United States Building Energy Efficiency Retrofits

Market Sizing and Financing Models

March 2012

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THE ROCKEFELLER FOUNDATION

DB Climate Change Advisors
Deutsche Bank Group

Investment Research Team

DBCCA Climate Change Investment Research

Mark Fulton – Editor
Managing Director
Global Head of Climate Change
Investment Research

Jake Baker
Assistant Vice President
Lead Analyst, Energy Efficiency Finance

The Rockefeller Foundation

Margot Brandenburg
Associate Director
Foundation Initiatives

Deutsche Bank, Corporate Real Estate

Ron Herbst
Director
Global Head of Energy Management
and Sustainability

Consultants to The Rockefeller Foundation

John Cleveland
Chief Executive Officer
Innovation Network for Communities

Joel Rogers
Chief Executive Officer
COWS (Center on Wisconsin Strategy)

Chinwe Onyeagoro
Chief Executive Officer
O-H Community Partners

We would like to thank the following individuals from Deutsche Bank for their insight:

Jeff Baer, Managing Director, Head of Global Logistics Services
Rick Bertasi, Managing Director, Global Head of Corporate Real Estate Services
Bruce Kahn, Ph.D., Director, Senior Investment Analyst, DBCCA
Brad Wollmer, Director, Global Lead of Asset Development and Sustainability

Editorial Letter: Large Opportunity in U.S. Energy Efficiency Retrofits

Mark Fulton
Global Head of Climate Change Investment Research
DB Climate Change Advisors

Heather Grady
Vice President, Foundation Initiatives
Rockefeller Foundation

Upgrading and replacing energy-consuming equipment in buildings offers an important capital investment opportunity, with the potential for significant economic, climate, and employment impacts. In the United States alone, more than $279 billion could be invested across the residential, commercial, and institutional market segments. This investment could yield more than $1 trillion of energy savings over 10 years, equivalent to savings of approximately 30% of the annual electricity spend in the United States. If all of these retrofits were undertaken, more than 3.3 million cumulative job years of employment could be created. These jobs would include a range of skill qualifications, and would be geographically diverse across the United States. Additionally, if all of these retrofits were successfully undertaken, it would reduce U.S. emissions by nearly 10%. The potential employment and climate benefits presented by energy efficiency retrofits have led the Rockefeller Foundation to explore a program initiative in this area, and to partner with Deutsche Bank Climate Change Advisors to produce this research report as a publicly-available resource for all interested stakeholders.

For some time, advocates of clean technology have emphasized the market potential and rapid payback of energy efficiency upgrades and retrofits in buildings. Buildings consume approximately 40% of the world's primary energy and are responsible for 40% of global carbon emissions. Mature and proven technologies, designed and manufactured by established multi-national firms, can save energy and yield significant returns when replacing older, less efficient systems. However, the apparently simple act of upgrading and replacing equipment in buildings - from upgrading lights to replacing heating and cooling systems, or replacing building controls - has never achieved its full potential. In order to provide a clear understanding of this opportunity, we use this paper to establish the potential size of the retrofit market in the United States. We also examine the emergence of new financing models that offer the promise of overcoming historical barriers and unlocking the true potential of this market.

Case studies and various analyses have shown that the energy savings from retrofit projects can offer the potential for strong financial returns. However, a status quo bias, asymmetric information and structural barriers in the real estate industry have traditionally resulted in low levels of demand by home and building owners. Over recent years, a number of financing models have emerged which offer the potential to scale investment in these markets and overcome both the supply and demand side barriers. Utilizing the work done by the World Economic Forum as a reference point, we profile these models, including the Energy Services Agreement (ESAs), Property Assessed Clean Energy (PACE) and On-Bill Finance (OBF), in addition to examining the largest historical provider of energy efficiency upgrades, the Energy Services Companies (ESCOs).

Each of these models merits consideration, and we believe that a robust market will offer multiple options to building owners seeking third-party investment in building retrofits. The ESA model appears to be especially promising in the near term, given its potential to scale without policy or regulatory requirements. A number of firms have already demonstrated early traction utilizing this structure.

While parts of the market are poised to grow independent of government policy, an enabling policy environment could further accelerate adoption and facilitate greater, or more rapid, scale. Enabling policies go beyond subsidies to include measures such as building data disclosure requirements. Some models and market segments, such as single family residential and affordable multifamily, are more policy dependent than others.

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Summary

- **Scaling building energy efficiency retrofits in the United States offers a $279 billion dollar investment opportunity. The energy savings over 10 years could total more than $1 trillion.**[1]
- **Scaling building retrofits could mitigate more than 600 million metric tons of CO_2 per year (~10% of U.S. emissions in 2010).**[2]
- **Increased building retrofits could create more than 3.3 million new direct and indirect cumulative job years (excluding induced) in the United States economy.**

Figure 1: Summary of impact by market size, climate and employment categories

	Residential	Commercial	Institutional	Total
Economic/Financial Impact				
Energy Savings (Trillion Btu)	1,892	848	293	**3,033**
Total Investment ($ Bn)	182	72	25	**279**
Social Impact				
Cumulative Job Years Created (# FTEs over course of investment program, '000s)	2,152	857	296	**3,305**
Environmental Impact				
Greenhouse Gas Emission Reduction (million metric tons of CO_2 mitigated per year)	382	175	59	**616**

Source: Rockefeller Foundation, 2012. McKinsey, Unlocking Energy Efficiency in the U.S. Economy (2009); Center for American Progress, The Economic Benefits of Investing in Clean Energy (2009); Energy Information Administration Commercial Building Energy Consumption Survey 2003, Residential Energy Consumption Survey 200. Note: Analysis is based on an assumption of 30% energy savings in buildings built before 1980. Category impact information represents an aggregation of the values calculated for the segments associated with that category. TBtu = Trillion Btu.

Buildings consume approximately half (49%) of all energy used in the United States and three quarters of all electricity, according to the U.S. Energy Information Administration (EIA). Building energy retrofits, or the application of energy efficient or clean generation measures to existing building stock, represent a significant opportunity to save money, reduce climate impacts and generate or maintain jobs. However, the U.S. building stock is heterogeneous and the building retrofit market is actually comprised of a number of underlying market segments and sub-segments. The three main categories of segments include residential, commercial and institutional, as depicted above. The finance models and other market development strategies needed to realize energy efficiency measures at scale will vary by market segment, although a number of models and strategies can be applied in one or more segment. Due to the limitations of publicly available data at the segment level, this Market Scan does not include any information and analysis about the 21 segments within the Industrial category (not shown).

[1] This economic impact is a directional estimate, which converts the volumetric energy savings to dollar savings using sector specific energy prices from the U.S. EIA, as well as EIA estimates for sector specific electricity price escalation. It does not incorporate the feedback loop of reduced demand via energy savings affecting prices.
[2] Source: http://epa.gov/climatechange/emissions/usinventoryreport.html

Executive Summary

Retrofits require the replacement or upgrade of old building systems with new energy saving technology and processes. A retrofit is the physical and operational upgrade of a building's energy consuming equipment. In this context, there are four key categories that we have identified as important to integrate into a retrofit project:

1. "New kit": Repair, replace, and upgrade key internal equipment
2. New controls: Enable the system to operated more dynamically, with individual optimization by floor (or more granular) and appropriate schedules to be maintained
3. Integrated design: Evaluation of the cross-component impact of multiple systems be changed or upgraded
4. Active energy management (AEM): Systems to actively monitor and manage the performance of the upgraded systems and make corrections when necessary

The chart below details some of the key technology upgrades that are likely to be used in a commercial building or multi-family retrofit. Although these are not universally applicable across all of the building segments, it provides a picture of the types of technology used in an upgrade. The simple payback is a framework used to describe the return potential of energy conservation measures (ECMs) when installed in a building. The payback is the period of time required to recover the initial invested capital from the savings generated by reduced energy use. Investors will also pay close attention to other metrics such as the Internal Rate of Return (IRR) which evaluates the return of a project over a given period of time, incorporating the time value of money into the analysis. On a simple basis, a five year payback translates to approximately a 15% IRR over a ten year period, if cash flows are relatively consistent through the project term.

Figure 2: What energy conservation measures (ECMs) are used in a retrofit?

Controls	Payback (yrs.)
Controls retrofits and control strategies	3-4
Demand controlled ventilation	2-5
Mechanical	
Variable flow primary/secondary systems with controls, VFDs	2-4
HVAC	
Constant speed air handlers to variable air volume	2-4
VAV boxes, control setpoints, box flow minimums	5+
Boiler conversions from steam to hot water	5-8
High efficiency fully condensing boilers	6-8
High efficiency VFD chiller system	8-12
Lighting	
Install controls to schedule and interior systems	2-4
Convert incandescent to CFL	1-3
Replace exit signs with LED kits	<2
Convert T12 to high efficiency T8s with electronic ballasts	2-5

Source: Payback source DBCCA and Transcend Equity analysis, 2011. EIA and DOE Building Data Book, 2010; DBCCA Analysis 2011. Paybacks are pre subsidy and reflect a simple return of capital invested without additional return. Payback periods are estimates and there are no assurances that stated payback periods will be achieved.

Executive Summary – Financing Models

Summary

- **Over the past few years, there have been new emerging financing structures, such as Energy Service Agreements (ESAs), Property Assessed Clean Energy (PACE), and On-Bill-Finance options, which offer significant potential to address historical barriers and achieve scale across the different market segments.**

- **These provide additional options beyond ESCOs, which operate primarily in government markets (which include both commercial and institutional segments).**

- **PACE has potential as a model for all segments, but it requires significant regulatory support and acceptance from the mortgage industry. On-Bill Finance could be utilized with enabling regulation or used as a mechanism to enhance other financing models across the three building market segments.**

- **In particular, we believe that the Energy Service Agreement structure offers significant near term potential to scale quickly and meet the needs of both real estate owners and capital providers in the commercial and institutional market, without the requirement for external enablers such as regulation or subsidy.**

Below, we highlight the various financing mechanisms and structures potentially available for building energy efficiency retrofits. The traditional barriers facing the sector are discussed in the Financing Models section of the document. We exhibit the work of the World Economic Forum as a succinct summary of the different structures, from work on which Ron Herbst, contributing author, collaborated.

Figure 3: Summary of emerging financing models

		Financing Source	Project Size	Upgrade Scope	Source of Repayment	Recipient of Energy Savings	Collateral / Security	Incremental Cost to Borrower	Sale Restrictions
Emerging Models	**Energy Service Agreements (ESA)**	Private	$250,000 to $10 million	Extensive retrofit	Energy savings	Investor	Equipment; UCC1 Financing Statement	None	None. Can be transferred or terminated.
	Property Assessed Clean Energy (PACE)	Public and/or Private	$2,000 to $2.5 million	Extensive retrofit	Property tax pass-through of energy savings or tenant recovery	Owner/Tenant	Tax lien	Higher tax assessment less energy savings and any recoveries	None. Obligations remain with property.
	On-Bill EE Tariff	Public	$5,000 to $350,000 (depending on size of bill, nature of customer, etc.)	Selective interventions	Energy savings	Owner/Tenant	Equipment; UCC1 Financing Statement	Financing costs (P&I) funded through utility bill less energy savings	Tariff stays with the property
	On-Bill EE Loan	Public	$5,000 to $350,000 (depending on size of bill, nature of customer, etc.)	Selective interventions	Energy savings	Owner/Tenant	Equipment; UCC1 Financing Statement	Financing costs (P&I) funded through utility bill less energy savings	Tariff stays with the property

Source: World Economic Forum, 2011; DBCCA, 2012.

Figure 4: Summary of other financing models

		Financing Source	Project Size	Upgrade Scope	Source of Repayment	Recipient of Energy Savings	Collateral / Security	Incremental Cost to Borrower	Sale Restrictions
Other models	***Traditional Secured Lending***	*Private*	*NA*	*All*	*Loan payments funded from building cash flow*	*Owner/Tenant*	*Mortgage*	*Market interest rates*	*Repayment in full*
	Energy Performance Contracts ("EPCs")	*Private*	*Unlimited*	*Extensive retrofit*	*Loan payments funded from building cash flow*	*Owner/Tenant*	*Mortgage, general recourse*	*Loan payments less energy savings*	*Credit-worthy buyer, or pay out remaining value of contract*
	Government-owned development bank	*Public and private*	*Up to $14 million per project*	*Extensive retrofit*	*Loan payments funded from building cash flow*	*Owner/Tenant*	*Secured by collateral, backed by government. Also use credit default swaps and contingency funds*	*Interest + Cost of Retrofit*	*kFw Bank limited to Germany*

Source: World Economic Forum, 2011; DBCCA, 2012.

In the table below, we summarize the major existing market participants in the retrofit space. Not all of the possible financing models are shown below, as some are not yet widely used as independent structures (i.e. On-Bill Finance and Government Owned Development Banks). A number of emerging firms are particularly active across the ESA and PACE structures, and we highlight the track records of participants across each category. Significant opportunity still exists to address the larger building retrofit market, which has not yet been addressed at scale, despite early traction and progress among the emerging firms.

Figure 5: Existing retrofit market participants have demonstrated a successful track record but have not achieved sufficient scale for the full market opportunity

	EPCs used by Energy Service Companies (ESCOs)	Energy Service Agreements Providers (ESA)	Property Assessed Clean Energy (PACE)	Original Equipment Manufacturers (OEMs)
Description:	Firms focused on utilizing Energy Service Performance contracts to serve primarily MUSH / Government market	Emerging integrated developer / investor firms seeking to use ESA structure to fund retrofits	Emerging integrated developer / investor firms seeking to use PACE structure to fund retrofits	Manufacturers of large pieces of building infrastructure such as boilers, chillers, etc
Approximate Number of Players:	~16 Majors, Approx 100 Small	15-20+	15-Oct	3-5 global firms per equipment vertical
Approximate Deals Done:	Approx $4-6 bn / year	Approx 100-125	+/- 100 (approx $10-20M)	Multi-billion $ – all buildings have kit
Approximate Pipeline:	Approx $4-6 bn / year	Approximately $500M across all firms	TBD - Depends on regulatory approval	Multi-billion $
Strengths	Large, established firms. Integrated service delivery	Overcomes many barriers; bilateral contract does not require regulations	Offers strong security mechanism for investors	Large, established firms. Insight into deployed technology
Weaknesses	Require upfront payment, high margin expectations, tied to captive OEMs.	Limited scale to date. Fragmented market, requiring owner education.	Requires regulatory approval. Limited scale to date.	Most are pure OEMs or tied to ESCOs. Limited ability to innovate new deployment structures.

Source: DBCCA research estimates from market review and existing relationships, 2012. NAESCO.

Implications for Policy

Many of the barriers that exist to scaling energy efficiency retrofits in the United States could be addressed through enabling local and national policy and regulation. Recent activity suggests the industry will scale independent of policy change, but we believe that an improved enabling policy environment could dramatically speed this process. Enabling policy and regulation can be broad or targeted to specific market segments or finance models. Mandated efficiency targets, for example, could transform the industry across the board. Legislation that authorizes on-bill recovery for single family retrofits, on the other hand, would enable the development of a particular operational and financial model for a single segment. Both types of policies could play an important role in accelerating market adoption of energy efficiency. Below, we detail a framework for evaluating some of the policy solutions that might contribute to the development of these markets.

Presently, the best examples of enabling policy and regulation for energy efficiency retrofits in the United States can be found at the local and state level. In New York City, for example, mandatory energy disclosure and benchmarking laws generate demand for retrofits and the NYC Energy Efficiency Corporation was created as a public-private mechanism to finance this demand. A survey of local policy innovations, which is mostly outside of the scope of this paper, should also inform policy going forward. We invite policymakers to survey existing examples of local policy innovation when designing new policies.

With respect to an enabling policy environment for overall market development, we suggest that policymakers consider the following:

1. **Mandates (targets) that set comprehensive energy efficiency standards.** Mandated efficiency targets, such as those that have been recently employed in China, could transform overall demand for building retrofits. They are most easily applied to new buildings, however, and generally need to be implemented through local building codes. Enforcement of standards requires particular emphasis if they are to have a material impact on market adoption. As such, this type of policy has the greatest potential to transform the market but is also among the most difficult to execute and should be managed carefully.
2. **Disclosure requirements.** Disclosure and benchmarking laws, such as those implemented in New York City, may provoke energy competition response from industry. As an alternative, voluntary systems such as Greenprint can play a complimentary role. The federal government can support disclosure-related initiatives, such as recent work by the Department of Energy to create a Buildings Performance Database, to enable more precise analysis of energy efficiency and create a template for disclosure to facilitate standardized reporting (See appendix for more detail). Policymakers should also consider methods for ensuring validity of the data used for benchmarking.
3. **Leadership by example.** Government can lead by example by using its existing assets (e.g. GSA properties) to test emerging financing models and prove out different approaches, as it did with the LEED standards. Individual government projects can increase the visibility of retrofits, and government assets collectively can contribute to a critical mass of demand.
4. **Subsidies, incentives and guarantees to 'de-risk' energy efficiency investments.** While challenging in the current budget environment, deal-enhancements, such as first lost reserves, credit enhancements or subordinated debt, can de-risk early finance models and support further proof of concept in near term to stimulate scale. Subsidized capital is not a long-term solution but could help catalyze private market development. State-level infrastructure investment banks are one way to do this at the state level; a 'Green Bank' has been discussed to play this role at the national level.

In addition to the above, policymakers may choose to focus on policy and regulation designed to enable a specific finance or operational model for delivering retrofits. Examples of finance model-specific policies include:

- **Energy Service Agreements (ESA):** ESAs require relatively little additional policy support. Clarity on lease accounting classification by regulatory bodies helps expand roll-out, as described in the Appendix.
- **Property Assessed Clean Energy (PACE):** PACE requires significant enabling legislation to create an operational framework and to overcome resistance from existing real estate stakeholders. PACE zones must be established for commercial properties and standardized at the municipal level, as Sacramento, Miami, and Los Angeles have done or are seeking to do. Programs will likely require external administrators to coordinate them – there are examples of some city councils seeking to establish PACE programs but they face a lack of qualified applicants to utilize. Some advocates seek to gain mortgage industry acceptance via legislation, which requires another layer of regulatory design and approval.

