Clean Energy Transition

Challenges in Developing Economies versus Developed Economies

A. Introduction

Climate change is frequently referred to as one of the defining challenges of the twenty-first century. We concur. In broad terms, the climate challenge is relatively straightforward. Global average temperatures are rising as a consequence of anthropogenic emissions of greenhouse gases. In the absence of deliberate and global action to first substantially reduce and then eliminate (or even turn net negative) greenhouse gas (GHG) emissions, global temperature rise within this century is very likely to surpass two degrees Celsius (IPCC 2014), which is the (somewhat arbitrary) threshold set by the international community as a tolerable level of warming. Continuation of current levels of emissions or (worse) continued growth in emissions throughout the twenty-first century could result in warming far above the two-degree threshold with very bad implications for the environment of the planet and for human societies, particularly poor people.

These observations constitute the core arguments for serious efforts to reduce emissions, called mitigation policy, at the global level. A principal element to mitigation policy relates to energy use. Specifically, energy use must transition from technologies that emit substantial volumes of GHGs to technologies with limited or zero emissions. A 'clean energy transition' refers broadly to a substitution of technologies and associated fuel inputs across the full set of energy subsectors and consumers of energy, both as intermediates and final goods.

While the broad contours of the climate challenge, of which the mitigation challenge is a subset, are well understood, the specificities of almost all aspects of the climate challenge are deeply complex. Enormous efforts have been dedicated to the science of global change (IPCC 2014, 2013). While much remains to be learned, climate science provides solid foundations to the core arguments for serious efforts to reduce emissions. The technical challenge of inventing low emissions energy technology has been absorbing the attention of some of the world's top scientists and engineers for decades and has become increasingly commercial over the past decade. Further, a new wave of promising technologies is forming.

But, in the end, a solid foundation for action derived from climate science combined with an array of promising technologies for reducing emissions are not likely to be enough to catalyse a clean energy transition. A key phrase in the very first paragraph of this introductory chapter is 'deliberate and global action'. A clean energy transition is highly unlikely to occur on its own.

Policies must be put in place that will foment a clean energy transition and these policies must be effective globally (as opposed to just shifting emissions from one region to another). The challenge, perhaps the largest of them all, is implementing policies and programmes that actually achieve the necessary global emissions reductions. Here, political economy considerations take a leading role. These perspectives motivate our focus on the political economy of clean energy transitions.

B. A New Era

For the purposes of avoiding the potentially execrable outcomes associated with climate change, a long series of global agreements and meetings have taken place under the auspices of the United Nations. In the jargon that sprouts from such efforts, the first conference of the parties (CoP1) to the United Nations Framework Convention on Climate Change (UNFCCC) took place in 1995 in Berlin. Through the twentieth meeting (CoP20) in 2014 in Lima, relatively little was accomplished in terms of actually changing the trajectory of the global emissions of GHGs that drive climate change. CoP21 in Paris in late 2015 represents a potential breakthrough that ushers in a new era for climate mitigation.

The successful conclusion of CoP21 reflects three features of the current landscape that differ significantly from previous major attempts to set the planet on a more desirable GHG emissions trajectory. Most recent major attempt, prior to CoP21, occurred at CoP15 in 2009 in Copenhagen. First, CoP21 represented the culmination of a shift in the negotiation framework. At CoP15, the negotiations retained more of a 'top-down' approach wherein, essentially, a global emissions trajectory was determined and negotiators sought to parse country-level responsibilities for achieving this path.

In contrast, CoP21 in Paris employed a 'bottom-up' offer system, wherein individual countries propose what they perceive to be achievable and fair emissions trajectories for their particular circumstances. These offers are formally called Intended Nationally Determined Contributions (INDCs). In this new negotiating framework, the resulting projected global emissions trajectory is the sum of individual country INDCs.

