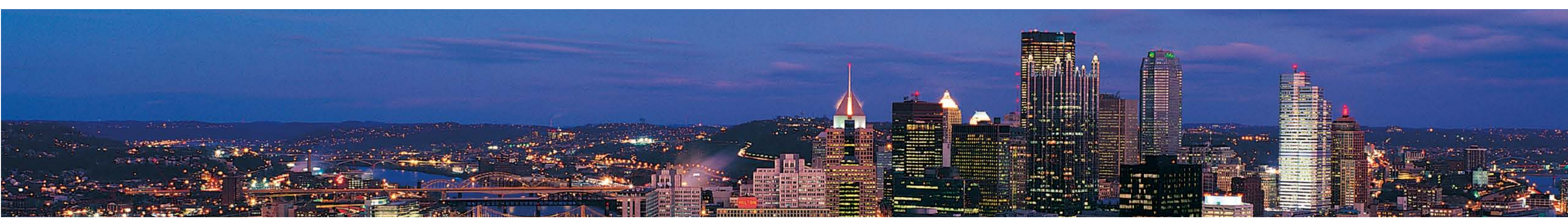
institute for building efficiency
an initiative of Johnson Controls

ENERGY EFFICIENCY TECHNOLOGY EXCHANGE AND CAPACITY BUILDING: A PRIVATE SECTOR PERSPECTIVE



Issue Brief

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Summer Associate, 2010

Johnson Controls

August 2010

BUSINESS COUNCIL FOR SUSTAINABLE DEVELOPMENT

The Business Council for Sustainable Energy (BCSE) represents the broad portfolio of existing clean energy business sectors, including renewable energy, supply-side and demand-side energy efficiency, natural gas, and electric utilities in North America. The Council's diverse membership is united around the core principle of promoting market-based policies that take a long-term view of both the U.S. and global energy needs and that properly consider the full economic and environmental attributes of energy production and use.

For over fifteen years, the Council has represented the views of clean energy technology industries in the United Nations Framework Convention on Climate Change process. The BCSE is also a founding member of the International Council for Sustainable Energy (ICSE), an alliance of the European, United Kingdom and United States Business Councils for Sustainable Energy and the Australian Clean Energy Council. The mission of the ICSE is to provide a cohesive and credible voice for the global sustainable energy industry in international climate change and sustainable development discussions.

JOHNSON CONTROLS INSTITUTE FOR BUILDING EFFICIENCY

The Institute for Building Efficiency is an initiative of Johnson Controls providing information and analysis of technologies, policies and practices for efficient, high performance buildings and smart energy systems around the world. The Institute leverages the company's 125 years of global experience providing energy efficient solutions for buildings to support and complement the efforts of nonprofit organizations and industry associations. The Institute focuses on practical solutions that are innovative, cost-effective and scalable.

INTRODUCTION

Johnson Controls and the Business Council for Sustainable Energy are facilitating a dialogue on the role of the private sector in the design and implementation of technology transfer initiatives under consideration before the United Nations Framework Convention on Climate Change (UNFCCC) negotiations. Existing technology transfer programs have not helped countries realize the full potential of energy efficiency. This issue brief is designed to begin a conversation about how technology transfer programs could support a scale-up of energy efficiency projects. It provides an overview of the importance and applicability of energy efficiency within technology transfer initiatives, and provides a 'toolbox of actions that countries can use to attract more private investment and project development. Two case studies are included to provide tangible examples of innovative, collaborative projects.

TECHNOLOGY TRANSFER OVERVIEW

Technology transfer is a key area of discussion before the UNFCCC international climate negotiations. While there is widespread support for transferring low-carbon technologies and for funding technology deployment from developed nations to developing nations, the exact mechanisms that will facilitate the transfer of these technologies is still under discussion. The key question confronting the international community is how to structure a program to effectively jumpstart private investment in clean energy projects around the world and attract talent and expertise to advance these growing markets. To help ensure the design of an efficient and effective technology transfer mechanism, the private sector should be given an opportunity and a role in the design process.