Implications for Policy

- **On-Bill Finance or On-Bill Recovery:** On-bill energy efficiency finance (when the capital for up-front retrofit measures is provided by utilities) or on-bill recovery (when capital is provided by a third party, but utility bills are used to remit loan repayments by building tenants) both require utility involvement and significant enabling legislation, but may play a critical for unlocking residential market development when well-designed. Public Utility Commissions (PUCs) must put in place enabling policies or mandates, with support from local regulatory and legislative bodies as needed. The specific elements of program design – such as transference of loan obligation when residents move, or pro-rated distribution of partial payments between utilities and capital providers – require careful thought, as they may impact substantially program viability. In addition, implementation of on-bill programs requires active participation from multiple stakeholders in the public and private sector. Execution will likely vary by region, and national adoption would be accelerated by the emergence of a few pioneering local and state models.

It should be noted that the analysis above is focused on policies that facilitate private sector investment in energy efficiency. Policies that seek to maximize or enhance the specific climate and employment outcomes of those investments, such as wage or training provisions, are considered out of scope for this document but have been addressed in other publications.

U.S. Energy Efficiency Market Sizing

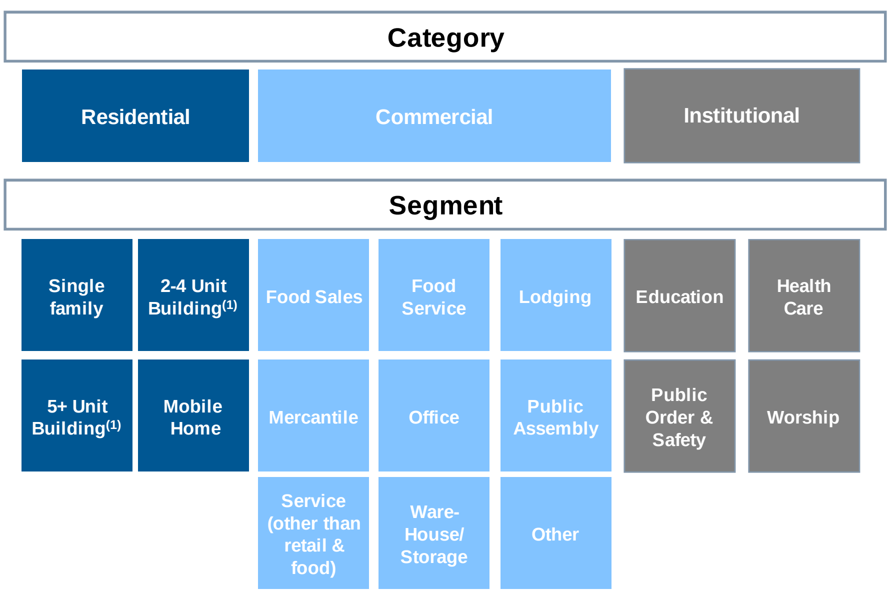
Summary

- **Scaling building energy efficiency retrofits in the United States offers a $279 billion dollar investment opportunity. The energy savings over 10 years could total more than $1 trillion.[3]**
- **Investments in residential energy efficiency upgrades offer $182 billion of investment potential, much of it in single family residential properties.**
- **Commercial real estate sectors offer $72 billion of investment potential, distributed across a variety of sub-segments.**
- **Institutional real estate sectors offer $25 billion of investment potential.**

Market Overview

Buildings consume approximately half (49%) of all energy consumed in the United States and three quarters of electricity consumed, according to the U.S. Energy Information Administration (EIA). Building energy retrofits, or the application of energy efficient or clean generation measures to existing building stock, represent a significant opportunity to save money, reduce climate impacts and generate or maintain jobs. However, the U.S. building stock is heterogeneous and the building retrofit market is actually comprised of a number of underlying market segments and sub-segments. The three main categories of segments include residential, commercial and institutional, as depicted below:

Figure 6: Taxonomy of real estate sector[4]



Source: Rockefeller Foundation, 2012. Energy Information Administration; OHcp/INC/COWS analysis.
Note: (1) 2-4 and 5+ units are classified as Multifamily. Market size and segment characteristics data is captured separately; all other information and analysis are combined. Due to the limitations of publicly available data at the segment level, this Market Scan does not include any information and analysis about the 21 segments within the Industrial category (not shown).

[3] This economic impact is a directional estimate, which converts the volumetric energy savings to dollar savings using sector specific energy prices from the U.S. EIA, as well as EIA estimates for sector specific electricity price escalation. It does not incorporate the feedback loop of reduced demand via energy savings affecting prices.
[4] While many stakeholders in the energy efficiency retrofit space are familiar with the "MUSH" (Municipal, University, Schools and Health) category, a description of the particular ownership of certain types of buildings, a refinement of data into this grouping proved infeasible in the context of this study due to the limitations of publicly available EIA data. Governments at the local, state, and federal levels own properties across a number of different segments, including office, education, public assembly, and residential and are therefore not called out separately in this study.

U.S. Energy Efficiency Market Sizing

The following analysis represents an estimate of the total size of pre-1980 building stock within each category with retrofit strategies capable of achieving an average efficiency improvement of 30%:

- In residential buildings, there exists an investment opportunity of **$182B**. Such an investment would save **1,892T** British thermal units (TBtus) in annual energy consumption
- In commercial buildings, there exists an investment opportunity of **$72B**. Such an investment would save **896 TBtus** in annual energy consumption.
- In institutional building stock, there exists an investment opportunity of **$25B**. Such an investment would save **293 TBtus** in annual energy consumption.

The size of the segments and sub-segments in each category are estimated in greater detail below. The potential climate and employment impacts of undertaking retrofits in these segments are estimated in the following section of the report.

Figure 7: Potential impact by market category

	Residential				Commercial									Institutional			
	Single Family	2-4 Unit Building	5+ Unit Building	Mobile Home	Food Sales	Food Service	Lodging	Mer-cantile	Office	Public Assem-bly	Service (other than retail & food)	Warehouse / storage	Other	Education	Healthcare	Public Order & Safety	Worship
Economic/Financial																	
Energy Savings (TBtu annually)	1,497	173	174	48	42	71	88	217	202	75	53	52	48	149	86	23	35
Total Investment ($Bn)	144	17	17	5	4	6.1	7.5	18	17	6	4.5	4.4	4	13	7.3	2	3
Social																	
Cumulative Job Years Created (# FTEs over course of investment program, '000s)	1,700	197	199	56	43	73	89	219	203	75	54	52	49	150	87	23	36
Environmental																	
Greenhouse Gas Emission Reduction (million metric tons of CO_2)	302	35	35	10	9	18	18	44	41	15	10.7	11	10	30	18	5	7

Source: Rockefeller Foundation, 2012. McKinsey, Unlocking Energy Efficiency in the U.S. Economy (2009); Center for American Progress, The Economic Benefits of Investing in Clean Energy(2009); Energy Information Administration Commercial Building Energy Consumption Survey 2003, Residential Energy Consumption Survey 2005, Residential Energy Consumption Survey 2009; Environmental Protection Agency Online Clean Energy Resources Center; OHcp/INC/COWS analysis. Note: Analysis is based on an assumption of 30% energy savings in buildings built before 1980. All numbers rounded to closest thousand/million/billion as appropriate; TBtu = Trillion Btu.

Residential market size

- The residential retrofit market represents an opportunity to invest $182B and achieve energy savings of 1892 TBtu annually.
- A great majority of the overall savings and investment opportunities in this category are in the single family segment, which represents the largest portion of residential building stock in the United States. However, the significant fragmentation that exists in this segment makes it difficult to develop.

The single family residential segment is by far the biggest opportunity in the residential category, and of any of the segments in our taxonomy. The potential impact and investment opportunity in that segment is over six times greater than in the next largest segment, as a result of the percentage of overall square footage represented by single family building stock (even though the energy use per square foot is less than many other segments). It should be noted, however, that there are at least two main challenges associated with market development in this segment. The first is the extreme fragmentation that exists within the single family market, which results in fragmented demand that is difficult to aggregate. The second is the relatively low level of effective demand, which is only likely to be addressed through strong regulatory requirements, retail consumer engagement strategies and/or other significant non-financial interventions.

There is greater concentration of potential demand in the multifamily building segments, which makes these markets easier to develop than those in the single-family segment. These segments present separate challenges, which stem in part from their occupancy profile. 83% of housing units in this category are rental units. In much of this segment, there are challenges in sub-metering and of 'split incentives' that arise when savings from retrofit measures do not accrue to the same party that finances upfront costs.

The residential building category is comprised of four segments: single family, 2-4 unit building, 5+ unit building and mobile homes. The energy savings and investment opportunities in each segment break down as follows:

Figure 8: Summary of estimated energy savings and invested capital required in each segment of the residential retrofit market

	Single Family	2-4 Unit Building	5+ Unit building	Mobile Home	Total
Energy Savings (TBtu annually)	1,497	173	174	48	**1892**
Total Investment ($B)	$144	$16.6	$16.7	$4.7	**$182**

Source: Rockefeller Foundation, 2012.

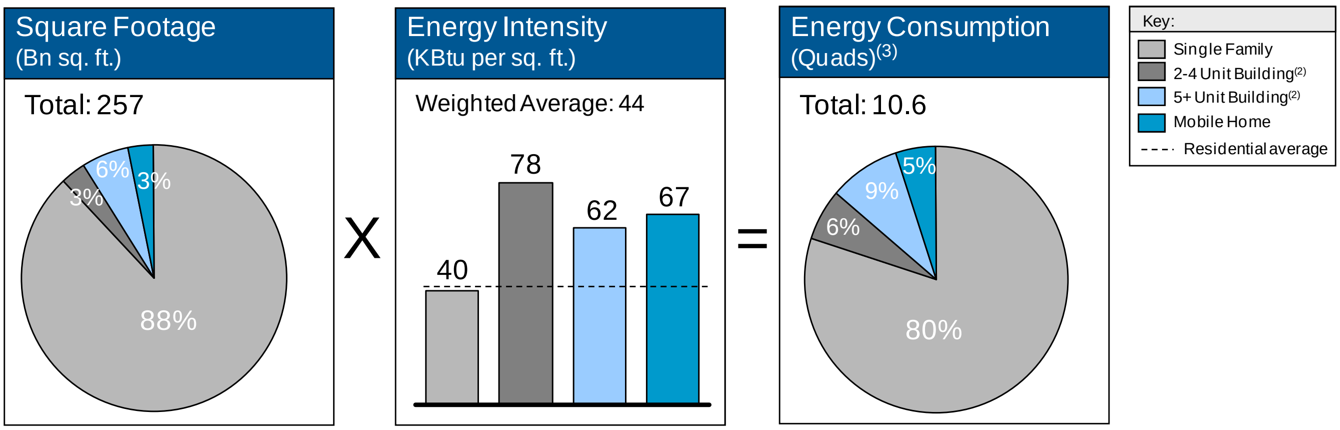
Figure 9: Underlying characteristics of each market segment

Single Family	Comprises 88% of the building stock, and consumes 80% of total energy. Energy intensity is lower than in other residential segments, reflecting in part the average larger sq. ft. per unit of SF building stock, as well as a greater proportion of newer, more energy efficient construction.
2-4 Unit	Comprises 3% of the building stock, and consumes 6% of total energy. Energy intensity is highest in this segment.
5+ Unit	Comprises 6% of the building stock, and consumes 9% of total energy. Energy intensity is higher than in Single Family, reflecting in part the average smaller sq. ft. per unit of MF building stock, but is lower than in 2-4 Unit Buildings, reflecting in part greater energy efficiencies due to factors such as lower surface area to volume ratio and centralized building systems in larger buildings.
Mobile home	Comprises 3% of the building stock, and consumes 5% of total energy. Average energy intensity is comparable to that of 5+ Unit Buildings, reflecting dramatically higher energy intensity of older units in this segment. Comprises 3% of the building stock, and consumes 5% of total energy. Average energy intensity is comparable to that of 5+ Unit Buildings, reflecting dramatically higher energy intensity of older units in this segment.

Source: Rockefeller Foundation, 2012.

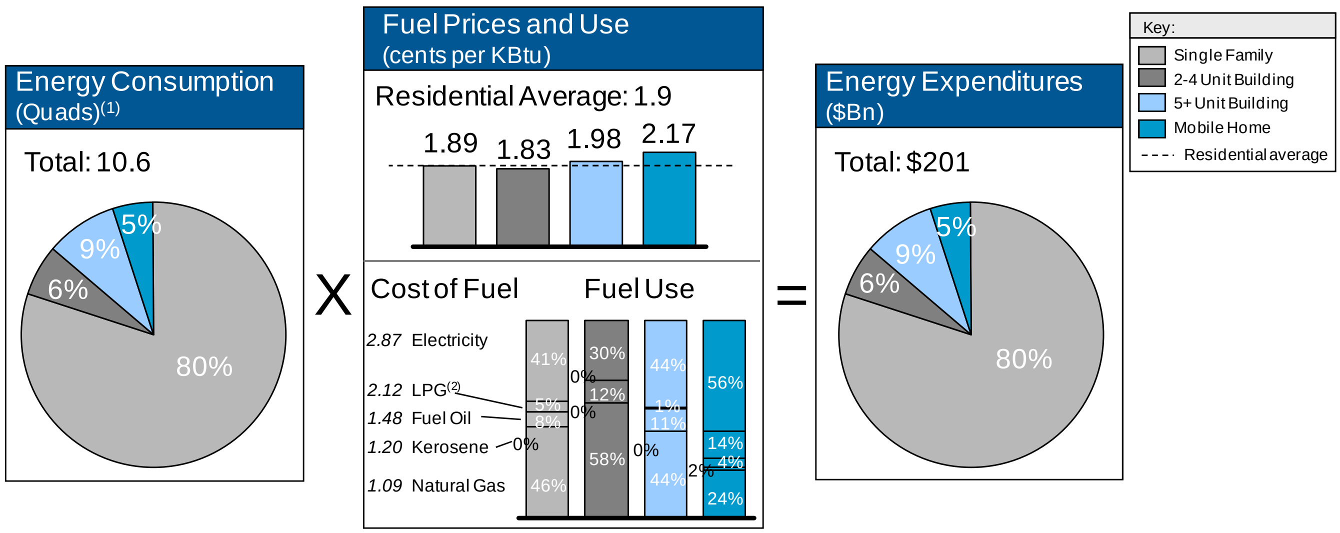
U.S. Energy Efficiency Market Sizing

Figure 10: Residential segments: Share of building stock & energy consumption



Source: Rockefeller Foundation, 2012. Greenhouse Gas Emissions from EIA's April 2011 Monthly Energy Review (data is for 2010). Residential data from EIA's RECS 2005 survey, Commercial & Institutional data from EIA's 2003 CBECS, Industrial data from EIA's 2002 MECS; OHcp/INC/COWS analysis
Note: (1) Commercial & Institutional are grouped together in the Greenhouse Gas Emissions chart; emissions data is not available by building type. (2) Vacant buildings not included. (3) Energy consumption is delivered consumption; excludes primary (off-site) consumption.

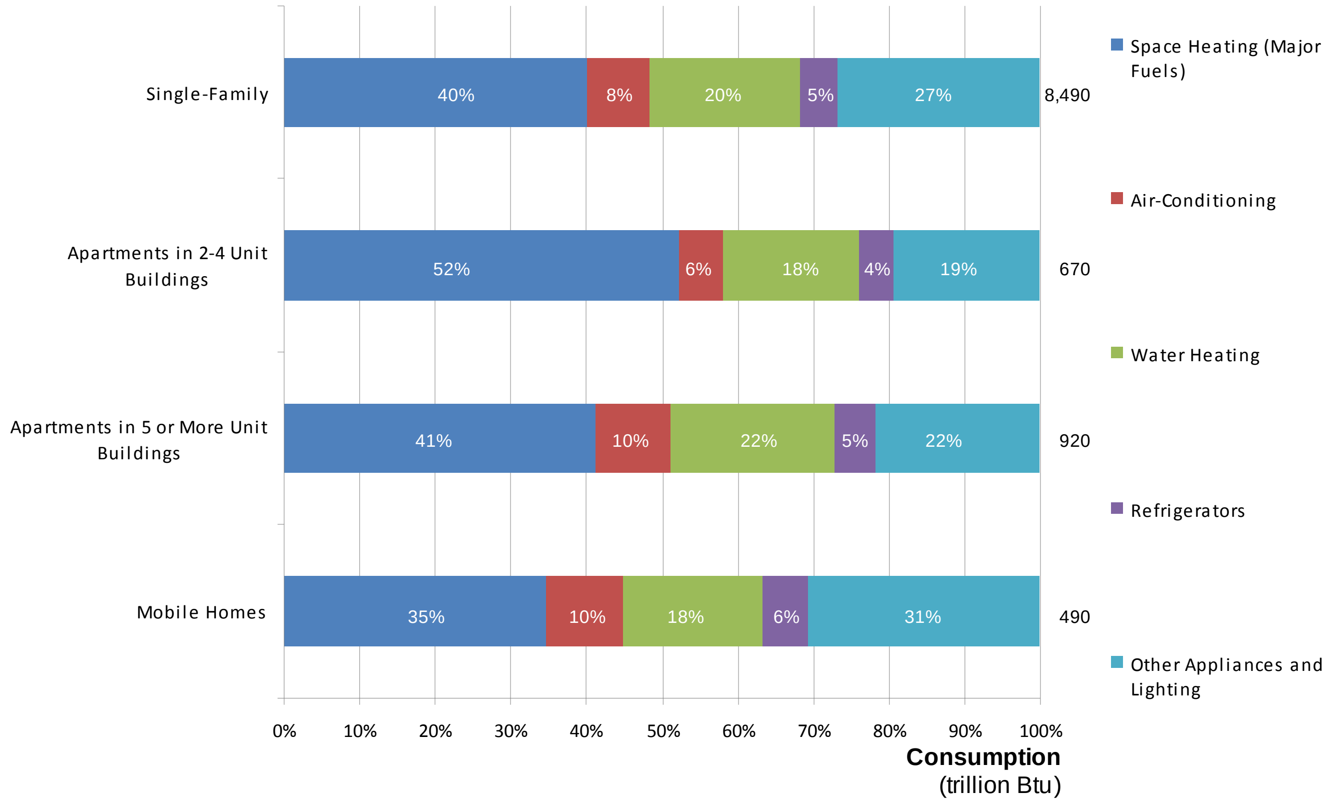
Figure 11: Residential segments: Share of energy spending



Source: Rockefeller Foundation, 2012. EIA 2003 RECS; OHcp/INC/COWS analysis.
Note: (1) Energy consumption is delivered consumption; excludes primary (off-site) consumption. (2) Liquefied Petroleum Gases.

