



# POWERING THE FUTURE

*GE Ecomagination*









# A LETTER FROM DEB FRODL

At GE, we have always believed in progress—in taking risks to improve our technology and build a brighter future for our customers. A decade ago, we decided that meant redefining what it means to be “green,” so in 2005, we launched Ecomagination with a simple but bold vision: Resource efficiency made economic sense. Green is green.

In 2014, we again renewed our promise to double our commitment to cleaner technology research and development by 2020—to invest in technology and solutions that would improve productivity and reduce impact. We committed to reduce our own footprint in both greenhouse gas emissions and water use.

In 10 years, we have indeed made incredible progress. What began as a \$700 million annual investment in cleaner R&D has matured into a \$15 billion commitment. Ecomagination is more than just a technology portfolio; it’s the way we do business. Nearly 8,000 Power & Water employees have joined Ecomagination Nation, committing to personally help decrease GE’s carbon footprint and energy and water consumption. By the end of 2014, we generated more than \$200 billion in revenue and reduced our greenhouse gas (GHG) emissions by 31% compared to our 2004 baseline, and water use by 42% as compared to the 2006 baseline.

In 2014, we integrated efficient hardware with Internet-enabled software—creating a new frontier in resource productivity. We opened the Ecomagination center in Masdar City, United Arab Emirates, to foster collaborative innovation that inspires local inventions and ultimately solves global challenges. And we have backed our promise of sustainable innovation with an increased commitment to invest \$25 billion in cleaner technology R&D by 2020.

But 2015 is about far more than celebrating an anniversary and past progress—it’s about looking ahead and doing better. Our world is too complex to stop here, especially as critical industries like ours look for ways to respond to a growing population and increasing constraints on our natural resources. We have to focus on the future—and we are doing just that. In 2015, we are bringing together the best of GE and the best of our partners to create the innovative breakthroughs that will transform the future of our industry.

Today, as Ecomagination enters its next chapter, we are at work to deliver on the promise to power productivity and achieve progress on an even greater scale. In our labs and factories, and on the ground with customers, Ecomagination is inventing the next industrial era and building the technologies needed to power the world.



# A DECADE OF ECOMAGINATION







## 2005 Goals

In 2005, GE launched Ecomagination, its commitment and strategy to solve the world's biggest energy and environmental challenges.

GE commits to:

1. Doubling our investment in cleaner technology research and development (R&D) from \$700 million/year to \$1.5 billion/year by 2010

2. Growing revenues from Ecomagination technology to at least \$20 billion
3. Reducing our greenhouse gas (GHG) emissions by at least 1% by 2012

## 2007 Expansion

In 2007, GE announced a new commitment in addition to the original three:

4. Reducing our global water use by 20% between 2006 and 2012



## 2014 Success

1. \$15 billion invested in cleaner technology R&D
2. \$200 billion in Ecomagination technology revenue
3. 31% reduction in GE's GHG emissions from the 2004 baseline
4. 42% reduction in GE's water use from the 2006 baseline



## 2010 Progress

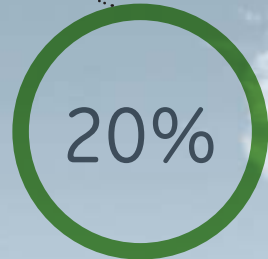
1. \$5 billion invested in cleaner technology R&D
2. \$85 billion in Ecomagination technology revenue
3. 22% reduction in GE's GHG emissions from the 2004 baseline
4. 30% reduction in water use from the 2006 baseline



# 2020 Goals



reduction in water use  
from the 2011 baseline



reduction in GE's GHG emissions  
from the 2011 baseline



invested in cleaner  
technology R&D

*"Creating cleaner technology to help our customers transform industries while driving greater resource efficiency, economics and environmental performance—that is what Ecomagination has always been about."*

*—Jeff Immelt, Chairman and CEO, GE*



# 175

.....  
countries



.....  
8 Global Research Centers





# A BETTER WORLD, TOGETHER

*Ecomagination understands that partnerships are powerful. Whether we are collaborating with customers or energy companies, convening industry leaders, or launching innovation challenges, our partners are essential.*



# 50K+

.....  
technologists working  
around the world



## Convening Power

Ecomagination is committed to bringing together industry leaders, entrepreneurs, the business community and academia to advance important ideas.

Ecomagination, GE Water and the Wharton School of the University of Pennsylvania hosted “The Economic Power of Water” event to bring together public and private organizations and thought leaders in water policy and research to explore the current challenges to unlocking the economic potential of water and to provide actionable next steps to create a more water- and energy-secure world. Over 175 attendees participated in a full day discussion and deep dive session.

