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Initiatives for energy efficiency and renewable energy have had priority in Denmark for over 25 years. The Danish plans and initiatives have resulted in development of new technologies and of successful use of energy efficiency and renewable energy. Aarhus, Denmark.

2. Buildings

Globally, buildings are responsible for between 30 and 40 percent of all primary energy use, greenhouse gas emissions, and waste generation.[327] The 2007 IPCC report identifies buildings as having the single largest potential of any sector for the reduction of greenhouse gases: the capacity to reduce projected emissions 29 percent by 2020.[328] Because of these two realities—the large environmental footprint and the capability to significantly reduce emissions—buildings have emerged as a critical area for climate change mitigation and the move toward environmental sustainability.

Fortunately, most of the changes required in the shift from conventional building practices toward energy-efficient buildings can be done primarily with existing technology with little or no net cost. Perhaps more importantly for businesses, individuals, and policymakers, energy-efficient measures in buildings have the potential of having a negative net cost over time, as the initial investment pays back over a period of time and can be reinvested back into the community. Energy efficiency leads to positive economic and employment growth.

The building and construction sector employs more than 111 million people worldwide, or approximately 5 to 10 percent of total employment at the country level.[329] Changes in how buildings are designed, built, and operated, along with how building components are manufactured and energy is used, are likely to affect job numbers and types of employment.

This section of the report explores the growing body of evidence that links energy-efficiency measures to employment opportunities and new jobs. Efficiency measures discussed include more comprehensive measures such as green buildings and retrofitting as well as individual building equipment and components, including: water heaters, cooking equipment, domestic appliances, office equipment, electronic appliances, heating, ventilation and air conditioning systems, and lighting. Macroeconomic studies of these energy-efficiency measures show an overall net increase in jobs. This section will highlight some of these major efficiency studies and draw upon them to assess the future job potential of the green building sector.

The section does not give a global quantitative number for the number of jobs created in green building. Certainly in some areas of the world, such as the United States and the European Union, it is possible to estimate employment numbers based on previous studies and emissions-reduction targets, but in most areas of the world, there is not enough data to report exact numbers. Instead, this section aims to show general trends in the building sector and to make the connection between increased investment in green building measures and increased employment creation.

The Environmental Impact

When buildings are viewed as a whole, they are one of the world's largest users of energy and emitters of greenhouse gases. In the European Union, buildings use as much as 40–45 percent of all energy.[330] They also use large amounts of raw materials and water and generate immense

quantities of waste and pollution. The building sector consumes more electricity than any other sector worldwide. In the United States, buildings account for 39 percent of total energy use, 39 percent of CO_2 emissions, 68 percent of electricity use, and 12 percent of water use.[331]

These percentages include not only the energy used to operate the building, but also the stored or embodied energy it takes to produce the building materials (steel, glass, aluminum, and cement), building components (tile, glass, carpet), and the energy required to transport the materials to the building site. It is important to note that despite the intensity of building materials used in construction and the long distances traveled to the construction site, the largest percent of energy use by far, approximately 80–85 percent, occurs during the operational phase for heating, cooling, ventilation, lighting, water heating, and to run appliances.[332]

There are major differences in building emissions between the developed and developing world. These emissions are by far the highest in developed countries where people light, heat, and cool larger areas of residential and commercial space and use electrical appliances. Per capita, the top three countries with the largest CO_2 emissions from buildings are the United States, Australia, and Canada.[333] While there are variations both between and within countries, overall, in developed countries, 60 percent of the operational energy is used for heating and cooling purposes.[334] This is followed by 18 percent for water heating, 6 percent for refrigeration and cooking, 3 percent for lighting, and 13 percent for other purposes.[335]

While the global North tends to use energy for heating, cooling, ventilation, water heating, lighting, and domestic appliances, about one-third of the world's population does not have access to electricity. In rural areas of China, India, and Africa, biomass is the main energy source for over 70 percent of the population.[336] In 2007, approximately 2.4 billion people used biomass as their primary energy source; by 2030, this number will increase to 2.6 billion.[337] The extensive use of firewood, animal dung, crop waste, kerosene, and paraffin for heating and cooking contributes to poor indoor air quality, health issues, and environmental degradation. The use of wood biomass contributes to growing deforestation and desertification.[338] In both the developed and developing world, energy use in buildings is unsustainable, and future projections show large increases in energy consumption.