Energy Efficiency: An Effective Place to Start

Energy efficiency technologies are commercially viable today and offer some of the most cost-effective solutions for reducing greenhouse gases. Energy efficiency solutions present opportunities for both carbon reduction and energy cost savings. Figure 1, the McKinsey marginal abatement cost curve,[1] shows that energy efficiency technologies are the only greenhouse gas reduction solutions that have negative marginal costs.

The magnitude of potential greenhouse gas emissions reductions within the building sector is significant. Buildings make up 25-40% of global energy consumptions and around 40% of greenhouse gas emissions.[2] The major developing countries, including China, Brazil, Russia and South Africa, are estimated to construct the equivalent of 5% of their existing stock per year through 2030.[3] This is compared to new construction on the order of 1% of existing capacity per year within OECD nations.

This not only represents a huge opportunity to reduce emissions, it is also marks the development of new, attractive markets for private investment. For example, recent analysis found that in China if 5% of existing buildings and 60% of new buildings achieve levels of energy consumption that are 50% lower than comparable buildings, the energy savings would be equivalent to turning off all the lights in the U.S. for a month.[4] These investments can also create "clean energy" jobs which are critical to the sustainable economic development of countries around the world.

Furthermore, the lifetime energy savings from green building designs and technologies are greater than the initial up-front costs.[5] Spending an additional 2% of upfront construction and design costs for efficiency and sustainability can, on average, result in lifecycle savings of more than 10 times the initial investment.[6]

NEW OPPORTUNITIES:

- **50% of new building construction will be developed in China through 2020 *(U.S. DOE)* and only 4% of buildings in China have implemented energy efficiency measures *(IEA)***
- **Energy consumption in India is expected to quadruple in the next 25 years *(Indian Government)***

[1] Enkvist, Per-Anders, Nauclér, Tomas and Rosander, Jerker. "A cost curve for greenhouse gas reduction:" The McKinsey Quarterly No.1 (2007), 38. Available at: http://www.epa.gov/air/caaac/coaltech/2007_05_mckinsey.pdf

[2] "World Energy Outlook" 2009. IEA.

[3] "World Energy Outlook" 2009. IEA.

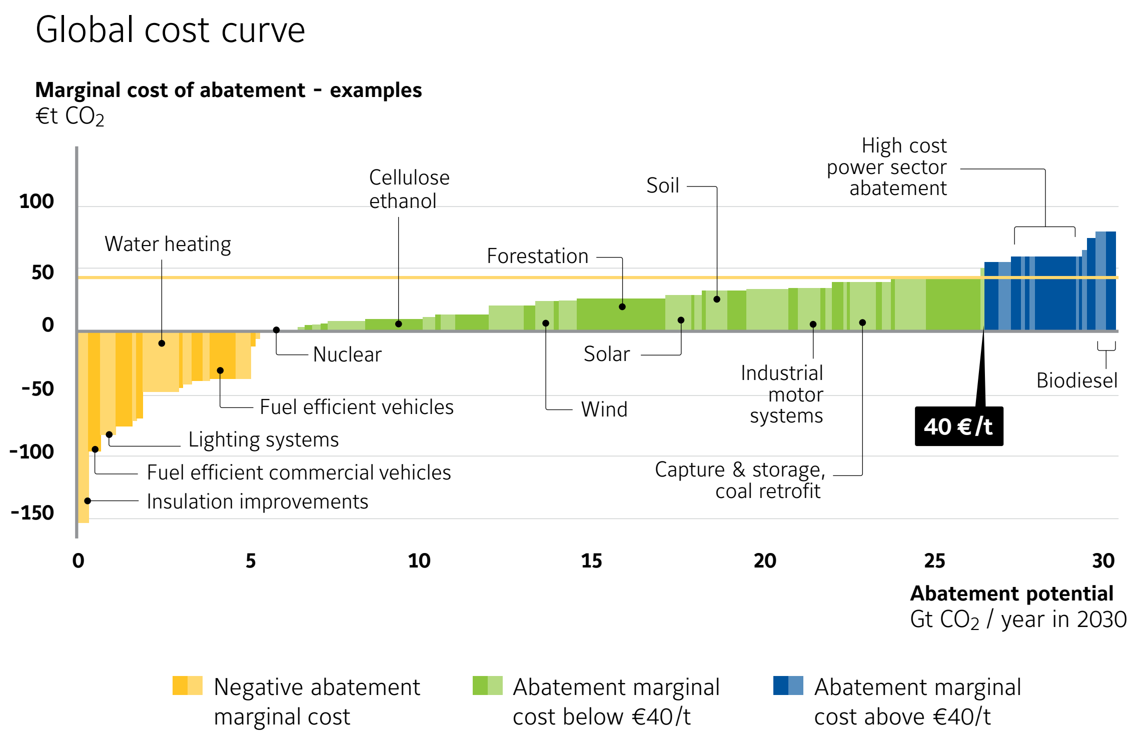
[4] "From Gray to Green: How Energy Efficient Buildings Can Help Make China's Rapid Urbanization Sustainable." 2009. Boston Consulting Group and the Natural Resources Defense Council. Accessed at: http://china.nrdc.org/files/china_nrdc_org/From_Gray_to_Green_EN_Final%202009%20Oct.pdf

