



# Building Energy Efficiency

Industry Outlook and Investment Opportunities

## Introduction

Over the last half century global urbanization has increased rapidly, and by 2050 nearly 68% of the world's population is expected to live in cities. This rapid pace of urbanization has led to the transformation of urban areas through massive investment. Construction activities account for nearly 10% of global GDP, employ 10% of the total workforce and by 2025 will comprise more than 16% of the GDP of emerging markets. Rapid urbanization has also resulted in increasing pressure on resource consumption, and inefficient building construction and usage generate greenhouse gas emissions which negatively impact the health and productivity of residents.

## Highlights

Demand for energy from renewable sources has continued to grow globally. The increasing demand for energy efficient buildings is catalysed by:

- Excessive resource use: buildings and construction are responsible for 60% of global electricity use; 12% of water use; 40% of waste generation, and 40% of material resource use.
- A drive to reduce global emissions: making buildings energy efficient is the most affordable way of cutting global CO<sub>2</sub> emissions, compared to reducing emissions in agriculture, industry, energy supply, and transport. Buildings are long-term infrastructure assets, while vehicles and heavy industrial machinery have significantly shorter useful lives. This implies that energy inefficient buildings have a longer time horizon to exact their harmful influence on the environment, thus it is important to invest in a shift to zero-carbon buildings.
- Many developing countries already suffer from high levels of air pollution. Energy efficient buildings reduce indoor air pollution that can result in adverse health impacts.
- Construction of energy efficient buildings is critical for low income urban residents, who are the least able to afford high energy prices or healthcare bills resulting from indoor air pollution.

## Building Envelope

A Building Envelope, which refers to the design of the exterior of a building including walls, windows, roofing, foundation, and doors, plays a fundamental role in a building's energy efficiency through affecting how much heating, cooling, light and ventilation are needed to keep optimal comfort levels. The global Building Envelope Market size was \$146,640 million in 2019, and is expected to reach \$188,350 million by 2026, with a CAGR of 3.6%.

[Energiesprong](#), a building standard and funding approach whose goal is to convert buildings to net zero energy, originated in the Netherlands to drive cheaper and more desirable retrofit solutions. More than 5,000 houses have been retrofitted in the Netherlands to be net zero energy at no extra costs for residents. A net zero house generates the total amount of energy required for its heating, hot water and electrical appliances. This is achieved by using prefabricated facades, insulated rooftops with solar panels, smart heating, ventilation and cooling installation. Energiesprong renovations are financed by future energy cost savings, plus the budget for planned maintenance and repairs over the next 30 years. New York and California are developing initiatives based on Energiesprong for retrofitting solutions.

#### *Emerging Building Envelope Companies and Technologies:*

- [WexEnergy \(US\)](#)
  - WexEnergy has developed WindowSkin, a completely transparent custom-fit window insulation (insulation?) system that easily mounts onto existing windows.
  - WindowSkin increases energy efficiency at about 15% of the cost of window replacements.
- [Freschfield \(US\)](#)
  - Freschfield is a technology company that develops solar panels, building skins, and other solutions to increase global energy sustainability.
  - The company has developed iSkin, a transparent energy-producing building skin that converts ultraviolet and infrared light into electricity, while letting the visible light pass freely into the building.
- [Cool Roof](#)
  - A cool roof is one that is designed to reflect more sunlight and absorb less heat than a standard roof. Cool roofs can be made of a highly reflective type of paint, a sheet covering, or highly reflective tiles and shingles.
  - Cool roofs can benefit buildings and occupants by reducing energy bills and increasing roof service life.
- [PHYSEE \(EU\)](#)
  - PHYSEE has developed SmartSkin technology, which integrates solar cells into glass to harness electricity from the sun.
  - SmartSkin has been proven to reduce a building's energy consumption by up to 20% while also producing the remaining energy necessary through its solar panels.

#### *Available funding:*

- NYSERDA
- California Energy Commission (EPIC grant)

### **Smart HVAC**

Smart HVAC incorporate communications and control to traditional HVAC systems. This allows it to make more efficient use of energy to heat or cool a space through maintaining specific requirements of heating, cooling and ventilation. Some smart HVAC systems include variable speed compressors, which can vary their start-up and operating speeds, depending on how much of a temperature increase or decrease is needed. Zoning controls allow the user to determine the temperature and flow of air in different parts of the building. The Smart HVAC market was valued at approximately \$8.3 billion in 2018, and is expected to grow to \$28.3 billion by 2025 at a CAGR of 19.1%.