Second, the rapid pace of technological advances in renewable energy technologies and systems, even if one considers just the past six years, is in the process of influencing the political economy of clean energy transitions (USDOE 2015). Historically, governments

aiming to take deliberate action to correct the colossal market failure of GHG emissions have suffered from a 'chicken and egg' problem. Specifically, many technologies that offered long-run potential to support a clean energy transition were also small-scale, immature and relatively high-cost. As a result, they were largely unattractive to private investors. While these factors provide a solid economic rationale for government support, the politics of supporting small-scale, immature, and relatively high-cost technologies are nonetheless difficult.

Difficult politics inevitably constrains the ambition of policies that are crucial for technology development. In sum, a circle exists wherein politics drives policy, policy drives technology, and the state of technology circles back to influence politics. Today, from the perspective of advancing clean energy technologies, this circle shows evidence of becoming virtuous as opposed to vicious. Since 2008, the year before CoP15 notably failed to produce a move towards effective global mitigation, the global solar module price index has fallen by a factor of nearly four, a rate of technical advance vastly more rapid than nearly all predictions.

Declines in the cost of wind power—while not as dramatic—have been rapid by any common standard. These advances both spur private investment and generally ease the politics of supporting clean energy transitions. Investments in energy production have reflected these shifts. In 2014, for the first time in history, the amount of new renewable generation capacity surpassed that of new fossil fuel-based systems on a global basis. This trend continued in 2015 with new renewable capacity outstripping fossil fuels again.

Third, the developing world confronts climate change issues with a far deeper and more sophisticated knowledge base than in 2009. In Copenhagen at CoP15, the critical role that developing countries must play in any effective global mitigation regime had become clear simply as a matter of arithmetic. Yet, the complex implications of climate change impacts, adaptation policies, and mitigation policies had really only begun to penetrate the major decision-making apparatuses of developing countries. For instance, the World Bank's Economics of Adaptation to Climate Change study, which was meant to serve as a critical input to developing countries for CoP15 in 2009, was only published in 2010, after the Copenhagen CoP meeting had ended. In our experience at the time around CoP15, work on climate change issues, particularly when one spoke to personnel from the critical central finance and planning units in developing countries, frequently amounted to delivering primers on climate change and energy transition policy basics. The process of internalizing the information and assessing appropriate policy responses had only just begun.

It would be an overstatement to say today that climate change information has been fully internalized and appropriate policies assessed in developing countries. Nevertheless, the process of doing so is much more advanced than it was in 2009. In country after

country, the central decision-making units have engaged. This is critical. The profound economic transformations inherent in a clean energy transition will need to be fully integrated into economic decision-making. The contributions from developing countries in this book are evidence of this increasingly sophisticated and nuanced view of the climate challenge. The more than 160 INDCs on the UNFCCC website are perhaps the most salient evidence.

India and China are cases in point. In 2009, it is fair to say that India's negotiation strategy aimed to position climate change as a developed country problem. In contrast, India's INDC offers serious attempts to reduce the carbon intensity of its GDP. China has gone further, offering to peak emissions by 2030 with declines thereafter. Taken as a whole, the INDCs presented at CoP21 represent a decisive break from past emissions trends. Recent analysis of the INDCs by the International Energy Agency (2015) indicates that nearly every country will have a strong focus on emissions mitigation, driving clean energy to more than 50 per cent of world energy by 2040. The scope and ambition of these offers stem from long and often difficult processes of internalization and policy option assessment that has taken place within both developed and developing countries.

These three shifts now combine to place country decision-making and country policies at centre stage. Like it or not, there is no current prospect for a unified global policy, such as a global carbon tax or cap-and-trade scheme, to which all nations agree to adhere. Rather, nearly all countries on the globe will set about to achieve their contributions in their own ways, and their means for achieving these ends will vary enormously. For example, the United States, a leading advocate in international fora for reliance on markets, looks set to pursue a domestic policy of regulatory edict. China, the paragon of the developmental state, announced intention for a nationwide cap-and-trade system in September 2015. Overall, the range of policies pursued, and hence the degree of policy experimentation, looks virtually certain to be very large.

