

TECHNOLOGY IN THE UN CLIMATE CHANGE NEGOTIATIONS: MOVING BEYOND ABSTRACTION[†]

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Abstract: This brief considers the technology negotiations of the United Nations Framework Convention on Climate Change (UNFCCC) within the wider context of low-carbon energy technology. In doing so, it focuses on how technology issues can be effectively embedded within a potential agreement at the 15th Conference of the Parties (COP15) in Copenhagen. The paper asserts that the negotiations must be conducted with cognizance of national decision-making processes and competing priorities. It puts forth a series of framing topics in order to more explicitly explore the large technology “ecosystem.” It concludes that the most appropriate area for international cooperation on technology under the UNFCCC lies in the direct provision of human and institutional capacity building with a focus on the least developed countries.

1. Introduction

Developing, deploying, and transferring low-carbon technologies and overcoming related investment challenges is a crucial issue for climate change as well as energy and economic policy. It is also an issue considerably wider than the remit and scope of the UNFCCC. There are numerous other forums for cooperative engagement¹ that, in some cases, may be well placed to deliver on specific actions. In addition, the bulk of ongoing and future implementation will happen at the national level. Hence, there is a need to understand specifically how cooperative international action on technology can best be incentivized under the Convention. Aspirations for an agreement should not attempt to encompass all aspects of mitigation and adaptation technology issues, but rather provide an appropriate political signal and a flexible, supportive framework for action.

The treatment of technology within the UNFCCC negotiation process has moved from a relatively marginal subject to one of importance. This evolution stems not only from the wide interest in the subject matter, but also the priority placed on technology funding and technology institutions by the G77 countries². The technology aspects of the UNFCCC have a long history, a unique terminology, and an embedded culture³ and process. Thus, the exact nature of the UNFCCC discussion is generally opaque to most (public and private) stakeholders in the energy sector.

Viewpoints present policy proposals, considered opinions, and commentary by distinguished policymakers, leaders from business and non-governmental organizations, and scholars. The Harvard Project on International Climate Agreements does not advocate any specific climate change policy proposals. Statements and views expressed in *Viewpoints* are solely those of the authors and do not imply endorsement by Harvard University, the Harvard Kennedy School, or the Harvard Project on International Climate Agreements.

There is a large, and rapidly growing, related literature as well as significant media and political attention directed on clean energy technologies for climate change mitigation. Often, these communications do not accurately reflect the details of the negotiations, the details of energy regulation and policy, or the link between the two⁴. Within this frenzy of activity, there are a number of clichés, and simplistic allusions often employed. While these simplifications have been useful to support a growing consensus and provide a general education on aspects of energy and climate policy approaches, they tend to gloss over the inherent complexity of implementation.

1.1 A Very Brief History

Technology is embedded in several articles of the UNFCCC⁵. The issue of “development and transfer of technology”⁶ has been a permanent item on the agenda at all COPs since the ratification of the Convention. The framework contained in 4/CP.7 has five main themes: technology needs and needs assessments, technology information, enabling environments, capacity building, and mechanisms for technology transfer. While these elements remain valid, the goal now is about increasing scale and pace, and moving to a “full implementation phase.” The conceptual challenge is how to reconcile the specific needs of active implementation with the somewhat passive role of contributing to enabling environments.

The Bali Action Plan (BAP) and the ongoing Ad Hoc Working Group on Long-term Cooperative Action under the Convention (AWG-LCA) discussions have reinforced and enhanced the treatment of technology, including it as one of the four “building blocks”⁷ of a future agreement. (All of the building blocks are intricately linked, and technology can play a significant role in all of them⁸.) The Expert Group on Technology Transfer (EGTT) was given a refined mandate at COP13. Its analytical outputs are relevant to the principle areas of the technology negotiations, namely: financing options, indicators, and strategies for the medium- and long-term.

1.2 Framing the Discussion

UNFCCC Executive Secretary Yvo de Boer⁹ stressed, “There is an urgent need to discover what effective language a Copenhagen agreement needs to entail in order to unleash the full potential of technology.” While this sentiment has helped spur the central inclusion of technology issues into the negotiations, the aspiration that the UNFCCC itself will unleash the full potential of technology is likely to be over-ambitious. Rather, that role will predominantly be played by: national governments, international cooperation inside and outside of the UNFCCC, and private sector companies and entrepreneurs. Climate change is one of many “influencing vectors” for technology, particularly in the energy sector. As such climate change must compete (and hopefully find synergies) with other policy priorities, such as energy security and economic development, within political and budget constraints.

