Breakthrough Energy

CORPORATE

Climate Action Playbook

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Overview

The world currently emits 51 billion tons of greenhouse gases (GHGs) into the atmosphere every year. To avert the most calamitous impacts of climate change, we need to get that number to zero by 2050.

Achieving net-zero emissions in the next thirty years may be the hardest feat humankind has ever attempted. To accomplish it while bringing clean, affordable, and reliable energy to everyone, we will need to accelerate the cycle of innovation, speed the path of new ideas from lab to market, reduce the green premium of zero- and low-carbon alternatives to fossil fuel-burning tools and equipment, and deploy bold technologies that can reduce GHGs across the economy.

While federal, state, and local governments all have critical roles to play in this collective endeavor, private-sector leadership is absolutely essential to ensuring success. As such, this playbook includes ideas and action items for businesses large and small to help speed innovation and reduce GHGs along their supply chain. This playbook also features several case studies that describe and demonstrate effective transformations already underway.

Breakthrough Energy recognizes and appreciates the companies and organizations that contributed to this work.

CORPORATE PLAYBOOK

Research and Development

Case Studies and Deep Dives

RESEARCH AND DEVELOPMENT

Introduction

Today's clean technologies have some potential to bend the carbon-emissions curve—but new, better, and cheaper green technologies are a key component of any realistic plan to achieve a net-zero-emissions economy by 2050. In other words, accelerated clean energy innovation is a fundamental component of halting climate change and limiting the rise of global temperatures.

Private-sector investment in research, development, and demonstration (RD&D) is key to achieving this accelerated innovation. Private-sector RD&D supports economic growth, drives down costs for key technologies, and promotes corporate leadership on clean energy and climate.

Corporations tend to use one of three models in their approach to RD&D: the internal model, the leveraged-resource model, and the collaborative model.

- The *internal model* of RD&D refers to technologies that companies develop for themselves to help meet their corporate priorities.
- The *leveraged-resource model* of RD&D addresses key corporate priorities using funding, facilities, and expertise from external organizations. This type of RD&D often takes the form of sponsored research, cost-sharing with the public sector, or collaboration with incubators and accelerators.
- Finally, the *collaborative model* of RD&D relies on partnerships among multiple different stakeholders. Unlike the leveraged-resource model in which key priorities come from just one company, the collaborative RD&D model is designed to meet the goals of multiple partners. This type of RD&D often takes the form of collaborative incubators, accelerators, fellowships, or third-party prizes.

RESEARCH AND DEVELOPMENT

Engaging Across the Innovation Cycle

Companies can also engage in RD&D at different stages of technological development. The following case studies evaluate technologies across three phases of development:

Applied R&D

When there is a key challenge that must be addressed through innovation, but the right solution has not yet been identified, applied R&D can help companies develop new technologies that can differentiate them from competitors.

Translational R&D

When a new technology seems to show significant potential for addressing a key corporate challenge, translational R&D can improve its performance and reduce costs to boost its commercial viability.

Validation & Early Deployment

When a technology meets criteria for performance and cost but has not yet been tested at scale, validation and early deployment can demonstrate its viability under real-world conditions.

RESEARCH AND DEVELOPMENT

Case Studies: Internal Model

In the private sector, the internal model of RD&D refers to technologies that companies develop for themselves to help meet their corporate priorities.

INTERNAL MODEL — APPLIED R&D

Impossible Foods

ACTION:

Invest in internal applied R&D to provide a strong foundation for scaling low-carbon solutions

Overview

Impossible Foods' creation of convincing plant-based beef has led to a revolution in the way consumers interact with alternative proteins. This revolution only happened because Impossible Foods invested in applied R&D. Other companies that invest in internal applied R&D can find new ways to innovate, cut costs, create new products, and profit even as they reduce their carbon emissions over the long term.

Challenge

New innovations, in the climate change space or otherwise, can take time and require significant funding. But while basic investment in research, development, and demonstration (RD&D) has always been a key part of national economic prosperity and competitiveness, the federal commitment to innovation has waned in recent decades, especially in the energy sector.

Companies and private-sector institutions have tried to fill the RD&D gap, but often these entities do not have the underlying internal technical and research expertise needed, or they lack the resources to collaborate with other potential research partners efficiently and effectively over the long term.

Goals

Internal RD&D is critical for companies who are focused on bringing solutions to market. Impossible Foods has made internal RD&D a core component of its overall mission to create a sustainable food future. With an aggressive 2035 goal to replace the use of animals as a food-production technology, Impossible Foods continues to invest significantly in refining current products and cutting-edge new developments via enhanced RD&D. To put their ambitious goal in context, Impossible Foods must scale up more than 100,000-fold and double their production, sales, and impact every year for the next 16 years.

Operational Overview

As part of the company's broader strategy to increase market adoption, the Impossible Foods R&D team set bold targets to improve the flavor, texture, appearance, and health and environmental impacts of their products. In 2019, Impossible Foods launched their reformulated flagship product, the Impossible Burger 2.0, after a year-long R&D effort. They also introduced other new products which continue to gain market traction across retail and grocery outlets.

Internal RD&D is critical to the Impossible Foods business model. These processes have helped Impossible Foods reduce costs and improve competitiveness with traditional meat products. In March, the company committed to reducing prices by 15 percent on average for its existing products in the United States. This price cut was possible in part thanks to their robust model for internal RD&D.

Key Inputs and Resources

While Impossible Foods' product and brand are now gaining market recognition, the company had to invest millions of dollars in internal RD&D to reach this point. This investment has supported its widespread adoption in major restaurant and grocery store chains, including Burger King, Starbucks, and Walmart.

Impossible Foods' investment in lab space, equipment, and employees has helped develop proprietary products that set the company apart from its competitors. For example, Impossible Foods has developed a process for producing plant-based heme, the molecule partly responsible for meat's taste, by fermenting genetically-engineered yeast.

Led by CEO Pat Brown, a former Stanford biochemistry professor, Impossible Foods continues to prioritize internal RD&D as part of its overall strategy. In 2020, the company invested $700 million in R&D and committed to doubling its R&D team over the next 12 months.

Led by CEO Pat Brown, a former Stanford biochemistry professor, Impossible Foods continues to prioritize internal RD&D as part of its overall strategy. In 2020, the company invested $700 million in R&D and committed to doubling its R&D team over the next 12 months, including by appointing key leadership roles.

Key Outputs

Impossible Foods' R&D efforts have led to the introduction and growth of several impressive innovations and new products in the market. The company has been able to improve the quality of their products, reduce costs, and increase their market penetration.

In March of 2020, the Impossible Burger was sold in 150 grocery stores. As of July, the product was available in more than 5,000 stores, including Kroger, Giant, Safeway, Vons, and Wegmans. Impossible Foods will continue its market expansion, underpinned by its strong commitment to continually improving the quality and cost of its products.

Replicating for Impact

Strong investment in internal applied R&D can enable a given company to forge innovations, reduce their greenhouse gas (GHG) emissions, and more successfully leverage collaborative partnerships. Ultimately a strategic balance between internal and external RD&D should be considered, especially when targeting an aggressive decarbonization goal.

Almost any company with decarbonization goals should have an RD&D strategy that includes a combination of internal RD&D and external knowledge acquisition and collaboration. Larger companies generally have bigger budgets and a capacity to explore RD&D, but smaller and more nimble companies like Impossible Foods can also make a big impact in the market through internal RD&D.

For those companies just getting started, this article does a good job of highlighting why internal RD&D is worthwhile. In addition, while many strategic consulting firms have published on this topic over the years, this essay by Arthur D. Little does an excellent job of showcasing the basic principles involved.

In addition, companies should look at the full life cycle and full commercialization scheme of any technology or product they plan to invest in. Internal RD&D investment is an important step, but companies should also reserve funding and resources for later-stage technology development.

INTERNAL MODEL — TRANSLATIONAL R&D

General Electric's Solar Energy Testbed

ACTION:

Establish an internal RD&D testbed to accelerate innovation on an industrial scale

Overview

General Electric's solar energy testbed shows how internal RD&D can accelerate technological and commercial innovation on an industrial scale.

Challenge

Stakeholders in the clean energy industry know that to keep the electricity grid from crashing, they have to find a consistent, reliable way to balance the supply and demand of energy. Achieving this balance using solar power means finding a way to store excess energy for use at night and on cloudy days.

Solving the problem of storing solar power so it can be used whenever it's needed is especially important now, as solar installations grow more common around the world.

Goals

In 2018, General Electric (GE) established a test site for battery storage and electrical subsystems in a 300-kilowatt solar field in upstate New York. This testbed aims to help the company understand the impact of solar energy on the grid, so they can create better battery-storage systems that can balance an inconsistent supply of solar power with more consistent demand for electricity. These storage systems will enable a more resilient, reliable grid that, in turn, will make it possible to use solar energy sources more effectively at the utility scale.

Operational Overview

GE's solar farm includes a state-of-the-art, grid-connected energy storage facility where company researchers can study different electrical architectures. GE Research built this facility to test the integration of Renewable Reservoir containers—stackable 20-foot shipping containers with modular, grid-scale batteries—with subsystems such as dc/dc converters, control cards, dc/dc solar optimizers, and battery modules.

Each of these 1.25-megawatt systems (known within the industry as BESS, or battery energy storage systems) holds 16,000 lithium-ion battery cells that can release four megawatt-hours of energy.

The Renewable Reservoir system allows producers to decouple the production and consumption of energy. This is especially important in the context of solar fluctuation—since right now, when more solar energy is produced than can be used or stored, that energy simply goes to waste.

Key Inputs and Resources

This effort to better store solar energy is driven by a cross-cutting team of technical, facilities, and operations leadership at GE, including GE Research and GE Renewable Energy. Key approvers are the on-site leadership team in Niskayuna, NY. GE's budget for this effort is in the low millions of dollars.

While GE does not make the solar panels or batteries it is using for this project (they are made by LG, Samsung, and other manufacturers), the company does have expertise in tying together the various components and systems involved. In this case, that means combining the needs of utility customers and the characteristics of the Renewal Reservoir battery systems into an algorithm that optimizes the product's output.

"The trick of being able to do this is, 'How do you take a battery and make it integrate with the grid, understanding all the complexities and everything that happens there?"

—Johanna Wellington
A mechanical engineer, product breakout leader for energy storage at GE's Niskayuna, NY facility

Key Outputs

These solar storage technologies are applicable across multiple points along the electricity supply chain including generation, transmission, and distribution. Ultimately, they will enable a more stable, resilient, and renewable-friendly grid.

In addition, this battery system is powerful enough to restart an entire power plant—a useful tool when weather or clouds cover a solar farm. GE showcased this capability at an event called "blackstart" in May 2017, when it used a similar system to restart a gas-fired power station in California's Imperial Valley. This battery system can also help operators stabilize the grid and is significantly smaller (8 x 8 x 20 ft and can hold 4-megawatts of power at a discharge rate of up to 1.25-megawatts per hour) than its predecessors of even just a few years ago.

In the future, GE hopes to collaborate with other developers of renewable energy and government agencies to add to the testbed's capability and use it to study future renewable-energy use cases. GE expects its primary customers will be the utilities that need to manage electricity from clean energy sources.

Replicating for Impact

Given the large capital requirements, bigger companies are usually better positioned to develop testbed systems that can experiment with new technologies. Additionally, larger companies with more verticals are better positioned to add value to a complex challenge, as they may have existing expertise across systems. (In this case, GE is neither the solar panel nor battery lead in the United States, but they have key integrated expertise across these systems). Other key criteria include an internal corporate culture that is willing to experiment, starting from the top down.

While this is an internal RD&D approach, GE fully expects to collaborate with other private- and public-sector partners to develop and deploy these critical technologies further.

INTERNAL MODEL — VALIDATION & EARLY DEPLOYMENT

National Grid Innovation

Overview

As the case of energy company National Grid (NG) attests, private, regulated companies can benefit when they integrate their internal RD&D initiatives to accelerate validation and early deployment. In this way, NG has successfully rebuilt their internal innovation mechanisms and demonstrated the key relationship between internal corporate structures and the external innovation and startup ecosystem.

ACTION:

Leverage a center of excellence to accelerate innovation and disruption

Challenge

Before energy companies can enact aggressive, long-term net-zero emissions policies, they may need to change the way their internal systems operate. This is a particular challenge for regulated companies such as utilities since innovation in that space has historically focused on cost and/or efficiency improvements rather than systemic disruption. Launching new innovative structures can sometimes conflict with a company's core business. At the same time, keeping a company growing while it moves toward its decarbonization goals often requires significant skills and resources as well.

Goals

National Grid (NG) has made a commitment to reach net-zero carbon emissions by 2050. This includes an interim reduction target of 70 percent by 2030 and the enactment of a carbon price to help inform major investment decisions. The company understood that meeting these commitments would "disrupt" their legacy innovation model, requiring multi-level changes—like new internal structures that leverage centralized technical expertise for new business models and technologies across the entire organization. The goal is to shift the whole company's mindset when it comes to identifying and solving problems that arise from working toward decarbonization.

Operational Overview

In 2017, NG decided to reorganize their strategic approach to innovation in two ways. They built a separate team dedicated to investment and innovation, and they embedded innovation activities across business units to ensure they were aligned with corporate objectives. This hybrid two-pronged approach recognized the importance of improving cost and efficiency within the core (usually regulated) businesses while also focusing company-wide efforts to understand, demonstrate, and implement new technology and business models.

In 2018, as part of this strategy, NG launched National Grid Partners (NGP), a $250 million corporate venture fund that spearheads the company's disruptive innovation efforts. Led by a president who also serves as NG's Chief Technology and Innovation Officer, the NGP team consists of about 40 people, including the employees running the venture fund, incubation, business development, fellowship, and an Innovation Center of Excellence. This team can most efficiently deploy new ideas across the organization.

NG reorganized their strategic approach to innovation by building a separate team dedicated to investment and innovation and by embedding innovation activities across business units to ensure their alignment with corporate objectives.

NGP works to integrate two separate innovation efforts: sustaining innovation, led by engineering, technical, and regulatory specialists in each individual business unit and disruptive innovation, led by the Vice President of Innovation. This effort focuses on two main project areas: Performance and Growth.

Performance works to bring projects to the core business that will add significant value. These are typically later-stage technologies that still must be proven in some capacity. Sometimes, the company establishes key supplier partnerships to engineer and deploy a specific innovation. The Innovation Center of Excellence, an internal home base for innovation, often pulls together internal technical specialists to encourage better and more consistent outcomes with a clear methodology and approach. It also includes initiatives to help drive innovative skills and thinking across the organization. For example, NG selects specialists to spend 2–3 months working with an innovative startup or places a more senior leader on the board of an NGP portfolio company.

For Growth, the $250 million fund invests in seed- through later-stage capital for strategic companies that could grow NG's business. In the current portfolio of twenty investments, about 75 percent are strategic, while the other 25 percent are at much earlier, "path-finding" stages. The focus of these investments is primarily on new and unregulated growth streams. NGP also participates in several fund of funds (FOFs) around the globe to gain insights into evolving technology and business models. Additionally, the team works on growth projects that will be spun out of National Grid outside of the fund.

Key Inputs and Resources

NG has about 22,000 employees in the U.K. and U.S. It is organized into a dozen business units, each of which has a technology group. Across all the business units, there are approximately 100 technical specialists—individuals with engineering, marketing, or operations backgrounds whose primary goal is to drive costs down, not necessarily innovate. Engaging these technical specialists is critical to shifting the culture of innovation at NG. For example, the Electricity Transmission business unit has a team of about 10 core technical innovation specialists that are responsible for building innovation back into their unit.

NGP has about 40 employees and an initial $250 million investment fund with a specific mandate for renewable energy and to drive new revenue streams for NG. The Innovation Center of Excellence, headed by a new Vice President of Innovation, sits at the nexus of NGP's efforts to bring in disruptive innovations and technologies while still meeting the core business where it is. The center's suite of services and programs aims to bring employees into a more innovative environment, encouraging them to develop skills to make their home units more innovative and proactive as well.

Key Outputs

There are several desired outcomes for this new shift at NG: a) to "spin in" new technologies or products to NG from external sources, b) to develop innovative technologies internally, and c) to identify new technologies to "spin out" as new businesses separate from NG.

A successful example of the spin-in approach is NG's supplier partnership with Copperleaf, a growth startup and software optimization company. In 2016, NG tested and implemented Copperleaf's C55 Decision Analytics software to enhance its gas distribution infrastructure in the northeast U.S., and in 2018, NG selected C55 for its electricity transmission and gas transmission operations in the U.K. In 2019, NG made a direct investment ($10 million) from its VC fund. This cascading series of engagements across NG provided a product that saved tens of millions of dollars for NG along with an important investment opportunity. (Read more here.)

All innovation projects across the business units and at NGP are summarized quarterly for review by the CEO and executive team. This helps ensure that new solutions are top-of-mind across NG and that appropriate pilots, demonstrations, and scale can happen efficiently.

Replicating for Impact

Senior leadership must drive innovation efforts, starting with the CEO. For example, NG's CEO oversees innovation efforts and often speaks about NGP's new approach. Standardized reporting is also crucial: NG has company-wide innovation reporting from both internal and external sources to the CEO level.

While NG's approach is not entirely centralized, having a centralized platform or center of excellence with staff and resources is an important source of structural and operational change. Companies should be willing to invest significant resources internally and adapt to new management structures.

For broader success, internal RD&D investment should be part of a comprehensive approach. Companies should consider the entire life cycle of innovation and commercialization as they consider their emissions goals. Getting the linkage right between external investments and the core business is also critical. Companies that can work with academic partners or VCs have an advantage as well.

RESEARCH AND DEVELOPMENT

Case Studies: Leveraged-Resource Model

The leveraged-resource model of RD&D addresses key corporate priorities using funding, facilities, and expertise from external organizations. This type of RD&D often takes the form of sponsored research, cost-sharing with the public sector, or collaboration with incubators and accelerators.

LEVERAGED-RESOURCE MODEL — APPLIED R&D

Exelon Hydrogen Production

ACTION:

Develop a Cooperative Research and Development Agreement (CRADA) to take advantage of resources and expertise at National Laboratories and research facilities

Overview

Exelon's work on hydrogen production demonstrates how private companies can leverage resources from key public partners to accelerate applied R&D with their own commercial goals in mind.

Challenge

As natural gas prices have fallen, and with them, market electricity prices, Exelon and other merchant utilities have faced increasing headwinds while trying to maintain the profitability of nuclear power plants. Each time a nuclear plant closes, it is replaced largely by gas-fired generation and therefore accompanied by a significant increase in emissions. To bolster the value of its nuclear fleet and reduce its reliance on electricity markets, Exelon launched an internal initiative in 2017 to explore options for altering nuclear plant configurations to produce new kinds of products and services.

Goals

The primary objective of Exelon's exploratory phase included creating and evaluating a long list of options for pairing nuclear plants with new kinds of off-takers, through the sale of steam, direct sales of electricity, or other kinds of unique services that nuclear plants might provide. Exelon's corporate strategy team took the lead on internal evaluation. In parallel, Exelon hosted an event with internal and external experts from academia, industry, government, and advocacy groups, to help narrow the list of ideas. From this analysis, Exelon identified hydrogen production as a promising option.

Most hydrogen is produced through steam-methane reforming, a process that inherently emits carbon. Exelon, by contrast, could pair nuclear electricity with hydrogen electrolysis units, producing carbon-free hydrogen for only a modest increase in price.

Even as Exelon began to sharpen ideas around the economic potential of eventually becoming a regional hydrogen supplier, the Department of Energy (DOE)'s Office of Energy Efficiency and Renewable Energy (EERE) offered a funding announcement to explore clean hydrogen production. This provided Exelon with a key opportunity to reshape their business model.

Operational Overview

Exelon first tapped its existing connections with researchers at the National Laboratories, and particularly with the Hybrid Nuclear Systems group at Idaho National Laboratory (INL). INL formed a team of labs and a consortium of

utilities, including Exelon, Southern Company, and Xcel, to apply for DOE funding for a regional analysis of hydrogen markets. Separately, INL and Exelon, together with several other National Labs (Argonne (ANL), the National Renewable Energy Laboratory (NREL), and Sandia), applied for funding to examine a specific Exelon nuclear plant site and the techno-economic feasibility of producing and selling hydrogen in that region.

Both teams were successful in securing funding, and after signing separate multi-party Cooperative Research and Development Agreements (CRADAs) for each project, Exelon leveraged $100,000 of research funding to unlock $1 million in DOE funding from the Office of Nuclear Energy and EERE at the National Labs. Both studies were completed with significant in-kind support from Exelon, in the form of overarching concept development as well as data.

These initial studies indicated the potential for economically viable hydrogen production at a nuclear plant. As a result, Exelon was well-prepared to take advantage of a second funding announcement from EERE for clean hydrogen production demonstration projects. Exelon again partnered with INL, ANL, and Nel Hydrogen, and successfully competed for $3.6 million in DOE funding to support $3.6 million in Exelon cost share.

With this funding, Exelon is working to build a 1-megawatt hydrogen electrolyzer at a nuclear plant site. The hydrogen from the demonstration electrolysis unit will be used on-site, decarbonizing the nuclear plant site's hydrogen use. In addition, the project will examine the technical and economic feasibility of operating the electrolyzer dynamically, to evaluate whether electricity price-responsive hydrogen production might be viable. If so, Exelon may follow this project with additional, fully commercial projects at a scale sufficient to support regional clean hydrogen needs in one or more locations.

Exelon's strategy execution involved several steps:

1. **Research the problem: Begin initial analysis and engage key internal and external stakeholders.** Exelon began with a leadership-driven analysis to identify a long list of potential options for nuclear plant repurposing. This included hosting a workshop to discuss trends across markets, technological applications, and regulatory barriers, with key stakeholders including DOE's National Labs, policymakers, and industry leaders. Ultimately, Exelon decided to focus on hydrogen, and specifically coupling a nuclear plant with hydrogen production.
2. **Develop a solution: Conduct economic analysis with a focus on proposing a solution.** Exelon worked with DOE and lab partners to conduct a site-specific techno-economic analysis and a case study for an existing Exelon nuclear plant. The results highlighted the potential of the site to achieve the desired technical and financial goals, encouraging pilot testing.
3. **Demonstrate the technology: Collaborate with partners to apply the approach. (Exelon is currently in this stage).** Exelon leveraged DOE funding and put together a public-private partnership to build and operate a 1-megawatt electrolyzer at a chosen plant site.
4. **Scale the solution: Deploy the technology across the fleet and share best practices.** Building on the success and outcome of the previous steps, Exelon's ultimate goal is to potentially become a regional hydrogen producer and scale its success across its fleet.

Key Inputs and Resources

Exelon's hydrogen strategy development and execution are driven by employees from its engineering, operations, and commercial organizations in collaboration with researchers at the National Labs. At Exelon, the project is primarily being driven by the corporate strategy technical and R&D group for now, but the nuclear operations teams will be more actively engaged as it moves towards demonstration and scaleup. DOE's financial support is critical as Exelon works to understand the technical and business risks associated with clean hydrogen production. The National Labs are also key partners in the effort.

So far, Exelon has committed over $100,000 in direct funding to the Labs and committed another $3.6 million for the hydrogen demonstration project. Strategic partners like Nel Hydrogen are also providing some in-kind services and support for the demonstration.

Exelon has committed over $100,000 in direct funding to the National Labs and committed another $3.6 million for the hydrogen demonstration project.

Key Outputs

While this project is still in progress, Exelon is on track to install, operate, and assess the performance of a 1-megawatt electrolyzer at a nuclear plant site for hydrogen production. Exelon hopes that results from this demonstration will provide the foundation for additional commercial hydrogen production projects.

Replicating for Impact

Other nuclear plant owners are well-positioned to explore a similar pivot into hydrogen production. For example, influenced in part by discussions with Exelon and its partners, Energy Harbor (formerly FES), Xcel Energy, and Arizona Public Service (APS) hope to demonstrate hydrogen production at three nuclear plants within the coming year.

Working with most National Labs requires time and diligence, but it can also provide an incredible opportunity with access to facilities, experts, and technological insights. Large corporations like Exelon are best positioned to work with the National Labs because of their flexibility and resources. (For example, the multi-party CRADAs required for this effort took over nine months to negotiate and contract.) Companies across different parts of the energy sector can also replicate this leveraged-resource model. However, companies without internal resources (both financial and administrative) will likely not be able to use this model without assignment of significant amounts of personnel and time toward writing funding applications and negotiating funding contracts.

Further reforms to improve and scale National Lab collaboration with industry are explored here.

LEVERAGED-RESOURCE MODEL — TRANSLATIONAL R&D

Eaton Electric Vehicles Integration

ACTION:

Leverage user facilities at one of the U.S. Department of Energy (DOE)'s National Labs or research facilities

Overview

Eaton's push for electric vehicle integration shows how private companies can leverage resources from key public partners to boost the commercial viability of the products they develop.

Challenge

Electric vehicle (EV) technology has improved dramatically in recent years, but these improvements have often not yet been incorporated into EV fleets (of buses, for example). This will be an expensive problem—and while there is a desire to collaborate across the public and private sectors to solve it, strong partnerships have not yet developed.

Goals

Eaton, a power-management company, set out to develop a framework for integrating advanced-mobility and distributed-energy technologies onto the grid. Eaton's partnership with the U.S. Department of Energy (DOE)'s National Renewable Energy Laboratory (NREL) is designed to expedite research on, and the commercialization of, new energy-related technologies. This partnership will provide opportunities for regional transportation and utility partners to optimize their vehicle technologies and provide services to the grid, such as voltage regulation and additional energy-storage capacity. (See more here.)

Managing fleets of electric buses for grid services means:

1. Reviewing operating data for commercial fleets;
2. Analyzing grid services from electric vehicles; and
3. Hardware-in-the-loop simulation of the control strategies.

Operational Overview

In January 2018, building on a decade-long relationship, NREL and Eaton signed a cooperative research and development agreement (CRADA) that would enable both organizations to collaborate closely on the evolving state of energy solutions such as microgrids, energy storage systems, and grid intelligence. The collaboration is based at NREL's Energy Systems Integration Facility (ESIF), a 182,500-square-foot research user facility that provides laboratory and support infrastructure to optimize the design and performance of electrical, thermal, fuel, and information technologies and systems at scale.

This is a new kind of partnership for ESIF. Eaton received access to NREL's lab, where the company sent more than a dozen employees to work closely with agency experts on research involving the integration of EV fleets with grid and new energy technologies. This public-private collaboration also gave NREL the industry input it needs to understand the economics and energy dynamics of fleets, which the agency can use in sectors such as shipping and mobility. (See video here.) NREL and Eaton also launched an industry advisory board to provide additional expertise and oversight for the project.

The public-private collaboration (between Eaton and NREL) gave NREL the industry input it needed to understand the economics and energy dynamics of fleets, which the agency can use in sectors such as shipping and mobility.

Key Inputs and Resources

There are currently 20 Eaton employees from the Eaton Research Labs team based at the NREL Energy Systems Integration Facility (ESIF).

NREL ESIF is financially supported by DOE's Office of Energy Efficiency and Renewable Energy (EERE). Through this collaboration, Eaton receives access to DOE facilities and sites to demonstrate the technology as well as experts from NREL.

Key Outputs

The NREL ESIF reports from 2018 and 2019 show some preliminary measures of success and returns on investment. Eaton was able to identify and evaluate scenarios that represent varied use of the EV fleet, which make it possible for researchers to develop real-time strategies for maximum benefit or maximum battery life cycle. Eaton also completed an integration demonstration of its Power Xpert Energy Optimizer (PXEO) controller at a simulated school site in real time. These results are used in techno-economic comparisons of the control strategies. Finally, Eaton was able to engage an industry advisory board to discuss broader challenges; and in September 2020, the company was awarded a Department of Energy grant to advance its electric grid cyber-resilience work with NREL.

Replicating for Impact

Larger companies are often better positioned to work with the National Labs due to the quantity of resources available to them, but many National Labs also have strong relationships with small to mid-size enterprises (SMEs). National Labs with a heavier focus on applied research are best suited to work collaboratively with industry on the development of technologies that have commercial goals and applications. For the success of these collaborations, it is critical to have corporate senior executives lead the effort, as well as innovative leadership at the National Lab that is willing to work with a corporation on clear commercial goals.

This type of engagement—offering long-term access to the labs and offices of federal user facilities—could be the first of many. It should be considered at other facilities and other labs.

LEVERAGED-RESOURCE MODEL — TRANSLATIONAL R&D

Saint-Gobain InNOVAte 2019 Challenge

ACTION:

Use resources and expertise from an accelerator to identify solutions for key technology challenges

Overview

The Saint-Gobain InNOVAte 2019 Challenge shows some of the ways private companies can leverage resources from key partners to identify priority technology solutions and boost their commercial viability.

Challenge

Relative to other industries, the construction industry has lagged in the research, development, and demonstration of lower-emissions technologies. But low-cost, low-emissions technologies for the construction of residential and commercial buildings have an enormous potential impact on decarbonization. As a result, corporate leaders, entrepreneurs, and innovators increasingly seek to develop low-carbon technologies in this space.

Goals

Saint-Gobain, a French multinational company operating in construction, intends to identify and develop innovative, low-carbon solutions for the design, construction, and operation of residential and commercial buildings. The company is collaborating with Greentown Labs, the largest cleantech incubator in North America with more than 100 startups in residence, to find these solutions in areas including advanced materials, digital tools, robotics and automation, and augmented reality/virtual reality (AR/VR). The end goal is to secure a mutually beneficial outcome for Saint-Gobain and startups using these technologies, with the possibility of an investment or other partnership agreements.

Operational Overview

Saint-Gobain and Greentown Labs launched an accelerator program, InNOVAte 2019, focused on developing innovative solutions to disrupt incumbent technologies within the built environment. (See more here.) Saint-Gobain's external ventures arm, NOVA, is dedicated to fostering partnerships with startups, incubators, and venture capital (VC).

The awardees are eligible for the following benefits:

- Partnership with and/or investment from Saint-Gobain and CertainTeed (Saint-Gobain's North American building materials manufacturer subsidiary);
- $25,000 in non-dilutive grant funding;
- Desk space at the Greentown Labs Global Center for Cleantech Innovation and access to Greentown's facilities;

- Acceptance into Greentown Launch, a six-month acceleration program for startups at Greentown Labs;
- Exclusive access to the Greentown Labs and Saint-Gobain networks (including access to Greentown's network of more than 150 investors and more than 40 companies); and
- Access to select Saint-Gobain testing capabilities, technical facilities, and expertise.

Saint-Gobain leverages the technical resources and expertise of Greentown Labs. Since its launch in 2011, Greentown's startup community has raised more than $1.2 billion in follow-on funding. Greentown also provides more than 100,000 square feet of prototyping lab and office space, an 1,800-square-foot wet lab, a shared machine shop, an electronics lab, and a suite of programs, resources, and tools.

Saint-Gobain's partner, Greentown Labs provides technical resources such as 100,000+ square feet of prototyping lab and office space, an 1,800-square-foot wet lab, a shared machine shop, an electronics lab, and a suite of programs and tools.

Greentown's in-house accelerator, Greentown Launch, operated the program by:

- Identifying and targeting technology challenge areas with Saint-Gobain;
- Issuing a call for proposal and sourcing candidates/startups;
- Reviewing and selecting applicants internally and with Saint-Gobain;
- Providing programmatic support and workshopping with support from Saint-Gobain; and
- Showcasing key technologies to Saint-Gobain.

Key Inputs and Resources

Four Greentown Labs employees serve on the partnerships team, but the executive leadership team and communications teams are also involved. A significant part of Greentown's role is to allow Saint-Gobain to not have to commit full-time staff. In effect, Greentown manages all the back end and administration so Saint-Gobain can focus on the technologies, startups, and mentoring. While Saint-Gobain's support is part-time, company representatives visit Greentown Labs several times over the course of the accelerator. Saint-Gobain is also the main funder and sponsor, but senior leadership from all three organizations (Saint-Gobain, NOVA, and CertainTeed) are engaged. There are no other collaborators besides the broader public-private network and reach of Greentown Labs to source the startups (including the Incubatenergy Network: see here).

Saint-Gobain funded the accelerator for approximately $250,000, plus additional funding to demonstrate, pilot, or invest with startups. Through this collaboration, they also received access to the Greentown community and startups in the network.

Key Outputs (learn more)

More than 110 startups around the world applied to be part of the program. Among the successful startups whose solutions are now being integrated into the core business at Saint-Gobain are:

- INOVUES Glazing Shields, a cost-effective and a non-disruptive solution to upgrading windows and curtain walls. The shields are securely mounted on the original glass from the interior or exterior, increasing insulation up to ten times and reducing energy consumption and peak heating/cooling loads by up to 40 percent. On March 31, 2020, INOVUES successfully installed its Glazing Shields system at Saint-Gobain's Research Center in Northborough, Massachusetts.
- Hyperframe, which designs building components to fit together without tools and requires no training to assemble. The company utilizes DFA (design for assembly) principles common in the electronics manufacturing industry to innovate across the building and construction process. Their technology utilizes HoloLens AR technology to optimize the installation process.
- Pre Framing Corp, a prefabricated software and hardware solution that allows homebuilders, general contractors, and framers to build standard and gable walls ten times faster than traditional methods, with less waste and more precision.
- Techstyle Materials, a multi-functional, millimeter-thin material technology that can be applied at the factory to common building products, such as drywall, sheathing, and roofing, to transform them into "smart" materials that respond to their environment. They also simplify construction and reduce labor costs by taking the place of multiple layers in a wall assembly.

Since the first Greentown Launch accelerator, more than 65 percent of startup participants have received follow-on investment and partnership deals.

