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GROWTH, INNOVATION AND COP21

THE CASE FOR NEW INVESTMENT IN INNOVATIVE INFRASTRUCTURE

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Key Points

- Forged by private and public sector cooperation, Mission Innovation was announced at the twenty-first Conference of the Parties (COP21) to the United Nations Framework Convention on Climate Change as a commitment to doubling, by 2020, the investment in energy innovation by participating countries. Mission Innovation heralds a new period of active private-public sector engagement on energy, climate and innovation policy.
- Energy innovations beyond wind, solar, lithium batteries and light-emitting diodes (LEDs), in fields as diverse as methane control, transportation, post-fossil fuels chemistry and materials, the circular economy and second-generation carbon capture, sequestration and use, are ready for scale-up. The firms commercializing these solutions are already substantial employers.
- The timing of country-specific global greenhouse gas (GHG) peaking can be accelerated by scaling up these innovations. Their potential contributions to GHG reductions from 2020 to 2030 could be substantial if scale-up policies are enacted now. Mechanisms to address market failures in finance and market access for these innovations will have direct and significant impacts on GHG reductions and will result in employment growth as firms grow both manufacturing and innovation to meet rising demand.
- Policy leaders will need to coordinate multiple policy interventions to backstop financial risk and to enable scale-up of innovations via fiscal policy, trade finance and public procurement policy for infrastructure, as well as through international development and climate finance. Coordinated policy implementation will facilitate increased global trade in manufactured environmental goods, and this increased trade may serve as the bridge to a lower-carbon global economy that sustains growth and good jobs for citizens (Bak 2015a).

Introduction: COP21 and Mission Innovation

On the way to Washington, DC, for a September 2015 visit, Chinese President Xi Jinping stopped in Seattle, WA, to sign an agreement aimed at combatting climate change by increasing the business ties between Chinese and US clean technology companies (South China News 2015). Five US states signed the agreement on commerce between China and clean-tech businesses from California, Iowa, Michigan, Oregon and Washington. On the same day, Bill Gates's energy company, TerraPower, signed an agreement with the China National Nuclear Corporation for joint cooperation on next-generation renewable and fusion nuclear power. In early 2015, Malaysia's sovereign wealth fund invested in General Fusion, a Canadian company based in Vancouver, to advance its energy innovation.

These agreements foreshadowed the launch of Mission Innovation made by Bill Gates with US President Barack Obama, French President François Hollande and Indian Prime Minister Narendra Modi on the first day of COP21 in Paris. Mission Innovation's state-level participants pledged to double investments in clean energy research by 2020, with the goal to shore up research budgets that have fallen to half what they were at the end of the 1970s. Similarly, the UK-based Apollo initiative seeks to mobilize US$150 billion for research and development (R&D) in energy storage and smart grid technologies to enable greater uptake of renewable energy (Gurria 2015). Implicit in the launch of Mission Innovation is the notion that more energy innovation will be needed — beyond wind, solar, lithium ion batteries and LEDs — to attain the decarbonization goals contemplated beyond 2030.

In addition, Bill Gates and 27 other wealthy investors started the Breakthrough Energy Coalition, a fund whose intent is to spur private and public sector cooperation and to raise investment in clean energy innovation. Bill Gates's agreement with the China National Nuclear Corporation is just one example of the new activity around energy innovation policy via private and public sector cooperation, and comes after previous private sector-only initiatives that did not bear fruit. These energy innovation initiatives take the baton from the New Climate Economy's proposals for policy action to support low-carbon innovation as one of 10 differentiated economically viable pathways to address climate change (Global Commission on the Economy and Climate 2015). They are among a growing number of initiatives seeking to bridge the current global economic system and one that fully accounts for the impact of carbon on the planet.

Innovation and Peaking GHGs

Global governance entities made reference to innovation in the leadup to Paris, but generally with a cross-cutting post-2030 focus. In this regard, global governance entities could be more ambitious in the 2020–2030 period. For example, for the pre-2020 period, the International Energy Agency (IEA) proposed immediate climate change efforts in the following areas: updated regulation; more renewable energy; the end of oil and gas subsidies; and policy alignment. Specifically, the IEA referred to reduction in the use of subcritical coal plants, methane control in the oil and gas industry, increasing renewable energy and a complete phase-out of fossil fuel subsidies. According to the IEA, these policies would contribute half the GHG reductions needed to achieve peak global emissions around 2020. The IEA noted innovation and clean technology shouldering a greater share of the GHG-reduction burden in the future (Birol 2015).

