Global Solutions Summit 2019
Synthesis and Policy Recommendations

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I. Introduction and Background

Global Solutions Summit 2019 (GSS 2019) convened at the United Nations Headquarters in New York City on May 13, 2019 with support from the UN Department of Economic and Social Affairs, the UN Conference on Trade and Development, the UN Commission on Science and Technology for Development, and the UN Office of Partnerships. The theme of GSS 2019 was "Inclusive Disruptive Innovation: The Imperative of Technology Deployment."[1] [GSS 2019, along with G-STIC, are UN Special Events complementing the official UN Multi-stakeholder Forum on Science, Technology, and Innovation for the Sustainable Development Goals. Additional information about GSTIC is available in Box 1 at the end of this section.]

When the global community adopted the 2030 Agenda for Sustainable Development, it placed a high priority on "harnessing science, technology and innovation to achieve the sustainable development goals" while "leaving no one behind." But what does it mean to harness science and technology for sustainable development? How is this related to inclusive disruptive innovation, the theme of GSS 2019? And what does all of this have to do with achieving the Sustainable Development Goals (SDGs) in the least developed countries that are furthest from the technology frontier and, therefore, one would surmise, least likely to deploy cutting-edge, disruptive innovations? Couldn't these countries make enormous strides simply by importing and using less disruptive development solutions?

The discussion at GSS 2019 centered around two fundamental observations.

- First, especially in the least developed countries, technical solutions for many problems that as recently as ten years ago were beyond the reach of most people at the bottom of the pyramid are now available and affordable as a result of what Laura Koch described as a "tsunami of new technology."

[1] GSS 2019 was the fourth in a series beginning with the Inaugural Summit at the US State Department in April 2014, a Second Summit at the Clinton Presidential Library in December 2016 and a Third Summit at UN Headquarters in New York City on June 4, 2018.

- Second, as UN Secretary-General António Guterres observed in his Foreword to the Global Sustainable Development Report 2019, despite the increased affordability and ubiquity of these new technologies and "despite considerable efforts these past four years, we are not on track to achieve the Sustainable Development Goals by 2030."

Why? What accounts for the confluence of scientific abundance and scant progress on the ground? Alas, all too often, new and existing development solutions end up sitting idly in the lab, producing no tangible benefits for anyone. As Dr. Akinwumi Adesina, President of the African Development Bank, noted in a speech to the UN Food and Agricultural Organization in Rome, "Technologies to achieve Africa's green revolution exist. For the most part, they are all just sitting on the shelves." This problem is not confined to green revolution technologies. For example:

- The World Bank recently reported that affordable, high quality "mini grids have the potential to provide electricity to as many as 500 million [unserved] people by 2030."[2] But the pace of mini-grid deployment will have to accelerate from 10-50 mini grids per year per country to over 1,600 to reach "the remaining unserved population, including those connected to frail and overburdened urban grids, or living in remote areas and fragile and conflict environments," in the top 20 energy access deficit countries."
- The UN recently noted, "billions of people still lack safe water, sanitation and handwashing facilities." The technology to address these problems already exists, but as the UN notes, "achieving universal access to even basic sanitation service by 2030 would require doubling the current annual rate of progress."
- According to one recent analysis, approximately 132 million smallholder farmers could benefit from using affordable biodigesters, but only 6.5 million units have been installed over the past 40 years.
- Andy Beard, CEO and co-founder of Vanu, told the Summit that more than 3 billion people lack internet connectivity and approximately 1.2 billion people have no connectivity whatsoever – voice, SMS, or internet –even though affordable technology to enable off-grid connectivity already exists.

What will it take to move newly discovered as well as existing scientific innovations from the shelves of research labs into the hands of the hundreds of millions of people in tens of thousands of communities in dozens of countries who need them to secure potable water, sanitation, electricity, high quality affordable health care, food security, and gender equity, among others? GSS 2019 set out to discuss practical, action-oriented proposals for harnessing STI for the SDGs so that the 4 billion people currently inhabiting the bottom rungs of the income pyramid can enhance their quality of life while simultaneously boosting their income.[3] What follows is a brief synthesis of that discussion and the resulting policy recommendations.

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[2] The complete World Bank Technical Report on mini-grids is available at: https://openknowledge.worldbank.org/handle/10986/31926. In a separate report dubbed The Hidden Face of Energy Poverty, the World Bank reports that an additional 1 billion people "live with connections to electric grids that simply don't work." Meeting their needs will require further accelerating the pace of mini-grid expansion.

[3] One of the principle conclusions emanating from GSS 2018 is that generating income and achieving the SDGs are inextricably linked. For details of this discussion see here, especially Section E: Generating Income to Deliver the SDGs on Page 15.

Box 1
G-STIC and GSS

G-STIC, the Global Sustainable Technology and Innovation Conference Series, is a key global meeting place and collaborative platform for identifying and upscaling market-ready integrated and innovative technological solutions that have the potential to significantly contribute to the achievement of the SDGs and the climate change goals, world-wide. The integrated technological solutions discussed at G-STIC tackle multiple sustainable development challenges across disciplines and sectors while, at the same time, ensuring that the solutions are socially acceptable, economically feasible and affordable, and environmentally sound.

G-STIC brings policy relevant information together in a living library of breakthrough transformative technologies across sectors, illustrated with best practices and inspiring examples. Such a library is indispensable for policymakers developing Science, Technology and Innovation (STI) roadmaps for the SDGs, while captains of industry can use it for exploring new business opportunities. At the same time, G-STIC is actively building knowledge bases on, and expert communities around, the levers of change needed to bring innovative technological solutions to the market at scale, including through identifying institutional, regulatory, policy and business changes that are needed to facilitate their deployment in different regions of the world.

G-STIC is hosted jointly by VITO (the prime research and technology organization on cleantech and sustainable development in Belgium) and 6 other not-for-profit, independent technology research institutes: ACTS (African Centre for Technology Studies, Kenya), FIOCRUZ (Oswaldo Cruz Foundation, Brazil), GIEC (Guangzhou Institute of Energy Conversion, China), IITD (Indian Institute of Technology Delhi, India), NACETEM (National Centre for Technology Management, Nigeria) and TERI (The Energy and Resources Institute, India).

Via their collaboration, both G-STIC and GSS aim at supporting the UN's efforts to accelerate the transitions needed to move towards more sustainable societies and economies in line with the SDGs and climate change goals. They each approach this goal from complementary perspectives, strengthening each other's findings and policy insights. GSTIC is particularly focused on innovative (disruptive) technological solutions and the changes needed to ensure their entry and deployment in the market at scale. GSS is focused primarily on developing and deploying transformative solutions for the billions of people at the so-called bottom of the pyramid.