Projected Growth of the Building Sector

Studies of the OECD countries indicate that energy consumption in buildings has increased continuously since the 1960s and is likely to continue into the future.[339] In the International Energy Agency countries, average home size increased by 17 percent from 1990 to 2004, and energy consumption rose by 29 percent.[340] In the United States, average new homes now reach 210 square meters (approximately 2,200 square feet), more than two times the average home size in Western Europe and Japan.[341]

Larger spaces require additional lighting, heating, and cooling and are generally followed by the rise of additional household appliances, which have become the fastest growing area of energy use in the residential sector.[342] From 1990 to 2004, even though four out of five of the major

large appliances—refrigerators, freezers, washing machines, and dishwashers—increased their efficiency, there was still a 50 percent increase in energy use of household appliances, with the United States, France, and Finland increasing their use by 70 percent.[343] This is largely attributed to the rise in ownership and use of air conditioners and small electrical appliances, including mobile phones, audio equipment, personal computers, and other electronics. (Many of these new smaller appliances still do not have energy-efficiency standards. The use of standby power in appliance also contributes to 1 percent of total carbon emissions.)[344]

In countries like India and China, where expansion of the middle class and urbanization is occurring rapidly, the emissions and energy use of buildings are projected to increase dramatically. More than 50 percent of all new building construction is now taking place in Asia, mainly in China. In the next two decades, 300 million Chinese are projected to move into urban centers, and China alone will add 2 billion square meters (21.5 billion square feet) of new construction each year, doubling its building stock by 2020.[345] The building sector in China is expected to grow by 7 percent annually; India and Southeast Asia will grow 5 percent.[346] The rapid pace of construction taking place in Asia is unsustainable, and unless traditional building and construction methods are altered, they will contribute immense amounts of energy, material, and water waste and contribute significantly to global climate change.

Energy Efficiency

The 2007 IPCC report states: "most studies agree that energy-efficiency will have positive effects on employment, directly by creating new business opportunities and indirectly through the economic multiplier effects of spending the money saved on energy costs in other ways."[347] The positive result of both environmental improvements and employment increases from energy efficiency measures is known as the "double dividend."[348]

European Union

One of the first studies to link employment and energy efficiency was a 1992 study by Jochem and Hohmeyer that looked at general energy-efficiency programs in West Germany between 1973 and 1990. The study found that approximately 400,000 new jobs were created during this time due to energy savings of 4.1 exajoules per year, which amounted to 100 new jobs per petajoule of primary energy saved.[349] Other studies in the late 1990s in Europe and North America also reported a net increase of jobs, but kept the figure closer to 40–60 new jobs per petajoule of primary energy saved. (The explanation for the decrease in jobs per petajoule of energy saved is increased labor productivity.)[350]

In 2000, a study conducted by the British Association looked at four different sectors—residential, schools, manufacturing, and public administration—and made not only conclusions about energy efficiency in general but also conclusions specific to the residential building sector. This study looked at 44 energy-efficiency investment programs in 9 EU countries (Germany, the United Kingdom, France, Spain, Finland, Austria, the Netherlands, Ireland, and Greece), 20 of which

were in the residential sector. The study, which used input-output modeling (I-O), case studies and macroeconomic modeling, found that in the majority of cases (38 out of 44), additional employment was created. (In two of the cases, employment growth would have occurred without the investment, and in four cases the results were inconclusive due to insufficient data.)

More specific to the residential sector, the study determined that for every €1 million ($1.37 million) spent in energy-efficiency programs, 11.3 to 13.5 full-time equivalent jobs were created.[3351] Jobs were created mainly in the installation and delivery of new efficient materials or equipment, but also in management, administration, auditing, and research and development.[352] Finally, the study concluded that because the numbers were small, although they were positive, employment creation should be viewed as an added benefit to energy-efficiency programs rather than the main driving force.[353]

United States

An abundance of studies in the United States link energy efficiency with employment. The U.S. National Action Plan for Energy Efficiency (NAPEE) lumps energy efficiency and renewable energy together and estimates that a $7 billion per year investment would generate 298,000 jobs annually.[354] A 2005 study in the Midwest proposes a 1 percent reduction in natural gas and electricity consumption resulting in 30,000 new jobs and $16 billion in saved costs from 2006–2010.[355] And a 2002 report conducted by the Southwest Energy Efficiency Project (SWEEP) analyzed the potential job creation in Arizona, Colorado, Wyoming, Utah, Nevada, and New Mexico. The High Efficiency Scenario, which increases efficiency 33 percent by 2020 and reduces emissions 26 percent by 2020 (compared with the base reference scenario) projected 58,400 jobs and $28 billions in savings between 2003 and 2020.[356] The program calls for a total investment of $9 billion over the same period. Energy-efficiency measures focused mainly on the building sector (appliances, air conditioners, lamps and lighting, efficient design, and construction of residential and commercial buildings) but also included transport (efficient motor systems) and industry (in general). The authors of the study concluded that the improvements were technologically feasible but were not being used.[357]