#### *Emerging Companies developing Smart HVAC solutions:*

- [Ventive \(UK\)](#)
  - Ventive designs innovative ventilation systems that lower operating costs and increase efficiency.
  - Ventive's Windhive combines passive ventilation, heat recovery and system intelligence to adapt to real-time conditions.
- [75F \(US\)](#)
  - 75F is a predictive building automation system that addresses HVAC, lighting, and control needs.
  - 75F uses IoT and cloud computing to predictively keep indoor environments optimized to save up to 70% in total energy costs.

- [Comfy \(US\)](#)
  - Comfy is an app that optimizes workplace building efficiency through real-time comfort and control.
  - Employees can choose HVAC conditions in their workplace, and this can reduce HVAC energy use by up to 20%.
- [BuildingIQ \(US\)](#)
  - BuildingIQ is an energy management software platform that forecasts energy demand and adjusts buildings' HVAC settings to optimize energy use.
  - BuildingIQ uses AI technology to predictively control HVAC systems.
- [Mode:Green \(US\)](#)
  - Mode:Green focuses on hotel integration technology, and has developed automated systems that mitigate overall energy consumption.

## Smart Meters

It is expected that by 2030 energy consumption will be 70% higher than in 2015, and energy efficiency solutions will account for more than half of greenhouse gas emission reductions. However, for sound energy management practices to be effective, the basic building blocks of metering and monitoring need to be implemented at a massive scale. Smart metering for both residential and commercial buildings leads to energy savings and concomitant cost savings. In a single operator owner occupied building, smart metering can generate effective energy savings of 10%, and in the long run (perhaps be more specific here about how long a period of time you mean) can deliver up to 30% of energy savings. This Advanced Metering Infrastructure (AMI), or two way communicating smart meters, now serve more than half of US electricity consumers. The AMI network collects masses of real-time data which can be instrumental for utility improvements, enable homeowners to optimize energy consumption and spending, and inform grid recovery. Despite the proliferation of AMI systems, there is scope for utilities to tap the full potential of these systems through data being disaggregated for key-end uses, creating behaviour tools like goal setting for residential buildings, and connections with other energy efficiency programs.

*Emerging Companies Developing Smart Meters:*

- [Steamaco \(Kenya/UK\)](#)
  - Steamaco is a company whose goal is to enable its customers to sell energy anywhere on the planet, and aims to serve the 1.2 billion people who are unconnected to utility grids.
  - Steamaco offers the world's most data-efficient smart meter which helps utilities operate reliably even when connectivity is scarce.
- [SparkMeter \(US\)](#)
  - Founded in 2013, SparkMeter offers comprehensive low-cost metering solutions in order to make access to electricity possible in underserved markets and remote locations.
  - SparkMeter has received funding from Breakthrough Energy Ventures, which is a fund led by Bill Gates.
- [Cisco Systems, Inc. \(US\)](#)
  - Founded in 1984, Cisco Systems, Inc. is an American multinational technology conglomerate and a key market player in the AMI market.
  - Cisco is a leader in the design and deployment of communications networks that drive AMI systems.
  - Cisco's Field Area Network is a unique system that helps enable pervasive monitoring and energy distribution through AMI.

- [Schneider Electric SE \(EU\)](#)
  - Founded in 1836, Schneider Electric is a multinational European company providing energy and automation technology solutions.
  - The company has developed EcoStruxure, a platform that increases AMI deployment and maximizes smart metering returns.
- [Itron \(US\)](#)
  - Founded in 1977, Itron is a technology company focused on energy and water resource management.
  - Itron has consistently been recognized globally for its breakthrough AMI technology and innovative solutions, and offers a variety of AMI services.