II. Synthesis of the Discussion

A. Inclusive Disruptive Innovation vs. Dumbed-Down Products for Poor People

As Russell Sturm, Head of Energy Access at the International Finance Corporation noted recently[4], "The poorest typically pay the most for the worst service." And yet when discussing innovations for the poorest strata of the population in developing countries, all too often scientists and entrepreneurs in Silicon Valley and other tech centers refer dismissively and with more than a hint of condescension, to the production of "dumbed-down products" stripped of "bells and whistles." By this, they mean that developing high-quality, full-featured products for the global middle class is a challenging scientific and engineering endeavor worthy of the time and attention of the best minds in Silicon Valley and other technology centers. But since technology flows inexorably downhill from the rich to the poor, they believe that

[4] Russell Sturm, "Achieving Energy Access for the Last Billion," Keynote Address at IEEE Energy Access Workshop, 1 October 2019, Baltimore, MD.

before these sophisticated products can be used and afforded by poor people in developing countries, they need to be dumbed down (simplified and cheapened) and stripped of many features offered to the global middle class. From this vantage point, therefore, harnessing STI for the SDGs entails scientists primarily in developed countries inventing sophisticated products and services for the global middle class and then letting scientists and engineers in poorer countries simplify them for developing country customers.

Speakers at GSS 2019 vociferously rejected this approach in favor of one that focuses R&D efforts directly on the needs of the billions of people at the bottom of the pyramid. For example, Maurizio Vecchione, Executive Vice President at Global Good, told the Summit that the global community is facing an R&D gap whereby, "We are focusing on transforming lives that don't need to be transformed and ignoring the needs of the bottom four billion." Or in the words of Nathan Myhrvold, former Chief Technology Officer at Microsoft and one of the founders of Global Good, "The tech industry has almost entirely been about making tools and toys for rich people. [At Global Good,] we sat down and thought, what are some of the ways we could direct technology to the poorest people on Earth—to transform the lives of people who need their lives transformed?" The objective, Joshua Setipa, Managing Director of the UN Technology Bank for the Least Developed Countries, declared at the Summit must be "to give the previously excluded access to the same technologies as the rich and access to technologies that are efficient, high performance environmentally friendly and affordable."

What does it mean in practice to direct technology to the "needs of the bottom four billion?" The first step, according to the Summit's keynote speaker, Professor Ramesh Mashelkar, is for scientists and engineers to cultivate a new mindset based on a "healthy disrespect for the impossible.[5] As Mashelkar explains, this is because rather than attempting to tackle problems that can be solved easily, they must start to focus instead on finding solutions to difficult problems. And rather than settling for the production of dumbed down products, scientists and engineers must invent better performing products that can be sold at a fraction of the price compared to the conventional products marketed to the global middle class. Mashelkar summarizes this challenge in the pithy phrase, "Much More for Much Less for Many More" or M-L-M.[6] By this he means:

- **Much More (performance)** generated by products whose performance and quality **equals or exceeds** that of goods and services consumed by the global middle class.
- **For Much Less** money. In other words, not a 10% price reduction but a 10X or greater price reduction compared to similar products currently on the market for the global middle class. The goal, according to Mashelkar, is nothing less than "radical affordability" and "affordable excellence" so that
- **Many More (people)**, primarily the billions of people at the so-called "bottom of the pyramid," can benefit from these innovations. Focusing on the bottom four billion is not just a feel-good humanitarian objective to salve the conscience of over-indulged wealthy consumers. As Vecchione told the Summit, the global population is expected to grow from seven billion today to between 10 and 11 billion by 2100. With a projected one billion population increase in Asia and

[5] Mashelkar, R A. From Leapfrogging to Pole-vaulting. Penguin Random House India Private Limited. Kindle Edition, Location 3649.
[6] A comprehensive discussion of MLM is available in C.K. Prahalad and R.A. Mashelkar, "Innovation's Holy Grail." Havard Business Review, July-August, 2010 available at: https://hbr.org/2010/07/innovations-holy-grail.

a three billion population increase in Africa, virtually all of this population growth in the ensuing decades will be concentrated in what is today considered to be the developing world. As a result, by 2100, Europe and North America will account for only 8% of the global population; the remainder will be concentrated in the so-called Global South. These seismic demographic changes, Vecchione asserted, will completely transform "every facet of industry, economy, and sustainable development." In their wake, the bottom of the pyramid will become the largest slice of the pyramid and the needs of developing world will be tantamount to the needs of the world.

B. Inclusive Disruptive Innovation: Fool's Errand or Realistic Formula

Despite these exhortations, the question remains: Is the quest for M-L-M a fool's errand or a realistic formula for achieving the SDGs? It is definitely realistic and achievable, according to Mashelkar. A hefty catalogue of inclusive disruptive innovations exists already and new additions are coming to market on a regular basis. Among the examples cited by Mashelkar during his keynote address and in other fora are:

- A high Quality Hepatitis B Vaccine that is 40X cheaper, not 40% cheaper, than the conventional vaccine.
- High quality cataract eye surgery offered by Arvind Eye Care for $30, not $3000
- High Quality Open Heart Surgery that is 20X cheaper not 20% cheaper.
- The high quality Jaipur Artificial Foot which is 300X cheaper than conventional a prosthetic limb.
- Breast cancer screening for $1 per patient.
- An ECG machine that costs $70 (compared to $10,000 for a traditional machine) and provides high quality ECGs for as little as $0.08 per test. Moreover, the machine is portable and can be used in the remotest corners of the world.[7]
- A robot that cleans sewer manholes remotely using robotic arms and computer vision. The robots not only do away with the inhuman practice of manual scavenging but the company that developed and deployed these robots is also training the scavengers, who are primarily untouchables, to become robot operators, thereby giving their families a life of dignity.

Vecchione supplemented this list by explaining that Global Good, which is "funded by Bill Gates," is implementing a comprehensive, two-step strategy for generating a systematic flow of inclusive disruptive innovations. Step 1 entails using predictive modeling and grants from the Gates Foundation to systematically identify and invent "affordable, accessible and appropriate technologies that solve the biggest problems in global health and development for the people who need it most — the global poor." Global Good hopes to achieve this objective, Vecchione explained, by combining grants from the Gates Foundation with the Global Good's world-class R&D capacity to reduce the technology and market risks inherent in developing inclusive disruptive innovations. Step 2 entails bringing these inventions "to market by commercial partners who use sustainable business models to deliver long term impact."

[7] Jeffrey R. Immelt, Vijay Govindarajan and Chris Trimble, 'How GE Is Disrupting Itself', Harvard Business Review, October 2009, https://bit.ly/2nxbuii.

