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# ENERGY AND GREEN GROWTH:
## RECASTING THE OPTIONS, RE-ENVISIONING SUSTAINABILITY

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## INTRODUCTION

The threats of global climate change, energy security, and human health present a major challenge to global development, but are also reasons to re-envision our approach to innovation and energy technologies. Re-envisioning sustainable development for the 21st century therefore requires more than environmentally benign economic growth—instead, it requires a broadening of clean energy entrepreneurship and innovation to encompass new regions, new technologies, and new approaches. For example, new centers of energy innovation in emerging economies and developing countries can become a fount of new ideas, approaches, and engineering solutions necessary to address climate change. With innovative capacity and technological expertise expanding in this way, the major obstacles to technological development are now institutional—access to capital and financing, access to markets, market transformation, and the integration of entrepreneurial risk takers with technical experts.

In this framing, green growth provides a route toward recasting our energy economy to be sustainable while simultaneously encouraging new industries and economic diversification. In this sense, green growth recognizes the integration of long-term strong economic and environmental performance and the promotion of new ideas, transformational innovations, and state-of-the-art technology. The energy sector poses a particular challenge in the context of green growth given the energy-dense fossil fuels and related infrastructure that continue to dominate the energy system. New sources of alternative energy must therefore be deployed at a pace, scale, and cost beyond that of the industrial revolution of the 19th century. Without such decisive action, energy-related carbon emissions could double by 2050.

## ELEMENTS OF GREEN GROWTH FOR ENERGY

Like the familiar concept of sustainable development, "green growth" is a concept often discussed, but whose details are nebulous. Many observers agree that green growth is a good and appropriate pathway for diverse economies and invoke it as a proper future route toward a low-carbon world. Translating this goal into policy, however, requires more precise language. We here propose a four-part approach to establishing a green growth agenda for the energy economy:

- **Energy innovation.** Innovation is at the root of all technological change and encompasses processes from basic research to commercialization of technologies. Any serious attempt to transform global energy use requires the technological building blocks created by the innovative process. Policy should encourage this innovation, recognizing the diversity of entrepreneurial cultures globally and seeking to focus the different ideas, experiences, and local needs of each place toward establishing new and transformative approaches to providing energy services.
- **Energy integration.** While new technologies are essential, sometimes the integration of multiple existing technologies for an existing need is sufficient. As one example, this "mundane science" approach has been applied successfully by integrating lower-cost LEDs, rechargeable batteries, and small solar panels to create a lighting technology for development that is simple, inexpensive, and robust. Integrated technologies can benefit from market confidence so policy can play a role in ensuring transparency and quality in the early stages of diffusion.
- **Energy implementation.** Because of inertia and inherent subsidies in many economies, clean technologies are often at a market disadvantage relative to conventional technologies, even though they may be less costly when exter-

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nalities are included. Many existing technologies could therefore be utilized more frequently without any economic loss to society, and policy can encourage this in many ways. Carbon pricing is one route, but minimum standards, labeling, and other regulatory incentives can help bring existing technologies off the shelf and into widespread use.

- **Energy transformations.** The goal of green growth for energy is the fundamental reworking of energy economies over a decadal timescale, while realizing benefits to the local economy. For this goal to be realized, though, signals to the private sector must be, to use Stern's phrase, "clear, credible, and long term." Studies of past energy transitions show that consistency in policy is one of the primary factors underpinning success.

## CHALLENGES

### Governance & Investment

Several key challenges surface when evaluating the integration of energy into a green growth framework, especially one needed to address the consequences of climate change due to increased emissions. International climate negotiations have led to mostly voluntary incremental steps insufficient to return greenhouse gas concentrations to pre-industrial levels. No clear global system of governance has arisen to address climate mitigation or adaption, yet such a threat requires cooperation on a global scale, for neither costs, impacts, or resources are evenly distributed. The G-20 countries hold 66 percent of the world's population, produce 90 percent of global GDP, and emit nearly 80 percent of global greenhouse gases.[1] As such, these countries constitute the global leadership for green energy.