U.S. Energy Efficiency Market Sizing

Figure 12: Residential segments: Energy use characteristics



Source: Rockefeller Foundation, 2012. EIA 2003 CBECS; OHcp/INC/COWS analysis.
Note: Because the EIA withheld data whenever the Relative Standard Error was greater than 50% or fewer than 20 buildings were sampled, some segments do not have energy consumption broken down into all 10 usage types. Additionally, percentages may not sum to 100% due to rounding.

Methodology:
The overall energy savings that could be achieved in each market category were calculated using the following methodology:

Figure 13: Summary of energy savings calculation methodology

Energy Savings (TBtu Annually) = **Number of buildings/units (4) (#)** X **Share of pre-1980 buildings/units (2,4) (%)** X **Targeted energy reduction (1) (%)** X **Average energy used per building/unit (4) (MMBtu)**

Note: Analysis is based on an assumption of 30% energy savings in buildings built before 1980. (1) The consensus view of a wide range of authoritative sources is that 30% energy use reduction is achievable and reasonable target in the context of a program of energy efficiency retrofits. (2) In cases where statistically significant estimates of the share of pre-1980 buildings are not available, we assume a value equal to the share of pre-1980 buildings in the most comparable building segment for which data is available (e.g., data on Food Sales buildings was unavailable, and was assumed to be equal to Food Service buildings).
Source: (3) OHcp/INC/COWS analysis of data from McKinsey & Co., and the Energy Information Administration (4) Energy Information Administration Commercial Building Energy Consumption Survey 2003, Residential Energy Consumption Survey 2005, Residential Energy Consumption Survey 2009. (5) Economic Benefit Strategy in Clean Energy, Center for American Progress, 2009. (6) Environmental Protection Agency Online Clean Energy Resources Center.

U.S. Energy Efficiency Market Sizing

The capital required to finance the retrofit measures that would result in the energy savings described above was calculated for each segment using the following methodology:

Figure 14: Summary of investment potential methodology

Total Investment ($Bn) = **Number of buildings/units [(4)] (#)** X **Share of pre-1980 buildings/units [(2,4)] (%)** X **"Quick Hit" retrofit cost per building/unit [(3)] ($)** / **"Deep" retrofit cost per building/unit, if applicable [(3)] ($)**

Note: Analysis is based on an assumption of 30% energy savings in buildings built before 1980. (1) The consensus view of a wide range of authoritative sources is that 30% energy use reduction is achievable and reasonable target in the context of a program of energy efficiency retrofits. (2) In cases where statistically significant estimates of the share of pre-1980 buildings are not available, we assume a value equal to the share of pre-1980 buildings in the most comparable building segment for which data is available (e.g., data on Food Sales buildings was unavailable, and was assumed to be equal to Food Service buildings). Source: (3) OHcp/INC/COWS analysis of data from McKinsey & Co., and the Energy Information Administration (4) Energy Information Administration Commercial Building Energy Consumption Survey 2003, Residential Energy Consumption Survey 2005, Residential Energy Consumption Survey 2009. (5) Economic Benefit Strategy in Clean Energy, Center for American Progress, 2009. (6) Environmental Protection Agency Online Clean Energy Resources Center.

The estimates of potential energy savings, and of the investment required to realize those energy savings, were developed using a variety of core assumptions, including the goal of 30% energy savings, the estimate of pre-1980 buildings and the estimated average cost per retrofit. The specific assumptions used to estimate the size of the residential segments are summarized in the table below:

Figure 15: Summary of retrofit requirements in each residential market segment

	Single Family	2-4 Unit Building	5+ Unit building	Mobile Home
Pre-1980 Construction[5]	61%	75%	56%	33%
Total No. Units (Mn)	48.4	5.5	9.6	2.4[6]
Total Square footage (Bn sq. ft.) [7]	118.5	6.1	8.0	2.2
Illustrative "Quick Win" Retrofit Measures	Lighting, weatherization (air sealing) Attic / sub-floor insulation Water boiler replacement Appliances	Lighting, weatherization (air sealing) Attic / sub-floor insulation Water boiler replacement Appliances	Lighting Weatherization (air sealing) Appliances	Lighting, weatherization (air sealing) Appliances
Illustrative "Deep" Retrofit Measures	Attic and wall insulation upgrade HVAC system retrofit Solar or geothermal electricity generation site installation Window/door replacements	Attic and wall insulation upgrade HVAC system retrofit Solar or geothermal electricity generation site installation Window/door replacements	Boiler HVAC system retrofit Attic / wall insulation upgrade Window/door replacements	Floor, wall, ceiling insulation upgrades Window/door replacements A/C or furnace replacement

[5] Pre-1980 residential buildings have higher energy intensities than newer construction and thus constitute prime retrofit targets.
[6] Approximately 2Mn units in use were built pre-1976, when a federal manufactured homes standard (the "HUD Code") including energy efficiency standards took effect. These units, and older units in general, present the greatest need for unit retrofits or replacement.
[7] Total square footage per segment calculated by multiplying total no. households by average floor space per household, for each household-occupied building age group in that segment.

Other Building Considerations	Largest energy savings potential in building envelope and HVAC retrofit measures	Largest energy savings potential in building envelope and HVAC retrofit measures	Largest energy savings potential in water heating efficiency measures and appliance upgrades 89% of existing stock dated 1960-80	Largest energy savings potential in envelope weatherization measures or in outright unit replacement

Source: Rockefeller Foundation, 2012.

Commercial market size

- The commercial retrofit market represents an opportunity to invest **$72B** and achieve energy savings of **896 TBtu** annually.
- The most significant overall savings and investment opportunities are in the mercantile and office segments, which represent a combined energy savings of **419 TBtu** and a combined investment opportunity of **$35.5B**. While the potential size of commercial market segments is significantly smaller than for residential category, its development may be facilitated by the greater concentration in energy savings and demand.

Commercial retrofit market segments comprise a smaller overall proportion of the total U.S. building stock than segments in the Residential category, but present a viable opportunity for development due to the relatively concentrated nature of energy savings, strong value proposition to owners and, therefore, potential demand. The highest concentration of ownership in the office building segment exists in non-owner occupied sub-segment, otherwise known as the commercial office lease market; where decision-making is authority lies within large organizations (e.g., REITS, fee-based property management firms, and large private and publicly traded real estate firms) instead of individual buildings.

The commercial building category is comprised of nine segments: food sales, food service, lodging, mercantile, office, public assembly, service, warehouse/storage and other. The energy savings and investment opportunities in each segment break down as follows:

Figure 16: Summary of estimated energy savings and invested capital required in each segment of the commercial retrofit market

	Food sales	Food service	Lodging	Mercantile	Office	Public Assembly	Service	Warehouse/ Storage	Other
Energy Savings (TBtu annually)	42	71	88	217	202	75	53	52	48
Total Investment ($B)	$3.6	$6.1	$7.5	$18.4	$17.1	$6.3	$4.5	$4.4	$4.1

Source: Rockefeller Foundation, 2012.

The following table describes the underlying characteristics of each segment:

Figure 17: Underlying characteristics of each segment

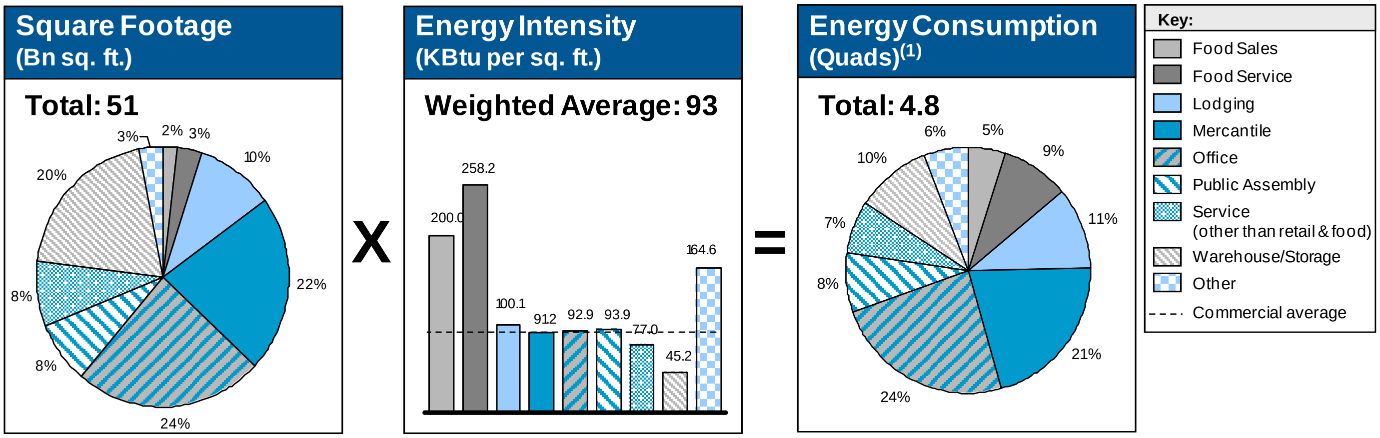
Food Sales	Buildings used for the retail or wholesale of food, including grocery stores, food markets and convenience stores	Comprise 2% of total floor space in the commercial category, but 5% of total energy consumption. The energy intensity of these buildings is 2.0 times the category average. The difference is likely due to the constant energy demands of large refrigeration units.
Food Service	Buildings used for the preparation and sale of food and beverages for consumption	Comprises 3% of total floor space in the commercial category, but 9% of energy consumption. The energy intensity of these buildings is 2.8 times the category average. The high energy demands of multiple pieces of relatively compact kitchen equipment likely accounts for this difference.
Lodging	Buildings used to offer multiple accommodations for short-term or long-term residents	Comprises 10% of total floor space in the commercial category, in line with 11% of energy consumption. The energy intensity of these buildings is only slightly higher than the category average. The demands of 24-hour lighting and heating/cooling are likely spread out across a relatively large amount of floor space
Mercantile	Buildings used for the sale and display of goods other than food, including malls	Mercantile buildings make up 22% of total floor space, in line with 21% of energy consumption. The energy intensity of these buildings is only slightly lower than the category average. Heating/cooling and lighting is spread out across a large amount of floor space in the buildings with greatest energy use – malls.
Office Buildings	Buildings used for general office space, professional offices, or administrative offices	Office buildings make up 24% of total floor space, in line with 24% of energy consumption. The energy intensity of these buildings is the same as the category average.
Public Assembly	Buildings (private and non-private) in which people gather for social or recreational activities	Comprise 8% of total floor space in the commercial category, but 8% of total energy consumption. The energy intensity of these buildings is equal to the category average.
Service	Buildings in which some type of service other than food service or retail sales, e.g. dry cleaners, gas stations, etc.	Service (other than retail & food) buildings make up 8% of total floor space in the commercial category and 7% of energy consumption. The energy intensity of these buildings is slightly lower than the category average.
Warehouse/Storage	Buildings used to store goods, manufactured products, merchandise, raw materials, or personal belongings, including refrigerated and non-refrigerated warehouses	Comprise 20% of total floor space in the commercial category and 10% of energy consumption. The energy intensity of these buildings is half of the category average. This low energy intensity is likely caused by the passive long term storage role for which many of these structures are used.
Other		“Other” segment buildings make up 3% of the total floor space in the commercial category and 6% of energy consumption. The energy intensity of these buildings is about 80% higher than the category average, likely because of the presence of energy-intensive buildings such as laboratories and data centers.

Source: Rockefeller Foundation, 2012.

U.S. Energy Efficiency Market Sizing

The distribution of energy spending across each segment is depicted in the figure below:

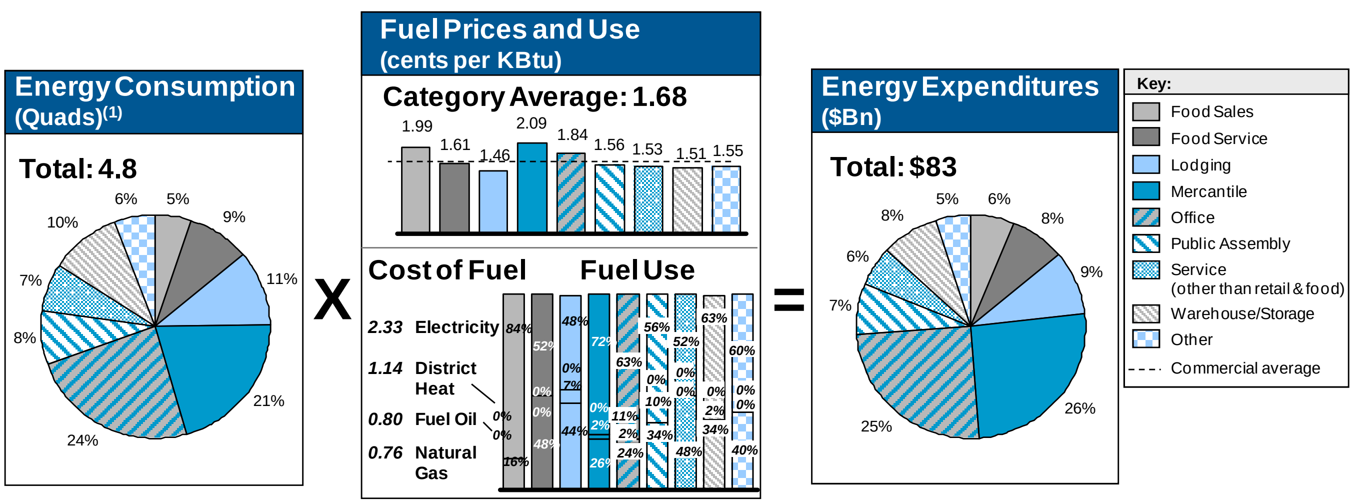
Figure 18: Commercial segments: Share of building stock & energy consumption



Source: Rockefeller Foundation, 2012. EIA 2003 CBECS; OHcp/INC/COWS analysis
Note: (1) Energy consumption is delivered consumption; excludes primary (off-site) consumption.

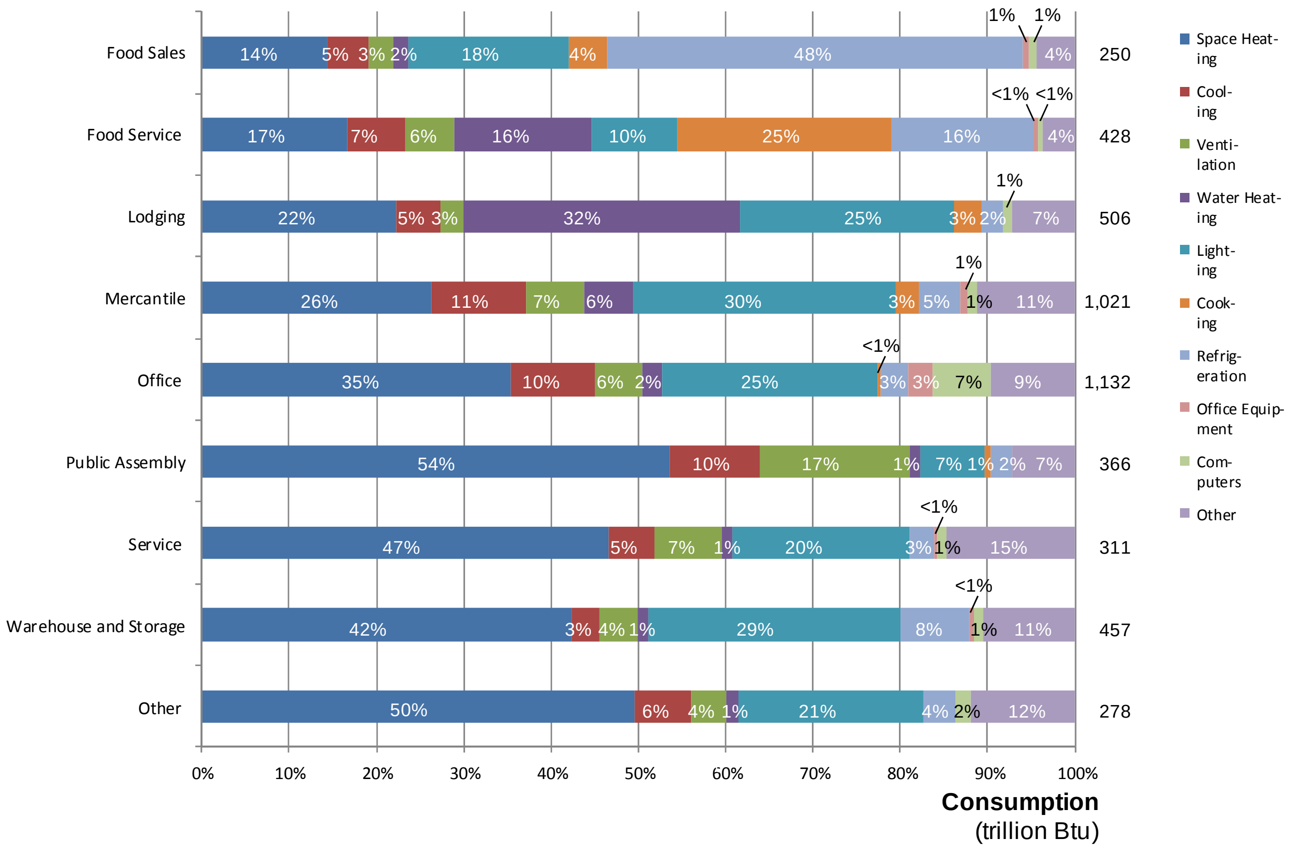
The breakdown of energy spending across commercial market segments is shown below:

Figure 19: Commercial segments: Share of energy spending



Source: Rockefeller Foundation, 2012. EIA 2003 CBECS; OHcp/INC/COWS analysis.
Note: (1) Energy consumption is delivered consumption; excludes primary (off-site) consumption.

Figure 20: Commercial segments: Energy use characteristics



Source: Rockefeller Foundation, 2012. EIA 2003 CBECS; OHcp/INC/COWS analysis.
Note: Because the EIA withheld data whenever the Relative Standard Error was greater than 50% or fewer than 20 buildings were sampled, some segments do not have energy consumption broken down into all 10 usage types. Additionally, percentages may not sum to 100% due to rounding.

The potential energy savings and investment opportunities summarized above were calculated using the same methodology described in the Residential market sizing section above. The specific assumptions used to estimate the size of the largest segments in the Commercial category, Mercantile and Office, are summarized in the table below.