As Vecchione explained, Global Good has an extensive pipeline of technologies in Medical Cold Chain Equipment, Global Health Technologies, and Smallholder Farm Solutions. The technologies in each of these domains are currently at various stages of development ranging from discovery to development to field trials to commercialization.

With respect to Smallholder Farm Solutions, Vecchione argued that scientists have optimized precision agriculture and modern green revolution technology for large farms producing single crops in vast quantities for sale as bulk commodities in global markets. As currently constituted, this technology is not relevant for smallholder farmers in Africa and elsewhere who till 84% of the world's farmland on small plots, operate mostly as subsistence farmers, and currently sell only small, sporadic quantities of their produce primarily in informal local markets. What these farmers need, according to Vecchione, is an inclusive disruptive green revolution that simultaneously increases agricultural productivity, helps smallholder farmers become commercially viable by enabling them to sell their produce in formal local markets, empowers women who comprise the vast majority of smallholder farmers, and catalyzes social change. With these needs in mind, Global Good harnessed its dollars and research capacity to develop such low-cost smallholder farmer technologies as devices for measuring grain moisture and detecting fungal hazards low cost, energy efficient pumps for lifting water more than 7 meters, and off-grid refrigeration mechanisms for reducing milk spoilage, among many others.

C. The Deployment Imperative

Alas, generating technology in the lab **for** smallholder farmers in Africa or their counterparts on small island developing states is not the same as getting that technology **to** smallholder farmers. As Banning Garrett[8] explained, there are an estimated 500 million smallholder farms in the world, supporting almost 2 billion people. Most are engaged primarily in very low productivity subsistence farming, producing barely enough to feed their families. The benefits of better technology – more production with less drudgery, less post-harvest spoilage and waste, and higher incomes which can be used to pay for potable water, off-grid electricity, sanitation, health care and other basic necessities -- would appear self-evident. Marketing inclusive disruptive technology to smallholder farmers, therefore, sounds like it should be fairly simple and easy. Just advertise the self-evident benefits and customers will beat a path to your door.

In reality, as Garret explained, marketing to smallholder farmers is especially challenging. Smallholder farmers tend to be located mainly in poorer, more remote regions with inadequate or non-existent infrastructure. This makes them expensive and hard to reach. Many smallholder farmers are reluctant to depart from generations-old traditional practices since even small mistakes in the choice of technology can plunge them from bare subsistence into starvation and destitution. Compounding the problem, is the fact that subsistence farmers have neither the income nor the credit to purchase new and improved technology. Nor are they likely to have the connections to formal markets that would enable them to convert greater productivity into higher income.

[8] Banning Garrett's remarks were drawn from Fred Davies and Banning Garrett, Connecting Farm, City and Technology Transforming Urban Food Ecosystems, published by the Global Federation of Competitivness Councils.

Under these circumstances, entrepreneurs – irrespective of whether they are working for NGOs, social enterprises, foundations, or multinational corporations – need to build financially and organizationally sustainable institutions that can simultaneously:

- Connect with large numbers of widely scattered, financially cautious, and generally destitute small farmers
- Handle a large number of small-value transactions
- Bundle the delivery of technology with pre-sales technical assistance and training and post-sales operations and maintenance support
- Organize innovative credit and payment arrangements for farmers who have little or no formal credit history
- Provide access to new income-generating sales channels
- Help smallholder farmers fit into a complex value chain running the gamut from on-farm production, post-harvest storage, value added processing, transportation, and distribution to customers
- Manage relationships with partners who can provide these complex and complementary services.

As Garrett points out, a growing array of entrepreneurs and enterprises, primarily but not exclusively SMEs, are developing innovative ways to thrive and prosper while supplying inclusive disruptive innovations to smallholder farmers. However, these entrepreneurs are often doing much more than merely supplying technology.

The entrepreneurs selling these technologies speak, often very passionately, about how their technology will facilitate a structural transformation in a portion of the smallholder economy and rural value chain, thereby empowering farmers to transition from informal, subsistence arrangements to more formal, commercially-oriented arrangements and relationships.[9] This transition, in turn, may help strengthen the marketing power of previously-powerless subsistence farmers. It may enable them to establish a credit history, open a bank account, and shift at least part of their time and attention from traditional subsistence crops to such higher value commercial crops as horticulture, commercial poultry, and fresh fruits and vegetables. In other words, inclusive disruptive technology not only enables shareholder farmers to earn more money doing the same things that they have always done (a laudable outcome in itself) but it also enables them to interact in a more commercial fashion with the market and to have a more productive and autonomous relationship with formal markets and other members of the rural value chain.

Even when the entrepreneurs do not express overtly disruptive intentions, their disruptive technologies often generate substantial externalities in the form of replenishing soil nutrients, eliminating chemical residue from the local water supply, limiting contact with hazardous chemicals, preventing devastating crop losses which throw families and communities into a downward cycle of poverty and despair leading to destabilizing urban to rural and international migration flows, and enabling farmers to cope with labor shortages generated by rural to urban migration. Other technologies enable smallholder farmers to qualify for organic certification, generate more local value added by processing agricultural products on-site, or shift from lower to higher value added crops.

[9] This paragraph and the following paragraph were taken from a report that I prepared for the Fintrac Feed the Future Partnering for Innovation Program funded by USAID.

Smallholder subsistence farmers are not the only ones who can benefit from the application of inclusive disruptive technologies in agriculture. These technologies are also relevant for Small Island Developing States. Dominica in the Caribbean is a case in point, as Kim Osborne from the Organization of American States (OAS) explained.

When Hurricane Maria struck Dominica in September 2017, the property losses totaled 225% of GDP. This was an unmitigated humanitarian and economic disaster. But the near total devastation also created an unexpected opportunity – an economic *tabula rasa* upon which to rebuild the island economy from the ground up. Pre-hurricane agriculture in Dominica, although a major source of employment, was a part-time occupation for farmers with limited agricultural and entrepreneurial skills. However, the construction of several new high-end resorts on the island provided an opportunity to modernize agriculture and aquaculture to serve the tourist industry.

