THE ENERGY IMPROVEMENT OF THE EXISTING URBAN BUILDING STOCK: A PROPOSAL FOR ACTION ARISING FROM BEST PRACTICE EXAMPLES

TERESA PAREJO-NAVAJAS

Improving energy efficiency in existing buildings presents an opportunity for reducing greenhouse gas emissions. Numerous measures meant to increase efficiency and decrease emissions have been implemented in cities across Europe and the United States. Standing out from the rest is New York City, a remarkable example of commitment to the fight against climate change. The city has urged its authorities to take important measures in order to eliminate (or at least diminish) the adverse effects resulting from its special characteristics, great urban density, and large percentage of greenhouse gas emissions coming from an aged building stock. Yet there is always room for improvement. Thus, this comparative study of some of the most successful measures developed in selected cities aims at providing legal professionals with best practices for greening the existing building stock of New York City and, eventually, of any city in the world.

TABLE OF CONTENTS

INTRODUCTION ................................................................. 354
I. ENERGY EFFICIENCY BEST PRACTICE EXAMPLES DEVELOPED IN EUROPEAN CITIES AND NEW YORK CITY ....................... 357
   A. Background ................................................................. 357
   B. The European Union (EU): Main Conclusions from Selected Best Practices ......................................................... 358
      1. Examples ................................................................. 358
   C. New York City (NYC): A Noteworthy U.S. Example .......... 362
      1. Characteristics of NYC’s Building Stock .................. 363
      2. NYC’s Energy Efficiency Measures .......................... 365
II. BEST PRACTICE EXAMPLES FOR THE MOST ENERGY INTENSIVE USES IN BUILDINGS ................................................... 367
   A. Heating ......................................................................... 367
      1. Space Heating .......................................................... 367
INTRODUCTION

Existing buildings offer substantial energy efficiency opportunities, measured in terms of energy and cost savings and in the reduction of greenhouse gas (GHG) emissions. Indeed, existing buildings are responsible for 41 percent of energy use and 36 percent of carbon dioxide (CO₂) emissions in the European Union (EU),¹ and 39 percent of total energy use and 38 percent of CO₂ emissions.

---

¹ Associate Professor of Administrative Law, Carlos III de Madrid
emissions in the United States.\textsuperscript{2} In New York City (NYC), the building sector is responsible for roughly 75 percent of total GHG emissions in the city.\textsuperscript{3} Understanding the energy consumption of buildings requires insight into the energy levels consumed historically and the mix of fuels used in that energy consumption. Given the predominance of existing buildings in major population centers around the world, adopting energy efficiency measures for existing buildings is one of the most important and cost-effective means available to combat climate change. Overall, energy use in buildings is rising across the entire world despite energy efficiency and mitigation efforts, and this trend is likely to continue if insufficient action to improve our buildings’ performance is taken and the world population continues to rise.\textsuperscript{4} Although there are several ways to reduce GHG emissions derived from energy use in buildings, scientists and governments agree\textsuperscript{5} that improving the...
energy efficiency of building systems and operations, as well as investing in cleaner on-site power generation, is a highly effective approach. In Europe, some cities have developed interesting measures that have been evaluated as best practice examples by numerous reports. Also, NYC is committed to reducing its GHG emissions by 80 percent below its 2005 levels by 2050 through the ambitious One City: Built to Last Plan, designed to address energy use improvement in the city’s building stock.

This Article aims to find innovative measures that would improve the energy performance of the existing built environment, thus contributing to the mitigation of the effects of climate change. This focus will help fill the current void in the literature on GHG emission reduction strategies in general, which is primarily oriented towards new buildings. Also, by testing the most successful European practices as well as the ones implemented in NYC—the city considered to be one of the most advanced in the matter—the Article will go a step further and draw conclusions that will summarize best practice guidelines for any existing building in any city in the world.

In order to outline guideline proposals for the energy improvement of the global existing building stock, I first point out some general energy efficiency recommendations that could be valuable for the existing urban environment in NYC. The analysis places special emphasis on measures that would overcome the so-

---


called split incentive,\textsuperscript{10} one of the largest hurdles for energy efficiency investment in the building sector.\textsuperscript{11} The split incentive is particularly relevant to those cities with a large proportion of rental housing, like NYC.\textsuperscript{12}

I. ENERGY EFFICIENCY BEST PRACTICE EXAMPLES DEVELOPED IN EUROPEAN CITIES AND NEW YORK CITY

A. Background

The building sector is mainly composed of two categories of buildings: residential and non-residential.\textsuperscript{13} Residential buildings include single-family houses (detached and semi-detached houses) and apartment blocks.\textsuperscript{14} Non-residential buildings are more diverse than those of the residential sector, and they are generally classified by use.\textsuperscript{15} This Article focuses on the existing residential building stock, which accounts for two-thirds of the total energy consumption of buildings,\textsuperscript{16} while also referencing the commercial and industrial sectors for comparison.

The diversity of ownership, housing types and ages, geographic locations, and climate conditions pose a real challenge for policy-makers seeking to design the most efficient measures

\textsuperscript{10} See infra Section III. Briefly, the split incentive problem exists where building owners are responsible for investment decisions, but tenants pay the energy bills. See Kate Bashford, Energy Efficiency in NYC: The Problem of Split Incentives, SALLAN FOUNDATION (Apr. 7, 2008), http://www.sallan.org/Snapshot/2008/04/energy_efficiency_in_nyc_the_problem_of_split_incentives.php. As a result, owners have little interest in commissioning energy-efficient buildings. See id. Hence, any investment that would reduce the energy bill has to be perceived as financially advantageous for the building owner as well. For more information about the split incentive problem, see id.

\textsuperscript{11} See MARINA ECONOMIDOU, BLDGS. PERFORMANCE INST. EUROPE, EUROPE’S BUILDINGS UNDER THE MICROSCOPE: A COUNTRY-BY-COUNTRY REVIEW OF THE ENERGY PERFORMANCE OF BUILDINGS 60 (2011).

\textsuperscript{12} See Bashford, supra note 10.

\textsuperscript{13} A building is regarded as non-residential when a minority portion of the building (i.e. less than half of its gross floor area) is used for dwelling purposes. Non-residential buildings are comprised of: industrial buildings, commercial buildings, educational buildings, medical office buildings, other buildings. Building Type – Non-Residential Building, BPIE: DATA HUB FOR THE ENERGY PERFORMANCE OF BUILDINGS, http://www.buildingsdata.eu/content/definitions/building-type-non-residential-building (last visited Nov. 8, 2014).

\textsuperscript{14} See ECONOMIDOU, supra note 11, at 30.

\textsuperscript{15} See BOSSEBOEUF, supra note 7, at 10.

\textsuperscript{16} See SOPHIE SHNAPP, REDUCING ENERGY DEMAND IN EXISTING BUILDINGS: LEARNING FROM BEST PRACTICE RENOVATION POLICIES 6 (2014).
for improving the energy performance of the existing building stock. Some measures must be directed at improving the main energy uses of the building (heating, cooling, and electricity use for lighting and appliances), others at boosting previous efficiency measures by upgrading the building itself or its design, and finally others at fostering behavioral changes in those inhabiting (or using) the buildings. While this Article mainly focuses on the first two groups of measures, the last will also be addressed in supplementary fashion.

Three main policy instruments are widely used to promote energy efficiency in the built environment worldwide: regulatory instruments, economic instruments (market-based and financial instruments and incentives), and the distribution of information that spurs voluntary actions. As there is no such thing as an existing overall “best” policy package, I bring attention to specific measures that have been successful along with the particular cities that have implemented them with the best results. For any city, the challenge is to find the combination of policies that will most improve the energy efficiency of its existing building stock, thereby playing a part in the global fight against climate change.

A previous article written by the author studied each type of instrument at a supranational (EU) and national (US) level—\textsuperscript{17}—the present analysis focuses on the instruments that have been especially successful in a certain country or city for the energy improvement of the building stock. The main purpose here is to ensure that the benefits extracted from best practice sharing\textsuperscript{18} can extend to any city in the world.

B. The European Union (EU): Main Conclusions from Selected Best Practices

1. Examples

There are numerous reports that analyze energy efficiency

\textsuperscript{17} See generally Teresa Parejo-Navajas, A Legal Approach to the Improvement of Energy Efficiency Measures for the Existing Building Stock in the United States Based on the European Experience, 5 SEATTLE J. ENVTL. LAW 341 (2015).

\textsuperscript{18} See SHNAPP, supra note 16, at 35. This Article defines “best practice” as a technological, behavioral, and/or economic change that spurs an improvement in energy efficiency.
practices applied to the European building stock, but this Article will mainly take into account the cities’ scores extracted from six of the studies: four privately sponsored and two managed by European institutions.

This Article will focus on the following European cities (and countries, as their policies are largely linked): Berlin, Germany; Stockholm, Sweden; Copenhagen, Denmark; London, United Kingdom; Paris, France; Madrid, Spain; Rome, Italy; and Vilnius, Lithuania. This sample includes some Nordic European countries, which are well known for being the most energy efficient in Europe, some Mediterranean countries, which have had more economic and behavioral difficulties but also impressive achievements in specific areas, and the best ranked Eastern European city. All of the selected European cities, as well as NYC, belong to the Covenant of Mayors, a European movement aimed at increasing energy efficiency and the use of renewables at the local level. By joining, Covenant signatories commit not just to meet but also to surpass the European Union’s 20 percent CO₂ reduction objective by 2020. Also, all of the selected cities except Vilnius belong to the C40 Cities Climate Leadership Group, a forum that promotes collaboration, knowledge sharing, and actions to fight against climate change.

After a detailed analysis of the measures developed in those selected cities, the main conclusions could be summarized as

---


20 See ECONOMIST INTELLIGENCE UNIT, supra note 7; EUROPEAN GREEN CITY INDEX (2009), supra note 7; INTERNATIONAL ENERGY EFFICIENCY SCORECARD, supra note 7; BigEE, WUPPERTAL INST., supra note 7; INT’L PARTNERSHIP FOR ENERGY EFFICIENCY CORP., supra note 7.