Figure 21: Summary of retrofit requirements in the office and mercantile commercial retrofit segments

	Mercantile	Office
% of Buildings Constructed Pre-1980	70.8%(2)	60%
Illustrative "Quick Win" Retrofit Measures	**Heating, Cooling, and Ventilation (HVAC)** Add weather stripping and caulking to reduce cooling load Add automatic door controls that shut off cooling when doors are left open Replace existing wall fans with high volume low velocity equipment Install doors between conditioned and unconditioned spaces Install variable speed ceiling fans **Water** Install a rainwater capture system **Other** Reduce plug load standby power Seal duct leaks	**Lighting** De-lamp and disconnect unused ballasts Install occupancy sensors Install high efficiency LED Exit signs Install timer controls or photocells for exterior lighting Convert T12 to T8 and T15 Change incandescent bulbs to CFL and HID **HVAC** Install variable frequency drivers and variable air volume systems Install heat recovery equipment Relocate thermostats to optimal locations
Illustrative "Deep" Retrofit Measures[8]	**Lighting** Day-lighting: add skylights and light pipes, including a redesign of the lighting system to reduce the number of fixtures. Upgrade interior lighting and add lighting controls Upgrade exterior lighting and add controls **Heating, Cooling, and Ventilation (HVAC)** Replace HVAC system and thermostats	**Building Envelope** Install high efficiency windows with suspending coated film and gas fill Install insulated reflective barriers **Lighting** Reduce lighting power density and manage energy use in tenant spaces using ambient, direct/indirect, and task lighting **HVAC** Chiller plant retrofit New air handling layout and installation of variable air volume units Installation of CO_2 sensors for control amount of outside air brought into the building based on occupancy levels
Other Building Considerations	There are three basic types of buildings in this segment: Establishments in enclosed malls (<1%) Establishments in strip malls (32%) Establishments in multi-use buildings or standalone structures usually found in central business districts or "main street" locations but also at dispersed locations (68%) Enclosed and strip malls make up less than a third of total buildings, but account for 69% of total energy consumption; more than half of this consumption is for lighting and space heating Almost 60% of non-mall retail properties are less than 5,000 sq. ft., and 96% less than 25,000 sq. ft. (3)	It is often just as easy to get a LEED-EB rating on a 40-year-old building as a new building because in a 40-year old building, much of the equipment will have reached the end of its useful life and can be replaced with new, more efficient systems; the 15-year old building can fall into an awkward in-between time space where owners are sometimes reluctant to invest in those improvements In multi-tenant buildings, owner will have to coordinate with tenants or ask for approval

Source: Rockefeller Foundation, 2012. BOMA International, 30 Easy Ways to Save Energy for Little or No Cost, 2006; Urban Land Institute, Building Retrofits, 2009; Earth Day New York, Lessons Learned Volume 6: Existing Buildings; OHcp/INC/COWS analysis. EIA 2003 CBECS; Rocky Mountain Institute, Retail Chain Case Study, 2009; Innovologie for U.S. Department of Energy, Who Plays and Who Decides: The Structure and Operation of the Commercial Building Market, 2004.

Note: (1) 1980 is a commonly used break point used in energy use analyses by the DOE and other authoritative sources. (2) Figure represents only retail buildings other than malls as mall data is not provided in 2003 CBECS; 314,000 of 443,000 non-mall retail buildings were constructed before 1980. (3) Figures from 2004 analysis of 1999 EIA CBECS public use sample by Innovologie.

[8] "Quick Wins" and "Deep" retrofit measures are derived from the Rocky Mountain Institute case study cited below. We have defined "Quick Wins" to be all those measures whose marginal capital costs are less than $10,000, and "Deep" measures to be those whose marginal capital cost is greater than $10,000 with the exception of replacing the HVAC system, which we have defined to be a deep retrofit measure.

Institutional market size

- The institutional retrofit market represents an opportunity to invest **$25B** and achieve energy savings of **293 TBtu** annually.
- The most significant overall savings and investment opportunities exist in the Education segment, which represents an energy savings opportunity of **149 TBtu** and an investment opportunity of **$12.6B**.

The Education and Health care market segments are smaller, in absolute terms, than the largest segments in the Residential or Commercial categories. Nonetheless, they may present compelling opportunities for development. In both segments, concentration of ownership - particularly long-term ownership, which enables longer-term payback periods – may improve the value proposition of holistic retrofit measures. Both types of institutions are also likely to have missions (student learning and long-term wellbeing) that place non-monetary value energy efficiency.

The institutional building category is comprised of four segments: education, health care, public order & safety, and worship. The energy savings and investment opportunities in each segment break down as follows:

Figure 22: Summary of estimated energy savings and invested capital required in each segment of the institutional retrofit market

	Education	Health care	Public Order & Safety	Worship	Total
Energy Savings (TBtu annually)	149	86	23	35	**293**
Total Investment ($B)	$12.6	$7.3	$1.9	$3.0	**$25**

Source: Rockefeller Foundation, 2012.

The following table describes the underlying characteristics of each segment:

Figure 23: Underlying characteristics of each segment

Education	Education buildings make up 55% of total floor space in the Institutional category, but consume only 48% of the total energy. The energy intensity of education buildings is 13% lower than the institutional category average. This may stem from the fact that the traditional education segment calendar is only 9 months or less, beginning in August or September and ending in May or June - not because educational buildings are more energy efficient than others in the Institutional category.
Health care	Comprise 18% of total floor space in the Institutional category, but consume 35% of the total energy. The energy intensity of health care buildings is 98% higher than the institutional category average, due to hospitals' unique operating practices: 1) long operating hours relative to other types of buildings and 2) hospitals in the U.S. are required to bring in 100% outside air (rather than recycle indoor air) in certain areas 3) use of specialized equipment.
Public Order & Safety	Public order and safety buildings make up 6% of total floor space in the Institutional category, and consume 7% of the total energy. The energy intensity of public order and safety buildings is 22% higher than the institutional category average.
Worship	Worship buildings make up 21% of total floor space in the Institutional category, but consume only 10% of the total energy. The energy intensity of worship buildings is 54% lower than the institutional category average. This may stem from the fact that worship buildings are only operating for an average of 32 hours per week.

Source: Rockefeller Foundation, 2012.

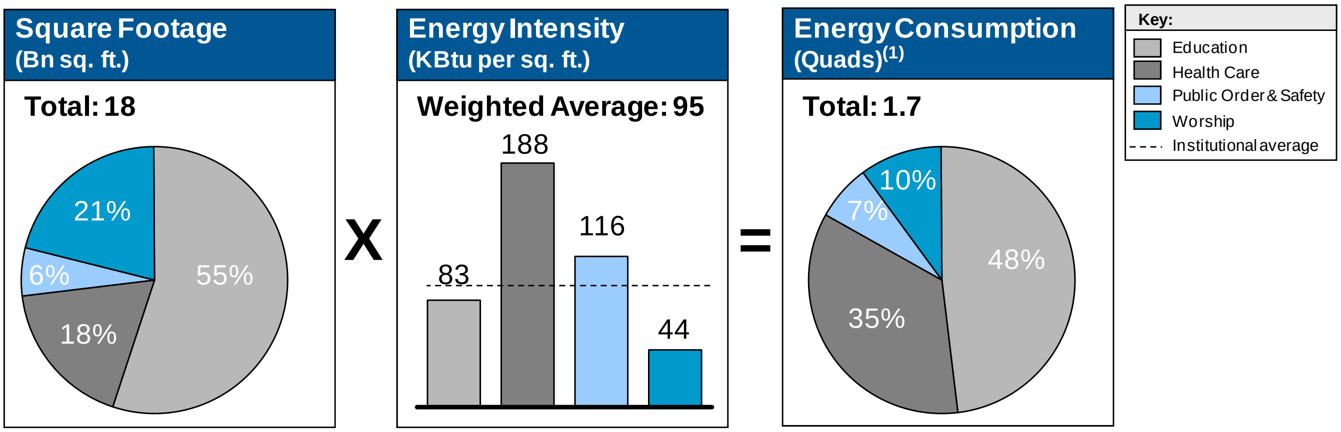
The potential energy savings and investment opportunities summarized above were calculated using the same methodology described in the Residential market sizing section above. The specific assumptions used to estimate the size of the largest segments in the Institutional category, Education and Health care, are summarized in the table below.

Figure 24: Summary of retrofit requirements in key institutional market segments

	Education	Health care
% of Buildings Constructed Pre-1980	61%	48%
Illustrative "Quick Win" Retrofit Measures	**Lighting:** Install energy efficient lighting and LED exit signs **HVAC:** Upgrade to programmable thermostats Replace ducts, pipe insulation, and steam traps as needed Install an economizer **Building Envelope:** Re-caulk and weather-strip windows	**Lighting:** Install energy efficient lighting and LED exit signs Install occupancy sensors **HVAC:** Replace filers, dampers, ducts, and pipe insulation as needed Install automatic blow down controls on boilers Install insulation around domestic hot water tanks and pipes Upgrade pumps and compressors **Building Envelope:** Re-caulk and weather-strip windows and doors **Plug Loads:** Replace CRT monitors with LCD monitors Install sensor-based controls on vending machines
Illustrative "Deep" Retrofit Measures	**Lighting:** Install lighting controls to decrease wasted lighting energy Daylighting retrofits **HVAC:** Replace or refurbish boilers and switch from central to modular system **Water Heating:** Replace storage water heaters with tankless water heaters **Building Envelope:** Install double-paned or low-e coating windows Upgrade the roof by increasing reflectivity, or installing vegetation, or upgrading insulation Purchase ENERGY STAR equipment	**HVAC:** Comprehensive HVAC retrofit including higher efficiency motors and variable frequency drives Connecting the HVAC system into a comprehensive Automated Building Management System that allows for slow down or shut down of fans to optimize energy savings Installation of a high efficiency chiller Replacement of over 400 aging window air conditioning units with a central high efficiency cooling loop **Plug Loads:** Installation of 7.5-megawatt cogeneration plant
Other Building Considerations	Value of deferred maintenance in the education segment is $70 to $100 billion 41% of public K-12 schools in GAO's nationally representative stratified random sample reported unsatisfactory energy efficiency GAO's report indicates that one-third of public K-12 schools need major repair or replacement of at least one building; another 40% need to repair or replace one or more building features	

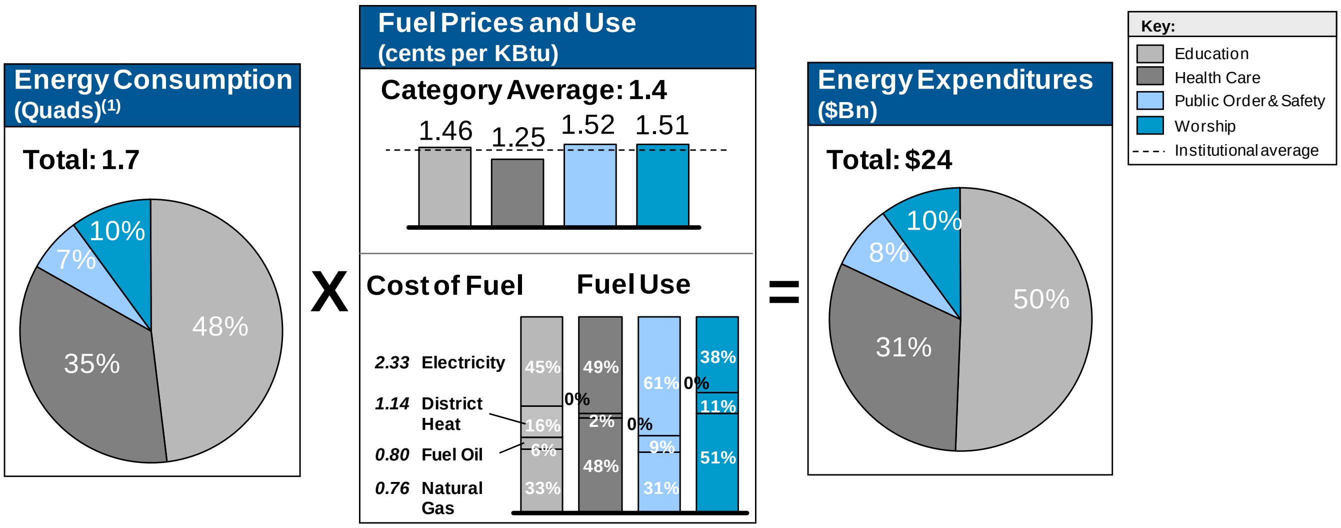
Source: Rockefeller Foundation, 2012.

Figure 25: Institutional segments: Share of building stock & energy consumption



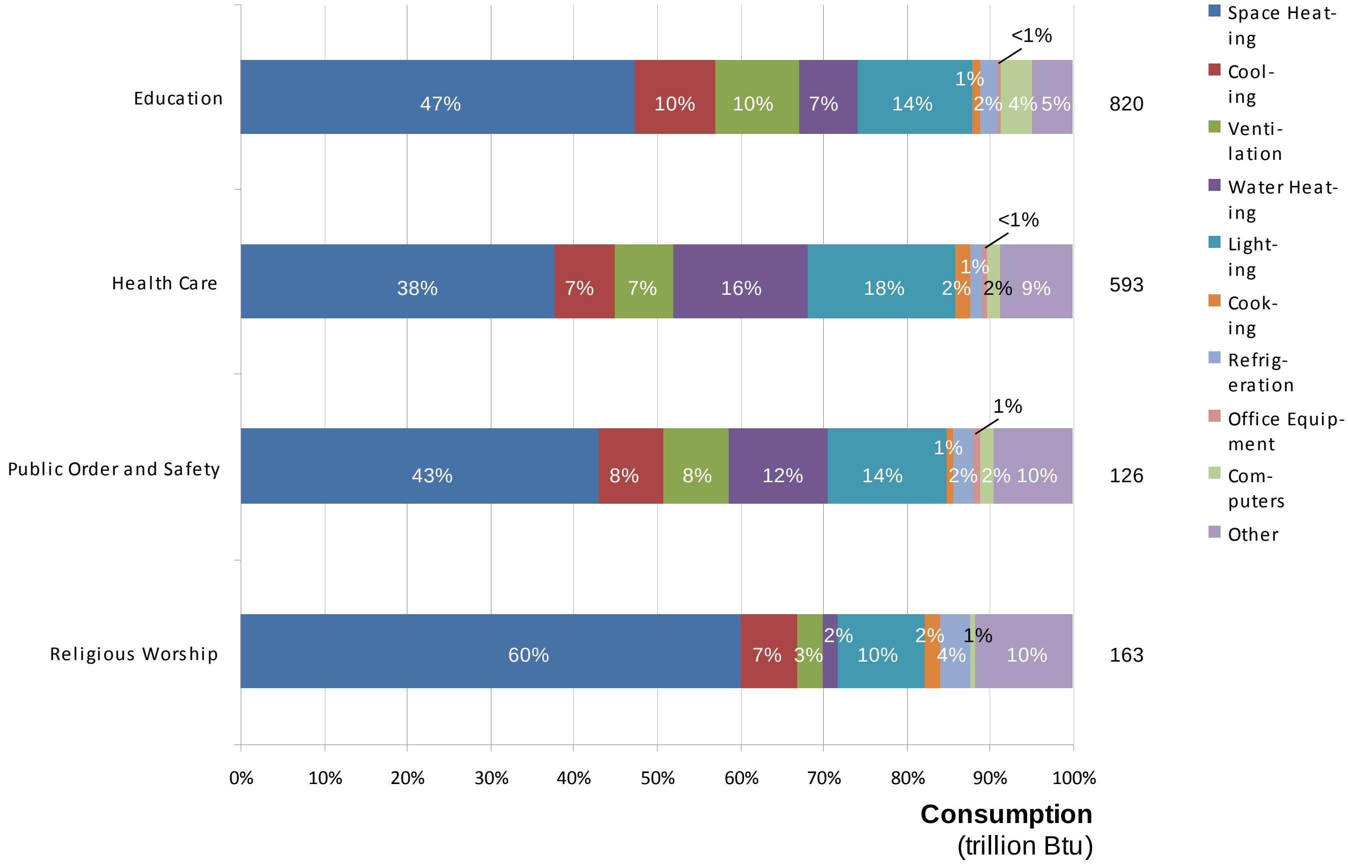
Source: Rockefeller Foundation, 2012. EIA 2003 CBECS; Lawrence Berkeley National Labs, Public and Institutional Markets for ESCO Services: Comparing Programs, Practices, and Performance, March 2005; OHcp/INC/COWS analysis.
Note: (1) Energy consumption is delivered consumption; excludes primary (off-site) consumption.

Figure 26: Institutional segments: Share of energy spending



Source: Rockefeller Foundation, 2012. EIA 2003 CBECS; OHcp/INC/COWS analysis
Note: (1) Energy consumption is delivered consumption; excludes primary (off-site) consumption.

Figure 27: Institutional segments: Energy use characteristics



Source: Rockefeller Foundation, 2012. EIA 2003 CBECS; OHcp/INC/COWS analysis.
Note: Because the EIA withheld data whenever the Relative Standard Error was greater than 50% or fewer than 20 buildings were sampled, some segments do not have energy consumption broken down into all 10 usage types. Additionally, percentages may not sum to 100% due to rounding.

Climate and Employment Impacts

Summary

- **Building energy efficiency retrofits can offer significant climate and employment impacts in the United States.**
- **Scaling building retrofits could mitigate more than 600 million metric tons of CO_2 per year (~10% of U.S. emissions in 2010).[9]**
- **Increased building retrofits could create more than 3.3 million new direct and indirect cumulative job years (excluding induced) in the United States economy**

Energy efficiency retrofits present a large and diverse investment opportunity, as described in the previous section. The nature of the underlying work required to realize that opportunity - whether it entails better sealing of building envelopes, HVAC upgrades, increasing the reflectivity of roofs or installing sophisticated energy management systems – presents additional and potentially significant climate and employment benefits. The potential size and scope of these impacts are estimated below.

Climate Impacts

The United States accounts for approximately 20% of world energy consumption. As noted in the previous section, buildings consume approximately half (49%) of energy consumed in the US, which is as much as the transportation and industrial sectors combined. According to the U.S. Energy Information Agency, fossil fuels (coal, oil and natural gas) supply three quarters (76%) of the energy consumed by those buildings. The combustion of fossil fuels to generate energy results in the production of carbon dioxide and other greenhouse gases (GHGs) that scientists increasingly agree is driving climate change. There is therefore a significant relationship between building energy consumption in the U.S. and global climate change.

