove useful to develop visualizations that communicate development benefits and contributions of LEDS initiatives to development goals, as doing so would educate key stakeholders of development benefits and enable countries to better prioritize policy actions (CLEAN 2011c; CLEAN 2011b).

Few LEDS networks[25] seem to foster interaction between private-sector companies and investors with country government officials and technical institutes (CLEAN 2011a). However, private-sector investment is regarded as a key element of low emission and climate-compatible development planning. Dialogue between private-sector leaders and policymakers is fundamental, as it allows the policymakers to understand the regulatory, fiscal, and other hurdles companies face in achieving sustainable development (Brown et al. 2008; Sathaye 2002; UNFCCC 2005). In addition, businesses may use their technical expertise to assist developing countries in their clean technology research and development (R&D) efforts.

CLEAN (2011b) emphasizes a need for increased engagement of developing countries in LEDS networks and platforms. In the near term, adaptation is vital for developing countries as (1) they are home to the world's most vulnerable populations and societies, and (2) for the most part, they lack adequate financial and technical resources with which to respond to climate change (Sagar 2010). It is clear that developing countries will also need to take action to slow their rapid greenhouse gas emissions growth in order to keep global warming below 2^{o}C. In order to keep the global average temperature below 2^{o}C, emerging economies as a group will need to reduce emissions by 15 to 30% by 2020 below the currently forecasted rate of growth in emissions (UNFCCC 2011).

Demand for energy is growing exponentially in developing countries due to rapid population growth (especially in Africa) and rapid economic expansion (especially in China and India) (OECD 2007, OECD 2011b). Growing demand is projected to lead to a near doubling in primary energy use, much of it unsustainable, by developing countries in the next two decades (OECD 2007). Because of this growth, developing countries will account for 50% of primary energy use and 52% of energy related CO_2 emissions by 2030 (OECD 2007). However, developing countries often lack the necessary data and tools, as well as the proper education and training to cope with these problems, and successfully develop and implement LEDS. Further engagement of these countries in networks, will facilitate their access to technical assistance for the development and implementation of their LEDS. The engagement of developing countries in networks would also benefit the entire network by providing a developing country perspective to better align activities to countries needs.

[25] Public-private and purely private partnerships in the area of green finance exist (San Giorgio Group 2011; Capital Markets Climate Initiative 2012; World Economic Forum website [http://www.weforum.org/]), and they have shown significant interest in fostering environmental sustainability. However, because these partnerships do not fall within the definition of a LEDS network, they are not examined here.

4 Experiences of Long-standing Successful Networks across Fields

In this section, we attempt to glean lessons learned from select LEDS network precedents.

Consultative Group on International Agricultural Research (CGIAR): In 2010, CGIAR[26] completely overhauled its governance structure to harmonize and maximize funding for priority research areas, and to simplify structures and reduce transaction costs (CGIAR 2009, 2011). The result is a more business-like partnership that links, in more binding[27] and transparent ways, donors who fund research with the scientists and others who conduct it (CGIAR 2011). CGIAR centers are united under the Consortium of International Agricultural Research Centers, a new legal entity that provides a stronger foundation for integrating research across centers and providing donors with a single point of contact (CGIAR 2011). In addition, the CGIAR Fund was established to enable donors to harmonize their contributions toward major research initiatives (CGIAR 2011). These reforms are expected to curb the recent tendency toward fragmentary funding of dispersed research efforts (CGIAR 2011). Given the increasing donor support of LEDS networks, it may be beneficial to implement governance structures similar to CGIAR to ensure both integrated research and harmonized funding.

Other Multilateral Environmental Agreements: Regional networks of national ozone units[28] (NOUs) provide a workable model for the participation of developing countries. These networks, now numbering nine, have helped NOUs in 148 developing countries overcome challenges they face in complying with the Montreal Protocol[29] and its subsequent amendments (UNEP 2001; Rasmusson 2002)[30]. UNEP (2002) shows how important the influence of neighboring countries is on creation of a successful national phase-out strategy for ozone-depleting substances,[31] and how the progress initially made by some developing countries attracted their regional counterparties to join the regional network. This experience appears to suggest that regional networks are useful for enhancing the participation of developing countries, especially in cases of highly technical issues.

[26] The CGIAR is a strategic alliance of countries, international and regional organizations, and private foundations supporting 15 international agricultural research centers. For more information, see http://www.cgiar.org/.

[27] The central innovation of the new model is its clear definition of the mutual accountability of those who conduct research and those who fund it (CGIAR).

[28] Regional networking provides a regular interactive forum for officers in NOUs to exchange information and experience, brainstorm innovative regional solutions, and enhance cooperation with developed countries as well as the regional counterparts (UNEP 2002).

[29] Networking activities have resulted in improved data reporting, policymaking, refrigerant management plans, and the development of peer pressure among ozone-depleting substances (ODS) officers to take early steps to implement the Montreal Protocol. Some of the most notable results of the regional networks are accelerated ratification of the Montreal Protocol and its amendments; earlier development of national ODS legislation and other policy measures; more regular data reporting; and improved compliance with the ODS phase-out schedules. (UNEP 2007)

[30] UNEP (2002) reveals that based on the subjective judgment of the national ozone officers, networking activities have exerted an important positive effect on improving the national ozone officers skills, expertise, and experience. The most significant improvements have been identified in the areas of reporting, data collection, promotion of public awareness, and the level of information relating to alternative technologies and substances.

[31] Examples mentioned include Malaysia, Philippines, Laos, and the Dominican Republic (UNEP 2002).

Resource Efficient and Cleaner Production (RECP) Network*[32]*: The RECP network is an example of a successful sector-specific (industry) network. The RECP network model is based on the fact that the countrywide application of resource efficient and cleaner production can come about only if the concept is promoted by professionals in the country itself and adjusted by them to suit the local conditions.[33] Based on a multi-stakeholders approach, national centers are initially established as a United Nations-backed technical cooperation project and are hosted by a national industry association, technical institute, or university. Over time, the centers start generating their own revenues from service fees, become financially and administratively independent, and acquire a separate legal entity, generally with buy-in from government, business sector, and civil society. What makes the RECP network a successful[34] model are (1) its sector-specific, impact-oriented nature, and (2) a governance structure that brings together international development aid, public and private sector, which warrants ownership, financial sustainability, and responsiveness to country needs.

