

# Achieving a more Sustainable and Fair Society: How Individual and Collective Action Shape the Energy Efficiency of Buildings

*Conseguindo uma Sociedade mais Sustentável e Justa: Como a Ação Individual e Coletiva Molda a Eficiência Energética dos Edifícios*

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## 1. Introduction

According to the UN Conference on Sustainable Development held in Rio de Janeiro in 2012, the States have the responsibility “to respect, protect, and promote human rights”<sup>1</sup>. This important task is essential for achieving the three dimensions of the sustainable development (economic, social and environmental) of any society, and which in cities, given all the challenges they are already facing (and that will eventually be worsened), will need to include the necessary actions to “make cities and human settlements inclusive, safe, resilient and sustainable” (goal 11 of the UN Sustainable Development Goals)<sup>2</sup>.

The energy consumption in buildings is on the rise and represents almost half of total greenhouse gas (GHG) emissions in cities, which are the main cause of global warming on the planet. Indeed, the stock of ex-

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1 See the conference here: <<http://www.unosd.org/index.php?menu=242>> (section 9). For more information, see: KNOX, 2015, p. 517.

2 Available here: <<http://www.un.org/sustainabledevelopment/cities/>>, accessed 4<sup>th</sup> January, 2017.

isting buildings are responsible for around 40% of energy consumption and around 37% of carbon dioxide (CO<sub>2</sub>) emissions in most developed countries<sup>3</sup>. New buildings have a better energy performance in general, but there still room for improvement. The improvement of the energy performance of and in buildings in cities are already an essential element in the fight against climate change, but population grows, particularly in cities, the use of energy will become strategic in any public policy. Indeed, 70% of the world's population will live in cities by 2030<sup>4</sup>, producing a mayor increase in energy demand for buildings operation and maintenance, which will need to be tackled through energy efficiency measures. Therefore, putting all the efforts in order to achieve sustainable development in cities (SDGs, goal 11)<sup>5</sup> is both, “a practical imperative, and a strategic policy choice”<sup>6</sup>.

For that purpose, there is a great scientific consensus that improving energy efficiency of building systems and operations is a very effective way to tackle this important problem<sup>7</sup>, and many measures have already being put into place accordingly, including regulation, market based instruments, economic incentives and voluntary actions<sup>8</sup>. However, it is also known that the behavior of occupants in a building can have as much impact on energy consumption as the efficiency of the building equipment<sup>9</sup>. Hence, improving the behavioral patterns with respect to the performance of the energy users in existing buildings represents a great opportunity for reducing GHG emissions worldwide, complementing the conventional measures used for the improvement of the design and operation of the buildings, such as the regulatory, or others, more innovative, such as the market-based instruments or the incentives. Based on the most relevant experiences around the world, this paper seizes the opportunity to help improving the energy performance of buildings at a global scale, starting

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3 This is the largest end-use sector, followed by transport (32%) and industry (25%). European Commission. Staff Working Document. “Report from the Commission to the European Parliament and the Council. Financial support for energy efficiency in buildings”, COM (2013) 225 final (2013) 143 final, at 6. Available at: <<http://eur-lex.europa.eu/procedure/EN/202562>>, accessed 15 January 2016.

4 Available here: <<http://publications.wri.org/buildingefficiency/#c10>>, accessed 14 August 2016.

5 Available here: <<http://unsdsn.org/>>, accessed 14 August 2016.

6 Available here: <<http://unsdsn.org/wp-content/uploads/2016/07/9.1.8.-Cities-SDG-Guide.pdf>>, pp. 11-12, accessed 14 August 2016.

7 See WILSON et. al., 2012, p. 780. See also, EUROPEAN COMMISSION, 2014.

8 PAREJO-NAVAJAS, 2015.

9 See WORLD BUSINESS COUNCIL FOR SUSTAINABLE DEVELOPMENT, 2008.

with what would seem the most basic one: how to ameliorate the energy behavior of those using buildings.

