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International Actions to Support Green Growth Innovation Goals

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Achieving global goals for poverty reduction, economic growth and environmental health will require widespread innovation and implementation of new and appropriate "green growth" technologies. Establishing a sufficiently large suite of innovative technology options, suitable to diverse economies, and at the urgent pace required will involve unprecedented innovation activity not only from developed regions, but also from new clusters and enterprises in emerging economies and least developed countries. By linking national governments, the private sector and the international community, international cooperation can contribute substantively in five green innovation priority areas:

1. Cultivating innovation capacity and ecosystems in least developed countries (LDCs);
2. Facilitating and strengthening existing entrepreneurial cultures;
3. Significantly scaling up research and development (R&D) activities through competitive grants;
4. Encouraging financing for large-scale demonstration and deployment of complex but transformative new technologies; and
5. De-risking entrepreneurial investments and stimulating intellectual property (IP) sharing.

In this brief[1] we describe several ways that international cooperation can play a critical role in facilitating this transformative process and outline six existing institutional structures that have been invoked as possible examples for scaling up to foster green innovation more broadly. Finally, we suggest several policy recommendations that are feasible in the near term.

GREEN INNOVATION CONTRIBUTES TO GROWTH AND DEVELOPMENT GOALS

Many of the biggest challenges facing countries today—economic growth in high-value activities with broadly shared benefits, poverty reduction and environmental quality—could be addressed substantially with clean and sustainable technologies that raise productivity and create new markets. Such innovation, which often contributes to broader social benefits not captured in market prices, has the potential to unlock solutions to challenges like climate change, energy access, environmental degradation, sanitation and water scarcity. Moreover, embracing new pathways that are more environmentally and socially sustainable need not divert resources from economic productivity, but rather can serve to fuel the engine of economic growth.

In a recent Brookings-GGGI report,[2] we identified many institutional gaps and market failures in the current global approach to green innovation. We also outlined the areas in which a new strategy for encouraging innovation, especially in least developed countries, could accelerate progress. Such a strategy would focus on the development of new and profitable business models, novel approaches to financing and underlying innovation capacity in our national and global institutions.

This approach to addressing global development goals through green technologies will require support for innovation across all development contexts. Establishing a sufficiently large suite of technological options at the urgent pace required will involve unprecedented innovation activity not only from developed regions, but also from new clusters and enterprises in emerging economies and least developed countries. The spread of mobile telephony demonstrates that new markets at the 'base of the pyramid,' sometimes viewed as marginal to the innovation agenda, do have the potential to drive change. Simultaneously, economic development has increased global capacity for R&D and created a new tier of emerging innovators in developing countries. Successful examples show that a vibrant innovation environment—helpfully construed as an innovation ecosystem (Figure 1)—is con-