[5] Kats, Greg. October 2003. "The Costs and Financial Benefits of Green Buildings: A Report to California's Sustainable Building Task Force."

[6] Kats, Greg. October 2003. "The Costs and Financial Benefits of Green Buildings: A Report to California's Sustainable Building Task Force."

Technological solutions to improve energy efficiency in buildings are available today and can be deployed at scale. Consequently, intellectual property barriers are minimal compared to other clean energy technologies. Energy efficiency offers a broad and flexible suite of approaches and technology options; companies and governments can implement a range of simple, relatively inexpensive measures, such as compact fluorescent lights or opt for more complex projects that incorporate sustainability and efficiency into new building designs. Regardless of the approach, all of these projects create jobs and economic opportunities.

Figure 1. Marginal Cost of Carbon Abatement for Various Technologies



Source: The McKinsey Quarterly No.1 (2007)

[7] Schiller, Steven. "CDM and Energy Efficiency: Challenges and Opportunities." April, 2009. Accessed at: http://www.schiller.com/images/Schiller_UNFCC_JWS_April_2009_final_comp_2.pdf

Barriers to Energy Efficiency Technology Transfer

Despite the cost-effective greenhouse gas emissions reduction potential for energy efficiency solutions, existing technology transfer mechanisms, such as the Clean Development Mechanism (CDM), have failed to effectively finance energy efficiency projects within the developing world. In fact, energy efficiency projects represent 0.4% of total certified emissions reductions (CER's) under the CDM.[7] Aside from the challenge of access to up-front capital that energy efficiency and renewable energy technologies share, there are two major barriers specific to energy efficiency that prevent investment flow into projects within existing technology transfer mechanisms.

First, measuring and verifying greenhouse gas emissions from energy efficiency projects is challenging. Companies must get baseline information of energy consumption before and after the project, which can be costly and time-consuming. The size of the project often does not warrant this degree of effort. Furthermore, there must be proof of 'additionality' to show that the project would not occur independent of the CDM funding, and this, too, can prove difficult, particularly for new buildings.