Ecomagination and GE Distributed Power hosted more than 150 guests from the government and industry at the “Future of Power” event in Shanghai. The event called for joint efforts to build an ecosystem for natural gas distributed power in China.

## Open Innovation

At GE we are proud of our more than 50,000 technologists working around the world to develop solutions to help build, power, move and cure the world. Even with the brain power inside GE, we know that we do not have all the answers. By bringing together the global innovation community, we are able to solve challenges more quickly and efficiently. Since launch, Ecomagination has held more than six global open innovation challenges. Most recently, in 2014, Ecomagination launched two open innovation challenges to bring the power of the innovation community together to tackle pressing water and energy challenges.

### *Innovation Challenge to Find Renewable Energy*

***Solutions for Seawater Desalination:*** The global production of desalinated water uses approximately 75.2 terawatt-hours of electricity per year, enough to power nearly 7 million homes. GE Ecomagination and the Aramco Entrepreneurship Center launched an open global technology challenge to accelerate the development of solutions focused on improving the energy efficiency of seawater desalination. Winning projects included highly permeable reverse osmosis membranes and high-pressure membrane distillation.





**Innovation Challenge to Reduce GHG Emissions in Canada's Oil Sands:** GE Ecomagination launched an Ecomagination open innovation challenge of up to CAD\$1 million to help accelerate technology development in Canada's oil sands. The innovation challenge targeted two of the biggest opportunities to reduce GHG emissions in the oil sands: new uses for waste heat and improved efficiency of steam generation. Winning projects included heat pumps to upgrade low-temperature heat for steam production and using thermoacoustic energy conversion as a way of offsetting fossil-fuel consumption.

### Statoil Partnership

GE Oil & Gas and Statoil have launched an ambitious collaboration to accelerate the development of sustainable energy solutions. The two companies have initiated a joint technology-focused program to pursue industrial solutions — developing low-cost, reduced carbon solutions within both conventional and unconventional oil and gas operations, onshore and offshore. Initial estimates show that the successful execution of the first five projects could result in significant benefits for the environment including significant combined CO<sub>2</sub> savings. Additionally, the collaboration aims to reduce water usage and emissions of fugitive methane and NO<sub>x</sub>, while

increasing efficiencies in oil and gas production. "This initiative with GE is a good example of an innovative approach to accelerate innovation and help address the energy needs of today and for the future," said Statoil CEO Eldar Saetre at the launch

### Last Mile Program

Nobody likes to see money go up in flames. But the existing pipelines that take gas from wellheads to processing plants are at capacity, forcing energy companies to burn off, or flare, as much as 30% of their natural gas production.

That's why in 2014, GE Ventures and Ferus Natural Gas Fuels started working together to capture the natural gas released from being flared at oil wells, compress it and use it as fuel for powering oil field equipment rather than using more expensive diesel fuel.

GE and Ferus NGF call this the system "**Last Mile™ Fueling Solution**" because it takes the gas the final distance, or the last mile, from the point of supply at the wellhead to the point of use without the need for pipes on the ground. It combines GE's CNG In A Box™ technology with Ferus's oil field logistics.

# TECHNOLOGY SOLUTIONS

*Ecomagination is committed to investing  
in cleaner technology and solutions that  
improve productivity and reduce impact.*





10 YEARS OF  
ECOMAGINATION

IN LOCOMOTIVE

41B

gallons of diesel saved

That's more than all of the diesel fuel  
consumed on U.S. Highways in 2012

\$98M

in fuel savings

IN WIND

549<sup>TWh</sup>

energy generated in total

The GE wind fleet produces the same  
amount of power used by 8.9 million  
US homes in a year

391M

tons CO<sub>2</sub> avoided

The same amount of CO<sub>2</sub> as  
absorbed by 3,187 million trees





### Digital Resource Productivity

A global resource challenge is upon us. In the absence of resource productivity improvements, both materials extraction and energy consumption will increase by 80% by 2030.

The combination of Ecomagination technology solutions and the Industrial Internet has the potential to play a key role in solving the global resource challenge. The integration of efficient hardware with Internet-enabled software is the new frontier of natural resource productivity. This approach provides an avenue to achieve resource productivity improvements above and beyond those that can be achieved through hardware advances alone.

We call this **Digital Resource Productivity**, and we believe that productivity improvements can be doubled over the next 15 years by integrating software and hardware to optimize resource use.

Together with our customers and other partners, we will use the power of advanced technology, big data and intelligent software to continually create a world that works better and more efficiently.

Digital Resource Productivity is not just a vision of the future — it is here today. Since 2012, GE has released 40 Industrial Internet solutions, with many more on the horizon. All of them are part of the Predictivity™ suite of solutions, which is now included in the Ecomagination portfolio. Some examples of these solutions include:

**PowerUp:** Part of Ecomagination's Brilliant Wind turbine platform, PowerUp harnesses the Industrial Internet to drive higher output for wind farms. For example, since European utility E.ON's 469 wind turbines enrolled in PowerUp, power output has increased by 4.1 percent.