The bulk of climate policy actions are normally implemented as a sub-set of national sectoral policy (energy, transport, agriculture, etc.). It is in these “economic” or “line” ministries where policy levers and associated budgets can be employed. The linking of international aspirations to national action is complicated by the knowledge and the decision-making “power” gaps that exist between UNFCCC negotiators (primarily environment ministries) and other government ministries¹⁰.

⁴This paper does not represent the views or positions of the United Nations, UNIDO, or Harvard University. The responsibility for opinions expressed lie solely with the author. This document has been produced without formal UN editing.

It is clear that the private sector plays a vital role in ensuring the scale and diversity of the investments required¹¹. Still, engaging them at the level of the climate talks remains challenging, given the nature of the international process. Some proposals on international public-private partnerships and global sectoral approaches are aimed at bridging this gap¹². Still, the mobilization of the private sector will remain largely through policy at the national level. As Rodrik notes, "...it is increasingly recognized that developing societies need to embed private initiative in a framework of public action that encourages restructuring, diversification, and technological dynamism beyond what market forces on their own would generate."¹³.

Finally, the UNFCCC talks do not happen in isolation. The current economic crisis and resultant government stimulus packages provide an additional impetus to focus on green investment and job creation. This provides a broader driver for low-carbon economic development than solely relying on climate change mitigation. The technology aspects of the UNFCCC negotiations offer a link to these issues for both developing and developed Parties and thus provide a positive platform from which to find areas for cooperation¹⁴.

2. Defining Technology

Our technological systems, critically our energy systems, lie at the heart of the climate change challenge, as essential contributors to economic development and social welfare, and as the principal source of anthropogenic greenhouse gas emissions¹⁵. An important typology of technology was defined by IIASA¹⁶ and contains: a) Hardware: manufactured objects; b) Software: knowledge required to design, manufacture, and use technology hardware; and c) "Orgware": institutional settings and rules for the generation of technological knowledge and for the use of technologies.

There are a wide variety of analytical models being used to consider and inform climate change policy at national, regional, and global levels. The IPCC Fourth Assessment Report¹⁷ found that there are over 750 emissions scenarios in the literature (and that figure is growing rapidly). In order to meet even modest stabilization targets most major studies reach similar conclusions, such as: a suite of technologies¹⁸ and associated policies and measures is required, the principal technologies have been largely identified, and the scale of deployment is unprecedented. An over-reliance on research and development (R&D) policies alone¹⁹ will not bring forth the required shift in investment patterns or scale of project implementation. While "game changing" technologies may arise, the innovative deployment of existing and emerging technologies and new ways to consider systems are, in the short-term, the most important areas to prioritize.

The results of these analytical exercises require considerable filtration and translation in order to appropriately inform the negotiations as well as the design and implementation of government policy. In addition, they are often not entirely useful in considering "software" or "orgware" dimensions. Using a phrase from a recent Pew publication²⁰, what we need is, "insight not [just] numbers". In addition, the process of technology innovation is inherently uncertain. Technology frameworks need to be robust against the possible failure of some technologies and adaptable to respond to the potential rapid emergence and success of others—humility is required.

The majority of barriers to low-carbon technology deployment, although complex, have been iden-

tified²¹. They can be classified generally as technical, regulatory, financial, behavioral, and political. An initial focus on governance and human and institutional capacity is required. These aspects are in essence precursors to, and a basis for, “enabling environments” for effective technology development and implementation (as well as almost every other aspect of development). Using a technological Innovation Systems (TIS) approach²² may help inform this process by creating a, “...social network, constituted by actors and institutions...constructed around...specific technolog[ies]²³.”

Although technology issues have become central to the post-2012 climate change policy debate, the exact nature of that “centrality” requires further reflection. Specifically, technology aspects of the UNFCCC are secondary (from a negotiation perspective) to the likely primary outline of an agreement²⁴, namely: developed country targets, developing country actions, and financing commitments. The UNFCCC can influence some of these much more than others²⁵. Still, under various outcomes at COP15²⁶, technology instruments will be a clear focus of detailed implementation efforts in the 2010–2012 timeframe.