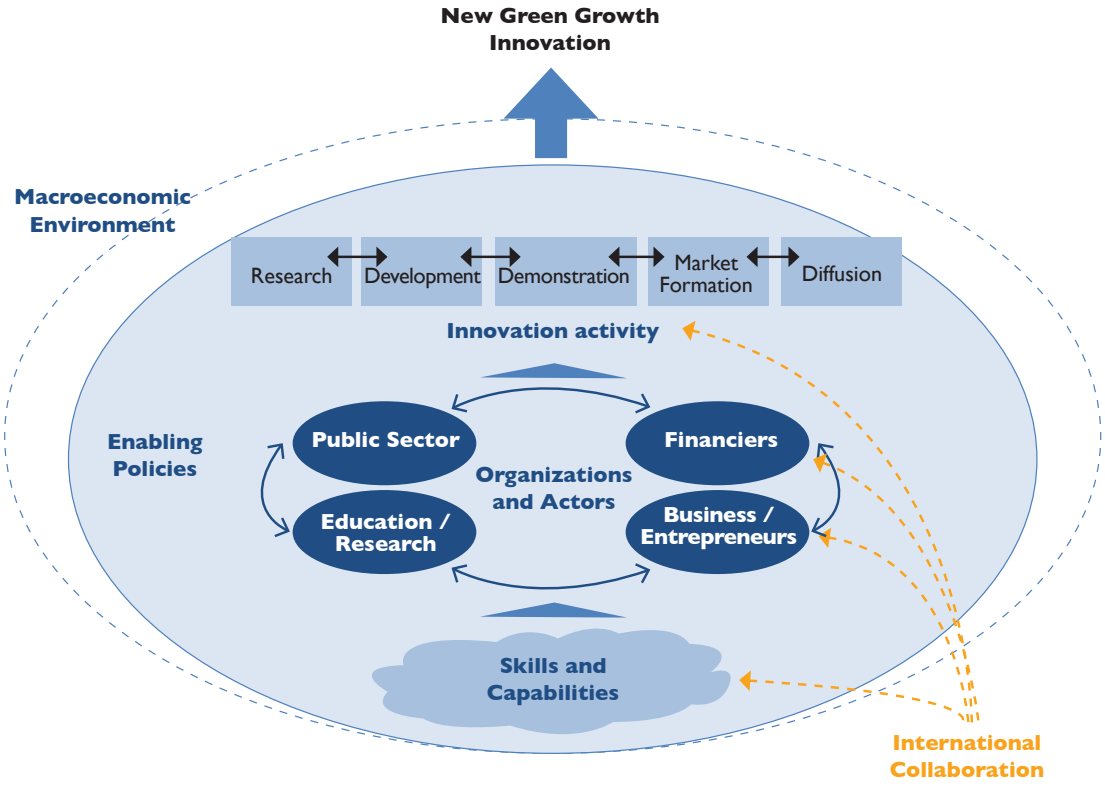
tingent on enabling policies and economic conditions that cultivate skills and capabilities, and that link the innovation actors and organizations. Such conditions include education and training support, direct public funding, legal frameworks, infrastructure, supply-demand mechanisms that drive strong private sector engagement and a business climate that encourages entrepreneurship.

The research presented here targets opportunities for international cooperation to catalyze new innovation capacity in developing countries. The research examines the state of innovation ecosystems in emerging and least developed countries, surveys existing international support programs and assesses gaps. Five areas of support are identified: a more aggressive program to help countries build innovation capacity; support for catalyzing an entrepreneurial culture; scaled-up investment in research and development to cultivate technical knowledge; large-scale financing for demonstration and deployment of complex but transformative new technologies; and investment de-risking and IP sharing.

BUILDING INNOVATION SYSTEMS IN MULTIPLE DEVELOPMENT CONTEXTS

Emerging economies represent a new tier of innovators that are developing deeper capabilities, establishing enabling conditions and achieving a strong innovation supply chain in parallel to their growing economic activity and industrial development. Nevertheless, the available evidence on innovation activities suggests that gaps between developing and developed countries remain large across both frontier and adaptive innovation.[3] Only a handful of emerging countries may be on

FIGURE 1: THE INNOVATION ECOSYSTEM



Source: Modified from U.N.World Economic and Social Survey 2011.

course to close these gaps, and many less developed countries are only beginning to build out their innovation infrastructure. Continued growth from emerging leaders and a quicker move to close remaining gaps would provide a welcome boost to global innovation capacity, activity and outcomes.

Data on innovation spending reveals large gaps between least developed countries, emerging economies and developed countries. No developing country apart from China is spending more than 1.2 percent of GDP on R&D, and the least developed countries spend well below 0.5 percent, as compared to developed countries, which spend on average 2.5 percent, and as much as 4 percent. Renewable energy R&D is dominated by developed countries (75 percent of total R&D in 2011), with the remainder taken up largely by China. High-income countries also produce the largest number of green technology patents. Despite these trends, analysis shows that research capacity in emerging countries is large relative to existing innovation activity, representing a positive trend in ecosystem maturity and suggesting some countries are underutilizing their potential capacity.

In addition to the broader lack of innovation support at a macro level, various micro barriers to green growth innovation sap entrepreneurial vitality in developing countries. These include a lack of suitable technical capacity and infrastructure; policy instruments that emphasize short-term economic growth over sustainability; high costs associated with initial technology transition; entrenched subsidies for high carbon infrastructure and technologies; institutional and governance limitations, such as a lack of enforcement mechanisms to support intellectual property rights; lack of access to capital; and lack of policies to internalize social and environmental costs, among others. A number of policy and incentive instruments have been developed to address these barriers. Applied to green growth technology innovation, these instruments include capacity building (both underlying science and innovation capacity, as well as policy-delivery capacity), operating standards and legislation (e.g. advanced market commitments, licensing agreements, open trade policies, manufacturer standards, etc.), incentive systems (e.g. research grants, subsidies, ranking systems, tax credits, etc.), and collaborative efforts (e.g. applied research networks, patent pools and commons, technology transfer programs, etc.). In LDCs, where the barriers remain most formidable, dramatic policy development will be required. In the emerging economies, doubling down on such policy and incentive instruments remains critical to fully building out and leveraging the innovation ecosystem.