For its part, the Organisation for Economic Co-operation and Development's (OECD's) policy prescription called for greater investment in innovation but with no specific targets. The OECD made quantified proposals for the following: quadrupling green infrastructure investment to US$1 trillion; stopping fossil fuel subsidies; making carbon markets more effective; decarbonizing transportation; and increasing development assistance through bilateral, multilateral and privately mobilized climate finance. The OECD continued to call for global emissions peaking by 2030 and zero net emissions by 2100 — a goal adopted by the Group of Seven in 2015. It made no mention of the potential impact of innovation in the pre-2020 period.

The United Nations advanced the Lima-Paris Action Agenda (LPAA) as a framework through which non-state actors, including subnational governments, businesses, civil society, international organizations and academic institutions could track, coordinate and leverage efforts. Under the LPAA, non-state actors are encouraged to translate Intended Nationally Determined Contributions into cooperative or individual initiatives under seven differentiated areas. Innovation is not specifically mentioned as a category in the LPAA framework; however, innovation may be viewed as a cross-cutting enabler (Fabius 2015).

COP21 and Climate Innovation Showcases

Anticipating the role of innovation, albeit post-2020, COP21 organizers hosted venues dedicated to showcasing innovation. Paris organizers chose the inspiring Grand Palais, located on the Champs Élysées, to present to the *grand public* an array of innovative climate solutions from around the world. As a key enabler of innovation, in particular for small and medium-sized innovative firms, the French Intellectual Property Institute hosted the public diplomacy showcase of 60 innovative firms that are commercializing climate solutions. A similar climate solutions showcase is planned for COP22 in Marrakesh, under the aegis of the Moroccan Institute of Intellectual Property.

It is fair to say that innovation re-emerged as part of the climate change policy array in Paris. What can be learned from current energy innovation policies to shorten the time needed to attain GHG peaking, and to shift the energy innovation discussion into current policy considerations?

Past Policies Have Built Climate Solutions that Are Ready for Scale-up: New Investment in Innovative Infrastructure Is Possible

Energy innovation investments require decades to bear fruit and thus reviewing the impact of past innovation policies is vital to members of Mission Innovation that are preparing to translate financial commitments into innovation policies that support GHG peaking.

Countries that have invested in energy innovation over the past 15 to 20 years, and that are considering investment in infrastructure as part of sustainable growth priorities, should consider the role of innovation in infrastructure. Rather than deploying infrastructure investment via new deployments of old technology, they could consider investing in new deployments of innovative solutions. They may find that new innovative infrastructure investment can be part of sustainable growth and circular economy plans now, and could provide GHG reduction benefits sooner than previously thought.

A Canadian case study based on five years of firm-level research suggests that first-generation energy innovation policies have succeeded in spurring private sector investment at scale, and have produced solutions that could contribute to achieving global GHG peaking through new innovative infrastructure.

Based on a cohort of 814 firms, 780 of which have less than CDN$50 million in revenue and 65 of which are publicly traded, annual investment in R&D by Canada's clean technology industry was CDN$1.4 billion in 2013. This R&D investment was equivalent to 110 percent of private sector R&D investment in the aerospace industry and to nine percent of total national private sector R&D. These R&D investments represented 12 percent of industry revenues, or about 2.5 times the Canadian pharmaceutical industry's R&D intensity. To translate these R&D projects into practice, 250 full-scale demonstration projects worth CDN$2.9 billion in combined private and public sector investments have been funded over 14 years by Sustainable Development Technology Canada (SDTC), a foundation whose starting capital originated from the sale of Canada's state-owned oil and gas enterprise.

Although still small, these same companies represent significant employment. In aggregate, they employ 50,000 people across 800 firms — on par with more concentrated industries such as forestry, processed foods and pharmaceutical and medical devices, and half the employment in Canadian oil and gas in 2012.

In the Canadian case study, historical energy innovation policies, including fiscal measures for accelerated depreciation of capital costs, fiscal R&D credits for labour and program-based grants for demonstration projects, have successfully spurred private sector energy innovation investments. They have also created firms with the potential for significant positive climate impacts sooner rather than later, as well as the potential to grow hundreds of thousands of middle-class jobs.