The technology negotiations would benefit from consensus on a number of framing topics²⁷. The remainder of this section highlights a few of these topics that relate to definitions. The following section (Section 3) looks at those topics that will need to be addressed directly in the negotiations, such as: actions that occur within or outside the UNFCCC and distinguishing between national and international actions. The notion is that by being explicit about these areas, the outcome can be moved beyond abstraction and thus improved.

2.1 Wider than Transfer

The IPCC²⁸ provided a broad definition of technology transfer as, “a set of processes covering the flows of know-how, experience and equipment for mitigating and adapting to climate change amongst different stakeholders” that also, “comprises the process of learning to understand, utilize and replicate the technology, including the capacity to choose it and adapt it to local conditions and integrate it with indigenous technologies”²⁹.

The BAP broadened the scope of the technology discussions under the UNFCCC; from focusing historically on technology transfer from industrialized to developing countries to covering aspects of international collaboration on technology development (including South-South cooperation) and deployment and diffusion. This is a necessary development since the overall challenge is to stimulate wide-scale, global adoption of a suite of sustainable, culturally embedded, and appropriate technologies.

2.2 Broader than Hardware

It is essential to consider not just hardware, but the systems in which they are embedded (ranging from electricity transmission and distribution systems to energy markets). To facilitate this integration, most low-carbon technologies require new or modified models of regulation, business, and infrastructure investment. Thus, considerable policy, project management, technical, market, legal, and financing skills will be required.

In addition to these challenges, it appears that orgware (as previously defined) is perhaps the most difficult (in both developed and developing countries); this is not necessarily appreciated in policy development. This is, however, an area where the role of the public sector (e.g. in regulation and standards organizations) is critical.

2.3 More than Carbon Price Signals

Agreement on aspects of technology may engender wider support for an agreement based on developed country targets³⁰. To that effect, Sugiyama³¹ offers a useful note of caution, urging negotiators to, "...ensure that technology and development cooperation do not dilute political attention to climate change, and that the [carbon market] regime does not cripple technology and development cooperation by creating an adversarial negotiation atmosphere."

The UNFCCC focus on national emissions targets emphasizes the idea of market-based policy approaches (bluntly as: *a price of carbon is the key to affecting change*)³². A more command-and-control policy view (paraphrased as: *markets may not be able to provide the entire spectrum of incentives required*) is again coming into vogue due to the global financial crisis' effect on the perception of markets³³. This helps to support arguments that show while a carbon price signal is vital yet insufficient for assuring technology change. This has two aspects; the first is that markets often undersupply basic research and early stage capital and that regulatory and technology-specific policies are required for development and deployment³⁵.

Of course low-carbon technologies do benefit from carbon price signals or revenues (in the case of CDM-projects). But those revenues are not as useful for obtaining project financing or offsetting risk as specifically designed policy instruments (e.g. feed-in tariffs³⁶). There is considerable experience with detailed design of such tools³⁷, but not at the UNFCCC negotiation table and not reflected sufficiently in the technology discussions at the UNFCCC.

2.4 Larger than Climate Change

The notion of economic development and energy security as side effects or co-benefits of climate policy needs to be carefully considered. Whether policies are designed with a focus on energy security or on climate change (or on industrial development, cost competitiveness, energy access, etc.) will have a significant impact on the result. While not mutually exclusive, the different foci do not necessarily guarantee a glorious result. Whether these goals are compatible depends quite specifically on the energy mix, technology, natural endowments of a country, the political context, available resources, issues of market power, etc.³⁸.

As an example of an area with multiple benefits, drivers and obstacles, the complex area of energy efficiency (EE) needs to be targeted by any future treatment of technology in the UNFCCC. The importance of this facet of energy policy has been widely considered over decades. Some of the policies such as: provision of energy audits, information/education/training, performance standards, and labeling can be supported by international bodies, but not necessarily through the UNFCCC. Three areas where the UNFCCC can likely support EE implementation are: within low-carbon development plans and actions, in programmatic CDM, and possibly within sectoral instruments⁴⁰.

Another example is even more complex, that of energy access (or energy poverty). The goals of energy access focus on supporting economic and social development and equity. While these principles are thoroughly embedded in the UNFCCC, it is still not entirely clear how to give priority to energy access without compromising environmental targets⁴¹; it is always difficult to optimize for two goals. Hence the strong interest in the role of technologies and technology “leap-frogging” in achieving low-carbon development pathways.