Replicating for Impact

Companies of any size or shape looking to assess technologies that can help them innovate might consider working with an accelerator. The accelerator process developed in this case is not entirely unique: the key is to find one willing to customize to fit corporate-specific needs and challenges. Building off an existing relationship, as Saint-Gobain and Greentown did, is also helpful.

Companies looking to buy something off the shelf and who are not able to spend time and resources working with a smaller company should not consider this approach. If they are interested in supporting the work of accelerators, they might consider a basic sponsorship to tap into the startup community.

LEVERAGED-RESOURCE MODEL — VALIDATION & EARLY DEPLOYMENT

Hawaiian Electric (HECO) Energy Storage

ACTION:

Fund innovative pilots or demonstration projects with external support

Overview

The valuable partnership between electric utility Hawaiian Electric (HECO) and startup incubator Elemental Excelerator showcases how companies can work effectively with an intermediary to accelerate the development, deployment, and commercialization of new emerging technologies and solutions.

Challenge

Grid stabilization and renewable energy integration are recognized challenges for the electricity sector. To achieve high penetration of variable renewable resources like wind or solar energy, technology is needed that can balance the generation of and demand for electricity, whether by mitigating short duration disturbances or supporting longer-term energy management. Utilities will need technology solutions at both the circuit and system levels to provide mitigation in both the short-term (contingency, frequency response, ramp rate control, voltage regulation) and long-term (storage of solar energy for dispatch at later times).

Goals

The state of Hawaii has made a commitment to achieve 100 percent renewable energy generation by 2045, so Hawaiian Electric (HECO) needs cost-effective, reliable technology solutions to address grid issues caused by the intermittency of renewable energy. The unique challenges HECO faces by operating five, island-based independent grid systems create a further need for innovative planning and technology strategies. HECO leverages external expertise and funding to help evaluate and develop advanced technologies that support its emissions goals.

Operational Overview

Hawaiian Electric engages with a key external partner, startup incubator Elemental Excelerator (Elemental), through its parent company's (Hawaiian Electric Industries) Global Partner membership with Elemental. In 2013, HECO supported demonstration projects in Elemental's first cohort of startups, and it has continued to work with Elemental and over a dozen of its portfolio companies on customer discovery and demonstration projects over the past seven years. HECO has provided input to Elemental for their cohort selection process and has brought several companies to Elemental for funding consideration and project collaborations.

Backed by the U.S. Office of Naval Research, the U.S. Department of Energy, and Emerson Collective, Elemental has worked with more than 90 startups since 2013 to help grow their companies and design and scale projects with commercial customers. Their outreach to startups follows three tracks:

- Go-to-Market Track: $200,000 for customer discovery and validating a scalable business model (8 months).
- Demonstration Track: An up to $1 million cost-reimbursable contract for project deployments in Hawaii or Asia Pacific (12-18 months). Startups Amber Kinetics and Varentec, discussed in further detail below, participated in this Demonstration Track.
- Equity & Access Track: An up to $1 million simple agreement for future equity (SAFE) for project deployments by companies increasing access to innovation for frontline communities in California (12-18 months).

Two good examples of HECO's collaboration with Elemental are Amber Kinetics and Varentec:

1. Amber Kinetics applied to Elemental to work specifically on a demonstration pilot project with HECO in 2014, with project commissioning completed in early January 2018. They aimed to test a second-generation model M32 multi-hour, medium speed, steel flywheel energy storage system for one year. This flywheel is capable of producing 8 kilowatts and delivering 32 kilowatt-hours (8 kW x 4 hours) of energy storage capacity. Given already high penetrations of renewable generation on Hawaii's island-based grids, as well as the push to meet more aggressive renewable targets, Hawaii was an ideal location for this demonstration pilot project. Since this first testing, Amber Kinetics has deployed 55 M32 units throughout the world.
2. HECO introduced Varentec to Elemental in 2017 to expand a piloting effort already underway to test their edge-of-the-grid voltage regulation technology. Varentec's Edge-to-Network Grid Optimizers (ENGO) and Grid Edge Management System (GEMS) platform for Integrated Volt-VAR Control ("IVVC") were tested at three distribution substations on the island of Oahu to mitigate overvoltage issues on high-penetration circuits, while maintaining grid operability and reliability. Under the Elemental project, HECO tested ENGO devices to evaluate their ability to increase solar hosting capacity and maintain tariff voltages, consistent with HECO's Grid Modernization Strategy.

Key Inputs and Resources

Hawaiian Electric's R&D team performed the testing on the Amber Kinetics M32 flywheel and supported the development of utility controls to integrate the flywheel into their operations. Their R&D team also developed algorithms to modulate power output for power smoothing of distributed energy resources (DER) based on simulated operating signals. For HECO, this project provided access to new flywheel technology. Elemental provided over half of the project funding which was matched in-kind by Amber Kinetics to provide hardware and staff. HECO's cost share (about one quarter of the project cost) supported the installation, controls development, and decommissioning.

Varentec's ENGO devices have traditionally been used for Conservation Voltage Reduction. However, HECO had a different problem to address—voltage fluctuations from large amounts of distributed solar energy on its distribution system. HECO recognized there was a potential for the Varentec ENGO to be used in a different configuration to allow even more customer-sited resources to be connected. In collaboration with Varentec, Hawaiian Electric employed different methodologies and test procedures to change the use of the device.

They collaborated with Elemental and Varentec to conduct field evaluations of 88 Varentec ENGO-V10 voltage regulation devices at three distribution substations in 2019. Elemental provided about 80 percent of the demonstration project funding. HECO provided in-kind labor toward site selection analysis, installation standards, and results evaluation (about 20 percent of project cost).

Key Outputs

The collaboration among HECO, Elemental, and Amber Kinetics was a success. HECO was able to verify the operation of a unique flywheel technology that could store energy for hours rather than minutes at a lower cost. The demonstration project provided utility personnel with direct experience with flywheel technology, which will support future energy storage engagements.

HECO also added utility supervisory controls and algorithms to expand the capabilities of the flywheel to interact with and support the utility grid. The project helped accelerate the development of a next-generation flywheel with increased size and capabilities at a lower cost. HECO also received positive PR benefits by participating in innovative R&D, including mention in a California Clean Energy Commission report.

The collaboration among HECO, Elemental, and Varentec was also successful. ENGO-V10 devices were assessed against actual field conditions, and the response times and reactive power injection to step changes in grid voltage were determined. The pilot showed ENGO's successful reduction of voltage variations caused by fluctuation from solar generation connected on the low voltage-side of the service transformer. No negative interactions were observed between the ENGO and smart inverters with fixed power factor or volt-VAR functions active.

HECO's parner, Elemental, has shown great success as an effective intermediary since its inception in 2013, funding more than 90 companies and over 59 demonstration projects to date and contributing to more than 1,000 jobs supported by its portfolio companies.

Elemental has shown great success as an effective intermediary since its inception in 2013, funding more than 90 companies and over 59 demonstration projects to date and contributing to more than 1,000 jobs supported by its portfolio companies.

Replicating for Impact

Almost any corporation looking to assess technologies to help them innovate should consider working with a startup accelerator. These intermediaries can play an effective role in coordinating and connecting corporate partners with technology developers and startups to help de-risk opportunities for partnership.

Companies should identify a strong, quality intermediary that is working with startups in the appropriate technology space and at the right stage. It is also critical that the goals and technology priorities of the corporation are aligned with the project scopes supported by the accelerator. Elemental is unique among accelerators in that it provides both project funding (up to $1 million) and facilitation, as they did with the HECO projects.

Companies looking to buy something off the shelf and who are not able to spend time and resources working with startup companies to assess technical gaps might not be the right fit for this approach. If they are interested in supporting the work of accelerators broadly and to get a sense for what is possible, they might consider a basic sponsorship to tap into the startup community.

RESEARCH AND DEVELOPMENT

Case Studies: Collaborative Model

The collaborative model of RD&D relies on partnerships among multiple different stakeholders. Unlike the leveraged-resource model, in which key priorities come from just one company, collaborative RD&D is designed to meet the goals of multiple partners. This type of RD&D often takes the form of collaborative incubators, accelerators, fellowships, or third-party prizes.

COLLABORATIVE MODEL — APPLIED R&D

AC Manufacturers and the Global Cooling Prize

ACTION:

Collaborate with other corporations to source and support innovative solutions

Overview

Companies can collaborate with public and private partners to meet their commercial goals. The Global Cooling Prize highlights some of the ways corporations and manufacturers can work together to develop and demonstrate new technologies on their way to market.

The Challenge

The combustion of fossil fuels to heat and cool homes is a major contributor to climate change across the world. Air conditioners also contain industrial coolants known as hydrofluorocarbons (HFCs)—potent greenhouse gases (GHGs) whose impact on global warming can be more than 1,000 times greater than carbon's.

Yet air conditioners are an essential part of modern life around the world. They mitigate the health risks of extreme heat, enhance labor productivity, and improve quality of life. They are also everywhere. There are 1.2 billion residential or room air conditioners in the world today. That number is projected to grow to 4.5 billion by 2050 due to population growth, urbanization, and rising temperatures.

Countries like India—with extreme heat risk, insufficient infrastructure, and large populations—are in dire need of alternative cooling solutions. If nothing changes, the International Labor Organization (ILO) has found that productivity losses to the Indian economy from heat stress could reach $450 billion by 2030—and $2.4 trillion per year worldwide. (That is equivalent to 80 million full-time jobs.) We need new technologies that meet these increasingly critical cooling needs without major climate impact.

Goals

The initial goal of the Global Cooling Prize was to incentivize the development of technologies that have at least five times less climate impact than typical air conditioners on the market today. When they are scaled, affordable cooling solutions which meet the prize criteria could mitigate up to 0.5 degree Celsius of global warming by 2100 compared to business-as-usual scenarios.

Alongside these goals, the program aligns with India's Cooling Action Plan to boost R&D efforts and strengthen commitment to accelerating clean energy innovation, provide affordable access to cooling in vulnerable parts of the world, and prevent up to 75 gigatons of carbon emissions through 2050.

Operational Overview

In 2017, the Rocky Mountain Institute received funding to match its deep expertise in the buildings sector with cooling solutions for the world's emerging economies—many of which have hot and humid climates. Conversations with the Government of India, Mission Innovation, and a growing coalition of collaborators led to the official launch of the Global Cooling Prize the following year.

This collaborative coalition includes organizations representing future demand for low-GHG cooling solutions as well as large air-conditioning manufacturers interested in supporting the development and commercialization of low-GHG air conditioners. These manufacturers were willing to participate at no cost to support the development of innovative solutions they could take to market in the future. Other leading AC manufacturers, including Daikin, Gree, Haier, and Godrej, chose to compete for the prize instead.

Eight finalists for the Global Cooling Prize were announced in November 2019. Since then, finalists have been developing, testing, and evaluating their prototypes. The prize will be awarded in March 2021.

The Global Cooling Prize process has involved the following steps:

1. **November 2018:** Prize launch
2. **July–October 2019:** Applications evaluated
3. **November 2019:** Announcement of finalists and interim awards
4. **November 2019–August 2020:** Prototype development and participant engagement
5. **September 2020–January 2021:** Testing and evaluation of prototypes
6. **March 2021:** Final awards ceremony

Key Inputs and Resources

Rocky Mountain Institute (RMI) led the development and implementation of the Global Cooling Prize program, while the Government of India's Department of Science and Technology provided additional expertise and financial support. The AC manufacturers not competing provided industry expertise, supply chain support, and even access to facilities to test technologies—all of which made it possible for small independent innovators, startups, and university labs to compete for the prize. With exposure to consenting participants and under the protection of the Global Cooling Prize's non-disclosure, non-use, and non-confidentiality framework, these AC manufacturers were able to evaluate opportunities to invest in or buy the technologies competitors developed.

The entire challenge cost roughly $6.5 million USD. The Prize will award a total of $3 million: $200,000 for each finalist team, and $1 million for the winner. Of course, the winner and finalists will also win global recognition of their accomplishments.

In addition to RMI, the Government of India, and AC manufacturers, other collaborators included Mission Innovation, Conservation X Labs, Alliance for an Energy Efficient Economy, and CEPT University (formerly the Centre for Environmental Planning and Technology) as well as more than 20 global non-profits. The program has also received communications and branding support from Virgin founder and CEO Sir Richard Branson, who serves as a Global Cooling Prize Ambassador.

Response to the Global Cooling Prize announcement was strong: there were more than 2,100 registrations from 96 countries and 139 detailed technical applications from 31 countries.

Key Outputs

Response to the Global Cooling Prize announcement was strong: there were more than 2,100 registrations from 96 countries and 139 detailed technical applications from 31 countries. Participating industry associations and AC manufacturers (whether they are competing or supporting the competitors) hope to see increased investment in the field. Likewise, the rapid commercialization of winning technologies can bring down costs.

The true potential for impact will come as the finalists—including Japanese companies Daikin and Nikken Sekkei—demonstrate their selected technologies and work to bring new products to market.

This prize model supports the commercialization of new technologies from both the supply side, by pushing technology development from innovators, and the demand side, by pulling signals of future market demand, investment, or procurement from leading AC manufacturers. The role of the buyer is critical to ensuring successful outcomes for the program.

Replicating for Impact

Working with a strong intermediary like RMI on a targeted challenge offers a low-cost opportunity for companies to invest in research and development. Corporations of all sizes should consider the challenge or prize model as they look for new ways to inform technology deployment.

COLLABORATIVE MODEL — TRANSLATIONAL R&D

Wells Fargo Innovation Incubator

ACTION:

Collaborate with incubators to inform and develop technologies that address key corporate priorities

Overview

The experience of the Wells Fargo Innovation Incubator showcases how private companies can collaborate with public- and private-sector partners to accelerate translational research and development.

Challenge

Advancing technology from idea to lab to scale is not easy. The public-sector research system in the U.S. is built to support researchers, not innovators or entrepreneurs—yet the private sector alone cannot justify the risks these investments often carry. (See more here.) In both sectors, the appropriate mechanisms to deploy capital for new ideas are often fragmented and difficult to tap. In this context, functional public-private partnerships can have an outsized impact.

Goals

More than five years ago, Wells Fargo decided to address this funding gap in the clean-tech venture space in a targeted way. The bank first focused on developing technologies in the buildings sector but has since expanded its focus to include sustainable agriculture as well. Their goal is to facilitate meaningful growth for innovators and startups and to encourage more effective collaboration across the public and private sectors. Success often depends on this cross-sector collaboration: for example, private-sector companies need to ensure that technological developments meet industry requirements.

Operational Overview

In 2014, Wells Fargo and the U.S. Department of Energy (DOE)'s National Renewable Energy Laboratory (NREL) launched the Innovation Incubator (IN2). The program, run collaboratively between NREL and the Wells Fargo Foundation, initially focused on reducing the energy impact of commercial buildings. In 2018, Wells Fargo expanded their partnership to include the Donald Danforth Plan Science Center (Danforth) with an additional focus on sustainable agriculture, including automated crop protection, crop nutrition, new crops, and physical infrastructure (see portfolio here). In 2019, IN2 added in low-carbon construction technology to support sustainable and efficient housing. (See the 2019 report here.) Today IN2 is on its seventh cohort and has been extended through 2024.

NREL and Danforth are non-profit labs with no financial interest in the program. As a result, they can serve a key role: they validate technologies, provide access to facilities and labs, and offer startup support for entrepreneurs.

IN2 plays three roles in developing new technologies:

1. It identifies promising technologies, working with the private sector to identify gaps and select top entrepreneurs through an application process.
2. It validates the technology, collaborating with third parties like NREL and Danforth.
3. It commercializes the technology, working with private-sector partners to scale the solutions.

IN2 supports startups to hit a successful marker/milestone with strategic partners and investors with more than $300 million in follow-on funding. So far, more than 40 startup companies focused on commercial-building energy challenges have gone through IN2.

Key Inputs and Resources

At Wells Fargo, a part-time manager spends a significant amount of time working with internal partners, developing external relationships, and creating thought leadership for the program. Approximately seven full-time NREL employees support the program, along with dozens of flex staff and researchers that work 1:1 with companies. At NREL, about 25 employees at the Innovation & Entrepreneurship Center play critical support roles. At Danforth there are currently 1–2 full-time employees. DOE has final sign-off on the projects.

Wells Fargo has committed $50 million over six years, most recently $20 million in December 2020. A significant portion of the funding is dedicated to support channel partners and grow the innovation ecosystem. These funds also provide access to facilities and demonstration and testing sites along with additional capabilities and expertise from NREL and Danforth.

Key Outputs

IN2 supports startups to hit a successful marker/milestone with strategic partners and investors with more than $300 million in follow-on funding. So far, more than 40 startup companies focused on commercial-building energy challenges have gone through IN2. The expansion into other decarbonization impact areas like agriculture serve as a testament to the strength of this approach. In May 2020, a six-team cohort focusing on agriculture solutions was announced.

For NREL and Danforth, specific metrics of success include brand and visibility boost. They have also shared their expertise and created new opportunities and incentives for employees.

Replicating for Impact

Companies of any size should consider working with an accelerator like IN2, which is successful in part because it reduces the barriers for companies to benefit from the expertise of a National Laboratory. The program is also highly specific and targeted in the technology areas of focus—which allows them to attract the best startups in these industries of interest. Because the funding is non-dilutive and includes expert support, IN2 brings together high-quality startups in a way that can benefit companies looking to deploy new climate technologies, improve their business models, and reduce emissions.

The IN2 approach is highly scalable and is not unique to Wells Fargo and/or the buildings and agriculture sectors. In fact, a large corporation could replicate this exact effort. That said, those without the resources and funding should focus on supporting existing accelerators like IN2, Greentown Labs, or Mass Challenge. Best-in-class accelerators have a critical mass of partners with similar interests who can benefit from the ecosystem and community.

Companies may find it easier and more beneficial to join a coalition or an existing accelerator like IN2 rather than working with a National Lab independently. Considering one's own internal policies and governance is a key piece of the equation for making these types of efforts work long-term.

COLLABORATIVE MODEL — VALIDATION & EARLY DEPLOYMENT

Microsoft Advanced Energy Lab

ACTION:

Establish centers of excellence with key technology partners to accelerate innovations

Overview

Microsoft's Advanced Energy Lab demonstrates some of the ways in which private companies can collaborate with partners and leverage public investment to accelerate validation & early deployment of data-center technologies with clear commercial goals.

Challenge

According to the U.S Department of Energy (DOE)'s Lawrence Berkeley National Laboratory, data centers account for two percent of the total electricity use in the United States. Finding resilient and reliable ways to meet this need for energy without releasing more carbon into the atmosphere is essential. On-site power generation with low-carbon fuels is one promising approach, but to implement on-site solutions, companies must integrate new technologies with existing systems and infrastructure.

Goals

Microsoft has several goals in mind for this project. They want to use natural-gas fuel cells to power their servers to improve efficiency, simplify their data centers, and ultimately move toward lower-carbon fuels. They want to optimize costs and enhance the sustainability of existing facilities across their global footprint. They want to realize reliability, emissions, and efficiency gains (for example, reducing CO_2 by up to 50 percent), inspire more innovation and future emissions reductions (for instance, by using biogas to power solid-oxide fuel cells including hydrogen-powered proton-exchange membrane fuel cells), and grow and deploy into new markets.

Operational Overview

In 2017, Microsoft, power company Cummins, and engineering consultants McKinstry launched the Microsoft Advanced Energy Lab in Seattle, Washington. This twenty-rack system delivers data and insights into how fuel cells perform in given environments. In addition to Microsoft, Cummins and Siemens provided funding alongside an investment from Washington State's Clean Energy Fund. McKinstry provided the facilities and engineering and construction services.

This lab data center primarily tests natural gas to validate efficiency gains and test the simplified environment. This is their first data-center lab that allows them to experiment with novel approaches for energy. At other facilities, Microsoft has tested low-carbon fuels, including biogas and hydrogen.

The Microsoft team developed a five-step process to evaluate innovations coming into the lab to advance in-rack natural gas-powered fuel cells:

1. Assess the technology's potential to commercialize.
2. Map out requirements and evaluate the technology's ability to meet them.
3. Test the technology in a factory setting.
4. Test the technology in an independent environment, ideally in a data center or National Lab.
5. Integrate the technology under real-world conditions.

Within just one year Microsoft Advanced Energy Lab was named Mission Critical Innovation of the year by Datacenter Dynamics.

Key Inputs and Resources

Two teams at Microsoft have driven this effort. The Datacenter Advanced Development team manages technology development and operations, including on-site testing and demonstration equipment. The Energy and Sustainability team focuses on external sourcing to ensure the success of the overall effort, including conducting market assessments, developing partnerships, and identifying key technologies as well as deployment into production datacenters after testing.

Public- and private-sector collaborators are critical to the project's success. The collaborative partnership includes Microsoft, Cummins, McKinstry, and Washington State, through the Washington State Clean Energy Fund. Microsoft and Cummins serve as the primary technology partners, while McKinstry provided infrastructure and Washington State helped fund the project.

Additional partners can participate at stage four of the technology development process. These partners include Federally Funded Research and Development Centers (FFRDCs) such as the National Fuel Cell Center at UC Irvine (for testing natural-gas technologies, for example) as well as private-sector partners such as Hewlett Packard (for testing chemical fuel cells).

Key Outputs

The project has seen immediate impact through positive publicity. It has also encouraged a great deal of technological development and a more rapid commercialization of fuel cells (natural gas as well as renewable gas). Within just one year the program was named Mission Critical Innovation of the year by Datacenter Dynamics.

Microsoft has been able to measure accomplishments, including successful integration of fuel cells (natural gas as well as other renewables) and emissions reductions of up to 49 percent.

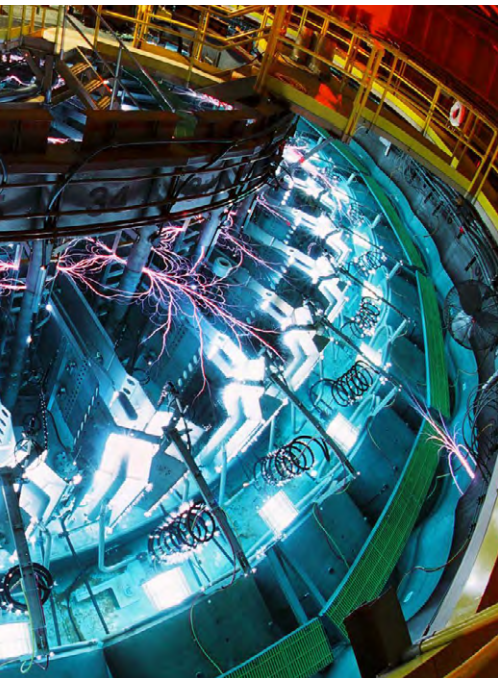
Replicating for Impact

Companies who operate data centers should evaluate opportunities for lower-carbon solutions. In general, this type of collaborative investment is ideal for companies with the ability to invest in R&D and who have long-term procurement goals. The five-step assessment process Microsoft developed should be useful to all companies trying to assess and test new technologies.

RESEARCH AND DEVELOPMENT

Deep Dives: Accelerating Corporate RD&D

RD&D DEEP DIVES



Saturn Accellerator at Sandia National Laboratory. National Labratories are U.S. powerhouses of science and technology

Partnering with DOE National Labs

Research, development, and demonstration (RD&D) is absolutely critical for companies working to reduce their greenhouse gas emissions as inexpensively as possible. To help achieve this goal, companies in the United States can take advantage of a unique and robust network of hundreds of Federally Funded R&D Centers (FFRDCs) that steward vital scientific and engineering capabilities; design, build, and operate unique scientific facilities; and promote innovations that advance U.S. competitiveness.

Among these FFRDCs are the 20 National Laboratories managed by the U.S. Department of Energy (DOE). The National Labs lead clean energy RD&D in the U.S., developing new climate technologies for companies accelerating the transition to net-zero emissions. They employ more than 60,000 people and represent $13 billion a year in taxpayer investment in RD&D capacity.

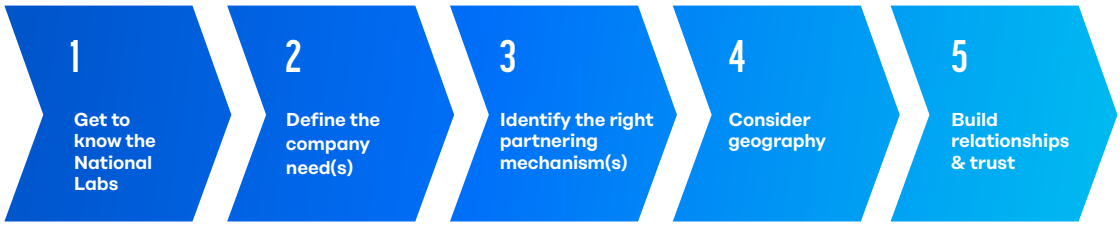
The National Labs also provide access to private-sector companies working to solve critical challenges across defense, energy, infrastructure, and other energy-related sectors. This critical energy infrastructure provides companies with new tools to achieve their goals and helps bring new clean technologies to market, benefiting the public and private sectors alike.

Companies Can Partner with a National Lab in Several Ways:

TYPE OF AGREEMENT	SHORT DESCRIPTION
Cooperative Research and Development Agreement (CRADA)	Labs and companies collaborate and share the results of a research and development project. [These are typically two-party agreements.]
User Facility Agreement (UFA)	Users (company) may access facilities, specialized equipment, instrumentation, and personnel to conduct research.
Strategic Partnership Project (SPP)	Work done for a company using specialized or unique facilities or expertise. [These are typically two-party agreements.] [Previously non-federal Work for Others.]
Agreement for Commercializing Technology (ACT) — [This ACT is a more recent mechanism]	Labs and companies complete a project using specialized or unique facilities or expertise. [Developed with industry in mind; particularly useful for multi-party agreements.]
Technology Licensing Agreement (Licensing)	Company licenses Lab technology. Use the Visual Patent Search to explore more than 16,000 patents.
Material Transfer Agreement (MTA)	A Lab and company agree to protect biological materials.
Small Business Research and Development Programs (SBIR/STTR)	Small business collaborates with Labs as a subcontractor. [1. Small Business Innovation Research (SBIR), 2. Small Business Technology Transfer (STTR)]
Technology Commercialization Fund (TCF) [Recent announcement]	Encourages private sector-National Lab collaboration. TCF federal funds are matched with non-federal contributions to perform technology maturation with the intent of supporting cooperative development of a technology with a private partner.
Technical Assistance (TA)	Labs provide short-term assistance to companies with problems requiring expertise not available commercially.

Companies Should Take the Following Steps to Partner with DOE National Labs:

Of course, each lab is unique in practice and may need to proceed in a different order.



1. Get to Know the U.S. DOE National Laboratories

There are several factors to consider in choosing which National Lab to partner with. These include the lab's technology domain expertise, facilities and infrastructure, technologies, and patents. The chart below, which outlines many of these factors, builds on the U.S. DOE Lab Partnering Service (LPS) portal (based in DOE's Office of Technology Transitions, or OTT).

Another metric to consider is which National Labs have more experience working with private-sector partners. This can be indicated by the number of previous agreements they have undertaken (such as CRADAs, SPPs, and ACTs). This data has not been published since 2016, but can be requested on an individual lab-by-lab basis.

U.S. DOE NATIONAL LABORATORIES	LOCATION	PRIMARY CAPABILITIES	RELEVANT EXPERTS	FACILITIES	PATENTS	EXAMPLE KEY FACILITIES/FACTS
Ames Laboratory	Ames, Iowa (outside Des Moines)	Materials	14	5	105	-Critical Materials Institute -Materials Preparation Center -Sensitive Instrument Facility
Argonne National Laboratory	Argonne, Illinois (outside Chicago)	Computing, storage, nanotechnology, photon	40	55	1293	-Joint Center for Energy Storage Research -Advanced Photon Source -Argonne Leadership Computing Facility -Argonne Tandem Linac Accelerator System -Center for Nanoscale Materials
Brookhaven National Laboratory	Upton, New York (on Long Island)	Materials, nanotechnology	11	19	504	-National Synchrotron Light Source II -Center for Functional Nanomaterials
Fermi National Accelerator Laboratory	Batavia, Illinois (outside Chicago)	Physics and accelerator research	5	0	49	-Accelerator Applications Development & Demonstration machine
Idaho National Laboratory	Idaho Falls, Idaho	Nuclear energy research, materials, fuels	41	25	538	-Advanced Test Reactor -Materials and Fuels Complex
Kansas City National Security Campus	Kansas City, Missouri + Albuquerque, New Mexico	Defense—warfighter, nuclear deterrents, manufacturing	0	0	0	-Manufacture 85% of non-nuclear components that go into nuclear stockpile
Lawrence Berkeley National Laboratory	Berkeley, California (Bay Area)	Advanced materials, batteries, storage, semiconductors, photovoltaics, grid modernization, fuels	23	40	1341	-Advanced Light Source -Molecular Foundry -National Energy Research Scientific Computer Center -ESnet (Energy Sciences Network) -Joint Genome Institute
Lawrence Livermore National Laboratory	Livermore, California (outside Bay Area)	Nuclear deterrent, nuclear proliferation, counter terrorism, super computing	9	13	2022	-High Performance Computing Innovation Center
Los Alamos National Laboratory	Los Alamos, NM	Nuclear deterrent, defense, security	3	5	1099	-Center for Integrated Nanotechnologies -Los Alamos Neutron Science Center -National High Magnetic Field Laboratory
National Energy Technology Laboratory*	Pittsburgh, Pennsylvania + Albany, Oregon + Morgantown, West Virginia	Advanced fossil energy	6	12	21	-High-Pressure Combustion Research Facility -Polymer Syntheses Laboratory -Geologic Services Laboratory
National Renewable Energy Laboratory	Golden, Colorado (outside Denver)	Energy efficiency and renewable energy	4	11	406	-Energy Systems Integration Facility -National Wind Technology Center -Hydrogen Infrastructure Testing and Research Facility -National Fuel Cell Technology Evaluation Center
Nevada National Security Site	Outside Las Vegas	Nuclear stockpile safety	0	7	0	-Nonproliferation Test and Evaluation Complex -Radiological/Nuclear Countermeasures Test Facility -Big Explosives Experimental Facility
Oak Ridge National Laboratory	Oak Ridge, Tennessee (outside Knoxville)	Fundamental science, neutrons, computing, materials	10	11	2723	-Bio-Inspired Nanomaterials Facility -Oak Ridge Leadership Computing Facility -Manufacturing Demonstration Facility
Pacific Northwest National Laboratory	Richland, Washington	Fundamental science, energy resiliency, national security	9	18	2432	-Computational Science Facility -Marine Science Laboratory -Radiochemical Processing Laboratory
Pantex Plant	Amarillo, Texas	Final assembly, dismantlement and maintenance of nuclear weapons	2	0	0	-High Explosives Center of Excellence
Princeton Plasma Physics Laboratory	Princeton, NJ	Fusion energy research	0	0	21	-National Center for Fusion Energy Research
Sandia National Laboratories	Albuquerque, New Mexico + Livermore, California (outside Bay Area)	Bioscience, computing, geoscience, materials, nanodevices, microsystems	26	35	2523	-Gamma Irradiation Facility -Shock Thermodynamic Applied Research Facility -Algae Raceway -Center for Integrated Nanotechnologies
SLAC National Accelerator Laboratory	Melo Park, CA (Bay Area)	Particle accelerator, light, X-rays	1	6	73	-Linac Coherent Light Source -Cryo-EM -Next Linear Collider Test Accelerator
Thomas Jefferson National Accelerator Facility	Newport News, VA (outside Norfolk)	Particle accelerator, advanced computing	1	6	0	-Linear Accelerator -Injector -Central Helium Liquefier
Y-12 National Security Complex	Oak Ridge, Tennessee	Uranium storage, research, materials	5	9	131	-Secure Manufacturing Services -Oak Ridge Metrology Center -Materials Growth and Supply Laboratory -Advanced Security Research Center

Source: https://www.labpartnering.org/choosing_a_lab

**Only government owned-government operated U.S. DOE National Lab. U.S. DOE HQ Office of Fossil Energy.*

Basic Lab Management and Operating (M&O) Model:

All 20 National Labs are government-owned, contractor-operated (GOCO) except for the National Energy Technology Laboratory (NETL), which is government-owned and operated (GOGO). The GOCOs all have a management and operating (M&O) contractor who runs the lab. These M&Os include state universities (University of California), private universities (Princeton), private companies (Honeywell), non-profits (Battelle), and consortia. (For instance, the Los Alamos National Laboratory (LANL)'s M&O contractors are Triad National Security, LLC—Battelle, the Texas A&M University System, and the University of California.) While all Labs have to follow DOE rules and protocol and keep taxpayer interest in mind (which can sometimes lead to additional bureaucracy and risk-averse behavior), M&O partners usually differentiate each lab from the rest of the network.

In addition, each National Lab is aligned to a specific part of the U.S. DOE structure. For example, the National Renewable Energy Laboratory (NREL) is directly connected to DOE's Office of Energy Efficiency and Renewable Energy (EERE). Other labs are directly connected to DOE's Office of Science. The figure below shows where the National Labs sit relative to one another on the spectrum of early basic science to technology development. It also shows whether the lab is focused on a single program or is multi-programmatic. This information should be helpful when considering what a company needs and the particular problem it is trying to solve. (See step #2.)

National Labs Spectrum Of Early Basic Science To Technology Development

Source: Modified from Information Technology & Innovation Foundation

The Lab Partnering Service (LPS) portal facilitates learning about each lab. Among other features, it provides companies with the ability to:

- Search by lab. For example, if the company wants to find out more about NREL, LPS provides information about the experts, facilities, technologies, stories, and patents there.
- Search by patent or technology. In addition, the Visual Patent Search provides an easy-to-use portal for patents.