Seeding green innovation ecosystems across the world's regional and economic contexts will require *both* the intentional deployment of national policies and international partnerships. While national policy is the key contextual driver of any innovation ecosystem, international partnerships can help fill the gaps that currently exist by fostering strong innovation ecosystems and increased innovation outputs. They can cultivate science, technology and innovation capacity, foster relevant R&D and entrepreneurial initiatives, and increase financing for IP diffusion and innovation-driven investment. Our broader survey of existing international efforts shows that large gaps remain in all of these key areas, and suggests that reinforcing domestic policies with enhanced international collaboration for innovation can significantly accelerate the green growth transformation, with benefits for all.

PROMISING MODELS IN INTERNATIONAL COOPERATION FOR INNOVATION AND THEIR APPLICATION TO GREEN GROWTH

Our analysis on international initiatives for early stage green growth innovation shows that over 160 international initiatives have been created to support developing country innovation activities, with services ranging

from financing and policy advocacy to on-the-ground technical assistance. Several high-visibility examples, selected because of their prominence in the current policy discussion, are briefly summarized below:

- **CGIAR:** The Center for Global International Agriculture Research (CGIAR)[4] is a global research alliance of 64 governments, private foundations, and international and regional organizations working to reduce poverty, hunger and malnutrition, and ensure sustainable development through improved agriculture. CGIAR has an annual budget of more than $500 million and operates a network of 15 research centers and three challenge programs related to water, food and unlocking crop genetic diversity. The centers conduct R&D on staple crops and ecosystems for human sustainability and have come to be viewed as best-in-class examples of international applied research centers. Despite their successes, limitations of the CGIAR model include the need for substantial funding and the permanent location of a physical center.
- **CERC:** U.S.-China Clean Energy Research Center (CERC)[5] facilitates joint clean energy R&D, utilizing teams of scientists and engineers from both nations, with broad participation from universities, research institutions and industry. Priority topics to be addressed under this initiative include building energy efficiency; clean coal (including carbon capture and storage); and clean vehicles. The center was established in 2009 and is supported by public and private funding of at least $150 million over five years, split evenly between the two countries. While the center is currently operational, IP issues were difficult to resolve and could represent a barrier to scaling-up.
- **CIETEC:** the Center for Innovation, Entrepreneurship and Technology (CIETEC), Brazil,[6] is a public-private partnership that was funded in April 1998, after an agreement signed by the Department of Economic Development, Science and Technology of the State of São Paulo (SDECT), the Brazilian Service of Support for Micro and Small Companies (Sebrae-SP), the University of São Paulo (USP), the Nuclear and Energy Research Institute (IPEN) and the Institute for Technological Research (IPT). Its mission is to encourage entrepreneurship and technological innovation, and support the creation and strengthening of new companies and innovative technology-based start-ups. CIETEC conducts different processes of pre-incubation, incubation and post-incubation of innovative companies aimed mainly at the strengthening and consolidation of these companies, their management, technological development, market share and high-level employment generation. CIETEC currently has operational and physical infrastructure to support about 130 technology-based companies.
- **UNFCCC Technology Mechanism:** The Technology Mechanism[7] was established under the United Nations Framework Convention on Climate Change (UNFCCC) in 2010 to facilitate the implementation of enhanced action on technology development and transfer to support action on mitigation and adaptation. The mechanism consists of a Technology Executive Committee (TEC) with a mandate to conduct needed analysis, recommend policy actions, guide development of low emissions development strategies and facilitate collaboration for tech transfer. It also consists of a Climate Technology Center Network (CTCN), which aims to facilitate networking and information provision. Although the mechanism was made fully operational in 2012, key issues including mobilizing funds and linking to financing mechanisms as well as rules for intellectual property rights have not yet been established.
- **WIPO Green:** WIPO Green[8] is a sustainable technology marketplace designed to accelerate the development and dissemination of green technologies to combat environmental chal-