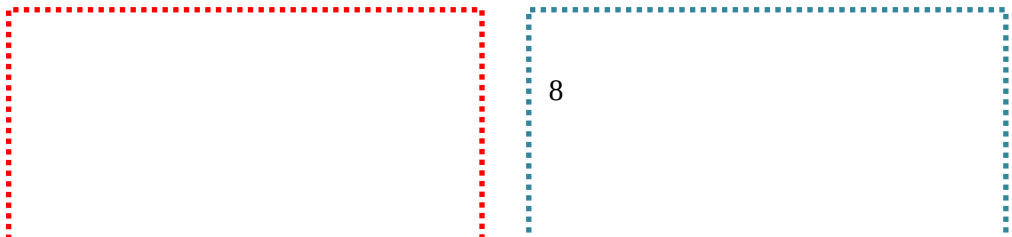
From a technological perspective, this is a fairly simple task. The horticulture and aquaculture know-how to supply the resort sector is well-known and readily available. The challenge, Osborne explained, is two-fold: (i) transferring this technology and know-how to local farmers and (ii) organizing them into a reliable supply chain capable of providing quality produce to the local resorts and perhaps, over time, to resorts on nearby islands. This is a time sensitive task since the local supply chain has to be up and running before the resorts open for business in 2020.

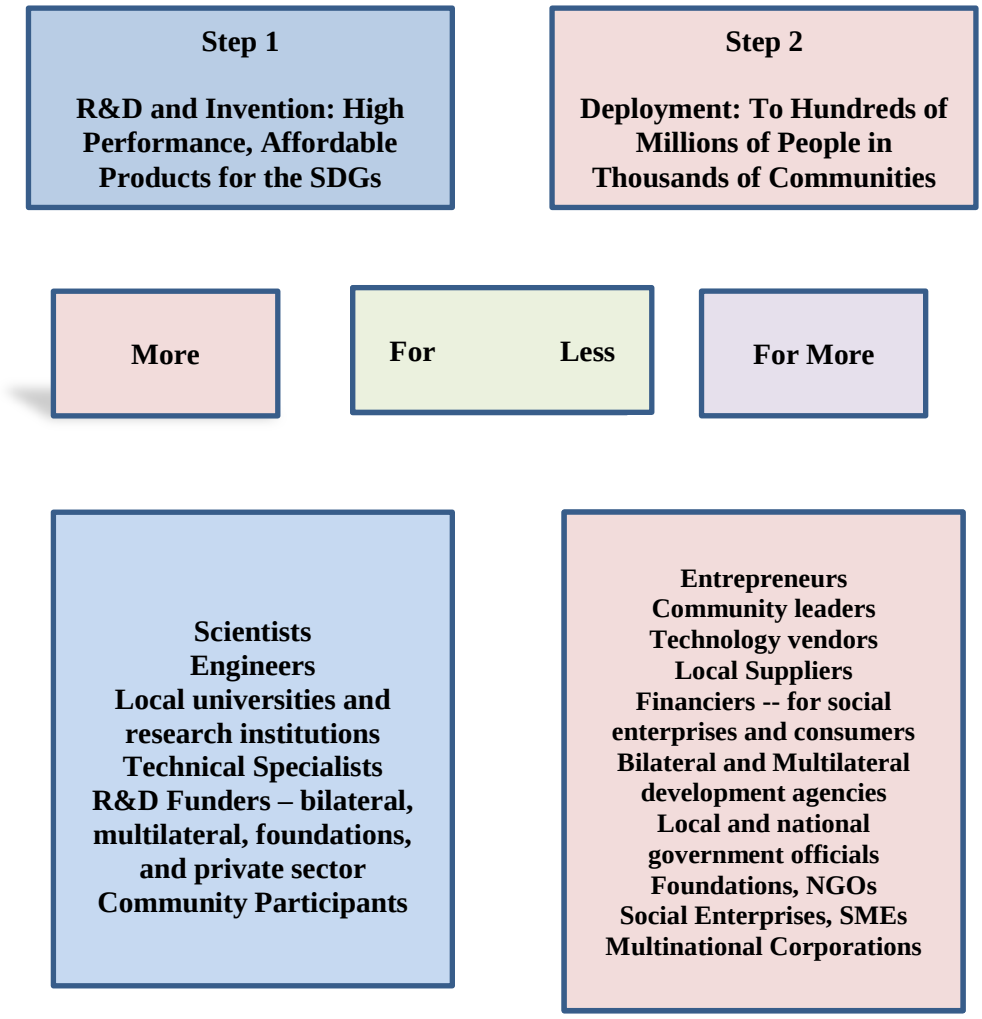
To capture this opportunity, Osborne explained, "producers will need to urgently retool their production, branding, and delivery systems." This, in turn, will entail (i) coordinating the activities of key stakeholders including farmers, hotels, tourism organizations, and local and foreign universities with the requisite know-how and training capacity; (ii) organizing and providing technical assistance, training, and technology based on global best practices; and (iii) organizing individual farmers into some form of collective, cooperative institution. The OAS and Inter-American Competitiveness Network, in collaboration with the Government of Dominica and local stakeholders, are preparing a draft roadmap to accomplish these tasks.

D. Passing the Baton

Harnessing Inclusive Disruptive Innovation for the SDGs is a two-step process. (See Figure 1, below) The first step, R&D and invention, is where scientists and engineers develop high-performance, low-cost technological solutions that are affordable to the billions of people at the bottom of the pyramid. This is what Mashelkar described as the challenge of affordable excellence or More for Less. Since the goal at this stage is to create products that are as good if not better than the goods and services currently sold to middle class consumers in high income countries, the technical and scientific challenge is substantial.

Figure 1. Harnessing Inclusive Disruptive STI for the SDGs





As a result of these upstream research activities, we now have proven, effective, and affordable solutions for many of the most pressing development problems: off-grid, renewable energy; potable water; high quality, affordable health care; solar powered irrigation pumps; off-grid food storage, refrigeration, and processing, among others. More encouraging still is the fact that new, even better, solutions are likely to continue emerging from research labs that devote their energies to the task of generating radically affordable, high quality products.

But R&D and Invention – More performance for Less Cost -- is only the first step along a much longer road to inclusive disruptive innovation. The indispensable second step -- Deployment -- occurs when entrepreneurs develop innovative business models and harness the surrounding ecosystem to deploy these radically affordable inventions at scale in new, unique, and inclusive ways. This is the so-called deployment challenge, which all-too-often is overlooked in official STI policy discussions. Deployment is not a scientific challenge, per se. Scientists, in all probability, will not play a leading role in deployment, although it is the fruits of their labor that will be deployed. It is the domain of entrepreneurs and business leaders who have to develop the necessary business models, supply chains, community organizations,

product marketing, and financing mechanisms that will move the technology from the lab shelves into the hands of people who need it most. It is, at a minimum, the purview of entrepreneurs, community leaders, equipment vendors, logistics experts, payment mechanisms, finance for social enterprises and consumers, government officials, foundations, NGOs, social enterprises, SMEs, large corporations, and local universities who comprise the deployment ecosystem.