Unfortunately, uncertainties in global climate governance after Copenhagen have reduced market predictability, which limits investment in alternative energy technology. Coupled with the recent global economic recession, limited capital has been available for energy innovation. G-20 countries did employ spending packages to stimulate the economy, but only a small percentage was applied to green initiatives.[2] This forgone opportunity only perpetuates the gap between government declarations on climate action and actual practice. To successfully mitigate and adapt to the effects of climate change by 2050, an estimated USD 46 trillion is required, or around USD 1 trillion a year.[3] Within that, investments in sustainable energy must increase more than two-fold, to exceed USD 500 billion per year, if CO2 emissions are to peak by 2020 and keep the rise in global average temperature under 2 degrees Celsius.[4]

In Copenhagen, developed countries pledged USD 100 billion in international support for both mitigation and adaptation by 2020. This will come from a variety of bilateral, multilateral, and private sources. The countries also agreed that part of this funding would be channeled through a Green Climate Fund (GCF). In Cancun, a Transitional Committee made up of developing and developed countries was tasked with designing the GCF based on an agreed framework, and work is underway.[5] The GCF should be designed to use scarce public funds

to support ambitious country strategies and policies that provide the enabling environment that supports the needed energy transition, while providing funding to reduce costs and risks of investments. The GCF should also aim to leverage private finance in ways that deepen domestic capital markets for clean energy investments. This is particularly important since private capital will ultimately be needed to finance the scaling up of the energy transition.

## Mitigation Policy, Technology, & Fossil Fuel Subsidies

Bolstering the level of green energy investment relies on clear and stable market signals, including consistent and comprehensive carbon pricing or other market instruments that account for externalities. Current mechanisms permit a great deal of uncertainty around future prices and at present no global system prices carbon appropriately. Such poor signals provide only inadequate incentives for the development and adoption of green energy innovations. The challenge for G-20 countries will be establishing stable markets for green innovation that will enhance efficiency and lower the cost of addressing climate impacts.

Many viable solutions in green energy face their own challenges. For example, questions about the prospects of nuclear expansion have been raised because of the problems at Fukushima. Germany, in particular, is determined to end its nuclear program by 2022. First generation ethanol has proven to be costly when not based on sugarcane, and second generation biofuels have not yet proven commercially viable. Greater work is needed to identify technology solutions for large-scale (and distributed) energy transitions.

Current energy policies also present challenges for green growth. Specifically, fossil fuel subsidies work against the host country by hindering the implementation of green energy innovation and exacerbating carbon pollution. In Indonesia, for example, subsidies reduce investment in new infrastructure and production processes and lock-in inefficient technologies. The overconsumption of cheap energy increases dependency on imports and makes public spending more vulnerable to shifts in global energy. Finally, fuel consumption correlates with income so that high-income groups primarily feel the benefits of cheaper energy, while the cost is spread across the whole population.[6]

In Pittsburgh, the G-20 agreed to phase out and rationalize over the medium term inefficient fossil fuel subsidies while providing targeted support for the poorest. Leaders stated, "Inefficient fossil fuel subsidies encourage wasteful consumption, reduce our energy security, impede investment in clean energy sources and undermine efforts to deal with the threat of climate change".[7] This was reaffirmed in Seoul where leaders agreed to "rationalize and phase out over the medium term inefficient fossil fuel subsidies".[8] Global estimates of subsidies to fossil fuel consumption in 37 developing and emerging economies amount to USD 557 billion in 2008 and USD 312 billion in 2009,[9] the majority of which—up to USD 250 billion—coming from G-20 countries.[10] Rescinding these subsidies frees funds for green investment, and OECD analysis suggests that most countries would record real income gains as much as 4 percent from unilaterally removing their subsidies, in addition to a 10 percent reduction in emissions by 2050 compared to business-as-usual.[11]

## Energy Demand & Access

The largest challenge facing energy in a green economy is increasing access to energy services, a task linked to reducing poverty, and improving human health and environmental quality. On the current trajectory, world primary energy use is expected to rise by over 54 percent by 2010,[12] requiring USD 33 billion per year to ensure universal access to electricity.[13] Over

three-quarters of this demand is anticipated in non-OECD counties, where energy directly affects access to clean water, sanitation, food security, and important social institutions, jeopardizing the achievement of the Millennium Development Goals. Globally, approximately 1.5 billion have no access to electricity, and another 1 billion can only access unreliable electricity networks. These groups partly constitute the 3 billion people who rely on traditional biomass for cooking and heating.[14] Developing, energy-poor countries in particular must expand access to reliable and modern energy services if they are to reduce poverty and improve the health of their citizens. Green growth policies should reduce such vulnerability to livelihood, while increasing productivity, enhancing competitiveness, and promoting economic growth.