21 See BOSSEBOEUF, supra note 7; EUROPEAN COMM’N, supra note 7.

22 It should be noted that the research project conducted by the Economist Intelligence Unit, sponsored by Siemens, which ranked Vilnius, Lithuania as the best Eastern European city in terms of overall energy performance, uses 2009 data. See ECONOMIST INTELLIGENCE UNIT, supra note 7, at 35, 37. The group has not yet elaborated a newer report.


follows:

|-------------------|------------------------------------|---------------------------------|
| Berlin (Germany)  | - Gross Domestic Product (GDP): $3.356 trillion  
|                   | - Population: 81,413,141  
|                   | - CO₂ emissions per capita: 9.221 Megatons (MT)  | - Strong building codes  
|                   |                                    | - Mandatory labeling programs  
|                   |                                    | - Public-private partnership  
|                   |                                    | - Knowledge sharing  
|                   |                                    | - Holistic approach  
|                   |                                    | (comprehensive retrofit)  |
| Stockholm (Sweden)| - GDP: $492.618 billion  
|                   | - Population: 9,798,871  
|                   | - CO₂ emissions per capita: 4.617 MT | - Strong building regulation  
|                   |                                    | - Mandatory labeling programs  
|                   |                                    | - High insulation standards  
|                   |                                    | - Extensive information and technical assistance supported by the public sector via subsidies  
|                   |                                    | - Extended use of energy service companies (ESCOs)  
|                   |                                    | - Subsidies for renovating heating systems to use renewable sources  
|                   |                                    | - Energy tax on carbon fuels accompanied by grants for installation of solar panels and deep retrofitting  
|                   |                                    | - Production and distribution of district cooling systems  
|                   |                                    | - Holistic approach  
|                   |                                    | (comprehensive retrofit)  |

<table>
<thead>
<tr>
<th>City</th>
<th>GDP: $295.164 billion</th>
<th>Strong building regulation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Copenhagen (Denmark)</td>
<td>Population: 5,676,002</td>
<td>High energy standards</td>
</tr>
<tr>
<td></td>
<td>CO₂ emissions per capita: 6.78 MT</td>
<td>Effective mandatory energy labeling</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Advanced energy renovation based on good financing framework, strong education campaigns, and research and innovation.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Public leadership</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Solar panel installation in municipal buildings</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>City</th>
<th>GDP: $2.422 trillion</th>
<th>Strong building regulation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paris (France)</td>
<td>Population: 66,808,385</td>
<td>Effective mandatory labeling system</td>
</tr>
<tr>
<td></td>
<td>CO₂ emissions per capita: 5.05 MT</td>
<td>Incentive schemes (including tax rebates)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Training and education campaigns</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Zero-interest loans for renovations</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>City</th>
<th>GDP: $1.815 trillion</th>
<th>Strong building regulation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rome (Italy)</td>
<td>Population: 60,802,085</td>
<td>Mandatory energy labeling</td>
</tr>
<tr>
<td></td>
<td>CO₂ emissions per capita: 5.724 MT</td>
<td>Incentive schemes</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Financial support schemes (tax allowances and low interest loans for renewables)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Tax incentive for energy efficiency improvements in existing buildings</td>
</tr>
<tr>
<td>City</td>
<td>GDP</td>
<td>Population</td>
</tr>
<tr>
<td>-----------------------------</td>
<td>-----------------</td>
<td>----------------</td>
</tr>
<tr>
<td>Madrid (Spain)</td>
<td>$1.199 trillion</td>
<td>46,418,269</td>
</tr>
<tr>
<td>London (UK)</td>
<td>$2.858 trillion</td>
<td>65,138,232</td>
</tr>
<tr>
<td>Vilnius (Lithuania)</td>
<td>$41.171 billion</td>
<td>2,910,199</td>
</tr>
</tbody>
</table>

C. New York City (NYC): A Noteworthy U.S. Example

NYC is known for its urban scenery. Buildings define most of the city’s environment—making them more energy efficient is key for the accomplishment of the city’s GHG emissions reduction goal. PlaNYC, the most recent effort of the city to address its greater long-term challenges, proposed several measures to reach a 30 percent reduction in GHG emissions by 2030. The city’s ambition has grown in the past years—in 2013, NYC completed a comprehensive study of the technical potential to further reduce GHG emissions by up to 80 percent by 2050 by using current

---

technologies and taking into account the uniqueness and complexity of NYC’s built environment. The New York City’s Pathways to Deep Carbon Reductions report found that in order to meet that goal, 62 percent of GHG reductions must come from making buildings more efficient, resulting in the One City: Built to Last plan. Once again, the building sector is a key player in the decrease of GHG emissions and, therefore, in the fight against climate change.

1. Characteristics of NYC’s Building Stock

NYC has a varied building stock, with approximately one million structures dedicated to diverse uses. The great majority of NYC’s buildings are more than 50 years old. The city’s construction development peak was in the 1920s, while the lowest points of development occurred in the 1930s and 1950s-60s. By 2030, today’s present buildings will still account for at least 85 percent of the total building stock.

Residential buildings dominate the building sector, representing 92 percent of buildings and 70 percent of the built area. Commercial and institutional buildings (primarily offices, but also hospitals, universities, and municipal facilities) represent 5 percent of buildings, but a disproportionate 22 percent of the built
area. Finally, industrial buildings only represent 3 percent of buildings and 6 percent of the built area.

Unlike most U.S. residents, only around 30 percent of New Yorkers own their apartment or house. This explains why the split incentive is one of the most important problems for NYC to overcome in order to achieve its building stock energy efficiency goals.

Despite the fact that emissions from buildings have fallen slightly since 2005—due to the conversion to cleaner-burning natural gas for heat and hot water, and the move to a cleaner electricity grid—the building sector in NYC is still responsible for about 75 percent of NYC’s GHG emissions. This proportion is almost twice the national average; however, this divergence is explained by the fact that most New Yorkers walk or use public transportation instead of driving, resulting in relatively few emissions from cars. Of the emissions coming from buildings, roughly 55 percent come from onsite combustion of natural gas and liquid fuels for heat, hot water, and cooking; the remaining 45 percent of emissions stem from electricity production and consumption. Generally speaking, office buildings have a significantly higher share of electricity use (around 65 percent) than multifamily buildings (around 30 percent), because while the former are “cooling dominated,” the latter are “heating dominated.”

Until around 1970, multifamily buildings used natural gas and “dirty” residual oils interchangeably; the dirty oils, though, were gradually replaced starting in 1960, and

35 See id.
36 See id.
38 See infra Section III.
40 NYC MAYOR’S OFFICE OF SUSTAINABILITY, supra note 3.
41 See NYC PATHWAYS TO DEEP CARBON REDUCTION, supra note 28, at 19.
42 See CITY OF NEW YORK, NEW YORK CITY LOCAL LAW 84 BENCHMARKING REPORT 21–22 (2012).
buildings constructed after 1990 use natural gas almost exclusively.\textsuperscript{43}

2. \textit{NYC’s Energy Efficiency Measures}

What follows is a brief description of measures set out primarily by \textit{PlanNYC} and its extension, the \textit{One City: Built to Last} plan. It includes the main policy instruments of the city that have resulted in a number of interesting and effective initiatives. These initiatives range from regulatory to voluntary actions, and are summarized below:

<table>
<thead>
<tr>
<th>Type of measure</th>
<th>Description</th>
</tr>
</thead>
</table>
| Regulatory      | - Zone Green: Zoning regulation amendment to remove impediments to the construction and retrofitting of green buildings.  
- Local Law 84: Benchmarking submission by building owners for public disclosure.  
- Local Law 85: NYC Energy Conservation Code (NYCECC), for all building types.  
- Local Law 87: Energy Auditing and Tuning.  
- Local Law 88: Lighting upgrades and energy usage information in buildings over 50,000 square feet and tenant spaces over 10,000 square feet. |

\textsuperscript{43} \textit{See id. at 21.}
<table>
<thead>
<tr>
<th>Economic (market-based)</th>
<th>Residential Programs:</th>
<th>Financing:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>- Home performance with Energy Star</td>
<td>- On-Bill Recovery Loans</td>
</tr>
<tr>
<td></td>
<td>- Solar Electric (PV) Incentive Program</td>
<td>- Smart Energy Loans</td>
</tr>
<tr>
<td></td>
<td>- Multifamily Performance Programs</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- State Energy Investment Program (EnVest)</td>
<td></td>
</tr>
</tbody>
</table>

| Multifamily
| Advanced Submetering Programs |
| Federal
| American Recovery and Reinvestment Act |
| New York State Energy Research and Development Authority (NYSERDA)
| Con Edison Multifamily Energy Efficiency Program |
| - Energy Services Agreements (ESA) |
| - Direct Loans |
| - Expenses for Conservation and Efficiency Leadership (ExCEL) |
| Local
| - Green Roof tax abatement |
| - Solar Panels tax abatement |

| Informational and Voluntary |
| - Energy Aligned Clause (EAC) |
| - Green Light New York (GLNY) |
| - GreeNYC |
| - The Mayor’s Carbon Challenges |
| - Municipal Entrepreneurial Testing System (METS) |
| - NYC Cool Roofs |

| Packaged measures (public-private collaboration) |
| - Retrofit Standardization Initiative |
II. BEST PRACTICE EXAMPLES FOR THE MOST ENERGY INTENSIVE USES IN BUILDINGS

What follows is a selection of notable energy efficiency measures directed towards the most energy-demanding uses in buildings (space heating, water heating, space cooling and use of electricity for appliances and lighting) in certain EU countries, compared with solutions implemented in NYC for each use.

A. Heating

1. Space Heating

   In Europe, space heating accounts for more than 65 percent of total residential building energy consumption.

   a. The Netherlands

   The Netherlands is the exemplar for space heating in Europe due to several factors: a large diffusion of condensing boilers; a rapid turnover of the dwelling stock; a major upgrade in thermal regulations; an effective program that expedites the retrofitting of the existing building stock; and high energy prices.

---

44 In Europe, residential space heating takes the highest share of the total use of energy (67%), followed by water heating and appliances (both with a 13% share), and then cooking and lighting (with 4% and 3% shares respectively). See Mark Levine et al., Building Energy-Efficiency Best Practice Policies and Policy Packages 46–47 (2012), https://china.lbl.gov/sites/all/files/gbpn-finaloct-2012.pdf. The largest energy source is natural gas (around 40%), whereas coal is the smallest (around 3%). See id.

45 In NYC, 55% of GHG emissions from the building sector stem from onsite combustion of natural gas and liquid fuels for heating (space and water heating), and around 45% come from electricity production and consumption (mainly used for air conditioning devices and other appliances, including lighting). See NYC Pathways to Deep Carbon Reduction, supra note 28, at 19.

46 See Levine et al., supra note 44, at 47.


Unexpectedly, the Dutch housing stock is predominantly composed of individual dwellings (around 70 percent), which consume around 10 to 30 percent more energy than collective dwellings. However, the Netherlands has a higher percentage of newly built dwellings than other EU countries, and the average energy performance of new buildings is much better. Therefore, the structure of the Netherlands’ housing stock does not explain its good performance compared to other EU countries; however, the age of its housing stock might. Most Dutch homes are heated by natural gas, a fuel that NYC aims to use for its space heating needs, and the Netherlands has a large diffusion of central heating, just like NYC. But the Netherlands has a large diffusion of condensing boilers (60 percent of dwellings), thanks to a subsidy policy, training programs, and information campaigns; condensing boilers typically achieve higher efficiency than other types of boilers. This significantly impacts heating efficiency, and therefore, the consumption of energy.

