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

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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.

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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 (CO_2) emissions in the European Union (EU),[1] and 39 percent of total energy use and 38 percent of CO_2

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emissions in the United States.[2] In New York City (NYC), the building sector is responsible for roughly 75 percent of total GHG emissions in the city.[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.[4] Although there are several ways to reduce GHG emissions derived from energy use in buildings, scientists and governments agree[5] that improving the

University; Sabin Center for Climate Change Law Affiliate, Columbia University. This paper was prepared as part of a research project conducted at the Sabin Center for Climate Change Law at Columbia Law School.

1 This is the largest end-use sector, followed by transport (32%) and industry (25%). Average annual energy consumption was around 220 kWh/sqm in 2009, with a large gap between residential (around 200 kWh/sqm) and non-residential buildings (around 300 kWh/sqm). COMM'N TO THE EUR. PARLIAMENT AND COUNCIL, EUROPEAN COMM'N, FINANCIAL SUPPORT FOR ENERGY EFFICIENCY IN BUILDINGS 6, http://publications.europa.eu/en/publication-detail/-/publication/28f270a1-ab38-4a95-aa5a-796fbd5ea0b1/language-en (last visited Oct. 18, 2016).

2 *See Why Build Green?*, U.S. ENVTL. PROT. AGENCY, https://archive.epa.gov/greenbuilding/web/html/whybuild.html (last visited Oct. 18, 2016). U.S. buildings rank second only to China in annual CO_2 emissions. U.S. GREEN BUILDING COUNCIL, BUILDINGS AND CLIMATE CHANGE 1, http://www.usgbc.org/redirect.php?DocumentID=5033.

3 *See About OneNYC Green Buildings & Energy Efficiency*, NYC MAYOR'S OFFICE OF SUSTAINABILITY, http://www.nyc.gov/html/gbee/html/about/about.shtml (last visited Nov. 12, 2015).

4 BUILDINGS PERFORMANCE INSTITUTE EUROPE, EUROPE'S BUILDING UNDER THE MICROSCOPE 43 (2013), http://www.europeanclimate.org/documents/LR_%20CbC_study.pdf.

5 The majority of carbon emissions into Earth's atmosphere are energy related and caused by fossil fuel combustion. *See Sources of Greenhouse Gas Emissions*, U.S. ENVTL. PROT. AGENCY, https://www.epa.gov/ghgemissions/sources-greenhouse-gas-emissions (last visited Oct. 18, 2016). Furthermore, according to the United Nations, the world population is projected to reach 9.6 billion people by 2050, which will lead to an inevitable increase in the use of energy, especially in cities. *See World Population Prospects: the 2012 Revision*, DEP'T OF ECON. AND SOCIAL AFFAIRS, UNITED NATIONS (June 17, 2013), http://www.un.org/en/development/desa/publications/world-population-prospects-the-2012-revision.html.

energy efficiency of building systems and operations, as well as investing in cleaner on-site power generation, is a highly effective approach.[6] In Europe, some cities have developed interesting measures that have been evaluated as best practice examples by numerous reports.[7] 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.[8]

This Article aims to find innovative measures that would improve the energy performance of the existing built environment,[9] 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-

6 *See* Charlie Wilson, Arnulf Grubler, Kelly S. Gallagher, & Gregory F. Nemet, *Marginalization of End-use Technologies in Energy Innovation for Climate Protection*, 2 NATURE CLIMATE CHANGE 780, 780–788 (2012); EUROPEAN COMM'N, ENERGY EFFICIENCY PLAN 2011 (2011).

7 The selected reports for this research are: ECONOMIST INTELLIGENCE UNIT, EUROPEAN GREEN CITY INDEX (2009); INT'L PARTNERSHIP FOR ENERGY EFFICIENCY CORP., DELIVERING ENERGY SAVINGS IN BUILDINGS (2015); AMERICAN COUNCIL FOR AN ENERGY EFFICIENT ECONOMY, INT'L ENERGY EFFICIENCY SCORECARD (2nd ed. 2014); *BigEE*, WUPPERTAL INST., http://www.bigee.net/ (last visited Oct. 18, 2016); DIDIER BOSSEBOEUF, ENERGY EFFICIENCY TRENDS IN BUILDINGS IN THE EU, AGENCE DE L'ENVIRONMENT ET DE LA MAÎTRISE DE L'ENERGIE (2012) (prepared as part of the Odyssee-Mure project funded by the European Commission); *Build Up*, EUROPEAN COMM'N, http://www.buildup.eu/en (last visited Oct. 19, 2016).

8 *See NYC Built to Last*, CITY OF NEW YORK, http://www.nyc.gov/html/builttolast/pages/home/home.shtml (last visited Oct. 18, 2016).

9 "Built environment" is defined as "the buildings and all other things constructed by human beings." *The Built Environment*, COLLINS ENGLISH DICTIONARY, http://www.collinsdictionary.com/dictionary/english/the-built-environment#the-built-environment_1 (last visited Apr. 1, 2015).

called split incentive,[10] one of the largest hurdles for energy efficiency investment in the building sector.[11] The split incentive is particularly relevant to those cities with a large proportion of rental housing, like NYC.[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.[13] Residential buildings include single-family houses (detached and semi-detached houses) and apartment blocks.[14] Non-residential buildings are more diverse than those of the residential sector, and they are generally classified by use.[15] This Article focuses on the existing residential building stock, which accounts for two-thirds of the total energy consumption of buildings,[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

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*.

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).

12 *See* Bashford, *supra* note 10.

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).

14 *See* ECONOMIDOU, *supra* note 11, at 30.

15 *See* BOSSEBOEUF, *supra* note 7, at 10.

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[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[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

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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).