The Seoul Consensus included agreements to address infrastructure deficits in the developing world, supported by a plan of action.[15] For countries with critical energy access needs, multiple strategies will be needed to address this problem at scale. These include investment in grid-level solutions, but pushing toward low-carbon alternatives such as hydro and newer forms of renewables (wind, solar and geothermal) while investing in regional energy grids and microgrids. Examples of support include the Climate Investment Fund (CIF) concessional financing for the introduction of wind and solar generation in South Africa, and proposed programs in Kenya and Ethiopia under the Scaling Up Renewable Energy Program, a pilot program also under the CIF. More broadly, leaders in Africa, supported by the Africa Infrastructure Consortium that now includes all members of the G-20, are focusing on a strategic regional energy investments. Financing for project preparation is now a key bottleneck, as are incentives to promote lower-emission alternatives for generation. A scaled up Project Preparation Facility for Regional Infrastructure in Africa, which builds on good but underfunded facilities managed by the African Development Bank and others, should be considered.[16]

While these initiatives will meet the needs for development and growth, particularly in urban settings, more needs to be done to meet the needs of rural populations, and to reach the poorest. Opportunities to move to forms of distributed energy through mini-grids powered by renewables are underexploited. In addition, more needs to be done to reach the poorest, building on examples of promising initiatives.

Two such initiatives have focused on finding sustainable and economically productive means to deliver lighting services to the poorest. The Energy and Resources Institute (TERI) began "The Lighting a Billion Lives" campaign in India with twin objectives: to bring solar lanterns and charging stations to poor rural households that lack electricity as a non-polluting means of night illumination, and to make such service self-sustainable. The initiative connects a number of community-based organizations, self-help groups, capacity building organizations, and local NGOs with defined roles at regional and local level, apart from product partners and energy service companies. Displacing kerosene and paraffin lanterns with solar lighting devices provides better illumination and smoke-free

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indoor environment for household work and education, improving opportunities for livelihoods both at the individual and village levels. In another example, Lighting Africa, a joint IFC and World Bank program, launched a campaign to change from fuel-based to solar lighting by targeting businesses and rural parts of Kenya, where about 80 percent of the population is without access to a public electricity utility and must rely on kerosene, candles, or wick sticks. The education campaign teaches how modern, solar lighting can improve health, increase household savings, and provide better illumination in their homes, schools, or businesses. Rental schemes and loans from microfinance institutions also help make solar lighting more affordable for rural households and businesses.

## USING PUBLIC SUPPORT TO ACCELERATE THE INNOVATION AND THE ENERGY TRANSITION

Examples from past energy transitions show that resource endowment is not nearly as important as consistent policy and the right pre-existing matrix of technologies, industries, and expertise. Brazil's biofuels industry owes its existence to government decisions to utilize and support the historical sugar industry in that country. Denmark's wind industry derived from decisions to invest heavily in building local capacity and the determination to provide long-term payments for wind energy. Germany and Japan became the world's leading solar producers not because of their particularly sunny locations but because they made investments in solar research, and with the support of their domestic industries were able to provide public support for purchasing PV electricity even when it was more expensive than existing generation (externalities excluded, of course).

Experience has shown that successful energy transitions exhibit the following characteristics:

1. **Long-term commitment** to incremental changes
2. **Shared public-private vision** to weather difficulties
3. **Public** support at all stages of Research and Development
4. **Specialization** to facilitate knowledge clustering
5. **Resource levels** do not determine the success of a new industry
6. Successful strategies that reflect the **social and political context**

These six elements provide some guidance on how to move forward with new green growth strategies, but on their own may be insufficient given different governance and economic situations across the world. As such, it is worthwhile examining more recent examples to see how public policy and financial support for innovation might work in newer contexts.

### Public Financing for Energy Innovation

There are many examples of government grants and capital subsidies for energy innovation. In Austria,

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three programs—the Factory of Tomorrow, Energy Systems of Tomorrow, and Buildings of Tomorrow—offer grants for early research, concept, commercial research, development, and demonstration for a total of EU 75 million. The Sustainable Public Procurement Programme's Energy Research Subsidies (EOS) in the Netherlands provide a similar R&D grant scheme with EOS NEO (small projects), EOS Long-term Research, EOS IS (Innovative Collaboration Projects) and EOS Demonstration. In 2009, Korea launched its "Green New Deal"—a USD 38 billion stimulus package, of which nearly 80 percent targets green growth initiatives. The Korean government committed 2 percent of GDP to green growth projects, including green infrastructure and research and development of green technologies. The aim is make Korea a low-carbon society focused on quality-oriented growth in renewable energy, ultimately cutting emissions by 30 percent from business-as-usual by 2020.[17]