Defining Energy Efficiency

Defining the energy-efficiency sector is a vexing problem, since most of the relevant activities, investments, revenues, and forms of employment are not found in distinct and thus easily identifiable factories or industries. Rather, they are embedded in a broad range of existing industries such as vehicle manufacturing, construction, lighting, heating and cooling equipment, electronics, consumer appliances, and so on. When discussing energy efficiency, a fundamental difficulty is to decide what constitutes an efficient product or piece of equipment. Ratings of eco-labeling programs such as Blue Angel in Germany or Energy Star in the United States can in principle serve as a yardstick for this purpose. But they serve different purposes, due to different levels of strictness, and thus may or may not be suitable indicators whether a given car, light bulb, window, piece of machinery, etc. is "efficient" or "inefficient."

A 2007 study for the American Solar Energy Society (ASES) makes a comprehensive effort to capture all relevant elements of what might be thought of as the "energy-efficiency industry." Among other items, ASES includes manufacturers of insulation materials, energy services and energy audit companies, recycling (collection and processing), reuse, and remanufacturing activities in a working definition. It relies on the U.S. Environmental Protection Agency's Energy Star ratings to determine the share of lighting products, appliances, windows and doors, and electronic and industrial equipment that could be considered efficient, and on LEED-certification for building construction.1 In the automobile sector, it counts vehicles that score at least 10 percent better than the Corporate Average Fuel Economy (CAFE) standards as energy efficient.[358] Table II.2-1 shows a list of U.S. goods and industrial equipment that are labeled energy efficient by the ASES study.[359]

Table II.2-1. Selected U.S. Goods and Industrial Equipment Considered Energy-Efficient

Category	Share Considered Energy-Efficient (percent)	Standard Applied
Lighting and Appliances, of which:	20	Energy Star
• Light bulbs (CFLs)	<5	
• Clothes washers	15	
• Refrigerators	23	
• Room air conditioners	28	
• Dishwashers	40	
Windows and doors	40	
Computers, copiers, fax machines, VCRs	90+	
Televisions	50	
Audio electronic equipment	40	
Heating, ventilating, and air conditioning	30+	
Industrial and related machinery	10	ASES estimate
Residential and non-residential housing	3	LEED Certification
Vehicles	15	CAFE + 10 percent

Source: See Endnote 359 for this section.

The ASES study is a laudable and much-needed effort to define the efficiency sector in a systematic manner and to establish baseline data that could make future studies more comparable. It concludes that in 2006, there were 3.5 million direct jobs in energy efficiency-related activities in the United States, plus another 4.5 million indirect jobs, for a total of just over 8 million. The biggest chunk is accounted for by the recycling industry, with 3 million direct and indirect jobs. Manufacturing of nondurable products contributes 1.2 million jobs; miscellaneous durable manufacturing 0.9 million; companies producing computers, copiers, and fax machines 0.7 million; and construction 0.5 million. Sketching three scenarios (base, moderate, and advanced) for future developments,

1 LEED stands for Leadership in Energy and Environmental Design. It is a rating system developed by the U.S. Green Building Council.

the study suggests that energy efficiency could offer 15 million, 17.8 million, or perhaps even 32.2 million jobs, respectively, by 2030.[360]

The ASES methodology is based on the assumption that existing U.S. government standards and efficiency ratings are sufficiently indicative of (currently) achievable energy efficiency. At least in some respects, however, this is a somewhat questionable assumption, and it follows that the ASES job results are, in part, overly generous.

Types of Jobs

Energy-efficient measures in the building sector lead to direct, indirect, and induced jobs. Jobs are created directly in the building sector. This is significant because most of the sector is comprised of small and medium-sized enterprises: 90 percent of global construction still occurs in microfirms that have 10 or less employees.[361] Even the largest companies in the sector are small in comparison to the leading multinationals in other major industries like energy, banking and investment, and retail. The jobs created in the building sector are mainly performed directly at the development site, and therefore are typically local.[362] Indirect jobs are created mainly in the manufacturing sector. And induced jobs are created as money that would have previously been spent on energy is freed up and re-spent in the community. Not only are jobs created in building operations and construction, but they are also created in manufacturing, administration, and consulting.