2.5 Beyond Abstraction

The wedges approach⁴² has had a significant influence on recent thinking in the technology and climate interface. It, along with the McKinsey cost curves⁴³ are perhaps the most powerful tools for illustrating to a wide audience the scale of the challenge and the importance of a diversity of technologies. Still, a wedge is just a triangle—a cost curve is just a series of rectangles. The implementation challenge is considerably more complex than what can be illustrated by two-dimensional geometry.

The UNFCCC technology negotiations tend to abstract and generalize discussions of specific policy and financing mechanisms. This is natural given that a UNFCCC agreement requires a full consensus among over 190 countries. But that abstraction belies the reality that the tools required for incentivizing development and deployment of clean energy technologies are generally well understood and in-practice in countries and localities all over the world. In addition, there are numerous ongoing financial tools offered and being utilized which are directly related to the UNFCCC such as those offered by the GEF, and the multilateral banks, with varying degrees of (perceived) success and effectiveness.

Finally, much more emphasis is required to ensure that the language of any agreement is understandable to the public and private stakeholders in the energy sector and supports their actions. As an example, it is crucial in moving to a low-carbon energy system for the power system operators and players (utilities) and regulators to be directly involved. Utilities and regulators in designing, budgeting, building and operating infrastructure, designing and operating energy markets, and incentivizing behavior through rules and tariffs hold the key to any transition.

3. Towards (and Beyond) Copenhagen

There are numerous proposals for post-2012 UNFCCC agreements. There is also a growing literature on specific technology agreements or how best to integrate technology into a wider post-2012 UNFCCC agreement. The main forum for these negotiations now occurs in the AWG-LCA⁴⁴.

3.1 AWG-LCA Text

There have been numerous Party submissions to the AWG-LCA process⁴⁵. By June 2009, there were nearly forty submissions that specifically refer to aspects of technology⁴⁶. In general they focus on: institutional arrangements, funding, RD&D, IPR⁴⁷, capacity building, and national actions and planning. The AWG-LCA working text⁴⁸ is 199 pages long and the term technology can be found on nearly every page (and it is joined with financing and capacity-building in the final section, Annex IV)⁴⁹. The August informal UNFCCC sessions made some small progress on the technology sections of the text⁵⁰. An attempt at finding areas of convergence around certain parts of the technology vocabulary was also produced⁵¹. It includes many of the “keywords” cited in other parts of this paper, including: cooperative R&D; IPR;

technology roadmaps; technology action plans; TNAs; monitoring, reporting, and verification (MRV); financing; and centers of innovation.

As an example of the need for evolving this exercise of finding convergence on aspects of vocabulary, there are many terms being utilized that have somewhat overlapping meanings to address national planning for low-carbon energy systems. These include: Technology Needs Assessments (TNA)⁵², Technology Action Plans (TAP), Nationally Appropriate Mitigation Actions (NAMA), Low-Carbon Development Strategies (LCDS), and Low-carbon Growth Plans⁵³. Clarity on the function of these tools in: supporting the design and implementation of national policies and actions, identifying knowledge and/or financial gaps and the need for international support, as well as their relationship to existing instruments will be crucial to moving to an agreement.

3.2 National and International Instruments

It is important to make explicit those tools and instruments that can be considered by the international community and those to be implemented (and supported) as a sub-set of national policy. The national elements are likely to be covered in low-carbon plans and actions. In these plans, the deployment of technologies is implicit and fundamental. These technology aspects may need to be made more explicit for negotiating purposes. However, any international requirement should not provide too many additional requirements to national planning systems that are already, in many cases, overburdened (and thus not effective in ensuring abatement activity actually occurs).

The international elements may be treated in a separate part of an agreement. Giving technology its own “article(s)” will likely be useful in ensuring political agreement. Some mechanisms for cooperative action or funding may include: technology roadmaps and platforms, innovation centers, training programs, knowledge-sharing networks, national technology planning support, standards design, testing facilities, early-stage financial support⁵⁴, R&D coordination, SME-focused support, collaborative demonstration projects, national technology experts, business development support, etc.

3.3 Inside and Outside of the UNFCCC

As the bulk of activity and instruments will be located outside the remit of the UNFCCC, it is essential to make more explicit this boundary and connection. To make links and assure coherence, a body with a mandated technology oversight function within, or related to, the UNFCCC is likely to be necessary to codify actions undertaken by various countries, appropriate technical and financial transaction support, and possibly funds disbursement.