lenges and whose objectives are the "accelerated adaptation, adoption and development of environmental technologies". It includes two components: a free database and a network. Users can access the database to make available their green technologies for licensing or partnership agreements, enter their technology needs and search for technologies and needs. In addition, users can access the network to obtain advice and services to assist transactions and connect with experts worldwide from industry, universities, governments, IGOs and NGOs. The initiative was created with industry, particularly the Japan Intellectual Property Association.

- **World Bank CIC:** The World Bank Group's *info*Dev launched a network of physical innovation centers, or Climate Innovation Centers (CICs),[9] in 2012 to accelerate the development, deployment and transfer of locally relevant climate technologies. The CICs boost developing country green growth and job creation by financing and supporting the competitive and profitable involvement of clean tech small and medium enterprises (SMEs) in local and international supply chains and markets. The aim is to create a global network of CICs that promote business-to-business linkages, enhance knowledge sharing, and facilitate trade and export opportunities. The network is expected to create over 2,400 enterprises, generate 240,000 direct and indirect jobs, install 3000 MW of off-grid energy capacity, provide energy access to over 28 million people, deliver clean water to over 10 million households and mitigate 65 million tons of CO_2. Business plans for CICs have been developed in Kenya and India and are underway in a number of other markets globally. The first CIC in Kenya secured $15 million in funding and was launched in 2011.

Despite these successes, existing initiatives have not achieved scale nor are they expanding at a rate to materially influence many countries' development trajectories. Many initiatives fail because of a real or perceived lack of equivalent protection and enforcement of IP rights across countries and the desire by private sector entities to protect IP for self-commercialization. CERC is a unique success story in this context, but it required years of negotiation and political capital to achieve its robust IP regime; many initiatives of a similar scale lack the funding and necessary backing to navigate this process.

Most international innovation programs with significant private sector participation have either relied on flexible approaches essentially determined by partners at the project level, or in some cases on broader frameworks that exclude nonmembers and usually require complex arrangements. Our 2012 study of international innovation programs documents multiple policies that to date have been unable to mobilize the implementation capacity, degree of innovation and pace of investment needed to ensure developing countries achieve a green growth trajectory consistent with goals such as zero net deforestation, a net increase in attractive employment opportunities through sustainable enterprises and reduced risk of cataclysmic climate change (e.g. a 450 ppm pathway) by 2020. Green growth innovation requires a particularly strong mix of concerted public policies, accelerated broad-based diffusion that goes beyond typical "catch up" and global coordination. An incremental shift of long-standing innovation support mechanisms is unlikely to suffice.

NEW PATHWAYS FOR INTERNATIONAL COOPERATION

Experience from existing initiatives (including the six described above) shows that scaled-up international cooperation to support green growth innovation should: build innovation capacity in LDCs; support innovation across the technology value chain; be flexible and take risks to respond to unknown future market needs; facilitate the sharing of intellectual property; include fi-

nancial innovation to de-risk private investment at early venture stages; attract the private sector and a new tier of developing countries as contributors; instill transparency and accountability; tackle the challenges of green growth innovation that requires global coordination; and build on existing initiatives.

Based on an assessment of existing gaps[10] and near-term tractability, a number of particular opportunities exist for a renewed international initiative to support green growth innovation:

- **A program to catalyze innovation ecosystems in least developed countries**. This could be pursued through dedicated funding or Innovation Capacity Catalyst Funds (ICC). Funds would support development of skills and capabilities, and facilitate linkages across actors in the system. Funds would be deployed flexibly, as appropriate to the local context, and might include: course development, faculty support and remote learning; education-research scholarships; knowledge network development; and seed funding for technology innovation centers or other research, development and demonstration (RD&D) related institutions. The recently established UNFCCC Climate Technology Centre and Network (CTCN) should play a key role in leveraging new funding and coordinating existing funding to drive such an initiative. In addition, larger multilateral programs could be formed, building on existing innovation initiatives that are primarily bilateral.
- **Internationally sponsored networks of business incubators** to spur entrepreneurship and start-ups working in green growth sectors. The goal would be to invest in a set of networks, with different approaches and different regional or sector coverage. The networks could select local incubator partners and support functions best developed at scale—facilitate innovator-entrepreneur collaboration across borders, provide seed funding, create joint mechanisms with large financing windows, establish partnerships with multinational global innovation supply chains, etc. This initiative could be driven by the expansion of existing multilateral efforts (e.g. *info*Dev) or by public-private partnership initiatives, such as the Green Growth Action Alliance (G2A2) created by the B20 last year.[11]
- **Significantly scaled-up innovation activity via competitive grants**. These grants would fund research and development in least developed countries, and would build research networks and capacity while yielding research results. Networks could take the form of regional science foundations in developing regions, or global science foundations focused on key sectors, and could be governed by intergovernmental agencies charged with setting broad innovation priorities and deploying funding in an open and flexible manner that facilitates new ideas. These foundations would not directly build innovation infrastructure, but support the expanding and linking of existing infrastructure. Existing intergovernmental collaborative arrangements (e.g. CGIAR) could form the basis for such "foundations". Alternatively, large funds focused primarily on technology deployment (e.g. the Green Technology Fund) could expand the scope of their funding to include innovation grants, potentially integrated with deployment investments.
- **Large demonstration programs to de-risk system-level transformation.** These programs would facilitate a critical mass of funding and technical resource for demonstration in developing countries with the ultimate aim of allowing developing countries to "leap frog" their infrastructure development more directly to green growth solutions. Focus areas include smart grids, low carbon transportation networks, integrated urban master planning, large-scale water management and carbon capture and storage (CCS). Programs would use grant funding to

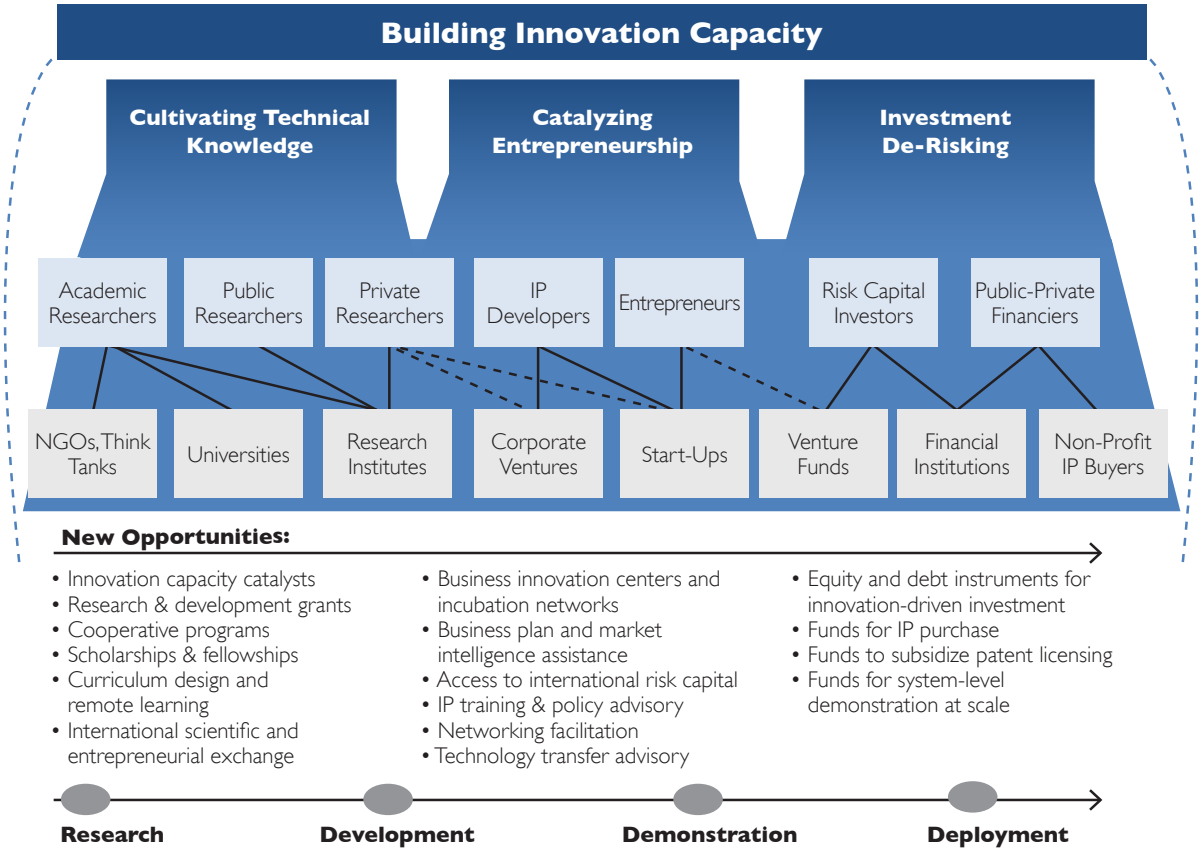
de-risk and leverage commercial financing. Such a program could be developed as a large, new intergovernmental fund, or it could be created as a coordination and fundraising mechanism working across multiple funds.