It is important to note that many of these studies point to a more equitable distribution of wealth since the money saved is invested back into the local economy. "The positive employment and income results are due primarily to the relatively low labor intensity of the energy sectors (coal, oil and gas extraction, fuel refining and electric and gas utilities) compared to the economy as a whole. Conserving energy reduces the energy bills paid by consumers and businesses, thereby enabling greater purchase of non-energy goods, equipment, and services. The result is a shift of economic activity away from energy supply industries and towards sectors of the economy which employ more workers per dollar received."[363]

Traditional energy services, which are generally managed in centralized urban areas, are replaced by jobs that can occur within all communities. The number of jobs in the manufacturing, construction, education, services, finance, and agriculture sectors are more labor intensive than the energy sector and stand to benefit from energy-efficiency measures. The Apollo Alliance estimates that for every $1 million invested in the United States, 21.5 new jobs are created from energy efficiency, as compared to only 11.5 jobs for new natural gas generation.[364] Because these new jobs are performed at the local level and are often done by small enterprises, energy-efficiency programs are especially important for underdeveloped regions and areas of high unemployment rates.[365]

There are some variations between studies on what percentage of jobs are created directly from energy-efficiency measures and how many are related indirectly to energy savings and the re-spending of those savings. One study from the American Council for an Energy-Efficient Economy (ACEEE) showed that 90 percent of jobs were indirect and 10 percent were direct.[366] Another study from Europe showed that one-third of jobs created by energy-efficient measures

were direct and two-thirds were indirect. Despite the differences in their conclusions, both studies show that the majority of jobs are created indirectly through savings that is redirected back into more energy-intensive sectors.

Job Losses

Not all job news is positive. Although most sectors of the economy stand to gain employment and to benefit from energy savings, some jobs in energy-intensive or energy-producing fields will likely be eliminated. Energy efficiency means a reduction in the production of carbon-based energy and energy- intensive products, which directly translates to a demand for workers in those sectors. Workers in coal, oil, gas extraction, and fuel-refining industries are likely to see a reduction of jobs in these sectors.[367] This shift from energy-intensive and -producing fields to other sectors requires a just transition for workers.

Green Buildings

Energy-efficient buildings, also known as green or high-performance buildings, drastically reduce emissions, material, and water use and have the potential to reduce energy by up to 80 percent or more. Green buildings reduce their energy load by integrating efficient systems (heating, cooling, lighting, water); use alternative energy sources (passive solar, alternative energy sources); retain energy (efficient insulation and windows, thermal mass); and use recycled, reused, or low-energy building materials.

Eleven countries, which have the potential to oversee 50 percent of all new global construction, are currently members of the World Green Building Council.[368] Dozens of other countries are considering or are in the process of forming green building councils, many of which are in emerging and developing countries.[369] (See Table II.2-2.) The councils adopt energy-efficiency standards for buildings. The most recognized programs are BREEAM (United Kingdom), CASBEE (Japan), Green Star (Australia, New Zealand), and LEED (United States, Canada, India), Passivhaus (Germany, Australia, United Kingdom), Minergie (Switzerland), and Haute Qualité Environnementale (France). In total, 21 countries have at least one established green building certification standard.

Table II.2-2. Countries with Green Building Councils

Established Councils	Emerging Councils
Australia*, Brazil*, Canada*, India*, Japan*, Korea**, Mexico*, New Zealand*, Philippines, Taiwan*, United Arab Emirates*, United Kingdom*, United States*	Argentina, Chile, China, Egypt, Germany, Greece, Guatemala, Hong Kong, Israel, Nigeria, Panama, South Africa, Switzerland, Turkey, Vietnam

**Current member of the World Green Building Council*
***In the process of joining the World Green Building Council*
Source: See Endnote 369 for this section.

In the United States, there are currently over 40,000 LEED-Accredited Professionals involved in design, construction, operations, or maintenance.[370] In addition, there are 1,500 LEED accredited professionals in India, 900 Green Star professionals in Australia, and 1,197 BREEAM-licensed assessors in the United Kingdom. These numbers have been increasing and are projected to rise further as green building takes over a larger share of the construction market.

The Apollo Alliance New Energy for America report projects that 827,260 jobs could be created in the United States through investment in high-performance buildings, both retrofitting and new green construction. The plan requires an $89.9 billion dollar investment to improve financing for green buildings, provide tax incentives, invest in research and development, and promote new building codes and standards.[371]

New green construction does allow for the possibility of some new jobs due to the increased investment in the construction phase. But most of the jobs created through green building practices are likely to occur from energy savings and reinvestment. The types of jobs will need to be redefined in terms of new skills, training, or certification requirements; however, many of these jobs are likely to be performed by people who are already working in the building sector.