Figure 28: Potential climate Impacts by building market segment

	Residential				Commercial									Institutional			
	Single Family	2-4 Unit Building	5+ Unit Building	Mobile Home	Food Sales	Food Service	Lodging	Mer-cantile	Office	Public Assem-bly	Service (other than retail & food)	Warehouse / storage	Other	Education	Healthcare	Public Order & Safety	Worship
Environmental																	
Greenhouse Gas Emission Reduction (million metric tons of CO_2)	302	35	35	10	9	18	18	44	41	15	10.7	11	10	30	18	5	7

Source: Rockefeller Foundation.

Energy efficiency retrofits enable substantial reductions in building energy use. These measures create monetary savings, from reduced energy costs, which can be used to repay the upfront cost of the measures. The energy savings that result from retrofits also reduce fossil fuel consumption and therefore GHG emissions.

[9] http://epa.gov/climatechange/emissions/downloads11/US-GHG-Inventory-2011-Complete_Report.pdf; http://www.bts.gov/publications/national_transportation_statistics/html/table_01_11.html; http://www.epa.gov/climatechange/wycd/waste/measureghg.html

Climate and Employment Impacts

The climate impacts that would be realized from retrofitting all pre-1980 building stock with retrofit strategies capable of achieving an average efficiency improvement of 30% are significant: doing so would reduce overall CO_2 emissions in the U.S. by 10%. The magnitude of potential climate benefits closely tracks the size of the relative investment opportunity per building segment:

- In residential buildings, there exists an opportunity to reduce energy consumption by **1,892 TBtu**, which corresponds to an annual reduction in carbon dioxide (CO_2) emissions of approximately **382.2M** metric tons. This would mitigate the GHG emissions from 82 coal-fired power plants.
- In commercial buildings, there exists an opportunity to reduce energy consumption by **896TBtu**, which corresponds to an annual reduction in carbon dioxide (CO_2) emissions of approximately **175.3M** metric tons. This would be the equivalent of emissions from 2.1M tanker trucks' worth of gasoline.
- In institutional building stock, there exists an opportunity to reduce energy consumption by **293TBtu**, which corresponds to an annual reduction in carbon dioxide (CO_2) emissions of approximately **59.4M** metric tons. This would be the equivalent of taking approximately 10.5M cars off the road.[10]

The following table summarizes the potential energy savings and annual CO_2 emissions reductions that could be achieved in the largest market segments of the market taxonomy presented on above.

Figure 29: Potential energy savings and annual CO_2 emissions reductions that could be achieved in the largest market segments

	Single Family	2-4 Unit	5+ Unit Building	Mercantile	Office	Educa-tion	Health Care
Annual Energy Savings (KBtu)	1,497	173	174	202	27.87	149	86
Annual GHG Emission Reduction (million metric tons of CO_2)	302.4	35	35	43.9	40.9	30.2	17.5

Source: Rockefeller Foundation, 2012.

Methodology

The overall energy savings that could be achieved in each segment were calculated using the methodology outlined in the previous section:

Figure 30: Energy savings calculation methodology

Energy Savings (TBtu Annually) = **Number of buildings/units (4) (#)** X **Share of pre-1980 buildings/units (2,4) (%)** X **Targeted energy reduction (1) (%)** X **Average energy used per building/unit (4) (MMBtu)**

Note: Analysis is based on an assumption of 30% energy savings in buildings built before 1980. (1) The consensus view of a wide range of authoritative sources is that 30% energy use reduction is achievable and reasonable target in the context of a program of energy efficiency retrofits. (2) In cases where statistically significant estimates of the share of pre-1980 buildings are not available, we assume a value equal to the share of pre-1980 buildings in the most comparable building segment for which data is available (e.g., data on Food Sales buildings was unavailable, and was assumed to be equal to Food Service buildings).
Source: (3) OHcp/INC/COWS analysis of data from McKinsey & Co., and the Energy Information Administration (4) Energy Information Administration Commercial Building Energy Consumption Survey 2003, Residential Energy Consumption Survey 2005, Residential Energy Consumption Survey 2009. (5) Economic Benefit Strategy in Clean Energy, Center for American Progress, 2009. (6) Environmental Protection Agency Online Clean Energy Resources Center.

[10] EPA GHG calculator: http://www.epa.gov/cleanenergy/energy-resources/calculator.html#results

Climate and Employment Impacts

The potential reductions in GHG emissions for each segment were calculated using the methodology below:

Figure 31: Greenhouse gas emissions reduction calculation methodology

GhG Emission Reduction (million metric tons of CO_2)	=	Number of buildings/units [2, 4] (#)	X	Share of pre-1980 buildings/units [4] (%)	X	Energy savings per building/unit [4] (MMBtu)	X	Metric tons of CO_2 emissions per (MMBtu) [6]

Note: Analysis is based on an assumption of 30% energy savings in buildings built before 1980. (1) The consensus view of a wide range of authoritative sources is that 30% energy use reduction is achievable and reasonable target in the context of a program of energy efficiency retrofits. (2) In cases where statistically significant estimates of the share of pre-1980 buildings are not available, we assume a value equal to the share of pre-1980 buildings in the most comparable building segment for which data is available (e.g., data on Food Sales buildings was unavailable, and was assumed to be equal to Food Service buildings).
Source: (3) OHcp/INC/COWS analysis of data from McKinsey & Co., and the Energy Information Administration (4) Energy Information Administration Commercial Building Energy Consumption Survey 2003, Residential Energy Consumption Survey 2005, Residential Energy Consumption Survey 2009. (5) Economic Benefit Strategy in Clean Energy, Center for American Progress, 2009. (6) Environmental Protection Agency Online Clean Energy Resources Center.

The potential reductions in GHG emissions from energy efficiency have been appreciated by climate scientists for their relative certainty and immediacy as well as their scale.

Employment Impacts

Figure 32: Potential employment impacts by building market segment

	Residential				Commercial									Institutional			
	Single Family	2-4 Unit Building	5+ Unit Building	Mobile Home	Food Sales	Food Service	Lodging	Mer-cantile	Office	Public Assem-bly	Service (other than retail & food)	Warehouse / storage	Other	Education	Healthcare	Public Order & Safety	Worship
Social																	
Cumulative Job Years Created (# FTEs over course of investment program, '000s)	1,700	197	199	56	43	73	89	219	203	75	54	52	49	150	87	23	36

Source: Rockefeller Foundation, 2012.

Energy efficiency retrofits, in addition to providing a sizeable investment opportunity and potential source of reduction in GHG emissions, also create significant potential demand for labor. The measures used to retrofit a building, and the nature of work involved, may vary significantly within and across market segments, and will depend on building type and age, energy reduction target, fuel source, and other factors. An illustrative set of measures can be found by market category in the previous section.

The average bundle of retrofit measures has several important labor market characteristics. First, they are relatively labor intensive: economists have estimated that $0.54 of every dollar spent on retrofits goes toward direct or indirect employee compensation.[11] Second, they have high domestic content requirements, with 97% of economic activity occurring in the United States. Finally, retrofit measures are associated with a relatively high number of entry-level jobs.

[11] http://www.americanprogress.org/issues/2009/06/pdf/peri_report.pdf

Climate and Employment Impacts

The potential employment impacts of retrofitting all pre-1980 building stock with retrofit strategies capable of achieving an average efficiency improvement of 30% are significant. The magnitude of potential direct and indirect employment impacts (i.e. the jobs associated with direct implementation of retrofit measures and the jobs associated with industries that supply intermediate goods for the measures) closely tracks the size of the relative investment opportunity per building segment:

- In residential buildings, the potential investment in retrofit measures would result in an estimated **2.16M** cumulative years of direct and indirect employment ('job years")
- In commercial buildings, the potential investment in retrofit measures would result in an estimated **876K** direct and indirect cumulative job years
- In the institutional segments, the potential investment in retrofit measures would result in an estimated **298K** direct and indirect cumulative job years

It should be noted that the above estimates do not include induced employment effects (in other words, the employment effects that arise when people employed in direct and indirect jobs spend their salaries) due to the challenges in modeling these effects. The estimates in this study capture both direct and indirect employment impacts, the direct employment being related to the CIM (construction, installation and manufacture) phase of the projects, as well as their ongoing O&M (operations and maintenance) requirements. The indirect employment is an estimate of the supply chain impacts that stem from the CIM phase (jobs that are created by suppliers who are providing the new equipment). We do not include the potential "induced" employment impacts with respect to energy efficiency initiatives that are designed to reduce the rate of growth in power demand over the forecast period. That is, reduced energy consumption by households and businesses saves them money which, in turn, allows them to spend more, creating further employment demand in the economy not specifically attributable to the assumed change in energy supply mix. Although there is an expected positive effect of induced job creation, we do not include it here because it is difficult to accurately measure without a complex integrated economy wide input/output model. As such, these may represent more conservative estimates than have been published elsewhere.

The following table summarizes the potential investment opportunity and employment impacts in the largest market segments of the taxonomy presented above.

Figure 33: Potential investment opportunity and employment impacts in the largest market segments

	Residential			Commercial		Institutional	
	Single Family	**2-4 Unit**	**5+ Unit Building**	**Mercantile**	**Office**	**Educa-tion**	**Health Care**
Total Investment ($B)	$144	$16.6	$16.7	$18.4	$17.1	$12.6	$7.3
Total Cumulative Job Years (# FTEs over course of investment program, '000s)	1,700	197	199	219	203	150	87

Source: Rockefeller Foundation, 2012.

The above estimates are derived from analysis done by Robert Pollin, James Heintz, and Heidi Garrett-Peltier in a 2009 paper entitled *The Economic Benefits of Investing in Clean Energy*.[12] They use a standard input-output model based on IMPLAN 2.0 and the IMPLAN 2007 data set, which provides information on 440 industries and is based on tables developed by the Department of Commerce's Bureau of Economic Analysis. As mentioned above, running the model results in an estimate that $0.54 of every dollar spent on retrofits goes to employee compensation through direct or indirect effects. Their analysis further suggested that this will result in 11.9 direct or indirect job years created as a result of each million dollars of investment. The method used in their analysis has been endorsed by organizations such as the U.S. Green Building Council in subsequent analyses, although the multiplier used varies with assumptions about relative proportion of individual measures and materials used to perform retrofits.[13] These jobs would encompass the spectrum of laborers to highly skilled professionals, and they would be geographically diverse across the United States as individual projects are pursued in multiple regions.

[12] http://www.americanprogress.org/issues/2009/06/pdf/peri_report.pdf

[13] See *A New Retrofit Industry*, June 2011. This report used the same methodology but estimated a somewhat lower direct and indirect job creation number as a result of retrofit investment (about 9.8 direct and indirect job years created per $1 million invested), likely as a result of the lower weight accorded to construction in their analysis of retrofit industry components or the fact that their report focuses on a subset of retrofit technologies and techniques.

Methodology

The employment impacts in this report were estimated by multiplying the size of the investment opportunity in each segment by the multiplier derived by Pollin, Heintz, and Garrett-Peltier:

Figure 34: Job creation calculation methodology

Job Years Created (# FTEs) = **Total investment [3] ($ millions)** X **Job Years created per $ million of retrofit investment [5] (#)**

Note: Analysis is based on an assumption of 30% energy savings in buildings built before 1980. (1) The consensus view of a wide range of authoritative sources is that 30% energy use reduction is achievable and reasonable target in the context of a program of energy efficiency retrofits. (2) In cases where statistically significant estimates of the share of pre-1980 buildings are not available, we assume a value equal to the share of pre-1980 buildings in the most comparable building segment for which data is available (e.g., data on Food Sales buildings was unavailable, and was assumed to be equal to Food Service buildings).
Source: (3) OHcp/INC/COWS analysis of data from McKinsey & Co., and the Energy Information Administration (4) Energy Information Administration Commercial Building Energy Consumption Survey 2003, Residential Energy Consumption Survey 2005, Residential Energy Consumption Survey 2009. (5) Economic Benefit Strategy in Clean Energy, Center for American Progress, 2009. (6) Environmental Protection Agency Online Clean Energy Resources Center.

As noted above, the potential employment impacts are notable not only for their scale but also for their ‘place-based’ nature. Otherwise stated, the jobs created through energy efficiency retrofits are difficult to outsource. A significant portion of the jobs associated with retrofit measures do not require a college degree, which also makes them more accessible to lower-skilled workers.

Financing Models

Summary

- **Energy efficiency investment has been the "low-hanging fruit" for many years in the energy and climate space. However, it has proven consistently farther out-of-reach than expected.**

- **ESCOs, using Energy Performance Contracts, have been the largest participant in the retrofit market to date, but their activity has been limited to certain ownership categories (e.g. Municipal, Universities, Schools, Hospitals and Government or MUSH) in the commercial and institutional sectors.**

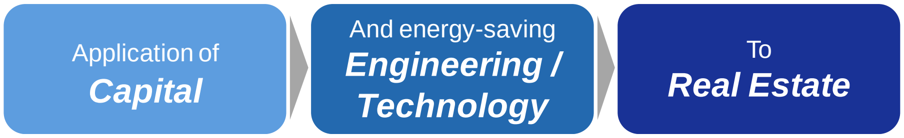
- **Over the past few years, there have been new emerging financing structures which offer significant potential to address historical barriers and achieve scale such as Energy Service Agreements (ESAs), Property Assessed Clean Energy (PACE), and On-Bill-Finance options.**

- **PACE has potential as a model, but it requires significant regulatory support and acceptance from the mortgage industry. On-Bill Finance could be utilized in a regulatory framework or used as a mechanism to enhance other financing models.**

- **In particular, we believe that the Energy Service Agreement structure offers significant near term potential to scale quickly and meet the needs of both real estate owners and capital providers in the commercial and institutional market, without the requirement for external enablers such as legislation or subsidy.**

I. What is a retrofit – a financing perspective

Figure 35: What is a retrofit?



Source: DBCCA, 2012.

As established in the preceding sections, retrofits offer a large investment opportunity across a variety of real estate market segments. In this section, we evaluate how a third party investor might approach and evaluate the potential for deploying capital into retrofit projects. We attempt to structure both challenges facing the creation of scale in retrofit investments and the extent to which financial solutions may be able to address these barriers. We also provide detail on emerging financial models that attempt to solve these historical barriers and provide owners with an opportunity to invest directly in energy saving upgrades for buildings.

To begin in more detail, we ask, what is a retrofit? The framework below offers a simple structure for understanding what a retrofit is from the perspective of an investor. This structure highlights why demand creation on the part of real estate owners is key to creating scale.

"Application of Capital":
In general, capital providers seek opportunities that meet risk-adjusted return targets with defined mechanisms for investment and repayment. Investors need to understand the structure of their investment, which asset class it falls into, and how the structure will provide security to the repayment of their initial investment. They also seek visibility into a clear pipeline of projects to ensure that the full extent of their capital will be deployed.

"Energy-saving Engineering / Technology":
The capital is utilized to upgrade older, inefficient equipment in the building. There is an existing ecosystem of large, proven investment grade providers who manufacture the technology needed for retrofits. This technology is mature and tested across a variety of new and existing buildings. Local and regional experts exist who are able to provide the necessary services and labor to conduct building retrofits.

"Real Estate":
By definition, retrofits are OF real estate as building owners control access to assets. In this context, retrofits must provide value to building owners on acceptable terms to both the building owner and the outside provider of capital. The real estate owner's decision to pursue an upgrade is potentially driven by mandate, old equipment expiration, the potential for financial returns, or possible brand benefits. We believe that a focus on serving the needs of real estate owners as the "customer" of a retrofit is required to create any kind of scale in the market.

Retrofits require the replacement or upgrade of old building systems with new energy saving technology and processes. From a physical perspective, a retrofit is the physical and operational upgrade of a building's energy consuming equipment. In this context, there are four key categories that we have identified as important to integrate into a retrofit project:

1. "New kit": Repair, replace, and upgrade key internal equipment
2. New controls: Enable the system to operated more dynamically, with individual optimization by floor (or more granular) and appropriate schedules to be maintained
3. Integrated design: Evaluation of the cross-component impact of multiple systems be changed or upgraded
4. Active energy management (AEM): Systems to actively monitor and manage the performance of the upgraded systems and make corrections when necessary

The chart below details some of the key technology upgrades that are likely to be used in a commercial building retrofit. The simple payback is a framework used to describe the return potential of energy conservation measures (ECMs) when installed in a building. The payback is the period of time required to recover the initial invested capital from the savings generated by reduced energy use. Investors will also pay close attention to other metrics such as the Internal Rate of Return (IRR) which evaluates the return of a project over a given period of time, incorporating the time value of money into the analysis. On a simple basis, a five year payback translates to approximately a 15% IRR over a ten year period, if cash flows are relatively consistent through the project term.

Figure 36: What energy conservation measures (ECMs) are used in a retrofit?

Controls	Payback (yrs.)
Controls retrofits and control strategies	3-4
Demand controlled ventilation	2-5
Mechanical	
Variable flow primary/secondary systems with controls, VFDs	2-4
HVAC	
Constant speed air handlers to variable air volume	2-4
VAV boxes, control setpoints, box flow minimums	5+
Boiler conversions from steam to hot water	5-8
High efficiency fully condensing boilers	6-8
High efficiency VFD chiller system	8-12
Lighting	
Install controls to schedule and interior systems	2-4
Convert incandescent to CFL	1-3
Replace exit signs with LED kits	<2
Convert T12 to high efficiency T8s with electronic ballasts	2-5

Source: Payback source DBCCA and Transcend Equity analysis, 2011. EIA and DOE Building Data Book, 2010, DBCCA Analysis 2011. Paybacks are pre subsidy and reflect a simple return of capital invested without additional return. Payback periods are estimates and there are no assurances that stated payback periods will be achieved.

Eight of the twelve ECMs included here potentially offer paybacks of five years or less. Some of the larger "big iron" upgrades in the Heating, Ventilation, and Air Conditioning (HVAC) category have paybacks that can stretch out further than five years. It is common to see energy efficiency experts discuss "blended payback," which is a term that reflects the combined payback of several ECMs bundled together. Projects can combine faster payback ECMs with slower payback ECMs to create a single project that fits return criteria.