Comprehending the energy consumption in buildings requires insight into the energy levels consumed over the years and the mix of fuels used in that energy consumption. Although there are several ways to reduce GHG emissions derived from energy use in buildings, experts have stated that “understanding and shaping behaviors can provide a significant boost in the more efficient use of all energy resources”<sup>10</sup>, reaching up to 25 to 30% of total energy savings<sup>11</sup>.

In essence, after showing some solutions that have been proven effective around the world, the paper outlines several recommendations for the improvement of the energy user’s behavior towards sustainable development of cities<sup>12</sup>.

## 2. The Meaning of Behavior Change

*Behavior* refers to the way in which one acts or conducts oneself, including not just people, but also organizations, and *behavior (or behavioral) change*, to “alterations in patterns of action and choices”<sup>13</sup> in this case, of occupants, operators and owners of buildings.

The way we live and consume is starting to get particular attention by policymakers<sup>14</sup>. Policies targeting sufficiency aim at capping or discouraging the rise of the use of energy due to the increment of the floor space, comfort levels, and equipment use<sup>15</sup>. This can be achieved mainly through regulation, voluntary actions or incentives. Indeed, individuals are not seen as mere bodies, upon which law and other moral practices should exercise their disciplinary effects. Now, (at least since the 20<sup>th</sup> century) liberal governmentality engages with individuals indirectly. It calibrates the behavior of individuals, modifying and acting on their milieu<sup>16</sup>.

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10 EHRHARDT-MARTINEZ, 2008, p. iii.

11 EHRHARDT-MARTINEZ, 2008, p. iii.

12 Available here: <<http://unsdsn.org/wp-content/uploads/2016/07/9.1.8.-Cities-SDG-Guide.pdf>>, pp. 11-12, accessed 14 August 2016.

13 WOLFE et al., 2014, p. 31.

14 Indeed, “the need to change consumer behavior and lifestyle, based on the concept of sufficiency” is gaining in importance in energy efficiency policy development. See WORKING GROUP III Technical Support Unit, 2014, p. 714.

15 LUCON, 2014, pp. 57 and 64.

16 FOUCAULT, 2008, pp. 229-230.

Behavior and culture drive substantial differences in building energy use. In many parts of the world, high performance mechanical cooling systems are used in excess or even capriciously, principally due to bad architectural design or the use of inappropriate materials for a specific climate (e.g. the overuse of glass in office buildings located in warm climates with a lot of sunlight)<sup>17</sup>, but also to lifestyles that lack a consciousness on the need to limit the excess in all possible forms. The same applies for the wasteful use of heating systems in many of those countries, in particular, in the US<sup>18</sup>.

However, there are still many barriers that need to be overcome, such as the lack of information for the building's occupants, managers or even the owners of the building, which lead to an absence of consciousness of their possible behavioral choices<sup>19</sup>. Indeed, behavior is conditioned by information, but also, by other measures, as it will be later explained. But building's occupants and operators are not usually "trained or informed" on how the building works, or even how their conduct may affect the energy performance of the building. Ultimately, the building's stakeholders –mainly building owners, managers/operators, and users- are the ones "living" (or using) the building. Sometimes the building's occupant is the same as the owner, but in most occasions, this is not the case, as residential buildings have multiple tenants, more commonly. Owners might have different interests than occupants, due to the "split incentive problem"<sup>20</sup>. Also, the role of operators or managers, which are mainly involved in the day-to-day problems of the building, is sometimes not sufficiently recognized<sup>21</sup>. But with the right incentives, they can play an important role in the improvement of the energy consumption behavior of the building users, revealing the "complicated network"<sup>22</sup> involved in the process.

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17 Available here: <<https://www2.buildinggreen.com/article/rethinking-all-glass-building-0>>, accessed 28 February 2015.

18 "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". Woods et. al., 2014, pp. 931-940.