In parallel, there is a clear requirement to not only define the basic framework and principles for a monitoring, reporting, and verification (MRV system), but also to indicate how and where it can be institutionally embedded. There is an emerging literature on what these MRV systems may look like conceptually. While it is a critical area, the negotiations should not get “lost” in the theoretical discussions related to the topic. MRV systems exist in practice in energy policy programs all over the world, so looking at precedent will be important⁵⁵.

3.4 Capacity Remains the Key

Governance, institutions, and associated human capacity⁵⁶ are critical to wider deployment of climate change technologies⁵⁷, the rate of which is likely to be determined by the absorptive capacity of a country, region, or sector. Within the UNFCCC, the issue of capacity building has a long history and is embedded in the Convention, the Protocol, and the AWG-LCA text⁵⁸. As capacity is developed within countries and localities it must then be effectively managed and employed towards policy goals (including attracting FDI, participating in international trade if desired, etc.). This is not a simple or linear process and is not limited to climate change issues. It is important to remember that capacity building is part of a wider process to enable productive growth. It must serve a number of functions, including assuring demand for innovation and its products⁵⁹.

The goal is for developing countries to become autonomous in deciding on and achieving their own paths towards energy sustainability⁶⁰. These issues are, however, difficult to address in the confines of the UNFCCC negotiations because of the very broad nature of institutional requirements, sovereignty sensitivities, and because they are closely linked with all other areas of public policy. The area is also difficult to monitor and verify against direct quantitative impacts on mitigation. Creativity will be needed to make these measures an enticing incentive for countries participating in the negotiation process.

The provision of enabling environments, especially in the least developed countries (LDCs), is likely the most cost-effective intervention that can be made under the UNFCCC. It is an area where the need for public sector interventions is clear. These interventions would also likely have significant tertiary benefits and synergies with other developmental goals⁶¹. There is a large array of ongoing activities in the areas of human and institutional capacity building, both within and outside of the UNFCCC. As an example, UNIDO has programs⁶² that could be augmented to focus on low-carbon energy technologies.

4. Final Comments

The opportunities (and not just the challenges) of wide deployment of low-carbon technologies must be continually emphasized in the goals and tone of the negotiations. This is particularly true for many developing-country UNFCCC Parties, which are looking for development as a first priority and for which these technologies can form an integral part of ensuring such a “just transition”. It is also true for those developed countries that understand innovation and productivity as key components in preserving competitiveness. The ability to help develop the “case” for these opportunities will be an important role for the UNFCCC.

Reaching an agreement in Copenhagen will require an understanding of the suite of tools and actions available and palatable to Parties. It will also require sensitivity to, and a realistic assessment of, the potential influence of the UNFCCC on the private sector. Low-carbon technology development and deployment looks to have a very positive future, especially if investors perceive a comprehensive and stable governmental approach to hedging risk. Building various capabilities from design to operation to management addresses tangible gaps. Large-scale action will be the ultimate measure of success.

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ANNEX 1: END NOTES

¹ Such as: the Asia Pacific Partnership (APP), the International Partnership for Energy Efficiency Cooperation (IPEEC), Major Economies Forum (MEF), Carbon Sequestration Leadership Forum (CSLF), and The Global Bioenergy Partnership (GBEP). Also UN-Energy (the UN's inter-agency mechanism for addressing energy issues) may prove to be a useful instrument to embed specific topics like energy access.

² This manifests primarily in the G77 proposal for a technology fund and an associated technology body to administer and support it.

³ Like any negotiating activity, the personalities of the negotiators have an impact on outcomes. Some aspects of the UNFCCC culture continue to operate in a pre-Kyoto paradigm of negotiating tactics that may no longer be valid.

⁴ Of course there is a plethora of important work in the area over many decades. Some of those papers are cited in Bazilian (2008). In addition providers of rigorous data and information like New Energy Finance are contributing significantly to the understanding of the markets and investment in the area.