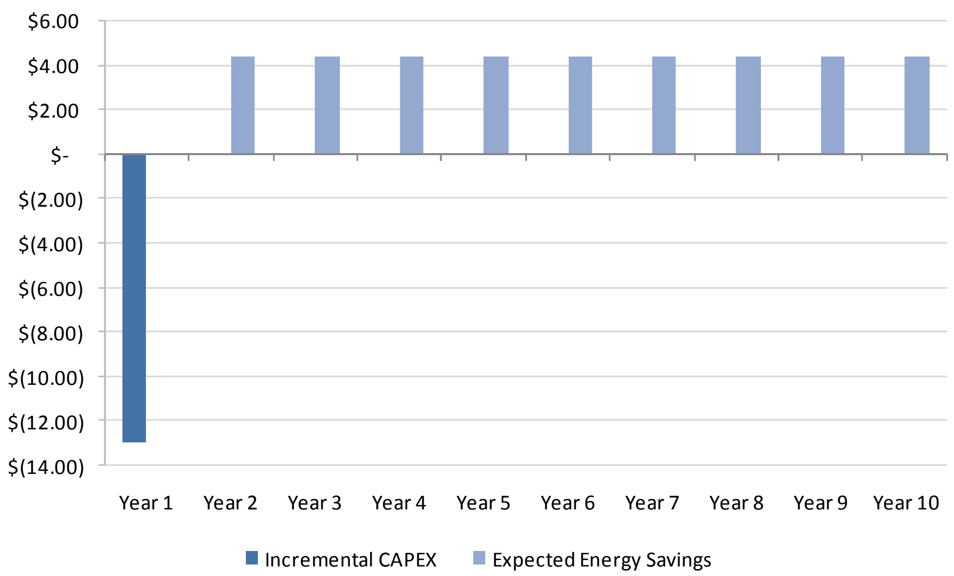
Not included in this diagram are building envelope improvements, which can also offer significant benefits, using technologies such as high efficiency insulation and coating materials, and high performance windows. In addition to the equipment and technology changes listed here, occupant and operator engagement are key to realizing savings. Much of the energy consumption in buildings comes from the direct action and usage patterns of the individual occupants, so there can be significant variance between buildings of a similar age and profile if the occupant usage patterns differ widely.

Most of the ECMs listed are produced by large, established global manufacturers. The technology is not speculative or immature. Many retrofit projects are the replacement of old equipment nearing or past its useful life with new, off-the-shelf equipment.

II. Existing retrofits offer strong potential returns

Over the past few years, the Empire State Building (ESB) has undergone a complex and high-profile retrofit. The ESB retrofit provides an example of the potential returns inherent in energy efficiency retrofits. As shown here, retrofits can offer strong returns through energy-savings driven cost reductions. It is worth noting that the retrofit was part of larger $500M+ building renovation and repositioning, with incremental energy retrofit cost of $13M driving $4.4M of annual savings. These savings offer an implied unlevered IRR of 30.8%.

Figure 37: Profile of Empire State Building retrofit ($M)



Source: DBCCA Analysis, 2012, Jones Lang LaSalle, 2011. Note: Costs savings are projected from current data.

III. Historical sources of financing

Building owners have historically had several options to fund the cost of retrofit upgrades. It is useful to understand the basic framework of each. These options have not enabled retrofits to take-off at scale due a number of barriers which will be discussed below.

- **Pay equity from their balance sheet / Fund upgrades from building cash flows:** Option constrained by structural barriers, split incentive, and availability of capital.
- **Take on parent-company level debt:** Option constrained by company appetite for indebtedness at the corporate level. May impact trading values of publicly listed vehicles.
- **Take on asset-level debt:** Mortgage covenants restrict the volume of debt on a building and require complex approval to secure. Many mortgages are held in securitized structures, making approval difficult

- **Utilize an Energy Services Company (ESCO):** Targeted option that has historically only been adopted by certain segments. Seen by many as expensive. Not usually a source of financing; acts as conduit for other sources.
- **Utilize various rebate programs / subsidized capital sources:** Option constrained by utility programs, government budget, and approval processes. Not viable as a long-term option, and is used by policy makers to kick-start early efforts as an enhancement to encourage use of other sources of capital.

IV. Barriers to industry scale

Despite many positive factors around individual retrofit projects, there are multiple barriers affecting both the demand and supply sides of the market. These barriers have been significant enough to prevent scale from being achieved. Many of these barriers are structural to the operation of the current real estate industry, such as the split incentive between tenant and landlord (discussed in more detail below). Although advocates of energy efficiency often describe the lack of scale as a major market failure, it might be more accurate to describe the challenge as one created because the real estate industry is operating exactly as it is currently structured – with multiple barriers preventing energy efficiency projects from being more widely adopted.

Figure 38: Reasons for lack of demand and industry scaling problems

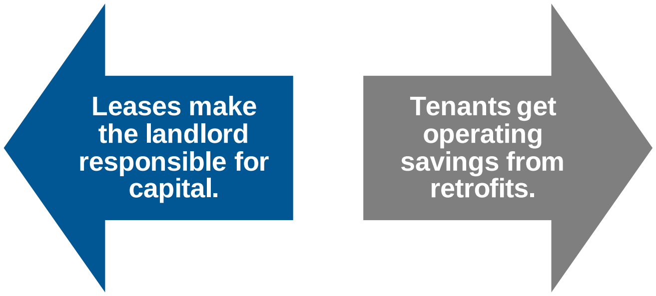
Demand barriers: Challenges affecting real estate	
Split Incentives	Tenant benefits from OpEx reduction while landlord must pay for CapEx
Unclear Benefits	Building owner doesn't understand energy efficiency opportunities and the associated benefits.
Long/Complex Sales Cycle	Building owner loses interest due to a complicated, 9 -12 month sales cycle.
First Cost Hurdles	Upfront Cap-ex hurdle for project
Debt Constrained	Mortgage covenants prevent the owner from taking on debt against the building.

Supply-side barriers: Challenges affecting market response and scale	
Market fragmentation	Real estate market is split across multiple ownership structures and asset class segments
Complex project delivery	Projects require complex sales, engineering, and financial analysis
Underwriting	Lack of proven industry standards to evaluate projects
Deal size	Deals are typically relatively small (e.g. <$5M)
Debt Constrained	Mortgage covenants prevent the owner from taking on debt against the building.

Source: DBCCA, 2012.

The "split incentive" is one of the classic issues preventing lack of change in commercial buildings. The split incentive is present in a large percentage of buildings and causes non-action. Landlords often have limited cost recovery mechanisms for energy savings in leases. Under many commercial leases, the landlord is obligated to pay for most capital expense items / capital upgrades. However, the tenant is obligated to cover most operating expenses, including utility and energy payments. For equipment upgrades that provide a return on investment via energy savings, there is a "split incentive" between the two parties. Landlords have little to no ability to recover the capital investment in ECMs. Individual tenants are unlikely to pay for a large capital investment that affects multiple other tenants and whose payback may extend longer than the period of time covered by their leases term. This issue is also present in many residential and government buildings. In multi-tenant residential, the problem is more extreme because individual tenants are often on very short single year leases. In government buildings and some schools, one agency is tasked with the responsibility to operate, and thus pay for operating expenses, while another entity is required to support the costs of capital upgrades as the real estate ages.

Figure 39: Classic issue: Owner vs. tenant and the split incentive



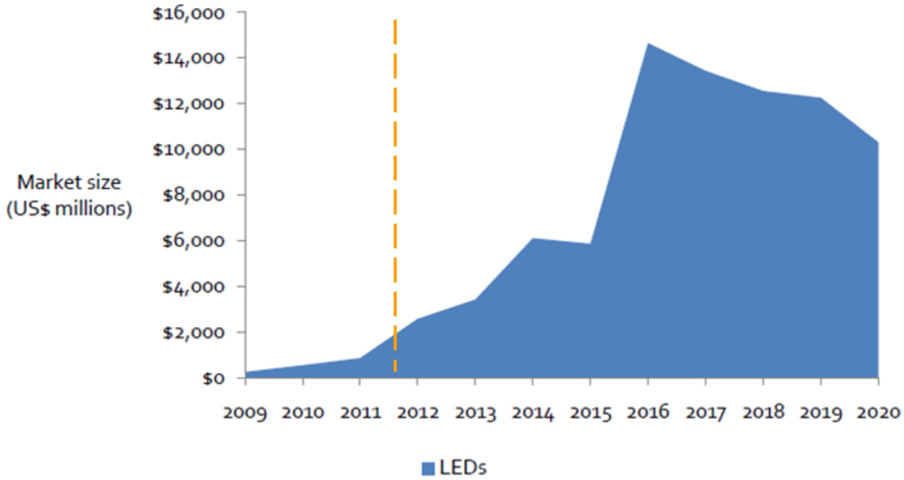
Source: DBCCA, 2012.

In addition to those laid out above, other barriers, including behavioral challenges have also prevented energy efficiency from scaling in buildings. A list of some of these examples is laid out below:

- On-site team may not have the operational knowledge to optimally run the building
- Property management contracts have not traditionally focused on energy saving measures
- Lack of building engineer level incentives to save energy
- Lack of data about possible energy savings
- Lack of knowledge about energy saving technologies
- Measurement and verification has been particularly difficult until recently
- Appraisal community does not actively consider value creation of retrofits
- Limited transaction comparables for “efficient” buildings
- Lack of disclosure of building energy efficiency ratings and non-standard energy audits
- Limited historical tenant demand

However, even in the absence of solutions to all of these barriers, building owners are beginning to adopt some of the fastest payback ECMs. Where there are strong returns and no split incentive, some capital upgrades are paid for by owners. When owners pay for upgrades themselves, fast payback projects like lighting are targeted first. LED lighting is expected to grow strongly and is already more than a billion dollar global market, despite being introduced relatively recently as a commercial technology. LEDs are able to solve problems for building owners beyond just saving energy. For example, lights in lobby ceilings or in elevated outdoor locations may require special lifts or tall ladders to replace, taking significant staff time and creating potential liability. LEDs offer much longer effective lifetimes, so building owners are able to avoid dedicating extensive staff effort to replacing hard to reach lighting fixtures.

Figure 40: Global LED market size: Rapid growth, but still not extensively deployed



Source: Lux Research, DBCCA, 2010.

V. Emerging financing structures

We believe that the World Economic Forum has offered one of the best summaries of available options for new and existing energy efficiency finance mechanisms. Contributing author Ron Herbst (DB's Global Head of Energy and Sustainability) contributed to the WEF document, and we exhibit their structure here.

Figure 41: Examples of emerging financing models

	Summary of Emerging Energy Efficiency Financing Models			
	Energy Services Agreement (ESA)	**Property Assessed Clean Energy (PACE)**	**On-Bill EE Tariff**	**On-Bill EE Loan**
Description	Lender funds cost of improvements & assumes responsibility for payment of energy bill. Lender captures energy savings and charges back to property owner based on historic consumption	Municipal programs funded via issuance of public bonds or private lenders. Secured by property lien and repaid via special property tax . (Also known as Environmental Upgrade Agreements "EUA")	Utility funds upgrades. Customers repay through monthly charge. Charge is tied to the meter, so the tariff stays with asset when the customer moves	Utility programs funded via rate payer proceeds, gov't funds and/or private loans and repaid through monthly utility charges. Loan repayment is tied to the customer, so must be repaid at property sale
Financing Source	Private	Public and/or Private	Public	Public and/or Private
Project Size	$250,000 to $10 million	$2,000 to $2.5 million	$5,000 to $350,000 (depending on size of bill, nature of customer, etc.)	$5,000 to $250,000
Upgrade Scope	Extensive retrofit	Extensive retrofit	Selective interventions	Selective interventions
Source of Repayment	Energy savings	Property tax pass-through of energy savings or tenant recovery	Energy savings	Energy savings
Recipient of Energy Savings	Lender	Owner/Tenant	Owner/Tenant	Owner/Tenant
Collateral / Security	Equipment; UCC1 Financing Statement	Tax lien	Equipment; UCC1 Financing Statement	Equipment; UCC1 Financing Statement
Recourse / Guarantee		None in US / In Australia - Low Carbon Trust loan loss reserve of 3 yrs of P&I		
Remedy for Non-payment	Non-payment of utility bill; discontinued service and tenant disruption	Foreclosure	Referral to collection agency and / or utility disconnection	Referral to collection agency and / or utility disconnection
Incremental Cost to Borrower	None	Higher tax assessment less energy savings and any recoveries	Financing costs (P&I) funded through utility bill less energy savings	Loan application fee, payments to financing entity, less energy savings
Typical term	Average 10 years; Generally does not exceed expected useful life of the improvements	Typically 5-10 years; Generally does not exceed expected useful life of the improvements	5 to 10 years	2 to 10 years
Underwriting Criteria / Data Required	1. Property due-diligence (DD) 2. Market DD 3. Borrower DD/Credit quality 4. Audits & Engineering models (inc savings calcs) 5. Construction contractor DD 6. Historic data re: energy efficiency projects	1. Property due-diligence (DD) 2. Market DD 3. Borrower DD/Credit quality 4. Audits & Engineering models (inc savings calcs) 5. Construction contractor DD 6. Historic data re: energy efficiency projects	1. Customer payment history - Customer for 2 years, no disconnections in past year 2. Energy audit	1. Strong customer payment history 2. Good customer credit quality 3. Energy audit
Measurement & verification requirements	Active energy management via continuous remote monitoring and diagnostics	Specific to each program / government guidelines and requirements	Pre / post inspection	Pre / post inspection
Sale Restrictions	None. Can be transferred or terminated.	None. Obligations remain with property.	Tariff stays with the property	Must payoff loan prior to property sale
Geographic availability	USA	Enabling legislation in AU and 4 US states (over 20 states authorized)	Available in up to 34 US states	Available in up to 7 US states
Barriers Addressed	SI, LC	SI, D *(Note 1)*	SI, D, LC, ST	SI, D, LC, ST

SI = Split Incentive D = Data U = Underwriting LC = Lack of Collateral L = Legal
UTC = Uncertainty of Tax Credits / Incentives ST = Small Ticket Item

Source: World Economic Forum, 2011; DBCCA.
Note 1: DBCCA notes that a number of market participants are hoping to address balance sheet constraints.

Figure 42: Examples of other financing models

	Summary of Other Energy Efficiency Financing Models		
	Traditional Secured Lending	Energy Performance Contracts ("EPCs")	Government-owned development bank
Description	Generally done as part of normal refinancing/building upgrade to improve value. Energy efficiency may or may not be a stated goal of the upgrade	3rd party capital to fund upgrades designed by turnkey providers, generally backed by performance guarantee. Payments tied to savings	Bank backed by government guarantee borrows at favorable rates in capital markets to lend to commercial banks at favorable rates
Financing Source	Private	Private	Public and private
Project Size	NA	Unlimited	Up to $14 million per project
Upgrade Scope	All	Extensive retrofit	Extensive retrofit
Source of Repayment	Loan payments funded from building cash flow	Loan payments funded from building cash flow	Loan payments funded from building cash flow
Recipient of Energy Savings	Owner/Tenant	Owner/Tenant	Owner/Tenant
Collateral / Security	Mortgage	Mortgage, general recourse	Secured by collateral, backed by government. Also use credit default swaps and contingency funds
Recourse / Guarantee		Contractual commitment to the owner re: specified energy reductions	Requires independent engineering review and conforming EPC
Remedy for Non-payment	Foreclosure	Foreclosure	Depending on Commercial Bank, either Foreclosure or Collection Agency
Incremental Cost to Borrower	Market interest rates	Loan payments less energy savings	Interest + Cost of Retrofit
Typical term	Vary	7 to 20 years	7 to 20 years
Underwriting Criteria / Data Required	1. Property due-diligence (DD) 2. Market DD 3. Borrower DD/Credit quality	1. Property due-diligence (DD) 2. Market DD 3. Borrower DD/Credit quality 4. Audits & Engineering models (inc savings calcs) 5. Construction contractor DD 6. Historic data re: energy efficiency projects	Standard due diligence, see traditional lending - additionally, must document proposed energy savings and demonstrate at least 20% improvement
Measurement & verification requirements	None	Energy services company performs ongoing M&V for defined period	kFw Bank ERP requires Energy Performance Certificate.
Sale Restrictions	Repayment in full	Credit-worthy buyer, or pay out remaining value of contract	kFw Bank limited to Germany
Geographic availability	Global	International	Germany
Barriers Addressed	D, U, LC	SI, D, LC	U, LC

SI = Split Incentive D = Data U = Underwriting LC = Lack of Collateral
UTC = Uncertainty of Tax Credits / Incentives ST = Small Ticket Item L = Legal

Source: World Economic Forum, 2011; DBCCA.

In the Appendix, we highlight the additional work done by the World Economic Forum and GE Real Estate to detail the structure of each of the emerging financing mechanisms[14].

Traditional secured lending requires an existing or new lender to provide additional debt finance to the building owner. There are some examples of equipment finance also being utilized where the lender takes a security interest in the equipment itself. This model does not overcome most of the barriers facing building owners, and it has existed as an option for the longest period of time. In particular, owners still face the split incentive issue, and it requires the owner to assume additional levels of indebtedness.

On-Bill EE Tariff and On-Bill EE Loan are emerging financing structures that utilize the existing utility bill to provide additional security to investors. This model holds promise as it integrates the utility into collections and invoicing and gives the investor some additional degree of protection. Tariffs represent an increase in utility bill payments while loans are an additional finance charge repaid on the utility bill. Both structures require local utility and regulatory approval, although significant progress is being pushed by groups like the Environmental Defense Fund with its work in California.

The government owned development bank has been put into place via kFw Bank in Germany and has not been examined as significantly in the United States. The model requires both government design and legislative approval and traditionally

[14] Ron Herbst, DB Global Head of Energy Sustainability, contributed significantly to the World Economic Forum report.

works through existing lenders. In many respects, it is very similar to traditional secured lending, except that the initial source of capital is government backed and therefore has a much lower cost of capital.

In order to see how the remaining structures (EPCs, ESAs, and PACE) have been put into practice, we now look at the major established market participants in the retrofit market.