19 Available here: <<http://www.wri.org/our-work/project/building-efficiency-initiative>>, accessed 14 August 2016.

20 For more information on the "split incentive" problem, see: EUROPEAN COMMISSION, 2014.

21 MOEZZI et al., 2014, p. 43.

22 MOEZZI et al., 2014, p. 54.

### 3. Some Ideas for the Improvement of the Energy Performance in Buildings through Behavior Change

Buildings function as “social systems”<sup>23</sup> that evolve overtime and, as such, reveal great complexity. Each individual within that system plays a specific role, which may not necessary be guided by sustainable development -or energy efficiency- objectives (e.g. the security of a building may advise for the lighting of the building during the night hours, despite the waste of energy it entails). Users (or occupants), managers (or operators) and owners, perform different tasks and activities within the system, but all of them would agree on the need for an adequate building environment. Therefore, focusing on the improvement of people’s behavior, through general measures and/or others targeting each specific group, is an opportunity to enable progress<sup>24</sup> towards sustainable development. And this can benefit from the most advanced technology at the lowest price (BAT principle)<sup>25</sup>, which is growing rapidly and is already mature enough to help improve the energy performance in buildings. That is why some guidelines need to be put in place in order to align building’s operational goals with those referred to the improvement of its energy performance, hence, the aim for sustainable development in cities. For that to happen, it would be necessary to know which conducts need to be changed, and, if so, how can they be transformed and which measures can be used in order to achieve behavioral change, where (and if) needed. This is what the ideas that follow will try to answer.

There are practices that have shown the effectiveness of promoting energy conservation behavior to achieve energy reductions by using various methods<sup>26</sup>. IPCC scientists, that have studied behavioral energy practices to achieve energy savings have concluded that: a) efficient thermostat settings are needed (cooler than average during the winter and warmer than average during the summer)<sup>27</sup>; b) dress codes and, cultural expectations towards attires in offices can be relaxed<sup>28</sup>; c) natural ventilation should

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23 MOEZZI et al., 2014, p. 64.

24 MOEZZI et al., 2014, pp. 59-60.

25 For more information about the BAT (best technology available at the lowest price) environmental principle, vir. Wurzel, Rüdiger.

26 SHEAU, BIN, WENG, 2011, pp. V1-376.

27 LUCON, 2014, p. 694.

28 LUCON, 2014, p. 694.

be possible in any building<sup>29</sup>, and d) lighting should be operational only during working hours (best 12h/day than 24h/day)<sup>30</sup>. Thus, design and education are key to achieving behavioral change which, in turn, can be accomplished through regulation and promoted through incentives, based on good information. The more educated (in the sense of being informed and conscious about the problem, and about the importance of individual action to find a common solution) a society is, the less the system will need to be based on hard law instruments to achieve compliance<sup>31</sup>.

What follows is a brief analysis of the possible measures to achieve a behavior change, when and where needed, from a double perspective: first, a static, referred to the design of the building -its structure and system and operation components-; and a dynamic one, relative to the use that those living/using/operating do of it.

1) Energy behavior deficits may start at the building design level (exterior design of the building, the material used, and also, the interior design, how it operates), hindering a better performance of the building's occupants. The building, its design and performance, conditions the individual behavior. Hence, the better the building performs itself, the easier to reach a more efficient energy behavior of its users.

– The *building's design* influences the individual's behavior (e.g. poorly isolated buildings lead to excessive use of energy for cooling and heating, or the location and appearance of the stairs of a building, which encourage or discourage the use of the elevator). At this stage of the process, architects and designers should be particularly cautious and choose the best options, and for that, *vernacular design* and *passive house standards* are a great baseline<sup>32</sup>. Example of this are the three Empire State Building retrofit key programs to influence tenant energy use, saving \$0.70–0.90 per s.f. in operating costs annually for an additional

29 LUCON, 2014, p. 695.

30 See here: <[https://www.mge.com/images/PDF/Brochures/business\\_ManagingEnergyCostsInOfficeBuildings.pdf](https://www.mge.com/images/PDF/Brochures/business_ManagingEnergyCostsInOfficeBuildings.pdf)>, accessed 3<sup>rd</sup> December 2015.