This second step is where inclusive disruption occurs. A technology or a scientific discovery, by itself, is not inherently disruptive. In fact, the phrase "disruptive technology" is a misnomer. There is nothing inherently disruptive about technology unless it is used and deployed on a massive scale, one so large that it renders old products and services obsolete. Disruption, in other words, is a function of deployment; it is not inherent in the technology. As Clayton Christensen observes, the first step in disruption is creating new markets. "But not just any new markets, new markets that serve people for whom either no products existed or existing products were neither affordable nor accessible for a variety of reasons. These innovations transform complicated and expensive products into ones that are so much more affordable and accessible that many more people are able to buy and use them….In a sense, market-creating innovations democratize previously exclusive products and services."[10]

From the perspective of Figure 1, these two steps follow logically and inexorably from one to the other. But in the real world, there is nothing inexorable or inevitable about this process. On the contrary, there is an enormous chasm – or series of broken circuits – hindering the transition from Step 1 to Step 2. This is primarily because Step 1 is the domain of scientists and engineers while Step 2 is the domain of supply chains, entrepreneurs, business models, and the myriad other actors -- primarily non-scientists -- involved in deploying, operating and maintaining technology that will service hundreds of millions of people in thousands of communities in dozens of countries. Seen from this perspective, M-L-M or inclusive disruptive innovation is akin to a relay race in which the baton must be passed smoothly, quickly, and efficiently from the scientists and engineers who took the lead in Step 1 to a completely different group of individuals who will take charge during Step 2.

Failure to pass the baton, smoothly and efficiently, according to Mashelkar, prevents "sustainable scalability" and, in the words of Adessina from the African Development Bank, leaves solutions sitting on the shelf. Compounding the problem is the fact that deployment is difficult enough on a small scale.[11] But while bringing potable water to an additional 800,000 or 8 million people per year million is a wonderful achievement, it is a drop in the bucket compared to the 800 million people who still lack access to clean drinking water. At these rates of deployment, we will not achieve the potable water SDG for at least another 100 years.

[10] Clayton Christensen. The Prosperity Paradox (pp. 26-27). HarperBusiness. Kindle Edition.

[11] GSS 2018 discussed the issues of scaling and deployment in considerable detail. For a summary of this discussion see here, especially Section A and Section B beginning on Page 3. Other notable discussions of the scaling/deployment nexus include the Miller Center for Social Entrepreneurships Replication and Scaling Initiative, the Next Billion blog series entitled Scaling Up Without Selling Out, Larry Cooley's Scaling Up Framework, the proceedings of the Purdue University Scale Up Conference, Natalia Agapitova and Johannes F. Linn, Scaling Up Social Enterprise Innovations: Approaches and Lessons and Greg Coussa, To Impact Millions, the Social Sector Needs to Scale Scaling Up.

With this in mind, Mashelkar concludes that successful inclusive disruptive innovations must possess seven attributes, summarized by the acronym "ASSURED" which stands for: (i) **A**ffordability; (ii) **S**caleability; (iii) **S**ustainability – economic, environmental, and social; (iv) **U**niversality – or user friendliness; (v) **R**apidity – in terms of deployment; (vi) **E**xcellence – high performance, affordable excellence; not dumbed down products; and (vii) **D**istinctiveness. To be successful during the development or M-L stage, scientists must strive to generate innovations that achieve **A**ffordable **E**xcellence. One without the other will not be sufficient. During deployment or L-M stage, the baton has to be passed from scientists and engineers to entrepreneurs and other deployment stakeholder who can covert affordable, excellent technological breakthroughs into deployment models that are **S**calable, **S**ustainable, **U**ser Friendly, **R**apid, and **D**istinctive. Failure along any one of these dimensions is a warning signal of impending failure.

E. The Logistics of Technology Deployment

How can we repair these broken circuits and ensure that deployment takes place on a scale that is commensurate with the challenge of achieving the SDGs? It is tempting to assume that Adam Smith's invisible hand will handle these chores and that if we simply create the proper policy framework, market forces and profit opportunities will ensure that the baton gets passed seamlessly and effortlessly from one group to the next. Good policies are indeed indispensable but, as the speakers at GSS 2019 suggested, good policies must be supplemented with a healthy dose of proactive support. A hands-off approach will simply not get the job done.

What would an effective hands-on approach look like? Leena Thomas of Global Business Inroads (GBI) argued that technology deployment is a contact sport requiring "constant hand-holding and curated matchmaking." Merely posting available technological solutions on a website or "platform" and hoping that interested buyers around the world will consummate a sale just as they do when buying used golf clubs on eBay will not be sufficient.

In the case of used golf clubs, the buyer typically knows precisely what he or she wants and how to play golf. That is not the case with buyers and sellers of development solutions. Inventors, for example, may not have any knowledge of how to do business in emerging markets, contacts in emerging markets, and or the capacity to reach out to potential customers scattered in various countries. Similarly, decision makers in emerging markets may not know precisely what they need, where to find it, how to evaluate competing products, or how to organize themselves to use these products effectively and efficiently.

Consider, for example, the technology deployment challenge as seen from the perspective of a scientist in the United States who wants to market a technology to address the needs of smallholder farmers in India or from the perspective of scientists in India and the European Union who are trying to commercialize potable water technologies in Africa. A successful deployment initiative will entail completing a series of essential tasks (Figure 2) and mobilizing a diverse set of actors (Figure 3). As Leena Thomas of GBI explained, these critical tasks include conducting market studies to validate the potential demand and social acceptability for the product, developing a detailed business plan specifying, among other things, a sales and customer outreach strategy, identifying essential local business partners, developing a local

supply chain, and identifying local suppliers and personnel to provide installation, training, and O&M support.