The National Laboratory complex can also be searched by technology and expertise from a search bar on the LPS homepage.

Overcoming Challenges

The two customary barriers to public-private partnership with National Labs are time and resources. While there is some movement at DOE towards creating common licensing structures and simplified terms to ease these burdens on companies, it is still important to understand and plan for these challenges.

- Time challenges: Some partnerships will take less time than others to execute, but in general companies should expect they will take anywhere from a few weeks to over a year. The best way to reduce this time is to plan and prepare for potential delays. Key time-saving steps include identifying relevant Principal Investigators (PIs) and other technical support team(s), getting their commitment, and engaging company GC/legal and relevant intellectual property (IP) experts in initial conversations to expedite contractual and legal reviews. Familiarizing the company with relevant federal guidelines is also important [see Developing Cooperative Research Agreements for examples].
- Resource challenges: Successful partnerships will have the support and buy-in of senior leadership at the company. This buy-in, as well as steps like accelerating internal signoffs, understanding federal guidelines, and identifying and committing personnel and technical resources early, will accelerate and streamline the path towards a final partnership agreement. It is also important to be as comprehensive in planning and budgeting as possible while understanding that, since there are multiple stages to any partnering mechanism or agreement, a shift in budget and resources may be needed along the way.
- Funding challenges: Partnerships will need to be funded. While these funds can come from a combination of resources, including directly from the company, other grants, and philanthropic funding, it is important to understand the basic cost structures up front. Standard funding commitments range from several hundred thousand dollars to several million or more. In fact, most National Labs will not engage with companies for less than one or two hundred thousand dollars, because a partnership needs to capture the attention of a researcher(s) for a substantial period and/or pay for the use of a high-overhead facility.

As with any business relationship, once a company works with a National Lab, it is typically easier the next time. There is a learning curve as well as trust and a relationship built on both ends that benefits future agreements and reduces some of these challenges above.

2. Define the Company Need(s)

Before they partner with a National Laboratory, companies need to understand what technical and/or business process challenges they are trying to solve and develop a strategy for how they will evaluate success. In this initial phase, companies should identify the people, processes, and organizational structures that will work with a National Lab. This includes putting in place technical Principal Investigators (PIs), relevant analysts to the RD&D focus area, and legal/contracting teams. Exact resource needs will depend in part on the mechanism partners agree on, the individual project(s), company senior leadership buy-in, and the overall financial health of the company.

The right mechanism for understanding company needs and aligning them successfully to both a specific National Lab and the appropriate partnering mechanism can vary from lab to lab. (For example, ACTs do not exist at every National Lab). At a high-level, however, a basic formula can be applied to determine which partnering mechanisms are best for addressing specific challenges or goals.

The table below depicts how a company's particular RD&D challenge or goal might best align with specific contract/partnering mechanisms at National Labs:

RD&D National Lab Challenge/Goal Checklist

CHALLENGE/GOAL	CONTRACT MECHANISM							
	CRADA	UFA	SPP	ACT	LICENSING	MTA	SBIR/STTR	TA
Commercialize a lab prototype					X			
New Product	X			X				
Research	X			X				
Test/Validate products		X	X					
Techno-economic analyis			X					X
Work with small business/startups							X	
Resolving technical challenges						X		X

As companies consider why they want to work with a National Lab or Labs, they should consider both the full life cycle and the full commercialization spectrum of the technology they wish to develop. There are other, more informal ways to work with National Labs as well, such as conferences, workshops, and publications. In all cases, partnering with a Lab should be one part of a multi-pronged problem-solving strategy, and companies should prepare to commit funding and resources to later-stage efforts, too.

While the primary goal of a partnership is usually to commercialize technology and generate IP, working with a National Lab brings many other benefits as well: user facilities, access to experts and researchers, global networks, validation, support in reaching regulatory or sustainability goals, and more. Often, these spillover developments and relationships turn out to be the main benefit of working with a National Lab.

3. Identify the Right Partnering Mechanism(s)

The U.S. DOE National Laboratories have effectively partnered with the private sector to commercialize new technologies for decades, as these many examples of successful collaborations can attest to. While some types of partnership agreements have not substantially changed since the Labs were first established, several new mechanisms now also facilitate partnerships and streamline

*Note: An additional agreement structure called the **Master Statement of Work** exists in which the field office for the Lab pre-approves a certain class of projects in advance of a collaboration. This can extend across all agreement types (such as SPP, CRADA, and ACT). Several labs, including NREL, PNNL, and Sandia, are moving this type of agreement forward.*

collaborative processes. Agreements for Commercializing Technology (ACTs), Cooperative Research and Development Agreements (CRADAs), and supportive intermediaries like the LPS make it easier for companies and National Labs to work together in a mutually beneficial way.

The following table summarizes the types of agreements companies can consider when partnering with a National Lab. These mechanisms have different pros and cons and align with different company goals, but each one can help outside partners access the capabilities of the National Lab system. An **ACCESS CRADA** is another structure DOE is currently exploring. It has two key qualities: (1) If Lab A has an existing agreement with a company, Lab B can provide RD&D services through Lab A back to that company without renegotiating the agreement. (2)

National Lab Partner Agreements*

TYPE OF AGREEMENT	SHORT DESCRIPTION	COST	TYPICAL USES	ADVANTAGES
Cooperative Research and Development Agreement (CRADA)	Labs and companies collaborate and share the results of a research and development project.	Shared or paid by company (payments either upfront or over time).	-Develop a new product -Conduct scientific research	-Ability to pool resources & knowledge
User Facility Agreement (UFA)	Users (company) may access facilities, specialized equipment, instrumentation, and personnel to conduct research.	Company pays approved rate or each party covers their own cost.	-Test & validate products	-Expedited user access to U.S. DOE Designated User Facilities (state-of-the-art) -Open to proprietary and non-proprietary research
Strategic Partnership Project (SPP) → Evolution of the non-federal "Work for Others"	Work done for a company using specialized or unique facilities or expertise.	Company pays full cost (payments either upfront or over time).	-Test & validate products -Conduct modeling & techno-economic analysis	-Fast (for easy to execute projects)
Agreement for Commercializing Technology (ACT) → A more recent mechanism	Labs and companies complete a project using specialized or unique facilities or expertise. In this model, an M&O contractor takes on all the execution risk of the project.	Company pays full cost, plus fees to contractor, but M&O contractor takes on the execution risk up front (payment is not due in advance but rather upon the delivery of a product).	-Develop new products -Conduct scientific research	-Flexible (negotiable terms & conditions on intellectual property provisions) -Fast (10-day approval process) -Gov't may only retain a research license on IP -Easier to conduct multi-party research -Allows the company to take on risks that the government is prohibited from accepting, such as performance guarantee or indemnification risk
Technology Licensing Agreement (Licensing)	Company licenses Lab technology. Use the Visual Patent Search to explore more than 16,000 issued patents.	Company pays a non-refundable fee, royalty, or other form of compensation.	-Commercialize a Lab prototype technology	-Enhances company technology innovation, product, or service offering with a federally-funded invention
Material Transfer Agreement (MTA)	A Lab and company agree to protect biological materials.	N/A	-Provide product protections	-Clarifies IP ownership
Small Business Research and Development Programs (SBIR/STTR)	Small business collaborates with Labs as a subcontractor. [1. Small Business Innovation Research (SBIR), 2. Small Business Technology Transfer (STTR)]	Companies are awarded funds to participate (DOE issues 300+ Phase I and 150 Phase II awards annually totally $200M+).	-Provide funding to startups and small businesses	-Helpful for small businesses
Technology Commercialization Fund (TCF)	Encourages private sector-National Lab collaboration. TCF federal funds are matched with non-federal contributions to perform technology maturation with the intent of supporting cooperative development of a technology with a private partner.	Copmany pays at least 50 percent of total project cost.	-Commercialize a Lab-developed technology	-Focuses on technology maturation and technology transfer
Technical Assistance (TA)	Labs provide short-term assistance to companies with problems requiring expertise not available commercially.	Company pays full cost or other arrangement depending on lab partner.	-Advise on technologies -Improve manufacturing processes -Performing scientific peer reviews	-Fast -Helpful for small businesses

Sources: www.energy.gov and www.labpartnering.org/p/partnering

If Lab A and a company sign an agreement and a Lab B later wants to join by accepting the pre-decided/approved terms, Lab B can enter into the existing agreement. In some ways, this is similar to a standard GSA table used for federal contracting.

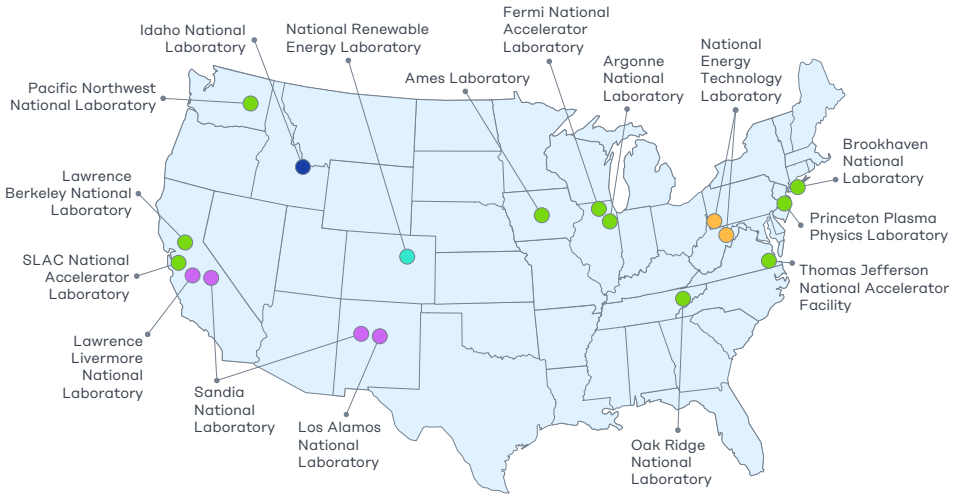
4. Consider Geography

While it is most important to work with the National Lab that has the strongest team and research in the company's area of interest, location should be considered as well. At a minimum, most partnerships with National Labs require a company to have some resources on the ground nearby and/or to travel there frequently. Because of the broad geographical distribution of the Labs, it may make sense to partner with one close to the company's existing facilities, offices, or supply chain partners.

For example, Exelon, headquartered in Chicago, Illinois, has a Master CRADA [see more in Developing Cooperative Research Agreements] with Argonne National Lab, located just outside the City. Exelon's primary goal is to build out their RD&D needs, but their collaboration is also aimed at enhancing the broader regional innovation ecosystem and partnerships with regional universities and other local stakeholders.

National Labs Innovation Ecosystems

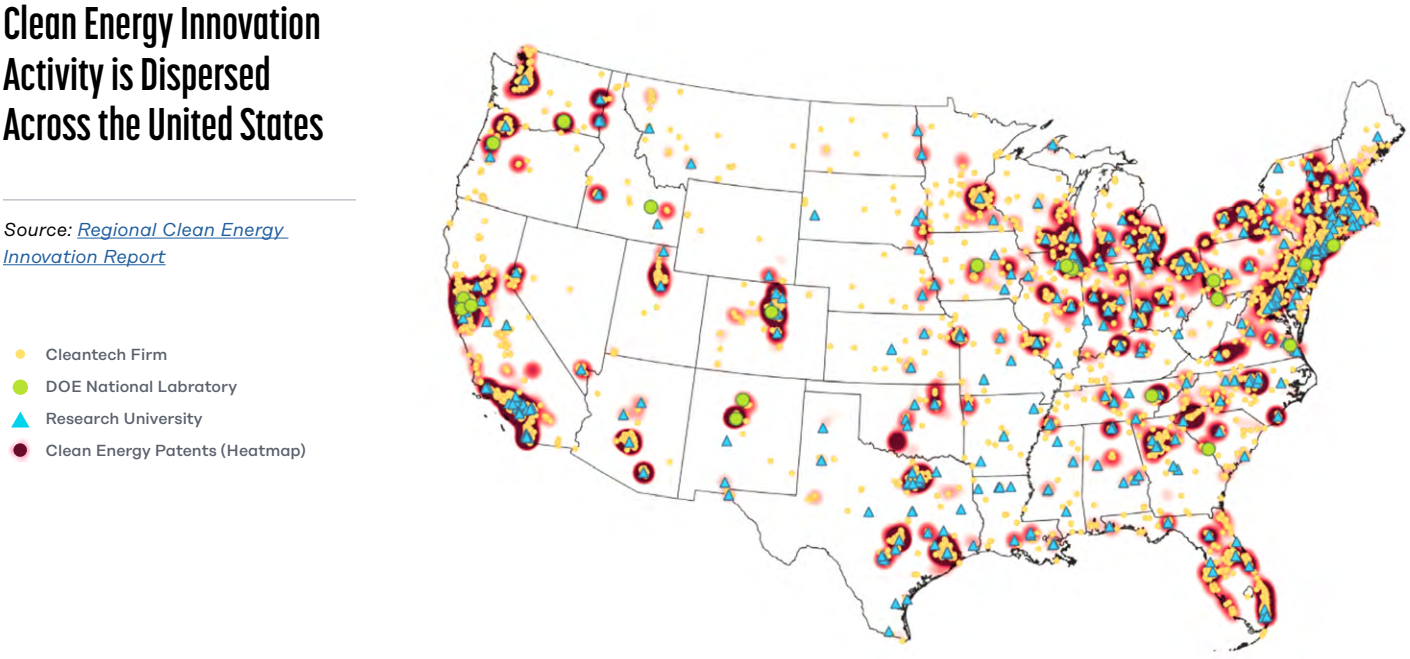
Source: Modified from https://www.energy.gov/science/mission/office-science-field-operations



As the map below indicates, many National Labs are part of vibrant innovation ecosystems which may provide additional benefits to a company. For example, NREL's ecosystem impact is estimated at $748 billion in Colorado alone. NREL collaborates closely with several regional partners—including Colorado University, where a joint Renewable and Sustainable Energy Institute (RASEI) expedites transformative energy solutions and advances renewable energy science, engineering, and analysis through research, education, and industry partnerships.

Clean Energy Innovation Activity is Dispersed Across the United States

Source: Regional Clean Energy Innovation Report



5. Build Relationships and Trust

As with any business partnership, building stronger relationships and trust with National Labs is critical to success both now and in the future. Consider what existing relationships company employees may have at National Labs and whether those channels may be helpful to facilitate new partnerships. Ensure handoffs for relationships as company employee transitions occur.

Many industry-lab partnerships begin with a researcher-to-researcher relationship. As such, empowering employees to participate in key convenings and discussions allows for networking and potential future lab collaborations. These include technical workshops hosted by DOE, National Labs, relevant trade organizations, and institutes such as the Electric Power Research Institute (EPRI). These forums also allow companies to talk about challenges, goals, technical capabilities, and commitment to the space. Companies can also

consider hosting their own workshops on a specific technical or research area and inviting key National Lab experts to attend. This is a great way both to get input and start building a coalition of support.

Some companies find it difficult to build relationships, trust, and deep or nuanced understanding of National Lab processes. By gathering, maintaining, and sharing consistent information across the National Lab complex (for example, spotlight on success around energy storage), the Office of Technology Transitions (OTT)'s Lab Partnering Service (LPS) reduces many of these bottlenecks and asymmetry in knowledge.

In addition, every Lab has a tech transfer/industry/partnership office or center that can also serve as a point of contact for companies. Although it may be easiest to start with LPS, this office can also be a key resource.

OTT also recently assigned several commercialization executives to work on a specific area of technological, regional, or other expertise. These executives navigate and advocate for both companies and National Labs. In addition, OTT plans to launch a Solutions Exchange to help answer direct questions/issues/needs and to help support companies as they pursue National Lab partnerships.

Moving forward, DOE should continue to help bridge the gap between the private sector and Labs. Additional intermediaries could add particular value if they are increasing contract flexibility (e.g., pre-negotiated access to the labs, bridge some of the terms around the 90-day advance) and confirming new sources of funding (e.g., it is difficult for National Labs to accept gifts and philanthropic funding).

RD&D DEEP DIVES

Argonne National Labratory
Photo credit John Hill

Developing Cooperative Research Agreements

Overview

A Cooperative Research and Development Agreement (CRADA) is a contract between one or more National Labs and one or more non-federal entities (such as companies, non-profits, or academic institutions). The agreement allows collaboration between entities that may include the National Lab's research and development (R&D) capabilities, expertise, and facilities. Often intellectual property (IP) is developed as a result, and generally this type of agreement is used to develop a new product.

CRADAs can vary in size, focus, and duration, and be with one National Lab or several. If the dollar value of the entire project does not exceed $500,000 USD, then a Short Form CRADA may be used to expedite the overall process.

Key Benefits of a CRADA

CRADAs enable partnerships between a company and a National Lab. They can help companies accelerate the development of new products or improve existing technologies. CRADAs can be particularly beneficial for companies who may not have in-house R&D capabilities or would benefit from additional expertise. Companies should especially choose a CRADA when the technology/RD&D goals involved are core to the company's mission.

Key Challenges with a CRADA

While CRADAs are perhaps the most widely used and known form of collaboration between the private sector and National Labs, they are not the only option. Other, simpler choices exist, such as Technical Assistance or Agreements for Commercializing Technology (ACTs), an alternative designed more recently to ease the burden for industry. Since payment is not due until the product/project is delivered, these types of agreements put most of the execution risk on the management and operating (M&O) contractor.

For some companies, the IP restrictions and resource-intensive nature of executing a CRADA may be too burdensome. In addition, all new IP developed during a CRADA is subject to U.S. competitiveness (i.e., manufacturing in the U.S.) requirements. Companies can apply for a waiver, but these are not frequently granted.

How to Develop a CRADA

Before deciding on a CRADA, companies should refer to Partnering with DOE National Labs for information on collaborating with the Labs.

Once a National Lab and a company have decided on a CRADA as the right partnership mechanism, the company will go through several steps with the National Lab over the life cycle of the CRADA. The following sections detail each of these steps with specific focus on the company's role.

Companies Should Take The Following Steps To Partner With DOE National Labs:

Key Terms and Definitions

- **Scope of work:** An informal, high-level description of the collaboration and work to be done. These are usually drafted jointly between the company and National Lab.
- **Joint Work Statement (JWS):** A proposal prepared by the National Lab Director describing the purpose, scope/summary, schedule, and estimated cost of a proposed CRADA for U.S. DOE HQ.
- **U.S. DOE HQ:** The headquarters for the U.S. Department of Energy in Washington, D.C. The U.S. DOE HQ oversees all National Labs and DOE Operations Offices.

(continued)

A. Confirm CRADA Mechanism with the National Lab

Organize Resources and Personnel

Before confirming the contract mechanism, companies should consider the following to make sure that the budget, team, and time commitment are established:

- Assemble a team at the company including relevant technical Principal Investigators (PIs), contract/IP/legal experts, and other relevant technical specialists. The corresponding lab personnel should also be engaged, as should the tech transfer offices.
- Minimize time to execution of the CRADA through efficient negotiations. While these negotiations can take anywhere from several weeks to more than a year to complete, companies can take steps to expedite the process. By being prepared and ready (via a contract/legal/IP and ready-to-go team) ahead of the steps described below in (B), the overall timeline will be reduced.
- Agree on funding levels and sources with the National Lab before starting the CRADA process. Typically, the costs for the CRADA are shared or paid by the company, either (1) entirely in advance or (2) via a pay plan that includes a 60- (in some labs 90-)day reserve of expected costs and (in some instances) funding for the first 30 days of work. The company should evaluate costs based on personnel, facilities, and access options and agree on target total spending. Agreements can range from $100,000 to millions of dollars depending on how the scope is negotiated. (Reminder: if under $500,000, a Short Form CRADA should be utilized to expedite the overall process.)
- Verify ability to access the National Labs. Ensure company personnel have the appropriate citizenship requirements to engage with the National Labs. Each

facility may have different requirements and sometimes foreign nationals can obtain approval. Be sure to check classification requirements specific to the National Lab and R&D/technology area. Also consider whether you want or have the capability to have personnel spend more time onsite (either full-time or part-time), as this can be beneficial to the company.

Review the Model CRADA

Companies should leverage supporting documents, including the DOE Model CRADA to understand contracting requirements. Key sections from the model CRADA include:

- The Statement of Work (SOW) includes technical description, tasks, the party responsible for tasks, a list of deliverables, PIs, and contact information. Proprietary information should not be included in the SOW unless it is deemed necessary to define the work. The length of the partnership will be negotiated into the original agreement (sometimes with no-go/go stage gates), as well as a clear end date with milestones.
- The Rights in Subject Inventions and Rights in Data sections outline how the company and lab will handle intellectual property. Many CRADAs allow for joint inventions. This approach often benefits both parties: Labs are generally open to joint patenting when there is a good relationship with their corporate partner.
- The section on U.S. Competitiveness addresses how the parties will agree on benefits to the U.S. economy, including intellectual property (IP) manufactured in the U.S. In some instances, companies can submit a waiver for this requirement (DOE provides an example statement for consideration by Caterpillar, Inc). It is more common for the company to prepare in advance their own U.S. Competitiveness statement to be approved by DOE. Once this statement is approved, it can then be used multiple times by the company in different agreements. This can be particularly useful for companies that do most of their work and manufacturing domestically (such as utilities).
- The closeout of the CRADA, outlined in the section titled Entire CRADA, Modifications, Administration, and Termination, often requires a more robust set of documentation and final reporting, as required by the U.S. Federal government. Companies prepare by setting clear, well-defined deliverables and reporting requirements upfront.

Engage Subject Matter Experts

Companies should engage legal, contracting, and IP experts before going into negotiations. Companies should ensure they have expertise covering:

- Ownership and IP, especially as it relates to joint inventions with the lab.
- Product liability and indemnification and hold harmless clauses.
- U.S. Competitiveness clauses and the opportunities to modify these requirements.

Confirm National Lab Commitment to Partnership and Type of Contract (CRADA)

As a final step, companies should obtain confirmation from the National Lab that its personnel will proceed to draft scopes of work and execute relevant planning with the DOE Operations Office and HQ.

- **Statement of Work (SOW):** This is based on the work summary approved in the JWS and includes: a technical description of the proposed CRADA's scope; tasks and deliverables and the parties responsible for each; Principal Investigators (PIs); and contact information. These are usually drafted jointly between the company and National Lab. Task Orders can also be added to the SOW.
- **DOE Operations Office** (also called field office or site office): These offices often serve DOE and the National Labs as a business service center, awarding grants and contracts, providing legal review, facilitating partnerships, and overseeing the Labs. For example, the Golden Field Office is a designated DOE field office supporting the Office of Energy Efficiency and Renewable Energy (EERE) and overseeing the National Renewable Energy Laboratory (NREL, also in Golden, CO). Often DOE Operations Offices are located near the National Labs.
- **National Lab** (or DOE Facility): Lab location where the CRADA will take place.

→ **More information can be found on DOE's website**

B. Negotiate Terms and Sign CRADA with National Lab:

There are eight basic steps to negotiating a CRADA (outlined below), but not all of them require the company to take significant action: many of these steps are National Lab responsibilities. The company can help speed the process by providing immediate response to any inquiry from the National Lab. The company will be most engaged on Steps 1, 3, and 5.

Eight Steps to Negotiating a CRADA

STEP	KEY COMPANY ROLES
Step 1: Both the company and National Lab researchers discuss ideas, identify mutual interests, and draft an informal scope of work.	The scope of work helps lay out the basic structure and goals. The company should make sure to work with the National Lab to draft this and have in mind the JWS and SOW to ensure key details are added in, even if only mentioned at high-level.
Step 2: National Lab determines contract considerations and the company identifies corporate support & funding.	The company should have already confirmed this in step (A), but if any funds remain to be sourced, they should be sure to figure this out as soon as possible.
Step 3: National Lab develops a Joint Work Statement (JWS) and sends draft CRADA to the company. Both the National Lab and the company draft the Statement of Work (SOW) with milestones.	The company should be prepared and ready to review the JWS/ CRADA with legal/contracts/IP team in place. Company PIs and other technical specialists should also be ready and prepared to work on the draft SOW with the Lab team.
Step 4: National Lab submits the JWS to DOE Operations Office. The company reviews the draft CRADA.	
Step 5: DOE Operations Office* approves JWS for the National Lab. Both the National Lab and the company review CRADA documents and complete negotiations.	The company should be prepared and ready to review CRADA documents in a timely manner to ensure no time delays.
Step 6: National Lab develops and distributes final CRADA. Both the National Lab and the company review final CRADA.	The company should be prepared and ready to review CRADA documents in a timely manner to ensure no time delays.
Step 7: National Lab obtains Laboratory, DOE Operations, and DOE HQ approval (if needed) of CRADA. Company approves final CRADA.	The company should be prepared to sign CRADA in a timely manner to ensure no delays.
Step 8: Execute CRADA (C).	The company should already be prepared to start the CRADA in terms of personnel and budget.

Source: DOE

**Not all CRADAs have to be reviewed by the DOE Operations Office, especially if they are smaller dollar agreements of ~$500,000 USD or less.*

C. Execute CRADA

Once work commences during this phase, the CRADA technical teams (Lab and company) will work together during the period of performance as defined in the SOW. For some companies, having personnel onsite or a temporary office space agreement at the National Lab is beneficial. This will be decided during the JWS and SOW drafting in Step (B). Every company should plan to make frequent trips to the lab for visits and meetings. It is important to spend time at the lab to help move the project forward, execute on the RD&D, and build stronger relationships with lab staff and leadership. Investing in human capital is important to deriving full benefit of the partnership.

Typical CRADA agreements have required reporting to the National Lab, often the DOE Operations Office, and sometimes DOE HQ. Research and technical work are executed based on deliverables and milestones as defined in the SOW. If an extension or change is required, National Lab and company leadership will renegotiate, and the amendment will need to be approved by DOE Operations Office (and sometimes DOE HQ).

D. Close Out CRADA

Once work is complete and milestones are met as agreed to in the JWS/CRADA and SOW(s), the final step is to close out the CRADA. This process follows fairly standard post award phase government contract standards. It is important to set upfront terms in the SOW or Task Orders on clear, well-defined deliverables and outputs.

Companies should have a frequent dialogue on the commercial outcomes of the work and place emphasis on building out the relationship even after the termination of the CRADA. Anywhere from 6–12 months before the end of the CRADA, the corporate team should put together a refined commercialization plan for the work done through the CRADA. This will enable better long-term outcomes and successful metrics for the company, as the RD&D will have a clearer transition path forward.

Additionally, see the U.S. Office of Management and Budget (OMB) guidance on grant close-out for reference.

Conclusion: Additional Benefits and Insights for Replication

While they can be complex, CRADAs are incredible instruments for advancing complex RD&D in collaboration with National Labs. Additional agreements and benefits may result down the line including deep relationships with researchers and technical specialists and access to other opportunities. This includes Technology Licensing opportunities and other innovation mechanisms such as Argonne National Laboratory's Chain Reaction Innovation (CRI). For example, Exelon's initial Master CRADA agreement has supported multiple SOWs, surfaced a potential Licensing opportunity, and resulted in Exelon exploring funding a fellow in a future CRI cohort. Once a company executes on a CRADA, subsequent agreements are generally easier since there is a built-in level of trust and understanding.

It is important to view a CRADA with a National Lab as one part of a multi-pronged strategy to addressing an RD&D goal, developing a technology, etc. Companies should consider the full life cycle of technology transfer and adjust resources and commitments accordingly. When a company does not have the capability to manufacture the technology, they will have to negotiate licensing it, which can delay time to a full return on investment.

The specialized access to intellectual property (IP) is an important aspect of any CRADA, but companies should be fully aware that there is often not an immediate ROI. Placing emphasis on joint inventions and expanding the scenarios in which inventions are jointly owned may be beneficial to the company as well as the lab longer-term. Finally, placing emphasis on other benefits such as a global network, access to unique user facilities, and other types of validation is important to evaluating success.

RD&D DEEP DIVES

Corporations have turned to universities such as MIT as essential partners in innovation. MIT's East Campus shown above. Photo credit: Nick Allen.

Collaborating with Entrepreneurship Programs

The Challenge

Even the most dynamic corporations don't always have the time and resources to deal comprehensively with all the technical, industrial, and regulatory challenges that come with commercializing innovation. To solve this problem, corporations have historically turned to technology scouts or RD&D organizations such as universities and National Labs. But there is often still a gap, known as the "valley of death," between an innovative technology in a lab and a successfully commercialized product. This is especially true for extremely capital-intensive technologies, such as those developed to limit carbon emissions.

The Solution

Over the past several decades, intermediary entrepreneurship programs—accelerators, for instance—have become an essential part of many innovation ecosystems. These entrepreneurship programs connect governments, corporations, and universities across innovation ecosystems, helping to scale new technologies and bring them to market as quickly as possible.

Companies can develop their own accelerators to boost internal innovations or engage with external startups and embed them into the company. (This model is known as "open innovation.") Additionally, companies may choose to open an innovation node or outpost in a specific region, such as Silicon Valley or greater Boston.

To help address this commercialization gap, Breakthrough Energy has established an entrepreneurship program called Breakthrough Energy Fellows. Breakthrough Energy Fellows provides funding and support to help technologies that have the potential to reduce CO2 emissions by at least 500 million tons per year by 2050 find the pathways they need to get from lab to market. The BE Fellows program will focus on deep decarbonization technology focus areas and will encourage multiple commercialization pathways, including joint ventures, technology/talent acquisitions, and startups. The program will be rolled out in 2021, and more details will be available via ongoing Breakthrough Energy communication channels.

Partnering with Entrepreneurship Programs

Companies should take the following steps to effectively partner with entrepreneurship programs:

1. Get to know the network and understand the basics.
2. Identify the right type of program.
3. Define company need(s).
4. Build relationships and sign a contract.

1. Get to Know the Network and Understand the Basics

The Basics of Entrepreneurship Programs

Before a company decides which entrepreneurship program to partner with, it must understand the fundamentals these programs have in common—as well as the critical differences among them. Many entrepreneurship programs share a set of basic characteristics, definitions, and structures, but may differ in their approach to each. Companies should consider the following questions as they evaluate entrepreneurship programs.

Criteria for Entrepreneurship Program Evaluation

QUESTION	CONSIDERATIONS
What is the timeline?	Timelines for accelerators typically range from 3 months to 2 years.
Is it cohort-based or rolling admission?	Most accelerators operate on a cohort model in which startups apply, are accepted, launch, and graduate on the same timeline. A few operate on a rolling admissions model, in which peer startups do not track at the same time.
How many entrepreneurs are in the cohort?	Answers to this question can range from several (Greentown Labs) to several dozen (Elemental Excelerator) to more than 50 (Y-Combinator).
What are the key milestones?	Most programs have educational, technical, business model, or commercial milestones for their startups.
What is the accelerator's challenge or area of focus?	Most programs have a challenge or opportunity statement and either focus broadly on a sector or a set of related sectors or on a specific industry, company, market, or regulatory challenge.
What is the area of geographical focus?	Programs can be local, regional, national, or global. Even if they are global, innovation is inherently regionally focused—especially in the earliest stages of commercialization—and so there are often regional partners or intermediaries that help connect into the innovator, founder, and partner networks.
What is the commitment required?	Programs can be virtual, in-person, or some combination. (For instance, some have weekend convenings/ summits for founders and CEOs while the work remains primarily virtual). More regionally-focused programs tend to have more in-person components whereas global programs tend to be almost wholly virtual. Some programs require the founder and startup to join in person for the entirety of the program, and startups need to be close to 100 percent committed. Others allow startups to participate in several entrepreneurial programs at once. (For example, several startups that have participated in MIT's delta v also participated in MassChallenge at the same time.)
What is the end goal?	Accelerator goals or metrics for success can range from achieving a major technical or commercial milestone to reaching an inflection point or a firm commitment from a company to partner and potentially acquire the technology. Not all startups will result in a scalable company.

Typical Programming

Accelerators follow a basic curriculum that usually ends with a culminating event: a demo or pitch day that brings together the community of investors (both equity and non-dilutive), strategic industry partners, supporters and mentors, and future entrepreneurs and scientists (talent). Sometimes these demo days are invite-only and focused on a specific stakeholder (corporate strategic partners and investors, for instance). More often, there is a public component, since many accelerators benefit from the potential to source new talent, entrepreneurs, investors, and partners.

Typical Funding

Some accelerators require nominal fees to join the program to ensure accountability. Others provide cost-of-living stipends to allow the innovator or founder to focus on advancing the technology. Accelerators can provide non-dilutive grants to go towards basic business and administrative needs, material needs and basic capital costs, and access to labs, facilities, and experts. Most accelerators include some set of shared services including legal and accounting support, software and other tools, shared workspaces, and ancillary services such as printing and phone lines for the duration of the program. Some also provide funding for or access to relevant lab space, facilities, and experts. Nearly all accelerators offer unique access to custom virtual and in-person networking events.

Some accelerators commit to equity investments up front; others commit to it on the backend. In either case, this investment usually comes in the form of a convertible note and ranges from $50,000 to $500,000.

Get to Know the Network

There are several broader networks and trade-like organizations that will provide access and insight into different entrepreneurship programs. These include:

- New Energy Nexus, an international nonprofit that supports clean energy entrepreneurs with funds, accelerators, and networks. New Energy Nexus started in California and also operates programs in China, India, Southeast Asia, and East Africa.
- Incubatenergy Network, a consortium of clean-energy-focused incubators. To date, the network is supporting more than 500 companies and has a significant pipeline.
- Northeast Clean Energy Council, whose mission is to create a world-class clean energy hub in the Northeast that delivers global impact with economic, energy, and environmental solutions.
- Cleantech Open has existed for more than a decade. Its programming spans key cleantech innovation hubs in the U.S. and around the world.
- The U.S. Department of Energy provides access to and information on key accelerators in the U.S.
- The Global Entrepreneurship Monitor is a networked consortium of national country teams primarily associated with top academic institutions. It carries out survey-based research on entrepreneurship and entrepreneurship ecosystems around the world.

