Sustainability
The Technology Challenge

Doing More with Less

GE at its heart is a technology company. Ever since Thomas Edison first set up the Company over 120 years ago, it has been focused on developing transformative technologies to meet the needs of society. That is still the premise of everything we do.

Explore GE's timeline of innovation **http://www.ge.com/innovation/timeline**

1879

Carbon Filament Incandescent Lamp

Edison invents the first.

1895

World's Largest Electric Locomotive

GE puts electricity to work.

1910

The First Hotpoint Range

Improving life in the kitchen.

1920

Portable X-Ray Machine

GE develops one suitable for dental and portable use.

1921

The Magnetron

A key element for World War II radar systems.

1941

Entering the Jet Age

GE builds the first U.S. jet engine.

1969

A Step on the Moon

Supplying technologies for the first landing.

1875–1969

1986

Lighting the Statue of Liberty

Providing products and funding to relight national treasure.

1998

LightSpeed™ CT Scanner

The first to capture multiple images simultaneously.

2002

Wind Power

GE enters the wind power business.

2003

Evolution® Locomotive

GE introduces new fuel-efficient locomotives.

2009

Vscan

Handheld ultrasound technology extends the reach of healthcare.

2010

The WattStation™

Charging electric vehicles at home or on the road.

2012

Durathon Battery

Next-generation battery developed at Global Research.

1986–Today

In 2012, as part of our public engagement and reporting on the Company's contribution to society, GE sought to gain external insight on the role of technology in addressing sustainability challenges. Our **Citizenship Advisory Panel,** made up of independent experts on social, environmental and economic issues, spent time with GE's chairman and CEO, Jeffrey Immelt, as well as with business and functional leaders at GE's China headquarters in Shanghai, and with senior scientists and technologists at GE's Global Research Center in Niskayuna, NY. We also held a **convening** with a group of experts from scientific, business and policy communities to discuss with GE technology leaders the role technology can play in solving sustainability challenges. This briefing draws on those discussions and on the questions and challenges that the external experts and stakeholders posed.

Today the global population stands at 7 billion people and is still growing. Economies are moving at multiple speeds. Emerging markets increasingly drive economic growth, yet the majority of their people still do not have full access to the products and services that could improve their quality of life. Meanwhile, the ecosystems on which we all depend are under ever-greater stress.

GE's sustainability challenge is to transform many of the fundamental building blocks of a healthy society, enabling access to life-enhancing technologies in such fields as energy, transport, water, agriculture and healthcare in ways that deliver *more* for *more* people with *less*.

Humans are fundamentally a technological species, and so addressing these challenges depends largely on our capacity to develop, deploy and effectively use appropriate technologies at scale. GE believes it has a key contribution to make as one of the world's leading providers of technology-based solutions.

Over the past decade, GE has doubled its investment in R&D, and set goals to invest $10 billion between 2010 and 2015 in clean-technology research and $3 billion by 2015 in healthcare innovations that would deliver better care to more people at lower cost.

Our strategy is focused on the two important opportunities that technology provides. The first is to continually improve the productivity of solutions that *build*, *power*, *move* and help *cure* the world. The second is to unlock the opportunity for distributed and decentralized operations. We are backing this up by building a culture that enables *reverse innovation*: local decision-making fueled by connection to local customers, local research teams and local senior leaders with the knowledge and resources to be responsive.

Success is not guaranteed. As a global community, we are in a race against time, as our past ways of managing ecosystems as well as social and economic systems no longer suffice. What we need to deliver is extraordinary—a paradigm shift in the relationship between economic growth and natural resource use and impacts, in particular greenhouse gas emissions but also resource scarcity, especially freshwater.

As the graph below highlights, global estimates are that demand for resources will grow faster than the efficiency improvements that can be achieved by deploying the best of current and emerging technologies[1]. At the same time, these global demand estimates do not account for the more than 2 billion people outside of the global middle class who lack access to reliable transport and energy, clean water and adequate food. It is clear that breakthroughs both in technology development and the business models that enable tech deployment are crucial.

1 Dobbs, Richard, Jeremy Oppenheim, Fraser Thompson, Marcel Brinkman, and Marc Zornes. (2011) Resource revolution: Meeting the world's energy, materials, food and water needs, McKinsey & Company.

Effective use of technology is about far more than making things. Technology needs to be accessible to the people who need it, at the right price. The right capabilities have to be in place, and often the right enabling policies, standards and financing arrangements. Increasingly, rapid deployment depends on enabling collaboration, often between competitors and across nations where shorter-term interests do not always coincide. And some technologies are underused because they are not trusted, especially those that are newer, less familiar and involve us doing things in often very different ways. Ample public debate is needed to ensure adequate understanding of the role that technology can play in sustainability, including its potential risks and unintended consequences.

TECHNOLOGY MATTERS

1.4 BILLION PEOPLE
STILL DO NOT HAVE ACCESS TO MODERN ENERGY

80% DECREASE
IN CARBON EMISSIONS NEEDED BY 2050 TO STABILIZE THE CLIMATE

DOUBLE THE CARS
EXPECTED ON THE ROAD BY 2030

95 LITERS OF WATER
ARE USED TO PRODUCE ONE KILOWATT-HOUR OF ELECTRICITY

2.6 BILLION PEOPLE
LACK ACCESS TO BASIC SANITATION

90% INCREASE
IN AGRICULTURAL PRODUCTION NEEDED BY 2030

2 BILLION PEOPLE
DO NOT HAVE ACCESS TO PRIMARY HEALTHCARE OR CLINICS

800 MAJOR NATURAL DISASTERS
EACH YEAR

60% OF DEATHS
ARE DUE TO CHRONIC DISEASE

GE Citizenship Advisory Panel Viewpoint

The panel is convened by **Dr. Simon Zadek**, an international expert and author on sustainability issues. He serves in this role in an independent capacity, and is a senior advisor to the International Institute for Sustainable Development and the Global Green Growth Institute.

Panel members advise GE in a personal capacity.

Isabel Hilton is an international journalist and broadcaster. She is CEO and founder of China Dialogue, a website that publishes information and debate on environmental issues in English and Chinese.

Jane Nelson is director of the Harvard Kennedy School's CSR Initiative, and a senior fellow at the school's Mossavar-Rahmani Center for Business & Government.

Valdemar de Oliveira Neto (Maneto) is regional representative for Fundación AVINA in Latin America and promotes human rights, corporate social responsibility and social entrepreneurship in Brazil.

Nick Robins leads the Climate Change Centre of Excellence at HSBC in London, researching and communicating the implications of climate change for the Bank and its clients.

Thero Setiloane is the chief executive officer of Business Leadership South Africa, an association of South Africa's largest companies committed to addressing the challenges of poverty, inequality and unemployment.

Salil Tripathi is the policy director of Institute for Human Rights and Business. He supports the involvement of business in advancing human rights.

We appreciated the opportunity to spend time with Jeff Immelt, Mark Little and senior scientists at the Global Research Center to explore how Citizenship strategies are embodied in GE's technology development. The fact that the company has doubled its research budget over the last five years indicates its commitment to developing and deploying critical new technologies to solve global challenges. We welcomed the openness and responsiveness of the discussion and the level of seriousness and strategic concern about global issues at the core of the business.

It was clear to us that GE Global Research operates in two time frames: first, driven by the long view, and second, addressing shorter-term market imperatives. GE's approach to structuring its investment in research confirms this, with a considerable portion of the Global Research Center's budget not tied directly to the immediate needs of market-facing businesses.

INTEGRATING SOCIAL AND ENVIRONMENTAL ISSUES INTO R&D DECISION-MAKING

The criteria for targeting GE's powerful research engine was of considerable interest. It was gratifying to hear of the increasing importance placed on lifecycle analysis in assessing technologies and design options at an early stage. While the social dimensions of this analytic tool were discussed, the Panel understood that the main focus was environmental. As the company is publicly committed to anticipating human rights issues and proactively resolving conflicts between national law and human rights, our view is that upstream investment and design criteria might usefully also embrace a focus on human rights. This is important as a means of better understanding and taking account of potential "unintentional consequences," such as those that have been surfaced and well-documented in the case of the availability of low-cost ultrasound imaging being used to support sex-selective abortion in some regions of India.

"GE should look at the potential impacts of its technologies, not just for the environment, but for human rights."

Salil Tripathi

"Are there areas where it can be made financially viable for people to leapfrog straight from kerosene lamps and diesel generators to clean energy?"

Thero Setiloane

"How can you accelerate progress in inclusive business and unlock technology with new models?"

Maneto

"What is GE's vision for distributed energy and achieving universal access to electricity?"

Jane Nelson

FORECASTING MARKET CONDITIONS AND NATURAL RESOURCE PRICES

A further dimension of these investment and design criteria concerned the forecasting of market conditions, and in particular the complex issue of establishing market and price scenarios for key natural resources such as water and critical pollutants such as carbon. Clearly, decisions regarding the likely future pricing of such resources and pollutants will have a major effect on investment and design choices. A growing number of companies in the energy sector are testing their capital expenditure plans against shadow carbon prices, and we believe that GE should provide its strategic sustainability assumptions for technology development, building on its Global Grind vs. Fast Blue scenarios.

MEETING NEEDS AT THE "BASE OF THE PYRAMID"

While GE's markets are primarily business-to-business and business-to-government, the Panel was particularly interested in the opportunities and constraints in cascading GE's technology portfolio to the "base of the pyramid." Discussion focused in the first instance on some of the cases where GE had found ways to do this, notably the development of the Vscan handheld scanner and the application of breakthrough technology for early TB diagnosis. The focus of the Global Research Centers in Shanghai and Bangalore on "in China for China" and "in India for India" demonstrate the potential for this approach becoming more common across GE's globally extended network of research centers and innovation hubs.