First-generation Energy Innovators Are Ready for Market Scale-up Policies

A closer look at the Canadian cohort of clean technology companies reveals more about the profile of innovators. From 2008 to 2013, 70 percent of Canadian clean technology R&D investment (three-quarters of which were energy related) was made by firms with less than CDN$50 million in annual revenue (Bak 2015b). What is more, firms have been operating well in advance of the implementation of GHG regulation, having been founded, on average, 17 years ago. While still an emerging industry, these firms have simultaneously created much-needed energy innovation *and* well-paid middle-class employment.

Depending on historical policies, Mission Innovation actors may observe a similar pattern: first-generation energy innovators are both older and smaller than expected, but their current aggregate impact on employment and their potential aggregate impact on climate change are substantial. Policy makers wanting to capitalize on the potential GHG and employment impacts of these innovations will need to bear in mind these firm-level characteristics.

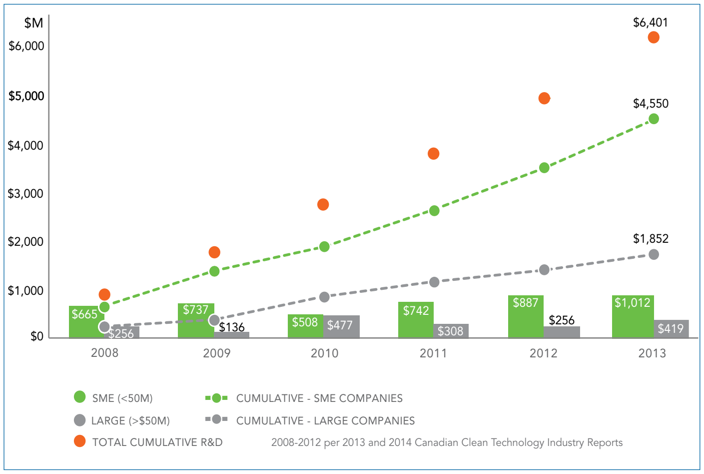
First-generation Energy Innovators Are Capital Intensive and Employ People to Manufacture the Product of Energy Innovation

Because energy systems are so complex and because they are made up, in part, of physical plants, first-generation energy innovators are capital-intensive firms. In addition to inventing new technologies, these firms must also instantiate their innovations within manufactured environmental goods. Business models that combine investing a significant percentage of revenue in R&D and operating complex manufacturing are not normally associated with small firms.

As a result, these firms find themselves in a policy no-man's-land needing industrial-scale capital rather than venture capital normally associated with innovators. This differs from other innovative sectors where open-source software has vastly reduced the transaction costs associated with bringing innovations to market and where intellectual property and global Internet governance are important policy concerns. These firms also find that they are only partly considered in fiscal policies that address only the cost of labour associated with innovation as opposed to the combined labour and capital costs.

First-generation energy innovators are akin to early Baby Boomers who were born before health and education infrastructure was put in place. These firms have had to adapt while they wait for scale-up and finance policies to be designed and implemented. This focus on adaptation is evident in firm-level findings on human resource (HR) gaps. For energy innovators, recruiting priorities are squarely focused on sales and capital-raising abilities. When scale-up and finance policies are in place, engineers and scientists may replace sales and finance professionals as the primary HR focus and will drive significant growth in well-paid jobs.

Figure 1: Small and Medium-sized Enterprises (SMEs) Dominate Significant Investment in R&D by Canadian Clean Technology Firms



Source: Bak (2015b).

What Can Be Learned from First-generation Energy Innovators to Accelerate GHG Peaking?

As policy makers consider a new generation of energy innovation and scale-up policies, the pioneering work of first-generation innovators can help pave a smoother path for second and third generations as well as accelerate the climate impact of innovations ready to be scaled up.

Markets for Energy Innovation Must Be Local Before They Can Scale Up Globally; Policies Should Reflect This

Research shows that energy innovation requires large investments over long periods of time. To amortize these deep investments and offer the potential for sufficient returns, it follows that markets must be global. Mission Innovation, Apollo and the Breakthrough Energy Coalition are proof of the global nature of these markets.