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,[19] but this Article will mainly take into account the cities' scores extracted from six of the studies: four privately sponsored[20] and two managed by European institutions.[21]

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.[22] All of the selected European cities, as well as NYC, belong to the *Covenant of Mayors*,[23] 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 CO_2 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.[24]

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

19 The European Commission has produced a number of such studies. *See Studies*, EUROPEAN COMM'N, https://ec.europa.eu/energy/en/studies?field_associated_topic_tid=45 (last visited Oct. 18, 2016).

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.

23 For more information regarding the project, see COVENANT OF MAYORS FOR CLIMATE & ENERGY, http://www.covenantofmayors.eu/index_en.html (last visited Oct. 24, 2016).

24 *See The Power of C40 Cities*, C40 CITIES, http://www.c40.org/cities (last visited Dec. 15, 2016).

follows:

City (Country)	**Country Economic Data (World Bank)**[25]	**Energy Efficiency Best Practices**
Berlin (Germany)	- Gross Domestic Product (GDP): $3.356 trillion - Population: 81,413,141 - CO_2 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 - CO_2 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)

25 The World Bank calculates the economic data at the country level. *See generally Countries and Economies*, WORLD BANK, http://data.worldbank.org/country The GDP and population numbers reflect 2015 data and the CO_2 emissions reflect 2013 data. *See id.* (providing a country-by-country breakdown).

Copenhagen (Denmark)	- GDP: $295.164 billion - Population: 5,676,002 - CO_2 emissions per capita: 6.78 MT	- Strong building regulation - High energy standards - Effective mandatory energy labeling - Advanced energy renovation based on good financing framework, strong education campaigns, and research and innovation. - Public leadership - Solar panel installation in municipal buildings
Paris (France)	- GDP: $2.422 trillion - Population: 66,808,385 - CO_2 emissions per capita: 5.05 MT	- Strong building regulation - Effective mandatory labeling system - Incentive schemes (including tax rebates) - Training and education campaigns - Zero-interest loans for renovations
Rome (Italy)	- GDP: $1.815 trillion - Population: 60,802,085 - CO_2 emissions per capita: 5.724 MT	- Strong building regulation - Mandatory energy labeling - Incentive schemes - Financial support schemes (tax allowances and low interest loans for renewables) - Tax incentive for energy efficiency improvements in existing buildings

Madrid (Spain)	- GDP: $1.199 trillion - Population: 46,418,269 - CO_2 emissions per capita: 5.083 MT	- Strong building regulation - Mandatory energy labeling - Grants for energy efficiency in buildings - Energy efficiency certificates, when selling or renting
London (UK)	- GDP: $2.858 trillion - Population: 65,138,232 - CO_2 emissions per capita.: 7.134 MT	- Strong regulation for new and existing buildings - Mandatory labeling - Energy efficiency certificates - ESCOs - Comprehensive loans for energy renovations - Non-statutory schemes and incentives (tax rebates) - Comprehensive retrofitting
Vilnius (Lithuania)	- GDP: $41.171 billion - Population: 2,910,199 - CO_2 emissions per capita: 4.274 MT	- Loans by private entities - Structural funds

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,[26] 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

26 *See About*, NYC MAYOR'S OFFICE OF RECOVERY AND RESILIENCY, http://www.nyc.gov/html/planyc/html/about/about.shtml (last visited 12 Oct. 2016).

technologies and taking into account the uniqueness and complexity of NYC's built environment.[27] 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,[28] resulting in the *One City: Built to Last* plan.[29] 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.[30] The great majority of NYC's buildings are more than 50 years old.[31] The city's construction development peak was in the 1920s, while the lowest points of development occurred in the 1930s and 1950s-60s.[32] By 2030, today's present buildings will still account for at least 85 percent of the total building stock.[33]

Residential buildings dominate the building sector, representing 92 percent of buildings and 70 percent of the built area.[34] 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

27 MAYOR'S OFFICE OF LONG-TERM PLANNING AND SUSTAINABILITY, CITY OF NEW YORK, ONE CITY: BUILT TO LAST 31 (2014) [hereinafter ONE CITY BUILT TO LAST], http://www.nyc.gov/html/builttolast/assets/downloads/pdf/OneCity.pdf.

28 MAYOR'S OFFICE OF LONG-TERM PLANNING AND SUSTAINABILITY, CITY OF NEW YORK, NEW YORK CITY'S PATHWAYS TO DEEP CARBON REDUCTIONS (2013) [hereinafter NYC PATHWAYS TO DEEP CARBON REDUCTION], http://s-media.nyc.gov/agencies/planyc2030/pdf/nyc_pathways.pdf.

29 ONE CITY BUILT TO LAST, *supra* note 27.

30 *Id.* at 85.

31 To learn the age of any building in New York City, see Eric Limer, *The Exact Age of Almost Every Building in NYC, in One Map*, GIZMODO (Sept. 19, 2013), http://gizmodo.com/the-exact-age-of-almost-every-building-in-nyc-in-one-m-1348558392.

32 *See* MAYOR'S OFFICE OF LONG-TERM PLANNING AND SUSTAINABILITY, CITY OF NEW YORK, NEW YORK CITY LOCAL LAW 84 BENCHMARKING REPORT 14 (2013) [hereinafter BENCHMARKING REPORT 2013], http://www.nyc.gov/html/planyc/downloads/pdf/publications/ll84_year_two_report.pdf.