Figure 2. Business Tasks for Technology Deployment

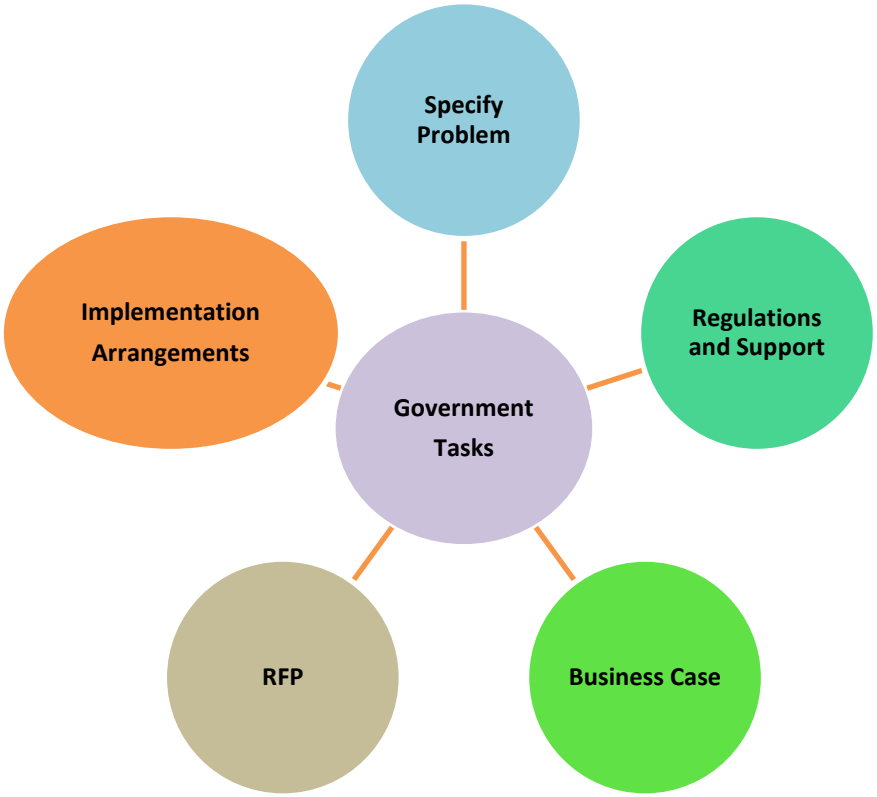
The scientists who developed these innovative solutions as well as the equipment vendors, NGOs and social enterprises who are striving to deploy these development solutions are probably not the best candidates to undertake these tasks themselves. Nor do they have the time, capital, and management capacity to hire and supervise others who will do the work on their behalf. In many cases, they may not even know where to find the necessary assistance. Coordinating the work of the diverse actors who must be mobilized to complete these essential tasks is complicated and expensive. It will not happen automatically. Unless someone with the necessary expertise ensures that they are handled expeditiously and efficiently, technology deployment will be stymied.

Figure 3. Technology Deployment Actors

In the case of Dominica, the OAS and affiliated partners are tackling these up-front organizational tasks. In other countries, GBI, with funding from bilateral donors and the EU, is paving the way for technology vendors to do business with potential customers in emerging markets.

Now consider the deployment challenge from the perspective of local and national government officials. (Figure 4)

Figure 4. Government Tasks for Technology Deployment



Before they can solve a problem, they must specify the precise technical parameters of the problem, specify a business case for solving the problem, call for scientists and entrepreneurs to recommend a range of potential technical and business solutions, determine how best to support entrepreneurs whose solutions appear to be most viable, and then connect the entrepreneurs proposing the winning solutions to local entrepreneurs and other members of the local deployment ecosystem. This may sound easy in theory, but someone needs to organize all these activities and also arrange a comprehensive outreach program to scientists, technology vendors and social enterprises with potential solutions. If the government does not have the capacity to handle these tasks in-house, an organization like GBI can organize the hand-holding and curated matchmaking.

Even if these problems are resolved to everyone's satisfaction, Chris Tan of PEMANDU Associates[12] explained that governments may still need to create dedicated performance management and delivery units to ensure that government programs lead to tangible progress on the ground.

Government programs, Tan explained, are announced at the strategic 30,000 foot level, where tactical implementation details can be glossed over. But if the devil is truly in the details, these plans will amount to nothing more than hollow rhetoric unless they are backed up by a multi-year flow of budget allocations and a laser-like focus on the mundane, nitty gritty implementation details. Hence the need for

[12] A recent World Bank evaluation of PEMANDU is available here.

performance management and delivery units "dedicated to driving diligent execution, relentless monitoring and real time problem solving" Potable water, for example, may be a government priority. But when it comes to the budget, the President or Prime Minister has to decide what falls by the wayside if scarce resources are devoted to a national potable water program. "The problem for governments," said Tan, "is how to make difficult decisions about deployment of finite resources in light of the plethora of choices that have been thrown in front of them. The problem is making difficult decisions."

But the problem does not end with the budget. "The hardest part," according to Tan, "is actually getting things done due to the plague of working in silos." Take the case of a hospital project. Presumably, the Minister of Health is responsible for delivering the new hospital on time and within budget. But the Minister of Health does not have jurisdiction over water, power, construction, finance, education and customs and none of these other ministries and agencies focus on how their day-to-day decisions support or hinder the implementation of the government's hospital program. The only one with jurisdiction across all silos is the President or Prime Minister who is often too busy to focus on how decisions made by each ministry affect the implementation of every priority program. Hence the need for an implementation unit like PEMANDU which, Tan explained, operates like a bank, "borrowing the influence of the President or Prime Minister and lending it to the minister who needs it [to facilitate implementation] at that moment."

"The secret to getting anything done is to ensure that people have a clear vision and a clear implementation path that enables them to take very precise actions slowly but definitively toward the end vision. A major transformation cannot take place in one fell swoop. The Government needs to pace implementation according to the needs of budget cycles. Not everything needs to be done this year." From this perspective, Tan explained, technology deployment is akin to a triple jump – a series of small discrete actions that take place in a specific order and are designed to achieve a specific objective.

To facilitate these "triple jumps" PEMANDU proposes an 8-Step methodology[13]:

1. Set the strategic direction by organizing workshops with key decision makers in the government
2. Organize multi-stakeholder "Labs" to prioritize initiatives and establish a detailed implementation plan
3. Convene a series of "Open Days" to solicit citizen feedback
4. Develop and publish a detailed roadmap explaining precisely what will be done to tackle a particular problem and how it will be done.
5. Publish detailed KPI targets for monitoring and tracking progress
6. Implementation and monitoring of KPIs
7. Organize third party audits
8. Publish annual reports telling people what has been done

F. Role of the Government

[13] More details about the PEMANDU 8-Step methodology is available here.

Scaling up technology deployment, especially in the realm of inclusive disruptive innovation, requires leadership, consensus building, and coordination. Performance evaluation and delivery units can be especially helpful in improving the probability that government programs will be conceived, designed, and implemented effectively and efficiently in the face of ministerial silos and other bureaucratic roadblocks. But this begs the question: What is the optimal role of the government in a world in which many of the organizations that have to be mobilized organized, consulted, and coordinated are not government entities? What is the appropriate linkage between these government programs and non-government entities that are actually in the field providing vital services (off grid power, potable water, wifi connectivity, etc.) to the billions of people at the bottom of the pyramid who, to date, have been left behind by prior government programs? Should governments adopt a policy of benign neglect, sitting passively on the sidelines and letting others do the work, unencumbered by government interference and regulations? Should governments actively empower and assist impact investors, private corporations, foundations, NGOs and others to accelerate deployment and provide essential services? Or should governments attempt to handle all of these deployment and service provision tasks on their own?