Canada's clean technology industry provides firm-level evidence of the global nature of markets. The industry estimates that 50 percent of revenues are currently from domestic markets but that this will decline quickly. Surveyed in 2014 on 2013 business results, firms expected that 70 percent of 2015 revenues would originate from outside domestic markets (Bak 2015b). This is consistent with the most globally focused industries. When asked about their strategic intent, 70 percent of the firms indicated that they intend either to be niche-focused global competitors (32 percent) or dominant global competitors (38 percent). The pace of growth in global trade in manufactured environmental goods would support this focus on global markets (Bak 2015a).

At the same time, all energy innovators are dependent on local markets. By their nature, energy innovation solutions must be integrated within complex systems. As climate innovation scales up, integration of these solutions into existing systems is best done locally, where there can be "broadband feedback loops" with both social and technical stakeholders of existing systems. This makes it possible to make local adaptations and quickly address integration concerns. For example, a company with an energy storage technology, be it a flywheel technology for short-term electricity modulation or an underwater compressed air chamber, will seek out a number of first deployments in local markets so they can work closely with local utilities to build out the complete solution that will be required to continue to deploy internationally.

Some jurisdictions, such as the United States, have for decades set aside public procurement budgets for SMEs and required that major vendors to the US government develop supplier relationships with SMEs. As a result of public procurement set-asides for SMEs, large firms established supplier agreements with SMEs that were highly innovative. Companies such as Intel, Microsoft, Apple and dozens of others benefitted from public procurement at critical times in the companies' growth.[1]

Domestically, the United States has garnered a number of benefits from requiring that larger firms procure from smaller firms if they are to participate in public procurement. Larger firms gain the benefit of speed and productivity through procurement of innovation delivered by SMEs. Smaller firms are strengthened by focusing on what the large firms require and also receive the benefit of access to scale and global markets while remaining drivers of innovation. Such procurement regulation could be viewed as part of a countervailing power framework that balances the access to public procurement of the largest firms with those of smaller firms, including energy innovation firms (Reich 2015).

When innovative firms are headquartered in markets that do not have market access policies in place for energy innovation, they may compensate by developing extended business models that support faraway deployments. In these circumstances, firms have adapted by combining domestic manufacturing and supply chains with global market representation, engineering services and finance. As they wait for scale-up policies locally, these firms

1 US regulations promulgated under the authority of section 15 of the *Small Business Act* (1958) authorize agencies to set aside contracts for small businesses generally. With respect to subcontracting requirements, *Public Law 95-507* changed the emphasis from voluntary to mandatory and from "best efforts" to "maximum practicable opportunity" for prime contractors with regard to their subcontracting obligations from SMEs. For reference, please see Federal Acquisition Regulation, subpart 19.7 — The Small Business Subcontracting Program: www.acquisition.gov/?q=browse/far/19/7&searchTerms=FAR%20Subpart%2019.7%20The%20Small%20Business%20Subcontracting%20Program.

seek out supportive market access policies globally. For example, firms with low-carbon public transportation such as hydrogen-fuel light rail solutions may be deployed sooner in emerging markets, such as China, which are investing in new innovative transportation infrastructure. While these business models are possible for a time, they weaken firms in the medium to long term. Prioritizing new investment in innovative infrastructure can address this risk.

Domestic fiscal incentives offer another lever for market access policies in the medium term. As an example, accelerated depreciation of energy innovation capital goods based on GHG performance may be considered. Where energy innovation solutions deliver top-quartile performance, policy makers may consider accelerated depreciation treatment while full carbon pricing regimes are put into place. Such interim policies can deliver triple benefits: accelerating market scale-up; increasing economic productivity per unit of GHGs; and growth in taxable corporate profits from energy innovators.

Take Aways for Policy Makers

- Where first-generation innovation policies have been fruitful, policy makers have the opportunity to accelerate progress to climate goals by implementing policies that scale up markets and finance for first-generation energy innovative firms.
- Because of the large investments and the long horizons to prove energy innovations at scale, local market access and financing policies will be needed.
- New investment in innovative infrastructure should be part of scale-up policies for energy innovation.

Global and Local Markets for Scaling Up Innovation Will Require Coordinated Financial Innovation

Through necessary adaptation, energy innovation pioneers have evolved into mini-multinationals. Like Russian dolls, innovators have developed multiple nested capacities, including global and local supply chains, modern manufacturing, deep R&D, expert services and finance. This adaptation is costly and in order to be profitable, these firms must to do business directly with customers, however large, be they public or private. In the Canadian case study, firms expect 61 percent of their revenue to come from direct sales to large firms and 29 percent to come from strategic partnerships where responsibility for selling to large customers is shared with a larger firm that is a partner. First-generation innovators anticipate that only nine percent of sales will come from "global value chains," where they would be called upon to deliver a single finely crafted — but as yet unpainted — Russian doll as a core component to a larger set.