33 ONE CITY BUILT TO LAST, *supra* note 27, at 25.

34 *See* NYC PATHWAYS TO DEEP CARBON REDUCTION, *supra* note 28, at 30.

area.[35] Finally, industrial buildings only represent 3 percent of buildings and 6 percent of the built area.[36]

Unlike most U.S. residents, only around 30 percent of New Yorkers own their apartment or house.[37] 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.[38]

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.[39] 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.[40] 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.[41] 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."[42] 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.*

37 Elyzabeth Gaumer, *Selected Initial Findings of the 2014 New York City Housing and Vacancy Survey*, NYC DEPARTMENT OF HOUSING, PRESERVATION AND DEVELOPMENT (2015), http://www1.nyc.gov/assets/hpd/downloads/pdf/2014-HVS-initial-Findings.pdf.

38 *See infra* Section III.

39 *Mayor Bloomberg, Deputy Mayor Holloway and Office of Long Term Planning and Sustainability Director Sergej Mahnovski Announce Significant Reduction in Greenhouse Gas Emissions and New and Expanded Programs to Continue the Progress*, NYC: THE OFFICIAL WEBSITE OF NEW YORK CITY (Dec. 30, 2013), http://www1.nyc.gov/office-of-the-mayor/news/440-13/mayor-bloomberg-deputy-mayor-holloway-office-long-term-planning-sustainibility.

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.[43]

2. *NYC's Energy Efficiency Measures*

What follows is a brief description of measures set out primarily by *PlaNYC* and its extension, the *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:

Type of measure	**Description**
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 86: Leadership in Energy and Environmental Design (LEED) Law. - 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.

43 *See id*. at 21.

Economic (market-based)	Residential	Programs:	- Home performance with Energy Star - Solar Electric (PV) Incentive Program
		Financing:	- On-Bill Recovery Loans - Smart Energy Loans
	Multifamily	- Advanced Submetering Programs - Multifamily Performance Programs - State Energy Investment Program (EnVest)	
Financial	Federal	- American Recovery and Reinvestment Act - Weatherization Assistance Program (low-income households)	
	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,[44] compared with solutions implemented in NYC for each use.[45]

A. *Heating*

1. *Space Heating*

In Europe, space heating accounts for more than 65 percent of total residential building energy consumption.[46]

a. *The Netherlands*

The Netherlands is the exemplar for space heating in Europe[47] 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.[48]

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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.

47 *See* DIDIER BOSSEBOEUF, INTELLIGENT ENERGY EUROPE, MONITORING OF ENERGY EFFICIENCY TRENDS AND POLICIES IN THE EU 41 (2015) [hereinafter INTELLIGENT ENERGY EUROPE], http://www.odyssee-mure.eu/publications/br/synthesis-energy-efficiency-trends-policies.pdf.

48 *See* Bruno Lapillonne, *Benchmark of the Specific Energy Consumption for Space Heating in Europe*, LEONARDO ENERGY (Jan. 31, 2012), http://www.leonardo-energy.org/blog/benchmark-specific-energy-consumption-space-heating-europe.

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.[49] 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.[50] 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,[51] a fuel that NYC aims to use for its space heating needs,[52] and the Netherlands has a large diffusion of central heating,[53] just like NYC.[54] 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.[55] This significantly impacts heating efficiency, and therefore, the consumption of energy.[56]

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.

51 *See* THE AMERICAN WOMEN'S CLUB OF THE HAGUE, AT HOME IN HOLLAND: A PRACTICAL GUIDE FOR LIVING IN THE NETHERLANDS 222 (11th ed. 2009).

52 *See* Jonathan Barnes, *Heating Oil Transition Offers Savings*, THE COOPERATOR (Apr. 2013), http://cooperator.com/article/heating-oil-transition-offers-savings.

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. BOSSEBOEUF, *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.[57] According to the SHAERE database,[58] the mean energy value of the social dwellings in the Netherlands was a D, a mediocre grade on the Dutch energy efficiency scale.[59]

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

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

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).

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).

60 *See* VIRGINIE SCHWARZ, EUROPEAN ENERGY NETWORK, ENERGY EFFICIENCY IN EUROPE 12, https://www.scribd.com/document/305236842/European-Energy-Network-Energy-Efficiency-in-Europe.

61 *See id*. at 11.

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.

63 *See* A.G. ENTROP, INFLUENCE OF PAST POLICIES ON TODAY'S ENERGY SAVING INITIATIVES 145 (2008), http://doc.utwente.nl/60323/1/Paper_Influence_of_Past_Policies_on_Todays_Energy_Saving_Policies.pdf.

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.*

76 *See* CONCERTED ACTION ENERGY PERFORMANCE OF BUILDINGS, http://www.epbd-ca.org/.

77 *See* ENTROP, *supra* note 63, at 150.

environment"[78] with a set of measures aimed at improving energy efficiency, and with them, the obligations derived from the EU Directives.[79] 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.[80]

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.[81] It was generally effective, but also had its failings. On top of the social problems this type of measure could generate,[82] 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.[83] A tax reform is aimed at solving these inconsistencies.[84]

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.[85] The Clean Heat Plan,[86] Local Law 43 (2010),

78 *Id.*

79 *See* MINISTRY OF ECONOMIC AFFAIRS & MINISTRY OF THE INTERIOR AND KINGDOM RELATIONS, THE THIRD NATIONAL ENERGY EFFICIENCY ACTION PLAN FOR THE NETHERLANDS 21 (2014), https://ec.europa.eu/energy/sites/ener/files/documents/2014_neeap_en_netherland.pdf.

80 *See* ENERGYCLAIM, http://www.energyclaim.nl/english/ (last visited Mar. 19, 2017).

81 *See Regulatory Energy Tax (Regulerende Energie Belasting - REB)*, INTERNATIONAL ENERGY AGENCY (Nov. 18, 2014), http://www.iea.org/policiesandmeasures/pams/netherlands/name-21050-en.php.

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.

83 *See Environmental Damage and Energy Tax Reform: The Dutch Challenge*, PBL ENVTL. ASSESSMENT AGENCY (Apr. 7, 2015), http://www.pbl.nl/en/news/newsitems/2015/match-energy-tax-rates-with-environmental-damage-costs.