The social (affordable) housing sector in the Netherlands

---

49 See ENERDATA FOR ADEME, QUANTITATIVE EVALUATION OF EXPLANATORY FACTORS OF THE LOWER ENERGY EFFICIENCY PERFORMANCE OF FRANCE FOR SPACE HEATING COMPARED TO EUROPEAN BENCHMARKS 5–6 (2011).
50 See id. at 8.
53 See Ben Gales, A Dutch Revolution: Natural Gas in the Netherlands, in ENERGY TRANSITIONS IN HISTORY 83–90, (Richard W. Unger ed., 2013). The dwelling stock structure, between individual and collective dwellings, influences countries’ energy performance, since an individual dwelling consumes on average more energy per m² than a collective dwelling, and dwelling stock structure is substantially different from one country to another. BOSEBOEUF, supra note 7, at 34.
54 Many buildings in New York City, particularly multiunit apartments and office buildings, use forced hot water or steam systems for heating. These systems use a boiler to heat water—the resultant hot water or steam flows through pipes to baseboard or free-standing radiators in each room. See generally Chapter 2: Boiler 101, in THE BOTTOM OF THE BARREL, http://www.edf.org/sites/default/files/10087_EDF_BottomBarrel_ch2.pdf.
55 See Nick Banks, Socio-technical Networks and the Sad Case of the Condensing Boiler, in ENERGY EFFICIENCY IN HOUSEHOLD APPLIANCES AND LIGHTING 141, 142 (2001).
56 See ENERDATA FOR ADEME, supra note 49, at 13).
represents over a third of the total housing stock.\textsuperscript{57} According to the SHAERE database,\textsuperscript{58} the mean energy value of the social dwellings in the Netherlands was a D, a mediocre grade on the Dutch energy efficiency scale.\textsuperscript{59}

The Netherlands’ success is due in part to stringent requirements for energy efficiency in existing dwellings, beginning in the 1970s.\textsuperscript{60} Indeed, the Netherlands has instituted the greatest number of thermal regulations in the EU over the past 30 years, with eight updates.\textsuperscript{61} Additionally, the National Program for the Insulation (NPI) of existing dwellings (1978 to 1987)\textsuperscript{62} applied to 2.5 million dwellings,\textsuperscript{63} 60 percent of the total dwellings at the time.\textsuperscript{64} On top of that, building code enforcement in the EU, which is generally a local-level responsibility and therefore varies among

\textsuperscript{57} See Marja Elsinga & Frank Wassenberg, Social Housing in the Netherlands, in SOCIAL HOUSING IN EUROPE 130, 130 (Christine Whitehead & Kathleen Scanlon eds., 2007).

\textsuperscript{58} The Social Rented Sector Audit and Evaluation of Energy Saving Results (SHAERE, as translated from the Dutch), “is a collective database, operational since 2010, which contains the dwellings of the participating housing associations.” NL The Netherlands - Scenario Results and Monitoring Approaches, EPISCOPE, http://episcope.eu/monitoring/case-studies/nl-the-netherlands/ (last visited Dec. 31, 2016).

\textsuperscript{59} See id. The energy performance ratings of the social housing stock in the Netherlands were based on SHAERE data produced between 2011 and 2013. See MARINA ECONOMIDOU, OVERCOMING THE SPLIT INCENTIVE BARRIER IN THE BUILDING SECTOR, JRC SCIENCE AND POLICY REPORTS, WORKSHOP SUMMARY, REPORT EUR 26727 EN, at 13 (2014). The Netherlands has a different energy labeling system with respect to the rest of the EU countries because the Dutch government has refused to implement the EU Directives that regulate this matter, for political and economic reasons. See generally ENERGYCLAIM, http://www.energyclaim.nl/english/ (last visited Dec. 14, 2016).


\textsuperscript{61} See id. at 11.

\textsuperscript{62} The NPI focused on existing buildings in the Netherlands. The activities developed under it were mainly: “grants for insulating existing homes; loans for the insulation of residential buildings; financial assistance for setting up an insulation plan; promotion of boilers installation; and several educational programs.” See ENERDATA FOR ADEME, supra note 49, at 34.


\textsuperscript{64} SCHWARZ, supra note 60, at 16.
states, is systematic in northern countries.65

The NPI provided subsidies for insulating techniques, covering 91 percent of total costs.66 Until 1980, the subsidy per dwelling could only be 30 percent of the investment, and dwellings without central heating could also apply for the subsidy.67 Thanks to a “special type of loan in cooperation with the banks,”68 which included “the cost for the organization and the execution of the program,” the subsidized housing corporations invested in the improvement of their isolation systems.69 It was decided that the Association of Dutch Municipalities would become members of the organizing committee.70 Although the NPI did not yet include a labeling requirement, it gave consumers a substantial cut in their annual natural gas expenditures.71

After the NPI, other policies were implemented. The Building Code (1992) introduced a requirement for the minimal thermal resistance of buildings.72 A total energy consumption limit was later included in the Building Code in 1995, using the so-called Energy Performance coefficient,73 comprising “space and water heating, ventilation, lighting, cooling, and renewable generation.”74 During the following years, the coefficient was reduced and the energy quality of new buildings improved.75 The Energy Performance Certificate was introduced after the European Energy Performance of Buildings Directive of 2002 (EPBD).76 This energy label grades the energy performance of a dwelling using a scaled score from A to G, and should be compulsory in the Netherlands (as in the rest of the EU countries) for homes that are on the market.77 Finally, the National Energy Saving Plan (2008–2020) was prepared “to reduce energy consumption in the built

65 See Levine et al., supra note 44, at 58.
66 See Schwarz, supra note 60, at 16.
67 See Entrop, supra note 63, at 146.
68 Id. at 147.
69 Id.
70 See id. at 146–47.
71 See id. at 149.
72 See id.
73 See id.
74 Id.
75 See id.
77 See Entrop, supra note 63, at 150.
environment" with a set of measures aimed at improving energy efficiency, and with them, the obligations derived from the EU Directives. However, the European Commission initiated two procedures against the Dutch government for failure to comply with their obligations with respect to the proper implementation of the EPBD.

High energy prices also led to a decrease in energy use. In 1996, an energy tax on the use of electricity and natural gas was put into place to encourage people to use less energy, more efficiently. It was generally effective, but also had its failings. On top of the social problems this type of measure could generate, tax rates for electricity and natural gas were higher than the environmental costs they generated, whereas in the case of fuel oils, rates were lower than the environmental cost. A tax reform is aimed at solving these inconsistencies.

b. New York City

Although just one percent of the total building stock in NYC burns heavy fuel oil, it contaminates more than the city’s road transport sector. The Clean Heat Plan, Local Law 43 (2010),

---

78 Id.
82 One such problem is so-called “energy poverty,” which occurs when a household cannot afford the cost of energy for everyday life. STEVE PYE & AUDREY DOBBINS, ENERGY POVERTY AND VULNERABLE CONSUMERS IN THE ENERGY SECTOR ACROSS THE EU: ANALYSIS OF POLICIES AND MEASURES 1 (2014). It is specifically defined as “the inability to secure a socially and materially necessitated level of domestic energy services (heating, lighting, cooling, and so on).” Id. at 22.
and other state legislation regulating heating oils (No. 4 and No. 6 grades)\textsuperscript{87} were put in place to address the public health hazard presented by the burning of these fuels,\textsuperscript{88} which emit sulfur dioxide (SOx) and fine particulate matter (PM 2.5).\textsuperscript{89} Under the new local rule, new boilers or burner installations had to switch immediately from No. 6 or No. 4 oils to cleaner fuels, such as ultra-low sulfur No. 2 oil, biodiesel, natural gas, or steam power.\textsuperscript{90} Also, existing buildings using No. 6 oil had to convert by 2012 to a cleaner fuel before their three-year certificates of operation expired—resulting in a full phase-out of No. 6 oil by mid-2015.\textsuperscript{91} Finally, boilers not replaced by 2030 would need to be modified to meet the new regulations.\textsuperscript{92}

To accomplish this, the Clean Heat Plan provides technical assistance and information about financing and incentives. A number of financing solutions are currently available in the marketplace in partnership with financial institutions and other private and public entities.\textsuperscript{93} Several incentives and rebates have also been developed for buildings to convert to cleaner fuels.\textsuperscript{94} 

\textsuperscript{86} The NYC Clean Heat Program provides technical and financial assistance to property owners to convert to cleaner fuels at a faster pace than required by regulation. See \textit{Welcome to NYC Clean Heat}, NYC CLEAN HEAT, https://www.nyccleanheat.org/ (last visited Dec. 15, 2016).


\textsuperscript{88} Just 1\% of all buildings in the city produce 86\% of the total soot pollution from buildings—more than all the cars and trucks in New York City combined. They do this by burning the dirtiest grades of heating fuel available, known as residual oil, or No. 6 and No. 4 heating oil. See \textit{Heating Oil Regulations}, NYC MAYOR’S OFFICE OF SUSTAINABILITY, http://www.nyc.gov/html/gbee/html/codes/heating.shtml (last visited Dec. 31, 2016).

\textsuperscript{89} See \textit{Program Progress}, NYC CLEAN HEAT, https://www.nyccleanheat.org/content/program-progress (last visited Nov. 19, 2015).

\textsuperscript{90} See \textit{Heating Oil Regulations}, supra note 88.

\textsuperscript{91} See \textit{id}.

\textsuperscript{92} See \textit{id}.

\textsuperscript{93} For a list of financing entities, see \textit{Financing}, NYC CLEAN HEAT, https://www.nyccleanheat.org/content/financing (last visited Nov. 1, 2016).

\textsuperscript{94} Such incentives include: i) discounted service contracts or group buying discounts, among other offers, to encourage buildings to convert from No. 6 or No. 4 heating oil to ultra-low sulfur No. 2 heating oil with biodiesel, ii) tax credits against personal income or franchise taxes for the purchase of biodiesel fuel for residential space and water heating, and iii) customized plans, such as Con Ed’s, to assist customers with the necessary capital to convert to natural gas, or National Grid’s, to cover up to 50\% of conversion cost for business and multifamily customers switching from heating oil to natural gas. See \textit{Incentives},
Other incentives are intended to save money through incorporating energy efficiency measures at the same time.95

Regulation has significantly pushed down the levels of SOx emitted from all types of oils since the launch of the PlaNYC (69% from 2008 to 2013). Even so, reducing PM 2.5 emissions requires the initiative of individual buildings to the switch to cleaner energy sources.96 However, the difficulty of tightening building regulations shows that fulfillment of the objectives entails challenges.97 Hence, contractor and building manager education efforts should be unequivocal about the benefits of the energy efficiency improvements.