– The Global Consortium of Entrepreneurship Centers, established in 1997, connects more than 200 university-based entrepreneurship centers across the United States.

2. Identify the Right Type of Program

Before companies commit to an entrepreneurship program, they should identify the right one for them. Incubators and accelerators are two of the most common types:

Incubators are typically physical locations with open-ended timelines. They may also include cohort-based programming or even mini-accelerators (Greentown Labs or LA Cleantech Incubator do this, for example), lab space, community events, and more. Incubators often cater to a broad range of technologies and startups at different stages.

Accelerators are typically time-bound, high-intensity programs that sometimes include physical space as well as investment (MassChallenge, for instance). Accelerators often focus on a specific sector, set of sectors, or industry challenge, while incubators are more often cross-cutting.

Entrepreneurship programs are constantly evolving, and many hybrid models are moving the intermediary space forward:

– Building on programs like entrepreneur-in-residences, research fellowships, and aspects of accelerators, a more recent model has emerged around cohort-based fellowships for entrepreneurial scientists and innovators. In fact, the U.S. DOE recently funded a cohort of intermediaries called the Lab Embedded Entrepreneurship Programs (LEEP) with a specific focus on embedding these scientists and engineers within U.S. National Labs.

– At slightly later stages of technology, there are also hybrid fund, accelerator, industry partner intermediaries like the recently launched Rocky Mountain Institute's Third Derivative and Elemental Excelerator's well-established Demonstration Track. Both of these accelerator-like intermediaries are focused on slightly later-stage startups that need capital, relationships, and direct industry commitments to help them scale.

Not all entrepreneurship programs that provide value fit neatly into the incubator or accelerator mold. There are other models that include hands-on funding sources, prizes, challenges, hackathons, fellowships, and other kinds of corporate engagement. Some examples include:

– Funds with hands-on programming: There are several high-impact funds that have accelerator-like components and excellent ROI (such as Clean Energy Trust).

– Funds with shared services: There are several high-impact funds that have physical space, lab access, and some programming (such as The Engine and Powerhouse).

– Entrepreneurs in residence or venture builders: This model embeds an expert in a R&D organization to build trust and teams and ultimately help spin out ventures (MIT Proto Ventures Program, for example).

- Independent labs that commercialize technology: This is a full life-cycle model that sees technology RD&D through to forming a company, fundraising, piloting and demonstration, and eventually independently operating companies (OtherLab, for instance).

Evaluating entrepreneurship programs means asking whether or not there is an existing critical mass of partners in the space, how much experience the program has, whether the program addresses a critical gap in the clean-energy ecosystem, whether working with companies is a core focus, and whether the existing portfolio is high-quality.

Entrepreneurship Program Examples: Accelerators

TYPE OF ACCELERATOR	TIMING	APPROXIMATE FUNDING TO STARTUP	TYPICAL STAGE OF COMPANY	ESTIMATED CORPORATE FUNDING	LEVEL OF EFFORT	KEY BENEFITS	EXAMPLE
Educational Accelerator Focused on instilling the entrepreneurial mindset first	~3 months	$5,000–20,000	Early, mostly pre-LLC	Anywhere from $50,000–1 million to sponsor accelerator up front	Low	Access to talent	MIT delta v
Accelerator with non-dilutive funding sources + other commitments Focused on developing strong entrepreneurs and founders and reducing specific pain points.	6 months –2 years	$10,000–300,000	Late-Stage R&D / Early Deployment	Anywhere from $200,000–millions to fund/sponsor accelerator	Medium	Development of innovative technologies to meet business needs	IN2
Accelerator with equity investment + other commitments Focused on scaling companies.	3 months – 1 year	$100,000–500,000	Late-Stage R&D / Early Deployment	Several million to become an LP. $100,000–millions to co-fund product deployment - pilot/ demonstration	Medium	Development of innovative technologies to meet business needs	EEx
Incubator with Accelerator in-house Often focused on supporting startups from a particular region, and can be driven in conjunction with company-funded priorities.	3 months – 1 year	$10,000–300,000	Late-Stage R&D / Early Deployment	Anywhere from $200,000–millions to fund/sponsor accelerator	Medium/ High	Development of innovative technologies to meet business needs	Greentown Launch
In-house Corporate/Industry Accelerator Focused on developing technology within a firm or bringing in outside technologies to accelerate capabilities	Varies	$100,000–millions	Early Deployment	Millions	High	Solve major challenges critical for future business model viability	Microsoft Ventures Accelerator

Note: The above categories are not mutually exclusive, and some accelerator or accelerator-like entities may share qualities.

3. Define Company Needs

Companies seeking any of the following should consider an accelerator:

- Deal flow
- Access to local and regional innovation ecosystems
- Access to potential partners and networks
- Demonstration/pilot potential
- Access to technical and innovative talent

Before they commit to any particular entrepreneurship program, companies should consider the volume and quality of the startups it includes. They should also consider its resource intensiveness, or "touch."

Volume: This refers to the number of founders or startups an entrepreneurship program accepts into each cohort. (It can range from fewer than 10 to more than 70.) Generally speaking, a company seeking high deal flow and/or trying to meet a significant number of goals or challenges may prefer a higher-volume accelerator. Likewise, a company seeking to tap into future talent may also find a higher-volume accelerator a better fit. However, companies should note that high volume does not always mean high quality. In larger entrepreneurship programs, consistency can be an issue.

Touch: This refers to the amount of time and resources an entrepreneurship program dedicates to each startup. (It does not refer to direct funding.) Generally speaking, companies looking for specific technologies or solutions may prefer a higher-touch accelerator. Likewise, higher-touch, more resource-intensive entrepreneurship programs tend to be higher quality.

4. Build Relationships and Sign a Contract

Once a company has zeroed in on its needs and selected the model and program best aligned to meet them, it can move into the contracting phase.

In this phase, a company needs to know how much time it will be expected to commit to the entrepreneurship program (usually 1 year minimum); the expected funding commitment; and what other resources it will be expected to provide. These could include legal or intellectual property if specific agreements are a potential outcome, internal experts in the specific technology or area of focus, and/or a program manager to manage relationships with the accelerator.

Some contracts might look more like a sponsorship or membership agreement. Others may include a much more substantial equity commitment.

Either way, before it can sign a contract, the company will need to engage some combination of the following:

- Corporate Social Responsibility
- Marketing/Communications/Branding
- Innovation teams
- Venture teams
- Scientific and Technical experts
- Senior leadership
- Legal/IP/Contracting

Because accelerators are often startups themselves, they can move fairly quickly, which means this commitment phase can take anywhere from a week to several months. To avoid delay, it is useful to establish internal alignment before a company pursues in-depth discussions with an accelerator.

CORPORATE PLAYBOOK

Procurement

Case Studies, Tools and Deep Dives

PROCUREMENT

Introduction

Corporate procurement can be a powerful tool for reducing greenhouse gas (GHG) emissions and driving private-sector demand for new clean technologies. Emissions in companies' supply chains are on average more than five times greater than their direct operational emissions.

Already, the decisions private and corporate entities make about how they obtain, transport, and use goods and services for their business define much of the current global carbon emissions profile. By making low- and zero-carbon procurement choices, they can likewise catalyze the development of cleaner products and processes.

In sum, this document advises companies to:

- Use procurement commitments to encourage demand for clean technologies that are commercially viable but need early markets to become more affordable and effective.
- Partner with early-stage companies to encourage the commercialization and wider use of low-carbon products in hard-to-decarbonize sectors such as energy storage, fuels, steel, and concrete.
- Use proven best practices and new tools to understand carbon emissions/cost tradeoffs and then specify appropriate low-carbon products via Requests for Proposals (RFPs).

By mapping their emissions footprint, prioritizing focus areas, partnering to learn or develop best practices, and aligning metrics across the company to accelerate action, corporations and private-sector entities can have a significant positive impact on reducing global GHG emissions.

PROCUREMENT

Case Studies: Electricity

Recommended Corporate Actions on Electricity Procurement:

- Establish clean electricity procurement contracts that maximize additionality, including power purchase agreements (PPAs) and green tariffs.
- Prioritize clean electricity procurement in regions where projects will lead to the largest long-term emissions reductions.
- Assess the impact of projects on their potential to reduce emissions.
- Procure emerging electricity technologies and sources of clean dispatchable generation—like geothermal, advanced nuclear, and fossil with Carbon Capture and Storage (CCS)—that will be critical to supporting deep decarbonization of the electricity sector at the lowest cost.
- Aggregate buyer demand to pursue collective power purchase agreements and other high-impact electricity procurement contracts.
- Shift electricity consumption to the lowest-emissions periods on the grid.
- Procure energy storage in ways that reduce emissions and create demand for longer-duration storage solutions.

PROCUREMENT

Responsible for 25 percent of global greenhouse gas (GHG) emissions, electricity generation is currently the single biggest contributor to climate change—and emissions from this sector are continuing to increase. The world needs clean electricity, both to reach net-zero emissions across the economy and to power clean transformations in other sectors such as transportation, manufacturing, and buildings.

Organizations looking to minimize their own emissions should turn to tools like power purchase agreements (PPAs), which can add clean electricity to the grid and displace fossil fuel-based generation. Corporations and private-sector institutions are leaders in this space, and corporate renewable-project procurement is booming: RMI's Business Renewables Center anticipates more than 60 gigawatts of new projects by 2030.

Not all approaches to clean electricity procurement have equal impact in terms of increasing demand for clean generation and reducing GHG emissions. While renewable energy certificates (RECs) are a basic tool for tracking renewable generation, for example, they cannot achieve meaningful GHG reductions alone.

Emissions impact depends on when and where megawatts are generated or consumed. For instance, California now curtails gigawatt hours of solar electricity production every spring during midday, because adding more clean generation during these times has little benefit—it results in an oversupply of clean energy that cannot yet be stored for later use. To avoid exacerbating this problem, organizations can look at a grid's marginal generation mix to understand which emissions a new clean electricity project would displace. They can also reduce emissions by shifting demand to times when cleaner energy is on the margin. Keeping these timing and location aspects of emissions in mind—in project siting, onsite clean energy generation, heating/cooling system optimization, and device deployment, for example—will reduce emissions without sacrificing function or financial performance.

Overall, measuring the impact of projects based on a marginal-emissions metric will help organizations prioritize the strategies that most reduce emissions. This puts generation, efficiency, and load-shifting strategies on an equal footing. It also focuses efforts on shifting clean generation to regions who most need it and supports clean energy integration. Using this mindful approach, organizations can achieve greater GHG reductions with the same investments, accelerating the transition to clean energy.

Companies can also encourage the transition to a fully net-zero emissions grid beyond 100 percent renewable purchasing. They should look toward emerging sources of clean, firm, and dispatchable generation—like geothermal, advanced nuclear, and fossil with carbon capture and storage (CCS)—that will be critical to supporting the decarbonization of the electricity sector at lowest cost. They should also consider the role of energy storage, particularly long-duration storage, in helping address the intermittency of variable renewable energy sources (VREs) like wind and solar power and identify opportunities to encourage demand for these storage products.

ELECTRICITY CASE STUDY

Emissions-Optimized Procurement
Boston University

ACTION:

Prioritize clean electricity procurement in places where projects will lead to the largest long-term emissions reductions

Overview

By evaluating avoided emissions as part of their clean electricity procurement decision-making, Boston University greatly increased the impact of its emissions reduction strategies and more than doubled the emissions reductions involved in a recent energy-procurement project.

Challenge

Many organizations are procuring substantial quantities of new clean electricity, but they do not always maximize the potential emissions benefit of these projects. Often, these projects are assessed solely on how much electricity they generate, not the amount of greenhouse gas (GHG) emissions they displace from the electric grid. Their effectiveness is also limited by focusing only on wind and solar power, rather than considering the full suite of zero-carbon electricity sources.

Goals

In 2017, Boston University (BU) adopted its "net-zero by 2040" Climate Action Plan which relies on strategies such as efficiency improvements, a shift from fossil fuel use to electricity for heating and cooling, and renewable energy procurement to reach its goal.

BU's electricity procurement strategy came with three mandates:

- Contribute additional renewable electricity to the grid;
- Cover the University's full electricity consumption; and
- Displace the greatest amount of GHG emissions possible.

Operational Overview

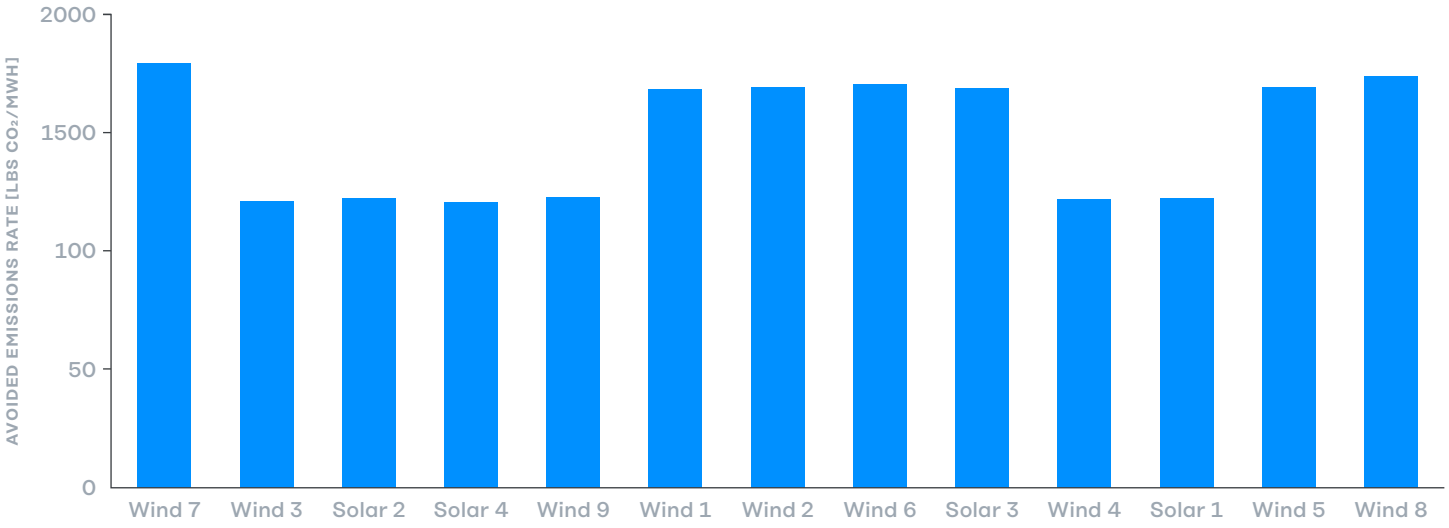
Additionality—the concept that an investment is causing more new clean electricity generation to be added to the grid than would occur without it—is a common metric when procuring renewable electricity, and BU incorporated it into its decision-making process. Including the avoided emissions of a project as well, however, unlocked a critical new opportunity for the University to leverage its buying power for greater emissions reduction.

With the goal to displace the greatest amount of greenhouse gas emissions possible, Boston University needed to look beyond the relatively clean New England grid. It considered projects in the four most carbon-intensive regions in the country.

To achieve its energy-procurement mandates, BU implemented a multi-tier selection process and enlisted internal and external partners to support the work, beginning with a Request for Proposals (RFP). This team of partners evaluated proposals against a list of minimum requirements, including GHG emissions reduction, additionality, education and research opportunities, project economics, size, and contract period. From there, the team chose twelve projects for further evaluation that included a detailed avoided emissions analysis (Figure 1). This led to a short list of projects for BU to evaluate in more detail using weighted selection criteria (Figure 2).

Annual Avoided Emissions Project Comparison

Avoided emissions of each project under consideration for comparison



With this information, BU selected a project in South Dakota that met all its criteria and generated the greatest potential impact. Including emissions reduction in its decision-making process ultimately resulted in BU achieving more than double the emissions reduction compared to a local project.

FIG. 2

BU Project Selection Matrix

CRITERIA	WEIGHT	WEIGHTED RANK			CRITERIA EXPLANATION	NOTES
		SOLAR 1	WIND 7	WIND 9		
Impact New Build	Required	X	X	X	Project will generate new renewable power that would not otherwise have been generated	Project additionality is a prequesite
Education & Research Opportunities	Required	X	X	X	Project will benefit students and faculty by allowing access to the project sites and real time data	Access to real time data and access to the project site(s) is a prerequisite
Green-e Certified RECs	Required	X	X	X	Third party certified project-based RECs	Project-based Green-e Certified RECs are necessary to validate the claims for the emissions reductions
Project Developer Financial Strength	Required	X	X	X	Long-term owner/operators have resources, experience, and financial strength to manage relationship over term	
Bid Size Flexibility	Required	X	X	X	Ability to provide 200,000 MWh/yr or 100,000 MWh/yr capacity to allow flexibility on strategy as determined by BU	
Project Economics (strong NPV/MWh)	30%	3	1	2	Financial strength based on risk-adjusted, projected cash flows, and impact on BU financial position and credit rating	The driver in a Contract for Differences is the margin modeled between the PPA price and the grid price/MWh. Favorable project ecoonomics are a prerequisite
GHG Reduction (CO_2e lb/MWh)	30%	3	1	2	Projected likely marginal GHG savings per MWh over the term of the project; favor projects with highest overall GHG reduction with consideration for higher early reductions	Strong correlation between high grid carbon intensity at time of renewable energy production; the purpose of is to maximize the BU's impact on GHG reduction
Environmental & Health Co-benefits	20%	2	1	2	Favor projects with lower construction and operational environmental and health impacts	
Ingegration with BU on-site procurement	10%	1	1	1	Integrate PPA purchases and sales into BU's energy purchasing through hedges or other mechanisms	
Term Length	10%	2	2	1	Offer 12 vs 15 year term; shorter term length ranks higher	
Average Weighted Rank:		2.5	1.1	1.8		

Key Inputs and Resources

Key factors in BU's success with its energy-procurement project stemmed from securing buy-in from internal decision makers. This began with the inclusion of selection criteria developed by the Climate Action Plan Task Force, whose Plan recommendations were approved by the University's Board of Trustees. With this approval, the BU Sustainability team was empowered to select the project with the most impact potential, while avoiding the need to increase student tuition.

BU also engaged credible partners to aid in the careful assessment of financial risk, return on investment, and cost effectiveness. While internal market experts at BU assessed project risk and financial performance, a market advisor, Edison Energy, managed the RFP process and determined projected project performance. Researchers at Carnegie Mellon University provided hourly emissions data, BU Sustainability performed the renewable energy versus GHG emission analysis, and WattTime, an environmental non-profit, provided validation.

BU's success with its energy-procurement project stemmed from securing buy-in from internal decision makers, which allowed the BU Sustainability team to select the project with the most impact potential, while avoiding the need to increase student tuition.

Key Outputs

By including avoided emissions as part of its energy-procurement decision-making, BU selected a project with more than double the emissions reduction than available local projects. The University executed a power purchase agreement (PPA) for a 48.6-megawatt project in South Dakota which, once it comes online later in 2020, is expected to match the 205,000 megawatt-hours of electricity BU consumes every year.

BU will buy and resell the power for use in the midwestern United States and the third-party verified renewable energy certificates (RECs) will be retired on behalf of BU. Bundling the sale of power with RECs in a PPA is critical to ensuring additionality. This work, along with the other clean-energy strategies the University is employing, moves BU closer to reaching net-zero emissions across its campuses and global operations by 2040.

Replicating for Impact

Any organization considering a PPA as part of its electricity procurement strategy should include an emissions assessment as part of its selection criteria. This ensures project procurement in regions that will result in the greatest impact on emissions globally, without sacrificing other important factors.

In addition, to maximize emissions reductions, companies should consider options beyond variable renewable sources, such as:

- New generation from firm, dispatchable zero-carbon sources like geothermal, advanced nuclear, hydropower, and fossil with carbon capture and storage (CCS); and
- Existing zero-carbon sources (nuclear generators, for the most part) that are at risk of being shut down.

Electricity purchasers should measure the avoided emissions of every project under consideration. Where possible, they should steer investment to projects that result in greater emissions reductions. The detailed emissions assessment using marginal emissions can be conducted broadly as part of the initial RFP process or with a short list of projects and can be conducted internally through a clean energy advisor or via a third party that specializes in such.

ELECTRICITY CASE STUDY

Energy Storage Procurement
Enel X

ACTION:

Acquire energy storage in ways that reduce emissions and create demand for longer-duration solutions. Ensure these solutions are co-optimized for cost savings and emissions reduction

Overview

Enel X has begun to include emissions co-optimization in its storage-control systems, which helps solve a problem that made energy storage an inadvertent contributor to emissions increases. Consequently, the company is turning behind-the-meter energy storage into an emissions-decreasing technology.

Challenge

In response to both customer demand and government incentives motivated by climate goals, resiliency, and cost savings, energy service providers are increasingly deploying energy-storage solutions, like batteries, that can smooth out the variability in wind and solar generation and thereby reduce GHG emissions. However, recent research suggests that batteries themselves do not inherently reduce emissions, because behind-the-meter energy storage is often operated for rate savings instead of emissions reduction. Because retail rates do not align with real-time grid or environmental conditions, GHG emissions may actually increase overall despite the use of battery storage.

Goals

To solve this problem, energy-service provider Enel X looked to deploy energy-storage technology in a way that would reduce emissions. Batteries can take advantage of the flexibility of rate structures by discharging during critical peak demand periods and recharging when power is cleanest. The company used software from WattTime, an environmental non-profit, to optimize for both cost and emissions reductions in its storage-control systems and made this technology available to customers around the world.

Operational Overview

Enel X learned about emissions-optimized storage procurement from the Self-Generation Incentive Program (SGIP) in California, which provides significant incentives for energy-storage deployment. In 2016, the California Public Utility Commission (CPUC) began evaluating the emissions impact of energy storage and found that these incentives in fact led to an overall increase in emissions on the California grid. To solve this problem and ensure SGIP would help California meet its climate goals, the CPUC began assessing how to restructure requirements to reduce emissions on an annual basis.

As an energy-storage developer, Enel X continually evaluates opportunities to refine its technology so that it aligns with climate objectives. After CPUC released an SGIP impact report in 2016 (and other academic research pointed toward similar emissions increases from storage deployment), Enel X began evaluating opportunities to ensure its storage technology led to better climate outcomes. The WattTime software technology allows Enel X to store electricity in ways that reduce emissions while still minimizing costs. Enel X has now integrated the capability into the systems they sell to customers.

California has also updated their SGIP program rules to address this unintended emissions increase. Regulators have included a requirement that storage systems must reduce emissions by 5kg CO2 per kilowatt hour of installed capacity to be eligible for their incentive. If systems do not achieve this threshold, the incentive will be reduced by $1,000 per ton of emissions above it.

Enel X's e-Mobility team has developed a similar capability for stationary storage via its JuiceNet Green program (also powered by WattTime). This program facilitates charging of electric vehicles when the cleanest energy is available on the grid.

Key Inputs and Resources

Since companies often use energy storage to save money, technology deployment may be driven by teams outside of a company's sustainability group, such as facilities or energy. As a result, it is important for these teams to collaborate to ensure that energy-storage projects do not move forward unless they also reduce emissions. Since this emissions co-optimization may potentially affect cost savings, the team will also need to work with other internal partners to model and determine how aggressive the emissions savings can be. Third parties like WattTime provide a real-time marginal emission signal and detailed forecasts that companies can integrate into their energy-storage controls.

A storage developer who can provide energy-storage controls that integrate emissions co-optimization is important. The developer should also be capable of providing modeling services to determine both cost and emission savings tradeoffs.

Key Outputs

Enel X turned batteries from a GHG emitter to a GHG reducer with minimal financial burden by including co-optimization. By including a small carbon price in the controls optimization and slightly shifting charging to more-favorable times from an emissions standpoint, the system was able to reduce emissions by more than 30 percent, while still achieving the bulk of the cost savings.

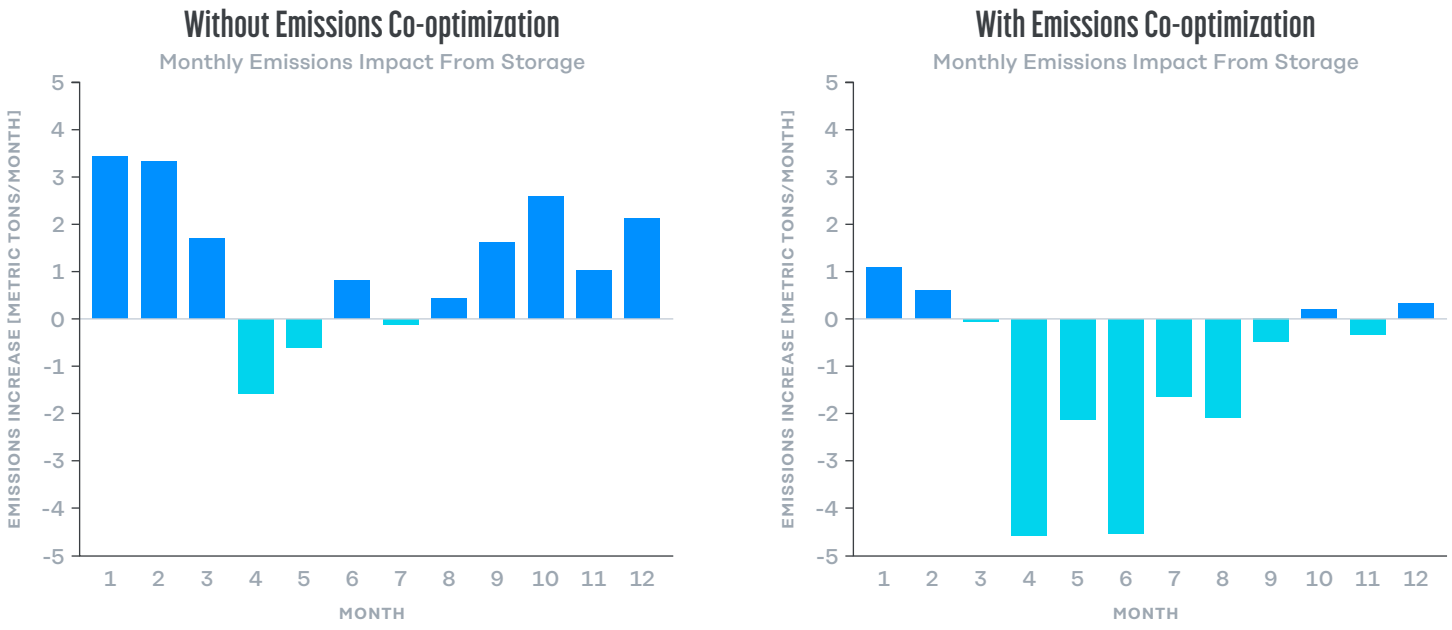
Impact of Co-Optimization on Monthly Emissions

CARBON PRICE	ANNUAL BILL SAVINGS	GHG EMISSIONS REDUCTION
$0/metric ton	$111,316/year	14.6 metric tons/year increase
$1/metric ton	$111,242/year	13.7 metric tons/year decrease

More specifically, the technology reversed the emissions impact of a battery from generating 15 metric tons/year of emissions to reducing emissions by 14 metric tons/year, while reducing cost savings by less than 0.1 percent ($74/year). Figure 1 shows the impact of co-optimization on monthly emissions performance.

FIG. 1

Monthly Emissions Performance Before and After Co-Optimization

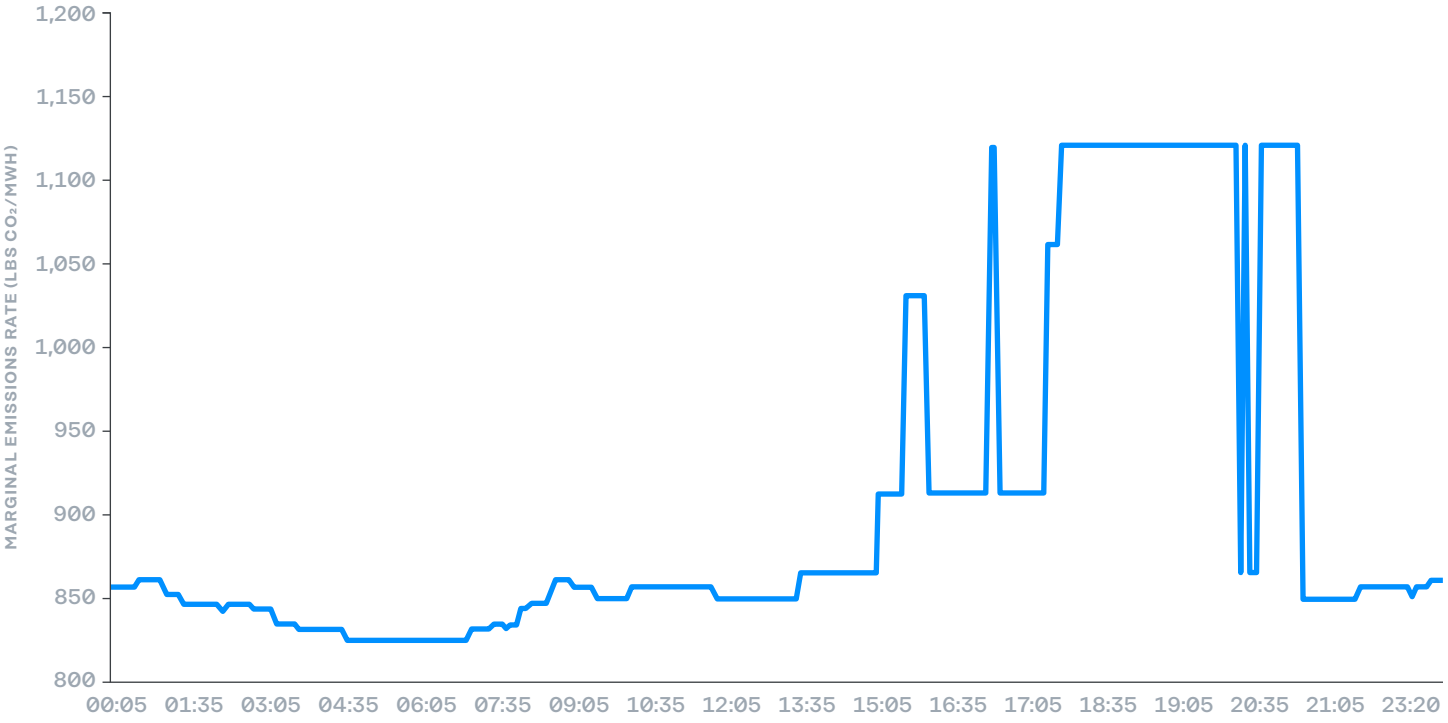


Replicating for Impact

Most behind-the-meter storage systems today only consider cost when charging and discharging. This typically causes increased emissions. Co-optimizing for both cost and emissions reductions is relevant for any entity considering or using energy storage for cost savings alone. These co-optimized systems can take advantage of the variation in grid emissions across a day, as seen in Figure 2.

FIG. 2

Granular Variation in Grid Emissions – California Independent System Operator (CAISO), 7/13/2019



This co-optimization approach can be used in any type of storage: thermal or electrochemical, short- or long-duration. In order to maximize climate impact, companies should only work with energy-storage developers that can provide this key capability.

Companies should also begin looking to procure long-duration storage solutions. As seasonal trends in emissions become more pronounced and renewable overgeneration becomes more common, long-duration storage will need to play a larger role in reducing the emissions of the electric grid.

ELECTRICITY CASE STUDY

PPA Buyer Aggregation
Massachusetts Institute of Technology (MIT)

ACTION:

Aggregate buyer demand to pursue power purchase agreements (PPAs) and other high-impact electricity procurement contracts collectively

Overview

As MIT proved with several partners in the Boston area, when smaller organizations band together to procure large-scale clean-electricity projects through power purchase agreements (PPAs), they can achieve much greater greenhouse gas (GHG) emissions reductions than they could as individuals.

Challenge

While large corporations have recently been procuring more clean electricity, many of these power purchase agreements (PPAs) remain out of reach for smaller organizations. That is because large-scale PPAs often exceed the power requirements of smaller organizations or have complex contracting requirements that can be difficult to navigate.

Goals

Massachusetts Institute of Technology (MIT), Boston Medical Center, and Post Office Square Redevelopment Corporation shared two common goals: to procure reliable, affordable power and increase the generation of clean electricity. Consequently, they used their combined size to pursue a larger clean-energy project than each individual partner would have been able to manage—while incurring less risk and accessing better financial conditions for the deal at the same time.

Operational Overview

In 2016, these diverse partners—a top-line research university, the largest Level 1 trauma center in New England, and a parking facility in the center of Boston's Financial District—came together in pursuit of a PPA for a solar project. As the largest buyer out of the group, MIT took the bulk of the electricity generated by the project.

The partners' alignment in support of a new renewable project made it easier to balance each party's priorities: price stability mattered most to Boston Medical Center, maximizing environmental benefits was MIT's focus, and Post Office Square had smaller energy needs. These three committed organizations ensured that the contract negotiations could advance toward a deal.

Key Inputs and Resources

External advisors can help close gaps in expertise and provide third-party support when needed. In this case, the three partners jointly engaged advisory firm CustomerFirst Renewables early in the process to educate the team and provide market expertise, contract negotiations, and neutral guidance for selecting the project.

Key Outputs

Thanks to this collaboration, a 60-megawatt solar project in North Carolina came online. MIT took more than two-thirds of the resulting output.