Redefined jobs include green building architects and designers, who as part of the green building sector must consider the entire life cycle of the building and reduce raw material use, emissions, and water use and improve energy efficiency, indoor air quality, and occupant health. Because green buildings are designed as single, integrated systems, the architects and designers must understand the various components involved in green building: efficient heating, cooling, lighting, cooking, appliances, and insulation; passive solar, thermal mass, renewable energy sources; and low-impact building materials. Understanding the green building process and local or national green standards requires additional knowledge, training, and certification. In most cases, these new green design jobs replace already existing ones.

© Martin Bond / Still Pictures
The Centre for Alternative Technology, showing polytunnel, geodesic dome and on the right, a photovoltaic roof for generating electricity. Wales, near Machynlleth, UK.

© Martin Bond / Still Pictures
Ecological houses at eco-village with earth sheltering (at rear), turf roofs and various active & passive solar features. Dyssekilde, near Hundestad. Denmark.

A shift away from traditional housing to green construction also provides a unique opportunity to meet Target 11 of the United Nations' Millennium Development Goals (MDGs), which aims to alleviate slum conditions for 100 million people by 2020.[372] (See Box II.2-1.) New developments in technology, such as solar panels and solar water heating, reduce the costs of alternative energy sources and lessen the dependence on traditional energy infrastructure. In addition, because most of the work involved in building sustainable housing is done through the delivery, installation, and construction, the vast majority of jobs created will occur at the local level and provide additional opportunities for employment.

Box II.2-1. Green Building, Slums, and the Millennium Development Goals

The world's present urban population now reaches over 3.2 billion people, or half the global population. The vast majority of this growth has occurred in less-developed countries. The rate at which people in developing countries are moving into urban centers is five times the rate at which new housing stock is constructed. The end result has been massive numbers of informal settlements and the explosion of slums. Currently 1 billion people, mainly in Africa, Asia, and Latin America, live in urban slums and lack durable housing, sufficient living space, clean water, and sanitation. By 2050, it is estimated that an additional 4 billion people, almost the entire expected projected world population growth from now until then, will live in urban areas. Eighty-eight percent of this projected growth is expected to occur in low- and medium-income countries.

The United Nations' Millennium Development Goals, which aim to alleviate 100 million people from slum conditions, are far from being met. A shift away from traditional housing to green construction may provide a unique opportunity to meet these targets. Certain infrastructure costs can be bypassed by new developments in technology. For example, dependence on an electricity grid may no longer be necessary with the installation of solar panels and solar water heating. By reducing energy costs, this makes the development goals more feasible for municipalities and residents.

Along with the growth in urban population has been the growth of the world's labor force. Since most of the work involved in building sustainable housing is done through the delivery, installation, or construction, the vast majority of these jobs will occur at the local level and can provide employment for people in these communities.

Source: See Endnote 372 for this section.

Despite the overall social, economic, and environmental benefits, sustainable building practices remain a niche market. The cost of green building or the perceived cost is still a major barrier. A 2007 report by the World Business Council for Sustainable Development reported that despite the increasing knowledge and understanding about green buildings, key decision makers still overestimate the cost. The 1,400-person survey found that the average guess for the additional cost of building green was 17 percent, when the actual amount is closer to 5 percent. A 2003 report by the U.S. Green Building Council put the increase at as little as 2 percent.[373] Other more conservative estimates for the most efficient buildings are around 10 percent. These additional costs, although sometimes initially prohibitive, are paid back over 2–7 years. After the initial payback period, they become a negative cost, as the savings over time are greater than the initial increase in investment.

Other barriers to greening the building sector include: short term profit motives over long-term savings, fragmentation within the building sector, lack of education, lack of available resources, and lack of mandatory standards.[374]

Retrofitting

According to the IPCC, retrofitting and replacing equipment in buildings has the largest potential within the building sector for reducing greenhouse gases by 2030.[375] Even with the continued growth of the building sector, most of the structures that will be built in 2030 have already been built. This is why retrofitting plays such a critical role in reducing emissions.

Retrofitting buildings directly increases employment because without an attempt to make the building more efficient, the work would not have been done. Types of jobs that are likely to be created directly in the retrofitting process are auditors, engineers, estimators, project managers, and various jobs in the constructions trades including pipe fitters, sheet metal workers, HVAC technicians, engineers, electricians, and general construction workers.[376] Most of these jobs are created during the initial construction or investment period and are likely to stimulate the local economy because they are performed at the work site.