84 *See* GREEN TAX REFORM: ENERGY TAX CHALLENGES FOR THE NETHERLANDS, PBL ENVTL ASSESSMENT AGENCY 4 (2014).

85 *See NYC Clean Heat*, M-CORE CREDIT, http://m-corecredit.com/clean-heat/ (last visited Oct. 23, 2016).

and other state legislation regulating heating oils (No. 4 and No. 6 grades)[87] were put in place to address the public health hazard presented by the burning of these fuels,[88] which emit sulfur dioxide (SOx) and fine particulate matter (PM 2.5).[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.[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.[91] Finally, boilers not replaced by 2030 would need to be modified to meet the new regulations.[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.[93] Several incentives and rebates have also been developed for buildings to convert to cleaner fuels.[94]

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 Welcome to NYC Clean Heat*, NYC CLEAN HEAT, https://www.nyccleanheat.org/ (last visited Dec. 15, 2016).

87 *See* 2010 N.Y.C. Local Law No. 43, N.Y.C. Admin. Code §§ 24-167–169.

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 Heating Oil Regulations*, NYC MAYOR'S OFFICE OF SUSTAINABILITY, http://www.nyc.gov/html/gbee/html/codes/heating.shtml (last visited Dec. 31, 2016).

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

90 *See Heating Oil Regulations*, *supra* note 88.

91 *See id.*

92 *See id.*

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

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 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

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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.

97 *See* Seth Silverman, *Scaling Residential Retrofits in New York City: Financing, Standardization, and Streamlining*, 27 ENVT'L CLAIMS J. 1, 72 (2015).

98 *See* LEVINE ET AL., *supra* note 44, at 46.

99 *See* ENERGY EFFICIENCY AND ENERGY CONSUMPTION IN THE HOUSEHOLD SECTOR, EUROPEAN ENV'T AGENCY, http://www.eea.europa.eu/data-and-maps/indicators/energy-efficiency-and-energy-consumption-5/assessment (last visited Nov. 19, 2015).

100 *See* U.S. ENERGY INFO. ADMIN., HOUSEHOLD ENERGY USE IN NEW YORK (2009), http://www.eia.gov/consumption/residential/reports/2009/state_briefs/pdf/ny.pdf.

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 CO_2 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.*

104 WORLD BUS. COUNCIL FOR SUSTAINABLE DEV., ENERGY EFFICIENCY IN BUILDINGS: BUSINESS REALITIES AND OPPORTUNITIES 19, https://www.c2es.org/docUploads/EEBSummaryReportFINAL.pdf.

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.

109 *See* CARSTEN PETERSDORFF ET AL., ECOFYS, MITIGATION OF CO_2 EMISSIONS FROM THE BUILDING STOCK 31 (2004).

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,[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.[117] Air conditioning (AC) units have been in widespread use in U.S. households for decades.[118] Conversely, only more recently has AC started to proliferate in Europe.[119] Even though the technology is spreading rapidly, it has had a negligible impact on energy demand, due to the mild climatic conditions in

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whereas the remaining 10% resulted from investment grants and official programs on energy efficiency. *See* BENGT JOHANSSON, SWEDISH ENVT'L 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).

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.

117 *See* Enrica De Cian, et. al, *The Impact of Temperature Change on Energy Demand: A Dynamic Panel Analysis*, 46.2007 Nota di Lavoro 2 (April 2007), http://ageconsearch.umn.edu/bitstream/9322/1/wp070046.pdf.

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/energysaver/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.

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.[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).[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.[122] Also, due to the great amount of electricity they use and the coolants they contain, AC units contribute greatly to climate change.[123] Therefore, it is worth addressing AC devices separately from the rest of electricity appliances.

a. *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.[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.[125] Indeed, thanks to efficiency

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120 *See id.*

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%). 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 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 id*.

122 ANETTE MICHEL ET AL., ROOM AIR CONDITIONERS: RECOMMENDATIONS FOR POLICY DESIGN 6 (2012), http://www.topten.eu/uploads/File/Room%20air%20conditioners%20Recommendations_May%202012.pdf.

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. *See* Guus J.M. Velders et al., *Preserving Montreal Protocol Climate Benefits by Limiting HFCs*, 335 SCIENCE MAGAZINE 922, 922 (2012).

124 *See* Directive 2010/31 of the European Parliament and of the Council of 19 May 2010 on the Energy Performance of Buildings, art. 1(f).

125 *See* EDITH MOLENBROEK, MAARTEN CUIJPERS, & KORNELIS BLOK, ECOFYS, ECONOMIC BENEFITS OF THE EU ECODESIGN DIRECTIVE: IMPROVING EUROPEAN ECONOMIES 1 (April 2012), http://www.ecofys.com/files/ files/ecofys_2012_economic_benefits_ecodesign.pdf (23rd November 2015).

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.*

129 *See Fluorinated Greenhouse Gases – Information*, DEP'T OF HOUSING, PLANNING, COMMUNITY, AND LOCAL GOV'T, http://www.environ.ie/en/Environment/Atmosphere/ClimateChange/FluorinatedGreenhouseGases/ (last visited Oct. 23, 2016).

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.[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.[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."[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.[138]

b. *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)[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.

Katrin Klingenberg & Mike Knezovich, *An Introduction to Passive House Principles and Policy*, 26 ENVTL. LAW IN NEW YORK 39, 39 (2015).

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." CHRIS GOODALL, 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." *Id.*

136 *See id.*

137 WORKING GROUP III, INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, CLIMATE CHANGE 2014: MITIGATION OF CLIMATE CHANGE 693 (2014) [hereinafter WORKING GROUP III 2014].