**RailEdge Movement Planner:** This software solution makes it possible for trains to move more freight faster and more efficiently on existing rail lines. With Movement Planner, railroads can expect velocity increases of approximately 10 percent — increasing capacity without laying a single track.

**Flight Efficiency Services:** By employing GE's Flight Efficiency Services, an Internet-enabled aviation navigation service that examines flight data to design more efficient flight patterns, Brazilian airline Gol Linhas Aéreas Inteligentes has saved US\$100 million



# 70%+

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decrease in emissions  
of Tier 4 locomotives over  
Tier 3 technology



over five years through reductions in fuel consumption and flight miles.

## Most Efficient Products in the World

Ecomagination has brought new discipline and accountability to the way we deliver technologies and solutions to market. We apply rigorous methodologies at every step to ensure that products drive maximum efficiency and productivity for our customers.

Some examples of these products include:

**The Tier 4 Locomotive:** Part of the Ecomagination-certified Evolution Series, our new Tier 4 locomotives decrease emissions by approximately 70% or more from Tier 3 technology and have saved our customers an estimated \$1.5 billion in infrastructure costs by providing a non-urea solution.

**The HA-Turbine:** Our HA-turbine is the largest, most fuel-efficient gas turbine in the world, at more than 61% efficiency.

**LEAP Engine:** The LEAP jet engine is targeted for a 15% improvement in fuel efficiency versus its predecessor, double-digit improvements in noise and emissions, and the lowest overall cost-of-ownership in the industry.

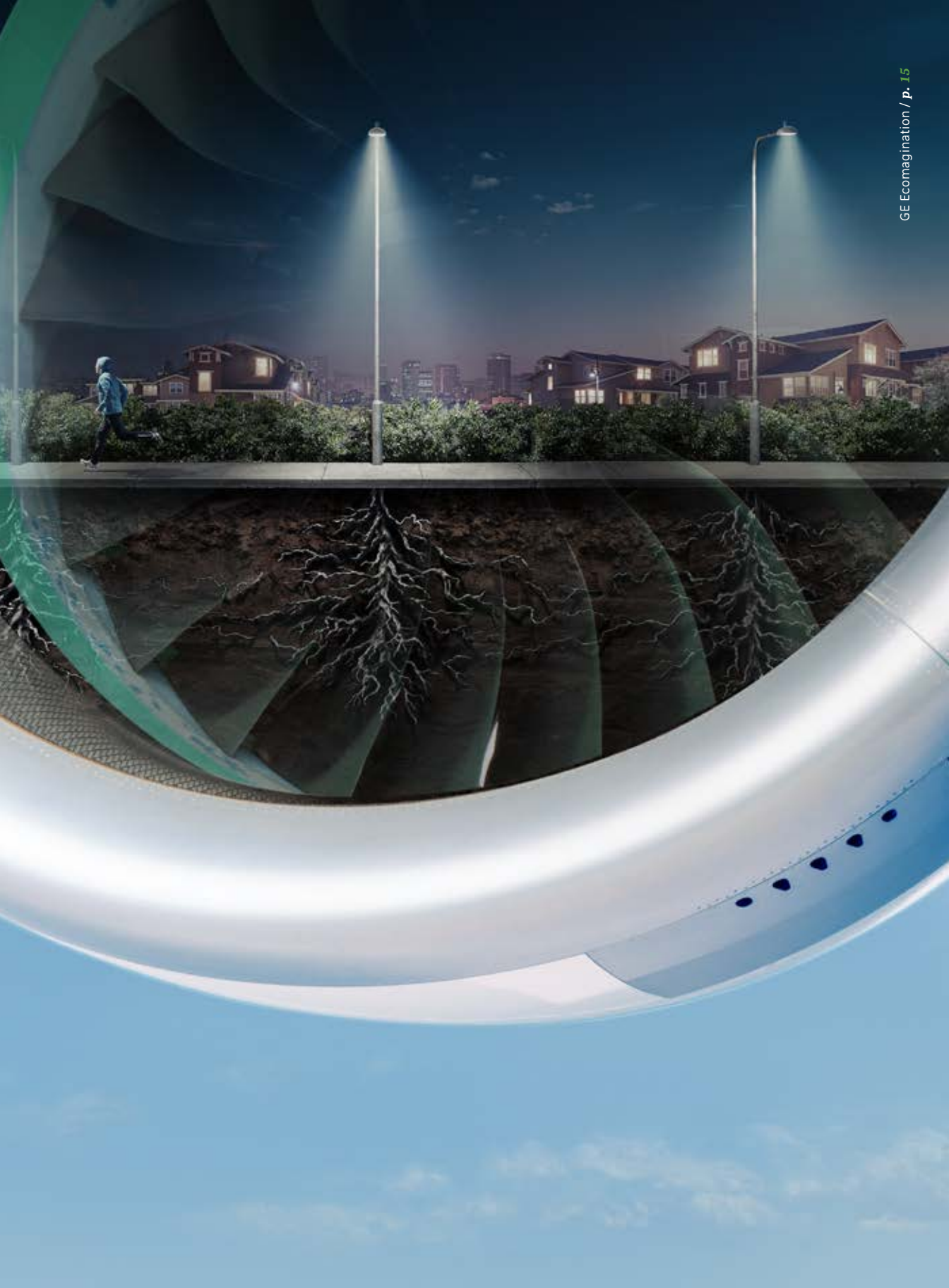
**Solid Oxide Fuel Cells:** There's more than one way to get energy out of natural gas. After scientists in Ecomagination labs cracked an important fuel cell conundrum, the Company is building a new pilot fuel-cell-manufacturing and -development facility in upstate New York. Innovations like the GE Fuel Cell hybrid will have an efficiency of up to 65%.