5 Opportunities for Improving LEDS Networks

In this section, we describe opportunities for improving LEDS networks based on the experiences of existing LEDS platforms and networks reviewed in Sections 3 and 4. We also offer opportunities for leveraging efforts with emerging LEDS initiatives.

Our review of network theory (Section 3) suggests a few building blocks for a well functioning LEDS network. First, identifying common interests of LEDS stakeholders and setting a clear goal for the network are vital. Based on the set goal for the network, the appropriate organizational structure and the level of formalization should be identified. Furthermore, LEDS networks should strive to develop both embedded and autonomous ties.[35] On one hand, members should repeatedly interact, develop joint problem-solving arrangements, and cooperate with one another on many issues. On the other hand, they should remain open to novel outsider information and actively communicate with similar networks. Due to the diversity of issues covered, the development and implementation of LEDS benefit from heterogeneity of ideas from stakeholders including governments, the private sector, and civil society. The complementarity of resources that heterogeneous participants provide is essential to success of the network. This is currently as far as the network theory can take us. A follow-up paper to UNIDO (Marx and Soares 2011) and case-by-case inquiry into different networks will enable us to provide

[32] This is a network of National Cleaner Production Centers (NCPCs) that have been established in 47 developing and transition countries to promote, coordinate, and facilitate RECP activities. The objectives of the NCPCs are (1) to build local capacity to implement cleaner production and (2) to provide core cleaner production services at the national level. For more information, see http://www.unido.org/index.php?id=o5133.
[33] The centers do not deliver ready-made solutions, but train and advise their clients on how to find the best solutions for their own specific problems.
[34] Several success stories show how NCPCs led to placing RECP high on the agenda of businesses and governments by providing several essential services, including technical assistance and in-plant assessments, training, information dissemination, policy advice, and clean technology and investment promotion (UNIDO, UNEP 2010). As demonstrated by the experiences of Sri Lanka, Kenya and Peru, for example, benefits are eminent in many enterprises, regardless of sector, location, or size; they include significant annual savings, increased product quality, improvement in production efficiency, access to larger market share, and creation of new business ventures.
[35] One might argue that this depends on the goal of the network. However, because our network analysis suggests that the network optimum is found in a mix of embedded and autonomous ties, we proceed with that idea.

additional findings, including more about success factors, the importance of financing mechanism, and governance structure of networks.

Our review of both LEDS related networks and the experiences of those implementing LEDS programs (1) suggests that networks need to evolve to cover a wider range of regions, issues, and activities, and (2) identifies several lessons that can inform efforts to strengthen these networks and related knowledge platforms. These lessons include[36] the value of:

1. Covering adaptation and mitigation issues in an integrated manner to advance both low-carbon growth and enhanced resiliency to climate impacts
2. Engaging a portfolio of both global and regional networks to allow for learning and exchange at both levels, recognizing that the greatest learning often happens among peers in a region
3. Developing sectoral- and topic-specific networks and platforms as much of the action is driven by sectoral development programs and existing public-private partnerships for each sector
4. Raising broad awareness and support for low emission development to enhance engagement in LEDS design and implementation across all countries and actors
5. Gaining strong buy-in and participation from developing countries along with donors and practitioners
6. Establishing close links and working relationships with the private sector given the critical private-sector role in financing LEDS projects
7. Ensuring that development objectives are an integral part of the LEDS discussion.

The effectiveness of LEDS related networks could be improved by tackling the aforementioned points but also by tapping several emerging opportunities, including:

> ***Central Repository for Quality Tools:*** Aiming to facilitate climate-compatible development planning, CDKN, the Institute of Development Studies (IDS), and Ecofys recently developed (1) an analytical report (Ecofys, IDS 2011) containing a rigorous review of existing tools and methods to support climate-compatible development planning (thus including LEDS tools) and (2) a complementary website[37] for stakeholders to search for tools that meet their needs. Instead of examining myriad tools, LEDS stakeholders will now be able to simply select their focus area, the policy stage or stages on which they are working, and the tool type needed, to quickly find the best tool. This report complements existing LEDS toolkits such as the one developed by the National Renewable Energy Laboratory (NREL) for the U.S. government-supported EC-LEDS program[38], which identifies a portfolio of data source, analysis tools, best practices, and related technical resources for each stage of LEDS analysis, plan development, and implementation.

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[36] More could be said after the case-by case inquiry. For instance, it might be interesting to examine the degree of effectiveness of networks and need for their harmonization as well as the need for coupling networks and knowledge platforms.

[37] See http://www.climateplanning.org/userguide.

[38] See http://en.openei.org/wiki/Gateway:Low_Emission_Development_Strategies.

Linked Open Data: Using LEDS-related data sets in an integrated searchable format represent another opportunity (CLEAN 2011a). To this end, many organizations are adopting linked open data to support data integration. Linked data uses the Web to connect related data or to lower barriers to linking data currently linked using other methods.[39] Linked open data is domain-independent and penetrates various areas and domains, thus proving its advantage over traditional data management (Bauer and Kaltenbock 2012). As linked open data facilitates innovation and knowledge creation from interlinked data, it is an important mechanism for information management and integration, which are of prime importance for LEDS networks and platforms.

Climate Technology Centre and Network: The Climate Technology Centre and Network (CTC&N) as initially envisaged by COP16 (UNFCCC 2011) represents an opportunity to facilitate expert assistance related to low emission development planning (CLEAN 2011a). Participants of CTC&N will be expected to provide information, training, and support for programs to build or strengthen capacity of developing countries to identify technology options; make technology choices; and operate, maintain, and adapt technologies (UNFCCC 2011).

Climate Innovation Centers: Development of Climate Innovation Centers[40] (CICs) (Sagar 2010) could prove very useful in formulating and implementing LEDS. CICs are envisaged to address the barriers that impede developing countries from transferring, developing, and deploying advanced climate technologies for both domestic use and export (Sagar 2010). Through a wide range of functions (Sagar 2010, Table 2), CICs are intended to transform the threat of climate change into an agent of technology innovation, helping tackle both global warming and sustainable development challenges in the developing world. As they would build technical, business, and policy capacity, CICs could help developing countries establish their LEDS, thus greatly facilitating the work of LEDS networks and platforms.