2. Water Heating

Water heating represents around 13 percent of EU household energy consumption.98 Energy consumption for water heating per dwelling has decreased in most EU countries since 1997, excepting Spain, Cyprus, Belgium, Slovenia, and Hungary.99 In the United States, water heating represents 18 percent of total energy consumption; in the state of New York, it is 17 percent (2009 data).100

a. Sweden

Impressively, from 1997 to 2009, Sweden reduced its water heating energy consumption by more than half.101 The growth of

NYC CLEAN HEAT, https://www.nyccleanheat.org/content/incentives (last visited Dec. 31, 2016).
95 Con Edison, National Grid, NYSERDA, and the New York State Weatherization Assistance program offer energy efficiency upgrade initiatives. See id.
96 Indeed, SOx levels and PM 2.5 emissions have been reduced by 69% and 23%, respectively, during the period ranging from 2008–2013. See Program Progress, supra note 89.
98 See LEVINE ET AL., supra note 44, at 46.
101 See BOSSEBOEUF, supra note 7, at 36.
biomass energy and the use of heat pumps dramatically changed the heating sector in Sweden.102 Likewise in the electricity sector, hydropower and nuclear have taken on leading roles in the energy mix, and wind power is gaining ground.103 The main policy measures in Sweden are general economic instruments, which provide financial incentives aimed at cost-effective solutions and promote competition between technologies. These include CO₂ and energy taxation, emissions trading, and tradable green certificates for renewable electricity. The economic instruments are complemented with other measures, such as research, development, demonstration efforts, and information efforts meant to influence consumer behavior.104

Throughout the EU, solar energy has been promoted as a substitute for conventional energy sources currently used for water heating, especially in southern countries that have good solar radiation.105 At first, the EU states received financial incentives (subsidies or soft loans) and fiscal incentives (tax credits).106 More recently, mandatory regulations for the installation of solar heaters in new buildings have been enacted in countries like Spain.107 Around 85 percent of dwellings in Cyprus have solar heaters; 35 percent in Greece; 17 percent in Austria; and 11 percent in Malta.108 The most significant progress has been observed in Greece, Malta, and Austria. Indeed, Austria is the benchmark for most medium solar radiation countries.109

---

102 To date, “the heating sector in Sweden—to a large extent, district heating—is practically fossil fuel free as a result of the increased use of biomass and heat pumps.” Sweden (2013), REEGLE, http://www.reegle.info/policy-and-regulatory-overviews/SE (last visited Nov. 20, 2015).
103 More than “47% of all energy that is used in Sweden comes from renewable energy sources,” according to 2009 data. Id.
105 See Bosseboeuf, supra note 7, at 36.
106 See id. at 37.
107 See Real Decreto (R.D.) 1027/2007, de 20 de Julio, que aprueba el Reglamento de Instalaciones Térmicas en los Edificios (approving the Thermal Installation Regulation in buildings).
108 See Bosseboeuf, supra note 7, at 36.
b. **New York City**

Many buildings in NYC use forced hot water or steam systems for heating powered by fuel oil or natural gas. As indicated before in Section II(A)(1)(b), even though only 1 percent of NYC buildings use dirty oil (No. 4 and No. 6), that small subset produces around 85 percent of all pollution coming from buildings.\(^{110}\) This disproportion applies not just to space heating but also to water heating, as those buildings use fuels for all heating purposes. Despite the improvements already accomplished in this regard by the Clean Heat program,\(^{111}\) the city is trying to go further by developing a series of energy initiatives including one that makes it easier for solar arrays to return power to the grid.\(^{112}\) It should be noted, though, that per a 2013 report,\(^{113}\) solar heating is still underdeveloped in NYC relative to energy efficiency goals. Consequently, the “Clean Heat” initiative has been crucial to achieve the shift from dirty oils to cleaner fossil fuels, such as natural gas or No. 2 oil, in the city’s existing building stock.\(^{114}\)

3. **Heating Analysis**

It seems that enforcement of existing thermal (space and water heating) regulations; implementation of high subsidies that include all costs of the investment chain; and implementation of some economic instruments that have proven effective in Europe (like the Energy Performance Certificate for homes and appliances) might contribute to the already successful space and water heating improvement measures in NYC. Particularly interesting are the firm Swedish commitments to a carbon tax.\(^{115}\)

\(^{110}\) See Heating Oil Regulations, supra note 88.

\(^{111}\) See Welcome to NYC Clean Heat, supra note 86.

\(^{112}\) This includes “a recent proposal to encourage solar development by broadening the terms under which solar arrays can feed unused power back to the electric grid.” CITY OF NEW YORK, PLANYC PROGRESS REPORT 2013, at 38 (2013), http://www.nyc.gov/html/planyc/downloads/pdf/publications/planyc_progress_report_2013.pdf.

\(^{113}\) As indicated by the Mayor’s Office, “in 2011 ‘roughly 10,000 of [NYC’s] largest buildings use[d] residual fuel oil, a viscous fuel that is nearly as dirty as coal,’ which causes 86% of soot pollution from NYC buildings.” MEISTER CONSULTANTS GROUP, NEW YORK CITY SOLAR WATER HEATING ROADMAP, at iii (2013), http://www.cuny.edu/about/resources/sustainability/solar-america/solarthermal/CUNY_NYC_Solar_Thermal_FINAL.pdf.

\(^{114}\) See Program Progress, supra note 89.

\(^{115}\) According to a study on the Swedish carbon tax published by the OECD, almost 90% of CO\(_2\) emissions reductions resulted from the reformed tax system,
and to innovation and technology promotion. Although a carbon tax would be a resounding and clear measure,\textsuperscript{116} it is still very controversial, not only in the United States but in most EU countries.

B. Cooling

1. Air Conditioning

There is a very strong relationship between air temperature and electricity consumption for air conditioning by households, although other factors, such as income level, are also determinative.\textsuperscript{117} Air conditioning (AC) units have been in widespread use in U.S. households for decades.\textsuperscript{118} Conversely, only more recently has AC started to proliferate in Europe.\textsuperscript{119} Even though the technology is spreading rapidly, it has had a negligible impact on energy demand, due to the mild climatic conditions in whereas the remaining 10% resulted from investment grants and official programs on energy efficiency. See BENGT JOHANSSON, SWEDISH ENV'TL PROT. AGENCY, ECONOMIC INSTRUMENTS IN PRACTICE 1: CARBON TAX IN SWEDEN, http://www.oecd.org/sti/inno/2108273.pdf; see also INT'L ENERGY AGENCY, ENERGY POLICIES OF IEA COUNTRIES: SWEDEN (2013). http://www.iea.org/textbase/nppdf/free/2013/sweden2013_excerpt.pdf (another interesting study on Swedish energy policy and climate change).

\textsuperscript{116} As recently noted by Michael B. Gerrard, “[a]lmost all economists agree that the best way to fight climate change is through a price on carbon, either through a carbon tax or a cap and trade system.” Michael B. Gerrard, CHALLENGES TO EPA’S PROPOSED CARBON RULES: WHAT IF THEY SUCCEED?, HUFFINGTON POST (Sept. 4, 2014, 6:57 PM), http://www.huffingtonpost.com/michael-b-gerrard/challenges-to-epas-propos_b_5698336.html.


\textsuperscript{118} In the United States, AC systems use about 5% of the electricity produced in the country, costing homeowners more than $11 billion a year. See ENERGY SAVER: AIR CONDITIONING, U.S. DEP’T OF ENERGY, http://energy.gov/enermysaver/air-conditioning. According to data released in 2011, 87% of all U.S. homes have an AC device. See RESIDENTIAL ENERGY CONSUMPTION SURVEY, U.S. ENERGY INFO. ADMIN., https://www.eia.gov/consumption/residential/reports/2009/air-conditioning.cfm. In New York, 53% of households have “individual window or wall air conditioning units,” and around 20% have installed “a central air conditioning system.” NEW YORK STATE ENERGY PROFILE, U.S. ENERGY INFO. ADMIN., http://www.eia.gov/state/?sid=NY.

\textsuperscript{119} See generally GEORGE HENDERSON, HOME AIR CONDITIONING IN EUROPE: HOW MUCH ENERGY WOULD WE USE IF WE BECAME MORE LIKE AMERICAN HOUSEHOLDS? (2005).
most EU countries.\textsuperscript{120} However, in recent years, there has been a rise in European average energy consumption for cooling, especially in southern countries (Italy, Spain, Malta, Cyprus, and Greece).\textsuperscript{121} The number of AC units is expected to rise by 70 million in Europe by 2020, which will lead to an energy consumption increase of 75 terawatt-hours per year.\textsuperscript{122} Also, due to the great amount of electricity they use and the coolants they contain, AC units contribute greatly to climate change.\textsuperscript{123} Therefore, it is worth addressing AC devices separately from the rest of electricity appliances.

a. \textit{European Union}

Directive 2002/91/EC, recast as Directive 2010/31/EU on energy efficiency of buildings, responded to this growth trend by requiring regular inspection of heating and cooling systems to ensure a minimum standard of energy efficiency.\textsuperscript{124} Directive 2009/125/EC, regarding ecodesign requirements for energy related products, including air conditioners and comfort fans, was also amended in order to curb this trend.\textsuperscript{125} Indeed, thanks to efficiency

\textsuperscript{120} See \textit{id}.

\textsuperscript{121} By far the largest market for air conditioning in the EU is Italy with 33\% of EU sales, followed by Spain (21\%), and Greece (13\%). \textit{EUROPEAN COMM’N, FULL IMPACT ASSESSMENT: PROPOSAL FOR A COMMISSION REGULATION IMPLEMENTING DIRECTIVE 2009/125/EC 11 (2012), https://ec.europa.eu/energy/sites/ener/files/documents/en_impact_assesment.pdf}. These three countries combined form two thirds of the EU market for air conditioning appliances. See \textit{id}. Since Greece is close to its expected maximum saturation, the main growth for the coming years will come from large markets such as Italy and Spain, unsaturated markets like France and the United Kingdom, and the northern European countries (a market for AC appliances that include a heating function). See \textit{id}.