Figure 43: Existing retrofit market participants have demonstrated a successful track record but have not achieved sufficient scale for the full market opportunity

	EPCs used by Energy Service Companies (ESCOs)	Energy Service Agreements Providers (ESA)	Property Assessed Clean Energy (PACE)	Original Equipment Manufacturers (OEMs)
Description:	Firms focused on utilizing Energy Service Performance contracts to serve primarily MUSH / Government market	Emerging integrated developer / investor firms seeking to use ESA structure to fund retrofits	Emerging integrated developer / investor firms seeking to use PACE structure to fund retrofits	Manufacturers of large pieces of building infrastructure such as boilers, chillers, etc
Approximate Number of Players:	~16 Majors, Approx 100 Small	15-20+	15-Oct	3-5 global firms per equipment vertical
Approximate Deals Done:	Approx $4-6 bn / year	Approx 100-125	+/- 100 (approx $10-20M)	Multi-billion $ – all buildings have kit
Approximate Pipeline:	Approx $4-6 bn / year	Approximately $500M across all firms	TBD - Depends on regulatory approval	Multi-billion $
Strengths	Large, established firms. Integrated service delivery	Overcomes many barriers; bilateral contract does not require regulations	Offers strong security mechanism for investors	Large, established firms. Insight into deployed technology
Weaknesses	Require upfront payment, high margin expectations, tied to captive OEMs.	Limited scale to date. Fragmented market, requiring owner education.	Requires regulatory approval. Limited scale to date.	Most are pure OEMs or tied to ESCOs. Limited ability to innovate new deployment structures.

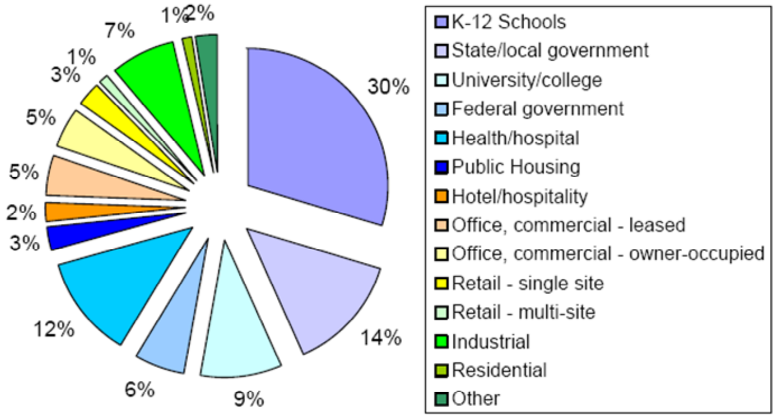
Source: DBCCA research estimates from market review and existing relationships, 2012. NAESCO.

The existing market is composed of four categories of competitors, ESCOs, OEMs, and two types of emerging integrated investors / developers, focusing on ESAs and PACE respectively. ESCOs, or Energy Service Companies, are large established firms focused on helping clients realize energy savings in existing buildings. Most large ESCOs are now tied to individual OEMs, particularly for HVAC technology. ESCOs often use a framework called an Energy Service Performance Contract, which seeks to provide credit enhancement to a deal via the use of an ESCO balance sheet backed performance guarantee. ESCOs do the majority of their work in the institutional and commercial sectors owned by the MUSH categories (Municipal, University, School, Hospital) sector and with the government, as detailed below. The ESCOs have not scaled significantly among privately owned buildings.

Detailed ESCO Overview: Largest participant in the retrofit market to date

According to survey work completed by the National Association of Energy Service Companies (NAESCO), the national trade association for ESCOs, the majority of ESCO projects have been completed in MUSH and government owned buildings. Schools, governments, and health/hospital sectors represent ~74% of the market activity. The NAESCO database includes 1,473 projects representing $2.3 billion in ESCO projects. ESCOs have had very limited success in accessing the private and commercial building market historically.

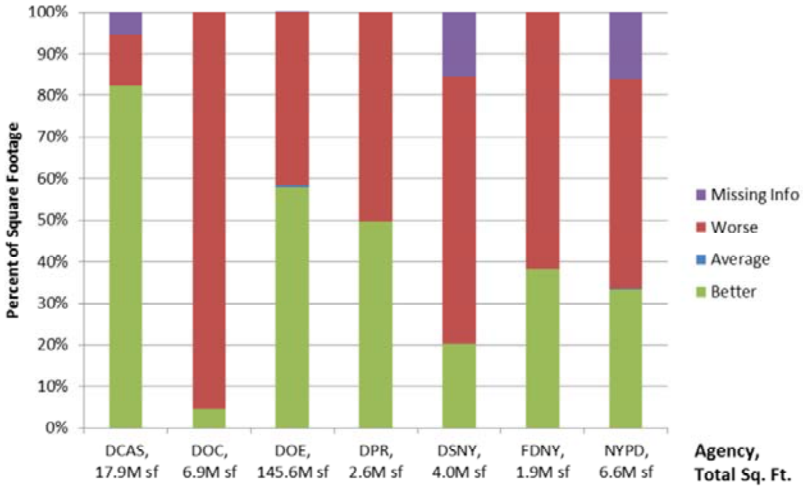
Figure 44: Historically, ESCOs have primarily addressed only the MUSH / Institutional market



Source: NAESCO Database Project, 2010.

We utilize New York City's recently completed government building energy benchmarking work as an example to frame the opportunity that still exists within the municipal and government sector. Following the passage of Local Law 84 in 2009, New York City required all public buildings greater than 10,000 square feet to publicly disclose their energy consumption. The chart below comes from the initial summary report on this data, published in 2011, and indicates that there is significant room for improvement across many of the agencies reporting, including the Department of Corrections (DOC), fire department (FDNY), and the police department (NYPD). The opportunity is not universal, as some segments are performing above national averages. The DOE is looking to compile similar data at a national level through its work on an energy efficiency buildings performance database, which seeks to provide actuarial style distributions of performance across a range of building categories and retrofit project types.

Figure 45: Even within the government sector, significant opportunity still exists for improvement: NYC Government building energy performance compared to national average (EUI: MM Kbtu / SF), 2010



Source: PlaNYC, 2011.

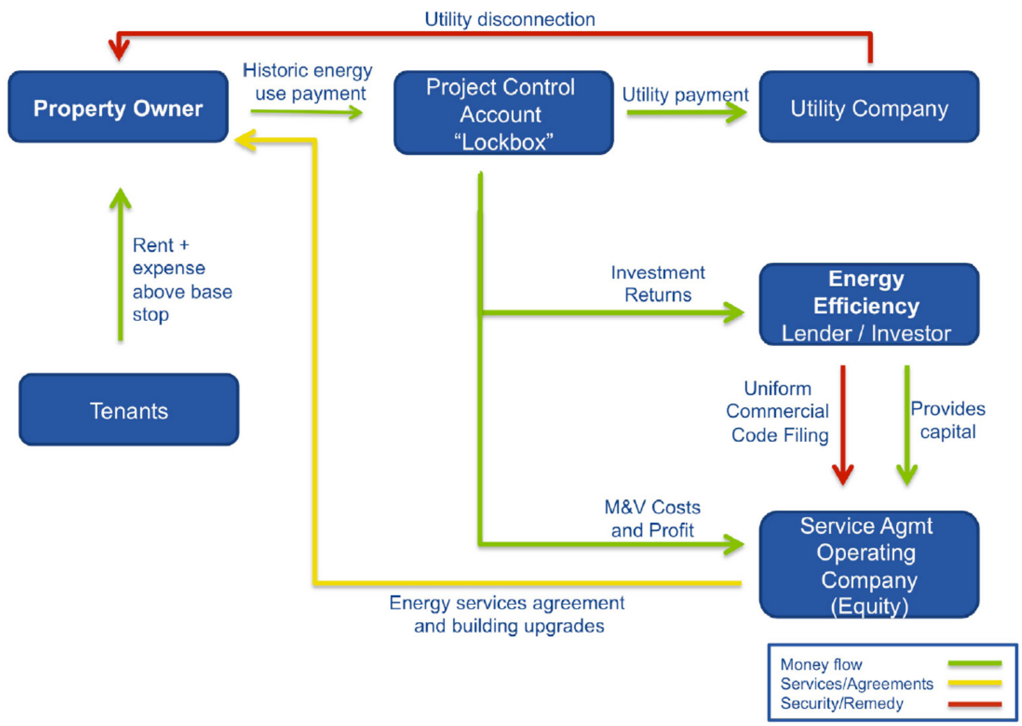
Emerging Financing Models and Other Market Participants

OEMs (Original Equipment Manufacturers) are the actual source of the equipment to be replaced. Building technologies have varied useful lives, but OEMs seek to sell upgrades or replacements to existing equipment in buildings and to new construction. OEMs face challenges when trying to pitch equipment upgrades to building owners based on the set of barriers laid out above. Much of the existing building market for OEMs is created by old equipment reaching the end of its useful life, when owners are forced to upgrade.

The two categories of integrated investor / developer firms are focused on two of the emerging financing mechanisms discussed in more detail below. One focuses on Energy Services Agreements (ESAs) and the other on Property Assessed Clean Energy (PACE). These structures utilize different mechanisms to overcome the barriers to scale in energy efficiency and create demand among both owners and capital providers. Each category is relatively new and immature, with firms still emerging and limited scale reached to date; however, we believe the potential for each is significant. Although the current focus of PACE is in the commercial sector, we believe that it could still be a possible tool for addressing the barriers to scale in the single-family residential space. PACE, under the right regulatory framework, could do much to unlock the residential market, although there are few who expect that this will shift in the near term, given opposition from the Federal Housing Finance Agency (FHFA). Currently, advocates are attempting to apply PACE to the commercial market, and coalitions, such as the one organized by the Carbon War Room, are working through the regulatory environment to gain the regulatory approvals (discussed in policy summary section) and mortgage industry buy-in required for the mechanism to begin to scale.

In this context, we believe that the Energy Service Agreement structure offers significant near term potential to scale quickly and meet the needs of both real estate owners and capital providers in the commercial sector. [15] ESA structures allow a bilateral contract to be negotiated between two commercial entities without the need for enabling legislation. ESAs offer a clearly defined structure for outside capital to invest in the energy savings potential of a building and earn a risk adjusted return via the energy savings of a retrofit project, while addressing the barriers and structures of commercial real estate owners.

Figure 46: Energy Services Agreement



Source: WEF, GE Capital Real Estate, 2011.

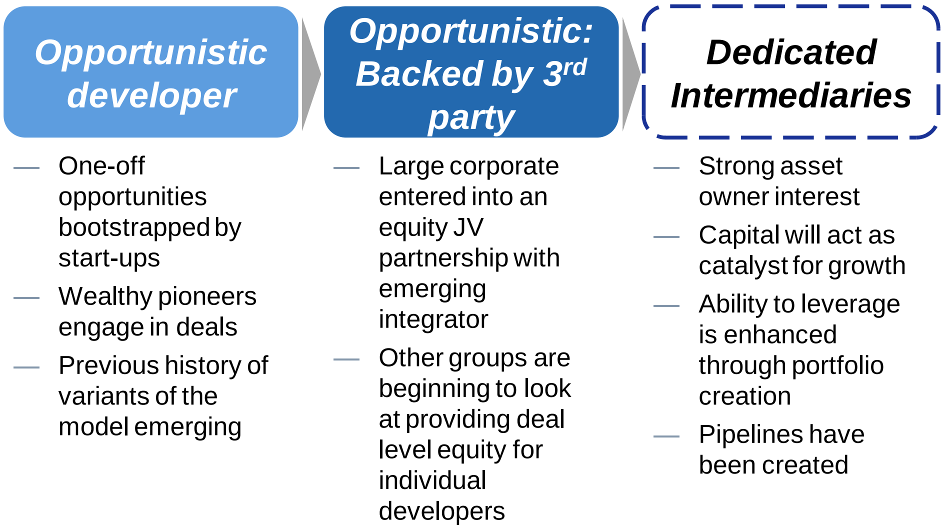
[15] Note that the terms ESA, MESA, Energy Efficiency PPA and others are often used interchangeably. Many individual project integrators are focused on branding their own deal nomenclature at this point, but we use ESA, Energy Services Agreement, as the highest level / generic framework for discussion of the category of financing structure. The core concept in all is the delivery of Energy Services, with Asset Investment by third parties, securitized by energy services agreements with the building owner.

However, there are many open issues for the industry resolve in order to achieve scale. Project underwriting and design must be standardized, both at a process and a documentation level. There are lingering questions around on vs. off balance sheet treatment of ESA structures as FASB and IASB accounting standards converge (see Appendix for more detail). Some ESA providers believe that ESA qualifies as a service agreement and therefore an off balance sheet operating expense, so it would not be covered by the clarified treatment of leases in the accounting convergence. The "rights" of the ESA investor during bankruptcy, tenant roll over, and the sale of the host building need to be clarified and standardized. ESA contracts are designed to focus on commercial real estate assets, but as the industry scales they will need to be modified and expanded to address other asset classes. For example, there will need to be simplified and structured processes to allow ESA providers to bid on government procurement contracts.

Emerging project integrators are showing traction with the ESA model, and there are examples of institutional scale partnerships in the market. We believe that the further engagement of institutional capital, as evidenced by the statements of the leaders of large public pensions and leading labor groups, will mark an inflection point in the growth of the ESA industry. ESA is, in our opinion, the retrofit finance structure that allows the commercial and institutional market to most efficiently evolve and scale on its own, enhanced by, but not requiring, external influences such as legislation and subsidy.

We believe that the application of institutional capital can act as a catalyst for significant growth and speed of development. At many recent conferences and industry meetings, there has been strong demonstrated investor interest from both equity and debt providers. We believe that emerging intermediaries are needed to provoke action, and that emerging models can meet the needs of both real estate and capital. The market appears to be following a development pathway similar to other categories (e.g. infrastructure or venture capital) where opportunistic one-off investments are followed by initial instances of opportunistic partnerships and structures and lead to the emergence of larger, dedicated intermediaries.

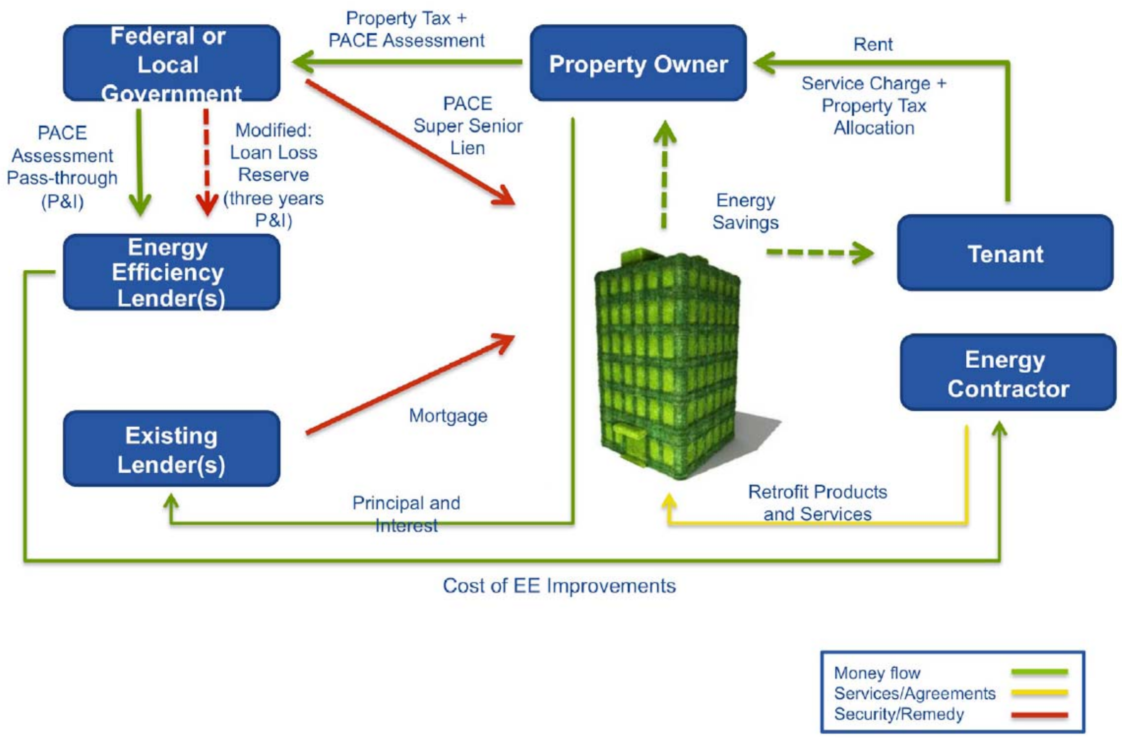
Figure 47: The industry is following a similar evolution to other sectors, with the emergence of more institutional capital sources



Source: DBCCA, 2012.

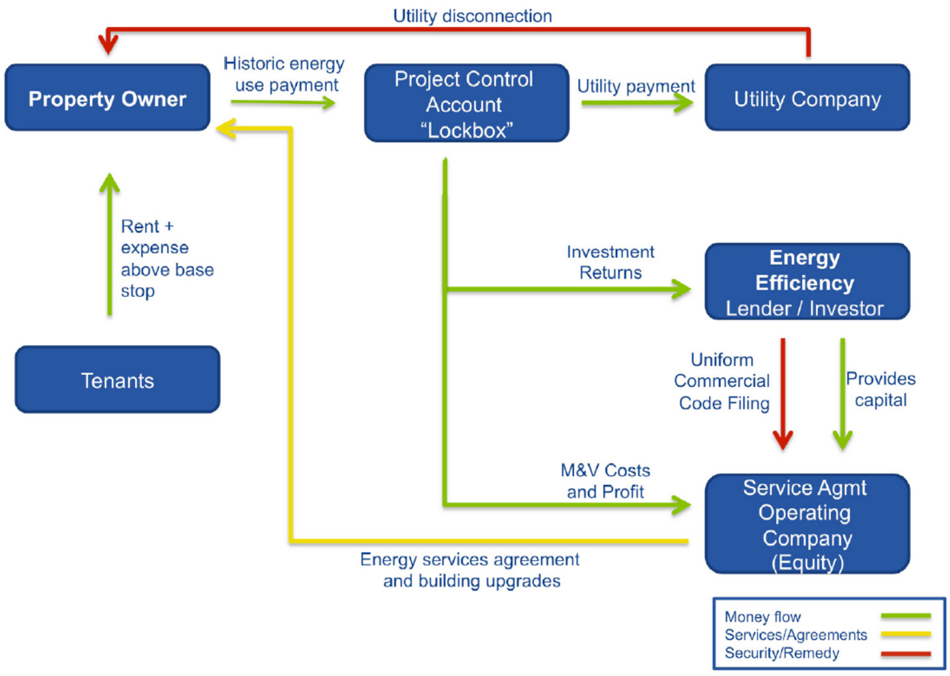
Appendix: Financing Model Details

Figure 48: Property Assessed Clean Energy (PACE)



Source: WEF, GE Capital Real Estate, 2011.