⁵ Beginning with Articles 4.5 and 4.7 of the UNFCCC, the key COP decisions on this issue are identified including, 4/CP.7 and 6/CP.10. Other important convention decisions are: Article 4, paragraphs 1, 3, 5, 7, 8, and 9, Article 9, paragraph 2(c), Article 11, paragraphs 1 and 5, and Article 12, paragraphs 3 and 4, and decisions 4/CP.7, 6/CP.10, 6/CP.11, and 3/CP.12. In addition Chapter 34 of Agenda 21 on the transfer of environmentally sound technologies is often cited in UNFCCC text. Article 4.1c calls on all Parties to the Convention, "to promote and cooperate in the development, application and diffusion, including transfer, of technologies, practices and processes that control, reduce or prevent anthropogenic emissions of greenhouse gases". Article 4.5 calls on developed country Parties to, "take all practicable steps to promote, facilitate and finance, as appropriate, the transfer of, or access to, environmentally sound technologies and know-how to other Parties, particularly developing country Parties, to enable them to implement the provisions of the Convention." This requirement for technology transfer—in effect technology support by developed countries to developing countries—is echoed in Article 4.7, which states that, "the extent to which developing country Parties will effectively implement their commitments under the Convention will depend on the effective implementation by developed country

Parties of their commitments under the Convention related to financial resources and transfer of technology". It is also treated in Agenda 21 Chapter 34 (U.N. Conference on Environment and Development—the 1992 Rio "Earth Summit").

⁶ The shortening of the term "development, deployment and transfer of" to just "transfer of" is potentially detrimental to the appropriate treatment of the subject.

⁷ Mitigation, adaptation, technology, and finance.

⁸ The Bali Action Plan identified technology, or rather "enhanced action on technology development and transfer", as one of four building blocks (para.1d) of a future international climate change regime. Together with enhanced action on the provision of financial resources and investment (para.1e), technology is a supporting pillar to the building blocks of climate change mitigation (para.1a) and adaptation (para.1b), and is explicitly referred to in relation to the building blocks of finance and mitigation.

⁹ De Boer, Y. (2008) Address at: Forum on climate change and science and technology & innovation Beijing, PR China, 24 April.

¹⁰ Even though some countries (e.g. U.K. and Denmark) have created joint energy and climate ministries, they are often internally divided in expertise, culture, and remit sufficiently to still have similar difficulties.

¹¹ That private sector role includes activities from entrepreneurship and R&D to legal services, technical expertise, and market building in businesses of all sizes. Still, much of those activities, even in liberalized markets and economies, requires governmental structures and institutional support.

¹² Proposals by G77 and by Japan act as an example.

¹³ Rodrik, D. (2004). *Industrial Policy for the 21st Century*. 2004. Harvard University

¹⁴ They also offer areas of intense competition between countries.

¹⁵ See for example: IPCC (2007), or World Energy Outlook (2008), International Energy Agency, France, and Ayres (2009) *The Economic Growth Engine: How Energy and Work Drive Material Prosperity*, Edward Elgar Publishing.

¹⁶ IIASA (2007) TNT Programme, <http://www.iiasa.ac.at/Research/TNT/>

¹⁷ IPCC (2007) Fisher, B., et al. (2007). Issues related to mitigation in the long-term context. in Metz, B. and Davidson, O., *IPCC Fourth Assessment Report. Report of Working Group III Mitigation*. Cambridge University Press, Cambridge.

¹⁸ This paper when referring to clean energy or low-carbon energy technologies is referring to those technologies generally classified as: energy efficiency, renewable energy, and carbon capture and storage.

¹⁹ Fundamental R&D does become more important in the short-term if very low (say 350 ppm) targets are being considered. Most of the main modeling exercises do not solve for this scenario, but when they do (e.g. Van Vuuren, 2007, Scenarios in the context of assessment of mitigation and adaptation, UNFCCC, Bonn) they employ technologies at large scale (like biomass CCS) that require considerable R&D. The actual funding amounts required for R&D under any scenario are extremely difficult to quantify as the process is non-linear and the outcomes and impacts highly uncertain. This is also why most of the negotiation inputs allude to “doubling” or “vastly increasing” R&D rather than specific amounts.

²⁰ Peace, J., Weyant, J. (2008) *Insights not Numbers*. Pew Center for Global Climate Change. Washington, D.C. USA.

²¹ Of course these barriers vary dramatically between technologies, market segments, and countries.

²² Bergek, A., 2002. Shaping and Exploiting Technological Opportunities: The Case of Renewable Energy Technology in Sweden (Thesis). Göteborg, Sweden, Chalmers University of Technology.