The most ambitious building retrofitting project to date is the German Alliance for Work and the Environment's initiative to retrofit German homes. The Alliance is a collaborative effort between the German government, unions, NGOs, and employers' federations. From 2001–2006, an estimated $5.2 billion (€3.8 billion) of public subsidies stimulated close to $20.9 billion (€15.2 billion) in investment and has resulted in 342,000 apartment retrofits as of March 2006—exceeding the initial goal of 200,000 apartment retrofits.[377] An estimated $4 billion was saved through additional tax revenues and reductions in unemployment benefits, along with 2 percent of annual emissions attributed to buildings in Germany.[378] Energy-efficient measures included improving heat insulation of roofs, windows, and walls; introducing advanced heating technologies and controlled air ventilation systems; and using renewable energy such as PV or solar thermal systems.[379]

© M. Renner, 2005
Solar thermal panels on the Ocean View Guesthouse. Sri Lanka.

The German Alliance for Work and the Environment estimated that 200,000 jobs would be created; however, a 2004 assessment of the German Alliance for Work and the Environment showed that only 25,000 full-time equivalent (FTE) additional jobs were produced. Another 116,000 were saved between 2002 and 2004 during a recession in the construction sector. Even though these numbers are lower than expected, the job numbers are still fairly substantial, with around 140,000 new or saved jobs. These results along with the additional revenue and savings prompted the German government to not only renew the project, but even increase the money allotted for the program. In 2005, Germany increased the funding of its building retrofit program to almost $2 billion (€1.4 billion) per year.[380] For every $1.4 billion (€1 billion) invested in the program, 25,000 additional jobs are expected.[381] In 2006, an estimated 145,000 additional FTE jobs were created.

A 2005 Ecofys study of the 10 European Union new member states—Cyprus, the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Slovakia, and Slovenia—projected 50,000 to 185,000 jobs by retrofitting the existing residential building stock. The program calls for a minimum of $2.2 billion (€1.6 billion) per year for large apartment buildings and up to $6.4 billion (€4.7 billion) per year to incorporate all houses.[382]

The Canadian government estimates implementing a retrofitting program on a national scale would result in 5,600 to 7,840 person-years of employment at the local level. This is 20 jobs for every $1 million invested, or 1 job for every $50,000. A potential investment of $280–392 million dollars invested in energy-efficiency improvements could reduce greenhouse gases by 800 kilotons per year. After the initial payback of 5 to 7 years, this would save the government $56 million dollars per year.[383]

The Clinton Climate Initiative (CCI) recently launched its Energy Efficiency Building Retrofit Program in 16 of the world's largest cities: Bangkok, Berlin, Chicago, Houston, Johannesburg, Karachi, London, Melbourne, Mexico City, Mumbai, New York, Rome, São Paulo, Seoul, Tokyo, and Toronto. This project involves five major banks, and four of the largest energy service companies (ESCOs) are providing $5 billion in funding for retrofitting of municipal buildings and providing incentives for private building owners to retrofit existing buildings.[384] (See Box II.2-2.) They also created the C40 Large Cities Climate Leadership Group to provide support for energy-efficiency programs in 40 megacities in both developing and developed countries.

Box II.2-2. Energy Service Companies (ESCOs)

Businesses that develop, install, and finance energy-efficiency projects are called ESCOs, or Energy Service Companies. ESCOs pay for the initial capital investment and are paid back over time through the energy savings, therefore covering the initial upfront costs and making energy-efficiency programs attractive to building owners. Since the 1970s, ESCOs have provided funding for $20 billion worth of projects worldwide, of which approximately $7 billion has gone for labor employment. The Lawrence Berkeley National Laboratory estimates that ESCOs have provided $4 billion in energy-efficiency investment in the United States, of which 25 to 30 percent is spent directly on labor to design, install, operate, and maintain efficiency programs in the building sector. This area has enormous potential to grow and create jobs.

Source: See Endnote 384 for this section.

Other major retrofitting projects are emerging. In 2005, Chinese officials announced that using existing technology, the country will transform all existing buildings into energy-saving buildings by 2020 and reduce energy use by as much as 65 percent.[385] In Berlin, the BEA (Berlin Energy Agency) created energy-efficient incentives at no cost to the building owners. New York City's PlaNYC commits 10 percent of the city's energy budget, $81.2 million dollars in 2007, to retrofit municipal buildings—which amounts to 5,000 new jobs in the building sector.[386] Table II.2-3 shows some additional municipal energy targets.[387]