\textsuperscript{123} Leading scientists in the field recently calculated that up to 27\% of the increase in global warming between 2010–2050 could be attributed to hydrofluorocarbons (HFCs), a substance used in AC units. \textit{See Guus J.M. Velders et al., Preserving Montreal Protocol Climate Benefits by Limiting HFCs, 335 SCIENCE MAGAZINE 922, 922 (2012).}


improvements (helped by the labeling mechanism established by Directive 2010/30/EU), the rate of household energy consumption per dwelling has decreased consistently since 2000 in the EU as a whole and in most EU countries individually.126 The economic recession also played a role in the decline since 2008.127 However, in 10 member states (mostly southern countries), the recession has not affected the increase in air conditioning consumption,128 because previous to the crisis, those countries had reached higher comfort levels that were difficult to modify once established. Lastly, Regulation (EU) No 517/2014, on fluorinated GHG (F-gas), and the repeal of Regulation (EC) No 842/2006, strengthened the existing measures and introduced a number of far-reaching changes, so that by 2030 the EU’s F-gas emissions will be cut by two-thirds compared with 2014 levels.129

AC products are similar in all EU member states. Most (55–75 percent)130 are split speed inverter AC devices, considered “today’s best available technology.”131 Thanks to regulation, mainly the new energy label requirements,132 the increasing use of AC in Mediterranean countries has an important counterweight. The implementation of the energy label, together with a subsidy policy for replacing old and inefficient AC units with the best available technology, is key to improving cooling energy efficiency.133

In the same vein, the European Commission has supported collaborative projects to demonstrate the potential of building requirements that minimize the need for cooling through passive means,134 including provisions for shading and additional

126 See INTELLIGENT ENERGY EUROPE, supra note 47, at 36.
127 See id.
128 See id.
130 See MICHEL ET AL., supra note 122.
131 Id.
132 Id.
133 See generally JEROME ADNOT, ENERGY EFFICIENCY OF ROOM AIR CONDITIONERS (1999); JEROME ADNOT, ENERGY EFFICIENCY AND CERTIFICATION OF CENTRAL AIR CONDITIONERS (2003).
134 The term passive building comprises both a set of design principles (or a design
ventilation in the summer.

The Passive House (Passivhaus, in German) is the oldest voluntary standard for super-efficient buildings in Europe and refers to a rigorous, voluntary standard for energy efficiency in a building.\textsuperscript{135} It contains the most stringent standards with regard to heating requirements, which prescribe a heating load (assuming a uniform indoor temperature of 20°C) of no more than 15 kilowatt-hours per square meter per year, irrespective of the climate.\textsuperscript{136}

The Fifth Assessment Report of the Intergovernmental Panel on Climate Change noted that “principles of low-energy design” can be used “to provide comfortable conditions as much of the time as possible, thereby reducing the pressure to later install energy-intensive cooling equipment, such as air conditioners.”\textsuperscript{137} Low-energy design principles have long inspired vernacular and passive house designs—the hallmark of which is a lack of “modern” heating and cooling systems.\textsuperscript{138}

b. \textit{New York City}

In NYC, in order to meet the city’s goal of reducing GHG emissions by 80 percent by 2050, the NYC Energy Conservation Code (NYCECC)\textsuperscript{139} sets energy-efficiency standards for new buildings and for the renovation of the existing ones, with the methodology) and a quantifiable performance standard that can be implemented in all building types (not only houses, but also apartment buildings, office buildings, schools, etc.). Buildings that meet the standard use dramatically (up to 80\%) less energy than conventional code buildings, and provide greater comfort and excellent indoor air quality.


\textsuperscript{135} “The Passivhaus idea is simple. A house insulated to the highest standards does not actually need a central heating system. Even in the depths of winter, it can be kept warm by capturing energy from the sun and from the heat given off by the people and electrical appliances it contains.”\textsuperscript{136} CHRISS GOODALL, \textit{TEN TECHNOLOGIES TO SAVE THE PLANET: ENERGY OPTIONS FOR A LOW-CARBON FUTURE} 132 (2010). “In hot climates, Passivhaus construction can help dramatically reduce the need for electric air conditioning.”\textsuperscript{137} \textit{Id.}

\textsuperscript{136} See \textit{id.}

\textsuperscript{137} WORKING GROUP III, \textit{INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, CLIMATE CHANGE 2014: MITIGATION OF CLIMATE CHANGE} 695 (2014) [hereinafter WORKING GROUP III 2014].

\textsuperscript{138} See \textit{id.}

purpose of: a) making sure buildings are correctly insulated from foundation to rooftop; b) using efficient lighting fixtures and creative designs that let in natural light to reduce energy consumption; and c) using “recycled energy” to further reduce energy consumption.  

The City Housing Maintenance Code and State Multiple Dwelling Law in NYC require building owners to provide heat and hot water to all tenants between October 1st and May 31st, but no regulation exists regarding the use of AC, only comfort guidelines.

2. Building Design

There is ample room for improvement in the field of AC—as in any technology—and the opportunity to reduce energy consumption without affecting the service offered. With future technological improvements and the possible adoption of correct habits of use (behavioral measures) and building design (“vernacular” and “passive house” standards), on top of regulation, energy efficiency measures in cooling systems can be more effective. Traditional principles of building design can be summarized in three essential principles: minimizing solar radiation, lowering heat loads, and improving ventilation.

Cooling demand depends precisely on the right execution of these principles and can be achieved with proper insulation of roofs,

---

140 Energy Efficiency, NYC Buildings, https://www1.nyc.gov/site/buildings/homeowner/energy-efficiency.page (last visited Dec. 15, 2016). The city defines “recycled energy” as including the use of “furnaces and air conditioning units that are sized appropriately for the size of your home.”

141 N.Y.C. Admin. Code § 27-2029 (2006). During the day (6 a.m. to 10 p.m.), when the outdoor temperature falls below 55° F, the minimum indoor temperature is required to be at least 68º F. At night (10 p.m. to 6 a.m.), when the outdoor temperature falls below 40° F, the minimum indoor temperature is required to be at least 55° F. Id.


144 See GOODALL, supra note 135.

walls, floor, and windows, as well as with good ventilation.\textsuperscript{146}

\textbf{a. European Union}

A 2012 study on the impact of Directive 2010/31/EU concluded that “in moderate climatic zones insulation has no significant effect [on] the cooling demand and therefore should only receive attention after the needs of reducing the heating demand are fulfilled.”\textsuperscript{147} Indeed, simple measures such as “efficient shading systems, lowered internal gains and . . . adaptive ventilation strateg[ies]” can easily lower the energy demand for cooling in regions with moderate temperatures.\textsuperscript{148} According to the same study, insulation plays a key role in the reduction of the cooling demand in warm climatic zones.\textsuperscript{149} As mentioned before, NYC’s summers are very hot and humid, similar to some Mediterranean cities, like Madrid or Athens, in terms of temperature.\textsuperscript{150} Hence, for those cities, the cooling demand can be drastically reduced by a combination of lowering the heat loads and ameliorating the insulation of dwellings:

- \textit{Shading devices} can reduce heat loads, by combating heat gain, preventing glare, and decreasing cooling energy requirements. However, the requirements are sometimes hindered by zoning regulations.\textsuperscript{151}
- \textit{Façade insulation}, in the case of an office building in warm weather, does not have a positive effect because the internal heat load of the building compared to a

\begin{footnotesize}
\begin{itemize}
\item \textsuperscript{147} See Petersdorff, supra note 109, at 28. According to the study, “these results for the moderate climatic zone are fully transferable to the cold zone.” \textit{Id.}
\item \textsuperscript{148} See \textit{id.} The energy released by people, machines, lighting and other sources that are not part of the heating system are “internal gains,” which can have a profound effect on the indoor climate and need to be controlled. \textit{Internal Gains Control, Comfortable Low Energy Architecture}, http://new-learn.info/packages/clear/thermal/buildings/active_systems/internal_gain.html (last visited Jan. 25, 2015).
\item \textsuperscript{149} See Petersdorff, supra note 109, at 28.
\item \textsuperscript{150} See Climate Change and Water Resources 146 (T. Younos & C.A. Grady eds., 2013).
\item \textsuperscript{151} See Urban Green Council, Increase Allowable Size of Solar Shades 1, http://urbangreencouncil.org/sites/default/files/a15U0000000LG LHlAK1388005367.pdf (a proposal to amend the NYC Zoning Resolution and NYC Building Code, with respect to “sun control device[s]”).
\end{itemize}
\end{footnotesize}
residential building is still relatively high. Internal heat gains must be extracted either by ventilation or by wall transmission. On the other hand, roof insulation still has a positive effect on cooling demand with high heat loads.152

- **Roof insulation** is a very efficient measure to minimize cooling demand, by reducing heat transmission and solar radiation. If the heat load is high, insulation can reduce the cooling demand by around 15 percent, but if heat load is low, the reduction can rise to 85 percent.153 In the case of an office building, roof insulation can result in a 24 percent reduction of cooling energy demand in spite of high internal loads.154 For cities like Athens or Madrid, the effectiveness of additional roof insulation increases: with a hotter climate and lower heat loads inside the building, the benefit of insulation on the reduction of cooling energy demand grows.155

- **Floor insulation**, on the contrary, causes an increase in cooling demand due to the avoidance of earth coupling.156

Therefore, a combination of measures is essential to reduce the cooling demand of a dwelling in a warm climate.

b. **New York City**

In 2009, as part of PlaNYC, NYC launched the °CoolRoofs° initiative aimed at promoting and facilitating the cooling of NYC’s rooftops through a public-private partnership.157 It is designed to cool one million rooftops in NYC by applying a reflective surface to the roof to help reduce cooling costs, cut energy usage, and

---

152 See Petersdorff, supra note 109, at 25.
153 See id. at 23, 28.
154 See id. at 25.
155 See id. at 24–25, 28.
156 See Dictionary of Construction.com, http://www.dictionaryofconstruction.com/definition/earth-coupling.html (last visited Aug. 16, 2014) (“[t]he practice of building into the ground to take advantage of the vast thermal mass of the earth, which typically remains a constant temperature at a certain depth below grade (depending on the climate)”). Id.
lower GHG emissions.\textsuperscript{158}

The capacity to keep cool is strongly affected by a building’s design (applicable not only to new but also to refurbished buildings), which may be more amenable to the usual forms of policy intervention. In warmer climates, vernacular architecture “tends to incorporate features that are effective in limiting high temperatures in summer,”\textsuperscript{159} such as passive house components, or green roof practices, which are very extensive in northern Europe.\textsuperscript{160}

NYC is also looking to passive house design, carbon neutral, or “zero net energy” strategies to inform the energy standards, as well as exploring innovative technologies to improve the energy performance of building appliances. Examples of these are: a) Knickerbocker Commons, the first mid-sized apartment building designed to passive house standards in the United States (located in Brooklyn, New York), and b) the promotion of “liquid desiccant air conditioning for AC appliances, which dehumidifies and cools simultaneously and cuts conditioning loads by half or more,” but that technology is still very new.\textsuperscript{161}

3. Cooling Analysis

As indicated before, space heating is the main energy use in NYC—at 56 percent, it is greater than the U.S. average.\textsuperscript{162} The energy use for AC devices in NYC represents only 1 percent of total energy use (compared to the 6 percent U.S. average).\textsuperscript{163} However, researchers have shown that there is great room for energy and financial savings in the use of cooling devices in the

\textsuperscript{158} See id.
\textsuperscript{159} HENDERSON, supra note 119, at 548.
\textsuperscript{160} Traditionally, turf roofs were extensively used in the north of Europe, but later on their popularity decreased. See GREENROOFGUIDE.CO.UK, http://www.greenroofguide.co.uk/what-are-green-roofs/ (last visited Jan. 13, 2015). Current green roof practices were promoted in Germany during the 1970s and 1980s, thanks to new technology applied to roofing and waterproofing. See id. New legislation helped the progression of the measure and by 2001, 43% of German cities had some incentive for this practice. See id. Also, other European countries, such as Switzerland and Austria, followed the same progression, and more recently, the green roof fever arrived in Canada, parts of the United States, Japan, and Singapore. See id.
\textsuperscript{161} See ONE CITY BUILT TO LAST, supra note 27, at 38, 92.
\textsuperscript{162} See U.S. ENERGY INFO. ADMIN., supra note 100.
\textsuperscript{163} See id.
city. 164 One example of a recent effort to achieve such savings is Intro 850, “an amendment to Local Law 38 that requires [stores and commercial buildings over 4,000 square feet] to post a notice that informs onlookers that an open door to an air conditioned space can be reported to 311.”165

It is clear that there has been progress, especially with respect to cultural and behavior standards, but there is still much to be done. Key policy recommendations include the use of a mandatory and clear energy label for AC devices, and the promotion of subsidies for the substitution of old and inefficient AC units for best available technology. Additionally, the use of passive house standards should be always considered when a building is going through major renovation. Finally, all regulations should be enforced rigorously.