Replicating for Impact

Partnering with other organizations can make it possible for an organization of any size, not just big corporations, to procure clean electricity by bringing larger deals within reach.

The structure of the partnership can vary. In many cases, larger organizations (MIT, in this case) will serve as the anchor off-taker and bring in smaller buyers to create additional demand. In other instances, smaller organizations can lead these procurements by teaming up and pooling resources to structure an agreement.

To find aggregation partners, private-sector organizations can look for others with similar goals and commitments to sustainability. Partners from the same geographic region may already be in communication about sustainability goals.

No matter the size or location of parties, clear communication and alignment on goals is essential to successfully engaging in a PPA aggregation. Defining roles and expectations, making priorities clear, and setting a process for decision-making will all help avoid hurdles that slow the process down.

Specifically, the parties should align early on key questions for the PPA, including:

- Risk tolerance;
- Financial performance;
- Procurement mechanism;
- Region where the project is located (local or remote); and
- Treatment of renewable energy certificates (RECs) from the project (retire, arbitrage, or disregard)

The contract used to procure energy can also vary, but a single standardized contract that is minimally customized for each partner will simplify negotiations with the developer. In addition, a neutral, third-party clean-energy expert is an essential part of the procurement process. The advisor can educate the teams on factors affecting the PPA, ensure everyone is operating with the same information, and interpret Request for Proposals (RFP) responses. Their guidance can also help partners identify issues and resolve disagreements where necessary. In addition, sharing a clean-energy advisor and legal counsel can help partners cut costs.

PROCUREMENT

Case Studies: Transportation

Recommended Corporate Actions on Transportation Procurement:

- Decarbonize fleets by purchasing electric vehicles (EVs), using low-carbon fuels, and procuring highly fuel-efficient modes of transportation.
- Leverage purchasing power to scale the production of emerging low-carbon fuels like sustainable aviation fuel (SAF).
- Support novel applications for transportation-related technologies, including hydrogen-powered forklifts in warehouses and fast-charging EV infrastructure.
- Reduce emissions from employee travel by decreasing work-related travel when applicable and committing to lower-carbon alternatives.

PROCUREMENT

Globally, the transportation sector makes up roughly 16 percent of GHG emissions. However, in many countries—including the United States—emissions from cars, planes, trucks, trains, and ships are growing to become the largest national contributor to climate change.

In recent years, the sector has seen significant progress on the path toward net-zero emissions. Paired with a decarbonized grid, electrification is one of the most promising pathways for vehicles that travel shorter distances. Since 2010, the cost of lithium-ion batteries has declined by 85 percent, which has made electric vehicles (EVs) increasingly competitive for a wide range of applications. But despite these encouraging developments, the sector still relies primarily on fossil fuels.

Companies and private-sector organizations can accelerate the transition away from these emissions-intensive fuels by buying EVs. This, in turn, will create demand for charging infrastructure and help develop a robust network of charging stations across the world.

While electrification will be critical to the decarbonization of transportation, it likely will not solve all the sector's challenges. Unless we achieve major breakthroughs in battery technology, electricity may not feasibly support long-distance modes of travel such as aviation, maritime shipping, and long-distance trucking. Developing cost-competitive low-carbon fuels will be critical to reducing emissions from those industries in an affordable way.

As such, companies should leverage their purchasing power to scale the production of emerging low-carbon fuels like sustainable aviation fuel (SAF), renewable diesel, advanced biofuels, and green hydrogen. Fuel consumers, such as airlines and freight transporters, can commit to buying lower-carbon alternatives to traditional fossil fuels. Companies who benefit from these services can also pay a green premium to create early markets for these fuels.

Beyond EVs and low-carbon fuels, corporations and private-sector entities should look for opportunities to support innovative applications for transportation-related technologies, including hydrogen-powered forklifts in warehouses and super-fast charging EV infrastructure in parking lots. All companies, even those without fleets of their own, can play a role in reducing transportation sector emissions by decreasing work-related employee travel and committing to lower-carbon alternatives like SAF.

TRANSPORTATION CASE STUDY

Low-Carbon Fleets
FedEx

ACTION:

Decarbonize fleets through purchasing electric vehicles, utilizing low-carbon fuels, and leveraging highly fuel-efficient modes of transportation

Overview

Over a decade ago, FedEx set ambitious decarbonization goals for its transportation fleets and has since worked to achieve them using a diverse set of technologies. Among its strategies to reduce emissions are reducing fuel usage through operational efficiencies, replacing vehicles with more-efficient models, and increasing the procurement of cleaner vehicles.

Challenge

For public- and private-sector fleet owners, managing the risks that accompany the replacement of fossil fuel-based vehicles with low-carbon alternatives can be challenging. Decarbonizing a fleet requires handling multiple dynamic factors adeptly, including operations, infrastructure requirements, technology readiness assessments, and financing strategies. While significant improvements can be made using existing products, emerging vehicle technologies will often be necessary to achieve a net-zero emissions fleet. Setting outcome-based decarbonization objectives (i.e. not locking in specific technologies for procurement), will allow multiple solutions to be tested and implemented while facilitating adoption of the least-expensive, best-performing technologies.

Goals

As a global shipping corporation, FedEx is responsible for a fleet of over 650 aircrafts and 180,000 vehicles around the world. Fuel consumption makes up over 90 percent of the total emissions footprint for the company. For over a decade, as FedEx has worked to reduce its carbon emissions, the company has continued to establish more aggressive targets for the adoption of cleaner transportation solutions.

FedEx's current commitments include:

- Reducing aircraft emissions by 30 percent (from a 2005 baseline) by 2020;
- Increasing FedEx Express vehicle efficiency by 50 percent (over 2005) by 2025;
- Obtaining 30 percent of jet fuel from alternative means by 2030; and
- Expanding on-site renewable energy generation.

Operational Overview

More than ten years ago, FedEx made a public commitment to lower the carbon intensity of its operations. An analysis of the company's carbon footprint showed that aviation was its single largest source of greenhouse gas (GHG) emissions, followed by vehicles, energy usage in facilities, and consumption of materials (especially paper/paper board). FedEx established goals to reduce emissions from these sources that are tracked and reported annually. These goals align with their corporate sustainability strategy to "reduce, replace, and revolutionize" operations across their business units.

FedEx began setting goals for fuel efficiency in 2008. As it meets each target, the company has continued to increase its level of ambition, giving the procurement and fleet-management teams the flexibility to meet clean objectives with a diverse set of solutions. These include electric vehicles (EVs), fuel cells, compressed natural gas, and route optimization. Meeting the current target (a 50 percent reduction in fuel efficiency over 2005 levels by 2025) will require the company to deploy existing strategies more widely and to introduce new technologies and new business models.

In late 2018, FedEx announced an expansion of its vehicle fleet: 1,000 new medium-duty electric panel vans for use in California. The company purchased one hundred of these vehicles from electric truck company Chanje and leased the other 900 from transportation and supply-chain management provider Ryder System. Ryder will support the electric trucks in the FedEx fleet primarily through its ChoiceLease program, which allows FedEx to tailor the maintenance package included with the lease—a type of operating flexibility that is essential to overcoming barriers to EV adoption. FedEx has also pursued additional technology partnerships, such as demonstration of platooning of heavy-duty vehicles in partnership with Volvo Trucks North America, that will help them achieve their sustainability goals.

FedEx has also made significant progress in addressing aviation emissions. The company launched a program called Fuel Sense that is designed to minimize the amount of fuel and energy aviation operations use. It includes over fifty corporate initiatives, including reducing engines while taxiing, upgrading the aviation fleet, and connecting to ground power at gates immediately. These activities help reduce fuel consumption and increase the use of lower-emission sources of energy.

FedEx has also partnered with Red Rock Biofuels on alternative fuels and put in place an offtake commitment, or purchasing agreement, for 50 percent of their planned production. In addition, FedEx participates in the public-private coalition "ecoDemonstrator" that tests advanced technologies on aircraft and shares its findings.

Key Inputs and Resources

Fleet owners must figure out how to prioritize, analyze, and implement methods to decarbonize their fleets, including operational improvements and deploying new technology. FedEx formed Sustainability Impact Teams to address their four priority impact areas—aviation, vehicles, buildings, and materials—and introduced crosscutting initiatives focusing on data and reporting. These standing teams, which meet regularly to facilitate implementation

of sustainability best practices across the organization, work to "compete collectively and manage collaboratively."

Executive leadership's buy-in is critical for any decarbonization strategy to be successful. FedEx's outstanding, long-term support for sustainability principles is demonstrated by its strong management, sufficient funding to meet climate objectives, and willingness to increase the ambition of targets once they are met. In addition, company executives have taken leadership positions in industry efforts to address climate change, including the Electrification Coalition.

FedEx has also developed partnerships with leading technology developers to deploy best-in-class technologies that can address long-term emissions reduction. It provides offtake agreements with low-carbon fuel suppliers and participates in pilots to accelerate technology development.

In FY2019, vehicle fuel efficiency reached a total of 40.9 percent improvement over the 2005 baseline. The company achieved this by continuing to upgrade the vehicle fleet and implement new technologies, including alternative fuels; improving in advanced automation; and optimizing its routing.

Key Outputs

Each year FedEx publishes a Global Citizenship Report where it details progress across its multiple corporate social responsibility (CSR) objectives, including aircraft emissions, alternative fuels, vehicle fuel efficiency, and clean electricity.

In FY2019, vehicle fuel efficiency continued to improve, reaching a total of 40.9 percent improvement over the 2005 baseline. The company achieved this by continuing to upgrade the vehicle fleet and implement new technologies, including alternative fuels; improving in advanced automation; and optimizing its routing.

Replicating for Impact

FedEx has been successful in reducing its GHG emissions because of the company's long-term commitment, strong partnerships with technology suppliers, and rigorous evaluation of metrics that ensure climate goals align with improved performance. Leadership from the top has been essential to this overarching procurement strategy and in ensuring that all FedEx stakeholders are coordinated in their pursuit of corporate goals. FedEx also continually updates their sustainability strategy, which allows them to replace vehicle fleets with new low-carbon technology as it develops. Extensive data on variables such as routes, local infrastructure, and fleet age helps FedEx evaluate the impact of potential policies, target locations for testing, and launch new vehicle technologies across their global operations.

Relying on partnerships has been critical to success as well. Programs such as Ryder's ChoiceLease program allowed FedEx to leverage external expertise, outsource training of key personnel, and reduce risks of fleet performance.

As companies look toward low-carbon fleets, they should first look toward existing initiatives and resources to facilitate their procurement. Efforts such as the Electrification Coalition, EV100, and Below50 provide valuable information and tools to help companies and cities electrify their infrastructure. One relevant program, Fleets for the Future (F4F), is a national partnership that includes regional councils, the Electrification Coalition, Clean Cities coalitions, and other industry experts tasked with creating a national procurement initiative. Fleet owners of all sizes can benefit from best practices for procurement strategies and save costs on both vehicles and related infrastructure.

TRANSPORTATION CASE STUDY

Sustainable Aviation Fuel
Microsoft, KLM, Alaska Airlines

Overview

By providing firm demand signals for certified sustainable aviation fuel (SAF), Microsoft collaborated with airline partners to help spur SAF development and adoption (along with other low-carbon fuels), reducing the risk to clean fuel producers as they commit to building larger production facilities.

Challenge

Aviation is one of the largest-emitting industries in the world today: it is the source of more than 2 percent of global emissions—more than all of Germany. Despite the COVID-19 pandemic's disruption to global travel patterns, commercial aircraft emissions could triple by 2050 given the projected growth of passenger air travel and freight. Using SAF can significantly reduce this overall carbon footprint, with possible carbon reductions of up to 80 percent relative to conventional fuels. Today's SAF, however, is more expensive than traditional kerosene, and existing supply makes up only a small fraction of overall jet fuel production.

ACTION:

Leverage purchasing power to scale the production of emerging low-carbon fuels like sustainable aviation fuel (SAF)

Goals

Since business travel is a major driver of its carbon footprint, Microsoft sought opportunities to reduce emissions associated with aviation—one of the hardest industries to decarbonize, with only a limited set of technological options currently available.

To identify high-impact opportunities to address employee air travel, Microsoft partnered with two airlines:

- Alaska Airlines, to cover Microsoft's most-traveled routes using SAF from SkyNRG.
- The airline carrier KLM, whose Corporate SAF Program helps companies invest in low-carbon fuels.

Through these efforts, Microsoft set out to:

- Significantly reduce emissions for employee travel; and
- Create an early market commitment to procure SAF, sending a demand signal to producers, investors, and other industry players.

Operational Overview

Microsoft wanted to increase its level of ambition in addressing its greenhouse gas (GHG) emissions. In 2019, after working to understand the challenges facing the aviation industry, the company set out to create more market demand for SAF. After evaluating potential partnerships with several airlines, Microsoft selected KLM because of its commitment to sustainability and interest in long-term decarbonization. In 2020, Microsoft selected Alaska Airlines, given its strong and long-standing commitment to sustainability. It was an early test case user of SAF in passenger travel, flying nearly 80 flights over the past 10 years.

Microsoft's commitment to procure SAF helps create demand for emerging, low-carbon fuels, thereby supporting their development, increasing their production, and reducing their costs.

In 2012, KLM developed the Corporate SAF Program, formerly known as the Corporate Biofuel Program, to help their corporate partners reduce aviation emissions. Through this program, companies can pay a green premium—the difference in price between SAF and traditional kerosene—and get credit for the emissions reductions from displacing the fossil-based jet fuel. KLM sources fuel from SAF providers like World Energy, which supplies fuel from its facility in Paramount, California to the Los Angeles and San Francisco airports.

Key Inputs and Resources

Microsoft has committed to addressing climate change across all its business units. Through its internal carbon price, Microsoft incorporates climate impacts into all its business decisions. Having buy-in from senior leadership, as well as dedicated staff across the Corporate, External, and Legal Affairs department, was critical to the projects' success. This effort in particular was a collaboration between Microsoft's Global Travel Team and the Carbon Program, which oversees the company's commitment to carbon neutrality. These teams were dedicated to ensuring the project achieved climate goals and met standards for environmental integrity.

The team at KLM was also integral in moving the project forward. Because of the company's existing relationships with SAF suppliers through the Corporate SAF Program, it was able to develop and sign a Letter of Intent (LOI) with Microsoft in only a few months.

In addition, Microsoft partnered with leading NGOs to understand the SAF market in greater detail, including the Environmental Defense Fund (EDF) and through participation in the World Economic Forum's Clean Skies for Tomorrow. The Forum's Clean Skies for Tomorrow initiative is a purpose-built platform for leaders throughout aviation's value chain to facilitate the transition to net-zero flying by mid-century.

Key Outputs

Participation in KLM's Corporate SAF Program enabled the purchase of an amount of SAF equivalent to all flights taken by Microsoft employees between the U.S. and the Netherlands on KLM and Delta Airlines. From SkyNRG, Microsoft purchased the equivalent carbon reduction to address CO_2 emissions equivalent to Microsoft employee travel between Seattle-Tacoma International Airport to San Francisco International Airport, San Jose International Airport, and Los Angeles International Airport — the three most popular routes traveled by Microsoft employees on Alaska Airlines.

Beyond this commitment, Microsoft's interest in reducing its emissions helps create demand for emerging low-carbon products. This allows these technologies to reach economies of scale and reduce costs.

Replicating for Impact

For many companies, employee travel is the largest contributor to greenhouse gases. Whenever possible, these organizations should consider limiting travel and using technology-enabled methods for collaboration. The COVID-19 pandemic of 2020 already forced many companies to find ways to conduct essential business without employee travel, and they can and should apply many of these lessons in normal times as well.

Work-related travel, however, will likely remain an integral component of business operations. Until battery technology develops significantly and scientists achieve breakthroughs in energy density, electric aircrafts will likely not be able to fly long distances. Developing cost-competitive SAF will thus be critical to decarbonizing the industry.

Commercial airlines are the largest buyers of jet fuel, so they will be critical to reducing costs. Alongside KLM, airlines such as United, British Airways, Virgin, and Delta have also made commitments to developing SAF and reducing GHG emissions.

Companies with large travel footprints can also play a significant role in creating demand for SAF. By paying a premium for emerging, low-carbon fuel, companies can support the development of this technology, increase its production, and drive down its costs.

In addition to KLM's Corporate SAF Program, other programs also help companies address long-term decarbonization of aviation. SkyNRG, a company based in the Netherlands, offers a Board Now program to support companies with SAF procurement.

Microsoft joined the Board Now program as part of its Alaska partnership.

PROCUREMENT

Case Studies and Tools: Buildings

Recommended Corporate Actions on Buildings Procurement:

- Implement net-zero buildings practices for new construction and retrofits for office space and facilities, including:
  - Onsite electricity generation,
  - Highly efficient, all-electric equipment,
  - Advanced envelope solutions, and
  - Next-generation building management.
- Use load flexibility in end-user devices such as EV chargers, smart thermostats, hot water heaters, or batteries to reduce emissions, improve energy efficiency, and minimize consumption.
- Utilize lower-carbon materials—such as cement produced with carbon capture technology, steel refined with green hydrogen, or bio-based materials like cross laminated timber—in the construction of new buildings. Companies can use tools like the Embodied Carbon in Construction Calculator to procure these lower-carbon materials.

PROCUREMENT

Along with the manufacturing of building and construction materials such as cement, steel, and glass, the non-residential building and construction sector accounted for nearly one-quarter of total global GHG emissions in 2018. This calculation also includes the emissions from end-use electricity consumption, coolants like hydrofluorocarbons (HFCs), and the embodied carbon of materials used in construction.

Operational carbon emissions, or those associated with a building's operations, include the energy used for lighting, heating, cooling, and powering equipment and appliances. Over the last 30 years, the buildings industry has made significant progress in reducing these emissions. Best practices for implementing improvements in electrification and energy efficiency range from simple no- and low-cost improvements to more expensive upgrades that may be funded via long-term savings.

Still, according to ENERGY STAR, the average commercial building today wastes 30 percent of the energy it consumes. Companies can help accelerate the transition toward net-zero energy buildings by further reducing operational emissions. They should also implement net-zero practices for new construction and retrofits of office space and facilities, including onsite generation, highly-efficient all-electric equipment, advanced envelope solutions, and next-generation building management.

Corporations who already use all-electric infrastructure can go even further. Up to 70 percent of electricity end-use is flexible, and the marginal emissions of the grid changes as often as every five minutes based on underlying sources of electricity. To maximize climate impact, companies should use load flexibility in end-user devices such as EV chargers, smart thermostats, hot water heaters, or batteries to reduce emissions, improve energy efficiency, and minimize consumption. Buildings can also act like batteries, shifting electricity demand to cleaner periods through real-time controls and automation.

In addition to operational carbon emissions, buildings contribute to climate change through the manufactured cement, steel, and iron used to make them. These are known as embodied carbon emissions. Operational carbon emissions can be reduced over time, as things like HVAC systems become cleaner and more energy efficient. Embodied carbon emissions, by contrast, are locked in place as soon as a building is built.

Embodied carbon encompasses the emissions associated with extraction, manufacturing, transportation, and installation of all the materials that are

needed to make a building. These "upfront" emissions include everything up to the point that a building actually turns on the lights and begins to operate. Experts estimate the emissions from manufacturing building materials comprise more than 11 percent of global emissions. To reduce these emissions, companies should use lower-carbon materials—like cement produced with carbon capture technology, steel refined with green hydrogen, or bio-based materials like cross laminated timber—in the construction of new buildings.

Although these emissions are getting more attention today, it has been difficult until recently for decision makers to map and compare materials. A new, free open-access tool, the Embodied Carbon in Construction Calculator, can help companies procure lower-carbon materials.

BUILDINGS CASE STUDY

Net-Zero Energy Buildings
United Therapeutics

ACTION:

Implement net-zero buildings practices for new construction and retrofits for office space and facilities

Overview

United Therapeutics Corporation learned a great deal from the design and construction of a net-zero energy building on its corporate campus. Other companies that want to undertake a transformative sustainable building project or apply building retrofits can benefit from this experience.

Challenge

Many buildings are heated using natural gas, propane, and electricity that comes from fossil fuel generation. While net-zero energy buildings can be found around the world, they are often located in areas with enabling implementation features such as favorable climate and significant open space. Biotechnology company United Therapeutics did not have these advantages in 2012 as they looked to build in downtown Silver Spring, Maryland. Their team took on a very difficult challenge: to build in an urban environment, with full on-site energy generation in the hot and humid Mid-Atlantic region.

Goals

In 2012, United Therapeutics established specific high-level objectives for the newest addition to its corporate campus, a 210,000-square-foot complex called the Unisphere. These included the achievement of a net-zero energy complex, renewable energy generation on-site, and a 70–75 percent reduction in overall energy consumption (compared to a benchmark building).

The specific operating goals for Unisphere's design and construction were:

1. Integrate systems to reduce energy use and optimize building performance during operation.
2. Create a system that responds to changes in state, including temperature, daylight, occupancy, and energy use.
3. Integrate the appropriate level of systems to support the net-zero energy goals.
4. Through the execution of invaluable controls mock-ups, ensure that specified equipment, devices, and systems could be integrated easily and early enough to influence procurement decisions.
5. Include provisions for the system to learn over time to improve energy efficiency further.
6. Inform and educate the occupants on how to effectively be a part of the net-zero success story through real-time building performance feedback and visual cues.

Operational Overview

In 2012, United Therapeutics partnered with architecture and engineering firm EwingCole and construction manager Whiting-Turner to design and build the Unisphere complex. These firms modeled and designed the building's energy profile to integrate several commercially available green technologies including:

- On-site solar photovoltaic power generation;
- An expansive geothermal exchange system to allow the design of a significantly more efficient HVAC system;
- Centralized controls and plug-load management with an enhanced power monitoring system;
- High-performance building envelope, with automated windows to ventilate the building and electrochromic glass technologies to manage the effect of solar heat gain;
- Earth-coupled heating/cooling, natural ventilation, and daylight harvesting;
- Water features to assist with passive thermal management; and
- Environmentally friendly finishes (such as carpet from recycled fishing nets), LED lighting, and accommodations for electric vehicles.

Since the Unisphere project was completed in September 2018, it has outperformed its design goals and achieved net-zero performance. It represents the largest net-zero commercial building in the United States.

Since the Unisphere project was completed in September 2018, it has outperformed its design goals and achieved net-zero performance. It represents the largest net-zero commercial building in the United States.

Key Inputs and Resources

United Therapeutics was dedicated to the success of the project. Company CEO Martine Rothblatt championed the net-zero objectives and mandated that energy performance would be the defining metric of the project. Rothblatt even insisted that the project team work to change state regulations that inhibited the installation of geo-exchange systems in urban areas.

EwingCole and Whiting-Turner were critical collaborators, as were the project's subcontractors—including Schneider Electric, which supported the integration of building controls. Early project alignment between supporting firms enabled the team to keep net-zero energy at the center of all considerations and did not sacrifice building performance during challenging design, permitting, or construction phases.

Key Outputs

After its completion in 2018, the Unisphere team worked for nine months to understand and refine the devices and controls and educate employees on the features of the building. The building demonstrated net-zero energy in its first year, obtained LEED Platinum certification, and diverted over 96 tons of construction waste from landfills during construction.

Replicating for Impact

Significant improvements to building electrification and efficiency can be applied for new construction and for retrofits to existing buildings. Energy modeling must be integrated fully within the project execution to ensure the building meets intended objectives. Below are ten best practices to consider for constructing more-sustainable buildings or, in part, for retrofit projects:

Matrix of Best Practices

Establish Net-Zero Energy/ Carbon Drivers	Align and Commit for Success	Establish Goals and Benchmarking	Evaluate Design Strategies	Modify Procurement Strategies to Prioritize Controls
Engage in Continuous Modeling	Design for Measurement and Verification	Plan for the Commissioning of the Project	Educate and Train the Building Occupants	Validate and Tune the Performance

Details for the Matrix of Best Practices

1 **Establish Net-Zero Energy/Carbon Drivers**
Establish ambitious goals for reducing climate impact and align the corporate mission toward realizing them.

2 **Align and Commit for Success**
The executive leadership and project execution teams must strongly advocate for the net-zero energy goal, and the collaborative team of owner, architect, occupants, and builder must work in unison toward meeting it. This culture from the top helps maintain focus in the face of the inevitable challenges that will arise.

3 **Establish Goals and Benchmarking**
Determine energy goals for the building based on its type and location. Evaluate different building system options and their potential impact on energy use. Estimate potential site renewable energy generation with multiple renewable strategies, including photovoltaics, wind, and fuel cells. Set goals that are challenging but realistic and validate them with continuous energy and production modeling throughout the design and construction process.

4 **Evaluate Design Strategies to Minimize Energy Consumption**
Begin with passive strategies which directly use natural energy sources, then move on to the most efficient active strategies for systems that use energy. Passive strategies can include solar orientation, daylight harvesting, natural ventilation, external shading, and passive heating and cooling such as earth ducts. Some active strategies to consider include geo-exchange, water or refrigerant-based systems, airside energy recovery, building automation, and plug-load management. Significant progress can already be made with the best "off-the shelf" technologies, without needing to take a risk on brand-new or untested technologies.

5 **Modify Procurement Strategies to Facilitate Early Engagement with Parties Responsible for the Implementation of Critical Project Elements**
Identifying the right contractor to oversee building controls is critical to the project's success. The procurement team should require a systems-integration mockup to be delivered within 150 days of engaging the controls contractor to prove integration capabilities of each system well-in-advance of actual systems installation. This virtual mock-up should prove out the specified control sequences and communications among all of the building's various systems and components.

6 **Engage in Continuous Modeling of the Project as it Progresses**
Continuously update and balance consumption and production models as design and construction progresses, being sure to include daylight and natural ventilation modeling. Any changes in equipment or installation should be incorporated to ensure net-zero energy goals will be met.

7 **Design with Measurement and Verification in Mind**
Create a measurement and verification plan for after occupancy and extend sub-metering to the appropriate levels, either at the electrical panel or circuit level. Strategize how to make large amounts of data usable and customize your dashboard to enable engagement and action.

8 **Plan for the Commissioning of the Project**
Engage an experienced commissioning agent from the design phase through early occupancy to ensure installed systems support the net-zero energy operating goals. Include post-occupancy service commitments for both the design and commissioning teams to validate performance and support ongoing operations.

9 **Educate and Train the Building Occupants**
Engage the occupants on an ongoing basis so they understand their role in the building's net-zero energy success. Create a user manual for the building and use data as a feedback tool for education with well-integrated displays showing important metrics and trends. Include the facilities-management team in the design and construction process to ensure they understand the importance of each system and their impact on the project's overall success.

10 **Validate and Tune the Performance**
Begin continuous monitoring of the building's performance against the consumption and generation models from the start. Determine why discrepancies occur and determine if changes can be made to optimize performance.

BUILDINGS CASE STUDY

Automated Emissions Reductions
Sonoma Clean Power

ACTION:

Use load flexibility in end-user devices and buildings to shift electricity demand out of high-emissions periods and into low-emissions periods

Overview

Sonoma Clean Power's work to design and build an energy-efficient headquarters highlights how building systems and end-use devices can reduce emissions through load shifting in response to a real-time grid signal.

Challenge

Devices and buildings consume significant amounts of electricity, but too often they still do not take advantage of load flexibility to reduce emissions. Dramatically increasing the number of building-control systems and smart devices such as electric vehicle (EV) chargers, thermostats, appliances, and batteries can take advantage of a real-time grid marginal-emissions signal to shift load and reduce emissions.

Goals

Sonoma Clean Power (SCP) is a Community Choice Aggregator in California serving Sonoma and Mendocino counties. This local not-for-profit electricity provider's standard power mix is 91 percent carbon free. It also produces an EverGreen product that is 100 percent renewable and produced entirely within its service territory. To align with its goal to turn the tide of the climate crisis, SCP is conducting a deep retrofit of its two-story wood-frame headquarters in downtown Santa Rosa as a low-emissions building, accomplished in part by leveraging end-load flexibility.

Operational Overview

Building loads have a lot of flexibility, offering an ideal chance to reduce greenhouse gas (GHG) emissions. For example, a building can shed load through EV chargers, battery storage, and conditioning systems during high-emissions periods and shift load to lower-emissions periods. SCP's building comes with a limited footprint and solar opportunities, so optimizing for load shifting became an important strategy. Consequently, SCP incorporated a microgrid to better integrate, control, and optimize energy assets. The microgrid controller enables load shifting for emissions reductions. It can also be operated independent of the grid, protecting essential services during local emergencies and providing a place of refuge to the community.

Key Inputs and Resources

SCP's mission centers on addressing climate change by making low-emission buildings a priority. To support that goal, SCP engaged architects and engineers who were committed to this mission and the overall project. EHDD led the project as the design architect; Point Energy Innovations produced the schematic mechanical and electrical design; and Guttmann & Blaevoet helped develop key sustainability and load flexibility strategies. Collaboration among these partners allowed the team to identify unique opportunities to reduce emissions.

Because most control systems are not capable of natively taking a real-time emissions signal, the design team worked with software engineers to convert a real-time emission signal to a price signal by adding a carbon price.

First, the building was designed to take advantage of basic energy efficiency measures like an upgraded envelope, comprehensive daylight access, and local thermal comfort controls to minimize overall building electricity demand, especially during high-emissions periods. Once they had designed a very efficient building, the team focused on load flexibility strategies.

The building's microgrid controller can respond to real-time grid conditions and emissions and adjust the following loads in response to a real-time emission signal:

- Energy storage
- Setpoint temperatures
- Lighting dimming
- EV charger
- Hot-water systems

To ensure the building reduces emissions as much as possible, the requirements that the microgrid controller be capable of shifting load in response to a real-time signal were written into the building design specifications. Because most control systems are not capable of natively taking a real-time emissions signal, the design team worked with software engineers to convert a real-time emission signal to a price signal by adding a carbon price. This real-time price, which acts as a proxy for the marginal grid emissions, can be sent to the microgrid controller through a real-time pricing capability.

Key Outputs

Incorporating a real-time emissions signal in the microgrid controller gives SCP the granular data it needs to optimize for emissions reductions without sacrificing financial performance.

While the new headquarters are not yet constructed, the design and construction are proceeding with this capability as a key feature. SCP will use this building to demonstrate emerging technologies and low-emissions operation to the community and reaffirm their commitment to an emissions-free electric grid.

Replicating for Impact

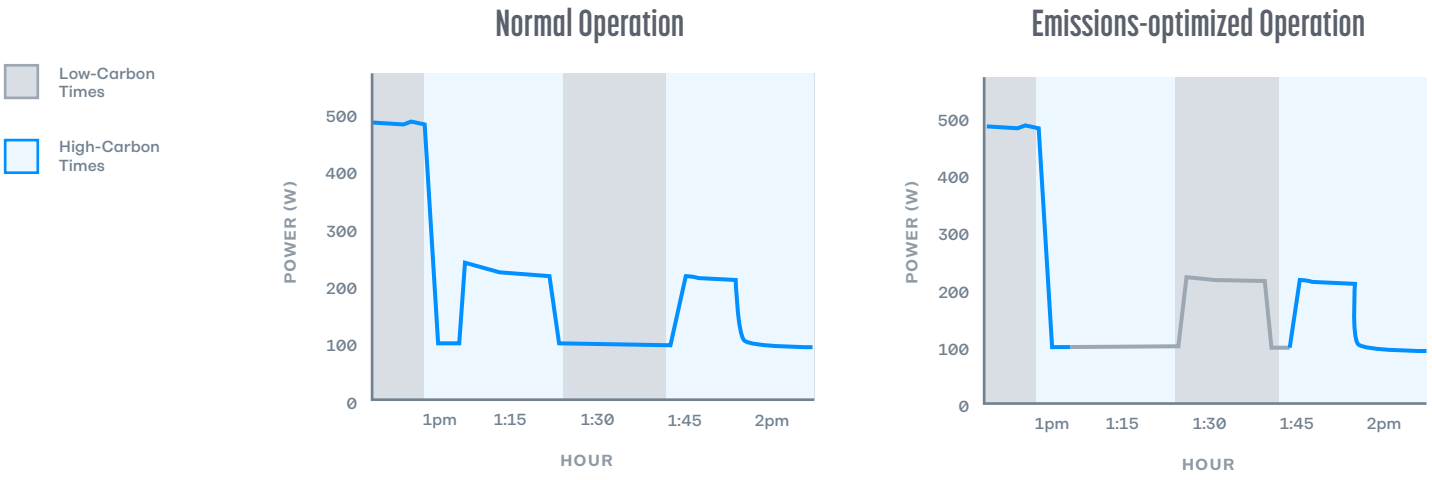
These cleaner load-shifting capabilities can be replicated by organizations of any size. However, organizations will need control over their building systems and energy consumption for this approach to be effective.

Building construction or remodels provide obvious opportunities to embed additional controls for emissions optimization, but existing buildings with any flexible load can also benefit. In new buildings or retrofits, the design team can build emissions load optimization in from the beginning. Otherwise, working with site managers and building engineers to identify flexible load can provide the opportunity to introduce this capability. For example, as Figure 1 shows, air-conditioner cycles can be aligned with low-emissions times on the electric grid without significantly impacting operations.

Building load control strategies that can respond to a varying emissions signal include zone temperature setpoints; short-term adjustments to duct static pressure controls to shift fan load, chiller, or compressor scheduling; and modulating and averaging ventilation rates over time. Buildings can integrate a real-time emissions signal into the building management system to shift load while still protecting occupants' comfort and ensuring reliable operation.

FIG. 1

Emissions-Optimized Device Operation



Load shifting for emissions reduction can also be integrated directly into end-use devices: EV chargers, smart thermostats, hot water heaters, or batteries, for instance. More and more of these smart devices are becoming available, making it possible to shift up to 70 percent of a building's load into lower-emissions periods.