*Notable Funds:*

- [FactorE Ventures](#)
  - FactorE is a global VC fund dedicated to investing in companies in the sustainable development sector.
  - Recently invested in company Odyssey, a company focused on the development, financing, and distribution of energy projects.
- [Elemental Excelsior](#)
  - Elemental is a West Coast VC fund that looks to invest in solutions to climate change in communities disproportionately impacted.
  - In 2015 Elemental invested in the company Blue Pillar, whose work is creating a centralized energy platform for communities in Hawaii.
- [Schneider Electric Ventures](#)
  - SE invests in emerging technologies and ideas within the energy management, electric mobility, and AI industries.
  - In April 2019, SE announced that their \$565 million fund would be expanding and investing in new ventures.
- [Clean Energy Ventures](#)
  - Clean Energy invests in companies commercializing advanced energy technologies to help achieve global scale.
  - CEV has made seven investments within the energy efficiency sector, including leading the funding for online energy marketplace company Energy Sage.

## **New Wave Heating**

New wave heating technologies primarily include the recovery of waste heat from business processes for reuse within businesses or local communities. It is estimated that between 20%-50% of industrial energy input is lost as waste heat. Heat recovery technologies can not only make industrial processes more efficient, but also lead to cost savings and a reduction of negative environmental impacts. Such technologies tie into green grids, and reduce reliance on fossil fuels for energy generation. Stanford University is a great example of these technologies, which are currently employed to make it one of the most energy efficient universities in the world.

- The market is poised to grow at a 6% CAGR between 2019 and 2023, with an expected incremental growth of \$16.8 billion within that time period.
- While such technologies have received interest, they still face some barriers to investment primarily due to high maintenance costs, materials constraints, and the long gestation period of the investment.
- Given the longer time horizon, this space especially needs catalytic capital, accompanied by regulatory and policy support.

*Emerging Waste Heat Recovery Companies:*

- [Climeon \(Sweden\)](#)
  - Climeon is a global leader in converting waste heat and geothermal heat into clean electricity.
  - The Climeon Heat Power System exploits temperature differences between hot and cold water to generate clean electricity.
- [Alphabet Energy \(US\)](#)
  - Alphabet Energy is a start-up company that uses nanotechnology and materials science to create thermoelectric generators that capture waste heat and generate electricity.
  - In 2014, Alphabet Energy introduced the world's first industrial-scale thermoelectric generator, the E1. The E1 takes exhaust heat from large industrial engines and turns it into electricity.
- [Evident Thermoelectrics](#)

- Recently acquired GMZ Energy uses patented processes to manufacture thermoelectric materials that improve performance and increase efficiency across multiple waste energy applications, thereby lowering costs.
- The company has announced the TG16-1.0, a new thermoelectric module capable of producing twice the power of the company's first product, the TG8.
- [Enertime \(US\)](#)
  - Enertime offers innovative energy solutions based on thermodynamics for energy efficiency and the production of heat and electricity from renewable resources.
  - An Enertime ORC machine allows for the recovery of superheated water at 200 °C or residual low pressure steam for electrical energy, thus increasing the energy efficiency of waste treatment units.
- [Heliex Power \(UK\)](#)
  - Heliex's product and technology generate electricity by harvesting existing steam or waste heat within a client's production processes.
  - The Heliex GenSet harnesses saturated process steam and generates low cost electricity that can be used onsite or sold back to the grid.

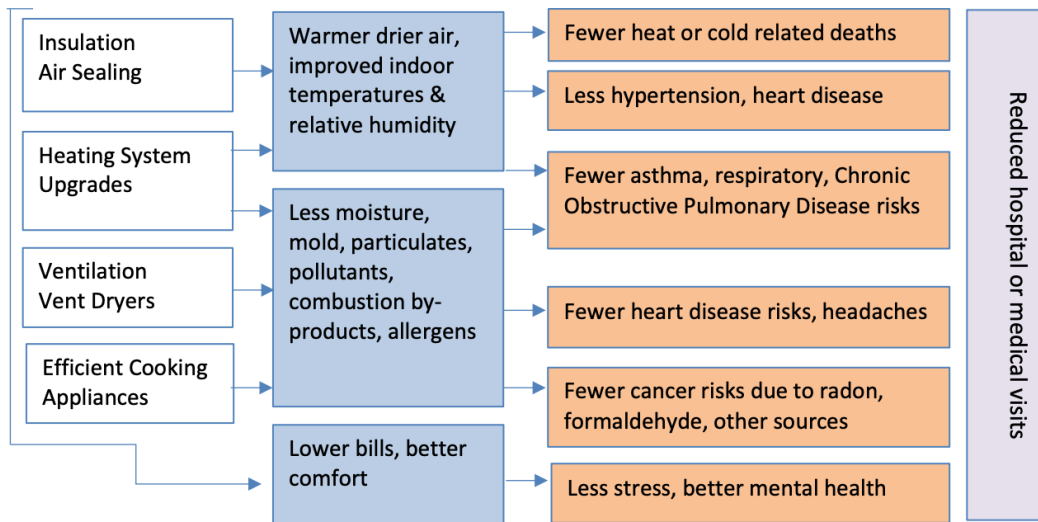
*Funds Investing in Waste Heat Recovery:*