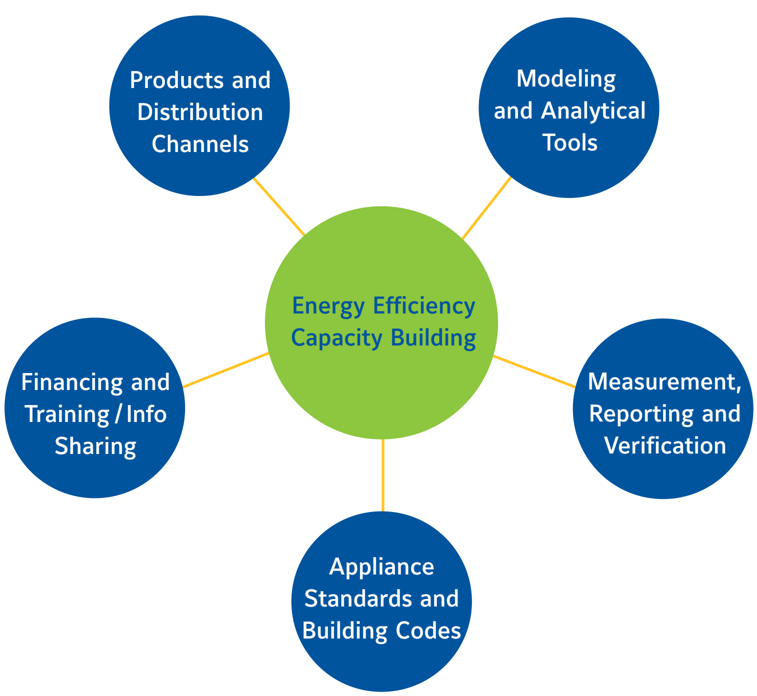
Second, transaction costs associated with CDM projects are high. This leads international carbon financiers to invest in projects that offer significant emissions reductions and financial returns, such as utility-scale renewable energy. In comparison, energy efficiency projects are too diffuse and small in scale to justify the transaction costs. In order to overcome this barrier, energy efficiency projects must be aggregated or new, larger, commercial systems-based projects should take precedent.

Both of these barriers should be adequately addressed in the new UNFCCC technology transfer framework. It is also worth considering how best to encourage energy efficiency through the international carbon markets as the discussion on the evolution of the global carbon market unfolds.

ENERGY EFFICIENCY TECHNOLOGY TRANSFER AND CAPACITY BUILDING: A TOOLBOX FOR DEVELOPING COUNTRIES

In order to harness the full potential of private sector investment in technology transfer (i.e., the direct investment, sales or lease of technology in developing markets) governments must work with companies, academic institutions and NGOs to develop attractive markets. There are a number of actions these governments can take to scale up clean technologies, including the implementation of policies and standards that incent investment, the development of training and education programs for the workforce, and the facilitation of information exchange in the market. Figure 2 below outlines a preliminary 'toolbox' of capacity building measures that could jumpstart this process. This list is not a comprehensive literature review or a prescriptive recipe for success. Instead, it provides an initial set of recommendations and a starting point for further discussion.

Figure 2. Toolbox of Capacity Building Measures to Facilitate Energy Efficiency Technology Transfer



Tool 1: Product and Distribution Channel

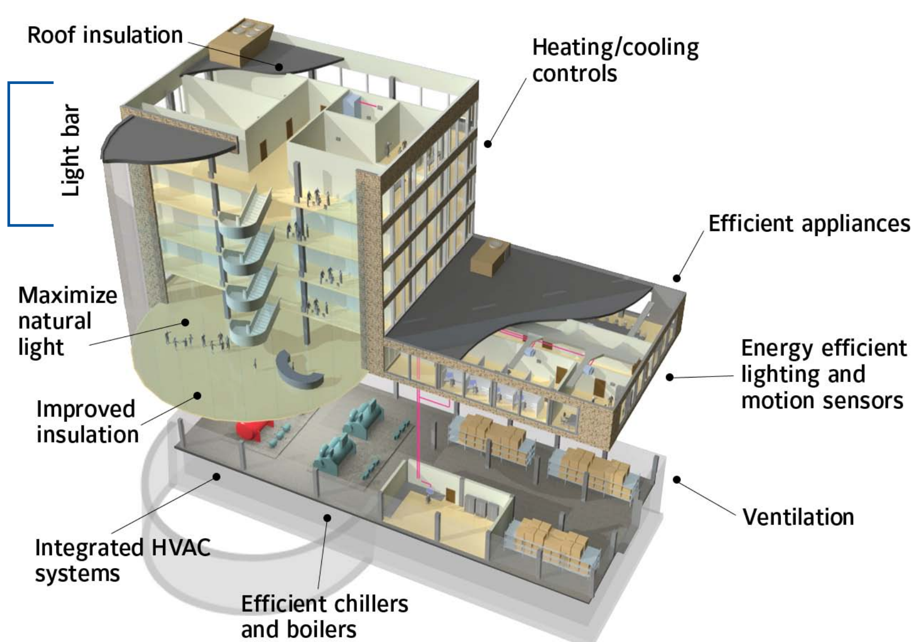
Governments must perform needs assessments to prioritize the most cost-effective and appropriate technologies for their domestic markets. These assessments should identify the technology needs and the barrier (e.g., policy, finance, etc.) to its wide-scale deployment. Access to these technologies through public-private partnerships, university R&D or other means is vital. There are a wide range of technologies and designs that increase building efficiency as shown in Figure 3. Low cost measures include compact fluorescent lighting changes, water heater wraps, water pipe insulation, furnace filters and setback thermometers.[8] All of these are commercially available and provide a relatively inexpensive way of retrofitting existing buildings or improving the efficiency of new buildings.