Marginal Abatement Cost Curves and Development Benefits: To address several shortcomings of marginal abatement cost curves,[41] CLEAN partners have proposed a new data visualization (see Figure B-1) to communicate simultaneously GHG mitigation potential and development benefits of technology options (CLEAN 2011c). The information needed for this new communication tool can build from many LEDS efforts, and it can particularly benefit from UNEP's Multi-Criteria Analysis for Climate (MCA4climate)[42] and technology needs assessments (TNA) supported by the United Nations Development Programme (UNDP) and the United Nations Environment Programme (UNEP). The data visualization would add to the existing benefits of marginal abatement cost curves and thus facilitate the LEDS decision-making process.

[39] See http://linkeddata.org/.
[40] See http://www.infodev.org/en/TopicBackground.19.html.
[41] See CLEAN (2011c), Ekins et al. (2011), and Kesicki and Strachan (2011) for more information about the shortcomings of marginal abatement cost curves.
[42] See http://www.mca4climate.info/.

***Increased Awareness from the Private Sector*:** Acknowledgement of climate change as a business risk[43] is an important stimulus for the private sector to provide its voice and constructive input to LEDS networks and knowledge platforms. The UNFCCC adaptation Private Sector Initiative highlights successful strategies that businesses and communities are using to adapt to climate change while simultaneously increasing their profits and using their resources more efficiently. The initiative provides a platform for businesses to contribute in a sustainable and profitable manner to a strong and effective response, both in their own adaptation efforts and, importantly, in those of the most vulnerable countries and communities around the world.

In Section 4, we identified several general lessons for improving the scope, design, and operations of LEDS related networks and platforms. These lessons could be shared with managers and participants of these networks for their consideration and for further review and refinement. A more in-depth, case-by-case inquiry into LEDS networks would enable a more detailed assessment and development of tailored recommendations for strengthening the various types of LEDS networks and platforms. UNIDO is developing a questionnaire that will further define success factors that improve the functioning of LEDS networks.

Tables A-1 through A-5 show network and knowledge platforms by topic, geographic area, and type of activity.

[43] For example, see UN Global Compact et al 2011, Agrawala et al. 2011, and the UNFCCC Private Sector Initiative website (http://unfccc.int/adaptation/nairobi_work_programme/knowledge_resources_and_publications/items/4747.php).

Appendix A. Network and Knowledge Platform Data

Table A-1. Network and Knowledge Platform Data: Adaptation

Name	Type		Participant Type	Number of Participants	Subtopics Addressed	Geographic Focus	Activities							
	Knowledge Platform	Network					Best Practices	Data and Tools	Expert Assistance	Peer-to-Peer Forum: Virtual (webinars/blogs)	Peer-to-Peer Forum: Workshops	Peer-to-Peer Forum: Country Peer Exchanges	Reports (emerging issues/innovation)	Training
Adaptation Learning Mechanism	X	X	Multilateral, Government, Financial institutions	9	Adaptation, Operational guidance, Capacity building	Global		X						
Africa Adaptation Programme	X	X	NGOs, Multilateral	15	Adaptation, Capacity building	Burkina Faso, Cameroon, Congo, Ethiopia, Gabon, Ghana, Kenya, Lesotho, Malawi, Mauritius, Morocco, Mozambique, Namibia, Niger, Nigeria, Rwanda, Sao Tome and Principe, Senegal, Tanzania, Tunisia		X					X	
AfricaAdapt	X	X	NGOs,	4	Adaptation, Communication facilitation	Africa						X		
Asia Pacific Adaptation Network (APAN)		X	Multilateral, NGOs,	6	Adaptation, Capacity building, Knowledge transfer	Asia, Pacific							X	
Caribbean Community Climate Change Centre	X		Developed countries, Developing countries		20	Antigua and Barbuda, The Bahamas, Barbados, Belize, Dominica, Grenada, Guyana, Haiti, Jamaica, Montserrat, Saint Lucia, St. Kitts and Nevis, St. Vincent and the Grenadines, Suriname, Trinidad and Tobago, Anguilla, Bermuda, British Virgin Islands, Cayman Islands, Turks and Caicos Islands	X	X						X
Regional Climate Change Adaptation Knowledge Platform for Asia	X					Asia		X					X	
weADAPT	X	X	Multilateral, Private, NGOs, University, Government		86	Global	X	X						

Name	Knowledge Platform	Network	Participant Type	Number of participants	Subtopics Addressed	Geographic Focus	Best Practices	Data and Tools	Expert Assistance	Virtual (webinars/blogs)	Workshops	Country Peer Exchanges	Reports (emerging issues/innovation)	Training
World Bank Climate Change Knowledge Portal	X					Global		X						
WWF-Climate Prep	X					Global	X				X			

Table A-2. Network and Knowledge Platform Data: Crosscutting

Name	Type		Participant Type		Subtopics Addressed	Geographic Focus	Activities							
										Peer-to-Peer Forum				
	Knowledge Platform	Network		Number of participants			Best Practices	Data and Tools	Expert Assistance	Virtual (webinars/blogs)	Workshops	Country Peer Exchanges	Reports (emerging issues/innovation)	Training
CLEAN (Coordinated Low Emissions Assistance Network) [44]	X	X	Multilateral, Government, NGOs,	45	Low emission climate-compatible development country support and technical methods and tools	Global	X	X		X	X		X	
Climate 1-Stop	X				Adaptation, Finance, Mitigation	Global	X	X					X	
Climate Action Network		X	Multilateral, Government, NGOs	700	Mitigation, Donor-strategies	Global						X		
Climate and Development Knowledge Network (CDKN)	X	X			Mitigation, Climate Change, Adaptation, Impacts, climate compatible development (CCD)	Global	X		X				X	X

[44] As of April of 2012, CLEAN merged with the *Low Emissions Development Strategies Global Partnership (LEDS GP)* in order to improve efficiency and enhance coordination of LEDS activities. CLEAN falls under the umbrella of the LEDS Global Partnership as a network of practitioners from around the world that collaborate on and share experiences with LEDS data, tools, methods, and assessments.