Despite these great cases, and the important message the company is sending in developing its R&D centers around the world, the Panel understood that meeting needs of base-of-the-pyramid consumers remains a small element of GE's current business and expectation for the future. The company's business model and culture, and its comparative advantage in selling larger systems, were but three of a set of reasons we heard why GE would find it hard to seriously ramp up its portfolio of high technology to provide small-scale, low-cost products. Healthcare was perhaps the exception in being the most likely candidate to go further than other parts of the business, in part because of the shifting market conditions that included greater convergence between consumer and healthcare products (although mainly at the upper end of the consumer market).

The scientists, technologists and officers we met demonstrated a keen personal and professional interest to explore ways of overcoming barriers to greater penetration into these growing

markets. The panel wondered if there could be appetite for a more systemic exploration of the potential for innovative partnerships to enable GE to develop and cascade technologies into base-of-the-pyramid markets without interfering with the main thrust of its current core business.

OPPORTUNITIES FOR FINANCIAL INNOVATION

Accelerated deployment of technologies that improve health, access to energy and water, and reduce environmental impacts depends on investor appetites to make these long-term investments. However, the global economic context, alongside some of the new financial market rules such as Basel III, could well constrain such deployment. This is especially true where energy and water savings and climate-friendly performance are not yet readily rewarded through market prices, fiscal incentives or the rule of law. GE Capital has the potential to take leadership in this context by providing capital for the longer term that integrates environmental, social and corporate governance factors into its decision-making and ownership practices.

In conclusion, the Panel would like to emphasize the role that GE could take in applying its unique expertise and leadership in shaping a more robust understanding of the role of technology in advancing the sustainability agenda in public policy spheres and broader circles of public interest.

GE'S LEADERSHIP VOICE IN PROMOTING THE POWER OF TECHNOLOGY

The response to the Panel's question to GE's most senior official about the relative importance of technology was "Technology is it!"—implying technology to be the single most important factor in forging a sustainable development pathway. The response from GE's most senior technologist to the same question was, similarly, to stress technology's core role, but also to flag the real dangers of underdevelopment or deployment of new technologies if the enabling conditions were not present.

GE is of course already communicating the importance of technology and underlying capacities for innovation and engineering in many ways. Yet its broader educational role could well be, and arguably must be, extended further. The intention to publish a Citizenship Report this year focused on the topic is certainly a step in the right direction. Yet the Panel would urge this move to be part of a longer-term strategy for raising the profile, dispelling the myths and clarifying the realities of how technology fits into a sustainable pathway going forward.

"The main challenge in the wake of the financial crisis is how we can mobilize long-term capital for investment in infrastructure, health, water, energy. We need to work out how to deliver long-term, patient capital for the infrastructure the world needs."

Nick Robins

"There is a danger that a 'technology will fix it' mindset is used to compensate for the failure of policy, or that we assume that we can get there with incremental improvements, when what is needed are disruptive technologies."

Isabel Hilton

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Watch interviews with GE's Citizenship Advisory Panel on technology and sustainability here.

In Conversation with Mark Little

Director of GE Global Research

"How do you decide which possibilities to research? Who sets the priorities?"

Technology development at GE is the lifeblood of our business and long-term success. Our approach to R&D is to leverage not only the strengths of our internal resources and people, but also to participate in a truly global web of people, institutions and ideas.

Overall, the Company spends around US$6 billion annually on R&D, of which around 10% is invested in research at the Global Research Centers, where we do the most long-term research. The Global Research Centers are spread across five countries—with bases in the U.S., Germany, China, India and Brazil. Nearly 3,000 researchers work on everything from molecular diagnostics to next-generation batteries and new materials. Another 33,000 technologists working across GE businesses put those technologies into practice.

Our work at the Global Research Centers is funded through a combination of resources directly from GE businesses and from external partnerships with organizations such as the U.S. military and the Gates Foundation. We also have around 25% of our funding which is un-earmarked. This is used to seed the development of more long-term technologies that today's market may not be ready to reward, and that, therefore, market-facing GE businesses cannot themselves finance.

Two or three times a year we hold a "Session T," which brings together our technologists, service and marketing people with customers to talk about the future trends and challenges they see. Then we develop technology plans based on these risks and opportunities. The most important question is whether the solutions we are developing measure up against our customers' concerns and needs. In healthcare, for example, this means reducing cost, improving quality and increasing access.

"How do you develop technologies that are accessible for poorer people and still commercially viable?"

GE focuses on high-tech, high-performance equipment, but we also recognize that there are opportunities to make high-tech solutions more accessible and affordable. There is no potential customer anywhere in the world that is off-limits for GE.

I used to think that to break into new markets in developing countries all we needed was international research, proven products and strong local marketing teams. But I was wrong. In India, the feedback we got was that our products were too expensive, with too many unnecessary features, and the Company was too slow to respond in servicing and sales. We had to redesign our whole approach to enable what we call "reverse innovation." A prime example of this is the VScan. It is a portable ultrasound machine. The idea came from doctors in India who told us that what they wanted was a scanning device as simple as a cellphone to be able to make diagnoses in rural clinics. The design

specifications came from India, but they draw on telematics from Norway, user interface from France, system integration from the U.S. and manufacturing expertise from China.

We have made real breakthroughs on cost in healthcare. Health is becoming more of a consumer business, and you have to be able to make devices cheaper and simpler. But we also have to be able to link up with businesses that can distribute into new markets, as we are primarily a business-to-business company.

We are also looking at ways of doing this with distributed energy and energy storage. We have recently started selling our Durathon batteries originally developed for hybrid locomotives to mobile phone operators to power transmission towers across Africa and Asia. There are around 640,000 of these towers in areas where there is no electricity supply, or it is unreliable, and the towers are powered by diesel generators, using $14 billion dollars worth of fuel. We have found that using a diesel-battery hybrid power system, fuel usage can be cut by up to 50%. The reliability and long life of this power supply helps telecom companies expand service to customers everywhere.

Sometimes innovation is not a straight road. For a long time, GE did not have a wind business as part of our energy portfolio. There was one researcher who was passionate about the potential of wind and kept knocking on Jeff Immelt's door. But at the time, Jeff saw wind as a "hula-hoop"—a passing fad. Finally, when Enron's wind business came on the market, he decided that it was worth GE taking a bet on the technology. Once we decide to do something, we have the technology and scale to make a difference. We acquired the business for $200 million. We put $1.5 billion of technology investment in, and now we have a $7.5 billion wind business. We have driven down the cost of wind power by developing bigger blades, composite materials and advanced drives, and we have improved the power electronics and control systems.

"How can we make sure that technology development is focused on solving the world's toughest problems?"

Cross-fertilizing innovations from one industry to another offers the potential for major gains. The technologies used for airplane engines have been turned into super-efficient, on-the-ground "aero-derivative" gas turbines. Technologies from medical diagnostics find their way into solutions to reduce water leakage. Superconducting magnets developed to make MRI machines radically more affordable are now being used to develop the next generation of wind turbines. Every GE business, from healthcare to aviation to power and water, now delivers software-based solutions and services. Early in 2012, GE opened a software research center in San Ramon, California, to provide a center for collaboration between experts from multiple industries to accelerate digital innovation.

"Can we get to sustainability through incremental progress, or does it depend on completely new and disruptive breakthroughs?"

We know that however many smart people you have in the building, there are always many more outside. We have university partnerships that are focused on specific areas, as well as working relationships with government, national labs and business partners around the world. But we also found we had a blind spot for collaborating with small innovative companies at the early stages of innovation. We just did not know how to work with them. So we set up the ecomagination and healthymagination challenges and a series of venture capital funds within the company to actively look for and work with start-ups in energy and healthcare.

We are working on both game-changing technologies, such as thin-film solar power, smart grid and molecular diagnostics, *and* incremental efficiency improvements to existing technologies to improve the performance of everything from airplane turbines to MRI machines. For a company with such a big footprint, we have to do both. GE power systems create nearly one-third of the world's electricity, spanning every kind of energy generation. Every 2 seconds a plane with a GE engine takes off. GE medical equipment is used to diagnose people in 100 countries around the world. Incremental changes can add up.

But it is clear that sustainability, whether in terms of climate, water or meeting needs in a world of 9 billion people, depends on technology *breakthroughs*. We cannot get there through incremental improvements alone.

We are doing everything we can to disrupt conventional energy. We are challenging our teams to come up with breakthroughs to meet the needs of the poor. We are developing advanced manufacturing technologies to enable more rapid commercialization and deployment of breakthroughs. In healthcare, we are looking beyond diagnosis of disease to supporting wellness. We are working to develop the "Industrial Internet," linking cars, trains, solar panels, wind turbines, building machinery, consumer products and hospital equipment into smart networks.

We believe that technology will be able to solve the challenges of sustainability. You don't have to choose between environmental protection and economic growth. But you do have to choose between different priorities, and develop good policies to drive innovation and deployment. The technologies we have today can offer low-carbon energy, abundant energy or the cheapest option. But they cannot yet do all three. Governments and consumers have to make choices, and they need good policies in order to do that.