Before proceeding, the technology drivers mentioned in this section merit a closer examination.

C. Technology Drivers

In controversies about technology and society, there is no idea more provocative than the notion that technical things have political qualities. The rate of technological advancement in the renewable energy space has been notably rapid. Established institutions, once isolated from rapid change, are now presented with a dynamic landscape of pathways for simultaneously achieving decarbonisation goals and sustainable development objectives.

With affordable low-carbon energy readily available or imminent in most contexts, institutional innovation is arising—out of necessity—across public policy, finance, business models, markets, planning, and other dimensions to promote deployment. These innovations—and the technical and political qualities they possess—are interacting with a range of incumbent actors and interests, and influencing the political economy of the clean energy transitions. Thus, a brief assessment of technology drivers is worthwhile.

The growing cost-competitiveness and advanced capabilities of renewable energy technologies, predominantly wind and solar, is a key pillar of clean energy innovation and technological advancement. We observe, in many contexts, the price of a newly constructed wind farm or solar plant is now at or below the cost of competing fossil fuel alternatives, even without considering the fuel price variability or environmental or health impacts.

With their geographically diverse and variable nature, these resources are reshaping, in particular, how power systems are planned, operated, governed, and even conceptualized. Furthermore, the modularity of solar panels enables a viable alternative to the traditional provider–customer relationship, quite literally empowering consumers through technology, regulation, and business model innovation to create their own energy.

The qualities of clean energy technologies also have implications for energy security in both developed and developing country contexts. Renewable technologies offer the prospect of reducing dependence on fuel imports. Energy trade between countries may or may not decline, however. There are portfolio effect gains from renewable energy generation over broad areas driven by the simple observation that it is likely to be windy and/or sunny somewhere.

In addition, hydropower resources are often concentrated in a few locations. Both of these factors point to increased regional energy trade as a potential corollary to increased dependence on renewable energy sources. As a result, energy security under a renewable energy future may take on a much more regional hue.

At the same time, the inherent dispersion of wind and solar resources, combined with new technologies and business models, present increasingly attractive pathways to expanding energy access from the bottom up, potentially leapfrogging the need for some of the cumbersome and difficult-to-finance infrastructure investments associated with traditional power systems. As will be discussed in Section 1.4, this dispersed nature of renewable energy may be particularly relevant for rural zones and smaller concentrations of demand located a distance from functional grids. Advances in data systems, communication technologies, and energy storage costs are accelerating decentralization and heterogeneity of the energy sector.

While technology is a fundamental driver, it has become increasingly clear that the availability of technology is not in itself sufficient to accelerate a clean energy transition; innovative and nationally-customized deployment strategies—hinging on public policy and regulation, market reforms, private sector engagement, and strong analytical tools and data—remain important factors.

More often than not, regulation and governance lag behind technology innovation; compelling forms of institutional innovation in order to play catch up. Ongoing innovations in energy systems often require either adaptation of established regulatory constructs to accommodate new technologies (a form of incremental change) or broad-based reform of the regulatory constructs themselves (perhaps via more reconstructive or evolutionary approaches). Across all contexts, addressing the techno-institutional complex perpetuating carbon-intensive systems—termed by some as 'carbon lock-in' (see, for example, Unruh 2000)— is a common theme.

Technology is highly likely to remain one of the key driving factors influencing climate commitments and energy-related development goals, both in terms of goal-setting and implementation. What is technically possible and economically attractive today vis-à-vis decarbonisation and sustainable development is much greater than it was during (for example) the Kyoto Protocol era. Continued rapid rates of technical advance are expected. In order to seize the opportunities offered by this technical advance, equally innovative approaches to regulation and policy are likely to be required. This highlights the inherent political economic factors to be considered, as various pathways are weighed and implementation efforts are mounted.