138 *See id.*

139 *See LL85: NYC Energy Conservation Code (NYCECC)*, NYC MAYOR'S OFFICE OF SUSTAINABILITY, http://www.nyc.gov/html/gbee/html/plan/ll85.shtml (last visited Dec. 31, 2016).

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.[140]

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,[141] but no regulation exists regarding the use of AC, only comfort guidelines.[142]

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"[143] and "passive house"[144] 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.[145] 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*.

142 CITY OF NEW YORK, NYC COOLING SEASON GUIDELINES 2013 (2013), http://www.nyc.gov/html/dem/downloads/pdf/NYC_Cooling_Season_Guidelines_2013.pdf (last visited Feb. 28, 2015).

143 *Vernacular Design*, ARCHITECTURE WEEK, http://www.greatbuildings.com/architects/vernacular.html (last visited Dec. 31, 2016) ("Vernacular refers to buildings whose design is determined by an informal local tradition, rather than by a particular designer.").

144 *See* GOODALL, *supra* note 135.

145 *See* WORKING GROUP III, INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, CLIMATE CHANGE 2007: MITIGATION OF CLIMATE CHANGE 397 (2007).

walls, floor, and windows, as well as with good ventilation.[146]

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."[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.[148] According to the same study, insulation plays a key role in the reduction of the cooling demand in warm climatic zones.[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.[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:

- *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.[151]
- *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

146 PASSIVE HOUSE INSTITUTE, ACTIVE FOR MORE COMFORT: PASSIVE HOUSE (Sarah Mekjian ed., 2014), http://www.passivehouse-international.org/upload/download_complete_PH_Brochure.pdf.

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." *Id.*

148 *See 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. *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).

149 *See* PETERSDORFF, *supra* note 109, at 28.

150 *See* CLIMATE CHANGE AND WATER RESOURCES 146 (T. Younos & C.A. Grady eds., 2013).

151 *See* URBAN GREEN COUNCIL, INCREASE ALLOWABLE SIZE OF SOLAR SHADES 1, http://urbangreencouncil.org//sites/default/files/a15U0000000LgLhIAK1388005367.pdf (a proposal to amend the NYC Zoning Resolution and NYC Building Code, with respect to "sun control device[s]").

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* DICTIONARYOFCONSTRUCTION.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*.

157 *See About NYC Cool Roofs*, CITY OF NEW YORK, http://www.nyc.gov/html/coolroofs/html/about/about.shtml (last visited Dec. 30, 2016).

lower GHG emissions.[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,"[159] such as passive house components, or green roof practices, which are very extensive in northern Europe.[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.[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.[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).[163] However, researchers have shown that there is great room for energy and financial savings in the use of cooling devices in the

158 *See id*.

159 HENDERSON, *supra* note 119, at 548.

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*.

161 *See* ONE CITY BUILT TO LAST, *supra* note 27, at 38, 92.

162 *See* U.S. ENERGY INFO. ADMIN., *supra* note 100.

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

164 *See, e.g.*, *Overview*, BUILDING ENERGY EXCHANGE, http://be-exchange.org/resources/source/28 (last visited Dec. 20, 2016).

165 *NYC to Retailers: Stop Air Conditioning the Sidewalk*, INTERCON (Oct. 19, 2015), http://intercongreen.com/2015/10/19/nyc-to-retailers-stop-air-conditioning-the-sidewalk/.

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.[170]

The energy consumption of electrical appliances increased until 2007, after which it started to gradually decrease.[171] On the one hand, there has been an improvement of the energy performance of large appliances,[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.[173] Nevertheless, important efficiency potential remains unrealized, especially for refrigerators.[174] Also, energy efficiency based reductions of large appliance energy consumption have been offset by an increase in ownership.[175] Additionally, small appliances have proliferated in most European countries following the economic crisis.[176] Therefore, the strongest lighting consumption growth occurred for small appliances (almost 5 percent per year, on average).[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.[178] Indeed, CFLs represent one of the most efficient solutions available today for improving energy efficiency in residential lighting.[179] The recent

170 *See id.* at 36.

171 *See id.* at 43.

172 These include refrigerators, freezers, washing machines, dishwashers, dryers, and televisions.

173 *See* BRUNO LAPILLONNE, KARINE POLLIER & NEHIR SAMCI, ENERGY EFFICIENCY TRENDS FOR HOUSEHOLDS IN THE EU 36 (2015), http://www.odyssee-mure.eu/publications/efficiency-by-sector/household/household-eu.pdf.

174 *See* BERTOLDI &ATANASIU *supra* note 168, at 83.

175 *See* INTELLIGENT ENERGY EUROPE, *supra* note 47, at 41, 46.

176 *See id.* at 43.

177 *See id*.

178 *See id.* at 45.

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.

drop in price, along with several informational and promotional campaigns, has had a positive impact on sales.[180] Also, specific national policies and measures were implemented in member states, such as the white certificate[181] schemes in the United Kingdom and Italy.[182] With the Ecodesign Directive (2009), a phasing out of incandescent bulbs was implemented until 2012.[183] LEDs, an even more promising lighting technology than CFLs, are considered A-class lamps in the Ecodesign Directive.[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.[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.[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,[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.[188] Savings could reach 43 terawatt-hours per year by 2020 if the targets are met.[189] It is estimated that electricity consumption in European households will

180 "The CFL[] stock in the residential sector grew by some 690 million units ([3.47] CFLs/household) over the period 2003–2007, with a 340% increase in the apparent consumption of CFL[s] from 145 million in 2003, 177 million in 2004, 241 million in 2005, a dramatic increase to 316 million in 2006, arriving [at] 628 million in 2007." BERTOLDI, *supra* note 166, at 38.