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Read more about GE Global Research:
http://ge.geglobalresearch.com/

Targeting Clean Technology Innovation to the Resource Challenge

Launched in 2005, ecomagination included a pledge to double research spending on clean technologies and a goal to increase sales of high-environmental-performance products from $10 billion in 2004 to at least $20 billion in 2010 (later raised to $25 billion), while reducing the Company's own greenhouse gas emissions. By 2010, the Company had met its initial pledges on investment and its greenhouse gas footprint, and despite difficult economic conditions, ecomagination sales had risen to $18 billion. In 2010, new goals were set for the next five years: to double ecomagination research to $10 billion; to grow ecomagination sales at twice the rate of overall sales; and to reduce energy intensity by 50% and greenhouse gas emissions and water use by 25%. The ecomagination portfolio now stands at 142 products and has earned a total of $105 billion in revenues.

However, in order to meet our ambitious goals we need to be more targeted in both our research and development and the way that we develop solutions to meet the critical needs of industry in a resource-constrained world.

In 2011, we started to develop a comprehensive bottom-up map of these needs and the opportunity they represent. The "Advanced Resources Map" is an internal GE tool that examines which sectors will need to more efficiently utilize resources over the next 10 years, and what this means for existing and potential customers in different regions. It looks at water, land and subsurface resources (including fossil fuels) and at the opportunities for improving efficiency at each stage in the life cycle of resources—from resource extraction, to production and distribution, to utilization, to end of life. Based on this analysis, we see an annual US$1.5 trillion market opportunity through 2020—to provide infrastructure that improves resource efficiency.

ADVANCED RESOURCES MAP

GE has the reach and scale to address many of these opportunities. The Advanced Resources Map below highlights where the Company's capabilities and focus are already aligned with these areas and where additional investment or new approaches are needed to unlock potential in different regions.

Mapping opportunities against GE presence and focus

GLOBAL MEGA TRENDS

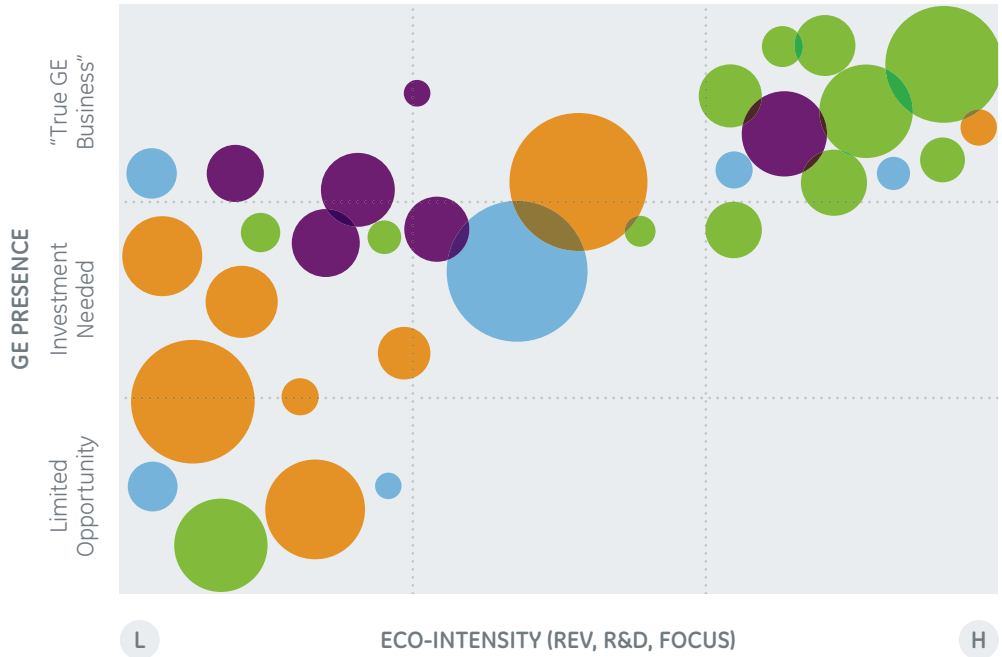
Population Growth/ Urbanization

Energy Demand

Water Reuse

Resource Constraints

GE ALIGNMENT



Sources GE calculations based on McKinsey, IEA, EU 2050, *China GreenTech Report*, Global Water Intelligence, OECD, SAM, EPRI, SBI Energy, ICWT, CLSA, Pike Research, Lux Research, ICID Annual Report, *Hatch Report*, Datamonitor, Eurostat and World Energy Council.

For example, there is significant opportunity in end-of-life processes such as recycling and waste disposal, and in agriculture, but GE plays a limited role in serving these industries. Distributed-energy systems will be critical to meet the world's energy demands sustainably. This is an area that GE is increasingly targeting through flexible energy-generation solutions, including biomass and renewables. Mini-grid systems combining diverse energy sources and cost-effective storage will play a key role in providing reliable, clean, affordable energy for more people. These are sectors where GE could play a much bigger role than it does today.

The Advanced Resources Map was developed through extensive engagement with customers, focusing in particular on those in emerging markets. Customers ranged from thought leaders on sustainability to those with a basic focus on complying with local regulations. Developing a compelling proposition to each of these customers is crucial to growing our ecomagination customer base and increasing the uptake of eco-efficient technologies.

Resource efficiency can impact the bottom line of any business. But the customers that are likely to be our strongest partners in driving the growth of efficiency innovations are **major international companies operating in resource-intensive industries, customers for whom sustainability is a core part of competitive strategy** and **businesses expanding internationally from their home base** and seeking to develop world-class performance.

We are working to design and test value propositions to solve key industry needs related to resource efficiency for these customers. This means not just offering a more efficient compressor or a better generator, but solutions that meet identified efficiency gaps and a sustainability proposition based on the total impact of our own cycle—from raw materials to manufacturing to customer use.

We are now carrying out commercial tests to pilot the approach in China, Brazil, Germany and North America. For example, in Brazil, a key challenge in the expansion of ethanol as an alternative transport fuel is the growing volumes of "vinasse," a liquid waste from the processing of sugar cane. For every gallon of ethanol, around 12 gallons of vinasse are produced, and if it is reused to irrigate crops, it can pollute water supplies. The solution being piloted by GE in Brazil is to separate out the organic material, leaving clean water and fermenting the concentrate to produce gas for fuel.

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Read more about ecomagination:
www.ecomagination.com

Building the Ecology of Innovation

GE is embedded in an extraordinary global network that spans the world's governments and public institutions, hundreds of research institutions and business collaborators, and thousands of environmental and other civil society organizations. This network is probably the world's most important ecology of knowledge and innovation, and the source of many of the technological innovations that will support tomorrow's pathway towards sustainability.

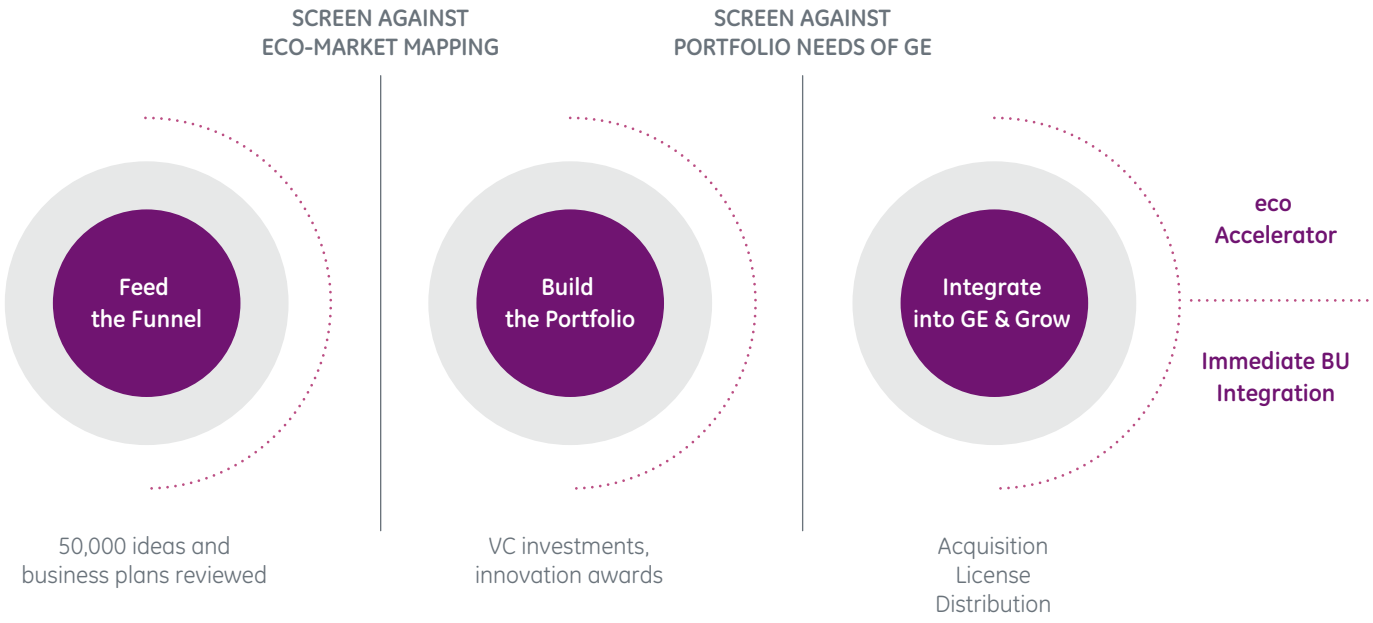
Accelerating innovation depends on extending our network to tap the widest possible range of innovators, and helping to bring the next generation of solutions to scale. In 2010, we established the **ecomagination Challenge**, a $200 million capital pledge in partnership with venture capital firms Emerald Technology Ventures, Foundation Capital, Kleiner Perkins Caufield & Byer, and RockPort Capital. It is thought to be the largest open innovation challenge of its kind. "We put out a challenge for promising start-ups and ideas for the smart grid. We did not anticipate the response we would get," says GE Energy's Kate Brass. "We thought we would get 500 entries, we got 5,000."