Name	Type		Participant Type	Number of participants	Subtopics Addressed	Geographic Focus	Activities							
										Peer-to-Peer Forum				
	Knowledge Platform	Network					Best Practices	Data and Tools	Expert Assistance	Virtual (webinars/blogs)	Workshops	Country Peer Exchanges	Reports (emerging issues/innovation)	Training
Climate Knowledge Brokers		X	Multilateral, NGOs, Government	21	Coordination	Global					X			
ClimateTechWiki	X	X	Multilateral, Universities, NGOs	9	Low-carbon and adaptation technologies	Global	X	X				X		
Energy and Climate Partnership of the Americas		X	Government, NGOs	33	Energy, Land use, Mitigation, Adaptation	North America, Latin America and Caribbean						X	X	
ESMAP (Energy Sector Management Assistance Program at the World Bank)	X		Multilateral		Low-carbon development, climate resilience in the energy sector, clean energy	Global	X	X	X		X	X	X	X
Finanzas Carbono	X				Finance, Development	Latin America and Caribbean		X		X			X	
GEF Knowledge Management Initiative	X				Climate change, Biodiversity, Organic pollutants, REDD+	Global						X	X	
Global Climate Network		X	Government, NGOs	11	Technology, Finance, Economic opportunity	Global					X		X	
Global Green Growth Institute (GGGI)		X	Developing countries, Developed countries, Multilateral	17	Green growth programs, Mitigation, Biodiversity	Global	X				X		X	
Green Growth Knowledge Platform (GGKP)	X	X	Multilateral, Developing countries, Developed countries		Green growth programs	Global	X	X		X	X	X	X	

Name	Type		Participant Type		Subtopics Addressed	Geographic Focus	Activities							
										Peer-to-Peer Forum				
	Knowledge Platform	Network		Number of participants			Best Practices	Data and Tools	Expert Assistance	Virtual (webinars/blogs)	Workshops	Country Peer Exchanges	Reports (emerging issues/innovation)	Training
Institute for Global Environmental Strategies (IGES)	X	X	Government, Multilateral, Universities	50	Climate Change, Mitigation, Development	Asia-Pacific Region		X				X	X	
IGES-Successful Practices and Policies Databases	X				Policy, Environment	Asia-Pacific Region	X	X						
Japan International Cooperation Agency (JICA) Climate Finance Impact Tool (Climate-FIT)	X				Mitigation, Adaptation, Development	Global	X	X					X	X
Joint Implementation Network (JIN)		X	Private, Universities, Multilateral,	59	Climate change, Policy	Global		X	X				X	
LEDS Global Partnership	X	X	Multilateral, Government, NGOs	28	LEDS country support	Global	X	X	X	X	X	X	X	X
The Renewable Energy and Energy Efficiency Partnership (REEEP)		X	Developing countries, Developed countries, Multilateral, Private, NGOs	400	Renewable Energy, Energy Efficiency, Policy , Regulation, Business, Finance, Transport, Smart grid	Argentina, Bhutan, Bosnia and Herzegovina, Brazil, Bulgaria, Chile, China, Colombia , Costa Rica, Ecuador, El Salvador, Ethiopia, Fiji, Ghana, Guatemala, Honduras, India, Indonesia, Japan, Kazakhstan, Kiribati Lesotho, Liberia, Malawi, Mali, Mexico, Moldova, Mongolia, Morocco, Mozambique, Namibia, Nepal, Nicaragua, Panama, Philippines , Poland, Russia, Samoa, Senegal, Serbia and Montenegro, Solomon Islands, South Africa, Sri Lanka, Tanzania, Thailand, Tonga, Tunisia, Uganda, Ukraine Vanuatu, Zambia	X	X	X		X		X	X

Name	Type: Knowledge Platform	Type: Network	Participant Type	Number of participants	Subtopics Addressed	Geographic Focus	Activities: Best Practices	Activities: Data and Tools	Activities: Expert Assistance	Activities: Peer-to-Peer Forum: Virtual (webinars/blogs)	Activities: Peer-to-Peer Forum: Workshops	Activities: Peer-to-Peer Forum: Country Peer Exchanges	Activities: Reports (emerging issues/innovation)	Activities: Training
Science and Technology Research Partnership for Sustainable Development (SATREPS)	X	X	Research Institutions, Development Agencies		Climate change, Low-carbon Development, Adaptation, Energy	Global	X		X				X	X
Southeast Asia Network of Climate Change Focal Points	X				National climate change programs	SE Asia			X					X
UNEP Southeast Asia Network of Climate Change Focal Points (SEAN-CC)	X	X	Multilateral, Government, Private Universities / centers of excellence	60	Climate change policies, inter-sectoral coordination, low-carbon and adaptation technologies	SE Asia (ASEAN countries)	X	X	X		X	X		X
UNEP Regional Gateway for Technology Transfer and Climate Change Action in Latin America and the Caribbean (REGATTA)	X	X	Multilateral, Government, Private, Universities / centers of excellence		Climate change policies, inter-sectoral coordination, low-carbon and adaptation technologies	Latin America and Caribbean	X	X	X		X	X		X
UNEP South African Network for Accelerating Investments in Climate Technology Transfer (SANAICTT)		X	Multilateral, Government, Private, Universities / centers of excellence	50	Climate change policies, inter-sectoral coordination, low-carbon and adaptation technologies	Southern Africa (SADC countries)	X	X	X		X	X		X
UNDP-Low-Emission and Climate-Resilient Development Strategies (LECRDS)	X				Low-carbon development	Global							X	
USAID-Knowledge-Driven International	X	X		N/A	Development	Global	X	X	X			X		X

Name	Type		Participant Type	Number of participants	Subtopics Addressed	Geographic Focus	Activities							
										Peer-to-Peer Forum				
	Knowledge Platform	Network					Best Practices	Data and Tools	Expert Assistance	Virtual (webinars/blogs)	Workshops	Country Peer Exchanges	Reports (emerging issues/innovation)	Training
Development														
World Bank Green Growth Knowledge Platform	X				Development, Policy	Global	X	X					X	
WRI Open Climate Network	X				Climate change	Global				X			X	

Table A-3. Network and Knowledge Platform Data: Cross-Sectoral Mitigation Networks