31 Available here: <[http://ec.europa.eu/smart-regulation/guidelines/tool\\_15\\_en.htm](http://ec.europa.eu/smart-regulation/guidelines/tool_15_en.htm)>, accessed 21 October 2016.

32 For more information on vernacular architecture and passive house standards, *vid.* for example: respectively, <<http://www.vafweb.org/>>.

cost of \$6 per s.f.<sup>33</sup> The ESB retrofitting project included design improvements (e.g. windows), equipment upgrading, and an ambitious tenant program, containing metering measures, guidelines on recommended strategies and use of efficient lighting techniques, and tenant incentive programs, such as the “feedate”, to distribute fees from those that missed sustainability targets to those exceeding them<sup>34</sup>.

– The architecture design must reach the *common adaptive comfort needs*. However, these may vary with cultural preferences and gender issues. Indeed, developed countries are less resilient to temperature conditions and therefore, need cooling or heating in less extreme circumstances. Also, temperatures are set for “an average man”, so cooling systems usually do not provide user comfort to women<sup>35</sup>. There are temperature standards for working spaces but they vary among countries, even in the EU<sup>36</sup> where there is a common regulation with Directive 89/391, EEC, as it only refers to the need for a room temperature “adequate for human beings”, without any further specification<sup>37</sup>. Buildings and their energy infrastructure need to be designed, built and used taking into account culture, norms and occupant behavior. Also, technology can improve vernacular designs<sup>38</sup>.

– *Building codes, energy codes and standards* set baseline requirements and govern building construction and retrofitting. However, they are usually focused on a single-element performance approach and not a whole-building approach<sup>39</sup>. They typically specify requirements for “thermal resistance” in the building shell and windows, minimum air

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33 Available here <<http://www.esbnyc.com/esb-sustainability/press-and-resources/empire-state-building-energy-efficiency>>, accessed July 24 2016.

34 Available here <[http://catalystreview.net/wp-content/uploads/2010/03/ESB-White-Paper\\_061809.pdf](http://catalystreview.net/wp-content/uploads/2010/03/ESB-White-Paper_061809.pdf)>, accessed 1 November 2016.

35 KINGMA; VAN MARKEN LICHTENBELT, 2015, pp. 1054-1056.

36 Available here: <<http://www.rehva.eu/publications-and-resources/rehva-journal/2013/022013/thermal-and-acoustic-comfort-requirements-in-european-standards-and-national-regulations.html>>, accessed 12 August 2016.

37 Available here: <<http://eur-lex.europa.eu/legal-content/GA/ALL/?uri=CELEX:31989L0654>>, accessed 23 July 2016.

38 PAREJO-NAVAJAS, 2015, p. 411.

39 PAREJO-NAVAJAS, 2015, p. 365.

leakage, and minimum efficiency for heating and cooling equipment. To this respect, examples in the EU have shown that the improvement of the space cooling can be achieved with a mandatory energy label. Enforcement of existing thermal regulations and implementation of subsidies and economic instruments like the Energy Efficiency Certificates (EEC) for homes and for appliances have also been proven very effective.

– Enforcement of existing regulations for appliances and lighting is key to accomplish energy efficiency goals.

2) However, if the building is well designed, its energy performance depends on how individuals operates, this is, on their (or the group's) conduct when using the building.

– *Information* is key to achieve behavior change and complements the other measures, including the regulatory. “Without the correct information about what constitutes an energy saving action, even motivated people are unlikely to make beneficial behavioral changes.”<sup>40</sup> The information policy should be considered part of the substantive functions of the public power and, as such, they are meant for both, the “enlightenment” of the audience, and the increase of the strength and effectiveness of the policy it self, but without enforcement being necessary<sup>41</sup>.