As pioneers, early innovators are accustomed to being "first in kind." When it comes to finance, this is problematic. In order to spread transaction costs and make profits, financial markets form around large aggregates of similar transactions. Beyond wind and solar, no such markets have formed around first-generation energy innovators, whose projects range from US$25 million for new energy systems, including energy storage, to US$100 million and up for next-generation carbon capture, storage and use systems and even US$500 million and up for green chemistry and next-generation renewable energy plants. For smaller projects (in the US$25 million range), these transactions fall well below thresholds for project finance. For large projects (in the US$500 million range), there are still too few transactions for financial markets to have formed. Again, like market access policies, early energy innovators have arrived before financial markets have formed.

Not only are financial markets as yet unformed, the financial conditions of each sale remain onerous. Let's take the example of new investment in innovative infrastructure, specifically low-GHG transportation. In these instances, public infrastructure is contracted through procurement arrangements via prime contractors; for public procurement there is an additional, larger Russian doll. Under normal business arrangements, prime contractors require that bank guarantees or letters of credit be posted for on-time delivery and performance to the contractual terms. In other words, they require guarantees that the innovation will be delivered on time, and will perform as promised. For energy innovations, these performance bonds are equal to the full value of the contracts. For innovative firms that do not yet have deep balance sheets, these guarantees can represent onerous business terms because they tie up the very funds needed to employ the people and purchase the materials to manufacture what the contract stipulates. The strains inflicted by performance bonds on energy innovation firms become risks born entirely by workers and investors. Clearly, working in and investing in energy innovation firms is not for the faint of heart.

The same considerations for risk pooling will be required in climate finance to enable all countries to benefit from innovative climate solutions. Development finance institutions will need to consider the role they should play to ensure developing countries get access to energy innovation. Underwriting public procurement entities may be required to enable contracting for procurement. Backstopping credit risk for public purchasers in developing countries combined with trade finance could deliver more equitable access to energy innovation. Tracking global trade in manufactured environmental goods would enable us to check that capacity-building policies are improving access to energy innovation.

Beyond letters of credit and guarantees, debt markets have little affinity for diversity, such as the 60 different solutions showcased at the Grand Palais or the 250 scaled-up projects in the SDTC portfolio. At a time of ultra-low interest rates, lenders require risk premiums of 15 to 25 percent for energy innovation scale-up projects. For policy makers seeking accelerated GHG peaking, pooling risk on both the procurement/buy-side and the solutions/sell-side of energy innovation will be as important to garnering the benefits of GHG reduction as the energy innovation policy itself.

Take Aways for Policy Makers

- Risk pooling among both sellers and buyers of energy innovation will be needed to scale up markets. Examples of risk pooling might include performance bonding funds available to municipalities that make new investments in innovative infrastructure.
- Climate finance will need to evolve to enable access to a full array of energy innovation by developing countries. Development finance entities can assist by supporting procurement risk pooling across developing countries.

First-generation Energy Innovation Firms Can Contribute to Sustainable Economic Growth and GHG Peaking Efforts Now

Beyond wind and solar, first-generation clean technology firms have commercialized innovations that are ready to be scaled up (Mazzucato 2013). As countries grapple with how to resolve tensions between growth goals and climate commitments, first-generation energy innovation firms are ready to grow employment and contribute to attaining post-2020 climate targets, thereby contributing to shifting global and national GHG to GDP ratios. Policy makers should expect first-generation energy innovation firms to be ready for coordinated finance and infrastructure investment policies to enable the move from invention to scale-up.

We should expect to see more private-public sector collaboration on policy innovations that will be needed for each of the parties to the Paris Agreement to set its road map to hold the average temperature increase to well below 2°C above pre-industrial levels and pursue efforts to limit the increase to 1.5°C. Achieving a peak in GHG emissions and then making steady progress on decarbonization will require more than renewable energy and regulatory changes. Achieving sustainable growth will require policies that enable GHG peaking while creating jobs. First-generation energy innovators can do just that, if new investments in innovative infrastructure are made.

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