Name	Type		Participant Type	Number of Participants	Subtopics Addressed	Geographic Focus	Activities							
	Knowledge platform	Network					Best practices	Data and Tools	Expert Assistance	Peer-to-Peer Forum: Virtual (webinars/blogs)	Peer-to-Peer Forum: Workshops	Peer-to-Peer Forum: Country Peer Exchanges	Reports (emerging issues/innovation)	Training
Global Methane Initiative (GMI)		X	Developed countries, Developing countries	41	Mitigation, Methane, Finance	Argentina, Australia, Brazil, Bulgaria, Canada, Chile, China, Colombia, Dominican Republic, Ecuador, Ethiopia, European Commission, Finland, Georgia, Germany, Ghana, India, Indonesia, Italy, Japan, Jordan, Kazakhstan, Mexico, Mongolia, Nicaragua, Nigeria, Norway, Pakistan, Peru, Philippines, Poland, Republic of Korea, Republic of Serbia, Russia, Sri Lanka, Thailand, Turkey, Ukraine, United Kingdom, United States, Vietnam		X					X	
International Partnership on Mitigation and MRV		X	Bilateral, Developing countries, Developed countries	27	Mitigation, Policy, Promoting High-Level Dialogue	Australia, Belize, Brazil, Canada, Chile, China, Colombia, Denmark, Ethiopia, European Commission, France, Germany, India, Japan, Malaysia, Mexico, New Zealand, Norway, Papua New Guinea, Poland, Republic of Korea, Singapore, Spain, Sweden, Switzerland, United Kingdom, United States	X	X			X	X	X	X
International Research Network for Low Carbon Societies (LCS-RNet)	X	X	NGOs	17	Mitigation, Low-carbon, Development	Global					X	X	X	
LEDS Gateway	X				Mitigation, Low-carbon, Development	Global	X	X		X				
Low Carbon World	X				Mitigation, Low-carbon, Development	Global		X		X				
Mitigation Action Implementation Network (MAIN)		X	NGOs, Multilateral	3	Mitigation	Partner countries			X				X	X
World Resources Institute's Measurement and Performance Tracking (MAPT)	X		Developing countries, NGOs, Industry		Mitigation, Inventories, Accounting, Corporate Reporting, Policy	Partner countries: Brazil, Colombia, Ethiopia, India, South Africa, Thailand	X	X	X		X	X	X	X

Name	Type		Participant Type	Number of Participants	Subtopics Addressed	Geographic Focus	Activities							
	Knowledge platform	Network					Best practices	Data and Tools	Expert Assistance	Peer-to-Peer Forum: Virtual (webinars/blogs)	Peer-to-Peer Forum: Workshops	Country Peer Exchanges	Reports (emerging issues/innovation)	Training
UNEP Climate Neutral Network	X	X	Developed countries, Developing countries, Universities, NGOs, Multilateral, Private	276	Implementation, Forestry/Land Use Change, Institutions, Implementing International MRV guidelines Mitigation,	Costa Rica, Ethiopia, Iceland, Maldives, Monaco, New Zealand, Niue, Norway, Pakistan, Portugal		X				X	X	

Table A-4. Network and Knowledge Platform Data: Energy

Name	Type: Knowledge platform	Type: Network	Participant Type	Number of Participants	Subtopics Addressed	Geographic Focus	Activities: Best Practices	Activities: Data and Tools	Activities: Expert Assistance	Activities: Peer-to-Peer Forum: Virtual (webinars/blogs)	Activities: Peer-to-Peer Forum: Workshops	Activities: Peer-to-Peer Forum: Country Peer Exchanges	Activities: Reports (emerging issues/innovation)	Activities: Training
Energy, Environment and Development Network for Africa (AFREPREN)		X	Developing countries	10	Energy development, Rural development, Renewable energy	Africa						X	X	
Africa Biofuel Network	X	X			Energy, Biofuel, Renewable energy	Africa				X		X		
Africa-EU Energy Partnership (AEEP)		X	Developed countries, Developing countries, Bilateral		Energy, Policy, Finance	Africa, European Union							X	
Association of Southeast Asian Nations (ASEAN)		X	Developing countries	10	Energy	SE Asia						X	X	
Clean Energy Ministerial (CEM)-Multilateral Solar and Wind Working Group		X	Multilateral, Developed countries,	20	Energy	Australia, Brazil, Denmark, European Commission, France, Germany, Japan, Korea, Mexico, Norway, Spain, South Africa, United Kingdom, United Arab Emirates, United States of America	X	X						X
CEM-Bioenergy Working Group		X	Developed countries	4	Energy	Global		X						X
CEM-Carbon Capture Use and Storage Action Group (CCUS)		X	Private, Multilateral, NGOs, Developed countries, Developing countries	27	Carbon Capture and Sequestration	Australia, Canada, China, France, Germany, Japan, Republic of Korea, Mexico, Norway, South Africa, United Arab Emirates, United Kingdom, United States						X		
CEM-Clean Energy Education and Empowerment Women's Initiative (C3E)		X	Developed countries	9	Energy, Renewable energy, Gender equality	Australia, Denmark, Mexico, Norway, South Africa, Sweden, United Arab Emirates, United Kingdom, United States						X		
CEM-Electric Vehicles Initiatives		X	Multilateral,	14	Energy, Transportation	China, Denmark, Finland, France,						X		

Name	Type: Knowledge platform	Type: Network	Participant Type	Number of Participants	Subtopics Addressed	Geographic Focus	Activities: Best Practices	Activities: Data and Tools	Activities: Expert Assistance	Activities: Peer-to-Peer Forum: Virtual (webinars/blogs)	Activities: Peer-to-Peer Forum: Workshops	Activities: Peer-to-Peer Forum: Country Peer Exchanges	Activities: Reports (emerging issues/innovation)	Activities: Training
(EVI)			Developed countries			Germany, India, Japan, Portugal, South Africa, Spain, Sweden, United Kingdom, United States								
CEM-Global Superior Energy Performance Partnership (GSEP)		X	Multilateral	11	Energy, Buildings, Energy efficiency	Canada, European Commission, France, India, Japan Korea Mexico, Russia, South Africa Sweden, United States						X		
CEM-International Smart Grid Action Network (ISGAN)		X	Multilateral, Developed countries, Developing countries	22	Energy, Generation, Transmission, Smart Grid	Australia, Austria, Belgium, Canada, China, European Commission, France, Germany, India, Italy, Japan, Korea, Mexico, Netherlands, Norway, Russia, Sweden, Switzerland, United Kingdom, United States	X		X			X		
CEM-Solar and LED Energy Access Program (SLED)		X	Developed countries	2	Energy, Solar, Lighting, Energy access	Italy, United States						X		X
CEM-Super-Efficient Equipment and Appliance Deployment Initiative (SEAD)		X	Developed countries, Developing countries	20	Energy, Equipment efficiency	Australia, Brazil, Canada, European Commission, France, Germany, India, Japan, Korea, Mexico, Russia, South Africa, Sweden, United Arab Emirates, United Kingdom, United States						X		
CEM-Sustainable Development of Hydropower Institute		X	Multilateral, Developed countries	6	Energy, Hydro, Development	Brazil, France, Mexico, Norway, United States					X	X		
Clean Energy Solutions Center	X	X	Multilateral, Government, NGOs	26	Energy, Policy	Global	X	X	X	X	X		X	X
ClimateWorks-Best Practice Networks		X	Multilateral, NGOs	11	Energy	Global	X					X	X	
ECOWAS Regional Centre for Renewable Energy and Energy Efficiency (ECREEE)		X	Developing countries	15	Energy	West Africa				X				