²³ “The TIS literature stresses...that most emerging technologies will have to pass through a so-called formative stage before they can be subjected to a market environment (Jacobsen and Bergek, 2004). So market diffusion is absent or insignificant, but during the formative stage actors are drawn in, institutions are designed and adjusted; in short, many processes unfold that, positively or negatively, will influence technology diffusion.” (See: Suurs and Heckert (2006). *Patterns of Cumulative Causation in the Formation of a Technological Innovation System*. Utrecht.)

²⁴ The July 2009 G8 and Major Economies Forum (MEF) meetings both considered: agreement on the scientific temperature goals, long-term targets for developing countries, and efforts and national plans by emerging economies. The MEF also alluded vaguely to a “Global Partnership” for technology cooperation.

²⁵ As an example, developed country targets are set by national legislation and legislators, not by the UNFCCC, and not by Ministries of Environment in most cases. Once enacted the relevant legislation cannot be changed quickly and is not normally responsive to international pressure (e.g. the Waxman/Markey Bill, or the EU Climate/Energy package).

²⁶ For example a comprehensive agreement at COP15 vs. a more political “vision” agreement. Both will require the development of specific mechanisms and rules over the following years.

²⁷ These are not discrete divisions and each has overlapping aspects.

²⁸ IPCC (2000) *Methodological and Technological Issues in Technology Transfer*. Bonn, Germany.

²⁹ Technology transfer is a subject much wider than climate change. As it is a topic in almost all economic sectors, there is a wealth of information and ongoing activities.

³⁰ Notionally, the psychologically “upbeat” character of technology deployment can elicit associations with wealth, innovation, and progress, compared to emission reductions, which is framed in terms of economic constraints. It is also seen by many G77+China Parties as a more concrete outcome for their own constituencies.

³¹ Sugiyama (2005) *Governing Climate*. IISD, Canada.

³² Largely this approach focuses on carbon markets. These are in place (e.g. EU ETS) and of great importance. The theoretical economic approach favours carbon taxes at the national (or even global level). Carbon taxes exist, of course, under various guises (e.g. taxes on gasoline and diesel). But prioritizing them as a key global carbon policy tool is naïve given the reality of the political constraints.

³³ de Coninck (as reviewer) points out that a viable agreement is not necessarily the most cost-effective agreement, but the agreement that provides the most in return, in a balanced way. This is largely the reason to include technology as a specific part of any agreement.

³⁴ As an example, within the recent flurry of clean energy policy being discussed and implemented in the U.S., the policy (anecdotally) causing the biggest “stir” is the Department of Energy’s stimulus package. This package includes direct grant support.

³⁵ Thanks to Robert Stowe for this clarity.

³⁶ Feed-in tariffs were originally largely established as industrial policy tools, not environmental ones. They are also often designed to primarily limit risk to investors, not supply revenue to developers.

³⁷ These issues are beyond the scope of this paper. There is a vast literature on the subject, including discussion about calculating public expenditures on RE subsidies using levelized cost calculations, the nature and optimization of electricity markets, the treatment of capacity, the nature of transmission system funding, regulation, construction, congestion, etc. Also the influential issues of energy subsidies as well as incumbent market influence are not addressed.

³⁸ For example, there are obvious synergies between renewable energy and energy efficiency for both climate and energy security objectives. Conversely, substitution of coal-fired generation by gas-fired generation may have adverse energy security outcomes while offering low-cost emissions reductions. Another example is the relationship between the UNFCCC and the Montreal Protocol (MP) around hydrofluorocarbons. They are being used in the MP as a transition chemical (as a replacement for CFCs), but have very large greenhouse gas potentials (several orders of magnitude higher than CO₂). This is being explicitly addressed in the negotiations.

³⁹ Although demand-side energy efficiency technologies are eligible under the CDM, to date the take-up in that area has been low. Programmatic CDM is being investigated as potentially well-suited to EE policies.

⁴⁰ The work of the IEA/OECD secretariat to the Annex I Expert group is very useful in better understand this area.

⁴¹ This difficulty is illustrated in the uptake of CDM in sub-Saharan Africa. It is fundamentally difficult to show a benefit below baseline emissions. When those baseline emissions are nearly zero because of the use of traditional biomass, lack of access to energy, etc. This is being considered by the UNFCCC.