C. Appliances and Lighting

Lighting represents around 10.5 percent of residential electricity consumption in the EU, and it is the third highest consumer household use of electricity, after heating and cooling appliances. 166 Some differences among countries exist, depending mainly on their annual usage of lighting. 167 Electricity consumption in NYC homes is much lower than the U.S. average, because many households use other fuels for major energy end uses like space heating, water heating, and cooking. 168

1. European Union

Until 2002, the consumption of electricity per dwelling in the EU increased 1.4 percent per year; since then, it has decreased by 0.2 percent per year, with particularly severe declines in Cyprus, Croatia, and Ireland due to the economic recession. 169 However, in some other EU countries (mostly southern countries), the effects of

---

166 See PAOLO BERTOLDI & BOGDAN ATANASIU, ELECTRICITY CONSUMPTION AND EFFICIENCY TRENDS IN EUROPEAN UNION 37 (2009).
167 See BOSSEBOEUF, supra note 7, at 45.
168 See U.S. ENERGY INFO. ADMIN., supra note 100.
169 See INTELLIGENT ENERGY EUROPE, supra note 47, at 46.
the financial crisis have not impeded the increase in household electricity consumption, primarily because of the rise of AC use.\textsuperscript{170}

The energy consumption of electrical appliances increased until 2007, after which it started to gradually decrease.\textsuperscript{171} On the one hand, there has been an improvement of the energy performance of large appliances,\textsuperscript{172} due to the implementation of the previously enumerated energy efficiency policies in Sections I(B) and I(C). In the EU, almost 10 percent of refrigerator, washing machine, and dishwasher sales are of highest-efficiency A-class appliances, rising to around 40 percent in the Netherlands and 45 percent in Germany in 2009.\textsuperscript{173} Nevertheless, important efficiency potential remains unrealized, especially for refrigerators.\textsuperscript{174} Also, energy efficiency based reductions of large appliance energy consumption have been offset by an increase in ownership.\textsuperscript{175} Additionally, small appliances have proliferated in most European countries following the economic crisis.\textsuperscript{176} Therefore, the strongest lighting consumption growth occurred for small appliances (almost 5 percent per year, on average).\textsuperscript{177}

The specific consumption per dwelling for lighting has decreased since 2000, in half of the EU countries and in the EU on average, due to the diffusion of Compact Fluorescent Lamps and Light Emitting Diode Lamps (CFLs and LEDs); it decreased by 35 percent in Sweden, about 30 percent in France and the United Kingdom, about 20 percent in the Netherlands and the Czech Republic, and 17 percent in EU on average.\textsuperscript{178} Indeed, CFLs represent one of the most efficient solutions available today for improving energy efficiency in residential lighting.\textsuperscript{179} The recent

\begin{footnotesize}
\begin{footnotes}
\item \textsuperscript{170} See id. at 36.
\item \textsuperscript{171} See id. at 43.
\item \textsuperscript{172} These include refrigerators, freezers, washing machines, dishwashers, dryers, and televisions.
\item \textsuperscript{174} See BERTOLDI & ATANASIU supra note 168, at 83.
\item \textsuperscript{175} See INTELLIGENT ENERGY EUROPE, supra note 47, at 41, 46.
\item \textsuperscript{176} See id. at 43.
\item \textsuperscript{177} See id.
\item \textsuperscript{178} See id. at 45.
\item \textsuperscript{179} The level of consumption depends not only on the lamps’ efficiency (i.e. the penetration of CFLs), but also on the number of lighting points per dwelling. See INTELLIGENT ENERGY EUROPE, supra note 47, at 48.
\end{footnotes}
\end{footnotesize}
drop in price, along with several informational and promotional campaigns, has had a positive impact on sales.\textsuperscript{180} Also, specific national policies and measures were implemented in member states, such as the white certificate\textsuperscript{181} schemes in the United Kingdom and Italy.\textsuperscript{182} With the Ecodesign Directive (2009), a phasing out of incandescent bulbs was implemented until 2012.\textsuperscript{183} LEDs, an even more promising lighting technology than CFLs, are considered A-class lamps in the Ecodesign Directive.\textsuperscript{184}

Information and Communication Technologies (ICTs) are among the fastest growing electricity end-uses in the residential and tertiary sector, currently growing at around 4 percent per year.\textsuperscript{185} The most advanced countries in ICT are the northern EU countries: Sweden tops the index, followed by Denmark, the Netherlands, Iceland, Luxembourg, Switzerland, Finland, and the United Kingdom.\textsuperscript{186}

With respect to electricity consumption of televisions (TVs), the European Commission adopted the Commission Regulation implementing the Ecodesign Directive for the requirements for TVs in July 2009,\textsuperscript{187} demanding a minimum energy performance by 2010 that is 20 percent more efficient for standard TVs and 30 percent more efficient for full-HD sets.\textsuperscript{188} Savings could reach 43 terawatt-hours per year by 2020 if the targets are met.\textsuperscript{189} It is estimated that electricity consumption in European households will


\textsuperscript{181} “White certificates,” or “Energy Efficiency Certificates,” are “tradable instruments giving proof of the achievement of end-use energy savings through energy efficiency improvement initiatives and projects.” \textit{See White Certificates, GESTORE SERVIZI ENERGETICI}, http://www.gse.it/en/White%20Certificates/Pages/default.aspx (last visited Oct. 14, 2016).

\textsuperscript{182} \textit{See BERTOLDI}, supra note 166, at 38.

\textsuperscript{183} \textit{See id. at 38.}

\textsuperscript{184} \textit{See id. at 39.}

\textsuperscript{185} \textit{See id. at 40.}

\textsuperscript{186} \textit{See id. at 41.}


\textsuperscript{188} \textit{See BERTOLDI}, supra note 166, at 40.

\textsuperscript{189} \textit{Id. at 46.}
keep rising as the “equipment for the reception, decoding, and interactive processing of digital broadcasting and related services” continue its growth, adding another problem for EU environmental policies.190

With respect to the tertiary sector, commercial indoor lighting and street lighting consume the largest amount of electricity (21.6 percent and 26.3 percent, respectively), followed by “electric space and water heating systems,” with a share of 19.7 percent, and, to a lesser extent, ventilation (12.7 percent) and commercial refrigeration (8.7 percent).191

The improvement of the energy performance of electrical appliances and equipment in Germany is more profitable than in the United States,192 due to the fact that energy prices are considerably higher in Europe. But the cost-effectiveness of these measures generally causes a rebound effect, neutralizing its economic positive effects, especially in commercial buildings.193

The German Government’s Energy Concept (Energiewende) for an Environmentally Sound, Reliable and Affordable Energy Supply,194 a long-term strategy for its energy supply, specifies national efficiency goals, including an 80 percent primary energy demand reduction goal by 2050 for the building sector.195 The main objectives comprise “reducing heating demand 20 [percent] by 2020; ensuring all new buildings are climate neutral by 2020; and increasing the thermal retrofit rate to 2 [percent].”196 Also, the

190 Id. at 83.
191 Id.
192 See HERMAN AMEKE ET AL., BUILDINGS ENERGY EFFICIENCY IN CHINA, GERMANY AND THE UNITED STATES 14 (2013).
193 See id.
194 For an English translation of the strategy, see FED. MINISTRY OF ECON. AND TECH., ENERGY CONCEPT FOR AN ENVIRONMENTALLY SOUND, RELIABLE AND AFFORDABLE ENERGY SUPPLY (2010).
195 Energy efficiency is an important pillar of the Energiewende and the country has set a target of 20% reduction in primary energy consumption by 2020, and 50% by 2050 when compared to 2008. See INT’L ENERGY AGENCY, ENERGY POLICIES OF IEA COUNTRIES: GERMANY 10 (2013). According to a 2013 report of the International Energy Agency, Germany has progressed and implemented a wide range of programs across all sectors. Id. at 9–10. However, “there is much to be done if Germany wishes to meet its 2020 targets and a comprehensive assessment of the energy saving potentials and targets for the individual sectors is needed, notably, in the industry and transport sectors.” Id.
196 See AMEKE, supra note 192, at 16.
Energy Efficient Renovation Program of the KfW Bank Group provides preferential loans and grants for single energy efficient components and for comprehensive retrofits. Energy audits, Energy Performance Certificates, and billing information tools, conducted at the beginning of the energy performance improvement process, are essential to it.

Notably, policies to reduce energy consumption from equipment and devices in buildings are mostly set at the EU level, mainly with the 2010/30/EU Labeling Directive and the 2009/125/EC Ecodesign Directive. These policies facilitate an EU-wide market for more efficient technologies, setting minimum energy efficiency standards, and requiring energy performance labeling for major appliances. As a consequence, over 90 percent of refrigerators, washing machines, and dishwashers sold in 2012 had an efficiency of A class or better.

2. New York City

In NYC, the lighting and sub-metering provisions of the Greener, Greater Buildings Plan (GGBP) require buildings to upgrade their lighting by 2025, but many people are not familiar

197 KfW, a German, government-owned bank formed in 1948 after World War II as part of the Marshall Plan, was designed to assist the German economy, in general, as well as the economies of developing countries. Kreditanstalt für Wiederaufbau, ALL BANKS, http://www.allbanks.org/bank/840 (last visited Dec. 20, 2016). It lends money to small and midsized businesses and buys securitized loan portfolios from German banks to maintain the solidity of the system. It also supports investment in housing and infrastructure, the protection and preservation of the environment, and venture capital projects. See id.