- **Dedicated funds to de-risk entrepreneurial investments and stimulate intellectual property (IP) sharing**. These funds could encourage private investment in developing country innovation projects by supporting earlier stages of product development and demonstration, opening access to IP, and fast-tracking pre-commercial deployment. Financial instruments include concessional loans, sovereign guaranteed loans, first loss funds, financing for patent pools, partial credit or risk guarantees, and equity or quasi-equity investments. They would be most effectively utilized in combination with (or embedded in) a larger deployment fund such as the Green Climate Fund, with the understanding that such de-risking funds would not be returned on average over time.

An important element cutting across all of these areas is increased focus on innovation as a fundamental driver of green growth. For example, the inclusion and emphasis of science and technology capacity building could be an element in the next generation of the Millennium Development Goals and Sustainable Development Goals.

The resulting "architecture" (as shown in Figure 2) is rooted in support for capacity building, and would provide full financial, technical and business support to researchers, developers, business people and financiers along the research, development, demonstration and deployment (RDD&D) continuum. Building on existing institutions by creating a consortium of actors with a coordinating mechanism could ensure low transaction costs while streamlining access to international finance and consolidating brokerage and intermediary services.

FIGURE 2: A NEW INTERNATIONAL APPROACH TO SUPPORT GREEN GROWTH IN DEVELOPING COUNTRIES



Source: Hultman, Sierra, Eis and Shapiro, 2012.

ENDNOTES

1. This brief is based on a longer report by the Brookings Institution & the Global Green Growth Institute: Hultman, Nathan, Katherine Sierra, Jason Eis, and Allison Shapiro (2012) Green Growth Innovation: New Pathways for International Cooperation. The Brookings Institution and the Global Green Growth Institute, November 2012.
2. Hultman, Nathan, Katherine Sierra, Jason Eis, and Allison Shapiro (2012) Green Growth Innovation: New Pathways for International Cooperation. The Brookings Institution and the Global Green Growth Institute, November 2012.
3. Frontier innovation activities are novel solutions that have not yet been introduced to the world. These novel solutions may be either radical or incremental, and are most common during research and development. Adaptive innovation activities involve the application of existing technologies into new contexts. This adoption may be an entirely "off-the-shelf" transfer or it may involve ancillary adaptations. It is most common during demonstration and deployment, and primarily involves "learning by doing" (Hultman, Sierra, Eis and Shapiro, 2012).
4. More information can be found on the CGIAR website: http://www.cgiar.org/
5. More information can be found on the U.S.-China Clean Energy Research Center website: http://www.us-china-cerc.org/
6. More information can be found on Brazil's Center for Innovation, Entrepreneurship and Technology website: http://www.cietec.org.br/
7. More information on the Technology Mechanism can be found on the UNFCCC website: http://unfccc.int/focus/technology/items/7000.php
8. Information on WIPO Green is found on the World Intellectual Property Organization website: https://www3.wipo.int/wipogreen/
9. Information on the World Bank's Climate Innovation Centers can be found on the infoDev website: http://www.infodev.org/en/Topic.19.html
10. Hultman, Sierra, Eis and Shapiro, 2012.
11. For more information on the Green Growth Action Alliance (G2A2), visit the World Economic Forum website: http://www.weforum.org/issues/climate-change-and-green-growth

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