The speakers at GSS 2019 offered a number of suggestions.

First and perhaps most importantly, is the recommendation to do no harm. Randy Welsch of Jibu, as well as several other participants, noted that several governments recently put excise taxes on potable water similar to the tax on imported liquor. In other cases, social enterprises found themseleves driven out of business by the sudden imposition of regulations that are more suitable for multinational corporations than for small social enterprises operating in the realm of potable water kiosks and rooftop solar. In still other cases, governments have slowed implementation by applying their own product certification and import licensing standards for products that are widely used around the world and have already been certified and licensed in neighboring countries. Irrespective of whether these policy "mistakes" are driven by government officials trying to preserve the status quo and protect vested interests or by overly zealous officials operating in their hermetically sealed ministerial silos, the first order of business for any government that is serious about implementing the SDGs (as well as for UN agencies and various bilateral and multilateral funders working with these governments) should be to identify and eliminate these roadblocks.

Second, and on a more positive note, speakers outlined a series of steps that governments can take to affirmatively support the deployment of inclusive disruptive innovations. In some cases, a Ministry may take the lead in handling deployment. For example, a Ministry of Health may establish a network of rural health clinics which could potentially be operated by a healthcare NGO or social enterprise, similar to the ones that Mashelkar highlighted in his keynote address. In other cases, they called for innovative public-private partnerships whereby the government empowers not-for-profit and for-profit private sector entities to provide the necessary services.

Government empowerment can take a number of forms. For example:

- Mashelkar suggest that governments mobilize their procurement power to become "not only the biggest, but also the most influential and demanding customer" for inclusive disruptive innovations. This demand-side push would "lead to a product or service being brought to the

market. This would generate customer feedback and establish a market for the new product; now it can attract private financial backing." One interesting example (not cited at the Summit) of public procurement pump priming is Solar Head of State which places "solar photovoltaic system on their executive residences to showcase the benefits of clean energy and create a global coalition of green leaders committed to championing solar power."

- Andy Beard of Vanu pointed out that markets for potable water, rooftop solar, and off-grid wifi, among others are unserved because entrepreneurs still have not figured out how to serve these markets even when the optimal technology is available. Enterprises, more often than not, are struggling to find viable, sustainable business models and, as a result, they may not always know what type of government support they need. Or they may ask for one type of support when they first enter a country – e.g. remove regulatory barriers to entry – and a second type of support – e.g., funding to support expansion – when they are trying to scale their operations. Even in the case of funding for expansion, governments and entrepreneurs need to decide between support for capital expenditures and support in the form of targeted subsidies to defray operating expenditures. To accommodate this uncertainty, governments need to be flexible in terms of the support they offer, adjusting and learning along with the entrepreneurs providing the service.
- Laura Koch, impact investor in renewables, echoed this plea for flexibility. In the case of the rooftop solar industry, for example, one government supported deployment by training installers and maintenance technicians at no cost to the rooftop solar enterprise. Another government offered support in the form of tax incentive for imports and regulatory easements. The support in each case was offered in return for quantifiable, verified installation progress by the rooftop solar company. She also noted that "blended" finance is becoming way to go for most renewable energy projects in Africa.
- Dan Bena noted challenges faced by the Indian state of Karnataka with the operation of the 16,000 water kiosks it installed in recent years to purify and dispense potable water. To tackle the challenges of ensuring long term sustainability of this significant investment, the state government partnered with Safe Water Network, a water sector NGO. Safe Water Network's initial phase of work focused on advancing service level benchmarks and putting in place a procurement program to deploy decentralized technical service capabilities capable of addressing local operational challenges. Bena cited this as an example of a pro-active public private partnership – one which combined government investment in infrastructure and funding support for deployment of private sector O&M expertise under the guidance of Safe Water Network. More implementations along these lines will go a long way toward speeding up the deployment of technology and related services to achieve the SDGs.
- Katherine Lucey, CEO of Solar Sister noted that energy access was viewed initially as a philanthropic endeavor. But these charitable endeavors had two drawbacks: they could not scale without a constant infusion of charitable support. As a result, they were not -- and never would be -- financially sustainable. Eventually, the for-profit and not-for-profit private sector entered the market with distributed roof-top solar solutions organized around pay-to-own and pay-to-lease schemes. But these commercially-oriented companies retreated from markets where, although the need and poverty were greatest, the ability to pay was weakest. At the same time, many philanthropic organizations retreated because they thought for-profits would be working in these communities. The net effect, Lucey argued, was a gap in the market for meeting the needs of the poorest strata of society. Filling this gap will entail bringing everyone together to figure out the

right delivery system, market mechanism, policies, and support systems for different communities with different needs and ability to pay. Governments, operating under the auspices of some sort of performance management unit and in collaboration with bilateral and multilateral funders, NGOs, the private sector and other critical stakeholders, need to develop policies and programs to address these issues, organize solutions, and gather support for those population segments that cannot be viable in a purely for-profit environment.

- Donna Katzin, of Shared Interest, cited another mechanism for establishing creative public private partnerships and problem solving alliances between governments, social enterprises, and local stakeholders. In Mozambique, for example, the government was attempting to revive a mothballed sugar mill that was essential for the livelihood of 3500 farmers. Similarly, in Malawi, a woman-operated seed enterprise needed working capital to purchase locally adapted climate resilient, soil restorative, high protein seed from 1000 women farmers. In each case, funds from bilateral donors were available to finance a portion of the project. To help secure the remaining finance, Shared Interest stepped in with guarantees to induce local commercial banks to fill the remaining financing gaps.

III. Conclusions and Solutions Recommendations

What does all this entail for the goal of harnessing STI for the SDGs? Two primary policy conclusions flowed from the discussion at GSS 2019.

First, national R&D programs, especially in low and lower-middle income countries where scientific resources are limited, should have a clear mission focus – namely developing new, and adapting existing, inclusive disruptive innovations that conform to Mashelkar's M-L-M criteria while addressing critical national problems. To achieve this goal, R&D funding competitions, for example, could require scientists to assemble multi-disciplinary teams of scientists and other relevant stakeholders. In their grant application, these teams would be asked to explain how their proposed research project will contribute to the generation of affordable excellent solutions – or the adaptation for local use of existing solutions -- to high priority national, regional, or international development objectives. Peer reviewers could include panels of national and international scientists as well as private sector officials and other relevant stakeholders who can provide their technical perspective on the practical applications for a particular proposal. Grants could be awarded by national governments and limited to scientists working in the country sponsoring the competition; on a regional basis – e.g., a consortium of scientists from several countries in a region; or on an international basis where scientists from developed and developing countries band together to tackle a specific issue. Funding for these grants could be provided by national ministries of science in the case of national competitions, or, in the case of regional and international competitions, from some combination of support from the World Bank, regional development banks, bilateral development agencies, foundations, and the private sector.