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." *See White Certificates*, GESTORE SERVIZI ENERGETICI, http://www.gse.it/en/White%20Certificates/Pages/default.aspx (last visited Oct. 14, 2016).

182 *See* BERTOLDI, *supra* note 166, at 38.

183 *See id.* at 38.

184 *See id.* at 39.

185 *See id.* at 40.

186 *See id.* at 41.

187 *See* Commission Regulation (EC) No. 642/2009 of July 22, 2009, implementing Directive 2005/32/EC of the European Parliament and of the Council with regard to ecodesign requirements for televisions, O. J. (L 191) 42.

188 *See* BERTOLDI, *supra* note 166, at 40.

189 *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

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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[197] provides preferential loans and grants for single energy efficient components and for comprehensive retrofits.[198] Energy audits, Energy Performance Certificates, and billing information tools, conducted at the beginning of the energy performance improvement process, are essential to it.[199]

Notably, policies to reduce energy consumption from equipment and devices in buildings are mostly set at the EU level,[200] mainly with the 2010/30/EU Labeling Directive and the 2009/125/EC Ecodesign Directive.[201] These policies facilitate an EU-wide market for more efficient technologies, setting minimum energy efficiency standards, and requiring energy performance labeling for major appliances.[202] As a consequence, over 90 percent of refrigerators, washing machines, and dishwashers sold in 2012 had an efficiency of A class or better.[203]

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,[204] 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. *See id*. 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.

201 *See Energy Efficiency*, EUROPEAN COMM'N, https://ec.europa.eu/energy/en/topics/energy-efficiency (last visited Aug. 16, 2016).

202 The European Commission has recently launched a study on the evaluation of Directive 2010/30/EU (Energy Labeling) and some specific aspects of the Ecodesign Directive, in order to prepare a review of both pieces of regulation. *See Evaluation of the Energy Labelling Directive and Specific Aspects of the Ecodesign Directive*, ECOFYS, http://www.energylabelevaluation.eu/eu/home/welcome (last visited Aug. 16, 2016).

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.[205] 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.[206]

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.[207] The regulated properties constitute only 2 percent of the city's building stock but comprise approximately 50 percent of the total built area.[208] 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."[209] 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.[210] That is the aim of the marketing campaigns included in GreeNYC[211] to improve the

LOCAL LAW 88 OF 2009 COMPLIANCE CHECKLIST AND USER'S GUIDE (2015), http://urbangreencouncil.org/sites/default/files/ll88_checklist_15.05.11.pdf.

205 *See Building Energy Exchange*, MAYOR'S OFFICE OF SUSTAINABILITY, CITY OF NEW YORK, http://www.nyc.gov/html/gbee/html/initiatives/glny.shtml (last visited Aug. 16, 2016).

206 *See* MAYOR'S OFFICE OF SUSTAINABILITY, CITY OF NEW YORK, BUILDING ENERGY EXCHANGE, http://www.nyc.gov/html/gbee/html/initiatives/glny.shtml (last visited Aug. 16, 2016). An example of the intense activity of the city of New York and its great commitment to the energy improvement of the building stock is the Building Energy Exchange project, which provides support for the building industry through energy and lighting efficiency education, technical exhibits, critical research, and networking opportunities. *See* BUILDING ENERGY EXCHANGE, http://be-exchange.org/about (last visited August 16, 2016).

207 *See* MAYOR'S OFFICE OF LONG-TERM PLANNING AND SUSTAINABILITY, CITY OF NEW YORK, OVERVIEW OF THE GREENER, GREATER BUILDINGS PLAN (2014), http://www.nyc.gov/html/gbee/downloads/pdf/greener_greater_buildings_plan.pdf.

208 *See Greener Greater Buildings Plan*, URBAN GREEN COUNCIL, http://urbangreencouncil.org/content/projects/greener-greater-buildings-plan (last visited Aug. 16, 2016).

209 BENCHMARKING REPORT, *supra* note 32, at 7.

210 *See* Memorandum from Ian Jurgensen to Mayor Bill de Blasio, (May 14, 2014), http://blogs.newschool.edu/epsm/files/2014/06/PlaNYC-and-buildings-not-covered-by-the-Greener-Greater-Buildings-Plan.pdf.

211 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.[212]

As of April 2015, 53 out of 111 Green Codes Task Force (GCTF)[213] recommendations[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.[215] Others, such as "Don't Exempt Existing Buildings from Green Codes" (NYC Local Law 85 of 2009), are partially enacted.[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,"[217] but its buildings represent the greatest share of its energy consumption. Residential electricity consumption has exploded along with the population.[218] Furthermore, there has been a surge in the number of electric devices in each home—over 50 percent of energy is

212 CITY OF NEW YORK, *supra* note 112, at 35.

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.

214 For the proposals, see CLIMATE ADAPTATION COMMITTEE, NYC GREEN CODES TASK FORCE: FULL PROPOSALS, http://urbangreencouncil.org/sites/default/files/greencodestaskforce_fullreport.pdf.

215 *See* MAYOR'S OFFICE OF SUSTAINABILITY, CITY OF NEW YORK, GCTF ENACTED PROPOSALS, http://www.nyc.gov/html/gbee/html/codes/enacted.shtml (last visited Aug. 16, 2016).

216 *See id*. (listing all enacted proposals).

217 Renee Cho, *How Much Energy Does NYC Waste?*, COLUMBIA UNIVERSITY EARTH INSTITUTE: STATE OF THE PLANET (Sept. 28, 2015), http://blogs.ei.columbia.edu/2015/09/28/how-much-energy-does-nyc-waste/.

218 *See* NEW YORK INDEPENDENT SYSTEM OPERATOR, POWER TRENDS 2014 (2014).