In phase I, 12 companies were selected, with $71 million invested. In phase II, focused on home energy use, a further 10 companies were selected and $63 million invested. Further region-specific challenges are also expanding the scope.

In 2011, we also set up **Energy Technology Ventures**, a joint venture with NRG Energy and ConocoPhillips focused on investment in later-stage growth companies that have already demonstrated commercial potential.

One company from the ecomagination Challenge has already been acquired by GE. Others continue to develop through the **ecomagination Accelerator**, a program that brings together capital investment, research and product development, marketing, and distribution to scale up solutions.

In 2011, GE was named a Global Cleantech 100 "Corporation of the Year" in honor of our commitment to innovation through our active support of clean-tech companies, along with our own development of clean technologies.



VISIT US ONLINE!

Read more about the ecomagination Challenge:
www.challenge.ecomagination.com

Below are just some of the start-ups and innovators that we are partnered with on clean technology.

PARTNER	INNOVATION	GE PARTNERSHIP PROGRAM			
		Eco Challenge	Energy Technology Ventures	GE Energy Financial Services	Eco Accelerator
1366 Technologies	Manufacturing solutions for silicon cells to cut the cost of solar power by more than 50%		✓	✓	
A123 Systems, Inc.	Advanced lithium-ion batteries for transportation, electric grid, telecom and commercial markets			✓	
Advanced Electron Beams	Replaces thermal and chemical processes for cleaner, more efficient, lower-cost manufacturing			✓	
Alta Devies	Improving the production economics of high-efficiency solar PV applications		✓		
Ciris Energy	Biochemical conversion of coal to methane at large scale and low cost		✓		
Consert	Converts domestic electric consumption into capacity and energy reserves for utilities	✓	✓		
CoolPlanetBioFuels	Converting low-grade biomass into high-grade fuel and carbon that can be sequestered		✓	✓	
Danotek Motion Technologies	More efficient, reliable and affordable methods of converting and producing power			✓	✓
Emefcy	Turning wastewater treatment from a huge energy drain to an electricity generator		✓		
Foro Energy	Commercializing high-power lasers for the oil, natural gas, geothermal and mining industries		✓		
FMC Tech (acquired)	Power line monitoring system: a nervous system for the smart grid	✓			
Glori Energy	Enhanced oil recovery		✓		
GMZ Energy	ThermoVoltaics; economically viable energy solutions based on direct heat-to-electricity conversion	✓	✓		
Grid Net	Smart-grid software company			✓	
Hara	Environmental and energy management software	✓	✓		
Ioxus, Inc.	Ultracapacitor technology for transport, alternative energy, medical, industrial and consumer products		✓		
Memsys Clearwater	Membrane distillation (MD) technology for shale gas, coal seam gas and other unconventional fuels				
Oblong Industries Inc.	Technology to transform the way we work, create and collaborate		✓		✓
Ocean Power Delivery	Offshore-wave energy			✓	
On-Ramp Wireless	Developing wireless networks for energy automation	✓	✓		✓
Project Frog	Designing and manufacturing smart buildings with modular kit	✓		✓	
SolarEdge	Solar-power optimization			✓	
Southwest Windpower	Small wind turbines for homes and industry			✓	
Sub-One Technology	Advanced internal coatings for pipelines			✓	
SustainX	Smarter energy storage using compressed air	✓		✓	
Tendril	Smart-grid software				
Think Global	Electric vehicles			✓	
TPI Composites	Lightweight, high-strength, large-scale composite structures for wind energy and other applications			✓	
ZiLift Ltd.	Artificial lift solutions for the oil and gas industry		✓		

Business Model Innovation

Making technologies that work is crucial but not enough. The world needs a new generation of business models to be able to finance and deploy technologies in ways that are financially viable and make the best use of available technology.

Emerging markets now generate half of global GDP and over 40% of world exports. Yet, the customers in these new mass markets are fundamentally different from those in developed markets. For example, the per capita income in the U.S. is $44,000, versus $1,000 in India. Apart from the top 10% of the economic pyramid, the customers in poor countries are fundamentally different from those in rich countries.

GE Healthcare has been taking a particular lead in disrupting its business model in order to unlock opportunities to reach more people in these growing markets.

GE HEALTHCARE: REVERSE INNOVATION

GE Healthcare specializes in high-tech medical diagnostic equipment: MRIs, ECGs and ultrasound scanners. Since the 1980s, the Company had been trying to sell these machines to hospitals in China, India and elsewhere in emerging markets, with moderate success. After a decade in the market, sales of ultrasound machines in China only amounted to $5 million.

These GE machines had been designed based on what doctors in wealthy countries were looking for in high-performance and other advanced features. But once we started listening to potential customers in China, we heard that price mattered most, followed by portability and ease of use. A Local Growth Team was set up in China and given unprecedented autonomy to develop technology to meet local needs. The team came up with the Vscan, a handheld scanner as light and simple to operate as a mobile phone, and costing $15,000, just 15% of the cost of our previous lowest-cost ultrasound. Complex features and high performance are not Vscan characteristics, but it is portable and easy to use.

We have since set up more than a dozen similar projects for "reverse innovation" to meet the needs of consumers in developing countries. In China, ultrasound sales rose from $5 million in 2002 to $278 million by 2008. The portable scanners also found markets in the U.S. and other developed countries, where they could be used in ambulances and in operating rooms where traditional scanners were too big.

"Quality, cost and access are crucial. All three are needed more. We need technology innovation to bring down costs, but also new business models to make new technologies accessible. What is GE doing to disrupt its business models?"

Similarly, in India, our electrocardiogram machines (ECGs) traditionally sold for $10,000, and they were large and required a well-trained doctor to operate. The Local Growth Team in India came up with an $800 ECG, which is portable, operates on battery, and is easy to use and to repair. It is built to meet the needs of rural health workers, using commodity components such as a ticket printer also found on public buses. The machine has no monitor, weighs less than a can of Coke and runs on a rechargeable battery, meaning it can be carried on the back of a motorbike. It is now sold in 120 different countries, including the United States.

Professor Vijay Govindarajan has written about GE's experience of reverse innovation.[1] As he points out, meeting the needs of the poor is not a strategy based on philanthropic motives, and neither is it a choice. Unless we are able to innovate to meet the problems of poor as well as rich customers, we are likely to find that emerging giants in local markets will out-compete us with low-cost strategies.

As professor in residence and chief innovation consultant to GE, Govindarajan urged the company to fully adapt the lessons of the Chinese ultrasound experience across our Healthcare, Infrastructure and Capital businesses. We must find ways to innovate around the infrastructure, regulatory and sustainability gaps in the developing world and to understand cultural differences and consumer preferences. This poses different challenges across each business.

OFF-GRID: FAST AND FLEXIBLE

In countries without an established electricity grid, distributed solutions—from rooftop solar panels to fuel cells to biogas—are crucial to providing more people with energy access and offering businesses reliable power. But we can't reach these new customers through our old marketing strategies, which tended to focus on selling large technology packages to national utilities. Now we need to be able to provide smaller bundles of technology to independent power producers, including businesses, governments and communities. In 2012, we launched PowerXpand™, a portfolio of distributed-energy technologies ranging from 1 megawatt to 31 megawatts and capable of running on a variety of fuels. Customers can buy or rent anything from a single gas engine to an entire turnkey power plant, with commissioning times aimed at less than 45 days, and in some cases as few as 11 days. Many of the products are plug-and-play, including a trailer-mounted aeroderivative gas turbine, and gas and diesel engines that come ready to use, installed in a shipping container that can be rapidly set up whenever and wherever needed.

In both rich and poor countries, the challenge of making energy-efficient and renewable energy choices competitive with conventional energy choices often has to do with making the balance between upfront costs and long-term savings compelling and taking the risk out of new technologies.

WIND: RUN IT LIKE WE OWN IT

The profitability of a wind turbine depends on how much energy it can generate each year over the course of its life. This partly depends on how windy a site is, but also on the size and reliability of the turbine generator. Building larger, stronger generators that operate in more wind conditions, generating more power with less maintenance downtime, is crucial to continuing to drive down cost. But the quality of operations and maintenance (O&M) is also crucial. GE monitors and maintains the wind turbines we install using built-in sensors that enable us to anticipate and respond to any problems quickly. In 2012, we launched a new O&M agreement in which the total cost of the service contract is based on the actual production levels achieved by the wind farm. In effect, this promotes a "run it like we own it" approach toward service, reducing both upfront costs and risks to customers and incentivizing GE to keep wind turbines operating at maximum efficiency.

ELECTRIC CARS: PAY AS YOU GO, EARN AS YOU GO

Electric vehicles are a means of cleaner, cheaper driving. But the upfront costs and fears about battery life are barriers to consumers making the switch. In Israel, we are collaborating with the start-up Better Place to pilot a new model for drivers. With Better Place, ownership of the car and the battery is separated. Drivers buy the car but lease the battery, paying on a subscription or pay-as-you-go basis for the electrons they use. Customers can charge their vehicles using GE's WattStation or swap out spent for fully charged batteries at one of the BetterPlace battery-swap stations. We have also developed the WattStation Connect program, which lets anyone with his or her own WattStation share it with others, collecting payment through a Paypal account.