Grand Challenges Canada and USAID's Grand Challenges For Development provide excellent examples of how these mission-oriented grant program might be organized and administered.[14] Finally, Box 2, describes one possible model for a potential regional research competition.

Box 2
STI Grants for
Harnessing R&D to the SDGs

The process would begin by compiling a crowd-sourced list of specific development problems facing a region.

This would be followed by a call for research proposals to address the high priority problems identified during the crowd source phase. Scientists from across the region -- perhaps working in collaboration with international scientists -- would be asked to form inter-disciplinary, multi-country teams to conduct the research and carry out all other essential functions associated with receiving a research grant. In addition to outlining the scientific dimensions of the proposed research, the funding application would also have to explain how the solution would be moved from the laboratory to last mile consumers wherever they live. In other words, scientists and other members of the consortium would have to think about technology deployment as well as scientific research. To handle the deployment portion of the application, scientists could be encouraged to form alliances with local business schools, business associations, community groups, NGOs, foundations, student entrepreneurship groups, or any other relevant groups. Other eligibility criteria might also include a proposed action plan for building the ancillary science, technology, vocational, and innovation capacity needed for the successful diffusion of the research results.

Second although R&D has a critical role to play in the process of harnessing STI for the SDGs, deployment is an indispensable component of inclusive disruptive innovation. Deployment should not be relegated to an afterthought. Therefore, roadmaps for national, regional and international STI programs, especially in the lower and lower-middle income countries, should pay at least as much time and attention to deployment as to R&D. According to the speakers at GSS 2019, the deployment components of these STI plans or roadmaps should explain how the government preparing the roadmap intends to address a number of issues including:

- Passing the baton from the scientific community to the other stakeholders who will play a lead role in deployment
- Building the capacity to evaluate development solutions currently in widespread use in other countries as well as the "tsunami" of new solutions emerging regularly from research labs around the world. These roadmaps should recognize explicitly that many of the most important inclusive disruptive technologies will not be developed in-house by local scientists working in local research labs. This autarkic approach is outdated and doomed to failure. This means they will

[14] Additional examples of mission-oriented grant programs are discussed in What Africa (and other Regions) Can Learn About Science, Technology and Innovation Capacity Building from the US Department of Defense.

have to be transferred to developing countries. This poses a number of problems. First, who will transfer the technology and to whom will they transfer it? Second, all-too-often, decision making in the country that needs the solution is hobbled by the inability to evaluate the cost and benefits of new and existing development solutions. Will they be cost effective? Will they deliver the promised benefits? Do they meet some minimum level of quality and performance standards? Are they tailored to the unique needs of that particular country or region? Government officials, entrepreneurs, and civil society in general need expertise to evaluate competing technologies and have the confidence that they are not making poorly informed decisions. And finally, the owners of the technology often need help in identifying customers, local partners, and local suppliers.

Roadmaps should address this constellation of issues. For example, a government or consortium of governments could agree to establish regional centers of excellence for water, off-grid electricity, wifi, health care, agriculture, etc. Modeled after the Manufacturing USA Institutes, these centers would evaluate available technologies, certify them for use, and help local officials, ministries, and entrepreneurs incorporate these development solutions into their business plans. Expertise about different technologies could be housed in different centers – e.g., one center for water, one for power, etc. Matchmaking organizations such as Global Business Inroads could be retained to help these centers identify potential solutions available around the world, build a business case for the solution, and introduce them to potential partners.

- A detailed deployment policy roadmap is only as good as the subsequent implementation of the roadmap's priorities. To ensure that government priorities are implemented effectively and efficiently and unexpected roadblocks are identified and removed in a timely manner, governments should consider establishing performance management and delivery units, similar to the concept outlined by Chris Tan of PEMANDU.
- As noted in the 2018 Summit,[15] successful deployment models in one country are generally not being transferred to other countries. This is not because social enterprises are unwilling to share their lessons of experience and help entrepreneurs in other countries develop the necessary know-how to adapt these business models for use in new countries. For example, Kurt Soderlund, CEO of Safe Water Network (SWN) explained at GSS 2019, that SWN is in the process of codifying the operational know-how gleaned from their work in India and Ghana where over the past 10 years, SWN has established more than 360 water stations serving approximately 1.5 million people. The objective now is for SWN to become a "network enabler," sharing these lessons of experience with stakeholders in other countries who want to provide potable water in countries where SWN does not operate. Unfortunately, funds to support know-how transfer by SWN as well as other social enterprises that have similar ambitions are simply not available. To rectify this problem, foundations and bilateral donors should establish a Global Know-How Transfer Fund to help transplant successful implementation models from one country to another.
- In addition, expanding into new markets can be prohibitively expensive and time consuming, especially for social enterprises striving to reach low-income, last mile consumers. In these situations, a proven business model and successful technology will not be sufficient to stimulate deployment unless they are accompanied by some sort of subsidy or incentive pay for

[15] For a summary of this discussion see here, Page 7.

performance program.[16] Foundations and bilateral donors may wish to establish a Deployment Support Fund to help entrepreneurs expand into new markets.

- As Mashelkar pointed out, actions speak louder than words. To demonstrate resolve in harnessing STI for the SDGs, government procurement programs could help generate a national and regional market for inclusive disruptive innovations. Governments, for example, could contract with social enterprises to put rooftop solar and potable water kiosks in schools, health clinics, municipal buildings and other government facilities. These procurement programs could provide an especially powerful demonstration effect in regions where access to off-grid electricity, wi-fi, and potable water, for example, is scarce or non-existent. In addition, by providing an initial market and assured revenues to help defray the cost of expansion into new regions, targeted procurement programs would help social enterprises gain a foothold in regions where they were previously not active. These procurement programs may require a change in government procurement regulations. If so, roadmaps should specify what changes might be needed to generate the expected deployment benefits while still providing effective safeguards against corruption and ensuring transparency in the selection of vendors.
- Finally, the UN Technology Bank for the Least Developed Countries can help its client countries put in place the policy and institutional reforms required to strengthen their deployment ecosystem so that they benefit from the preceding proposals.

[16] One possible model for this program is the Feed the Future Partnering for Innovation Program funded by USAID. A recent evaluation of this program with useful lessons of experience is available here.