- [GM Ventures](#)
  - GM Ventures focuses on companies in automotive-related companies that can advance technology in General Motors vehicles.
  - GM helped fund US waste heat-to-power company Alphabet Energy with \$23.5 million round of funding.
- [TPG](#)
  - TPG is a California-based investment firm with \$79 billion in AUM with investments across a variety of industries.
  - TPG was a participant of the funding round held for Alphabet Energy.
- [Energy Technology Ventures](#)
  - Energy Tech. is a joint fund with GE, NRG Energy, and ConocoPhillips looking to develop the future of energy efficiency.
- [BP Ventures](#)
  - The VC arm of global oil company BP, BP Ventures looks to contribute to the global demand for energy while reducing carbon emissions.
  - BP's Whiting refinery is a waste-to-heat recovery system that generates steam from waste gas.



- [I2BF Global Ventures](#)
  - With over \$400 million AUM, I2BF is a global VC fund focused on early stage technology companies.
  - In 2011, I2BF helped clean cooling and heating company GMZ Energy secure Series C financing.

Figure ES1: Occupant Health and Indoor Environmental Benefits of Residential EE



Tohn Environmental Strategies \* The National Center for Healthy Housing \* Three<sup>3</sup>

## Impact Measurement

Energy efficient buildings can reduce air pollution, energy and resource consumption, and outdoor emissions. They can save lives, and provide financial and productivity gains.

- Residential energy efficiency programs typically improve the building envelope and heating systems, creating warmer and more comfortable homes. The pathways by which home energy upgrades can also help to improve indoor environmental conditions and occupant health is shown in Figure ES1 above.
- Energy efficient buildings in the US have already contributed to carbon emissions reduction by 34%.
- Energy efficient buildings use 25% less energy than traditional construction, and reduce building maintenance costs by 20%.

## Investment Outlook

While the construction of energy efficient buildings has been in its nascence, there is growing investor and regulatory focus, increasing the industry's market potential:

- It is possible to reduce building emissions 87% by 2050 with energy efficient technologies, yet only 1% of such reductions have been achieved to date.
- The energy efficiency technology industry is expected to grow \$908 billion by 2022, mainly driven by government policy incentives.
- The market for energy efficient buildings is large in developing countries where building construction activities are only slated to grow. Countries like China, India, Kenya and Mexico are making investments in carbon zero buildings.
- Energy efficiency building investments are especially attractive to real estate portfolio holders or those with longer investment horizons.

Some of the key barriers to investing in energy efficient buildings and technologies are slowly being overcome:

- Growing maturity of the industry has led to a consolidation of standards and norms across varied processes and technologies including energy efficiency, structural efficiency and indoor environment enhancement.
- There is increased information and knowledge sharing in the energy space between lenders and project owners with regard to efficiency risk-return profiles.

Lastly, a key catalyst of unlocking investments in the building energy efficiency industry has been a spate of supportive policy frameworks which aim to decrease risk in energy efficiency investments.

- Net Zero Carbon Buildings for All, a multi-year, multi-stakeholder initiative launched at the UN Climate Summit, aims to mobilize \$1 trillion to support decarbonization of buildings by 2030.
- Building Efficiency Accelerator was set up by Johnson Controls, Inc., the Global Environment Facility (GEF), and P4G to achieve the US Sustainable Energy for All's initiative of doubling energy efficiency by 2030.
- Energy Efficiency Financial Institutions Group, which is supported by the EU Commission, provides de-risking and underwriting services to support innovative businesses within this space.
- In the United States, the Department of Energy recently announced investments of more than \$19 million in research to drive innovation in building energy efficiency, and allocated \$74 million for 63 selected projects to research, develop and test energy efficient building technologies.