### International R&D Support

International R&D support has been a pivotal tool in bolstering energy innovation in lesser-developed and emerging countries. Many initiatives are underway to support developing countries in the development of low-emission strategies and policies. These include programs under the recently created Global Green Growth Institute; bilateral programs such as the Low-Emissions Development Strategy support from the United States; multilateral programs such as those being carried out by the Clean Energy Ministerial (CEM), the International Renewable Energy Agency (IRENA), the Energy Sector Management Assistance Program (ESMAP), and support from foundations. A High-Level Dialogue on Low-Emission Development Policy was launched in Washington in July 2011 convened by the World Bank, UN Energy, the Clean Energy Ministerial, the Governments of France, Mexico and South Africa, and ClimateWorks. This dialogue focused on ways to scale up knowledge sharing and coverage, and impact. A number of collaborative mechanisms are being considered and should be encouraged.[18]

The Clean Energy Ministerial, for example, launches 'opt- in' technology initiatives involving middle income and emerging countries. Its flexible process and focus on operational efforts means it lends itself to information sharing, priority setting, and coordination. For example, the Clean Energy Solutions Center is collecting and disseminating lessons learned with policy to drive clean energy innovation in many member countries. In addition, the Multilateral Solar and Wind Working Group is developing an international atlas of solar and wind resources, and the Carbon Capture, Utilization and Storage Action Group is creating an international strategic plan to overcome the barriers to demonstration at the commercial scale.

## RECOMMENDATIONS

The four-part approach to establishing a green growth agenda for alternative energy presents both domestic and multilateral opportunities to foster an environment where multiple solutions can be forged to solve climate change.

- **Energy innovation.** There must be a change in domestic investment founded in fiscal and regulatory policies. Direct government investment into green energy infrastructure and innovation over the medium and long term generates certainty, catalyzes larger flows of private sector resources, and establishes a predictable market for scale-up. The United Nations Environment Programme, in particular, has called on the G-20 economies to engage in a Global Green New Deal by investing at least 1 percent of GDP into green economic sectors, to include energy efficiency, renewable energy technologies, and sustainable transport.[19]

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The UNEP Global Green New Deal also highlights the use of international policy architecture to boost direct investment and financing in non-G-20 countries through aid and technology and market development.[20] Climate agreements—like those that may arise out of the COP 17 in South Africa—should complement independent domestic efforts and focus specifically on global funding mechanisms that can secure the predictable and sustained financial flows required by developing countries. Systematically enhancing the absorptive capacity of less-developed countries through financing and long-term institution building will ensure the successful innovation and adoption of appropriate energy technologies.[21] As part of this approach, the G-20 should call for the Green Climate Fund to be designed to promote the energy transition by supporting ambitious country programs while deepening private capital markets.

- **Energy integration.** Countries should take advantage of existing alternative energy technologies—wind, solar, hydro, bio, geothermal, nuclear, etc.—by integrating them into their current energy systems. Deploying these technologies—large or small scale, concentrated or distributed—will ultimately increase access, reduce emissions, and buffer against fluctuating energy prices. Domestic measures must coordinate with global initiatives to support energy innovation and market transformations in countries with varying degrees of demand and capacity. As higher income nations successfully implement new technologies, they are more able to facilitate integration in lesser-developed nations—a process that would benefit from a coherent international regime that promotes technology transfer through existing multilateral organizations—e.g. patent pools and knowledge networks through the UNFCC. There are significant opportunities for South-South transfers in addition to the North-South exchanges, since these nations may have implemented energy technologies better tailored to the needs of developing countries. China, for example, single-handedly accounts for three-quarters of the climate-mitigation transfers from OECD to non-OECD countries.[22]

  Energy infrastructure and services programs in lesser-developed countries and regions being supported by the G-20 under the Seoul Consensus should aim to address serious energy access imperatives, but should also proactively support a move to a low-carbon trajectory, to prevent locking these countries into a fossil fuel future. This will require using international public funds for project preparation, as well as to lower project costs and risks so that these can compete in the market with higher emission alternatives.

- **Energy implementation.** Successful deployment of proven technologies requires the correction of domestic market failures, namely perverse subsidies, which disincentivize efficient use of resources and lower the cost of pollution. Unilaterally revoking all fossil fuel subsidies, establishing a carbon tax regime,

and mixing price-based and other instruments can increase competition and returns on green investment and innovation and close the gap between private economic gains and social benefits. Such policies must effectively price environmental externalities and place a premium on inventiveness and efficiency. Models predict carbon pricing will reduce the pace of economic growth by only a few percentage points of real GDP by 2030, but can boost employment when revenues are used to reduce taxation on labor and business.[23] Taken together with domestic stimulus and green investment, more opportunities exist for growth than are lost in an energy transition. The Pittsburgh and Seoul agreements to phase out fossil fuel subsidies should continue to be a priority for the G-20.