An example of improved access to information is the *one-stop solution center*, such as the one implemented in the UK, Sweden or in The Netherlands, which would help provide market incumbents with clear information and tools on energy renovation projects, including deep renovations<sup>42</sup>. Another example is the Spanish Energy Efficiency Certifi-

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40 Available here: <[http://ec.europa.eu/environment/integration/research/newsalert/pdf/understanding\\_the\\_why\\_to\\_effective\\_energy-saving\\_421na6\\_en.pdf](http://ec.europa.eu/environment/integration/research/newsalert/pdf/understanding_the_why_to_effective_energy-saving_421na6_en.pdf)>, accessed 3 August 2016.

41 The so-called “active publicity” is known in the U.S. as “nudge” or soft mechanisms for boosting certain social behaviors that are capable of substitute or at least complement more intense public power actions. This was used by the Obama administration and is explained in the book: SUNSTEIN, 2014. PAREJO ALFONSO, 2015, p. 162.

42 SHNAPP, 2014.

cate (EEC) Register, included in the most recent regulation<sup>43</sup> (some other Member States also have created them, like the UK), to comply with the informative requirements established by the European regulation<sup>44</sup>, is an effective measure. The Register is a statistical inventory on the EECs registered in each Autonomous Community –regions within the Nation– that helps inspection and monitoring activities, and that informs the public about the level of compliance in the energy efficiency objective.

On top of that, the information costs are key to overcome the “split incentive” for energy efficiency investment in the existing building stock. The *Investor Confidence Project* (ICP) belonging to the Environmental Defense Fund<sup>45</sup>, “defines a clear road-map from retrofit opportunity to reliable investor ready energy efficiency”<sup>46</sup> with important positive externalities, in particular, “increase market transparency, increase deal flow and enable origination channels, create standardization and enable data from the full project life cycle”<sup>47</sup>. The establishment of standards facilitates the identification of the energy efficiency best practice projects, setting “a credentialing system that provides third-party validation”<sup>48</sup>. These improvements optimize transactions for energy upgrades, reduce costs and increase the market value of the buildings, allowing for a feedback process<sup>49</sup>.

– *Educational campaigns* are necessary to guide the behavior of stakeholders, in particular, the occupants of the building, since they use the

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43 Royal Decree 235/2013, 5 April, on the basic procedure for the energy efficiency certification of buildings. Available, in Spanish, at: <[http://www.boe.es/diario\\_boe/txt.php?id=BOE-A-2013-3904](http://www.boe.es/diario_boe/txt.php?id=BOE-A-2013-3904)>, accessed 15 January 2015.

44 Article 20, Directive 2010/31/EU.

45 The EDF is a US non-profit environmental group. Available in: <<https://www.edf.org/>>, accessed 3rd January 2017.

46 Available in: <<http://www.eepformance.org/>>, accessed 5th December 2015.

47 Available in: <[http://aceee.org/files/pdf/conferences/eeff/2013/Golden\\_4C.pdf](http://aceee.org/files/pdf/conferences/eeff/2013/Golden_4C.pdf)>, accessed 5th December 2015.

48 Available in: <[http://www.edf.org/sites/default/files/icp\\_europe\\_fact\\_sheet\\_011215.pdf](http://www.edf.org/sites/default/files/icp_europe_fact_sheet_011215.pdf)>, accessed 5th December 2015.

49 Available in: <[http://www.edf.org/sites/default/files/icp\\_europe\\_fact\\_sheet\\_011215.pdf](http://www.edf.org/sites/default/files/icp_europe_fact_sheet_011215.pdf)>, accessed 5th December 2015.

appliances<sup>50</sup>. They can include public campaigns and outreach programs (workshops, media campaigns, videos, etc.) to encourage citizens to make an efficient use of the light. However, there is great risk in “targeting behavior at the expense of knowledge”<sup>51</sup>, if these campaigns do not explain the energy savings. Education and awareness raising are key elements of the informative measures, in which local authorities play an essential role for the success of the communication strategy on sustainable energy use. Example of this is the “Birdie” character that arose from the GreeNYC within PlaNYC (2007), “to create a consistent and compelling voice for the City's environmental communications with the public”<sup>52</sup>.

A benchmark example of citizen awareness due to access to information and educational campaigns 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, as space cooling is negligible “due to cultural preference for natural ventilation”<sup>53</sup>.