1 Immelt, Jeff, Vijay Govindarajan and Chris Trimble. (2009) How GE Is Disrupting Itself. *Harvard Business Review.*

Toward a Sustainable Energy Mix

The world's prosperity depends on reliable, available and affordable energy. It took the United States 100 years to build enough power plants to reach the 1,100 gigawatts of generating capacity the country now has. Over the next 15 years, four times this generating capacity will need to be created around the world, principally in rapidly growing emerging economies.[1] Meeting this growing energy demand while protecting our environment and limiting carbon emissions to safe levels presents an unparalleled, historic challenge.

As the International Energy Agency's (IEA's) New Policies Scenario, illustrated below, highlights, current government policy commitments are pointing toward an energy future in which oil, coal and gas continue to play the largest role in energy production but nuclear and renewable energy account for more than half of all *new* capacity.

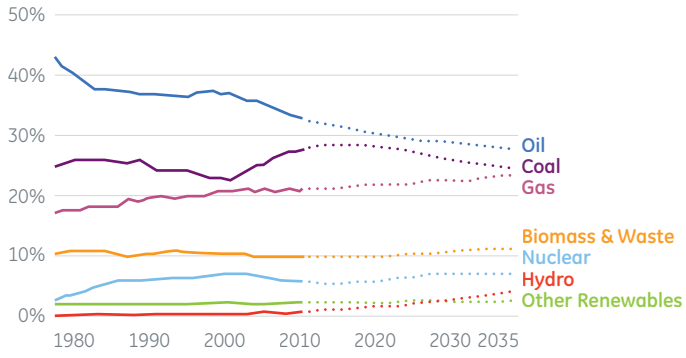
For GE, this means we must advance technologies that provide the cleanest possible coal, oil and gas solutions, while at the same time driving down the cost of nuclear and renewable energy, to make more ambitious policies for low-carbon transformation viable. Our portfolio of technologies serves every kind of energy generation, and so does our vision of a sustainable energy mix:

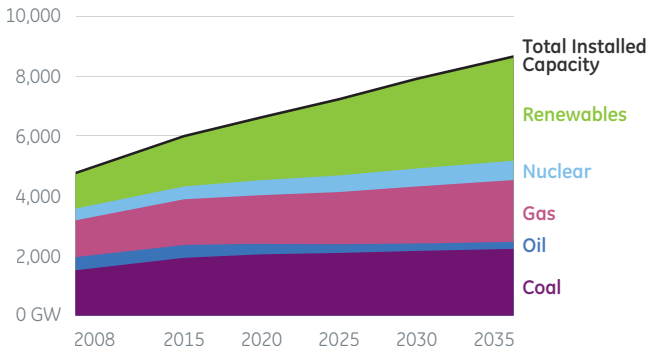
- Transport still depends on oil. Currently, aviation, road transport and shipping, as well as much off-grid electricity generation, depend on petroleum products. The IEA says that even with energy efficiency and the ongoing development of biofuels, oil demand will continue to grow. But oil is getting harder to find, requiring deeper wells and longer pipelines. New technologies enable stranded oil resources to be unlocked, enhance oil recovery from existing fields and help to access unconventional, complex reservoirs. Oil fields have an average recovery rate of 34%. So a 1% increase would result in approximately three years of additional production from each well. Over the long term, hybrid and electric vehicles have the potential to revolutionize transportation, reducing the need for oil in road, rail and even air transport. GE is working both to improve the efficiency, safety and environmental impacts of today's oil industry *and* to create the infrastructure and technology to replace it.

- Coal is our most abundant source of nonrenewable fuel. Coal offers reliable and cost-effective baseload power. The U.S. alone has an estimated 275 billion tons of recoverable coal—enough to meet our current levels of demand for 250 years. Abandoning it is simply not an option. We need to move coal power to the next level of environmental performance and acceptability. GE has been a pioneer of integrated gasification combined cycle (IGCC), which is available and in commercial-scale operation today. IGCC emits significantly lower volumes of nitrous oxides and sulfur dioxides than traditional coal-fired plants and provides a basis for carbon capture and storage (CCS). The IEA calculates that there should be about 1,500 full-scale CCS plants in operation by 2035. Currently, there are just eight. There remain many complex challenges involved in effectively and safely transporting and storing CO_2, and in bringing the cost down. We have therefore invested to advance the science behind CO_2 management. GE designs and supplies IGCC plants with a "carbon island," or retrofitted CCS, for when the policy environment makes it commercially viable.

1 IEA. (2009) World Energy Outlook.

IEA New Policies Scenario





Source: IEA. (2011) Global Energy Outlook.

- Natural gas is the cleanest-burning fossil fuel. Modern gas plants have efficiency ratings of around 60% and emit around 50% less CO_2 than coal. Recent discoveries of natural gas combined with advances in hydraulic fracturing ("fracking") have made natural gas the cheapest fuel available. It offers an abundant and affordable energy source in many locations. Gas can replace old coal-fired power stations and enables variable supplies of wind and solar power to be integrated into the grid.

  It is important, however, that unconventional oil and gas resources are developed in an environmentally responsible way. There is already increasing public and government concern about the industry's impact on water supplies and the local environment, as well as on air emissions. GE supports increased transparency by the unconventional gas industry to enhance understanding of the impacts of production; continued development and implementation of industry best practices to mitigate environmental concerns; reasonable and protective regulations that promote the adoption of advanced technologies; and collaboration among government, industry, nongovernmental organizations, universities and the private research community to develop and deploy additional technologies and cost-effective best practices and regulations to minimize potential environmental concerns.

  Technology-based solutions will be crucial to developing unconventional gas supplies safely, responsibly and efficiently. Advanced water-treatment and recycling technology is available to reduce wastewater produced by natural gas exploration and production activities. Likewise, advanced natural gas engines are available to produce cleaner power on-site and reduce the use of diesel motors and generators in drilling operations.

- There are unexploited opportunities for biogas to expand. Electricity can be generated from unusual waste. GE Jenbacher engines are used to make electricity from cheese whey, whisky mash and leftover school lunches. In Cambodia, we are supplying engines that burn methane produced by fermented rice chaff. This not only produces renewable energy, but it also prevents pollution by methane, a gas that is 21 times more contributive to global warming than carbon dioxide. Biogas is highly efficient for combined on-site power and heat generation, reducing greenhouse gas emissions and leaving behind high-quality agricultural fertilizer. Since GE acquired Jenbacher in 2003, it has developed a suite of gas engines that can run on a variety of fuel stocks and has installed these engines in 100 countries, in projects ranging from combined-heat-and-power in factories and hospitals to municipal waste treatment and farm digesters. The efficiency and fit of the engine are crucial for ensuring that projects create return on their investment.

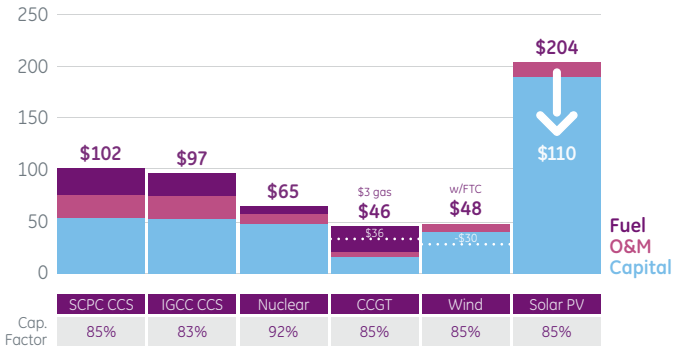
- A next-generation nuclear energy is needed. We believe that nuclear power is an important part of a safe and sustainable energy future. Today's nuclear power stations are aging, and we have a stock of used nuclear fuel that could take around 300,000 years to return to the low-level of radioactivity of mined uranium. GE Hitachi Nuclear Energy (GEH) is developing an advanced recycling technology solution that can recycle used nuclear fuel—without creating dangerous weapons-grade nuclear materials—and generate more electricity while dramatically reducing the long-term radioactivity of the used fuel. This turns a problem into a solution. The United States could meet its electricity needs for 100 years simply by recycling the existing stockpile of used nuclear fuel it is currently storing. Legislation is essential to supporting sustained investment in used-fuel solutions. GEH also looks to the U.S. government to authorize the export of ARC/PRISM, as potential overseas customers have expressed an interest in this technology.

- Wind is becoming cost-competitive. Within the next two years, wind will generate 5% of the planet's electricity. Since 2008, 42% of all new power-generating capacity added in the U.S. has been wind, and it is estimated that wind energy could supply about 20% of America's electricity. GE entered the

wind business in 2002; since then, we have invested US$1.5 billion in wind technology development and have installed 18,000 units with around 28 GW of capacity. A critical challenge has been to develop larger, more efficient wind turbines and enhance their performance and reliability to reduce downtime. We have developed taller towers and longer blades, using stronger, lighter materials, as well as developing remote monitoring and controls. New models deliver 19% more energy than previous versions. This has succeeded in bringing the cost of wind power down from around 15 cents per kWh to around 5 cents per kWh, making it competitive in many locations.

- Solar has the potential to revolutionize energy systems. While almost every electricity-generation technology involves a version of the process developed almost 200 years ago—spinning some kind of turbine—solar photovoltaic (PV) technologies and fuel cells generate electricity *directly*. Commercializing them will unleash a whole new generation of innovation and applications. We are still near the beginning of that learning curve. Currently, solar power is more expensive to produce than mechanical generation and depends on policy incentives for adoption. GE has been working hard to reduce the cost of solar energy, developing high-performance solar inverters, monitoring and controls; thin-film solar panels; and racking and cabling for utility-scale solar. Electricity production costs have dropped by as much as 70%, nearing about 10 to 15 cents per kilowatt in the past few years, and the cost of solar modules has dropped by 50%. It is an environment that requires players to be agile and smart. We are focusing our efforts on developing the next generation of solar module technology to achieve breakthroughs in efficiency and cost.