- **Energy transformations.** For domestic green growth strategies to be more effective, they must be embedded in consistent, comprehensive, and long-term energy policy objectives that facilitate the incremental transition to a low-carbon or carbon-free system. Looking internationally, given the notable market channels through which technology transfer and financing take place—e.g. trade, FDI, licensing—opening barriers to trade and investment will enhance the diffusion and deployment of green energy technologies globally. For example, tariff barriers on energy efficient appliances, coupled with subsidies on electricity and inefficient fuels, hinders green growth in some developing and emerging economies.[24] The spillover from a smoother flow of technology, and the associated specialized services required, would augment the benefits of targeted technology transfer and financing to develop further alternative energy markets. The G-20 should encourage the provision by the international community of scaled-up knowledge and advisory services on low-emission development policies. This should include finding ways to accelerate learning of best practice, ensure coherence of approaches, and broaden coverage. Following on the High-Level Dialogue on this topic convened in July 2011 at the World Bank, the G-20 should task the international community—both funders and providers—with developing approaches that encourage collaboration and scaling up of support.

## ENDNOTES


1. UNEP (2009). *Global Green New Deal: An Update for the G20 Pittsburgh Summit*. G20, Pittsburgh.
2. UNEP (2009). *Global Green New Deal: An Update for the G20 Pittsburgh Summit*. G20, Pittsburgh.
3. IEA (2010), *Energy Technology Perspectives*, OECD/IEA, Paris.
4. IEA (2008). World Energy Outlook 2008. Paris.
5. Sierra, K, "Designing the International Green Climate Fund: Focusing on Results", Brookings, April 2011.
6. Mourougane, A. (2010), "Phasing Out Energy Subsidies in Indonesia", *OECD Economics Department Working Papers,* No. 808.
7. Leaders Statement, The Pittsburgh Summit, September 25, 2009. http://www.g20.org/Documents/pittsburgh_summit_leaders_statement_250909.pdf
8. The G20 Seoul Summit Leader's Declaration, November 11–12, 2010 http://www.g20.org/Documents2010/11/seoulsummit_declaration.pdf
9. IEA (2010), *World Energy Outlook*, OECD/IEA, Paris.
10. UNEP (2009). *Global Green New Deal: An Update for the G20 Pittsburgh Summit*. G20, Pittsburgh.
11. OECD (2011), *Towards Green Growth,* OECD Publishing.
12. OECD (2008), *Environmental Outlook to 2030,* OECD, Paris.
13. IEA (2010), *Energy Technology Perspectives,* OECD/IEA, Paris.
14. AGECC (2010). *Energy for a Sustainable Future: Summary Report & Recommendations.* United Nations, New York.
15. The G20 Seoul Summit Leader's Declaration, November 11–12, 2010 http://www.g20.org/Documents2010/11/seoulsummit_declaration.pdf
16. A forthcoming Brookings policy brief outlines the case for such a PPF, which could be sized at USD 1 billion.
17. Jones, R. S. and B. Yoo (2010), "Korea's Green Growth Strategy: Mitigating Climate Change and Developing New Growth Engines", *OECD Economics Department Working Papers, No. 798, OECD Publishing.*
18. http://climatechange.worldbank.org/content/climate-change-thinkers-converge-high-level-dialogue-low-emission-development
19. UNEP (2009). *Global Green New Deal: An Update for the G20 Pittsburgh Summit*. G20, Pittsburgh.
20. UNEP (2009). *Global Green New Deal: An Update for the G20 Pittsburgh Summit*. G20, Pittsburgh.
21. Haščič, I. and N. Johnstone (2011), "The Clean Development Mechanism and International Technology Transfer: Empirical Evidence on Wind Power", *Climate Policy.*
22. Dechezlepretre A., M. Glachant, I. Hascic, N. Johnstone and Y. Ménière (2011), "Invention and Transfer of Climate Change Mitigation Technologies: A Global Analysis" in *Review of Environmental Economics and Policy.*
23. OECD (2011), *Towards Green Growth*, OECD Publishing.
24. Steenblik, R. and J.A. Kim (2009), "Facilitating Trade in Selected Climate Change Mitigation Technologies in the Energy Supply, Buildings, and Industry Sectors", *OECD Trade and Environment Working Papers,* No. 2009/2, OECD, Paris.