198 KARSTEN NEUHOFF, FINANCIAL INCENTIVES FOR ENERGY EFFICIENCY RETROFITS IN BUILDINGS 1 (2012)

199 Interestingly, the energy audits include “desk advice provided by the German consumer association and on-site advice provided by the Agency for Economy and Export Control, BAFA,” which has “been shown to have [a] large impact.” AMEKE, supra note 192, at 16–17.

200 BOSSEBOEUF, supra note 7, at 7.


203 See LAPILLONNE, supra note 173, at 37.

204 See URBAN GREEN COUNCIL, LIGHTING UPGRADES AND SUB-METERING
with the new codes or new technologies. To overcome these barriers, NYC’s government created Green Light New York, a lighting resource center where building professionals take classes and see lighting strategies demonstrated.

Launched in 2009, the GGBP requires the city’s largest buildings to benchmark (measure and report) their energy and water use annually; to complete energy audits and retro-commissioning of building systems; and to upgrade lighting. The regulated properties constitute only 2 percent of the city’s building stock but comprise approximately 50 percent of the total built area. Assuming compliance, the Office of the NYC Mayor predicts the GGBP regulations will “reduce citywide GHG emissions by roughly 5%, result in a net savings of $7 billion, and create roughly 17,800 jobs by 2030.” But there is much yet to be done for buildings under 50,000 square feet, which constitute the other half of the city’s built area. That is the aim of the marketing campaigns included in GreeNYC to improve the


See Benchmarking Report, supra note 32, at 7.


GreeNYC is an NYC government campaign “dedicated to educating, engaging and mobilizing New Yorkers to help New York City meet its ambitious sustainability goals,” which include an 80% GHG emissions reduction by 2050. Small Steps, Big Strides, GreeNYC, https://www1.nyc.gov/site/greenyc/about/about.page (last visited Oct. 14, 2016).
energy performance of residential air conditioners and light bulbs.\textsuperscript{212}

As of April 2015, 53 out of 111 Green Codes Task Force (GCTF)\textsuperscript{213} recommendations\textsuperscript{214} have been enacted or partially enacted, including: “Increase Lighting Efficiency in Apartment Buildings” (NYC Local Law 52 of 2010); “Use Manual On - Automatic Off Lighting” (NYC Local Law 48 of 2010); “Reduce Artificial Lighting in Sunlit Lobbies & Hallways” (NYC Local Law 47 of 2010); “Increase Lighting Efficiency on Construction Sites” (NYC Local Law 51 of 2010, and NYC Local Law 18 of 2014); “Ensure Lighting Systems Function Properly” (NYC Rules, Title 1, Ch. 5000 (DOB)); and “Expand Boiler Efficiency Testing & Tuning” (NYC Rules, Title 15, Ch. 2 (DEP)), among others.\textsuperscript{215} Others, such as “Don’t Exempt Existing Buildings from Green Codes” (NYC Local Law 85 of 2009), are partially enacted.\textsuperscript{216}

3. Appliances and Lighting Analysis

As stated above in Section II(C)(2), one challenge NYC faces is a lack of information on new codes—many people are unfamiliar with them. NYC “has been called the greenest city in the United States and one of the greenest in the world,”\textsuperscript{217} but its buildings represent the greatest share of its energy consumption. Residential electricity consumption has exploded along with the population.\textsuperscript{218} Furthermore, there has been a surge in the number of electric devices in each home—over 50 percent of energy is

\textsuperscript{212} City of New York, supra note 112, at 35.
\textsuperscript{213} The GCTF is a diverse group of individuals, formed by the Urban Green Council and the NYC Mayor’s Office in 2008 to green local construction codes and regulations affecting buildings. See Case Study: Green Codes Task Force, C40 Cities (June 4, 2012), http://www.c40.org/case_studies/green-codes-task-force.
\textsuperscript{214} For the proposals, see Climate Adaptation Committee, NYC Green Codes Task Force: Full Proposals, http://urbangreen council.org/sites/default/files/greencodestaskforce_fullreport.pdf.
\textsuperscript{216} See id. (listing all enacted proposals).
consumed by uses other than heating and cooling, including electronics.219 A labeling system like Europe’s could solve this issue in a number of ways, compelling appliance owners to gradually replace less efficient devices.

D. Efficient Consumer Behavior

“[T]he need to change consumer behavior and lifestyle, based on the concept of sufficiency” is gaining in importance in energy efficiency policy development.220 Policies targeting sufficiency aim at capping or discouraging increasing energy use due to increased floor space, comfort levels, and equipment.221 This can be achieved through incentives like the feed-in tariff.222

Behavior and culture drive substantial differences in building energy use around the world. In many parts of the world, high performance mechanical cooling systems are used capriciously, mainly due to bad architectural design, the use of inappropriate materials for the climate (e.g. the overuse of glass in office buildings),223 and lifestyles based on the excessive use of disposable products (in all developed countries, but especially in the United States).224

219 See Cho, supra note 217.
220 WORKING GROUP III 2014, supra note 137, at 714.
221 See id. at 715–19.
222 According to the Regulatory Assistance Project, energy efficiency feed-in tariffs are “the obverse of energy efficiency obligations. Instead of establishing the quantity of energy savings desired and letting the market (via the obligated energy companies, or otherwise) determine the price of meeting them, they establish a price that will be paid for efficiency savings and let the market determine the quantity of savings that will be delivered.” CHRIS NEME & RICHARD COWART, ENERGY EFFICIENCY FEED-IN TARIFFS: KEY POLICY AND DESIGN CONSIDERATIONS 306 (2012), http://www.raponline.org/wp-content/uploads/2016/05/rap-nemecowart-eefitpolicydesign-2012-april-18.pdf. For more information on the use of feed-in tariffs in the United States, see Today in Energy, U.S. ENERGY INFO. ADMIN., https://www.eia.gov/todayinenergy/detail.cfm?id=11471 (last visited Dec. 2, 2015).
223 See Alex Wilson, Rethinking the All-Glass Building, BUILDING GREEN (June 29, 2010), https://www2.buildinggreen.com/article/rethinking-all-glass-building-0.
224 “In 2010, the USA accounted for 37% of food service disposables globally and is projected to remain the largest market for these consumable goods by a wide margin.” Laura Woods & Bhavik R. Bakshi, Reusable vs. Disposable Cups Revisited: Guidance in Life Cycle Comparisons Addressing Scenario, Model, and Parameter Uncertainties for the U.S. Consumer, 19 INT’L J. LIFE CYCLE ASSESSMENT 931, 931–40 (2014).
Various methods have been shown to promote energy conserving behavior. Behavioral best practices include: (a) efficient thermostat settings (cooler during the winter and warmer during the summer); (b) the relaxation of dress codes and cultural expectations towards attires in offices; (c) the use of natural ventilation, which should be possible in any building; and (d) lighting that is operational only during working hours. A benchmark example of this is Germany. Given its mild, humid climate with warm summers and cold winters, much of the energy consumed in its building stock is for space heating. Space cooling is negligible “due to cultural preference for natural ventilation.”

III. OVERCOMING THE SPLIT INCENTIVE: THE MOST IMPORTANT BARRIER FOR ENERGY IMPROVEMENT INVESTMENT IN THE EXISTING BUILD STOCK

The split incentive is one of the greatest problems in the pursuit of energy efficiency investment in rental buildings, and it is particularly relevant in NYC, as most NYC residents rent the homes in which they live. The split incentive arises when the tenant pays for the operation costs of the space (including energy use), while the landlord pays for the capital costs (including the

226 See WORKING GROUP III 2014, supra note 137, at 694.
227 See id.
228 See id. at 695.
230 See AMEKE, supra note 192, at 14.
231 Id.
energy-using amenities). In other words, the split incentive is the “dynamic between a building owner and a tenant where the energy savings benefits may not impact the person who pays for the transaction.” Hence, the landlord or owner of the building, who wants to minimize capital costs and maximize rental revenues, has no incentive to invest in measures that would improve energy efficiency over time, as the tenant will be the one that benefits from it. According to Coasean theory, in the absence of transaction costs, if property rights are well-defined and tradable, voluntary negotiations will lead to efficiency. Therefore, transaction costs are a critical factor negatively influencing the development of energy efficiency projects. The transaction costs associated with energy efficiency improvement projects in existing buildings are related to “the costs of collecting information on, making decisions about, and monitoring the performance of investments.”

However, policy experts around the world agree that there is no single solution for the split incentive problem. The solution has to arrive, therefore, from the best combination of different and complementary measures, designed on a case-by-case basis and through bargaining between the landlord and the tenant. Yet, some general ideas can be extracted from best practice examples, to try to resolve this important barrier to energy improvement investments in buildings all around the world.

In Europe, article 19(1) of Directive 2012/27EU on energy efficiency recognizes the importance of addressing the split incentive problem in the building sector. Practices from Italy,
the Netherlands, the United Kingdom, Denmark and Sweden have shown some interesting results in both the social housing sector and in private residential units.240

What follows are some of the most successful practices to overcome the split incentive:

A. Regulatory Measures

Building codes, energy codes, and appliance standards that promote high-energy performance can obviate the tenant-landlord investment problem over time, because the investments will be mandatory for the owner or landlord, particularly when making the necessary capital upgrades in both new construction and periodic upgrades (retrofits).241

An example of this is the United Kingdom legislation adopted in 2011 that prohibits leases of property with very poor energy performance (level F) after 2018,242 which sends a clear signal to the market.243 Using this regulation, tenants are allowed to demand energy efficiency upgrades on their properties and residential landlords receive financial support for compliance during the transitional period (2014–2017) through a tax break scheme.244

Improving energy efficiency will require technological ingenuity, as well as overcoming ingrained political ideologies.245

240 See ECONOMIDOU, supra note 59, at 11.
241 See ECONOMIDOU, supra note 59, at 5.
243 See ECONOMIDOU, supra note 59, at 9.
244 See id.
245 See Bashford, supra note 10.
Therefore, rising awareness of energy prices and supplies, complemented by a better understanding of the effects of climate change, are necessary steps to enhance the effectiveness of energy policy in the United States.246

Regulatory measures are not usually considered appropriate for the social housing sector, as low-income rental mandates are often politically unacceptable and can disincentivize landlord participation.247 However, the participation of a social housing landlord in a program could be set off with incentives, such as a share of savings that would cover the energy upgrade.248

A good example is the Dutch social housing sector, which represents a substantial share of the country’s rental market, and which has a very poor average energy index (equivalent to label D).249 The objective for the year 2020 of the “updated National Covenant on Energy Saving in the rental sector” was to achieve a B level average energy label.250 With that purpose, a 2011 regulation included the energy efficiency rating system of each dwelling in the rent information, giving the social landlord the opportunity to raise the rental price in the case of an improvement and therefore, to regain part of the investment.251

B. Financing Contracts

“Green leases” are rental agreements in which tenants gain incentives by participating in all kinds of sustainable actions applicable to the building—among others, energy efficiency renovations. The green lease could be a two-party or a three-party agreement. The two-party agreement places a surcharge on the rent

246 See id.
247 See ECONOMIDOU, supra note 59, at 17.
248 Some program requirements must still be included: “inspections, transparent energy information and commitment by the landlord to maintain participation. Utilities should be protected from risk/default while decoupling legislation, allowing utilities to gain incentives for running effective efficiency programmes, is critical. A revolving fund, using sources such as system benefit charges or carbon charges, could be set up to provide guarantees, address default and risk concerns for financing these upgrades as well as lower the interest rates if considered necessary.” See id.
249 Before the implementation of this measure, Dutch social dwellings had an average energy performance index of 1.73, a poor rating, equivalent to a D per the energy labelling system. See id. at 13.
250 See id.
251 See id. at 13–14.
each month in an amount that is less than the savings realized by the tenant, but sufficient to provide a revenue stream to the landlord in order to pay back the energy efficiency capital investment. The three-party agreement includes an energy service company (ESCO). Such arrangements have been mostly used in the United States, and are not widely used in the EU. Experience in Denmark has shown that a standard green lease based on energy label improvements made publically available can increase awareness and guide landlords and tenants in this type of practice.