⁴² Pacala, S. and Socolow, R. (2004) "Stabilization Wedges: Solving the Climate Problem for the Next 50 Years with Current Technologies", *Science*, Vol. 305, Issue 5686, pp. 968-972, 13 August 2004.

⁴³ E.g. McKinsey and Company (2009) *Pathways to a Low Carbon Economy*.

⁴⁴ The more "technical" aspects of the negotiations under SBI and SBSTA are likely to play a lesser role. Still, some of the rich detail in these talks could support LCA text if it is properly considered. The constraint now is around the volume of words and time.

⁴⁵ With regard to technology, the AWG-LCA primarily is considering several issues including (para.1d): (i) mechanisms to accelerate deployment, diffusion and transfer of affordable environmentally sound technologies, including mechanisms for removal of barriers and provision of financial and other incentives; (ii) cooperation on research and development of current, new and innovative technology; (iii) mechanisms and tools for technology cooperation in specific sectors, including sectoral approaches; and (iv) measuring, reporting and verification of technological (as well as financial and capacity-building) support for nationally appropriate mitigation actions by developing country Parties.

⁴⁶ WRI (2009) has collated the submissions received until August 2009. The 39 submissions that specifically focus on technology are summarized (see: WRI (2009) Summary of UNFCCC submissions, www.wri.org).

⁴⁷The topic of Intellectual property Rights (IPR) has been consciously omitted from discussion in this brief. It is a feature of the technology negotiations, and one that requires attention and time. That being said, the topic area tends to unnecessarily polarize the debate, and the author thus considers that its insertion into this brief would have been a distraction. Trade issues, which are often bundled along with IPR issues in the negotiations, also require specific attention (probably more than IPR). But again the issue is considerably wider than climate change and the UNFCCC. On a personal note, the author would like to note the passing of Professor John Barton of Stanford University. His work on trade and IPR issues was intelligent and thoughtful (e.g. Barton J. 2007, Intellectual Property and Access to Clean Energy technologies in Developing Countries. Draft. ICTSD. Issue paper 2.).

⁴⁸ as of June 22, 2009

⁴⁹ In addition, there were 17 other formal proposals by Parties under the Convention and the Protocol.

⁵⁰ The technology section is now (August 13, 2009) approximately 21 pages long.

⁵¹ The only reference is: Technology Transfer and Capacity Building: Background material (August 11, 2009)

⁵² A new TNA handbook was released in Bonn at the June 2009 UNFCCC sessions. It recognizes the need to evolve TNAs to a wider function than simply a needs assessment. A new GEF instrument will support capacity for developing a new set of TNAs for certain countries.

⁵³ Project Catalyst has outlined the precedent for these plans and identified good practice and gaps (Low Carbon Growth Plans, Working Draft 7 August 2009).

⁵⁴ There is a wide literature about early-stage financial tools (including risk instruments), and those that can be effectively introduced by the public sector (see e.g. UNEP SEFI publications).

⁵⁵ For conceptual the work, see the OECD/IEA Annex I Expert Group. For a study of how MRV is already done in practice (in China), see WRI.

⁵⁶ See: Bell (2007) UNCTAD. *The Least Developed Countries Report 2007*. Background Paper. Bell classifies the specific capabilities required as: operation or production capability, design, engineering and management capability, and R&D capabilities.

⁵⁷ This is, of course, also widely recognized in many other technology and service-related sectors. It is not an abstract concept. Training programs and business development centers, as just two examples, are in place over decades in many countries in many fields.

⁵⁸ Article 9 of the Convention and Article 10(e) of the Kyoto Protocol. Decisions 2/CP.7 and 3/CP.7 are the frameworks for capacity building agreed in Marrakech.

⁵⁹ See: Rodrik, D. (2004) *Industrial Policy for the 21st Century*, Harvard University.

⁶⁰ This notion is from personal communication with Hugh Outhred.

⁶¹ Some of which are codified under the Millennium Development Goals (MDGs). The relationship between energy and the MDGs is outlined in a UN-Energy publication.

⁶² Such as: joint UNIDO/UNEP National Cleaner Production Centres (NCPC) and a new programme on Resource Efficiency and Cleaner Production (RECP) which, inter alia, specifically addresses technology transfer issues, an Industrial Subcontracting and Partnership eXchange (SPX) Programme, and a series of Investment and Technology Promotion Offices (ITPO) that link developed country products and services with markets in the developing world.

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