**LightGrid:** In 2014, San Diego became the first U.S. city to install Ecomagination's "intelligent" lighting system, called LightGrid, which links its streetlights to the Industrial Internet. The city replaced more than 3,000 light fixtures with GE LED lights equipped with GPS beacons and wireless controls technology to measure and manage its energy usage. Intelligent street lighting systems can reduce electricity consumption by 50%–70%.

# BUILDING THE FUTURE

*GE is inventing the next industrial era  
and building the technologies needed  
to power the world.*





## GE Ventures

GE is committed to accelerating the commercialization of innovative ideas. In the spirit of Ecomagination, GE Ventures, Energy makes venture capital investments in innovative companies in the energy sector. The goal of GE Ventures, Energy is to be the global partner of choice to accelerate the commercialization of world-class ideas and technologies by providing capital as well as access to GE's expertise, resources and global scale.

GE Ventures, Energy made a number of exciting investments in 2014 in portfolio companies that are innovators in the energy sector. Here are two that are helping to change the way we power our world:

**Sungevity:** Sungevity provides homeowners with an instant installation quote and a snapshot showing how much they would save on their electricity bills

using its proprietary remote solar design technology. Sungevity then tailors an energy plan right for each home's layout and energy needs. With a presence in the U.S., Australia and the Netherlands, Sungevity has been recognized as a leader in the global solar market, bringing affordable solar energy to more households globally.

**Stem:** Stem is a developer of a cloud-based energy solution. Stem has developed a system that leverages real-time data, cloud-based predictive analytics, state-of-the-art energy storage, and value-added services to help businesses optimize their energy use, and for utilities to help stabilize the grid. Since 2009, Stem has been analyzing how various types of businesses use electricity and how they are charged for it. It has used this information to design a solution that protects companies from unnecessarily high electricity costs without requiring any changes to the way they run their businesses.





## R&D Pipeline

The hillsides around Tehachapi, a brown and blustery town on the edge of California's Mojave Desert, are bristling with a forest of wind turbines of all makes and sizes.

But the tallest and strangest one stands down in the valley. It rises 450 feet from base to blade tips — almost half the height the Eiffel Tower — and has a large spinning silver aluminum dome bolted to its rotor. "It almost looks as if a UFO got stuck on the face," says Mike Bowman, the leader of sustainable energy projects at GE Global Research. "But the dome could be the future of wind."

GE calls the experimental design the Energy Capture Optimization by Revolutionary Onboard Turbine Reshape (ECO ROTR), and the Company started testing it here last month. If the experiments confirm wind tunnel data, the 20,000-pound dome could lead to larger and more efficient turbines for windy locations

that are currently too hard to reach for the industry. "As far as I know, there's nothing like this in the world," Bowman says. "This could be a game changer."

The project is part of Ecomagination's R&D investment commitment to reach \$25B invested by 2020.

## Partnerships

Believing there was an opportunity for enhanced understanding and sustainability in the transportation industry, Ecomagination and Norfolk Southern hosted a Railroad Sustainability Symposium. The two-day conference brought together representatives from companies such as BNSF, CSX, the Association of American Railroads and more. Blair Wimbush, Norfolk Southern Vice President, Real Estate, and Corporate Sustainability Officer, said, "This symposium was a great opportunity to bring together some of the best minds in sustainability to exchange innovative ideas and best practices for incorporating economical environmental practices into core business strategies."

# 3%

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increase in amount of  
electricity generated by  
ECO ROTR wind turbines



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