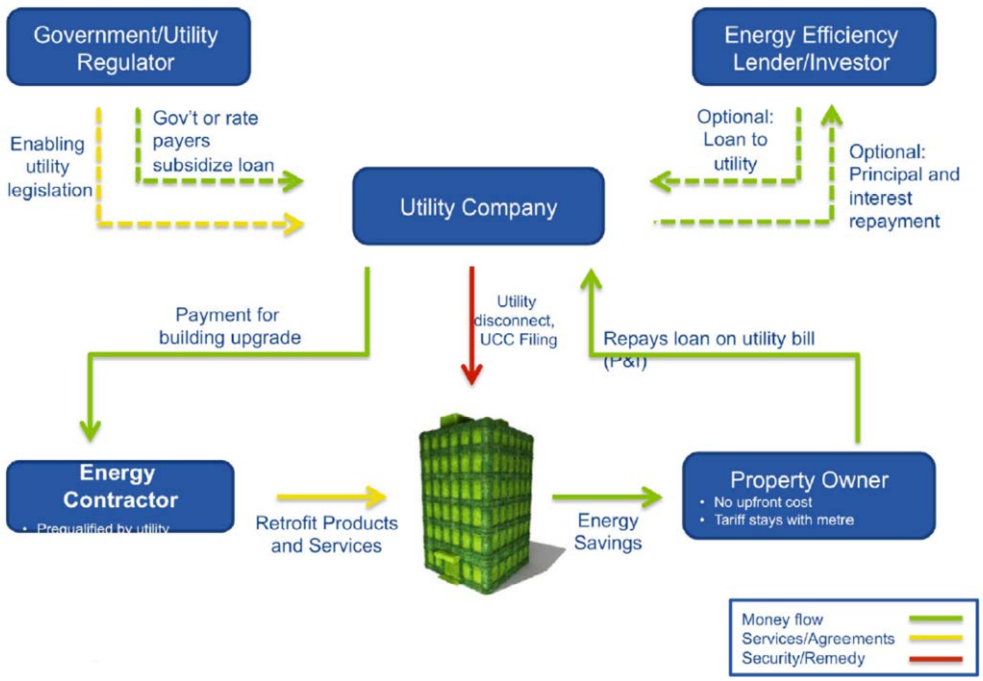
Figure 49: Energy Services Agreement



Source: WEF, GE Capital Real Estate, 2011.

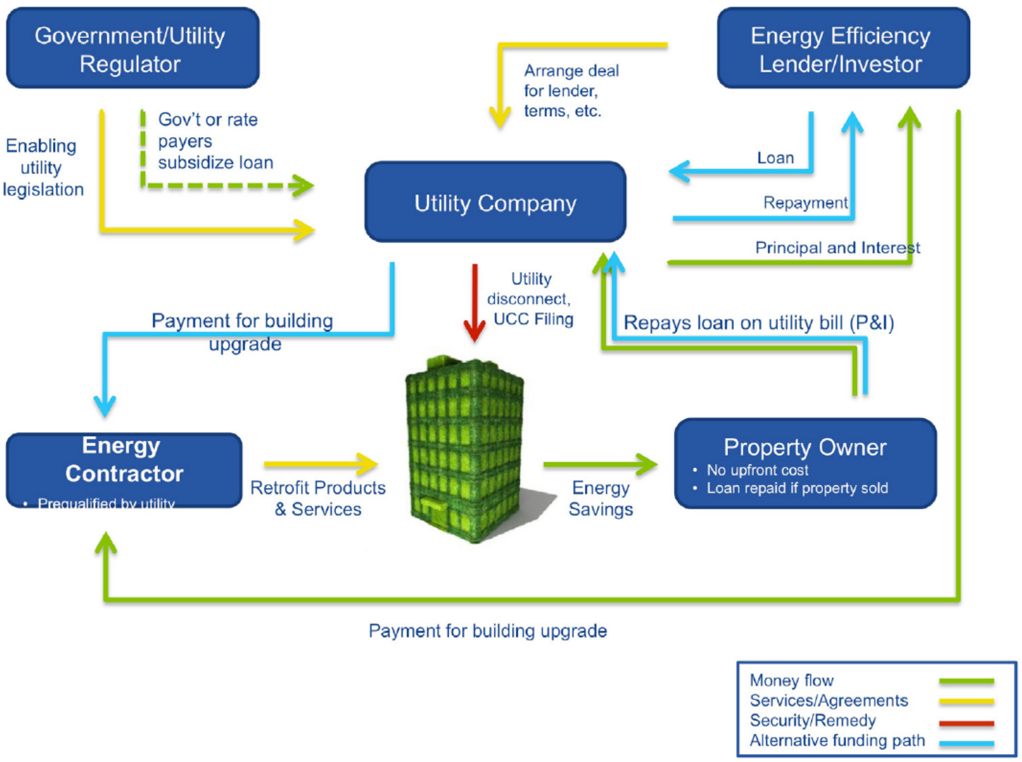
Appendix: Financing Model Details

Figure 50: On-Bill Tariff



Source: WEF, GE Capital Real Estate, 2011.

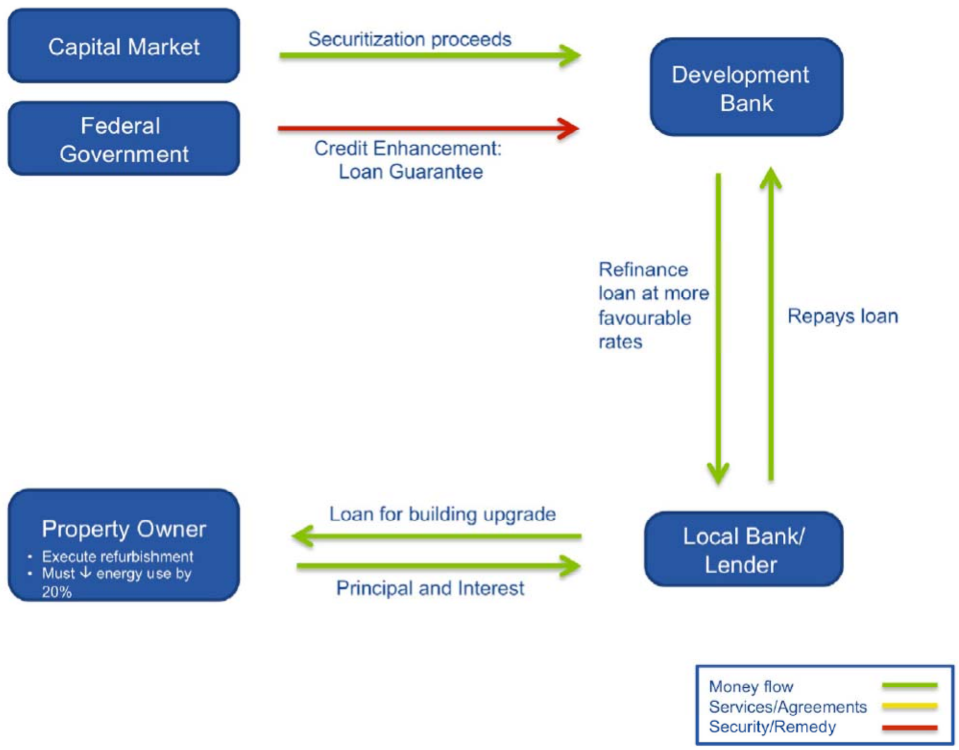
Figure 51: On-Bill Loan



Source: WEF, GE Capital Real Estate, 2011.

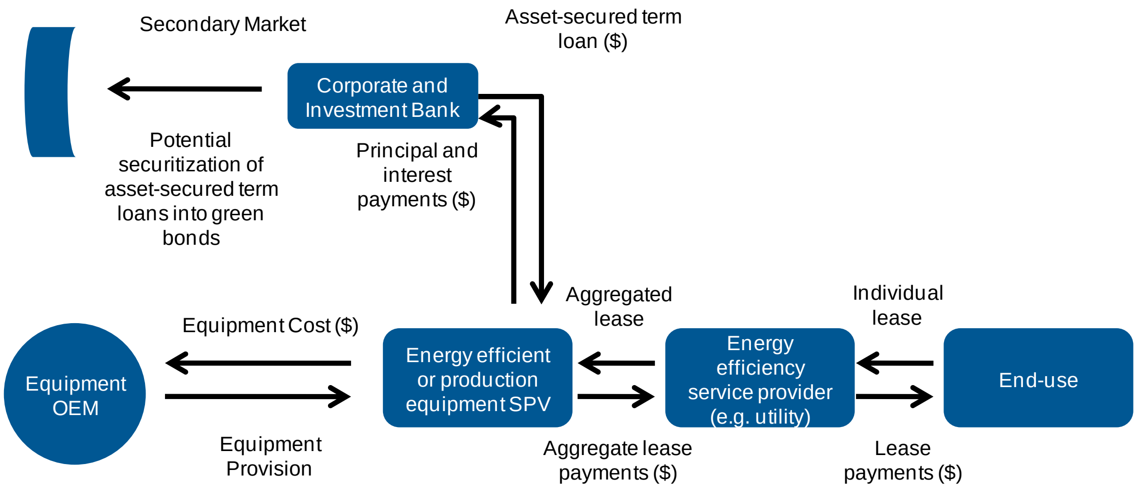
Appendix: Financing Model Details

Figure 52: Government-owned development bank



Source: WEF, GE Capital Real Estate, 2011.

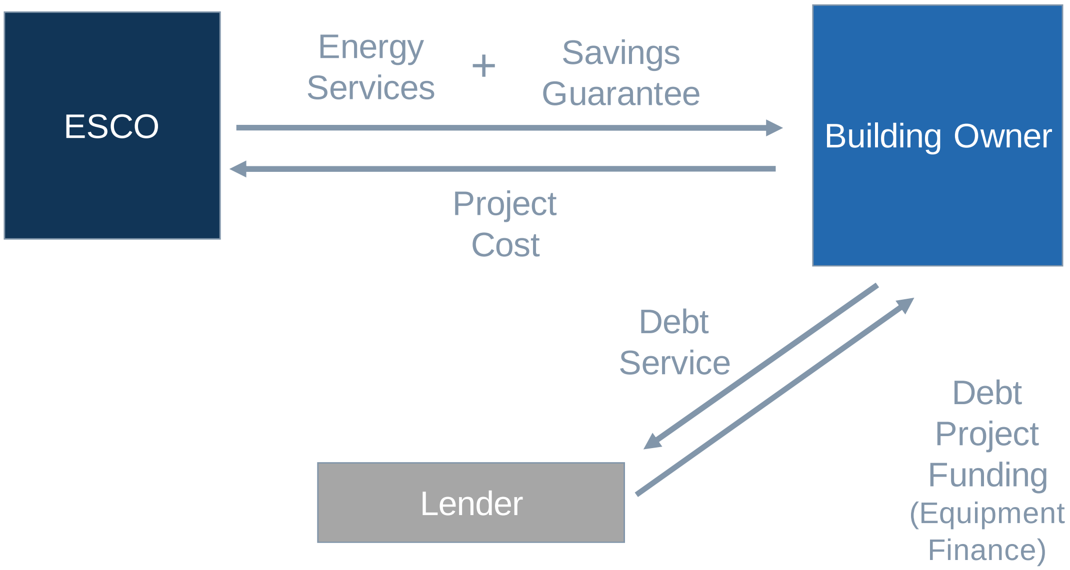
Figure 53: Equipment Lease Finance



Source: WEF, 2011; Carbon Capital: Financing the Low Carbon Economy", Accenture and Barclays, http:/wwwaccenture.com/SiteCollectionDocuments/PDF/Accenture_Barclays_Carbon_Capital.pdf, 1 February 2011.
Note: Providing individual leases for energy-efficient or micro-generation is not viable from the perspective of many large banks because of the small scale. To make these types of leases possible, a large-scale debt facility of the type that corporate and investment could provide is critical. Using debt finance to purchase equipment will have an impact of the balance sheet of both service providers and the bank providing the debt. This is a major barrier as it would influence the credit rating and debt ratio of the service provider while affecting the risk-weighted assets of banks. Alternative structuring of the SPV or securitization of the debt into public markets could provide alternatives

Appendix: Financing Model Details

Figure 54: Energy Performance Contract (ESCO model)



Source: DBCCA, 2012.

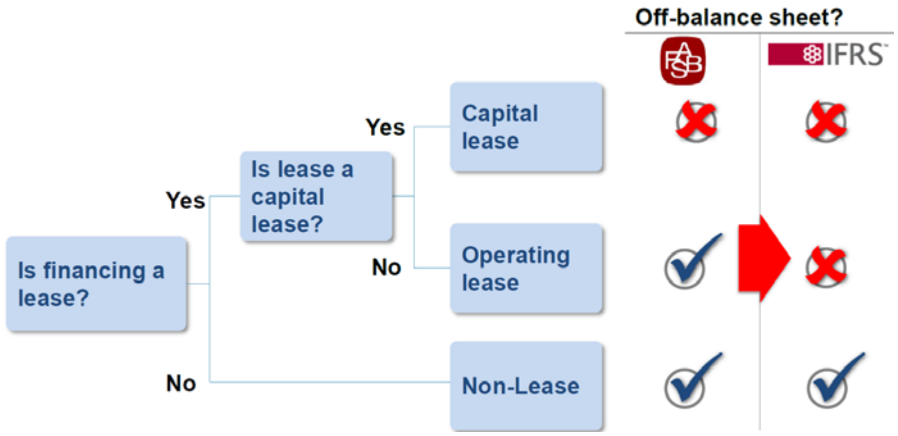
Appendix: Accounting Treatment

Figure 55: Cleantech Group: "Alignment of international accounting standards could have broad effects for energy efficiency financing"

The regulatory bodies	Disparate approach	Recent developments
FASB • US standards for private sector entities • U.S. reach IFRS **IASB** • International standards for private sector entities • Global reach	• Key difference for EE financing is approach concerns **accounting of leases** • FASB carves out **operating lease, which remains off-balance sheet** • IASB does not	• 2002: FASB began process of aligning accounting standards with IASB • Jan, 2012: Renewed vigor to finalize universal treatment of leases • Committed to **adopt new treatment by 2013**

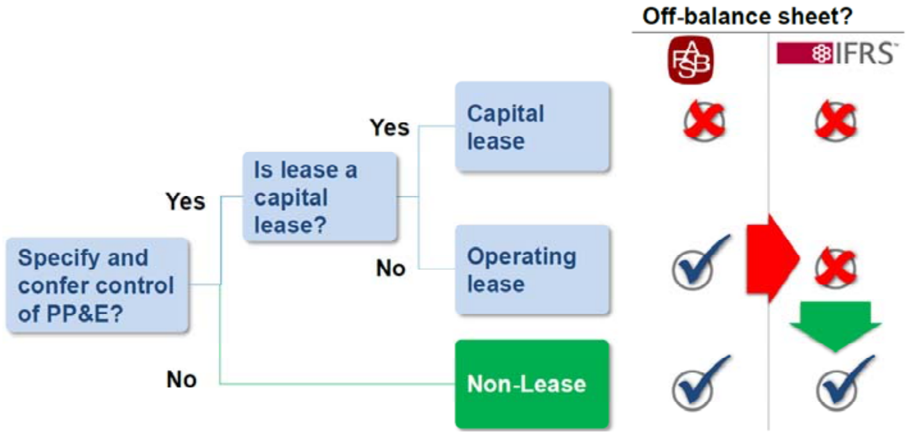
Source: Cleantech Group, 2012.

Figure 56: Cleantech Group: "If FASB adopts new lease treatment, operating leases would not remain off-balance sheet"



Source: Cleantech Group, 2012.

Figure 57: Cleantech Group: "Emerging models seek to ensure non-lease treatment to remain off-balance sheet"



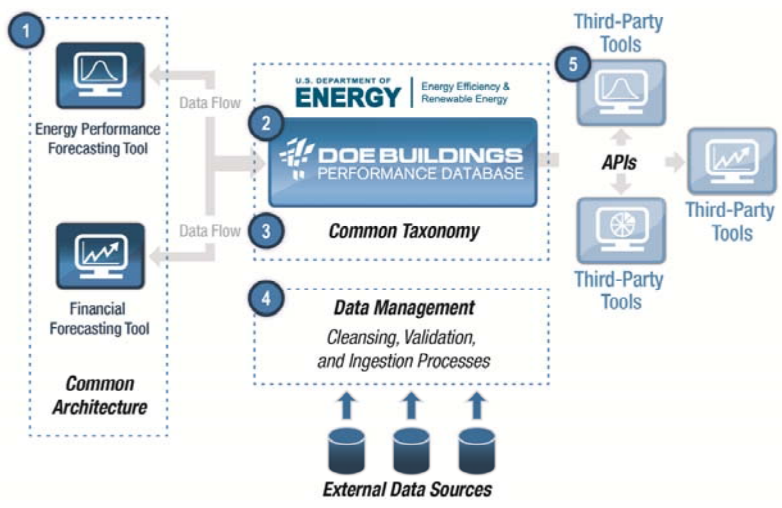
Source: Cleantech Group, 2012.

Appendix: DOE Buildings Performance Database

DOE has recently released the beta version of the Buildings Performance Database, an initiative which utilized the multi-disciplinary expertise of the National Labs to produce a decision-support platform, comprised of energy data from commercial and residential buildings and data analysis tools.

The initial tool set includes an energy savings forecasting tool that uses an actuarial based methodology to develop energy savings distributions. There is also a financial tool that forecasts cash flows from these energy savings distributions. DOE has sought to enable risk based analysis of energy efficiency projects. This framework will enable engineering and financial practitioners to evaluate energy efficiency products and services and make better informed decisions on completing and investing in these improvements. We believe that the BPD is an example of the non-regulatory enhancements to the enabling environment and will help industry to standardize analysis around a set of accepted data definitions and statistical processes, even at the beta version stage.

Figure 58: DOE Buildings Performance Database (BPD) Overview



Source: DOE, 2012.

Key components of the DOE BPD are listed below:

1. Applications– Web-enabled tools that leverage data to forecast energy savings and related cash flows. Over time, additional tools will be created and released to the market.
2. Data Warehouse – a platform to house the Energy data within the standard taxonomy.
3. Common Taxonomy – a standardized "data model" to organize energy use and building characteristic data
4. Data Management – processes and tools to support the on-boarding and validation of data from multiple sources
5. 3rd Party Tool Support – APIs that allow 3rd Party developers to create applications that use the data within the DOE BPD

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I-026428-1.2