[8] "Energy Efficiency as a Low Carbon Resource for Achieving Carbon Emissions Reductions." September, 2009. Environmental Protection Agency. Accessed at: http://www.epa.gov/cleanenergy/documents/suca/ee_and_carbon.pdf

The greater opportunity for implementation or transfer of energy efficiency technology lies within the building systems and advanced technologies, but these tend to be more expensive than conventional options. These include advanced HVAC systems, energy efficient appliances, and integrated IT energy management systems. Unlike other energy technologies, energy efficiency requires a number of different materials and technologies and optimal performance necessitates engaging technical expertise to integrate a suite of technology solutions into a building.

Access to these technologies and the development of adequate distribution channels is one of the first critical steps to technology diffusion within developing country markets. In this case, once a market is made more attractive for private investment, companies will be more willing to work with governments to ensure adequate infrastructure improvements for efficient distribution channels.

Figure 3. Anatomy of an Energy-Efficient Building



Key Questions:

1. Which technologies and products would result in the largest amount of abatement for the lowest cost?
2. What are the cost-effective technologies that could be deployed across markets? Which technologies might be pursued in specific national markets based on local resources, cost, abatement potential, cultural acceptance, etc.?
3. How could a UN mechanism or national government help facilitate the development of systems-based thinking or life cycle approaches to building design?

Tool 2: Modeling and Analytical Tools

Energy efficiency investments often depend on integration with existing architectural structures and components. It is not a "black box" but rather, an optimization of new and existing equipment, information and control technology, and human behavior. Many of the most ambitious whole-building retrofit projects seeking to maximize energy efficiency must be carefully designed, and require on-site engineering that is custom to each facility, making these types of projects out of reach for many building owners and operators.

Fortunately, decades of implementation of energy efficiency projects in developed countries have led to significant progress in streamlining the process and minimizing transaction costs for all but the most complex projects. Software tools are available to help with upfront modeling and analysis, as well as with project execution and providing verification of the energy savings. In addition to engineering and technical tools, there is a second wave of efforts being focused on the process itself – calculators offer cost projections, guides to help introduce integrated design approaches, independent labels which classify the buildings' energy use, etc.

Just as information software and modeling tools have refined and streamlined the energy efficiency efforts in developed economies, they could also greatly accelerate the uptake of efficiency projects in developing countries. With support, countries around the world should be able to quickly expand and go to scale with energy efficiency that contributes in the near term to meeting greenhouse gas reduction goals.

While there are dozens of tools available to assist project developers with all phases of the energy efficiency process, there are a few basic categories that are particularly useful in the pursuit of significant levels of energy efficiency in buildings:

- Energy Modeling
- Building Information Modeling (BIM)
- Building Controls
- Measurement and Verification (M&V)
- Process Optimization

Key Questions:

1. How should nations collaborate on shared, common, and publically available analytical software? What, if any, are the intellectual property rights challenges? Is common software and data desirable?
2. What is the most effective way to increase cost savings associated with efficiency through technology and modeling integration?

Tool 3: Measurement, Reporting And Verification Of Building Energy Performance

From a financial perspective, the key question behind the decision to make an energy efficiency investment is whether the promised savings will be realized. This requires energy measurements before and after efficiency projects in order to compare energy performance. With the advances in connectivity and interoperability of the past several decades, commercial buildings have become hosts for large and complex databases full of information about physical characteristics, operating conditions and energy consumption. Analytical tools can use these data to provide a clear picture of the savings associated with an individual efficiency project or a comprehensive sustainability strategy. This would allow companies to overcome the barrier of quantifying and verifying greenhouse gas emissions reductions through retrofit projects.