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]

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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.[225] Behavioral best practices include: (a) efficient thermostat settings (cooler during the winter and warmer during the summer);[226] (b) the relaxation of dress codes and cultural expectations towards attires in offices;[227] (c) the use of natural ventilation, which should be possible in any building;[228] and (d) lighting that is operational only during working hours.[229] 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.[230] Space cooling is negligible "due to cultural preference for natural ventilation."[231]

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.[232] 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

225 *See* Low Sheau Ting et al., *Promoting Energy Conservation Behaviour: A Plausible Solution to Energy Sustainability Threats*, 5 INT'L PROCEEDINGS OF ECON. DEV. AND RES. 372, 374 (2011).

226 *See* WORKING GROUP III 2014, *supra* note 137, at 694.

227 *See id.*

228 *See id*. at 695.

229 *See* RESPONSIBLE ENERGY, MANAGING ENERGY COSTS IN OFFICE BUILDINGS (2010), https://www.mge.com/images/PDF/Brochures/business/ManagingEnergyCostsInOfficeBuildings.pdf. The city of Paris recently instituted such a ban. *See also* Sara Gates, *Paris Illumination Ban: 'City Of Light' Begins Turning Off Its Lights At Night To Save Energy*, HUFFINGTON POST (June 1, 2013 2:10 PM), http://www.huffingtonpost.com/2013/07/01/paris-illumination-ban-city-of-light-dimming_n_3529378.html). Though not an outright ban, Local Law 88 (2009) amends New York City's administrative code to require building owners to upgrade lighting systems and install sub-meters in certain buildings. *See Local* Laws, NYC BUILDINGS, http://www.nyc.gov/html/dob/html/codes_and_reference_materials/local_laws.shtml.

230 *See* AMEKE, *supra* note 192, at 14.

231 *Id.*

232 *See* Rupert Neate & Lisa O'Carroll, *New York's Rent Controls: 'Essential for the Future of the City,'* THE GUARDIAN (Aug. 19, 2015), http://www.theguardian.com/us-news/2015/aug/19/new-york-rent-controlled-homes.

energy-using amenities).[233] 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."[234] 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.[235] Therefore, transaction costs are a critical factor negatively influencing the development of energy efficiency projects.[236] 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."[237]

However, policy experts around the world agree that there is no single solution for the split incentive problem.[238] 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.[239] Practices from Italy,

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233 *See* Bashford, *supra* note 10.

234 ROIS LANGNER ET AL., REDUCING TRANSACTION COSTS FOR ENERGY EFFICIENCY INVESTMENTS AND ANALYSIS OF ECONOMIC RISK ASSOCIATED WITH BUILDING PERFORMANCE UNCERTAINTIES, at v (2014), http://www.nrel.gov/docs/fy14osti/60976.pdf.

235 *See* Ronald H. Coase, *The Coase Theorem and the Empty Core: A Comment*, 24 J. LAW & ECON. 183, 183–87 (1981).

236 *See* LUIS MUNDACA, TRANSACTION COSTS OF ENERGY EFFICIENCY POLICY INSTRUMENTS 281 (2007).

237 LARS G. HEIN & KORNELIS BLOK, TRANSACTION COSTS OF ENERGY EFFICIENCY IMPROVEMENT (1995), http://www.eceee.org/library/conference_proceedings/eceee_Summer_Studies/1995/Panel_2/p2_12/paper.

238 *See* Bashford, *supra* note 10.

239 The text reads:

> Member States shall evaluate and if necessary take appropriate measures to remove regulatory and non-regulatory barriers to energy

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]

> efficiency, without prejudice to the basic principles of the property and tenancy law of the Member States, in particular as regards: (a) the split of incentives between the owner and the tenant of a building or among owners, with a view to ensuring that these parties are not deterred from making efficiency- improving investments that they would otherwise have made by the fact that they will not individually obtain the full benefits or by the absence of rules for dividing the costs and benefits between them, including national rules and measures regulating decision-making processes in multi-owner properties.

Directive 2012/27, of the European Parliament and of the Council of 25 Oct. 2012 Directive 2012/27/EU on energy efficiency, amending Directives 2009/125/EC and 2010/30/EU and repealing Directives 2004/8/EC and 2006/32/EC, 2012 O.J. (L 315) 19.

240 *See* ECONOMIDOU, *supra* note 59, at 11.

241 *See* ECONOMIDOU, *supra* note 59, at 5.

242 *See* Adam Mactavish et al., *Sustainability: Minimum Energy Performance Standards for Commercial Buildings*, BUILDING.CO.UK (June 26, 2014), http://www.building.co.uk/sustainability-minimum-energy-performance-standards-for-commercial-buildings/5069388.article.

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.[252] The three-party agreement includes an energy service company (ESCO).[253] Such arrangements have been mostly used in the United States,[254] and are not widely used in the EU.[255] 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.[256]

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.[257]

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

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252 *See* HEATING, VENTILATION & AIR-CONDITIONING HIGH EFFICIENCY SYSTEMS STRATEGY, FACTSHEET: OVERCOMING SPLIT INCENTIVES 1 (2013), https://www.environment.gov.au/system/files/energy/files/hvac-factsheet-split-incentives.pdf.

253 *See id.* at 3.

254 *See* ELISABETH STUART ET AL., CURRENT SIZE AND REMAINING MARKET POTENTIAL OF THE U.S. ENERGY SERVICE COMPANY INDUSTRY (2013), https://emp.lbl.gov/sites/all/files/lbnl-6300e_01.pdf.

255 *See* VINCENT BERRUTTO & PAOLO BERTOLDI, DEVELOPING AN ESCO INDUSTRY IN THE EUROPEAN UNION 2 (2004).

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.