U.S. Electricity Generation Leveled Cost/GWh (GWh = 1000 MW)



Source: GE Energy Marketing—$5 gas, $2.80 coal, 4% interest rate, 12% after-tax ROE, 35% tax rate, 1.5% property tax & insurance, no incentives, CO_2 credit/cost, real 2010 $.

The key factor driving investment in different forms of energy generation is cost. The graph below compares the cost of energy generation using clean coal technology (supercritical pulverized coal (SCPC) or integrated gasification combined cycle (IGCC) with carbon capture and storage), nuclear, combined cycle gas turbine (CCGT), wind power and solar PV. The cost estimates are based on U.S. assumptions, but the balance of fuel, capital and O&M costs among different countries is comparable.

In addition to **diversified energy sources, energy efficiency, smart grid, smart logistics** and **better energy storage** provide crucial opportunities to use energy more effectively. Every day, heat billows into the atmosphere from boilers, generators, smoke stacks, ovens and kilns, from homes, farms, factories and municipal facilities. Billions of dollars are lost as wasted heat in the U.S. every year. Further energy is wasted by engines idling, planes waiting to land and excess power-generation-capacity spinning. Information unlocks opportunities to manage energy resources and use them more efficiently; to make buildings, travel and logistics more efficient; and to advance personalized and preventative healthcare.

Governments around the globe are adopting energy policies to encourage investment in clean-energy technologies and support the build-out of modern electric infrastructures. Already 1 billion people are covered by carbon-trading systems, from Australia to California, Europe, and some provinces of China. It is clear that greenhouse gas regulation in the long term is inevitable. Advanced energy technology development and deployment are crucial for developing a clean, secure, reliable and efficient energy mix. But to realize this potential, and with it gains in job creation and economic growth, policy makers must be willing to adopt an integrated, long-term energy policy that accelerates the deployment of clean-energy technologies.

VISIT US ONLINE!

Read more about GE's viewpoints on energy policy:
www.ge-energyforourfuture.com

In Conversation with Brandon Owens

Global Strategy and Planning, GE Energy

"What are the factors that will determine the way the energy future will develop?"

Economic growth plays an enormous role in shaping the energy mix; it determines what the demand for energy will be and its geographic distribution. We know that most of the growth in energy demand will be in developing countries. But will the developed economies grow fast or slow? Will cooperation prevail or protectionism increase? The other major uncertainty is public policy. Prospects for a strong international agreement on climate change in the near term have faded. Instead we are seeing bottom-up policies being developed at national, state and provincial levels. This is being driven by economic as well as environmental goals, as governments seek to secure affordable, reliable energy supplies and develop new industries alongside health and environmental goals.

The unconventional-gas revolution has changed the energy picture dramatically. In the U.S., natural gas prices are at their lowest level in 10 years. Other countries like China and Poland are also exploring unconventional-gas reserves. How quickly can unconventional-gas resources expand and at what cost? This is one of the key questions for the global energy industry.

"How does GE factor in these long-term trends and uncertainties into its investment and technology decisions?"

GE businesses do a lot of careful thinking about the future. The energy business has one of the longest timelines of any industry, so we tend to look out the farthest. One of the things we have done to support this thinking is to develop scenarios to map out possibilities and implications. Our current set of scenarios map out two possible futures. "Fast Blue" is a world that sees stronger economic growth and a rapid transition of the energy system driven by natural gas. The other scenario, "Global Grind," is one of slower economic growth, where commodity and fuel prices are weak, trade protectionism increases and environmental concerns are given less priority. In the Global Grind scenario, there are incremental technology improvements but no major breakthroughs. Nuclear plants are retired, but old coal is retained. In Fast Blue, on the other hand, old coal plants are retired faster and replaced by gas and renewables. Technological advances help create a cleaner and more efficient energy system, but perhaps not as fast as we had all hoped for a few years ago. The whole purpose of painting the global energy future in vivid detail is to help us think comprehensively about different ways the future may unfold. The energy future is highly uncertain, so we have to remain flexible and help our customers to remain flexible.

The conventional wisdom around gas over the last decade was that it would be a bridge fuel, only lasting a few decades and then giving way to zero-carbon technologies, such as carbon capture and storage, nuclear power and renewable energy technologies. Now, with the new sources of gas and technology innovation, gas has become cheaper and more plentiful. This has turned conventional wisdom on its head. Gas is now a low-cost resource that is likely to play a role in the longer term. Gas is an essential part of a sustainable energy picture. Gas is also complementary to renewables, providing flexible power to co-dispatch around solar and wind power. Gas power plants also would lend themselves to future carbon capture and storage retrofits, should environmental regulations tighten in the future. So gas has moved from being perceived as a bridge fuel to being viewed as a destination fuel. It's been a pretty dramatic shift in the last several years.

"What does the golden age of gas mean for renewables and clean energy?"

The other big shift is the digital wave. The world of digital communications is converging with power, water and transport infrastructure. We call this the Industrial Internet. It is going to transform the power system. The goal is to develop a new generation of intelligent systems that can predict and respond to changes. That's what we're working on here at GE—integrating digital technologies into our energy systems to make them smarter. This will help our customers be more flexible and react to the changing environment more quickly.

"Are there any other big changes on the horizon that you're thinking about?"

This kind of long-term thinking drives both our investment planning and the way we engage with public policy. We have to be able to support our customers to win, whichever scenario prevails. That's the goal of all of our efforts around scenarios and strategic planning: to help our customers win.

In Conversation with Bill Flanagan

Leader, GE Ecoassessment Center of Excellence

"How does GE align its research and development to contribute to meeting society's needs in the 21st century?"

Our challenge is to meet the needs of a growing global population in a world where energy, water, materials and the natural environment are increasingly under pressure. To design for this environment, we need to understand what a product's impacts are across its whole life cycle. This means starting with how its materials are extracted from nature, how the product is produced, how it is used and, ultimately, how it is disposed of. It is really important to be able to quantify this, so that we are not just talking about green technologies but can really pinpoint how green they are at every stage, and how the design can be improved to deliver a greater net environmental benefit.

"How does GE apply this thinking to its product development?"

In 2008, we set up the Ecoassessment Center of Excellence to integrate lifecycle thinking into our product design and evaluation processes. A lifecycle approach looks at not only the energy and water use, and greenhouse gas emissions associated with products, but also the materials they use. Are they scarce? Are they toxic? Are they recyclable? We use a robust and internationally recognized lifecycle assessment approach that we've tested by working with different businesses on tricky problems and design dilemmas. For example, for GE Energy, we looked at how much energy is used in the production of wind turbines and solar cells. For GE Healthcare, we looked at the lifecycle impacts of a disposable technology for making biopharmaceuticals and found that the results were counterintuitive: The product with disposable components turned out to be more environmentally friendly than the fully reusable conventional technology, because the conventional technology required an enormous amount of water and energy for cleaning and sterilization.

No. What makes more sense is to target the approach strategically and selectively to make the most difference. A full lifecycle study is not always needed; what is important is that product developers consider environmental impacts early in the design phase of a new product or technology, rather than after it's been fully developed. We have also developed a simple lifecycle management tool that can be applied broadly to identify issues and hotspots, as well as opportunities to create products and technologies that perform better for the environment and for our customers. We are working with each business to figure out where best to apply such tools and eco-concepts in their product development pipeline. Lifecycle thinking is also driving our research and development funnel, through the Advanced Resources Map, which looks at opportunities for efficiency improvement at each stage in the life cycle of natural resources, from extraction to use to disposal. That is a really exciting development. It offers the prospect of integrating lifecycle thinking from the beginning to the end of the product development process and of driving solutions toward where the need is greatest.

"So, do you apply lifecycle assessments to all new products?"

Our work on ecoassessment is focused on the environmental aspects, but sustainability needs to be a balance of environmental, social and economic aspects. For example, lifecycle assessment is concerned with environmental impacts; our EHS teams manage supply chain responsibility; and human rights champions think about human rights concerns. There are additional cross-cutting issues, such as use of scarce materials and conflict minerals. We also know that sometimes there have to be trade-offs between environmental, social and economic concerns. We are still in the early stages of being able to think about all three in an integrated way. We know that it cannot be a checklist approach.

"Do you assess the overall sustainability of products—social, environmental and economic?"

Human Rights Risks

"Does GE consider human rights risks, and the potential for human rights benefits, when it develops new technologies and new markets?"

New technologies and business models also bring with them new, and sometimes unexpected, risks. The "Industrial Internet," which will harness and automatically analyze data generated by industrial equipment to improve the delivery of healthcare, energy, transport and other services, is likely to open up new dilemmas related to human rights and privacy, which GE will need to address.

GE has experienced addressing ethical issues in relation to technology. Several years ago, the use of an ultrasound highlighted the need for GE to anticipate human rights risks and work through dilemmas, enforce rigorous internal controls, work with governments to promote standards, and raise public awareness.

ETHICAL ULTRASOUND

While ultrasound technology offers major health benefits in diagnosing a wide range of conditions, it has also been used for the purposes of female feticide in countries where there is a cultural preference for male children. GE Healthcare has been working to address both uses, to enhance the human right of access to healthcare on the one hand and to avoid complicity in a highly emotive and complex human rights issue on the other.