BUILDINGS CASE STUDY

Low-Carbon Building Materials
LinkedIn

ACTION:

Use lower-carbon materials in the construction of new buildings

Overview

When LinkedIn designed and built a new 245,000-square-foot headquarters, the company demonstrated how using commercially available low-carbon concrete products for construction can significantly reduce the overall embodied carbon of a building or infrastructure project

Challenge

Cement, an important component of concrete, accounts for approximately 7 percent of global carbon dioxide emissions. Demand for cement and concrete is projected to grow significantly as these products are used to build buildings, water infrastructure, sanitation facilities, and highways throughout the world.

There are considerable challenges in developing lower-carbon cement and concrete that also meet performance criteria such as set time, strength, and compatibility with other materials.

Manufacturers can reduce the carbon footprint of concrete in a number of ways, including using low-carbon fuels during production, reducing the amount of cement in concrete, substituting cement with supplementary cementitious materials (such as fly ash and slag) and deploying carbon-capture technologies to directly sequester CO_2 and further optimize cement efficiency.

Goals

LinkedIn, the world's largest professional network with nearly 740 million members globally, has committed to reducing its global carbon emissions by 75 percent (relative to a 2013 baseline). In the construction of its new 245,000-square-foot, 1,000-person headquarters building and adjacent parking garage in Silicon Valley, LinkedIn wanted to implement all available technologies and practices to reduce the embodied carbon footprint of the complex as well as its operating impacts. These efforts include sourcing the lowest-carbon materials for the building, exceeding LEED Platinum building standards, generating solar electricity on-site, using recycled water, installing highly efficient mechanical systems, and planting drought-tolerant landscaping.

The use of low-carbon blended concrete solutions alone for the headquarters will result in a 30 percent emissions reduction compared to the industry average concrete.

Operational Overview

When the project was first introduced, LinkedIn's construction lead identified a variety of low-carbon concrete mixes suitable for the technical specifications of the proposed headquarters. This range of mixes allows the team the flexibility to minimize the building's embodied carbon while delivering on the engineering requirements, construction schedule, and cost parameters.

LinkedIn's concrete supplier for this project, Central Concrete (a business unit of U.S. Concrete) used CarbonCure's CO2 utilization technology to consume CO2 sourced from industrial emitters into its concrete. Once injected into mixing concrete, the CO2 chemically converts into a mineral which improves the concrete's strength. This CO2 mineralized concrete can be used as-is or in combination with other strategies, such as switching to low-carbon fuel during production or substituting cement for post-industrial byproducts in the concrete (such as limestone, fly ash, and slag) to reduce overall embodied carbon even further. Central Concrete established its partnership with CarbonCure in early 2017 and introduced this low-carbon concrete as part of its product mix in 2018. Today, about 250 concrete plants across the U.S., Canada, and Southeast Asia use CarbonCure, and the company has supplied more than 5.5 million cubic yards to hundreds of construction projects including transportation infrastructure, commercial, and residential construction.

The sustainability commitments the executive leadership of LinkedIn made have been critical to implementing emerging technologies like lower-carbon concrete.

Key Inputs and Resources

The sustainability commitments the executive leadership of LinkedIn made have been critical to implementing emerging technologies like lower-carbon concrete. The success of this project can be tied directly to the background and educational outreach of LinkedIn's construction lead, who worked closely with material suppliers and had a strong understanding of the industry. Central Concrete, the project's concrete supplier, and CarbonCure, its technology partner, were important collaborators and could provide data about their products' performance.

Low-carbon concrete products are already commercially available and can be specified on private and public projects within normal Request for Proposals (RFP) processes. In some cases, organizations can achieve embodied carbon reductions at no additional cost. For example, concrete made using CarbonCure's technology can provide an emissions benefit at comparable prices to standard concrete. Deeper decarbonization requires combinations of technologies, so organizations will need to balance overall cost and sustainability objectives within each project.

Key Outputs

The headquarters project will not be finished until 2021, so in-use metrics are not yet available. However, the use of low-carbon blended concrete is expected to result in an emissions reduction of about 30 percent relative to standard concrete. Since the embodied emissions from building materials are locked in place upon construction, LinkedIn will see the climate benefits of its low-carbon choices right away.

Replicating for Impact

All companies and governments pursuing new construction or retrofits should utilize low-carbon concrete and appropriately structure their RFPs to facilitate bids with these materials. Tools such as the Embodied Carbon in Construction Calculator (EC3) assessor can help organizations compare options and trade-offs for each material and calculate the embodied carbon impact for their overall project.

Organizations looking to source low-carbon materials should work with project architects, contractors, and engineers to ensure they optimize specifications for embodied carbon reductions, cost, and performance. Looking beyond construction, private and public organizations alike can accelerate the concrete industry's path to decarbonization by implementing low embodied carbon procurement policies and incorporating embodied carbon reduction goals into greater corporate sustainability programs.

BUILDINGS TOOL

Tool: Embodied Carbon in Construction Calculator

→ Get the EC3 Tool

www.buildingtransparency.org

Overview

Created by a consortium facilitated by the Carbon Leadership Forum, the free, first-of-a-kind Embodied Carbon in Construction Calculator (EC3) tool enables users to analyze and compare the carbon content of building materials.

Challenge

By 2060, the world will add 2 trillion square feet of buildings: the equivalent of putting up another New York City every month for the next 40 years. At least half the carbon footprint of these new buildings will take the form of embodied carbon, the emissions generated by a building's construction. Unlike operational carbon emissions, which can be reduced over time with energy-efficiency renovations and the use of clean electricity, embodied carbon emissions are locked in place as soon as a building is built.

Owners, design teams, and contractors need better ways to calculate and evaluate the carbon footprint of materials they use in construction and make more informed supply chain decisions. In addition, most products in the market today are competing primarily on cost and have not been evaluated based on their embodied carbon footprint, even though some manufacturers' (those with new, efficient facilities with low-carbon energy sources) equivalent low-carbon products are already cost competitive.

The Tool

The Embodied Carbon in Construction Calculator (EC3) is an exciting new open-source tool that can track the embodied carbon emissions in building materials like steel, cement, glass, and wood. The tool helps users identify and track their project's impacts with environmental product declarations (EPDs), which act as a "nutrition label" for building materials that corporate buyers and governments can use to incorporate carbon intensity into their procurement decisions. The EC3 tool takes the data from their growing catalogue of EPDs and presents the embodied carbon impacts in a way that is easy to use and act upon. What would once have taken days for experts to do can now be done in minutes by general practitioners.

EC3 is the first open-source tool that allows for supply-chain-specific analysis of embodied carbon data, using the first searchable and sortable database of all United States and Canadian EPDs for concrete, steel, wood, glass, aluminum, insulation, gypsum, carpet, and ceiling tiles.

Replicating for Impact

Any company that owns, builds, designs, and manufactures buildings can use EC3.

Building owners can use EC3 to source low-GHG materials in the construction of their new campuses, facilities, and buildings. For example, Microsoft used EC3 for the remodel of its new, 72-acre campus, reducing the embodied carbon emissions of its campus by 30 percent at no additional cost.

Design professionals and builders can identify low-carbon suppliers and set embodied carbon reduction targets. For example, Perkins & Will has piloted the EC3 tool on two projects in California and Washington. Using EC3 can also generate LEED certification points.

Manufacturers can use the tool to learn the steps to create an EPD, ensure their products are fairly represented, and differentiate themselves with low embodied carbon product options.

Governments can work with the Building Transparency team to facilitate simple, straightforward compliance with procurement policies. For example, the EC3 tool has integrated a 'Buy Clean California Compliant' filter for project teams to easily identify EPDs that meet the requirements of the Buy Clean California Act.

EC3's users can easily estimate the embodied carbon emissions that will result from material production and construction processes. By enabling simple visualization of a project's potential and realized embodied carbon impacts, along with the ability to see baselines and set reduction targets, companies that take advantage of EC3 can accelerate efforts to reduce embodied carbon on a global scale.

As an open access methodology and resource, the EC3 tool also provides a platform that others can build upon. Likewise, as more owners specify and procure low-carbon products, more investment in those products will follow.

PROCUREMENT

Case Studies: Manufacturing

Recommended Corporate Actions on Manufacturing Procurement:

- Address Scope 3 emissions throughout the supply chain by integrating climate evaluation criteria into contracts and Requests for Proposals (RFPs).
- Procure low-carbon materials commonly used in products such as aluminum and plastic.
- Create early markets for key technologies to address emissions from industry and manufacturing—including carbon capture, direct air capture, and green hydrogen—through commercial-scale demonstration projects.

PROCUREMENT

The manufacturing sector—which includes the cement in our bridges, the steel in our cars, the clothes we wear, the books we read, and the plastic toys and containers we buy—accounted for 31 percent of global greenhouse gas (GHG) emissions in 2017, making it the largest contributor to climate change that year.

To make these products, large manufacturing facilities rely on fossil fuels for heat and power. Further emissions come from the chemical processes used to develop key materials and from high levels of electricity consumption.

While some emission reductions can be attained in the same ways as other sectors (net-zero electricity procurement and efficiency, for example), eliminating emissions from many manufacturing processes is still a challenge. Fortunately, solutions are emerging—including electrifying those processes that currently use fossil fuels, developing low-GHG alternatives to fuels where electrification isn't cost-effective, deploying carbon-capture technologies, and reducing emissions from the production of oil and gas.

All companies, even those that do not manufacture their own products, can support these decarbonization efforts. The private sector can leverage its large buying power—including plastics used in containers, aluminum used in cans, and metals used in electronics—to put pressure on supply chains to reduce the carbon intensity of production. To address Scope 3 emissions (indirect emissions from sources other than electricity), companies should integrate climate-evaluation criteria into contracts and Requests for Proposals (RFPs). They can also work directly with suppliers to procure low-carbon materials. Committing to long-term contracts for low-carbon products, even if they come with a green premium, will force producers to reduce emissions, and the costs of low-carbon alternatives will come down over time.

Manufacturers also have a critical role to play in decarbonizing this sector. Commercial-scale demonstration projects can and should create early markets for key technologies that address emissions from industry and manufacturing, including carbon capture, direct air capture, and green hydrogen.

MANUFACTURING CASE STUDY

Low-Carbon Products
Apple

Overview

Apple's commitment to sourcing lower-carbon raw materials for its products has demonstrated the value of partnerships among upstream producers to test, scale, and commercialize new processes and materials.

ACTION:

Source low-carbon materials for end-use products

Challenge

While aluminum is a popular material due to its light weight, strength, and recyclability, the production of aluminum is a significant contributor to carbon emissions. On average, each ton of aluminum produced emits 11.5 tons of CO_2.

This is because aluminum has been mass-produced the same way since 1886. The traditional smelting process, a key step in aluminum production, involves passing electrical current through a large block of carbon, emitting CO_2 as a byproduct. The use of net-zero electricity in this smelting process can reduce the emissions by more than half, but the emissions related to the smelting itself remain.

In addition, the raw material the smelting process uses, alumina, is not generated sustainably. That means decarbonizing aluminum will require a complete redesign of both the smelting process and the production of alumina. However, scaling new processes within such a massive and global-commodity–production supply chain is difficult. Impactful solutions will need to be applicable for retrofits to existing plants and sufficiently cost-effective at scale to compete with fossil fuel-based technologies.

Goals

As a world-leading technology provider, Apple's ultimate goal is to use only recycled and renewable materials in its products. As part of that effort, Apple has engaged its supply chain to continually reduce its material use and carbon impact. Product manufacturing represents 74 percent of overall emissions. Because Apple uses aluminum housings for many of its most popular electronics products, aluminum is an important contributor to its overall carbon footprint. Today, some products (such as the MacBook Air, Mac Mini, iPad, and Apple Watch) are produced with 100 percent recycled aluminum. However, until Apple can source its entire demand from recycled aluminum, access to low-carbon aluminum at scale is important.

Operational Overview

Apple began its supply-chain decarbonization effort by comprehensively mapping emissions sources: the company set up Material Impact Profiles (MIPs) to analyze the environmental and social impacts of materials used in its supply chain. It is using these MIPs to prioritize efforts and establish a multi-year plan for reducing emissions.

Apple's first action to find low-carbon aluminum was to source the material from producers with low-carbon electricity processes, which can significantly reduce emissions and is relatively fast to implement. In fact, some producers have certified low-carbon aluminum today. This resulted in important changes to Apple's aluminum supply chain and a favorable impact overall in global aluminum production. Additionally, in 2015 Apple created the Supplier Clean Energy program to promote renewable energy use among their suppliers. Through the program, Apple's products will be made entirely with clean energy by 2030. That means transitioning hundreds of their manufacturing suppliers to 100 percent renewable sources of electricity. Over 70 suppliers have already committed to 100 percent renewable electricity for Apple production, of which 2.7 gigawatts is operational today.

The next step of this effort involved looking at aluminum's process emissions. In 2015, Apple's engineers identified a patented technology that had been in development at Alcoa Corporation for mass-producing aluminum with lower emissions. The technology enables a process for smelting that gives off oxygen instead of CO_2, provides significantly higher anode lifetime, and is expected to achieve a 15 percent improvement in both operating cost and productivity. Apple recognized the sustainability advantage and wanted to help accelerate the scale-up of this technology.

Apple's technology team brought Rio Tinto Aluminum to the table as a potential partner with significant experience in the scaling of smelting processes. The resulting discussions led to the formation in 2018 of Elysis, a joint venture by the two major aluminum companies (Alcoa and Rio Tinto). The collaboration between these two major aluminum manufacturers brought together complementary expertise and created sufficient economic impact potential to attract government support (outlined below).

In December 2019, Apple purchased the first-ever commercial-sized batch of this new aluminum, which was produced at the joint venture's Technology Center near Pittsburgh. Elysis plans to install further production capacity at a research facility being built in Quebec and to fully commercialize the process by 2024. It also plans to grant licenses to other technology partners—key for the construction of new plants and retrofitting of existing smelting facilities.

Apple's commitment to its sustainability goals, coupled with the size of its supply chain, has been essential to driving the overall effort. This approach compliments Apple's fundamental work on material efficiency in its product design, as well as the use of robotic technologies to improve recyclability and create fully circular supply chains.

Key Inputs and Resources

A program this complex required executive leadership from all the companies involved, especially the senior-level commitment from Apple to source low-carbon aluminum. In addition, several departments at Apple were responsible for connecting the two aluminum producers and facilitating the partnership to form the joint venture. Equally important has been the willingness of governments in Canada to assist with funding the scaling of the technology there, where the ten smelters operated by Alcoa and Rio Tinto are all powered by 100 percent renewable energy sources.

Ultimately Apple partnered with both aluminum companies and the Governments of Canada and Quebec to invest a combined $144 million USD for this development. The funding for the joint venture, Elysis, was provided primarily by the Canadian and the Quebec governments (about $45 million USD each) and Apple (about $10 million USD). Rio Tinto and Alcoa will invest over $40 million USD over the next three years to scale up this low-carbon aluminum process.

The carbon footprint of the low-carbon aluminum process is expected to be approximately 80 percent less than the carbon footprint of standard aluminum, when produced at the new facility in Canada on 100 percent hydro-electricity

Key Outputs

Since the goal is to produce commercial-grade aluminum, the metrics for quality and performance both in the production process and in Apple's final product performance will be essentially identical to current specifications. However, the carbon footprint of this new process is expected to be about 80 percent less than that of standard aluminum, when produced at the new facility in Canada on 100 percent hydro-produced electricity.

No specific financial details about the cost to manufacture, nor the selling price of the product, have yet been disclosed. According to Elysis, the scaled process will ultimately have lower operating costs than traditional aluminum smelting.

Replicating for Impact

This type of industry-shifting development requires the engagement of major supply-chain partners and both regional and federal governments to establish a vision for an outcome and assist in sharing the risk and cost to attain scale. Once companies have mapped their carbon emissions footprint, they should look for opportunities to disrupt the status quo of hard-to-decarbonize materials using both procurement and financial commitments. Smaller companies unable to take on a project of this size and scope on their own can still be part of a consortium to support the development of a critical technology.

The specific technology highlighted here should be applicable to the retrofit of existing smelters and new facilities. Since Elysis plans to license the technology, this low-carbon aluminum should be widely available in due course. Until that time, all companies that have aluminum as part of their supply chain can consult the Aluminum Stewardship Initiative (ASI) platform to find a number of certified lower-carbon aluminum grades (primarily hydro-power-produced ones today), and to inform their Request for Proposals (RFP) requirements to specify lower-carbon aluminum products. As new sustainable aluminum products are certified and become available, including this newest innovation, the ASI platform should reflect them.

PROCUREMENT

Case Studies: Agriculture

Recommended Corporate Actions on Agriculture Procurement:

- Increase demand and consumption of alternative proteins in restaurants, grocery stores, and corporate cafeterias.
- Source sustainably-produced foods that avoid the use of harmful products like palm oil and proteins that rely on unsafe farming and fishing practices.
- Reduce food waste throughout the supply chain, at the production of meals, and during consumption by employees.

PROCUREMENT

The agricultural sector made up approximately 18 percent of global greenhouse gas (GHG) emissions in 2017. These emissions come primarily from soils used in cultivating crops, methane produced by livestock raised for meat and dairy production, and deforestation.

As the world population continues to grow, the demands for food will increase by almost 50 percent, with even higher growth rates estimated for animal-based products. Slowing and reversing the rise of agricultural emissions while still meeting growing global demand for food will require significant innovations in agricultural practices. On the supply side, new technologies, practices, and policies will need to increase efficiency while reducing the use of fertilizers, increasing carbon sequestration through soil management, and reducing methane emissions from livestock. At the same time, demand-side measures can reduce the consumption and waste of GHG-intensive foods.

As major consumers of food, companies and private-sector institutions have a critical role to play in decarbonizing the agricultural sector. Meat and dairy are likely to remain the most GHG-intensive foods, so they should be a key starting point for corporate buyers. The plant-based meat and dairy market is taking off, driven by a flurry of innovation in new food products that increasingly resemble conventional meat and dairy in taste, texture, and price. Companies should increase demand for alternative proteins like plant-based meat and low-GHG dairy products in restaurants, grocery stores, and corporate cafeterias. They can also source sustainably-produced foods that avoid the use of harmful products like palm oil and proteins that rely on unsafe farming and fishing practices.

Food waste is another critical problem in the agricultural sector that leads to significant emissions from unnecessary food production, transport, cooling, and cooking and methane production at disposal. Some studies estimate that as much as 8 percent of global GHG emissions come from wasted food. Companies should thus work to reduce food waste throughout the supply chain, at the production of meals, and during consumption by employees.

AGRICULTURE CASE STUDY

Alternative Proteins
Burger King

ACTION:

Increase demand and consumption of alternative proteins in restaurants, grocery stores, and corporate cafeterias

Overview

Burger King's recent embrace of the Impossible Burger illustrates some best practices that a company can use to successfully introduce alternative proteins and significantly reduce the overall environmental impact of the food it sells.

Challenge

Today, even as the global demand for meat products continues to grow, emissions from livestock account for 14.5 percent of total global carbon emissions. Because beef has the highest carbon intensity of all meat products, replacing it with lower-emissions alternatives can lead to significant climate impacts. But even consumers actively trying to replace meat consumption with lower carbon alternatives are often not willing to compromise on flavor and texture.

Goals

Burger King was one of the first big fast-food chains to introduce a major plant-based offering marketed as having the same attributes as a well-known meat-based product. The plant-based alternative, however, would reduce carbon emissions by almost 90 percent relative to the traditional product. Burger King introduced the Impossible Burger as part of its quest to engage flexitarians, recognizing that the vast majority of people buying plant-based meats (90 percent) are meat eaters looking for healthier options. Burger King also recognized that customers increasingly want their food supply chain to be as sustainable and transparent as possible. By introducing low-carbon meat options, Burger King hoped to grow their customer base, lower ingredient costs, and differentiate themselves from competitors while reducing emissions.

Operational Overview

Burger King's highly successful launch of the Impossible Whopper in stores nationwide in 2019 is the latest evidence of widespread demand for climate-friendly foods that don't require consumers to give up the food experiences that they love. Burger King launched the Impossible Burger in the St. Louis market as a test in April 2019. After seeing a significant increase in sales and engagement of new customers, the burgers quickly launched nationwide. At the same time, Burger King also introduced the Impossible Whopper Jr.

Key Inputs and Resources

Expanding plant-based inventory or menu items is one of the most impactful ways that food providers and consumers can reduce their environmental

footprint. Burger King's introduction of the Impossible Whopper was focused unequivocally on flavor, and the company extended some of its core branding (the "Whopper" name) to the Impossible Burger, communicating to consumers that it would provide the same taste experience they expect from other Burger King items. Burger King and the Impossible Whopper engaged customers who may never have had alternative proteins, which is clearly reflected in the sales results. The sales have been highly incremental and are attracting new guests into Burger King restaurants. The Impossible Whopper is one of the most successful product launches in Burger King history.

Building upon the success of the Impossible Whopper, Burger King launched the Impossible Croissan'wich in January 2020, featuring Impossible Foods' plant-based pork product.

According to life cycle assessments analyzed by the Good Food Institute, swapping out a conventional animal-based Whopper for an Impossible Whopper reduces greenhouse gas emissions by 89 percent, land usage by 87 percent, and water usage by 96 percent.

Key Outputs

The impact of successful introduction of plant-based products like the Impossible Burger can be significant. According to life cycle assessments analyzed by the Good Food Institute, swapping out a conventional animal-based Whopper for an Impossible Whopper reduces greenhouse gas emissions by 89 percent, land usage by 87 percent, and water usage by 96 percent.

Looking at the financial impacts of the introduction shows that Burger King's April 2019 test in St. Louis generated a 28 percent increase in sales, compared with a 2 percent sales increase for McDonald's in the same market and time period. In addition, per the company's Q3 earnings release, the launch of the Impossible Whopper drove 5 percent comparable sales growth in the U.S.

Replicating for Impact (learn more)

The plant-based sales success experienced by Burger King and many other food providers such as Panera, Pret a Manger, Kroger, Costco, Dunkin', and other food-supply channels is evidence that embracing climate-friendly foods can be a win-win for the planet and for profits. Retail sales data for 2019 by Plant Based Foods Association and the Good Food Institute notes that retail sales of plant-based foods have grown by 11 percent overall in the past year, with sales of refrigerated plant-based meat up 63 percent versus frozen at 4 percent.

Food providers should work to carry more foods made from plant-based protein and refine their marketing, merchandising, menu placement, and other strategies to maximize their appeal to mainstream consumers. While there are important health and sustainability benefits to plant-based foods, the most important positioning of plant-based foods still needs to be focused on consumers' most fundamental food motivations: taste, price, and a desire for familiar foods.

As some of the primary channels through which consumers obtain and learn about their foods, retailers and foodservice operators play an important role in shaping consumer perceptions of plant-based and alternative protein foods. Those looking for support in adding more plant-based foods can work with plant-based brands, distributors, and research organizations like the Good Food Institute to source relevant products, promote them effectively, and create a strategy for integrating alternative proteins with existing brands and operations.

AGRICULTURE CASE STUDY

Food Waste
Google

ACTION:

Introduce new technologies, processes, and practices to reduce food waste in corporate-run kitchens

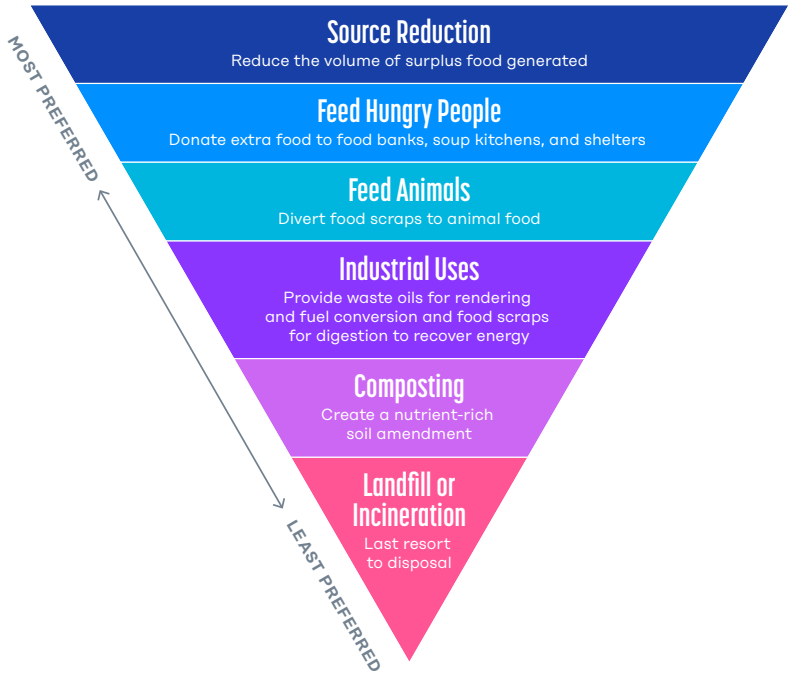
Overview

As Google has recently demonstrated, companies that operate kitchens (corporate dining, healthcare, hospitality, or university) can shrink their overall carbon footprint by significantly reducing food waste and championing plant-forward menus.

Challenge

Globally, we waste one-third of the food we produce. A full 3.5 billion acres of farmland and 45 trillion gallons of water are used to grow that squandered food. If food waste were a country, it would rank third in greenhouse-gas emissions, behind China and the United States. Food waste is also a big drag on the bottom line for foodservice kitchens: 4–10 percent of a typical kitchen's food purchases are wasted. In order to understand total costs to the company, the lost hours prepping, cooking, and ultimately hauling away wasted food all need to be added to the original purchase price.

Food Recovery Hierarchy



The United States Environmental Protection Agency (EPA)'s Food Recovery Hierarchy offers guidance on where kitchens can focus their efforts to reduce food waste. "Source Reduction"—actually preventing food waste from being created in the first place—is at the top of the hierarchy and provides huge environmental and financial benefits to companies. To establish long-term reductions in food waste and associated emissions, they must align incentives across procurement divisions, foodservice employees, and customers.

Goals

Google believes that "creating sustainable workplaces is good for people and the environment." Part of the company's corporate commitment to sustainability involves reducing the carbon footprint of its food-production complex, which was serving more than 250,000 meals each day before the COVID-19 pandemic. As such, Food at Google is focused on using technology to reduce food waste, choosing sustainable and plant-forward ingredients, bringing creativity to the kitchen, and making the landfill a last resort.

Operational Overview

Google and one of its foodservice providers, Compass Group, are aligned in their commitment to reduce food waste and lower the overall carbon footprint of the meals they provide.

Since accurate measurement of food preparation, processing, and consumption is critical to food waste prevention, Google's food team has partnered with Leanpath, a company whose mission is "to make food waste prevention and measurement everyday practice in the world's kitchens." Since 2014, Food at Google has been installing Leanpath's hardware and software that allows kitchens to track their food waste. This tracking data is automatically analyzed, giving chefs a complete view of what is being wasted and why. Kitchens can then make informed adjustments to purchasing and prep that stops waste from occurring. Leanpath works with the Food at Google team to identify further ways to reduce waste, using knowledge built upon Leanpath's fifteen years of experience. Changing the size of plates, managing portion size, cooking in batches, or replacing the size or depth of pans put into stations later in the serving window, for example, can keep food available across cafe operating hours while reducing waste.

Food at Google has also worked to reduce waste by sourcing produce and repurposing ingredients that might otherwise go unused. One of Food at Google's earliest efforts was to buy "ugly veggies" that may otherwise have rotted in the field or ended up in a landfill. Prior to the pandemic, Google purchased several hundred thousand pounds of imperfect fruit and vegetables at their corporate cafes in the Bay Area each year—produce that provides delicious meals and reduces supply-chain waste. The Food at Google team continues to push other innovations to use as much as possible from every ingredient. In some instances, food can be repurposed. For instance, leftovers from one meal or a snack can be thoughtfully and safely incorporated into dishes the following day.

In addition to food waste reduction, the Food at Google team has worked to make its food offerings more "plant forward." Menus with lower percentages of meat in them have a significantly lower carbon footprint. Key aspects of this approach include making tasty vegetable-based meals and emphasizing international cuisines which often feature less meat. In addition, placing plant-forward items at the top of the menu or in the "quick pick" to avoid lines helps customers shift their daily meal choices. The organization has also been investing in training the kitchen staff in plant-forward cooking in partnership with the Culinary Institute of America. To continue to advance best practices and share understanding, Google is also a participant in the Menus of Change University Research Collaborative and the World Resource Institute's Better Buying Lab.

Since 2014, Food at Google has avoided over 9 million pounds of food waste.

Key Inputs and Resources

The Food at Google team also coordinates and advocates for these food-waste initiatives as a part of the broader sustainability strategy. Since time and long-term consistency are essential to success, having executive-level sponsorship and advocacy is key to implementing at pilot locations, influencing behaviors, understanding best practices, and continuing to deeper implementation.

Working with companies like Compass and Leanpath can provide further experience, tools, data analytics and recommendations necessary for improvement. Compass has a well-recognized commitment to tackling food waste as well as environmental sourcing practices. Leanpath brings its years of experience with a wide variety of kitchens to make suggestions and coach food service employees.

Key Outputs

Food at Google has seen excellent results as it continues to focus on food waste across the company. Since 2014, the kitchens have avoided over 9 million pounds of food waste. The company evaluates its progress in reducing food waste via a metric it calls the Food Efficiency Ratio (FER): the value of food thrown away divided by total food spending. While the industry average is approximately 8 percent, Google has successfully lowered its ratio to between 2 and 4 percent across its kitchens.

While Google has not disclosed specific dollar savings, a number of studies indicate that the return on investment (ROI) for food-waste reduction efforts is favorable. A landmark 2019 report from Champions 12.3—a United Nations-affiliated organization comprising governments, businesses, research institutions, and others—found that for every $1 invested in food waste prevention, $7 were saved in operating costs. This was primarily through reduced food purchasing, savings on menu items as ingredients were repurposed, and lower hauling fees.

In addition, a sense of teamwork has been established within the Food team. The mission of reducing food waste engages team members and rolls over into how they think about sustainability and waste in their daily lives. This sense of teamwork and mission focus generates a positive culture that is helpful in attracting and retaining talent.

Replicating for Impact

Every organization that procures or prepares food can implement activities to reduce waste. The Food at Google team notes that even just collecting the data began to change the kitchens. In other words, signaling that food waste is important will cause people to change their behaviors.

The first step in preventing food waste is becoming aware of it. For many kitchens, food waste has been "invisible," but tracking food waste changes that. For example, Leanpath offers a food-waste savings calculator on its website that factors in a company's food cost, primary service style, and other variables to tally how much could be saved. Leanpath also publishes a number of resources that provide detailed, actionable insights for anyone looking to reduce food waste, from tips for chefs on menus and inventory strategies to suggestions for reducing waste on buffet tables. A number of global platforms and consortia also provide reports and networks for organizations looking to do more to reduce food waste, including ReFED, Champions 12.3, and WRAP.

While most food-waste reduction strategies lead to climate benefits at no additional cost, implementing best practices can pose some challenges. Kitchen-staff turnover can raise the learning curve for companies with innovative approaches to food-waste reduction. Buy-in is key at both the corporate and kitchen levels. On the Food team, this problem has been addressed by having two team members (known as "Leanpath Champions") who engage staff and drive operational changes at each office location as part of their daily work. In addition to the environmental and financial benefits of preventing food waste, kitchen staff can embrace a new mission-driven component of their work: they see themselves as the key to solving the global food waste crisis.

Companies must also manage the tension between employees' desire for "on demand" meals and snacks and reducing waste. Education can be a critical tool to address the balance between sustainability and employee benefits. Informing employees about food waste trends and visualizing food waste in a cafe can help raise awareness.

PROCUREMENT

Deep Dives: Accelerating Corporate Procurement

PROCUREMENT DEEP DIVES

Buying Down the Green Premium

To address climate change and reach a net-zero-emissions future, we must quickly scale and deploy low-carbon technologies. To help lower the costs of low-carbon technologies and accelerate acceptance and demand for emissions-reducing solutions, corporations should prioritize them in their procurement practices.