Name	Type		Participant Type	Number of Participants	Subtopics Addressed	Geographic Focus	Activities							
										Peer-to-Peer Forum				
	Knowledge platform	Network					Best Practices	Data and Tools	Expert Assistance	Virtual (webinars/blogs)	Workshops	Country Peer Exchanges	Reports (emerging issues/innovation)	Training
Energy Development in Island Nations (EDIN)	X	X	Developed countries	3	Island Nation Energy development	Island nations	X	X	X					X
Environment and Development Action in the Third World (ENDA-TM)		X				Africa							X	
Energypedia	X				Energy, Renewable energy	Global	X	X						
Global Network on Energy for Sustainable Development (GNESD)		X	Multilateral, Government, NGOs	21	Energy, Development	Global		X			X		X	
Global Village Energy Partnership (GVEP)	X	X	Bilateral, Multilateral, Finance	15	Energy, Finance	Global			X				X	X
IEA-International Low-Carbon Energy Technology Platform	X				Energy, Technology	Global	X			X				
International Partnership for Energy Efficiency Cooperation (IPEEC)	X	X	Developed countries, Developing countries	15	Energy efficiency, Policy	Australia, Italy, Brazil, Japan, Canada, Mexico, China, Russia, EU, South Korea, France, United Kingdom, Germany, United States, India	X	X		X				X
International Renewable Energy Agency (IRENA)	X	X	Developed countries, Developing countries	85	Renewable energy	Global	X	X	X	X		X	X	X
Latin American Energy Organization (OLADE)	X	X	Developed countries, Developing countries	27	Energy	Latin America and Caribbean							X	X
Leonardo Energy	X				Renewable energy, Energy efficiency, Training	Global	X	X		X	X			X

Name	Type		Participant Type	Number of Participants	Subtopics Addressed	Geographic Focus	Activities							
	Knowledge platform	Network					Best Practices	Data and Tools	Expert Assistance	Peer-to-Peer Forum: Virtual (webinars/blogs)	Peer-to-Peer Forum: Workshops	Peer-to-Peer Forum: Country Peer Exchanges	Reports (emerging issues/innovation)	Training
OAS-Renewable Energy in the Americas (REIA)	X				Energy, Development	North America, Latin America and Caribbean	X		X				X	X
Open Energy Information	X				Renewable energy, Data	Global	X	X		X			X	
Reegle	X				Renewable energy	Global		X		X	X			X
Renewable Energy Policy Network for the 20th Century (REN21)	X	X		N/A	Renewable energy, Policy	Global		X					X	
UNEP-en.lighten	X				Energy, Energy efficiency	Global	X	X					X	
United Nations Energy Knowledge Network		X	Multilateral	21	Energy	Global	X	X		X			X	

Table A-5. Network and Knowledge Platform Data: Land Use

Name	Type		Participant Type	Number of Participants	Subtopics Addressed	Geographic Focus	Activities							
										Peer-to-Peer Forum				
	Knowledge Platform	Network					Best Practices	Data and Tools	Expert Assistance	Virtual (webinars/blogs)	Workshops	Country Peer Exchanges	Reports (emerging issues/innovation)	Training
Adaptation and Mitigation Knowledge Network		X		N/A	Mitigation	Global				X				
Center for International Forestry Research	X				Forestry,	Global		X						
Coalition of Rainforest Nations		X	Developing countries	42	Forestry, Biodiversity	Cameroon, Central African Republic, Democratic Republic of Congo, Equatorial Guinea, Gabon, Ghana, Kenya, Lesotho, Liberia, Madagascar, Nigeria, Republic of Congo, Sierra Leone, Uganda, Dominica, Dominican Republic, Bangladesh, Malaysia, Pakistan, Indonesia, Thailand, Viet Nam, Oceania, Fiji, Papua New Guinea, Samoa, Solomon Islands, Vanuatu, Central America, Belize, Costa Rica, El Salvador, Guatemala, Honduras, Nicaragua, Panama, Argentina, Chile, Ecuador, Guyana, Paraguay, Suriname, Uruguay						X		
Consultative Group on International Agricultural Research (CGIAR)		X	Developing countries, Developed countries, Finance, Multilateral, NGOs	22	Agriculture	Global		X		X			X	
Food and Agriculture Organization of the United Nations (FAO) Climate Impact on Agriculture (CLIMPAG)	X				Forestry, Agriculture	Global		X						
Institute for Global Environmental Strategies - REDD+ Project Database	X				Forestry, REDD	REDD Partner Countries		X						

Name	Type		Participant Type	Number of Participants	Subtopics Addressed	Geographic Focus	Activities							
										Peer-to-Peer Forum				
	Knowledge Platform	Network					Best Practices	Data and Tools	Expert Assistance	Virtual (webinars/blogs)	Workshops	Country Peer Exchanges	Reports (emerging issues/innovation)	Training
Sustainable Development Policy and Practice - Forests and REDD	X				Forestry, REDD	Global				X				
UNFCCC-REDD Web Platform	X				Forestry, Mitigation	Global	X	X	X				X	
Verified Carbon Standards - REDD Methodology Modules	X				Forestry, REDD	Global		X						X

Appendix B. Comparison of Technology Needs Assessments, Nationally Appropriate Mitigation Actions, Roadmaps, and LEDS

Table B-1 (Cox and Benioff 2011, Table 1) compares some of the types of international instruments used to support low emissions planning. Assistance activities include support for green growth, low emissions or low-carbon growth plans, TNAs, NAMAs, and technology roadmaps.