D. Challenges in Developing Versus Developed Economies

The political economy of energy transitions is of interest across both the developed and developing worlds. As emphasized, the mitigation challenge cannot be addressed by developed countries alone. The volume of current emissions from developing countries combined with their rapid growth trajectories highlight the importance of developing countries in any effective global mitigation regime. Developing countries simultaneously confront enormous development challenges. Eliminating absolute poverty is also a defining challenge of the twenty-first century, as set forth in the Sustainable Development Goals.

Developing countries are highly unlikely to shelve their developmental aspirations in favour of mitigation objectives. Thus, the political economy of clean energy transitions in the developing world present some of the thorniest and most important challenges.

With respect to the developed world, their historical emissions, relatively comfortable material circumstances, institutional capabilities, and technical knowhow lead to the expectation that they will lead the energy transition. This means reducing absolute emissions in the near term and achieving very deep cuts by mid-century. This change must be undertaken by energy systems characterized by weak or even negative energy demand growth as well as deeply entrenched actors and interests.

In sum, the challenges facing both developing and developed countries are not to be taken lightly. While developed countries are expected to lead—for example, with respect to government commitments to research, development, demonstration, and deployment activities for new technologies—the critical role of regulatory frameworks, policies, and institutions have already been emphasized. These require localized solutions in both developing and developed country contexts. The dividing line between these two broad country groups is neither clear nor fast in other respects as well. Citizens of developed countries expect economic progress through time along with environmental stewardship, and developing countries certainly have their share of entrenched interests.

Nevertheless, the broadly defined challenges facing developed and developing economies do differ in important ways. In particular, driven by population/labour force growth, technological catch-up, a relatively high marginal product of capital and substantial growth aspirations, developing countries' economies can be expected to grow more rapidly than developed economies. Accordingly, the demand for new energy supply is likely to be much greater in the developing than developed world.

There are multiple edges to this challenge. On the one hand, the INDCs set forth by developing countries point to a reorientation away from the well-trodden path of employing massive fossil energy to fuel development. This charting of a new path, or new paths, is almost surely less straightforward than following prior recipes. As institutional and human capabilities in developing countries are characteristically weak relative to developed countries, the need to chart new paths and confront new challenges provokes legitimate concern.

On the other hand, fossil-based systems have a series of, by now, well-known shortcomings. First, developing countries frequently encounter difficulties implementing fossil-fuel-based systems, particularly for electricity generation. These difficulties arise from numerous factors. The bottom-line is that unreliable power supply has long been a hallmark of many developing country cities and is frequently pointed to as a substantial brake on economic development. While intermittency in output is a characteristic of many renewable generators, that variability reduces substantially at a system level; and meeting or improving upon the reliability levels currently attained in many developing country contexts is often a fairly low bar of accomplishment. The relatively modular nature and short investment lead times of wind and solar power generation systems also favour developing countries where demand growth tends to be much more variable and much less predictable than in developed country contexts.

Second, fossil-fuel-based systems are poorly suited to rural areas. This is particularly true of electricity generation. Around 1.2 billion people (about 17 per cent of the world's population) lack access to electricity, and the vast majority of these people live in rural areas of developing countries (IEA 2015). Rural inhabitants in zones that lack access to electricity are frequently absolutely poor. In short, existing fossil-based power systems serve the least well off of the world's population very badly. Various renewable technologies have been shown to scale effectively in these areas. Bio power systems currently serve dozens of villages in South Asia, and next generation bioenergy systems also hold out additional promise for rural zones. With the rapid advances in solar and battery technology, distributed solar systems provide a potentially unprecedented opportunity to extend electricity access to some of the world's poorest citizens.

Third, localized pollution impacts of fossil-fuel-based systems can be intense. oor air quality gives rise to serious health concerns. New Delhi and Beijing are just the most recent examples of places where low air quality seriously impacts wellbeing. Clean energy systems have the potential to diminish or even effectively remove these real costs. Fourth, fossil-based systems both fuel and disrupt development. Experience in countries with fossil fuel endowments indicate that they are not an unalloyed boon for their economies in general and the welfare of their citizenry in particular. The vagaries of fossil fuel prices, and concomitant

macroeconomic instability, combined with the tendency for revenues derived from sale of fossil resources to concentrate in a few hands have not been helpful for development patterns in many countries leading some authors to proclaim a 'resource curse' (Frankel 2010). For most fossil fuel importers, variations in fossil fuel prices have large impacts, often with implications for political stability.