Table II.2-3. Selected Municipal Energy Targets in the Building Sector

City	Target
Baden-Württemberg, Germany (southwestern state)	20 percent of heating from renewable sources in newly constructed residential homes
Berlin, Germany	30 percent decline in energy use in public buildings by 2010; solar water heating incorporated into 75 percent of new buildings annually
Copenhagen, Denmark	Energy audits for all buildings exceeding 1,500 square meters; all new buildings must rely on district heating (electric heating banned)
Leicester, United Kingdom	50 percent decline in municipal building energy use by 2025 (from 1990 level)
Oxford, United Kingdom	10 percent of homes to use solar hot water or PV by 2010
Seattle, Washington	LEED standards for all buildings over 5,000 square feet (465 square meters)
Berkeley, California, USA	Green building standards for all sold, renovated, or transferred homes
Portland, Oregon, USA	LEED Gold Standard for all new city-owned construction
Tokyo, Japan	5 percent renewable energy use in large municipal facilities

Source: See Endnote 387 for this section.

The European Trade Union Confederation reports that it would cost $4,300 billion (€3,145 billion) to retrofit the EU's residential building sector in order to reduce CO_2 emissions by 75 percent. The ETUC report creates two time periods under which this 75 percent reduction could take place. In the 2050 scenario, 1.38 million full-time equivalent jobs would be created; in the 2030 scenario, 2.59 million full-time equivalent jobs would be created. These ambitious EU scenarios require that governments play a key role in funding energy-efficiency programs which will in turn help fund new employment and stimulate economic growth. The other, less-ambitious scenarios would result in less job creation. The Business as Usual (BAU) and Eurima scenarios, which reduce emissions by 8 percent and 16 percent respectively, would create 20,000–62,500 full-time equivalent jobs for BAU and 160,000–500,000 full-time equivalent jobs for the Eurima scenario.[388] Comparing these scenarios demonstrates that the larger the investment and the faster that these programs can be implemented, the larger number of jobs that can be created.

Energy-Efficient Building Components

Jobs in the green building sector, both new construction and retrofitting, are likely to stimulate jobs in the manufacturing of green building components and systems, including: efficient waste, lighting, HVAC, water filtration, and insulation systems, and energy-efficient appliances. PV panels, solar water heaters, small wind turbines, or geothermal heat pumps are often used to provide alternative energy sources for green buildings and will add to green manufacturing jobs.

Urbanization, the growth of the middle class in developing countries, the trend for bigger homes, and the desire for more electrical appliances and technology will add to the growth of these industries. Energy-efficient appliances use more skilled labor than manufacturing inefficient ones.[389] The U.S. Department of Energy predicts that standards for clothes washers, water heaters, and fluorescent lamp ballasts would create 120,000 jobs in the United States through 2020.[390] The Apollo Alliance estimates that an investment of $3.5 billion to modernize appliance standards would result in 29,876 jobs and create $5.89 billion in personal income.[391]

In India, replacing traditional cook stoves with recently developed advanced biomass cooking technologies in 9 million households could create 150,000 jobs. (These numbers do not include employment generated in biomass plantations.) Advanced biomass cooking techniques are especially important for the reduction of the negative health effects and respiratory diseases associated with using traditional cooking biomass (animal dung, wood, crop waste) inside poorly ventilated homes. This improvement could be especially significant for the health outcomes of women and children.[392]

With regard to the cost of funding green building projects, it is important to note that energy-efficiency programs are the most affordable kind of emissions-mitigation projects. The McKinsey Global Institute has identified lighting, insulation, air conditioning, and water heating as being four of the five most cost-effective ways to reduce emissions. (The only program not related to buildings is increasing the efficiency of commercial vehicles.)[393]

Lighting

Lighting is one of the lowest hanging fruits for energy-efficiency measures because the transition can occur at relatively low costs with already existing technology and provides immediate results. A global switch to replace one in five light bulbs by 2030 would decrease carbon dioxide emissions by 400 million tons.[394] Energy-efficient light bulbs are cost effective over the long term. The total cost of burning 10,000 hours of light is $34 (€25) for CFLs as opposed to $116 (€85) for incandescent bulbs.[395]

Traditional light bulbs are already being replaced by more energy-efficient light bulbs and lighting systems. Australia announced in early 2008 that it would ban the sale of all incandescent bulbs by 2010, and the U.S. state of California has proposed a similar bill for 2012. European Union leaders have proposed to create efficiency requirements for offices and street lighting by 2008 and for

lighting in private homes by 2009, which would save the EU 20 million tons of carbon emissions yearly.