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."[258] The EU FRESH project,[259] developed in Italy, showed the effectiveness of such energy contracting "for energy efficiency upgrades in the social housing sector on a large scale."[260]

The PAYS scheme is most common in the United Kingdom and Ireland,[261] as well as in the United States (called PACE)[262] and Canada.[263] In NYC, there have been successful PAYS projects, but some political barriers still need to be overcome.[264] However, electricity prices in New York State are among the highest in the United States;[265] therefore, any savings on the electricity bill would be highly appreciated by energy consumers. Also, this

258 *See* Jahi Wise, *Rural Middle-Income Energy Efficiency Project Catches a Spark*, CLEAN ENERGY FINANCE FORUM (May 8, 2015), http://www.cleanenergyfinanceforum.com/2015/05/08/rural-middle-income-energy-efficiency-project-catches-spark.

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.

261 *See* RTÉ NEWS, *'Pay as You Save' Retrofitting Scheme Planned* (Sept. 26, 2011), http://www.rte.ie/news/2011/0923/306505-energy/ (an example of the PAYS practice in Ireland); SMALLEST NORTHERN PERIPHERY PROGRAM, *Pay as you Save Scheme*, http://www.smallestnpp.eu/documents/4_PAYS.ppt (last visited May 2, 2017), for an example of the PAYS practice in the United Kingdom.

262 *What We Do*, WORLD RESOURCES INSTITUTE, http://pdf.wri.org/bottom_line_energy_efficiency_financing.pdf (last visited Dec. 31, 2016).

263 *See generally*, BRITISH COLUMBIA, ENERGY EFFICIENT BUILDINGS STRATEGY: MORE ACTION, LESS ENERGY (2007), http://www2.gov.bc.ca/assets/gov/farming-natural-resources-and-industry/electricity-alternative-energy/energy_efficient_buildings_strategy.pdf.

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

265 *See New York: Electricity Prices Explained*, CALL ME POWER (Nov. 26, 2014), http://callmepower.com/ny/tariffs/electricity-prices.

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,

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266 *Green Deal: Energy Saving for Your Home*, GOV.UK, www.gov.uk/green-deal-energy-saving-measures/overview (last visited Nov. l2, 2016).

267 *Green Deal: Energy Saving for Your Home*, GOV.UK, https://www.gov.uk/green-deal-energy-saving-measures/how-to-pay (last visited Feb. 9, 2016).

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 #ixzz3T5d1LN8j (last visited Oct. 24, 2016).

address default and risk concerns for financing the energy upgrades, and lower the interest rates.[271] Note that, in social housing units, landlords should be compensated for transaction costs[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.[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 *Investor Confidence Project* (ICP) belonging to the Environmental Defense Fund, "defines a clear road-map from retrofit opportunity to reliable [i]nvestor [r]eady [e]nergy [e]fficiency,"[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."[275] The establishment of standards facilitates the identification of energy efficiency best practice projects, setting "a credentialing system that provides third-party validation."[276] These improvements optimize transactions for energy upgrades, reduce costs and increase the market value of the buildings, allowing for a feedback process.[277]

Another example of improved access to information is the *one-stop solution center*, such as the one implemented in the

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271 *See* ECONOMIDOU, *supra* note 59, at 9.

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.").

273 *See id*.

274 *Certified, Standardized, Bankable Energy Efficiency Delivered to Market*, INVESTOR CONFIDENCE PROJECT, http://www.eeperformance.org/ (last visited Oct. 24, 2016).

275 ENVTL. DEFENSE FUND, BUILDING CONFIDENCE IN ENERGY SAVINGS 2, http://aceee.org/files/pdf/conferences/eeff/2013/Golden_4C.pdf (capitalization and punctuation in quote altered).

276 ENVTL. DEFENSE FUND, INVESTOR CONFIDENCE PROJECT EUROPE 2, http://www.edf.org/sites/default/files/icp_europe_fact_sheet_011215.pdf.

277 *See id*.

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.

279 *See* CHARLES GOLDMAN ET AL., ENERGY EFFICIENCY SERVICES SECTOR: WORKFORCE EDUCATION AND TRAINING NEEDS, at xvi–xviii (2010), https://eetd.lbl.gov/sites/all/files/publications/report-lbnl-3163e.pdf.

280 *See* ECONOMIDOU, *supra* note 59, at 10.

281 *See* GLOBAL ENV'T FACILITY, PROMOTING ENERGY EFFICIENCY IN BUILDINGS: LESSONS LEARNED FROM INTERNATIONAL EXPERIENCE 13 (2009).

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-ct5/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:

Proposal:	
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.
4. Financing	- Enhance public-private collaboration.
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.

	classified by type. - Financing instruments available and specific characteristics, indicating the most suitable for each type of renovation. - Best practice examples sharing: publication of the program's results, including data regarding the number of homes that accessed to the measures; the cost and energy saved; and the default rate associated with them. - All information should be collected in a one-stop source.
6. Behavior and voluntary measures	- Advertising and education campaigns on energy efficiency practices. - Information on the benefits of energy efficiency practices (in economic and health terms). - Promotion of vernacular and passive house standards.
7. Innovation	- Special efforts to invest in new technologies and ideas. - Promotion of competition for original energy efficiency solutions, such as the retrofit standardization initiative. - Comprehensive retrofits in particular should be promoted.
8. Split incentive	- Packaged policy solutions with combination of measures. - For all buildings: o Education campaigns o Revolving funds with a benefit charge supporting energy efficiency - For *large buildings:* standard third-party lease (with an ESCO), based on energy label improvements and sufficiently publicized (green lease). - For *smaller buildings*: on-bill financing (PAYS), designed to provide incentives to all stakeholders. - For social housing: o Social rent evaluation included in the energy performance of the building. o Staggered energy improvement requirements.

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.