With respect to the construction and real estate sectors, *training*, as an information tool, is especially important for managers and operators, and should be constantly updated according to the best state of the technology<sup>54</sup>.

– *Feedback techniques* to raise awareness of energy use and its costs. Continuous feedback has been proven to be more effective than weekly or monthly.<sup>55</sup> Group feedback is more effective when compared with other group's performance.<sup>56</sup> Example of this type of measure is the *regional training for planning and monitoring energy efficiency measures in the*

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50 Available in: <[http://www.edf.org/sites/default/files/icp\\_europe\\_fact\\_sheet\\_011215.pdf](http://www.edf.org/sites/default/files/icp_europe_fact_sheet_011215.pdf)>, accessed 5th December 2015.

51 Available in: <[http://www.edf.org/sites/default/files/icp\\_europe\\_fact\\_sheet\\_011215.pdf](http://www.edf.org/sites/default/files/icp_europe_fact_sheet_011215.pdf)>, accessed 5th December 2015.

52 Available in: <<http://www.nyc.gov/html/gbee/html/initiatives/greenyc.shtml>>, accessed 3 July 2016.

53 Available in: <<http://www.nyc.gov/html/gbee/html/initiatives/greenyc.shtml>>, accessed 3 July 2016.

54 GOLDMAN et al., 2010.

55 WOLFE et al., 2014, p. 53.

56 WOLFE et al., 2014, p. 53.

*building sector*, commissioned by the German Federal Ministry for Economic Cooperation and Development. The program develops training courses “for auditors to assess the energy efficiency of buildings, as well as advanced specialist training for the inspection of boilers, heating and ventilation systems and for monitoring implementation of energy-efficiency measures” in South-East European countries<sup>57</sup>.

– *Incentives and rewards* are promotion-type measures, designed to foster a better conduct of individuals in their energy performance in buildings and therefore, should be driven by the public sector, although the private sector can (and should) collaborate<sup>58</sup>. They are meant to transform or direct the individual’s behavior towards an established goal and take the form of grants and subsidies, tax credits, rebates, low interest loans, energy-efficiency mortgages, among others<sup>59</sup>.

The “weapons of influence”<sup>60</sup> are an incentive group of measures created by Cialdini<sup>61</sup> to change the behavior of individuals through “persuasion”, leading, in this specific case, to a more efficient use of energy by individuals. They include i) reciprocity (vs. group competition), as if everyone gives something away, everyone stands to gain; ii) commitment and consistency strategies, giving tribute to a specific idea or goal; iii) social proof, being approved or recognized as a good practice by the group; iv) authority and leadership of the messenger to spread the idea or goal, which needs to be carefully selected; vi) scarcity (in this case, of energy sense), to reduce its demand, as a short-term emergency measure.

The public commitment to encourage behavior change linked to a specific goal has been proven to be more effective than private ones, as the former is connected to social values and norms, meaning that a specific

57 Available here: <<https://www.giz.de/en/worldwide/20317.html>>, accessed 5 August 2016.

58 Example of the public-private partnership is the EeB partnership (energy efficiency in buildings), between the European Commission and the private sector, represented here by the Energy Efficiency Building Association, to use and integrate technology to reduce GHG emissions in buildings, to transfer the building industry into a sustainable business, attracting investors and to develop and innovative industry to improve the EU competitiveness around the world.

59 PAREJO-NAVAJAS, Teresa. *op.cit.*, p. 367.

60 See: CIALDINI, Robert B. *Influence Science and Practice*. Boston: Allyn and Bacon, 2001.

61 See: <[http://www.influenceatwork.com/wp-content/uploads/2012/02/E\\_Brand\\_principles.pdf](http://www.influenceatwork.com/wp-content/uploads/2012/02/E_Brand_principles.pdf)>, accessed 4 August 2016.

behavior is “acceptable in a societal group”<sup>62</sup>. However, incentives and rewards need to be carefully selected as they might provoke the opposite effect (e.g. money rewards)<sup>63</sup>. Example of this is the energy bill showing the performance of all tenants comparing the energy data to generate a behavioral change in those with an inefficient use of energy: comparing energy bills among neighbors might generate an increase in the energy consumption of those below the norm (boomerang effect)<sup>64</sup>. Several companies around the world, such as OPOWER in the U.S. “provide software solutions to utilities to implement this comparative billing strategy”, and have shown excellent results<sup>65</sup>. However, at the end, the implementation of a single measure is never the way to solve the problem and at the end, what works is a combination of measures.