Table B-1. Comparison of Technology Needs Assessments (TNAs), Nationally Appropriate Mitigation Actions (NAMAs), Roadmaps, and Low Emission Development Strategies (LEDS)

Program	Background	Key Questions Addressed by Host Country	Primary Products
TNAs	TNAs are an approved element of United Nations Framework Convention on Climate Change (UNFCCC) technology transfer framework under Article 4.5. The Global Environment Facility (GEF) has provided TNA support to more than 90 countries and has initiated support for more in-depth TNAs to about 30 countries.	What are the priority mitigation and adaptation technologies to achieve climate and development goals? What portfolio of domestic programs and projects and international cooperation will facilitate implementation of these technologies?	Description of priority adaptation and mitigation technologies Action plan for domestic programs to advance technology deployment Potential projects for international support to advance technology deployment
NAMAs	NAMAs were adopted under the Bali Action Plan as a mechanism for developing countries to undertake voluntary projects to reduce GHG emissions with international support. The Copenhagen Accord notes that countries should describe NAMAs in their national communications and establishes registry of NAMA projects proposed for international support. The COP 16 draft decision notes that NAMAs should “include information on mitigation actions, the national greenhouse gas inventory report, including a description, analysis of the impacts and associated methodologies and assumptions, progress in implementation and	Which projects and programs are the priorities for reducing GHG emissions and achieving development goals? What domestic action can be undertaken to advance these mitigation measures? What international technology, financing, and capacity building support are needed to implement these projects?	Description of priority mitigation projects Proposals for international support for mitigation projects that would be combined with domestic action

Program	Background	Key Questions Addressed by Host Country	Primary Products
	information on domestic measurement, reporting and verification and support received…"[a]		
LEDS/Low-Carbon Development Strategies (LCDS)	As first noted in the Copenhagen Accord, the COP 16 draft decision states that "a low-carbon development strategy is indispensable to sustainable development"[b] and encourages developing countries to prepare low-carbon development strategies.[c] Pilot projects to assist countries with LEDS development have been initiated by the United States, Netherlands, European Commission, and others.	What are the near and long-term development and low emission goals and benefits? Which technology and market pathway will best achieve these goals? What portfolio of policies and measures will yield low emission growth? How can these policies and measures be implemented and the plan monitored and refined? What international support is needed?	Development and low emission goals and benefits for the country and by sector Pathway for low emission development Action plan of low emission policies and measures Process for plan implementation, monitoring, and refinement Proposals for international support for low emission development
Roadmaps	A technology roadmap is a specialized type of strategic plan that outlines activities an organization can undertake over specific time frames to achieve stated goals and outcomes. Technology-specific roadmaps are intended to support the development of specific types of technologies. The roadmaps serve to achieve consensus on low-carbon energy milestones, priorities for technology development, policy and regulatory frameworks, investment needs, and public engagement.[d]	What is the status of the technology in question? What is the potential for the technology in question? What goals and milestones should be established for the specific technology? What are the gaps and barriers to deployment of the technology? What action items can overcome these barriers? Which are highest priorities? What is the timeline? How can these actions be effectively implemented and monitored?	Quantified goals for each technology or sector of interest Timeframe of milestones for achieving interim targets Identification of gaps and barriers to deployment of the technologies Identification of action items to address the barriers Prioritized actions, timeline for implementation of the actions and tracking system to assess progress

[a] Draft decision -/CP.16.Outcome of the work of the Ad Hoc Working Group on long-term Cooperative Action under the Convention. #64. Pg. 10. http://unfccc.int/files/meetings/cop_16/application/pdf/cop16_lca.pdf
[b] Draft decision -/CP.16.Outcome of the work of the Ad Hoc Working Group on long-term Cooperative Action under the Convention. #6. Pg. 2. http://unfccc.int/files/meetings/cop_16/application/pdf/cop16_lca.pdf
[c] Draft decision -/CP.16.Outcome of the work of the Ad Hoc Working Group on long-term Cooperative Action under the Convention. #65. Pg. 10. http://unfccc.int/files/meetings/cop_16/application/pdf/cop16_lca.pdf
[d] Text from Antonia Gawel, IEA

Table B-2. Potential Functions of the Climate Innovation Center (CIC)

CIC Function	Gap or Barrier Addressed
TECHNOLOGY	
Help improve the technology development process to ensure the availability of technologies for local markets	
Undertake technology needs assessment and/or options analysis to understand which technologies are best suited to advance adaptation and mitigation in the local context	Lack of understanding among firms about the scale and scope of climate challenges and lack of familiarity with technological possibilities and performance of existing technologies; emphasis mostly on mitigation rather than adaptation
Facilitate applied R&D through provision of small grants; improved communication, interactions, and collaboration among actors (entrepreneurs, firms, universities, government laboratories); and international networking and experts-in-residence	Inadequate applied R&D due to lack of market signals, limited existing technical capabilities within firms and other organizations, or lack of coordination among actors
Work with governments to develop demonstration programs to identify technologies with high potential and fund projects to evaluate technology and product performance under real-world conditions through demonstrations and field-trials	Uncertainty about in-situ costs and performance, and lack of end user awareness; lack of funding or institutional structures to enable technology demonstration and to utilize the learning in technology/ product improvement
MARKETS	
Promoting demand through creation and strengthening of markets for climate technologies	
Market analysis to help better understand the characteristics of the demand and markets for specific technologies	Lack of clear understanding among policymakers and firms about potential size and nature of markets
Help develop policies to enhance markets for climate technologies (this can involve, for example, feed-in tariffs, renewable portfolio obligations, government procurement programs, environmental standards)	Climate technologies may cost more than existing options in the absence of climate policies; buyers are risk-averse about new technologies; firms do not invest in technology development, manufacturing facilities, and supply networks until markets exist.
Identifying and overcoming barriers to deployment (for example, lack of consumer awareness tackled through information and labeling programs, making financing options available for firms that cannot invest in energy-efficient options that have high initial investments but low payback periods)	Lack of awareness, information, and market structures limit uptake of climate technologies, even if they are cost-competitive with existing options.
COMPANY	
Supporting entrepreneurial as well as existing ventures to succeed in the business of climate innovation	
Advance enterprise creation by linking technical researchers with entrepreneurs, venture capitalists, and business people; provide some limited seed funding for new firms	Lack of business skills within research/ technical personnel; lack of seed funding to start new technology firms
Provide business advisory services such as strategic and business development advice to start-ups; information provision about new	Lack of detailed understanding about technologies, markets, consumer needs, business strategy, and business development possibilities