Overview: Understanding the Green Premium

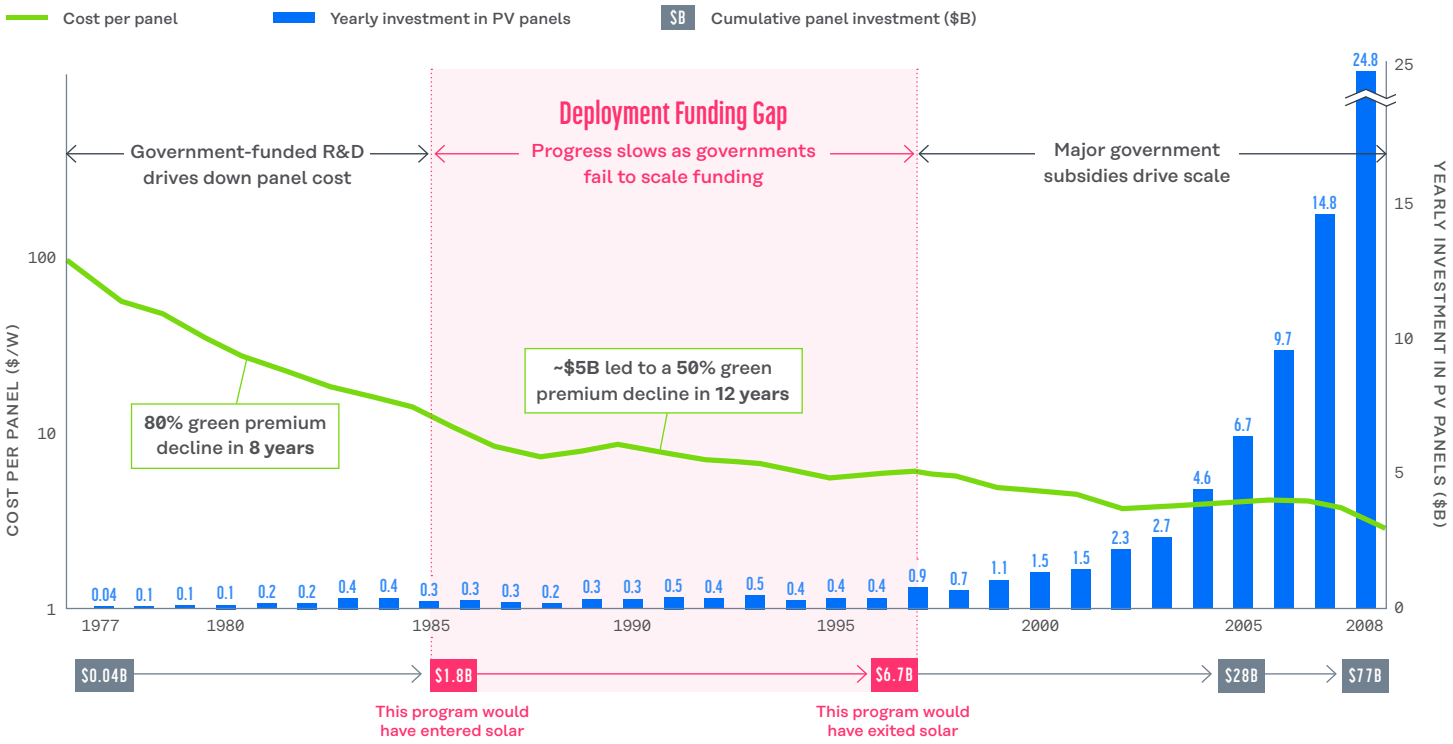
A good way to evaluate the best low-emissions technologies for procurement is a calculation called the "green premium," meaning the additional cost of choosing a clean technology over one that emits greenhouse gases.

Currently, clean solutions are often more expensive than high-emissions ones for several reasons. For one, the true economic and environmental costs of technologies like fossil fuels are often not factored into the price we pay for them. For another, when a technology is first introduced, it often costs more and is less easy to use than the incumbent solution. However, the use of the technology by early adopters and feedback for further development improves both the confidence in and cost of a new product. This early investment in a new technology often helps lower its costs more than later-stage investment.

For corporations looking to advance their low-carbon emissions agenda, this means that procurement of these products often comes with an initial green premium. Some important examples include transportation fuels and manufacturing materials. However, as a new technology is used and scaled, efficiencies develop that drive down its cost and increase both the willingness and confidence of buyers to use it. In some cases, the scaling factor is sufficient to lower the cost to produce green technologies to parity or even less.

FIG. 1

Solar Investment Over Time



Tipping Points

1977 — NREL is founded and drives US solar research

1978 — Energy Tax Act put in place in the US to subsidize solar

1985 — University of NSW passes 20% cell efficiency; Energy Tax Act expires, decreasing funding for solar deployment in the US

1997 — Kyoto Protocol passed and countries establish regulations that promote solar, including government procurement mandates and codes and standards reform

2000 — German feed-in tariffs begin; Subsidy equivalent to $500/tCO$_2$*

2002 — California RPS; German feed-in tariffs account for $800M/yr

2006 — First solar PPA

2005-2008 — Polysilicon shortage keeps panel prices from declining

Solar might have deployed sooner if funding hadn't stagnated in the late 80s and 90s. The goal of this program is to supplement funding during the deployment funding gap for critical emissions reduction technologies.

Sources: Breakthrough Energy internal analysis; Kavlak, Evaluating the Causes of Cost Reduction in Photovoltaic Modules *(2018); Solar PV Project Financing, DOE EERE, "The History of Solar," IEA-PVPS.*

For example: today, in some markets, the cost of solar PV has fallen to or even below the cost of incumbent technologies for electricity generation. This is the result of over 40 years of investment and innovation at scale by both the public and private sectors. (See Figure 1.)

While large-scale solar and wind projects have lowered costs considerably, other low-emissions electricity-generation technologies are still in earlier stages of adoption. In addition, a number of low-carbon technologies for other sectors, such as advanced biofuels and low-carbon materials, have begun to move down their cost curves, but they still need further scaling and/or innovation. (See Table 1.)

TABLE 1

Critical Climate Technologies with Green Premiums

GRAND CHALLENGE	TECHNOLOGY EXAMPLES
Electricity	Geothermal Advanced Nuclear Carbon Capture Utilization and/or Storage Advanced Storage Technologies
Transportation	Low-Carbon Fuels Advanced Battery Technologies
Buildings	Bio-Based Materials (e.g. cross laminated timber) Super-efficient cooling technologies;
Manufacturing	Low-Carbon Steel Low-Carbon Aluminum Low-Carbon Cement
Agriculture	Alternative Proteins
Carbon Removal	Direct Air Capture

Green Premium Examples

Transportation: Advanced Biofuels

In long-haul transportation sectors such as aviation and maritime travel, the distance between refueling opportunities makes today's batteries impractical. In those cases, low-GHG liquid fuels, such as advanced biofuels and electrofuels created with clean-power generation, are essential.

The green premium for advanced biofuels relative to fossil-based transportation fuels, however, remains significant. Today, these lower-carbon alternatives are more than twice as expensive as their incumbent counterparts. (See Table 2). In some cases, such as with sustainable aviation fuel (SAF), industry and governments have undertaken a wide range of efforts to begin scaling approved production processes while continuing the necessary R&D to tackle challenges related to the sustainable sourcing of raw materials and efficiencies of processing. Companies, NGOs, airlines, and governments are all working to reduce this green premium through collaborative efforts such as the Clean Skies for Tomorrow initiative and the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA). Because these programs alone won't be enough to buy down the green premiums for SAF, corporate buyers must work with airlines to create markets for emerging climate technologies and further reduce costs. Airlines should also take ambitious action to procure SAF through long-term offtake agreements—even if that means paying a premium over kerosene-based jet fuel in the short term.

Some airlines are taking innovative approaches to solving this problem. For instance, in August 2019, Lufthansa launched a program called Compensaid that allows consumers to pay a premium for sustainable aviation fuel (SAF) to offset the emissions from air travel. These programs are designed to create demand that can then enable the SAF producer to scale further, reducing costs and increasing availability.

TABLE 2

Comparison of Green Premiums for Advanced Biofuels

FUEL TYPE	2019 RETAIL PRICE PER GALLON IN US	ADVANCED BIOFUELS PRICE PER GALLON	GREEN PREMIUM
Jet Fuel	$2.22	$5.35	140%
Diesel	$2.71	$5.50	103%
Gasoline	$2.43	$5.00	106%
Heating Oil	$2.71	$5.50	103%
Natural Gas	$1.01	$2.45	142%

Source: Rhodium Group.

Manufacturing: Low-Carbon Materials

Many potential technologies that could shrink the carbon footprint of building materials such as steel and cement and widely used packaging materials like polyethylene-based plastics are being evaluated at lab, pilot and, increasingly, commercial scale. Analysis of the use of carbon capture and storage (CCS) for decarbonization of each of these materials shows a green premium that ranges from 9 percent to 140 percent. (See Table 3.) These green premiums can be further reduced as the technologies scale and/or develop further.

CCS technologies can abate emissions during production. Alternatively, some products—aluminum, for instance—can come with a significantly lower carbon footprint if purchased from manufacturers who source their electricity for production from zero-carbon sources. This low-carbon aluminum still has a green premium, but there are many more producers who can supply it. Likewise, technologies and processes developed for the production of more sustainable concrete do not completely eliminate carbon emissions, but they do make material reductions in the product.

TABLE 3

Comparison of Green Premiums for CCS Decarbonization of Plastic, Steel, and Cement

MATERIAL	AVG PRICE PER TON	CARBON EMITTED PER TON OF MATERIAL MADE	CALCULATED PRICE AFTER CARBON CAPTURE AND STORAGE (CCS)	GREEN PREMIUM RANGE
Plastic (ethylene)	$1,000	1.3 tons	$1,155	9 – 15%
Steel	$750	1.8 tons	$872 - $964	16 – 29%
Cement	$125	1.0 ton	$219 - $300	75 – 140%

Source: Rhodium Group.

Buildings: Heat Pumps

Even when the financial benefit of a new product over the incumbent is clear, there can still be barriers to scale. For instance, Table 4 shows the estimated cost to install heat pumps in new residential construction for multiple regional markets in the U.S. versus natural gas furnace/electric A/C. In spite of the financial benefits, if builders and consumers are not aware (or confident in the performance) of a product like heat pumps, they won't adopt them. Producers can begin to solve this problem by further highlighting the combination of benefits (such as cost, performance, and ease of use) to industry influencers. At the same time, policy incentives should continue to increase demand.

TABLE 4

Comparison of Green Premiums for Heat Pumps in Regional Markets in the U.S.

CITY	COST OF NATURAL GAS FURNACE & ELECTRIC A/C (INSTALLED)	COST OF AIR-SOURCED HEAT PUMP (INSTALLED)	GREEN PREMIUM
Providence	$12,667	$9,912	-22%
Chicago	$12,583	$10,527	-16%
Houston	$11,075	$8,074	-27%
Oakland	$10,660	$8,240	-29%

Source: Rhodium Group.

Prioritizing Corporate 'Green Premium' Actions

Companies have a significant role to play in creating demand for low-emissions products, increasing scale, and lowering cost. They should:

1. **Understand Critical Clean Technologies.** Before identifying where procurement can have the most impact, it is important to understand which technologies will be most critical for reducing emissions. Technology-based modeling can be a helpful tool for understanding which climate solutions will be part of the lowest-cost decarbonization pathways. Analysis by groups like the International Energy Agency can inform technology pathways, as can tools like the Carbon Reduction Assessment—New Enterprises (CRANE) tool launched by the PRIME Coalition in 2019. CRANE allows users to estimate and develop scenarios for emissions reductions, comparing a wide range of new technologies to their incumbent counterparts.
2. **Identify Technology Areas of Interest.** Companies should identify which technology areas align with their corporate interests. This could include technologies that will help companies hit emissions-reduction goals or maintain the viability of their business as regulatory and consumer pressure to address climate change increases. For Microsoft, for example, this type of analysis led to a focus on electricity use at its data centers. First, the company focused on procurement of 100 percent low-carbon electricity, then it established a data center test facility to devise and develop further improvements.

3 **Evaluate Cost and Emissions Implications.** Companies should assess the cost and emissions implications of lower-carbon products. They can (and should) procure technologies that have no or very low green premiums through standard procurement processes that prioritize low-emissions products in their evaluation criteria. A number of tools exist to help companies understand investment into new and commercially available technologies and their impacts on carbon emissions. For example, procurement teams can use the Embodied Carbon in Construction Calculator (EC3) tool to understand the emissions intensity of construction materials.

4 **Structure Opportunities to Maximize Climate Impact.** Companies should evaluate where and how choosing to procure products with a green premium can facilitate scaling of climate technologies and enable further cycles of learning and cost reduction. In other words, the choice to pay a green premium can become a strategic part of the company's overall decarbonization plan.

Taking Action to Buy Down the Green Premium

Companies can help lower the green premium of new clean technologies using a number of different procurement mechanisms. They can:

Choose the lowest-carbon products available in the market first, letting the market know the company is serious about lowering emissions in its supply chain. In Apple's low-carbon aluminum case study, the company first approached its suppliers with a demand for aluminum produced using hydroelectricity. This decision sent a signal to the market that an important global buyer valued low-carbon aluminum. Apple then chose to invest in a much more significant way to facilitate the demonstration and scale of an even lower carbon solution that will take several more years to come to market.

Join a consortium of companies focused on similar low-carbon outcomes. As the SAF example above illustrates, a company can join with other partners to negotiate supply, pay the green premium, and track delivery for the new sustainable fuel. This approach leverages multiple companies' demand, allowing producers to scale to larger, more-efficient facilities or gain engineering knowledge that will lower a product's overall cost, opening it up to further demand and new markets.

Choose the lowest-emissions product despite the cost. LinkedIn, for example, decided to pay the green premiums to buy the most sustainable concrete products available for their new headquarters project. In another company's situation, this could mean procuring a product for a niche part of the business where the extra expense can be justified. As costs come down, the procurement of the low-emissions option can be expanded to other areas of the company.

PROCUREMENT DEEP DIVES

Apple Headquarters in Cupertino, CA. Apple's Supplier Clean Energy Program has garnered over 4 gigawatts of commitments since 2015.

Integrating Low-Carbon Products into Requests for Proposals (RFPs)

As a company maps its carbon emissions footprint and establishes priorities, a robust strategy for the procurement of materials, products, and services can accelerate progress toward a company's emissions-reduction goals.

Setting Corporate Baselines and Targets

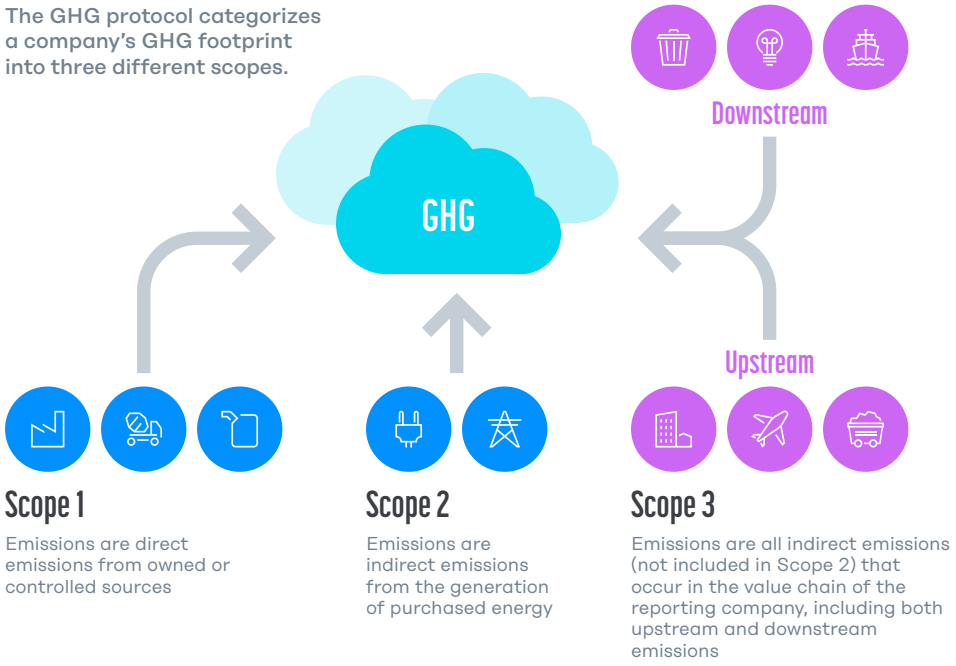
First, a company should understand its carbon-emissions baseline and establish reduction targets. These targets should include all of a company's emissions: those from their own operations (Scope 1 and Scope 2) as well those across its value chain (Scope 3). (See Figure 1 below.) The Scope 3 emissions for many companies are more than five times larger than those under the company's Scope 1 and 2. While this playbook doesn't address setting baselines and targets, other organizations—including the World Resources Institute (who manages the GHG Reporting Protocol) and Science Based Targets—provide robust resources to tackle these challenges. It is critical that companies disclose their emissions through organizations like CDP and set targets that support the path toward net-zero emissions by midcentury. While there are many actions that can be taken to directly reduce emissions, companies should also support the development of critical climate technologies upstream and downstream of their operations (including the building materials used for corporate offices or the jet fuel used for business travel).

FIG. 1

GHG Footprint Scopes

(Source)

The GHG protocol categorizes a company's GHG footprint into three different scopes.



Once baselines and emissions reduction targets are set, corporate procurement personnel can then move ahead with implementing appropriate procurement procedures and policies. These include:

- Engaging Suppliers. Companies should establish a process for engaging with existing and new suppliers and translate climate goals and priorities into language appropriate for the supplier base. For example, Skanska has created a Supplier Code of Conduct tailored by country, as well as a "Best Practices Guide for Responsible Sourcing."
- Establishing an Effective RFP Process. Companies should evaluate where they can update internal processes for procurement to meet climate objectives.
- Evaluating Impact and Cost. Companies should establish what success looks like and how they will measure it, including appropriate baselines and benchmarks.

Engaging Suppliers

To align suppliers with emission-reductions targets, companies should share their decarbonization commitments, priorities, frameworks, and processes with the existing supplier base. For example, a major centerpiece of Apple's Environmental Responsibility Report is a diagram of its lifecycle carbon footprint. This report also shares information about Apple's Supplier Clean Energy Program, which has garnered over 4 gigawatts of commitments since 2015.

Consistently sharing goals across communications channels in globally accepted language (Scope 1, 2, 3 emissions, for example) helps suppliers understand how they can better position and deliver their products and services to help meet

these goals. In addition, companies can host working sessions with suppliers (individually or in groups) to answer questions, get feedback, understand where each supplier is on its own emissions-reduction plan, access new products, and engage in pilots or demonstrations.

Companies may come to find that using new suppliers more committed to emissions reductions may help them reach their overall goals. The platforms and consortia in Table 1 can be helpful starting points to identify potential new suppliers and help define applicable performance criteria.

Establishing an Effective Request for Proposals (RFP) Process

While a Request for Proposals (RFP) can take many forms depending on the industry and project, the document generally covers five areas:

1. Introduction and background information
2. Description of the opportunity/requirements
3. Structure of the response
4. Evaluation process and selection criteria
5. Timelines

TABLE 1

Criteria for Identifying Potential New Suppliers

GRAND CHALLENGE	AREA OF INTEREST	CONSORTIA, PLATFORMS AND RESOURCES
Electricity	Onsite Electricity and Power Purchase Agreements (PPA)	Renewable Energy Buyers Alliance (REBA), RE-100
	Automation	WattTime, EP100
	Energy Service Providers/ Benchmarking Platforms	Bright Power, Elevate Energy, New Ecology, WegoWise
Transportation	Vehicle Fleets	Electrification Coalition, EV100
	Low-Carbon Fuels	Below50, BoardNow
Buildings	Building Materials	Building Transparency
Manufacturing	Sustainable Aluminum Products	Aluminum Stewardship Initiative
	Sustainable Biomaterials (aviation, marine, plastics, textiles, etc.)	Roundtable on Sustainable Biomaterials (RSB)
Agriculture	Alternative Proteins and More-Sustainable Food	Good Food Institute, Menus of Change University Research Collaborative, Better Buying Lab
	Food Waste Reduction	LeanPath, ReFED, Champions 12.3, and WRAP

Areas 2 and 4—the description of the opportunity/requirements and the evaluation process and selection criteria—are the most important. They ensure clarity and specificity about the performance, cost, quality, and carbon footprint a company is requesting, along with how these will be prioritized and evaluated.

Description of the Requirements

There are several ways companies can specify requirements in their RFPs to further climate goals and objectives. They can:

- Require Disclosure. It is critical for a company to understand the emissions impact of its supply chain, so buyers should require their suppliers to disclose emissions and other relevant information. For example, Environmental Product Declarations (EPDs) can be used to disclose information about building materials like steel, cement, and aluminum. EPDs can be used by procurement and sustainability personnel via the Embodied Carbon in Construction Calculator (EC3) tool to compare materials.
- Require Certifications. For many technologies, certification bodies exist that have completed life-cycle assessments (LCAs) of their climate and environmental impacts. For example, the Roundtable on Sustainable Biomaterials (RSB) certifies products like sustainable aviation fuel.
- Establish Emissions Reduction Goals. Buyers can specify emissions reduction requirements directly in their RFPs. For example, Microsoft required that building materials suppliers for their new campus meet a 30 percent reduction in carbon intensity below the industry average.

Companies should pull from available materials as they draft procurement guidance and RFPs. For example:

- Fleets for the Future has established EV procurement considerations and specifying language.
- PepsiCo has committed to source only traceable, sustainable palm oil and has published a Global Policy on Sustainable Palm Oil detailing its expectations of all suppliers. The RFP documents should provide references and links to this type of detailed corporate policy.
- Building Transparency has created a free Embodied Carbon in Construction Calculator (EC3) that helps determine the embodied carbon of various materials used in buildings by category.

While every procurement is different, generally, evaluations of RFPs have several steps:

1. Set up the evaluation team.
2. Establish scoring criteria and weightings (these should be done when drafting the RFP and consistent with the details disclosed therein).
3. Develop a scoring system (e.g., 5-point scoring).
4. Conduct the review process. This process will include:
   a. A compliance review to ensure that the suppliers meet the basic requirements.
   b. A down-selection process by internal reviewers based on the scoring criteria. In some cases, external experts can provide input in this phase.
5. Presentation to leadership and selection.

For complex, technical RFPs (such as Boston University's emissions-optimized procurement, below), companies should engage a variety of experts at the start of the process to help design the RFP, set the rating criteria, and evaluate proposals.

Considering Cost

Buyers should determine how to weigh cost against climate objectives. Procurement teams should review approaches from past RFPs and make adjustments based on accelerating low-carbon goals.

Buyers should consider both the full life cycle—including upfront costs, energy, and maintenance—and the end-of-life costs (such as disposal and recyclability) of a given product.

Boston University Project Selection Matrix, Including Mandatory Requirements and Weighted Selection Criteria

CRITERIA	WEIGHT	WEIGHTED RANK			CRITERIA EXPLANATION	NOTES
		SOLAR 1	WIND 7	WIND 9		
Impact New Build	Required	X	X	X	Project will generate new renewable power that would not otherwise have been generated	Project additionality is a prequesite
Education & Research Opportunities	Required	X	X	X	Project will benefit students and faculty by allowing access to the project sites and real time data	Access to real time data and access to the project site(s) is a prerequisite
Green-e Certified RECs	Required	X	X	X	Third party certified project-based RECs	Project-based Green-e Certified RECs are necessary to validate the claims for the emissions reductions
Project Developer Financial Strength	Required	X	X	X	Long-term owner/operators have resources, experience, and financial strength to manage relationship over term	
Bid Size Flexibility	Required	X	X	X	Ability to provide 200,000 MWh/yr or 100,000 MWh/yr capacity to allow flexibility on strategy as determined by BU	
Project Economics (strong NPV/MWh)	30%	3	1	2	Financial strength based on risk-adjusted, projected cash flows, and impact on BU financial position and credit rating	The driver in a Contract for Differences is the margin modeled between the PPA price and the grid price/MWh. Favorable project ecoonomics are a prerequisite
GHG Reduction (CO_2e lb/MWh)	30%	3	1	2	Projected likely marginal GHG savings per MWh over the term of the project; favor projects with highest overall GHG reduction with consideration for higher early reductions	Strong correlation between high grid carbon intensity at time of renewable energy production; the purpose of is to maximize the BU's impact on GHG reduction
Environmental & Health Co-benefits	20%	2	1	2	Favor projects with lower construction and operational environmental and health impacts	
Ingegration with BU on-site procurement	10%	1	1	1	Integrate PPA purchases and sales into BU's energy purchasing through hedges or other mechanisms	
Term Length	10%	2	2	1	Offer 12 vs 15 year term; shorter term length ranks higher	
Average Weighted Rank:		2.5	1.1	1.8		

PROCUREMENT DEEP DIVES

Pricing Carbon into Operations

As companies take increased action on climate change, internal carbon pricing is a critical tool to align efforts across businesses and functions, facilitate review of new low-carbon business models, drive investment in low-carbon technology solutions, and communicate to key stakeholders.

Overview

Carbon pricing provides a market mechanism to acknowledge the social, economic, and environmental costs that carbon emissions generate in the form of air pollution or adverse effects on climate. (These are often referred to as "externalities.") Today, the public and private sectors use and build upon several carbon pricing tools. With governments, for example, these externalities are often captured as carbon taxes or through cap-and-trade or emissions trading systems.

Companies increasingly recognize that internal carbon pricing is a powerful tool to manage and drive all elements of their greenhouse gas (GHG) reduction strategies. Assigning a monetary value to GHG emissions means they can be included in, and readily inform, both the operational and investment decision-making processes of the company. This internal carbon price may be fixed or increase in value over time. Not every company will set carbon prices at the same level.

The use of an internal carbon price across a company helps to identify what would normally be hidden risks in a project, business, or investment. When carbon emissions carry a visible price and are brought into profit-loss calculations, the company encourages low-carbon innovation and decision-making, drives down overall carbon emissions, and ensures economic competitiveness over the long term.

Implementing Internal Carbon Pricing

As of 2019, more than 1,600 companies reported using internal carbon pricing or plans to do so within two years. A company seeking to implement internal carbon pricing should:

1. Understand internal carbon pricing strategies.
2. Determine the company goals for utilizing internal carbon pricing.
3. Set an internal carbon price.
4. Publish commitments and update progress.

1. Understand Internal Carbon Pricing Strategies

Companies can use several strategies to implement internal carbon pricing. The three most common are: implicit prices, shadow prices, and internal carbon fees (or taxes). Many companies use a combination of these strategies to meet their specific goals and objectives.

Implicit Price: The implicit price reflects how much it actually costs a company to reduce GHG emissions in its operations (for example, the price of powering offices with clean electricity versus fossil fuel-based electricity). This value should incorporate a holistic set of costs for both the operational and embodied carbon in business operations—including electricity, transportation, buildings, manufactured products, and food. The implicit price is calculated by dividing these costs by a company's emissions footprint. Implicit prices can be an important tool in establishing baseline prices and understanding the implications of emissions reductions, but they are only effective in combination with a strategy to reduce carbon emissions, such as shadow pricing or an internal carbon fee.

Shadow Price: A shadow price refers to the use of an internal carbon price in support of business strategic planning, without charging a compliance cost for business units throughout a company. This pricing can help the company understand the impact of future carbon price regulation on its businesses, test assumptions, assess risk for specific business strategies, and help prioritize investment decisions. Since it does not charge business units directly (unlike an internal carbon fee), it does not generate a funding pool that can be used to achieve decarbonization goals.

Internal Carbon Fee: The most ambitious carbon-pricing strategy is setting an internal carbon fee. Companies that use internal carbon fees go beyond using shadow pricing for strategic planning and analysis; they actually "charge" business units for their emissions. Many companies then use the "revenue" from these charges to support investment into clean technologies and/or carbon reduction projects. An internal carbon fee can help change behaviors within individual business units, and ultimately the company, towards their GHG reduction targets. Transparent internal carbon fees can align both business units and individual employees with reduction targets and help them focus on what each can do to attain them.

2. Determine Corporate Goals and Objectives

A fundamental step for any company considering the use of internal carbon pricing should be clarifying their goals and objectives for its use. Internal carbon pricing provides a decision-making tool that can be used in a variety of ways, including:

a) Understanding Exposure to Regulation and Carbon Pricing Policy

Scenario planning around relevant national and regional carbon prices, as well as future policy perspectives, can help a company set internal carbon prices and assess future business risks and impacts. Often companies utilize shadow prices for this purpose. They may also set different prices/ranges by region or period of time to identify where a business or product line has significant regulatory exposure.

b) Minimizing Risk in Business Decisions

Many companies use internal carbon pricing for business-scenario planning. For example, M&A groups can use internal carbon pricing to analyze risks for various acquisition or divestiture options. Companies interested in justifying low-carbon investments use carbon pricing to set appropriate hurdle rates. In addition, for decisions on capital investments with significant supply-chain emissions such as buildings or other infrastructure, internal carbon pricing in procurement processes can reduce these emissions, direct decisions towards more sustainable suppliers, and increase demand for low-carbon offerings. Shadow or implicit prices are often used for these analyses.

c) Calculating Funding Sources for Low-Carbon Solutions

Charging an internal carbon price to business units for their carbon emissions should encourage their engagement with alternative approaches and technologies. Companies take a variety of approaches to applying these fees. Some charge employees for the carbon footprint associated with their business travel, while others charge at the business unit level for Scope 1 & 2 carbon emissions. Some are even moving to charge businesses for supply chain or Scope 3 emissions. Companies can use these funds to purchase offsets for hard-to-mitigate areas of the business. These fees can be increased in the future after initial actions have been taken by business units and further emissions reductions become more challenging. More advanced or systemic approaches and technologies will likely be needed to close this final gap.

d) Demonstrating Climate Leadership to Key Stakeholders, Including Shareholders and Customers

Ultimately, a company should explain and report its carbon emissions reduction commitments to all its stakeholders. While many companies have been publishing ESG reports for years, there is increasing urgency to report on targets and progress clearly and consistently. Internal carbon pricing can be a helpful tool for these efforts.

The financial sector has also becoming increasingly engaged on climate risks and reporting by companies. As more institutions, like asset manager BlackRock, put sustainability at the top of their investment criteria, the pressure increases on companies to make climate-related commitments and become more transparent on both their goals and progress. For example, companies are being encouraged to implement recommendations of the Financial Stability Board-Task Force on Climate-related Financial Disclosures (FSB-TCFD) related to carbon pricing and disclosure.

Once a company has established its goals and objectives for the use of internal carbon pricing, it can integrate the appropriate strategies (or combination of strategies) into normal corporate analysis and decision-making processes as appropriate. Successfully implementing and using internal carbon pricing to drive decision making requires true integration into the strategic and business-management practices of the corporation. It also requires strong support from the executive suite.

Some companies, like Microsoft (which instituted a carbon fee in 2012), use the revenue from their internal carbon fee to fund sustainability projects and raise employee awareness. In fact, Microsoft now assesses this fee both on direct emissions and emissions from its supply chains. Other companies, like Ben & Jerry's, have created internal funds from the carbon taxes they charge their business units. These funds then support various forms of external reduction strategies consistent with their businesses.

3. Establish an Internal Carbon Price

After stakeholders agree upon their goals and objectives and select their mechanisms, the company needs to set an internal price for carbon. There are a number of approaches to doing this, and companies with different objectives may choose very different internal carbon prices.

Setting an internal carbon price requires balance and communication. A company should set an internal carbon price high enough to materially affect investment and business strategy decisions—but in order to successfully implement an effective carbon-pricing scheme, everyone in the company must be on board.

This can be done by setting a lower carbon price at first and raising it over time. Some companies, however, have started with pilots involving one business unit or product line to gain experience in how to best integrate pricing strategies into day-to-day work across functions. Communicating what carbon pricing is, how it will be used, and how it aligns with the company's overall sustainability goals is essential.

Companies should set their internal carbon pricing by weighing a variety of factors. These include prices from existing government carbon pricing programs; possible future regulatory trends; current costs of emissions reductions to the company; and peer-company practices. A growing number of resources are available to assist companies as they consider what internal carbon pricing may be appropriate, including:

- The World Bank recently published a report that frames the mechanisms and pricing currently in place globally.
- The United Nations has published an Executive Guide to Carbon Pricing Leadership and Business Leadership Criteria on Carbon Pricing.
- The We Mean Business Coalition has also published resources to help companies set internal carbon prices.

4. Publish Commitments and Update Progress

Once internal carbon pricing has become part of a company's strategic business processes, the company should communicate how this pricing relates to its overall strategy on carbon emissions reduction and commit to publicly reporting progress over time.

The necessary transition to a low-carbon economy will create both challenges and opportunities for all companies. By setting an internal price on carbon now, companies will be better prepared to understand and address the risks they face and help ensure they choose the right business and investment priorities for long-term, sustainable success.

CORPORATE PLAYBOOK

Policy Engagement

POLICY ENGAGEMENT

Overview

Companies are producers and consumers—of electricity, fuels, products, and food. Public policy impacts them in both of these roles. Consequently, they can be powerful advocates for the practical policy solutions we need to reduce greenhouse gas emissions, address climate change, and bring clean, reliable, and affordable energy to everyone.

It is critical that companies engage in policy discussions and advance legislation, funding, and regulation that will reduce emissions as much as possible and keep the path to net-zero aligned with economic development priorities.

POLICY ENGAGEMENT

The most effective decarbonization solutions will come from coordinating private-sector leadership, advocacy, and action behind public policy. Breakthrough Energy has developed a robust set of resources for policymakers in the United States and Europe to use as they aim for net-zero emissions by 2050. These policies focus on transforming the five major economic sectors—electricity, manufacturing, agriculture, buildings, and transportation—responsible for most emissions.

→ **US Federal Climate Policy Playbook**

Certain key policies, such as investing in R&D, incentivizing innovation and entrepreneurship, and putting a price on carbon, can spur transformational change across multiple economic sectors. These cross-cutting Priority Innovation Policies are essential to get the world to net-zero emissions by 2050.

→ **Priority Innovation Policies**

Companies, too, will play a crucially important role in moving policymakers toward effective climate solutions.

Influencing Policy

For example, companies can:

1. Demonstrate support for and highlight the value of critical federal, state, and local climate policies required to achieve net-zero emissions.
2. Advocate directly through meetings with policymakers.
3. Join coalitions and industry organizations in support of climate policies.

Engagement by Grand Challenge

The following pages outline key policy areas for corporate engagement.

POLICY ENGAGEMENT

Priority Innovation Policies

Today's technologies have the potential to bend the carbon-emissions curve—but new, better, and cheaper innovations are a key component of any achievable plan for reaching a net-zero-emissions economy by 2050. In other words, accelerated clean energy technology is essential to halting climate change and limiting the rise of global temperatures.

Policy Spotlight:
National Institutes of Energy Innovation

Government investment in clean energy research, development, and demonstration (RD&D) can accelerate this necessary innovation and catalyze greater private-sector investment. But current levels of public-sector RD&D funding are not enough to put the United States and the world on a path to net-zero carbon emissions.