In India, for example, it is illegal for healthcare workers to communicate the sex of the fetus if it is detected during a prenatal examination. Manufacturers and distributors are prohibited from selling, renting, permitting or authorizing the use of ultrasound machines for fetal sex determination and must confirm that customers have a valid registration. Manufacturers must provide the government with a quarterly report on buyers. However, in general, the laws are weakly enforced, and reports of female feticide are still commonplace, if not increasing. Human rights campaigns therefore focused on the corporations that produce and sell ultrasound technology. GE Healthcare responded with increased safeguards against illegal sales and support for campaigns that increase awareness of the human rights issues at stake.

GE not only ensured full compliance with applicable laws, but also took additional steps to help raise awareness among the parties involved in the sale or use of the equipment:

- Instituted mandatory training for all relevant sales and service employees and dealers
- Added explicit warnings to Terms and Conditions sections of all sales contracts and dealership agreements, and auditing and reporting on all dealer and direct sales (When GE first instituted these measures in 2002, the Company's ultrasound sales growth declined from the previous year by approximately 22%, and the sales decline for black-and-white ultrasound machines was especially sharp.)
- Refused to sell ultrasound technology to family planning clinics
- Placed stickers directly on the machine clearly stating that using the ultrasound to detect gender was illegal
- Created a marketing campaign to promote "Rights of the Girl Child," and began funding educational programs for girls
- Met with social activist groups to ensure open communication and transparency (A single sale of ultrasound equipment goes through up to five internal checks, from the initial sales contact to equipment installation, and again on servicing, to verify that the customer has a valid registration.)

There are of course other ultrasound manufacturers willing to flout the law. Ultimately, unless the implementation of the legal framework is strengthened, and, more broadly, unless there are cultural shifts in the value placed on girl children, the problem of female feticide will not be solved. GE Healthcare India has met with government officials to share information about its internal controls and sales practices that go beyond the requirements of the law, and has called upon the government to increase enforcement activities and education programs.

In addition to the impact of technology itself, GE also recognizes the importance of monitoring its supply chain and its relationship to potential human rights issues. For example, GE is expanding efforts to address concerns about the use of "conflict minerals," minerals mined in the Democratic Republic of the Congo (DRC) and in the surrounding region, in our supply chains. We have participated with a group of companies, NGOs and socially responsible investors in an effort to provide advice and comments to the Securities and Exchange Commission (SEC) to assist in crafting and implementing regulations for Section 1502 of the Dodd-Frank Act. GE is also developing a program that would implement appropriate due diligence processes regarding the origin of certain materials in our supply chain and that would strive to eliminate any materials that may be supporting the conflict in the DRC. To support this work, we are participating with approximately 30 leading global companies in the OECD pilot program to implement the OECD conflict minerals due diligence guidance.

The Deployment Challenge

"What does it take to scale up breakthrough technologies, to get them out of the lab and onto the street?"

Policy and innovation enhance each other. Breakthroughs in clean-energy technology reduce the cost of ambitious policies, while enabling policy environments are crucial to accelerating technology advances. One without the other, and progress stalls.

Electric vehicles are a clear example of this two-way relationship. Government support has been critical in the development of the technologies that have brought electric vehicles to the stage where they are ready for wider deployment. Powering a car with electricity now costs as little as 20% of running it on gasoline, and it is quieter and cleaner. But upfront vehicle and infrastructure costs remain hurdles to large-scale adoption, and electrification on a mass scale is an enormously complex undertaking. Policy continues to be important, both to coordinate and incentivize deployment, and to accelerate further technology breakthroughs in battery performance and second-life battery applications. Clear and consistent incentives would lower the initial purchase price and could be gradually phased out as technology prices continue to fall. Governments can also play a leading role in developing industry scale through their own vehicle fleets. Public policies that support the development of charging infrastructure and the smart grid are also a key component. Requiring utilities to offer off-peak rates for electricity use, for example, would encourage people to charge their cars overnight using low-cost, lower-emission energy.

GE has been working on the technology for hybrid and pure electric vehicles since the 1970s, often with the active support of the U.S. Department of Energy. GE is applying its resources at every level to attack the deployment problem and bring solutions to scale.

- Technology research To date, GE has invested more than $150 million to develop advanced battery technologies across hybrid locomotives, tugboats, mining trucks, and heavy-service vehicles. We have also been researching the overall impact that electric-vehicle charging will have on the electric grid.

- Technology partnerships GE is already working with advanced battery–maker A123 Systems, which is a leader in the lithium-ion battery technology used in hybrid cars—and GE is also a venture capital investor in the company. Meanwhile, in April, GE and Nissan announced that they're teaming up to research new technologies that will be needed in cars, on the grid, and at home or work to make smart-charging a reality.

- Product development GE technologies are embedded in electric vehicles (EVs), batteries, the smart grid and charging infrastructure. WattStation™ EV chargers enable people to charge their electric vehicles easily at home, and building owners to install charging stations.

- Partnerships GE and Better Place, a pioneer in creating a practical charging network, announced a technology-and-financing partnership to accelerate the global deployment of electric-vehicle infrastructure. The teams will collaborate in four key areas: technology development, battery financing, electrifying corporate vehicle fleets, and consumer awareness.

- Procurement GE owns one of the world's largest vehicle fleets and operates a leading global fleet-management business, GE Capital, Fleet Services. In 2010, we committed to buy 25,000 electric vehicles by 2015 for our own fleet and our fleet customers. By electrifying our own fleet, we will accelerate the adoption curve, drive scale and move electric vehicles from anticipation to action. After an initial pilot phase, this plan has now shifted to full-scale deployment, led by GE Healthcare. In 2012. every single sedan GEHC purchases for employee use will be a Chevy Volt.

- Marketing GE Capital, Fleet Services has been running electric-vehicle roadshows and has opened the GE Vehicle Innovation Center to provide customers with first-hand experience of alternative-fuel vehicles and GE's enabling technologies.

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Read more about electric vehicles:
www.ge.com/innovation/electric_vehicles/index.html

Technology and Development

"How can we ensure that developing countries, for example in Africa, are not left behind by this next industrial revolution? They want to become producers, and not just consumers, of the next wave of technologies."

Increasingly, countries seek to do business with and promote partners that are willing to make a long-term commitment to their markets. This is also our goal. GE invests in countries that provide a business climate, infrastructure and incentives that allow us to be confident that we can invest for the long term. We believe that local investment can contribute to the development of stable, prosperous economies and expand long-term business opportunities for GE.

GE IN AFRICA

GE is expanding in Africa. The company has 1,500 employees on the continent; offices in Egypt, Kenya, Algeria, Angola, Nigeria and South Africa; and facilities for GE's Oil & Gas and Energy businesses in Algeria, Angola and Nigeria. Although overall GE is still a small company in Africa, accounting for around 2% of global revenues for GE and fewer than 1% of our employees, it is growing fast. Over the past five years, revenues in Africa have risen from US$500 million to $3.6 billion.

Although GE has long had a presence in Africa, activity has tended to be limited to sales to multinational clients. In 2009, the Company began to explore growth opportunities, beginning with a philanthropic engagement in 2004, "The Africa Project," that later developed into "Developing Health Globally." These partnerships provided a learning base for the Company to explore the potential and practical realities of delivering products and services in Africa.

Lazarus Angbazo, president & CEO, GE East, West & Central Africa, says that crucial to the sevenfold growth in revenues over the past five years has been responding to the demand for international investors to act as development partners, not just equipment providers. "We need to have a different level of conversation with the governments and the customers. It's not just about selling the equipment, but it's about working with the customers to develop solutions that address real needs. It's also about creating the local partnerships that will allow us to actually develop these solutions.... In order to develop, we need to increase our investment and expand the local capabilities."

In Nigeria, this has resulted in the signing of a Company-to-Country agreement with the national government, aligned with Nigeria's goals for growth and its technology and education strategies. The agreement is aimed at fostering partnerships and driving critical infrastructure projects across the country. The partnership also plans to develop technical and managerial employment opportunities for Nigerians as well as joint initiatives designed to heighten Nigeria's reputation globally through a solid compliance and integrity program. As a result of the agreement, GE Transportation has supplied 25 diesel locomotives and has provided workforce training to the Nigerian Rail Company. In response to the country's Local Content Law, GE has established a welding facility and trained local welders for specialty roles. This creates local capacity and employment, and enables GE to offer customers quality products made within a compliant business environment.

It is vital to ensure that less technologically developed societies benefit from new technologies rather falling behind. Societies must develop their peoples' skills and technological capabilities, whether to absorb technologies, to participate more fully in global production chains or to become technology developers. As the experience of Nigeria highlights, industrial strategies, created by governments often working with the business community, are an important enabler for any country to advance along an economic and associated technological pathway.

GE understands this and seeks wherever possible to support such strategies through alignment in technology transfer and investments. Recently there has been a surge in local-content requirements in many developed and developing countries that make contracts for public procurement contingent on local partnerships and manufacturing investment. While appreciating the intent of such local-content requirements, our experience is that they are generally less effective than positive-incentive policies and partnerships, often imposing substantial resource costs on the host economy for little long-term gain.

GE supports a more open, incentive-based investment climate where local investment is driven by market opportunity, availability of capital and capable partners. Governments can best facilitate investment through measures that improve the competitiveness of local suppliers and enhance the attractiveness of the local business environment. To accomplish these objectives, policies and regulations should include the following elements:

- Respect for the rule of law
- Encouragement of the use of contractors with a record for transparency and ethical commitments
- Improvement of local infrastructure to support private sector investment
- Implementation of education and training programs to develop local talent
- Support for local entrepreneurship
- Incentives for businesses that invest locally
- Recognition of investments by foreign companies, such as import-duty exemptions for intermediate goods used by local enterprises

With such conditions in place, GE believes that countries will be better able to attract the world's best companies, in terms of their technological offerings and long-term vision and commitment.