CIC Function	Gap or Barrier Addressed
technologies; market analysis and consumer surveys	
Training programs to upgrade business management, managerial, operational, and technical capabilities	Limited skills of existing personnel, lack of appropriately-trained workers
Provide support services and infrastructure for start-ups and other small firms	Lack of resources to invest in appropriate infrastructure
Working with governments to streamline policies for effective operation of small businesses	Bureaucratic hurdles and complex policies impede effective functioning of small firms and act as barrier to entrepreneurship
REGULATIONS	
Ensuring that the regulatory framework supports climate innovation	
Help develop regulatory framework that supports the uptake of new climate technologies in existing markets	Regulations may hinder the introduction of new climate technologies that may incur higher costs or have different performance characteristics than existing option (for example, by requiring utilities to choose lowest-cost options)
Help develop technology standards and certification schemes to build consumer confidence in new technologies	Uncertainty on part of consumers about performance of new technologies
Help with modification of regulations that may impede technology development and diffusion	Regulations may serve as a barrier to the development of fledgling or even established local businesses (e.g., high customs duty on parts but not assembled goods)
Improve financial regulatory architecture to promote investments in climate innovation	Financial regulations may limit investment and exit strategies for investors, limited openness to new debt and financing instruments
Improve evaluation and protection of intellectual property	Lack, or ineffective functioning, of intellectual property rights (IPR) rules and institutions impedes both innovators as well as investors
FINANCE	
Facilitating the expansion of financing options for climate innovation by both helping deepen the pool of funds available and enhance access for firms	
Work with governments and private investors to increase pool of funds to support various, especially early, stages of climate innovation	Limited funds available to support technology innovation, especially climate innovation, in many developing countries
Help expand early-stage financing through co-investments, loans or risk guarantees to help viable businesses attract private-sector funding	Lack of financing (typically first or second round) for early stage technology/ product development due to classic innovation barriers combined with perceived energy technology market/ policy risks.
Help overcome “valley of death” by working with government to develop programs to provide financial support for the translation of technologies to viable products through for example early-stage innovation grants to small firms or new business units	Limited funding from private and public sources available for moving technologies to product ready for market but no internal source of funding within firm, especially if start-up, since too early for cash flow from technology

CIC Function	Gap or Barrier Addressed
Explore innovative options to develop and tap new avenues of finance	Financing approaches often are not tailored to the needs and context of developing countries
Facilitate easier access to finance for firms through improved interactions between firms and funders, coordinate funding avenues, elimination of bureaucratic hurdles, and enhancing investor confidence	Access to financing is impeded by bureaucratic hurdles, limited avenues of interaction with funders, and limited information about, and confidence in, firms available to funders
COORDINATION AND NETWORKING	
Streamlining the innovation process through a bird's-eye view of various activities in the innovation process	

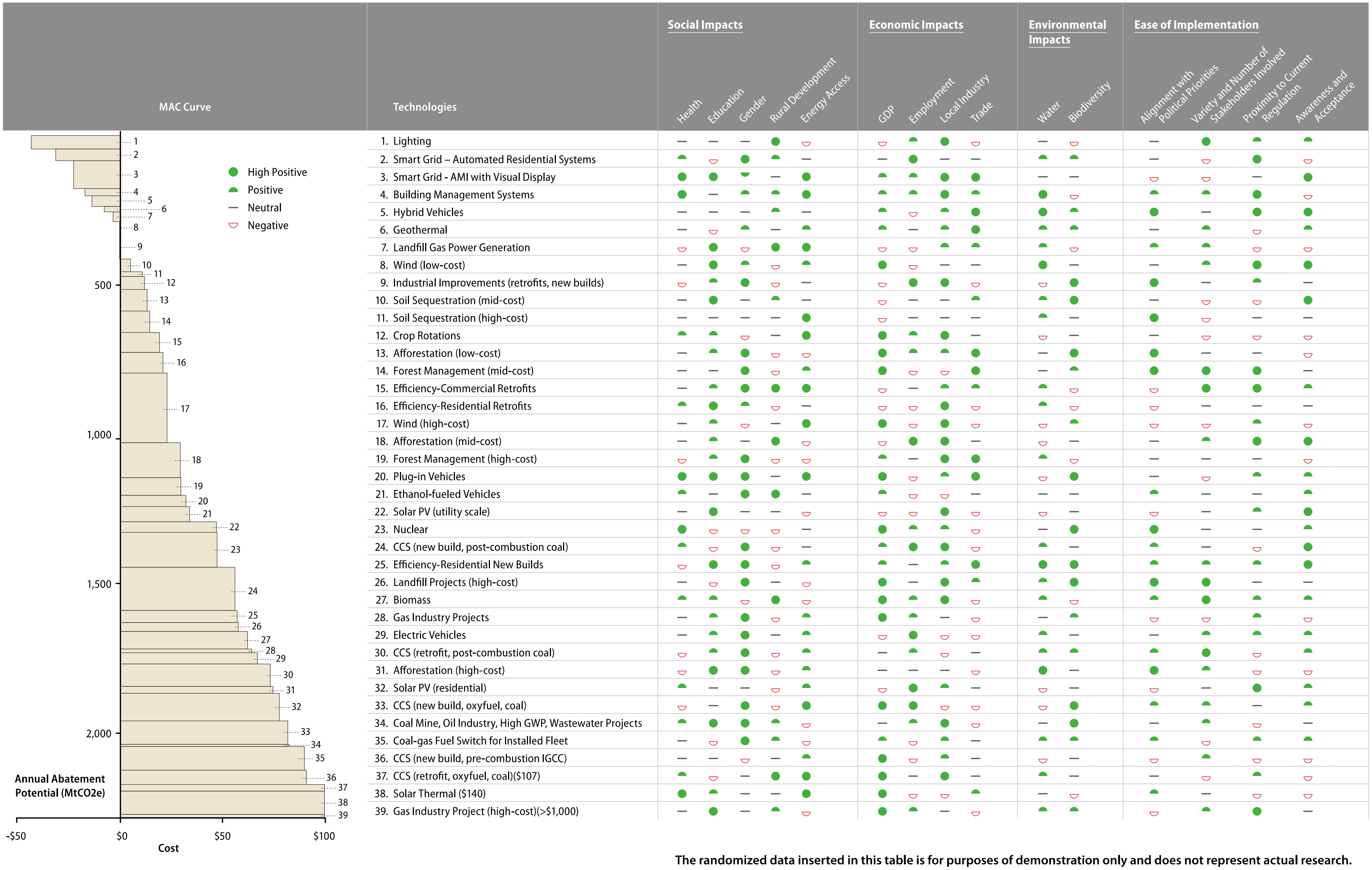

Figure B-1. Data visualization proposed to simultaneously communicate GHG mitigation potential and development benefits of technology options

Source: CLEAN (2011c)

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