There are, however, clear challenges to confront in measuring, reporting and verifying the performance of new buildings – and existing buildings often as well– because there is no clear baseline with which to compare performance. Establishing benchmarks or tools requires an additional effort to identify the mechanism and process to measure and verify energy savings, especially for new construction projects. Several sources, including The American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE), the Federal Energy Management Program (FEMP) and the International Energy Agency Demand Side Management (IEADSM) have established guidelines for measuring, reporting and verification (MRV), but the UNFCCC must build off of these efforts to establish global, uniform MRV standards for efficiency to be utilized by national governments and the international community, as appropriate.

Key Questions:

1. What is the best process for identifying an appropriate baseline for new buildings?
2. What technical capabilities are required to ensure that measurement and verification is accurate?
3. What is the added cost of measuring and verifying emissions reductions for efficient buildings?

Tool 4: Appliance Standards and Building Codes

Building codes and appliance standards establish minimum energy performance requirements and are the dominant policy tool used around the world to improve energy efficiency. Building codes and appliance standards reduce overall energy consumption, thereby delaying or replacing the need to build new, capital-intensive traditional energy generation plants. These standards can drive market growth for energy efficiency technologies, jumpstart domestic innovation within universities and the private sector, and reduce consumer energy bills.

Building codes embed efficiency into the building and its systems throughout their useful lives by specifying certain requirements for windows, insulation, etc. Likewise, equipment standards raise the required level of efficiency for all similar products on the market: air conditioners, refrigerators, etc., are all required to meet certain minimum performance characteristics. In appliances today, there are economically-competitive energy efficient technology options that could be substituted for less efficient alternatives if there were adequate financial or regulatory incentives, and if policy focused on appliance efficiency.

When instituting codes and standards, governments should consider the following issues:

- Compliance and enforcement, including the provision of incentives to enable compliance
- Monitoring and maintaining efficiency performance throughout the lifetime of the building stock
- Continue to improve standards with technological innovation

Key Questions:

1. What are the most important appliance standards for countries to implement?
2. How stringent should these codes and standards be – is there a tradeoff still between maximizing energy and environmental performance and economic growth? Is the energy access limited by seeking high performance appliances?
3. Should these standards vary across countries or be uniform in order to maximize opportunities for technology transfer cross-borders?

Tool 5: Financing and Capacity Building

Upfront capital expenses are largely regarded as the most significant barrier to energy efficiency implementation.[9] Community banks, energy service companies (ESCOs), governments and private financial institutions have tested a number of financial mechanisms to more effectively incent companies to prioritize efficiency retrofits. Yet, there is much more to be done, and the government can play a fundamental role in providing collateral, streamlining programs that support energy efficiency projects in order to attract more private investment, or encouraging the creation of ESCOs or targeted energy efficiency programs within lending institutions. An effective model is one that offers solutions for sharing risk and establishes unconventional partnerships among the key players to address some of the issues specific to the area.
Governments can also invest in and support training programs for energy efficiency technology installation, financing and maintenance. A technically savvy workforce equipped with replicable project approaches is critical for widespread adoption of energy efficiency measures. Countries may have access to the technology and financing, but their domestic capacity and expertise may be limited. Universities and labor unions can house these programs with the help of additional government, NGO and private sector resources and support. Collaborative programs can help attract multi-national companies looking for markets with skilled workforces.

[10] "Energy Efficiency Indicator Survey." 2010. Johnson Controls, Inc.

Key Questions:

1. How should a UNFCCC Fund be set up to most effectively leverage private sector investment and facilitate technology transfer?
2. How can the international financial banks and institutions be more effectively engaged in this discussion? What is their role?
3. What is the best model for governments to collaborate with companies, unions and NGOs to train their workforces?