Between 1995 and 1998, Mexico carried out the first large-scale energy-efficiency lighting program in a developing country by replacing old lighting with 1 million compact fluorescent bulbs in households. This program, called ILUMEX (Illumination of Mexico), demonstrated positive economic returns for residents, the power sector, and communities. It helped generate direct and indirect jobs and trained indigenous people to work on large-scale efficiency programs. Smaller lighting programs have also been implemented in Belize, Bolivia, Brazil, Costa Rica, Cuba, Ecuador, Peru, and Venezuela.[396]

Manufacturers of CFLs and LEDs (light emitting diodes) are likely to see tremendous growth in these areas. The three major multinationals that have traditionally dominated the incandescent lighting market—Philips, GE, and Sieman's Osram Sylvania—are also anticipating a switch away from incandescent lights to more efficient ones. Philips has announced that by 2016 it will no longer sell incandescents. And GE and Siemen's Osram Sylvania are designing new types of lights to replace today's standard bulbs. Philips and Sylvania already lead the LED market, with a 50 percent share.[397] In the photonics industry, which has five major markets (one of which is LED lighting and displays), the estimated number of jobs is expected to grow in the European Union from 500,000 in 2003 to 1.5 million in 2010.

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Variety of designs Energy saving lamp. It uses 20W of electricity but produces 100W of illumination. 80% lower electricity consumption compared to traditional bulbs. Lasts 10 years when used an average of 3 hrs per day.

Conclusion

The aforementioned energy-efficiency measures in the building sector—green building, retrofitting, and building components (including water heaters, cooking equipment, domestic appliances, office equipment, electronic appliances, heating, ventilation and air conditioning systems, and lighting)–have great potential to both reduce greenhouse gas emissions and create jobs. But they remain underutilized. New green building initiatives are also a step in the right direction, but only represent a small fraction of the potential in this sector. (Canada reported that just 150 building projects (1.5 percent of total construction costs) were registered as LEED in 2005, and the 2007 ASES study concluded that only 3 percent of buildings in the United States qualified for LEED certification.)

For the most part, these retrofitting programs and green building initiatives are confined to a handful of countries in the global North. Aside from the German retrofitting program, the Clinton Climate Initiative, and a few other emerging projects, the amount of capital available for green building, retrofitting, and energy-efficient measures pales in comparison to the amount needed to make a significant dent in emissions. Table II.2-4 is a list of key policy recommendations specific to the building sector. It is not intended to be all-inclusive, but focuses instead on the most important initiatives in this area.

Table II.2-4. The Way forward

Type of Policy	Policy
Standards	• Establish minimum green building standards for all new construction. This is especially important in the developing world, and especially in China, where almost half of all global construction is taking place. It is more cost effective to build new green construction than to retrofit projects at a later time. • Create regularly updated minimum standards and standardized labeling for equipment and appliances (water heaters, HVAC, cooking, appliances, lighting, electronics, office equipment, windows, and others). More than 50 countries currently have either standards or labeling programs, which have resulted in energy savings, but much more is needed. Inefficient lighting programs must be phased out.
Financing	• Create financing programs for retrofitting. Buildings have an extremely long lifetime, often more than 50 years, but this lifespan is shrinking. Reverse the trend by renovating and retrofitting old buildings as opposed to building new. These projects are extremely labor intensive and will result in a large number of building and construction jobs. • Target programs that have immediate results and are very cost effective, especially lighting programs, air conditioning, water heating, and building insulation. Provide incentives and funding opportunities for people to make these changes • Support a global effort to scale up new green building, retrofitting, and energy-efficiency programs in the developing world. Establish funds for energy-efficiency programs in developing and emerging economies.
Research and Development	• Increase R&D funding to explore more energy-efficient buildings (e.g., passive houses and zero-emission buildings). Current funding is much too little: in the United States, federally funded research for buildings amounts to just .02 percent of the annual construction budget. The U.S. Green Building Council suggests that the National Institutes of Health and National Science Foundation increase their research budgets to 2 percent for buildings.

The sheer number of buildings that need to be retrofitted is staggering. The United States and European Union alone have 250 million such homes. Based on the results of the Apollo Alliance and European Commission studies, greening the building industry in the two regions would create almost 2 million jobs (3.5 million jobs using the ETUC study's Advanced Scenario of a 75 percent CO_2 reduction in the residential building sector by 2030). Although exact figures are unknown, it is easy to imagine that a worldwide transition to energy-efficient buildings could create millions or even tens of millions of jobs and would green existing employment for many of the estimated 111 million people already working in the sector. Furthermore, greening municipal, commercial, industrial, and residential buildings will radiate out to people who work in these energy-efficient buildings.