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In Conversation with Carl Horton

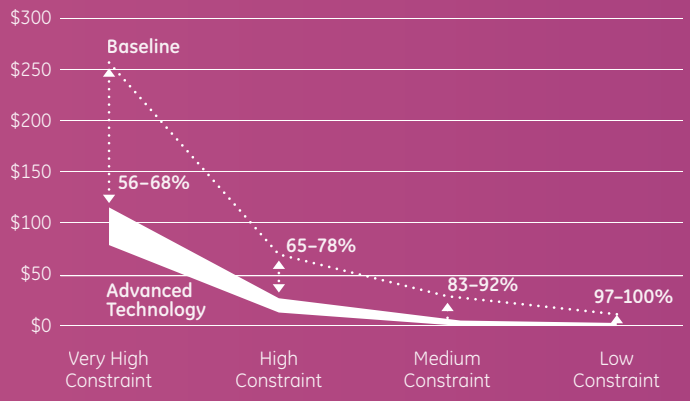
Chief Intellectual Property Counsel

"How can clean technologies be made affordable around the world?"

Speeding up technology development and diffusion is the only practical way to improve affordability. Meeting global climate change goals using only today's technologies would result in a prohibitively high price tag. For example, one study finds that if we were limited to technologies available in 2005, the cost of achieving climate goals would be more than $20 trillion greater than the estimated cost taking into account expected developments in energy efficiency, hydrogen energy technologies, advanced bioenergy, and wind and solar technologies.[1] Other studies have found that accelerated technology development offers the potential to dramatically reduce the costs of stabilization by 50% or more, yielding economic benefits of hundreds of billions to trillions of dollars globally.[2]

Achieving these technological breakthroughs requires significant investment. Today, over two-thirds of clean technology R&D is funded by the private sector.[3] And given current economic realities, the contribution of industry is especially critical. Maintaining and increasing investment will happen only if companies are able to achieve predictable returns from the winning technologies they develop and are not required to "give away" such solutions. Thus, meaningful intellectual property (IP) protection is a necessary prerequisite for investment, as it brings clarity and certainty to the marketplace. To attract technology, countries must take practical steps to improve the functioning of their patent offices and court systems; in contrast, efforts to weaken or limit IP rights send the wrong message to innovative companies seeking to identify future manufacturing and R&D partners in developing countries.

100-Year Cumulative Global Mitigation Cost
(Trillions of 2000 US$)



"Are intellectual property (IP) rights a barrier to technology transfer?"

There is a lot of focus on IP rights in the international debate on clean technologies. In contrast to what we hear from some Geneva players, none of whom are involved in technology development and diffusion, IP rights play a positive role in the global diffusion of technology by enabling market-driven decisions that will help drive down the cost of clean technology. The cost of a wind turbine or other forms of clean technology comes largely from the engineering and fabrication, the expert workforce, and the expensive metal and other components. Trade tariffs and local-content requirements also add significant costs to deploy these solutions in many countries, serving as an inherent drag to setting up economies of scale. IP costs, by contrast, represent a very small portion of the total cost. Clean technologies are highly complex, making it difficult for a single company to hold all the rights to a particular product or solution. Most are based on established technologies, many of which are off-patent.[4]

It is important to remember that technology diffusion—meaning technologies being adopted locally; know-how being shared; and a local population or workforce using or learning how to use new and innovative technologies—is not something that occurs overnight or can be forced upon participants. Effective capacity building requires substantial financing, investment infrastructure, and the education and training of people to form a local knowledge base, without which there would be no resources to absorb the new technologies.

"How does GE work in partnership models to diffuse technologies?"

Technology transfer is best done in an environment where information can be widely shared. Where IP is robustly protected, we are able to negotiate business agreements that enable meaningful transfer of both patent licenses and know-how through co-operative ventures. Protected sharing of discrete technologies enables us to work together to develop faster paths to viable solutions.

One example is our work with Transnet Rail Engineering, a state-owned South African company. The company ordered 143 locomotives, and all but the first 10 are being assembled locally at a plant in Koedoespoort. We worked closely with Transnet to develop a comprehensive plan that complements local strengths and transfers world-class skills and technology where possible. In this case, GE provides a kit for local assembly. To help master the assembly process, employees at the Koedoespoort plant received training at GE facilities in the U.S., Mexico and Australia. In addition, the locomotives themselves are built with a significant number of parts sourced locally. Over 50 locomotives have been delivered so far. As a result of this collaboration,

Transnet and the country of South Africa are able to deploy fuel-efficient and low-emissions diesel-electric, heavy-haul locomotives, a technology that represents a US$400 million investment over eight years. We've operated similar projects in China, Brazil and Kazakhstan. These kinds of arrangements work well when they are based on mutually agreed terms. In the absence of collaboration—for instance, in situations involving compulsory licensing—critical know-how is not transferred. This sharply reduces the benefits normally associated with technology partnerships and associated capacity building.

We are involved in the World Intellectual Property Organization (WIPO) "WIPO Green" initiative, which aims to overcome barriers that impede diffusion of technologies. It is creating a one-stop shop where governments, businesses and foundations can collaborate and learn about opportunities for technology licensing, funding and technical assistance.

"What is required in a national IP strategy to support technology deployment?"

The right IP system is one that is universal. History shows that as countries go from being net consumers of ideas to producers of technology innovation in their own right, they recognize the importance of protection for intellectual property. GE partners for the long term, building these relationships from one of supplier and customer to being a local manufacturing partner, and where there is a favorable environment for technology development and diffusion—i.e., a positive IP agenda—we commit to R&D and manufacturing for export. As these relationships evolve—as we have seen in China, India and Brazil—what matters most to us is the quality of the IP assets and the ability to enforce them.

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Read more about WIPO Green:
www3.wipo.int/green

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3 Based on 2010 figures. OECD. Main Science and Technology Indicators, 2010/2. 2011, p. 18.

4 John H. Barton. (2007) Intellectual Property and Access to Clean Energy Technologies in Developing Countries: An Analysis of Solar Photovoltaic, Biofuel and Wind Technologies. ICTSD Issue Paper No. 2. See also, Copenhagen economics study, commissioned by the European Commission: Are IPR a Barrier to the Transfer of Climate Change Technology? 19 January 2009; Richard Newell. (2008) International Climate Technology Strategies. Discussion Paper 08–12, Harvard Project on International Climate Agreements.

Conclusion

Technology is essential to any pathway of transition toward sustainable development—of that there is no doubt. And we believe that GE is amongst the world's leading creators of technological solutions to many of today's most pressing challenges.

Yet for GE to make the greatest difference requires us to be far more than a producer of smart technology. While it is certain that the world needs more technological advances and breakthroughs, many of the barriers to the development and deployment of technology-based solutions are not so much technical as institutional.

As Mark Little points out, there are real public policy choices that need to be made to unlock the potential power of technology to do good. Supporting policies could facilitate the long-term investment needed to develop and manufacture the next generation of sustainable energy products and equipment.

The economics of sustainability require business and technological innovations backed by investment, but getting the economics right has again much to do with societal priorities and associated policy choices. Policy choices can aid in driving reduced emissions, better management of water resources, and enabling greater access to modern healthcare.

Social dimensions of change are equally important. Behavioral changes in how we as individuals live our lives are a crucial part of any successful approach to reducing the global environmental footprint. Policy and pricing play important roles in influencing such behavior, but changes in culture and norms catalyzed by exemplary leadership must also be part of the equation, and technologies such as the smart grid and peer-to-peer platforms can also support behavior change.

GE, like all companies, has a role to play in this great transition. Indeed, GE has a particular role as a global company involved in providing technology and finance for a wide swath of concerns, from water and energy use to locomotives and healthcare. Basically, our contribution is to develop technologies that build power, cure and move. For such technologies to be effective, however, means far more than their just "doing their job" in enabling light bulbs to be switched on, water to be made drinkable, and people and goods to be able to safely reach their destinations. For technologies to be truly fit for their purpose, they have to be priced so that people can afford them, and perform in ways that satisfy a growing list of demands, especially regarding their broader social and environmental impacts.

Ecomagination and healthymagination are two of our more visible, cross-cutting strategies for addressing environmental concerns and seeking to increase access to life-saving healthcare. But GE takes on challenges such as access and environmental impacts across all of its businesses, products and geographies, and builds them into each element of our research and development process. Our application of environmental lifecycle analysis across a growing range of technologies from design to deployment exemplifies this commitment, as does our increasing "in-country, for-country" technology portfolio that has a particular focus on cost and accessibility.

Getting things right, as we believe we do, does not mean we have all the answers. Deploying clean energy at scale, for example, or getting potable-water technology to hundreds of thousands of poorer communities worldwide remain huge challenges, and as yet unfulfilled collective ambitions. Encouraging governments to put the right policies in place is a significant part of our efforts to accelerate technology deployment, as is engaging the financial community at large, alongside the mobilization of finance through GE Capital.

Engaging with the broader technology community and forming alliances with other businesses and nonprofit organizations are all vital elements of GE's strategy to help shape an enabling environment for driving the development and deployment of our technologies. We firmly believe that through such actions and alliances, GE, with others, can indeed deliver the technology-based solutions that can effectively address pressing challenges, can be widely accessed and used, and can deliver the right outcomes while being mindful of social and environmental impacts.