In NYC, the green lease would work best for large institutional, commercial, or industrial tenants with large energy loads, who can foresee a protracted rental period. Adding a third party, an ESCO, would be essential to the success of this model due to the enormous costs of the projects and the competitiveness of the market.

On-bill financing schemes are designed to provide incentives to all stakeholders as they offer attractive solutions for addressing the split incentive. Examples include:

1. **Pay-As-You-Save**

   Pay-as-you-save (PAYS) schemes enable building owners or tenants to purchase and install energy efficiency products with no up-front payment and no debt obligation. Those who get the

---


253 See id. at 3.


256 See ECONOMIDOU, supra note 59, at 21. The city of Boston has also adopted green leasing, but its prevalence is still limited. See A BETTER CITY, GREEN LEASING: A BETTER TENANT/LANDLORD STRATEGY FOR ENERGY EFFICIENCY 8 (2014), https://www.abettercity.org/docs/abc-rpt%20green%20leasing%2012%2014.pdf. Still, Bostonian policy makers are actively promoting the tactic through outreach to brokers, real estate lawyers, and property managers, as well as by encouraging the city to lead by example and to use green leases in its municipal buildings. See id. at 8–9.

257 See Bashford, supra note 10.
Energy savings pay for these products through a tariffed charge on their utility bill (on-bill mechanism), but only for as long as they occupy the premises where the products were installed. Hence, the PAYS mechanism is transferable to the subsequent tenant or, in the case of a small appliance (such as an AC unit), the energy service charge would be transferred to the new residence, along with the appliance. The mechanism could include a third party that verifies the efficiency and savings of the products (energy contractor), and a local utility that would “finance and install the energy-efficiency technologies.”

The EU FRESH project, developed in Italy, showed the effectiveness of such energy contracting “for energy efficiency upgrades in the social housing sector on a large scale.”

The PAYS scheme is most common in the United Kingdom and Ireland, as well as in the United States (called PACE) and Canada. In NYC, there have been successful PAYS projects, but some political barriers still need to be overcome. However, electricity prices in New York State are among the highest in the United States; therefore, any savings on the electricity bill would be highly appreciated by energy consumers. Also, this


259 FRESH, short for Forwarding Regional Environmental Sustainable Hierarchies, is a “project promoting eco innovation through sustainable construction in eight European regions.” FRESH, http://www.freshproject.eu/ (last visited Dec. 1, 2016).

260 ECONOMIDOU, supra note 59, at 15.


264 For more information on the political problematic of the PAYS in NYC, see Bashford, supra note 10.

scheme needs little public funding and there is no subsidy involved, which makes it more likely to be supported from a political perspective.

2. Green Deal

Thanks to the United Kingdom’s Green Deal (2013), the landlords of buildings could recoup their investments on energy improvements, charging tenants via their utility bills.\(^{266}\) When the occupant leaves the building, the refund remains with the utility bill, no matter who the tenant and the electricity supplier are or how they behave.\(^{267}\) One of its weaknesses is that “the high interest rate attached to the loans,” which are considered to be “uncompetitive” compared to “traditional commercial bank loans.”\(^{268}\) Also, the loans are linked to the property that has been energy-upgraded, which creates uncertainty on its future sale.

C. Incentives

Cost savings for both the tenants, subject to the repayment fee in their utility bills, and for landlords, in the form of a small share of savings, covering the transaction costs attached to the energy upgrade, are critical to overcome the split incentive problem. The property’s value increase due to the energy improvement should be very attractive for the landlord’s interest. Also, utilities should be protected from risk or default in the midst of decoupling legislation,\(^{269}\) in order to allow them to gain incentives to implement energy efficiency programs. A revolving fund\(^ {270}\) with a benefit charge or a carbon charge system could provide guarantees,


\(^{268}\) See ECONOMIDOU, supra note 59, at 19.

\(^{269}\) The decoupling tool aims at separating the energy delivered by a utility from its revenues. It is essentially used “to eliminate incentives that utilities have to increase profits by increasing sales, and the corresponding disincentives that they have to avoid reductions in sales.” THE REGULATORY ASSISTANCE PROJECT, REVENUE REGULATION AND DECOUPLING: A GUIDE TO THEORY AND APPLICATION 2 (2011).

\(^{270}\) A “revolving fund” is “an account established to finance a continuing cycle of operations through amounts received. . . .” *Revolving Fund*, BUS. DICTIONARY, http://www.businessdictionary.com/definition/revolving-fund.html #ixzz3T3d1LN8j (last visited Oct. 24, 2016).
address default and risk concerns for financing the energy upgrades, and lower the interest rates.\textsuperscript{271} Note that, in social housing units, landlords should be compensated for transaction costs\textsuperscript{272} in order to undertake the energy investments.

Additionally, tax break schemes, used in the United Kingdom, allow landlords to deduct the cost of acquiring and installing certain energy savings measures against their income tax. They have had limited impact.\textsuperscript{273}

D. Information and Educational Measures

Addressing information costs is key to overcoming the split incentive for energy efficiency investment in the existing building stock. The \textit{Investor Confidence Project} (ICP) belonging to the Environmental Defense Fund, “defines a clear road-map from retrofit opportunity to reliable \textit{[i]nvestor \textit{[r]eady \textit{[e]nergy \textit{[e]fficiency,]}},}\textsuperscript{274} with important positive externalities. Positive externalities of such information include: “increase market transparency, increase deal flow and enable origination channels, create standardization, and enable data from the full project lifecycle.”\textsuperscript{275} The establishment of standards facilitates the identification of energy efficiency best practice projects, setting “a credentialing system that provides third-party validation.”\textsuperscript{276} These improvements optimize transactions for energy upgrades, reduce costs and increase the market value of the buildings, allowing for a feedback process.\textsuperscript{277}

Another example of improved access to information is the \textit{one-stop solution center}, such as the one implemented in the

\begin{flushright}
\textsuperscript{271} See ECONOMIDOU, supra note 59, at 9.
\textsuperscript{272} See ECONOMIDOU, supra note 59, at 7 (“‘Transaction costs’ in the energy efficiency investments are costs related to gathering and assessing information [on] equipment or material, making agreements in order to carry out and enforce the contract, monitoring and verifying the actual level of energy efficiency improvement, etc.”).
\textsuperscript{273} See id.
\textsuperscript{277} See id.
\end{flushright}
United Kingdom, Sweden or the Netherlands, which helps provide market incumbents with clear information and tools on energy renovation projects, including deep renovation.278

With respect to educational measures, training for the construction and real estate sectors is especially important, and should be constantly updated according to current technology.279 Experience has shown that:

- **Single-type measure solutions** have proven unsuccessful. Denmark has put into place *packaged policy solutions* that include: mandatory energy savings, a revised rent act, green leases, improved energy labels and actions to further facilitate ESCO activities.280

- **Comprehensive retrofits** deliver the highest average savings and are significantly more cost-effective than other measures.281 However, they are more complex and demand more information and training. Therefore, they are easier for richer countries to enact. Incentives and educational campaigns should be promoted in order to make this approach more accessible.

Finally, attention should be paid to housing units in which *reverse split incentives*282 are found, such as in the cases of university housing and public housing projects, in which the tenants are not the ones that pay the energy bills, regardless of their use.283 In Sweden, the dominating residential lease type is the so-called inclusive rent, in which all operating expenses are borne by the landlord.284 The landlord is answerable to the utility company, as the tenant pays rent inclusive of utilities to the former

---

278 See SHNAPP, supra note 16, at 31.
280 See ECONOMIDOU, supra note 59, at 10.
282 A reverse split incentive occurs “when the owner pays for the energy/services and thus the tenant has little/no motivation to limit their use (e.g. hotels, but also schools).” DANIELE FORNI & ANETT ZAJÁROS, SPLIT INCENTIVES 2 (2014), http://www.ca-eed.eu/themes/energy-services-c5/executive-summary-5.4-split-incentives.
283 See ECONOMIDOU, supra note 59, at 7.
284 See id. at 23.
and not to the latter. While tenants do not have any direct incentive to improve the energy performance of the buildings in which they live, this incentive is clear for the landlord, who will make the greater effort to save energy.285

CONCLUSION

From the above analysis of the energy efficiency measures carried out in parts of the world’s existing building stock, some guidelines may be laid down in order to contribute to the energy improvement of any existing residential building in the world. The guidelines can be summarized in the following table:

<table>
<thead>
<tr>
<th>Proposal:</th>
<th></th>
</tr>
</thead>
</table>
| 1. Regulation | - Must be clear and accessible to the general public, and especially to the stakeholders.  
- Must incorporate the latest technology.  
- Must be accompanied by measures involving education on its implementation—it should provide an investment on training.  
- Should take into account other regulations in order to remove impediments to energy improvements (e.g. zoning).  
- Should be enforced rigorously to ensure compliance. |
| 2. Energy labels for appliances | - Must be mandatory but flexible, and able to adjust to different baseline levels.  
- Must be upgraded to require the best technology available.  
- Public subsidies or loans should be put into place for replacement of old technologies. |
| 3. Energy labels for buildings (rating) | - Must include a specific requirement for energy efficiency. |
| 5. Information | - Regulations in force and sanctions in case of non-compliance.  
- Available mechanisms for energy improvements, in both the building elements and the home appliances, |

285 See id. at 23–24.
These proposals have been extracted, as previously indicated,
from best practice examples already at work in cities across the globe. Any of them could ultimately inspire measures that could be carried out in any city in the world, improving the energy efficiency of their existing residential building stock and contributing to the mitigation of the effects of global climate change.