Finally, developing countries may possess inherent advantages in terms of clean energy endowments. Many developing countries are relatively well endowed with sun, wind, and unexploited hydropower potential. In a world dominated by clean energy systems, many developing countries may possess an inherent comparative advantage in energy-intensive activities. For these reasons, a clean energy transition is not necessarily an impediment to the growth aspirations of the developing world. And, there are a series of solid rationales for developed countries to assist developing countries in realizing a clean energy transition. Not least, a failure on the part of developing countries to transition to cleaner energy sources implies a failure to stabilize the global climate, with negative implications for everyone. Developed countries are also responsible for a disproportionate share of the stock of greenhouse gases in the atmosphere. This would be highly problematic if the lack of space for even greater stocks of atmospheric GHGs imposed a tight trade-off between the development aspirations of the citizens of developing countries over the next few decades and a permanent alteration of the global climate. The fact that the developed world has effectively claimed squatters' rights on the global atmospheric commons becomes a lot less problematic if new paths to fuelling development are opened as the fossil fuel pathway is foreclosed.

The practical and ethical arguments for assisting developing countries in taking these new pathways are strong. At the same time, it is not a question of simply willing a clean energy system into place whatever the cost. As emphasized, the changes inherent in a clean energy transition are profound, involving the full economic system with implications for competiveness and economic growth. Improperly done, those costs could easily be very high and would likely sap the will for undertaking that very transition. Hence, economic efficiency and reasonable equity are key. Efficient and relatively low-cost transitions to a stable global climate are widely viewed as imminently possible. The cost estimations in the Fifth Assessment Report of the IPCC indicate approximately a year or two of global growth by around mid-century. In other words, global GDP per capita with mitigation would reach the same level in 2055 as it would have attained in about 2053 without mitigation. These calculations typically ignore the benefits of mitigation in terms of climate change impacts avoided as well as health benefits from reduced pollution. Also, there are real possibilities to enhance the equity of the energy transition through, for example, more rapid rural electrification and better urban air quality in developing countries.

E. Looking Forward

A clean energy transition is not easy. This is amply illustrated in the case studies. Even if the technical path is clear and fully illuminated, a clean energy transition will involve the shift of resources between competing economic sectors and political constituencies alongside changes in institutional and policy frameworks. Stakeholders in this process have varying degrees of political and economic power. Regardless of the society or the political system, understanding how political economy factors influence clean energy transitions is crucial to effective policy formulation and facilitating transitions to sustainable energy systems.

Despite the challenges, this introductory chapter has adopted a purposefully optimistic tone. This seems appropriate. CoP21 does represent a substantial break from the past. Technological change in clean energy sectors has been very rapid. Institutional and policy changes are evident in many countries. And, resource allocations are shifting as evidenced by the large investments in clean energy systems that are occurring worldwide. In effect the set of INDCs derived from CoP21 pledge an essentially global transition towards clean energy systems. Put differently, global mitigation efforts have begun in earnest.

While the first steps have been taken, much more effort is required. Over the next few years, countries need to follow through on their INDCs. Looking further ahead, it is well known that the sum of the commitments in the INDCs does not result in an energy system that is sufficiently environmentally benign as to be compatible with a stable global climate. Even more ambitious commitments/transformations will be necessary in future.

While a freewheeling 'bottom-up' approach appears to have been well suited to getting started, it is likely that limitations to the highly dispersed approach adopted in Paris at CoP21 will become apparent. For example, the solicitation of INDCs is not an approach that is particularly well suited to addressing the vexing and inter-related issues of international trade, carbon trade, and footloose industries/carbon leakage.