To help address this funding deficit, we are working to create a National Institutes of Energy Innovation (NIEI), a government-led institution modeled after the National Institutes of Health (NIH) with a singular, coordinated mission focused on the development, commercialization, and early deployment of the clean energy technologies of the future. NIEI's key organizing principle would be to connect basic science with the translational and demonstration programs that are necessary to build the tools needed to prevent the worst impacts of climate change, while setting the U.S. up as a technological and market leader in this sector.

At its core, NIEI would:

- Grow annual clean energy RD&D funding across the federal government to $35 billion in order to achieve the level and pace of innovation required to achieve net-zero emissions by 2050;
- Organize federal energy RD&D priorities to be end-use inspired rather than fuel-inspired to improve outcomes, efficiency, and coordination of research;
- Match RD&D funding to fit the current energy decarbonization challenges to facilitate the potential for game-changing breakthroughs in innovation; and
- Create pathways for technology demonstration and early deployment to support market success.

→ **Learn more about the National Institutes of Energy Innovation**

POLICY ENGAGEMENT

Electricity

Electricity is an essential part of modern life: it powers our homes, schools, stores, offices, hospitals, and factories. Electricity generation is also the second-largest source of greenhouse-gas emissions in the United States. In 2017, it accounted for 30 percent of emissions.

For decades, coal generated roughly half of our electricity, with oil, gas, nuclear, and hydro generating the other half, but this power mix has begun to shift. The recent shale boom has doubled natural gas's share of power generation in the U.S., and wind and solar generation are increasing, too. At the same time, energy efficiency is helping to flatten the demand for electricity.

These changes have reduced GHGs, but continued progress is not guaranteed. To reach net-zero emissions, we must first decarbonize electricity generation and then adopt carbon-free electrification across all sectors of the economy.

Policy Spotlight: Building the Macro Grid

We need to bolster the reliability and resilience of power systems, enable the use of more variable renewable energy (VRE) sources such as wind and solar, and help provide the necessary infrastructure for wide-area power exchange across the country. As such, the governments should support the development and deployment of a macro-grid that can expand transmission infrastructure.

→ **Learn more about Building the Macro Grid**

Other ways companies can advance electricity policies:

- Improve the design of electricity markets by engaging Regional Transmission Organizations (RTOs).
- Advocate for clean electricity standards at the federal and state level.
- Include energy storage in integrated resource planning.

→ **For more see solutions on Electricity Policies**

POLICY ENGAGEMENT

Transportation

The internal-combustion engine revolutionized transportation: increasing human mobility, opening new educational and economic opportunities, and facilitating the movement of goods around the world. But that mobility has come at a steep cost to the climate. Fossil-fuel combustion in cars, trucks, trains, planes, and ships is the leading source (32% in 2017) of GHG emissions in the U.S. While cars are the largest source of transportation emissions today, trucks, planes, and ships are the fastest-growing sources.

We cannot mitigate the most catastrophic impacts of climate change without decarbonizing transportation. Doing so will require a complete transformation of the way goods and people move from place to place.

The key components of this transportation revolution are electrification, low-GHG liquid fuels, and more-efficient mobility. Electrification (plus a decarbonized grid) is one of the most promising solutions for vehicles that travel shorter distances between refueling. For longer-distance and off-road applications, low-GHG liquid fuels can accomplish the same goal. More-efficient vehicles and increased access to transit are also essential components of a comprehensive transportation-decarbonization strategy.

Smart, well-designed policies can shape the technology and investment decisions that will put the entire U.S. transportation sector on a path to net-zero emissions.

Policy Spotlight: Clean Fuel Standard

A Clean Fuel Standard (CFS) requires the producers and importers of fuels used in transportation to reduce their greenhouse gas (GHG) emissions over time. As a performance-based standard, a CFS encourages the use of low-carbon transportation fuels based on their carbon intensity (CI), or their lifecycle GHG emissions per unit of energy.

→ **Learn more about a Clean Fuel Standard**

Other ways companies can advance transportation policies:

- Promote public investment in electric vehicle infrastructure and low-carbon fuels.
- Advocate for zero-emission vehicle mandates at the federal and state level.
- Support fuel-efficiency standards for vehicles.

→ **For more see solutions on Transportation Policies**

POLICY ENGAGEMENT

Manufacturing

Manufacturing—the cement in our buildings and bridges, the steel in our cars and appliances, the clothes we wear, the books we read, the plastic toys and containers we buy—directly accounted for 23 percent of GHG emissions in the U.S. in 2017, making it the nation's third largest source after transportation and power generation. (That number includes emissions from the production, transportation, and transformation of oil and gas, but not from the combustion of those fuels in buildings, power plants, and vehicles. It also excludes emissions associated with the generation of electricity used in industrial processes.)

To get our manufacturing sector to net-zero emissions, policy action needs to encourage the development and deployment of new technologies. Low-GHG technological options in this sector are more nascent than in power generation, buildings or transportation, and there are fewer existing policy levers to speed their development. Fortunately, more opportunities are emerging to decarbonize manufacturing—including electrifying processes that currently use fossil fuels, developing low-GHG alternatives to fuels where electrification isn't cost-effective, increasing efficiency, deploying carbon-capture technologies, and reducing methane emissions from the production and transportation of oil and gas.

Policy Spotlight: Buy Clean

Buy Clean is a public procurement policy aimed at infrastructure and building materials. Its goal is to rapidly reduce greenhouse gas (GHG) emissions embedded in the products government entities buy. It is a powerful tool to incentivize the purchase of low-carbon materials from manufacturers. The proposed policy framework sets a performance-based standard based on carbon intensity (CI), which includes the direct emissions from a product's production, transportation, and use.

→ **Learn more about Buy Clean**

Other ways companies can advance manufacturing policies:

- Promote public investment in low-carbon manufacturing technologies.
- Advocate for standards to reduce emissions.

→ **For more see solutions on Manufacturing Policies**

POLICY ENGAGEMENT

Buildings

Buildings emit carbon in two ways: through their daily use (known as operational carbon emissions) and via the manufactured cement, steel, and iron used to make them (known as embodied carbon emissions). Operational carbon emissions can be reduced over time, as things like HVAC systems become more energy efficient. Embodied carbon emissions, by contrast, are locked in place as soon as a building is built. That means we can't decarbonize the buildings sector without getting the manufacturing sector to net-zero at the same time.

To reduce building emissions, we need policies that encourage the deployment of new technologies such as low-GHG building materials and ultra-efficient heat pumps and that create incentives for the electrification and improved efficiency of clean technologies that already exist.

Policy Spotlight: Building Codes and Standards

It is critical to build all newly constructed buildings to zero-emissions standards as soon as possible instead of continuing to lock in inefficient operations and the emissions that result. Building to these standards is also significantly more economical than paying for retrofits in the future. Governments should use building codes or other authorities to require all new construction (residential and nonresidential) to be highly efficient, all-electric, and zero emissions by a certain year.

To support the broader decarbonization of other sectors, building codes should incorporate additional design considerations, such as charging infrastructure for electric vehicles, demand-response and load-flexibility technologies to improve grid reliability and promote renewable integration, and low-embodied-carbon construction materials

→ **Learn more about Building Codes and Standards**

Other ways companies can advance buildings policies:

- Support public deployment of heat pumps and electric building equipment.
- Advocate for standards to reduce buildings emissions.

→ **For more see solutions on Buildings Policies**

POLICY ENGAGEMENT

Agriculture

American farms are some of the most efficient and productive in the world: the U.S. is the world's second-largest agricultural producer and its largest exporter of food. But right now, direct emissions from agriculture comprise more than 8 percent of total U.S. emissions. Soil is the largest single source of these agricultural GHG emissions (49 percent), as fertilizers and other soil-management practices release nitrous oxides (N2O) into the atmosphere; the second largest (44 percent) is the methane produced by livestock raised for meat and dairy production.

Slowing agricultural emissions while still meeting growing global demand for food will require significant innovations in agricultural practices. On the supply side, new technologies, practices, and policies will need to increase efficiency, reduce the use of fertilizers, increase carbon sequestration through soil management, and cut methane emissions from livestock. At the same time, demand-side measures can minimize the consumption and waste of GHG-intensive foods.

Policy Spotlight: Soil and Nutrient Management

Roughly half of all agricultural GHG emissions in the U.S. come from soil-management practices such as tillage, fertilization, and irrigation. However, numerous scientific studies show that management systems designed to improve soil health can also aid carbon sequestration and reduce GHG emissions. At the same time, they provide important environmental co-benefits: they can improve water quality, suppress pathogens, and support safer pollinator habitats and biodiversity in general. They can also benefit farmers and ranchers by increasing a soil's available water-holding capacity and nutrient availability, improving drought resilience, reducing input costs, and mitigating erosion. Scaling up these practices can increase carbon sequestration and reduce GHG emissions across the agricultural sector.

→ **Learn more about Soil and Nutrient Management**

Other ways companies can advance agriculture policies:

- Support public investment, incentives, and programs to reduce agricultural emissions.
- Promote policies that level the playing field for alternative proteins.
- Advocate for public programs to reduce food waste.

→ **For more see solutions on Agriculture Policies**

POLICY ENGAGEMENT

Carbon Removal

Carbon removal includes the natural and technological processes that remove excess carbon dioxide from the atmosphere and store it permanently underground, in trees and soils, or in durable products, reducing net emissions into the atmosphere.

For instance, natural, ecological processes such as photosynthesis enable carbon-dioxide storage in trees and soils. Conversely, when forests are degraded, and lands are poorly managed, net global carbon emissions increase. Since 2005, the amount of natural carbon removal in the U.S. has remained relatively constant. It currently removes enough carbon to offset about 12 percent of the country's carbon-dioxide emissions.

Policy Spotlight:
Expansion of a Carbon Sequestration Tax Credit

Section 45Q is a federal tax credit that helps advance the market for carbon capture and technological carbon removal in the United States. The 2018 Budget Deal increased the financial incentives for carbon-removal projects via 45Q: the updated tax credit provides $50/ton of CO_2 captured for geological storage and $35/ton of CO_2 captured for enhanced oil recovery or other utilization purposes.

Despite this boost, the policy as it exists today is still not enough to incentivize large-scale deployment of carbon removal technologies, such as carbon capture and direct air capture (DAC).

→ **Learn more about the Carbon Sequestration Tax Credit**

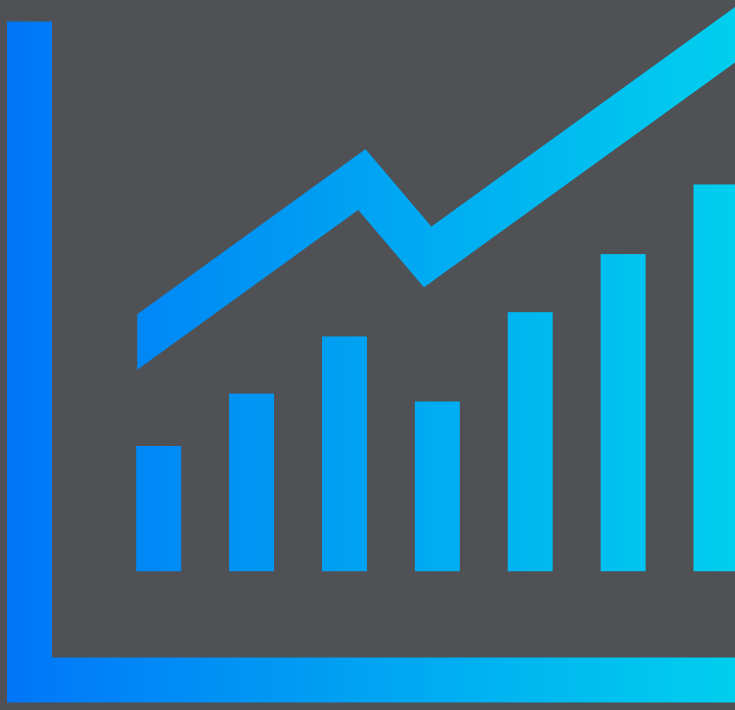
Other ways companies can advance carbon removal policies:

- Support public investment in RD&D for carbon removal technologies.
- Promote programs that support natural sequestration on working and public lands.
- Advocate for deployment policies that support direct air capture, like a clean fuel standard.

→ **For more see solutions on Carbon Removal Policies**

CORPORATE PLAYBOOK

Investment



INVESTMENT

Overview

Corporations have a significant role to play in accelerating new low-emissions technologies to market. (See the RD&D and Procurement sections.) Corporate sponsorship of research, development, and demonstration (RD&D) projects and procurement practices that signal and focus market demand are important "investments" in new technologies.

In addition, financial investments by corporations in early-stage entrepreneurs and nascent technology companies can provide unique benefits that accelerate and scale game-changing low-carbon products. By providing capital along multiple stages of a technology's development, companies and private-sector institutions can help high-potential innovations better navigate their transition from idea to market.

Corporations can also use their investment strategies to make a difference against climate change—either by themselves or in partnership with other companies. Usually, however, the best way to maximize leverage and acceleration is through investment via corporate partnerships with philanthropists, governments, and other intermediaries. In this way, companies can share risk and bridge gaps between investing instruments.

In all these cases, the benefits to the corporation are access and returns: access to innovation, technology, and talent; and returns in the form of equity, innovative technology, or more-efficient internal processes. Clear investment strategies linked to corporate sustainability goals help shape and drive the market towards climate impact solutions and lower overall emissions.

Companies can use investment strategies to accelerate the adoption and growth of new green technologies by:

1. Supporting the development of climate entrepreneurs.
2. Providing direct operational support for emerging low-carbon technologies.
3. Becoming a partner in innovative funds that prioritize climate impact, including those that leverage expertise and funding from the public sector.
4. Improving access to capital for emerging climate technologies that face structural market barriers to scale.

Supporting the Development of Climate Entrepreneurs

To ensure that the most promising ideas and inventions become world-changing green products, early support for entrepreneurs is fundamental.

But early ideation stage funding—aimed at supporting development of the initial concept and the training and structural support needed to launch and develop a company—is often the most difficult for an entrepreneur to procure. Many entrepreneurs must rely on savings, maxing out their credit cards or friends and family for this financial support, and so the critical development training gets sacrificed.

Companies can fund entrepreneurs directly, but it is usually easier and more impactful to provide funding through an organization or intermediary that has structures and processes in place to select the recipients and administer the funding and other structural components (like stipends, cost-of-living grants, curriculum, and mentors). These investments are often designed as fellowships whose short-term benefits accrue from developing the person and their initial technology concept; longer-term benefits come from establishing cohorts of climate-committed entrepreneurs. In most cases, companies that financially back these fellowships can, if they wish, participate in the screening of candidates and host networking events.

A. Support Early-Stage Hard-Tech-Oriented Entrepreneurs

Companies can support existing programs that accelerate early-stage entrepreneurship and offer benefits like lab space, facilities, and expert networks. Organizations like Activate and Argonne Chain Reaction Innovations have been successful in engaging leading scientists and engineers in the innovation process and accelerating their ideas through the use of government facilities and equipment. These programs provide this support without taking any ownership position in the technology or potential future company. Although none of these programs to date have been focused exclusively on decarbonization, they have inspired others in the philanthropic and private sectors to engage in funding entrepreneurial development fellowships, with several targeting low-emissions technologies (like Carbon 180, for example).

These are usually nonprofit programs that require funding from philanthropists, companies, and governments to support operational costs and provide stipends for entrepreneurs. The majority of these programs enable corporate engagement

at various levels of partnership starting with memberships around fifty thousand dollars per year and can extend, for the funding of multiple fellows, to a million dollars per year.

Breakthrough Energy will be rolling out its own fellowship program in 2021, Breakthrough Energy Fellows, to focus fully on addressing specific decarbonization challenges by recruiting innovators of technologies that reduce CO2 emissions by at least 500 million tons per year by 2050. The program will provide innovators with nondilutive funding and match them with Business Fellows and seasoned executives to provide critical mentorship and subject matter expertise, to help advance the technologies. These industry partnerships will guide development and enable commercially-relevant testing, validation, and piloting, and corporations will be able to play other key roles in the Fellows program to support their overall climate and business goals.

B. Support Later-Stage Entrepreneurs Through Early Deployment

Once ideas have been developed in the lab, they will need support to enter the market. Companies can support high-quality entrepreneur-development programs that help innovators through the early deployment phase—accelerators and incubators, for instance. These programs, like Greentown Launch, provide training and development for the entrepreneur and expose them to a broader ecosystem for launching their technology and finding potential partner and investment opportunities. These programs generally provide this funding in exchange for some future stake in the startup.

C. Support University-Based Entrepreneurship Programs

Many leading universities also have programs to help stimulate entrepreneurship that companies can help sponsor. For example, companies should look to support programs like Proto Ventures at Massachusetts Institute of Technology (MIT), where over two years expert "Venture Builders" will lead teams of faculty and students as they translate new and exciting projects into real ventures. Companies can become a "Channel Sponsor" for two years.

Other, more hands-off ways to support entrepreneurship at universities include company sponsorship for on-campus entrepreneurship programs and initiatives.

For more information about partnering with these programs, see Collaborating with Entrepreneurship Programs.

For companies who also engage in other types of investment (such as corporate venture capital or demonstration funding), these investments can be an excellent way to monitor new concepts in areas that matter to them and set the stage for deeper engagement in the future. Generally, support for a fellowship can be a simple contract with the intermediary, since that support is not linked to investment in the future company or technology.

Providing Direct Operational Funding for Emerging Low-Carbon Technologies

Companies can provide direct support for emerging low-carbon technologies and projects through equity investments, nondilutive funding, and demonstration projects.

Companies can invest in startups directly through a Corporate Venture Capital (CVC) fund, by providing cost share to a publicly-funded project or by allocating funding to an onsite demonstration. Whichever path is chosen, a company must be committed to supplementing the appropriate level of capital with the engagement and staffing that will support the progress of the technology and company in question.

A. Expand Equity Investments through Corporate Venture Capital (CVC)

CVCs' expenditures rose by over 400 percent between 2013 and 2018. CVCs can be useful tools for companies looking to make a climate impact while furthering their business goals. For example, National Grid launched the $250M CVC fund National Grid Partners in 2018, which has helped them develop innovative new technologies to decarbonize their business.

There are three basic types of CVCs:

- Institutional: Institutional CVCs are dedicated funds with cash committed from the corporate balance sheet. These funds are focused on maximizing financial outcomes and investment in strategic product areas, and they typically lead investment rounds, have a full staff of professional investors, and take a similar approach to a traditional venture fund.
- Strategic: Strategic CVCs use cash committed from the corporate balance sheet and are focused on developing high-priority technologies of interest. These funds may lead investment rounds but may not operate at the same pace as institutional CVCs or traditional venture funds.
- Tourist: Tourist CVCs use capital pulled each time from balance through the finance department or board approval. These funds generally do not lead investment rounds and are often smaller than institutional and strategic funds.

These three models provide flexibility for a corporation to enter into a CVC with the appropriate mix of funding level, staff engagement, and desired outcomes. To maximize climate impact and return on investment, companies should particularly look to the institutional and strategic CVC models. Along with the financial and capital resources, companies can also offer key corporate and industry insights as well as access to their extensive global network to help new technologies grow.

Corporations directly funding startups in climate-related areas via non-equity structures is a relatively new phenomenon. As companies take more significant steps to address climate challenges, vehicles like Microsoft's Climate Innovation Fund are also being implemented to allow for more flexibility and to deploy appropriate investment instruments, including both debt and equity, to move startups ahead.

B. Support On-Site Demonstration Projects

Companies can also support demonstrations of new technologies at their own facilities. For example, General Electric established an internal RD&D Solar Testbed to accelerate innovation on an industrial scale. There, GE scientists partner with technology developers to test different electrical architectures. GE also collaborates with these technology developers and government agencies to enhance the testbed's capability. Similarly, Microsoft established its Advanced Energy Lab to accelerate innovations that will decarbonize their data centers. The lab will be able to test low-carbon fuels, including biogas and hydrogen.

In addition, companies can work with accelerators and other intermediaries to identify and select companies for demonstration partnerships. For example, Elemental Excelerator's Demonstration Track connects corporations with startups to establish pilots and demonstration projects in Hawaii, California, and Asia. Elemental often provides partial financing for the startup to engage with the company on the pilot. Similarly, EPRI's Incubatenergy Labs is designed for startups to engage with utilities in paid demonstration projects. This program is structured to provide innovators and startups with maximum access to utilities in a concentrated manner. EPRI's accelerator is focused on utilities, but more-diversified companies may still find this intermediary of value for de-risking certain technologies.

C. Provide Non-Dilutive Funding Alongside Government Grant Programs

Companies can help provide the cost-sharing commitment necessary for a startup to access many government funding opportunities. Innovative clean-energy technology entrepreneurs can tap into this non-dilutive funding from federal and state governments to help their technology advance and scale. This funding allows the startup to de-risk early-stage proof-of-concept and in some cases provides first prototype or demonstration development funding.

Government funding has existed for decades in this technology stage. It ranges from Small Business Innovative Research (SBIR) grants to Cooperative Research and Development Agreements (CRADAs) with U.S. DOE National Laboratories to loan guarantees at the federal and state level. These government grants help de-risk new technologies, but as startups move along the path to commercial development, they often have cost-sharing or matching requirements. Finding corporate partners willing to help with cost-sharing as well as pilot and demonstration sites, industry connectivity, and expertise are essential. In providing these services, companies also benefit by seeing their capital go much further.

Partnering with a startup in this capacity can create the conditions for a longer-term relationship or investment. But even though a company may be sharing costs or providing a site for pilot and demonstration, these agreements are in essence made with the government entity providing the grant. That can mean additional tasks for both the startup and the corporate/cost-sharing partner including reporting, accounting, and other requirements.

Federal funding sources that require a match include:

SBIR (and STTR): These research-to-early-commercialization grants for startups always require a match, and it is usually 3:1 (for every $3, $1 will be provided by the government). It is often required to have a company or corporate partner committed prior to applying. Funding ranges from $100,000s to around $1 million.

SCALEUP: The new Seeding Critical Advances for Leading Energy technologies with Untapped Potential (SCALEUP) program at the U.S. Advanced Research Projects Agency-Energy (ARPA-E) builds upon the ARPA-E RD&D focus to support the scaling of high-risk and potentially disruptive new technologies across the full spectrum of energy applications. The cost-share requirement is 33.33 percent with a reduction option of 20 percent for qualified small businesses. Minimum award is $2 million (maximum $20 million including cost-sharing), and targeted follow-on funding to prior ARPA-E awardees.

State funding sources that require a match include:

BRIDGE (CA): The California Energy Commission (CEC)'s Bringing Rapid Innovation Development to Green Energy (BRIDGE) program has deployed over $41 million to get energy technology startups scaling to first pilot and demonstration, and it is expected to deploy another $54 million. Funding is in the low millions and is targeted follow-on funding to prior CEC or federal grant awardees. A minimum cost share of 20 percent is required.

InnovateMass (MA): Massachusetts Clean Energy Center (MassCEC)'s InnovateMass program provides up to $250,000 in grant funding and technical support to startups deploying new clean energy technologies. Although formal fund matching is not required, it is required that startups apply with one more demonstration project partner(s) who will commit resources by providing a host site or sites for the proposed project. Along these lines, companies can also decide to fund pilot and demonstration projects more directly regardless of government cost share.

D. Provide Non-Dilutive Funding Directly to a Startup

While government grants are often the primary source of non-dilutive funding, companies can also directly fund technology development to meet their climate objectives.

For example, the financial services company Stripe has recently developed a program to provide direct, non-recoverable investment as part of its 'Negative Emissions Commitment.' The company has pledged at least $1 million per year to pay for removal of carbon dioxide from the atmosphere. The company recently announced its first four purchases from companies focused on capture and/or storage of carbon dioxide. Stripe continues to expand its carbon removal ambitions with new commitments such as early-stage R&D funding and developing ways for other interested companies to contribute alongside them.

Investing in Innovative Funds that Prioritize Climate Impact

Climate-related investment is significantly underfunded—especially considering we need to get to net-zero emissions by 2050. But investment funds that are focused on climate solutions and decarbonization can provide key capital for low-carbon technologies to develop and scale.

Companies can invest in a shared-risk structure through climate-focused funds with other corporations, philanthropic organizations, and governments. Companies should look for active investment opportunities as a limited partner (LP) to complement corporate RD&D efforts and gain access to a broad pipeline of emerging technology developments that might support their business model.

A. Support Entrepreneurship Programs that Provide Investment Opportunities to Startups

Many entrepreneurship programs, such as Clean Energy Trust and the LA Cleantech Incubator, provide investment opportunities to startups alongside technical and business support. Companies can support these programs by investing in their funds and coordinating with them to make follow-on investments. In many cases, companies can play an active advisory role in these programs to support the selection process and provide industry guidance to enable success for these emerging companies.

Some examples of these entrepreneurship programs include:

- Elemental Excelerator: Elemental Excelerator makes investments in clean energy startups in Hawaii and California, starting at $100,000. As a nonprofit, Elemental uses all returns to provide further programming and support to startups. Elemental, who has been funded by organizations like the U.S. Navy and Emerson Collective, is expanding its work with companies and investors. Companies can work with startups through Elemental's Global Partners membership and use Elemental to help de-risk certain technologies.
- Clean Energy Trust (CET): Clean Energy Trust makes seed investments in clean energy startups on a rolling basis through its revolving 501vc Seed Fund, which is capitalized by corporate and philanthropic contributions. This evergreen fund has a typical investment size (convertible note) between $100,000 and $300,000 and an emphasis in the mid-continental U.S.

- Third Derivative (D3): Launched in 2020 by Rocky Mountain Institute and New Energy Nexus, D3 will make $100,000 investments (convertible note) into clean energy breakthrough startups with a focus on pilots and demonstrations. Currently, D3 is working with VC funds, funds of funds, and philanthropic investment capital. Companies can join as founding members, and in the future D3 will look towards CVC engagement. To date, D3 has invested in nearly 50 startups.
- LA Cleantech Incubator (LACI): LACI launched a $5-million early-stage investment fund in 2020, a separate legal entity from the core non-profit. The fund is a follow-on investment vehicle that participates at levels between $100,000 and $500,000 on the terms set by a lead investor who has conducted significant financial due diligence. Companies can currently become a member of LACI and benefit from the deal flow and de-risking that LACI provides. See LACI's initial investments here.

B. Become a Limited Partner (LP) in Climate-Focused Investment Funds

Companies and investors can and should support climate-focused funds across all parts of the commercialization pipeline, including venture, early deployment, and growth investment.

Venture Investment

Venture investment in climate technologies is a critical mechanism to support early-stage companies. Breakthrough Energy launched Breakthrough Energy Ventures (BEV) in 2016 to help address the commercialization gap for companies at the venture stage. BEV investments support technologies across all five Grand Challenges that have the potential to reduce CO2 and GHG emissions at scale. Although corporations cannot invest as LPs in BEV, the fund syndicates with other investment vehicles.

Companies and investors can also follow climate-focused venture funds that have a proven track record in supporting emerging technologies.

They include, but are not limited to:

Energy Impact Partners (EIP)
EIP has launched several funds to invest strategically in companies shaping the clean energy landscape. In 2019, EIP launched its Fund II and put $405 million into clean energy investments, and in 2020 it announced Microsoft would be joining its Global Partner network. EIP's other investment partners include utilities such as National Grid and Xcel Energy.

The Engine
The Engine is a "tough tech" venture fund—meaning technologies that require a significant amount of R&D—spun out of MIT in 2018. In addition to MIT, their LPs are primarily high-net worth individuals, but they are exploring corporate investors as they look to raise a Fund II.

The Climate Pledge Fund
In June 2020, Amazon announced a $2-billion VC fund to invest in clean energy with a focus on transportation, energy, food, and more to help fulfill the goals of The Climate Pledge, which commits signatories to meet the Paris climate agreement targets by 2040—a decade early. This fund will look to back companies that can help signatories reduce their emissions and meet The Pledge.

Growth and Infrastructure Investment

Scaling low-carbon technologies will take significant capital, and companies looking for climate investment opportunities can support these efforts.

Companies and investors should also become LPs in climate-focused growth and infrastructure funds.

Efforts that have a proven track record in this space include:

Copenhagen Investment Partners
Copenhagen Investment Partners (CIP) is a fund management company supporting the development of clean energy technologies. CIP expects to raise as much as €7 billion for its Copenhagen Infrastructure IV fund, which will go toward technologies such as offshore wind, transmission, and energy storage.

Lime Rock New Energy
Lime Rock New Energy is a dedicated energy-focused growth equity fund that invests in high-growth areas for the renewable energy industry, energy efficiency, and the built environment as well as the electrification of transportation in North America.

Aligned Climate Capital
Aligned Climate Capital focuses on accelerating the flow of capital into sustainable real assets ranging from clean energy and efficient transportation to green real estate and sustainable natural resources. It creates investment products for institutional investors, family offices, high net worth individuals, and foundations. It designs and manages investment products independently or with established asset managers.

C. Leverage Philanthropic Capital to Maximize Climate Impact

Over the past five years, the use of program related investments (PRIs) has accelerated. PRIs are a loan, equity investment, or guaranty made by a foundation in pursuit of its charitable mission rather than to generate income. Companies can look to their philanthropic arms as vehicles for this investment. Building on the success of NGOs, companies like Autodesk and Wells Fargo are actively engaged in this space, and there is considerable room for growth. Intermediaries such as the Prime Impact Fund provide investment vehicles for corporate foundations. As of June 2020, Prime's latest fund round of $52 million included both philanthropy and corporate investment, and it has plans to do more.

Companies should also consider other innovative vehicles such as low margin debt vehicles, via Community Development Financial Institutions (CDFIs). CDFI's are place/region-based partners for corporate foundations. Foundations can make loans to CDFIs, co-lend alongside CDFIs, offer grant-funded credit enhancements for CDFI loans, and even guarantee loans made by CDFIs. Although they range in quality, CDFIs are useful tools for corporate philanthropy, especially those focused on specific regions of the U.S.

Philanthropic vehicles can be particularly important in helping technologies through the early-deployment funding gap. Technologies in this stage often have high green premiums and need philanthropic support to catalyze the replacement of fossil fuel-based technology. Companies, individuals, and governments should look for opportunities to philanthropically fund demonstration projects to help bring down costs for technologies like green hydrogen, sustainable aviation fuel, and direct air capture.

D. Support Innovative Public-Private Partnerships

Companies and investors can and should work with governments on co-funded investment vehicles, which can bring together expertise from the public and private sectors. Breakthrough Energy has launched two such partnerships, with the European Commission and Natural Resources Canada, that provide examples for public-private programs to support climate investment.

Breakthrough Energy Ventures Europe (BEV-E)
In 2019, The European Commission, European Investment Bank, and Breakthrough Energy Ventures (BEV) formed a first-of-its-kind pilot program to leverage private capital and public funding for clean-energy technologies. The €100 million pilot effort was funded equally by BEV and the European Commission. The fund will pursue the pro-climate technology emphasis laid out by BEV with a requirement for investment in European companies. This means that the fund will be looking for early-stage technology companies across the five Grand Challenge areas (electricity, transportation, buildings, manufacturing, and agriculture) that have the potential at scale to remove 0.5 gigatons of CO_2. The European entity will be managed by BEV. In the future, partners could replicate and/or grow this vehicle so this pilot could be a model for public-private partnerships.

Breakthrough Energy Solutions Canada
In 2019, Natural Resources Canada (NRCan) and Breakthrough Energy Ventures (BEV) established Breakthrough Energy Solutions Canada to advance early-stage climate technologies. BEV provides expertise to help NRCan define technology focus areas, develop selection criteria, and evaluate funding decisions. Like BEV-E, Breakthrough Energy Solutions Canada will follow BEV's investment requirement for technologies to have the potential for reducing 0.5GT of CO_2 emissions. In January 2020, NRCan announced the 10 winners for the initial funding call.

The selected projects will have the opportunity to attend showcase events and be considered for future funding from BEV, Business Development Bank of Canada (BDC), and other private investors.

Improving Access to Debt Capital Markets

For many low-emissions technologies, access to low-cost capital financing is critical to competing with fossil fuel-based energy at scale.

The risk profile for emerging technologies, however, can be a challenge for traditional financing institutions. To improve the flow of capital for scaling and deploying emerging low-emissions technology solutions, banks and lending institutions should adopt innovative financing strategies.

The emergence of green bonds (such as securities to support green projects) has helped improve access to debt capital markets for climate-related projects. The green bond market has grown considerably in recent years, reaching over $250 billion in 2019, according to the Climate Bonds Initiative. The types of projects that typically qualify for green bonds include renewable energy, low-carbon transportation infrastructure, and building efficiency upgrades.

While green bonds have helped allocate funding toward climate positive projects, new vehicles and programs are needed to activate debt capital markets for technologies required to achieve net-zero emissions. Rather than limiting focus on low-carbon technologies that are closer to cost parity with fossil fuel-based incumbents, companies should structure debt offerings to support the emerging, capital-intensive climate technologies that face the biggest barriers in terms of access to financing.

Lenders should develop programs that acknowledge the need to take on additional risk to scale critical climate technologies. These companies can coordinate with technology experts and philanthropic entities willing to take first-loss positions. This can minimize risk and enable lenders to offer lower-cost capital debt to best-in-class technology developers.

Companies should also collaborate with public-sector finance institutions that have played an important role in scaling new climate solutions. Green banks in the United States and the European Investment Bank offer low cost of debt capital to address gaps in current clean energy capital markets. These institutions tackle barriers such as perception of risk by using credit enhancement, inefficiencies of scale by aggregation and warehousing, and marginal economics by co-investing. Globally, blended finance structures facilitated primarily by multilateral development banks (MDBs) have successfully mobilized significant amounts of private capital into sustainable development projects.