Also, the “green building” rating schemes are effective reward systems for the promotion of energy efficient buildings. Although not the only ones, the most well known are the Building Research Establishment Environmental Assessment Method (BREEAM), originated in the UK, and the Leadership in Energy and Environmental Design (LEED), in the U.S.<sup>66</sup>.

– *Social marketing* at the community or group level, to encourage individual change. A best practice example is the *Project Porchlight* campaign, sponsored by utilities and governments across the U.S. and Canada. The campaign is a support public policy to encourage the use of more efficiency CFL bulbs and the implementation of energy programs promoted by the utility company. The success of the campaign was based on the involvement of the whole community, the use of volunteers, and the economies of scale.

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62 WOLFE et al., 2014, p.58.

63 WOLFE et al., 2014, p.58.

64 WOLFE et al., 2014, p.58.

65 Resulting in energy usage reductions averaging 1.5-3.5% per customer in pilots across the US. Available in: <<http://www.environmentalleader.com/2010/03/22/using-social-marketing-to-promote-energy-efficiency-and-conservation/#ixzz4HNz3W6sb>>.

66 See: <[https://www.esmap.org/sites/esmap.org/files/DocumentLibrary/ESMAP\\_Energy\\_Efficient\\_MayoralNote\\_2014.pdf](https://www.esmap.org/sites/esmap.org/files/DocumentLibrary/ESMAP_Energy_Efficient_MayoralNote_2014.pdf)>, p. 13.

Taking into account all the previous, and according to the World Resources Institute<sup>67</sup>, four are the main measures to improve the behavior in the use of energy in buildings: i) *competition and challenges*, involving games that foster social integration and reward mechanisms, that are not necessarily monetary; ii) *occupant engagement* for tenants in commercial buildings (such as the Empire State Building retrofitting program); iii) *occupant feedback*, that uses individual information on their use of energy in real time (via smartphones); and iv) *Strategic Energy Management (SEM)*, that includes and audit and training programs.<sup>68</sup> All these measures involve incentives, information, and education actions, and should be complemented by others, such as regulation and market-based instruments.

#### 4. Conclusion

Buildings are complex social systems in which behavior of individuals is managed by regulations, informal rules, social norms and incentives. In this context, behavioral change in buildings must be undertaken at the different levels within the system and its success depends on compliance as well as on knowledge and individual capabilities and role performance expertise. Information, transparency and training are key to keep the system evolving and achieve internal and external challenges, to which measures and policies must adjust<sup>69</sup>.

Therefore, behavioral measures and policies for the improvement of the energy performance in buildings must take into account:

- Buildings and their energy infrastructure need to be designed, built, and used taking into account culture, norms, and occupant behavior;
- Technology can improve vernacular designs;
- Enforcement of existing regulations for appliances and lighting is key to accomplishing energy efficiency goals;
- Incentives complement regulatory measures to transform or direct the individual's behavior towards an established goal without enforcement;
- Informative measures, which need to complement the mandatory ones;

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67 WORLD RESOURCES INSTITUTE & WRI ROSS CENTER FOR SUSTAINABLE CITIES, 2016.

68 WOLFE et al., 2014, pp. 96-99.

69 WOLFE et al., 2014, p. 32.

- Educational campaigns, which are necessary to guide the behavior of stakeholders, especially tenants, since they use the home appliances;
- The public sector should take the lead and set the standards, although public-private collaboration is necessary;
- Success is always the result of a combination of measures. Yet, those measures need to be complementary.

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