CASE STUDIES

Advocates of technology transfer have struggled to translate the concept and theories into tangible solutions. There are, however, several projects in construction or complete that can serve as useful models for companies, governments and other stakeholders to replicate. With regard to energy efficiency, there are a variety of solutions that can be applied to projects of varying scales and budgets.

Incorporating energy efficiency into the core design of new commercial buildings and/or capital upgrades for old commercial buildings, however, can result in more greenhouse gas reductions per dollar spent. The scale of these projects may also be more attractive within existing technology transfer mechanisms. Two recent projects, the Empire State Building and the Zero-Emissions Building in Singapore, are useful case studies and models for system-wide, integrated efficiency and sustainability measures within commercial buildings. They both highlight the importance of collaboration and dedication among a variety of stakeholders and of making their project design and analysis transparent to facilitate information sharing.

Empire State Building

Johnson Controls is collaborating with the Clinton Climate Initiative, the Rocky Mountain Institute, the City of New York, and Jones Lang LaSalle to retrofit the Empire State Building. This project can serve as a useful process model for collaboration, financing, implementation and information sharing.

The five partners used an eight-month iterative design process to vet over 60 energy efficiency ideas. The final result is an annual savings of $4.4M and a 38% reduction in energy consumption to create "the world's most environmentally conscious office tower built before World War II."[10]

[10] "A landmark sustainability program for the Empire State Building." Jones Lang LaSalle, Climate Climate Initiative, Rocky Mountain Institute, Johnson Controls.

The Empire State Building began the project with a goal of establishing a process for assessing, quantifying and documenting the costs and benefits of potential efficiency strategies that could be replicated and applied around the world. The building managers merged its capital upgrade budget and design with energy savings initiatives to establish a plan that balances net present value of investments with overall carbon dioxide emissions reductions.

The process was broken into four phases:

1. Inventory and Programming: gather data on energy usage patterns within the building
2. Design and Development: analyze data gathered to assess strategic options and the costs/benefits of each
3. Design Documentation: develop final report on tenant energy usage and develop energy model
4. Final Documentation: measure financial and sustainability metrics for retrofits

A key lesson learned is that the development of robust solutions requires 'dynamic, multi-year models and collaborative efforts'. All data on this project has been published on a central website in order to provide a real world, in-depth case study and learning tool. Transparency and information sharing will enable companies and governments to replicate successful aspects of this project in other parts of the world.

Singapore's First Zero-Energy Building

In 2009, Singapore's Building and Construction Authority (BCA) announced the first zero-energy building (ZEB) in Southeast Asia. This project exemplifies tangible and effective R&D efforts around building efficiency and innovation. With an $11M budget, the BCA retrofitted a 3,000 square meter building improving its energy efficiency by 40-50% relative to similar-sized buildings and adding renewable energy generation units to make it completely independent of the electricity grid.

The BCA was successful, in part, due to the collaborative nature of the project and the inclusion of a variety of stakeholders. Partners included the National University of Singapore (NUS), the Solar Energy Research Institute of Singapore (SERIS) and private sector partners. Funding came from the MND Research Fund for the Built Environment, a $50M fund managed by the BCA, and EDB's Clean Energy Research Test-Bedding Programme.

The project exemplifies the challenges and opportunities facing governments who seek to promote and deploy energy efficiency technologies. It serves as a model for funding, constructing and educating around efficiency initiatives. The Singapore government established a fund for similar projects, worked with universities to prioritize innovative research within this area, and established a training center for future growth in the sector. The building is designed to raise awareness on energy efficiency, serve as a training ground for students and test a variety of efficient technologies prior to broader adoption. It serves as a model for other countries to replicate.

CONCLUSION

The world faces a significant opportunity in the coming year to advance international climate efforts through technology transfer mechanism design and agreement. There are models in which public sector and UN support could help unleash significant levels of private sector energy efficiency deployment in buildings. In order to do so, the private sector must contribute to the international discussions around technology transfer implementation to ensure that the model establishes the right incentives and encourages nations to create policies and collaboration efforts to effectively jumpstart this process. This discussion draft serves to outline a model for consideration, and highlights a number of actions countries can take now to advance their markets for clean technologies.

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