GBPN
Global Buildings Performance Network

Building Policies for a Better World

WHAT IS A DEEP RENOVATION DEFINITION?

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LIST OF ACRONYMS

AERG- Advanced Energy Retrofit Guides
CO_2 - Carbon dioxide
DHW- Domestic hot water
DOE- US Department of Energy
DR- Deep renovation/ refurbishment/ retrofit
EED- EU Energy Efficiency Directive
EPBD- EU Energy Performance Building Directive
ESCO - Energy Service Company
EU- European Union
GBPN- Global Buildings Performance Network
GHG- Greenhouse gas
HVAC- Heating, ventilation, and air conditioning
kW- Kilowatt
kWh - Kilowatt-hour
MEP- Member of the European Parliament
nZEB- Nearly Zero Energy Building
O&M- Operations & Maintenance
US- United States

EXECUTIVE SUMMARY

Existing Buildings Mitigation Potential by Renovating Deeply

A huge potential for energy savings lies in the renovation of the existing building stock. It is a prerequisite that these buildings are renovated "deeply" for the building sector to reduce their greenhouse gas (GHG) emissions and meet global energy reduction objectives. The Global Building Performance Network's (GBPN) mission is to dramatically reduce the energy use of existing buildings and consequently reduce the GHG emissions associated. GBPN facilitates this by following a "deep energy efficiency scenario".

An agreed upon understanding of DR (deep renovation / retrofit / refurbishment) and the major challenges surrounding this issue will support development at a regional or national level and will call for global action. The acronym "DR" is used in this document because most regions use different definitions or expressions for the action of a deep improvement. The most commonly used expressions are: deep renovation, deep retrofit, deep refurbishment, and to a lesser extent, deep reduction. The problem is that these expressions mean different things to different analysts. Thus, there is a need to come to a better understanding to minimise confusion and mis-communication. A standard renovation or refurbishment will often harvest the minimum possible energy savings, ranging between 20% and 30%, sometimes even less. However, by renovating deeply, using state-of-the-art technologies, it is possible to reduce the energy consumption of a building by more than 75%.

Webinars and Questionnaire – Methodology

The GBPN organised a project to help provide a harmonised DR definition, these include. The project included two webinars, a questionnaire and a review process. Initially, a desktop research study was completed to collect current global and local definitions and conditions of a deep renovation. The findings were presented in a webinar that comprised of thirty international experts in the field of building renovation. The webinar was used to collect the opinions and understandings of what these experts believe to be a DR definition. These opinions were presented as conditions and targets of a DR definition in a questionnaire that was sent to the same group of experts. The questionnaire sought to harmonise and clarify a definition for DR.

What is Deep Renovation?

What does deep renovation mean? It became obvious from the reaction of the panel of experts that there is no common definition of DR established, neither at a regional or international level. The definition of DR varies between the regions. The results of the questionnaire displayed a clear distinction between the terms "deep renovation" and "deep retrofit". Experts from Europe found that renovation was the term most commonly used whereas experts from the US found that retrofit was the term usually used. Generally, the definition relating to a deep renovation aimed for the deepest reductions of all the terms, these improvements mainly concern the buildings envelope. The definition of a retrofit focuses mainly on the building's mechanical systems.

In Europe most definitions focus on heating, cooling, ventilation and hot water and the general understanding is that these should lead to an improvement of at least 75% after the building has been renovated. Most commonly, DR in the US calls for improvements in the range of 30% – 50%, however, this is based on full energy consumption including plug load. The relative targets or the final energy consumption after a deep renovation / retrofit project will range within the values mentioned in the definitions depending on climate zones, loads and type of buildings and should be specified at local level.

The end result of this exercise resulted in the GBPN and its experts setting some commonly agreed definitions of deep renovation and retrofit. GBPN will use the definitions stated in chapter "Deep Renovation Definitions"[1] and will be consistent in using these.

[1] The full list of definitions can be found in chapter "Deep Renovation Definitions".

INTRODUCTION

The GBPN and its Four Key Regions

If the current greenhouse gas emissions (GHG) emission reduction objectives set by policy-makers are to be met, it is necessary for the building sector's emissions to be considerably reduced. For this reason the Global Buildings Performance Network's (GBPN) mission is to significantly reduce GHG emissions associated with building energy use. This involves making standard best practice policies and state-of-the-art technologies by 2020, a time-frame of less than 10 years. For existing buildings this means that energy efficiency improvements must be standard practise for all renovations.

The GBPN work specifically in four regions – China, Europe, India and the United States. Together, these regions are responsible for nearly two-thirds of the buildings sector's global GHG emissions and a similar share of the mitigation potential.

Context

Buildings use around two thirds of the total global energy use and represents more than 30% of global energy-related CO_2 emissions, existing buildings will account for a major part of this consumption, especially in developed countries (Urge-Vorsatz et al., 2012). By 2050, energy use from buildings is expected to double due to a global rise in floor area of around 130%, a rise in thermal comfort levels and today's policy trends not being ambitious enough.

Energy improvements in new buildings can be made through state-of-the-art technologies and policies becoming today's standard practice. Large energy savings in existing buildings can be realised by renovating deeply. A study commissioned by the GBPN and prepared by the Central European University (CEU), the 'deep energy efficiency' scenario (from now on called the deep scenario) "demonstrates how far today's state-of-the-art construction and retrofit know-how and technologies can take the building sector in reducing energy use and CO_2 emissions, while also providing full thermal comfort in buildings." (Urge-Vorsatz et al., 2012). This 'deep' scenario demonstrates that the anticipated growth of energy use of the building stock can become a reduction of global total energy use of around 30% by 2050 if current state of the art mechanisms are applied and realised on a large scale.

The GBPN has chosen to focus on and promote the implementation of this 'deep' scenario. This scenario shows that following state-of-the-art-deep renovation practices presents the existing building stock with a huge opportunity to reduce GHG emissions and meet current climate change targets.

Existing Buildings

Following the deep path means that ambitious energy efficiency improvements must become standard practice for all buildings that are undergoing major (even minor) renovation within 10 years. For new buildings, standards that establish a minimum level of performance can be put in place to ensure maximum building efficiency. The deep path becomes even more challenging when it comes to existing buildings, as there are many varying factors that determine the overall performance and saving potentials of these buildings and the possibilities to change are more limited.

A state-of-the-art energy renovation can, in many cases, reduce the energy consumption of a building by more than 75%. However, a standard renovation or refurbishment will often achieve energy savings in the range of 20% to 30%, sometimes even less. In order to meet stringent climate change objectives and to avoid the worst-case scenarios of climate change, buildings need to reduce their carbon emissions by 50% (UNEP-SCIB, 2009). This is impossible unless new and renovated buildings are designed to be highly energy efficient and use much less energy compared to what is used today. Even though highly efficient building technology is readily available, deep renovations are not in demand and are not yet standard practice. Deep renovation is at a very early stage of market uptake; this is confirmed by the confusion that arises when trying to define a "deep renovation".

At present, there is not a standard definition for a 'Deep Renovation'; on the contrary there are many different meanings that vary across regions. The acronym "DR" is used in this document due to different regions using different terms for the action of a deep improvement, the most commonly used are: deep renovation, deep retrofit, deep refurbishment, and to a lesser extent, deep reduction.

Most examples of DR are at an experimental or demonstration stage. The fundamental goal of this on-going DR project is to find out how we can up scale DRs, a key initiative for the existing building stock. For this purpose, this paper presents a unique attempt at defining DR. This on-going DR project will also attempt to identify the necessary criteria in selecting best practice buildings and best practice policy packages however this will not be documented in this report[2] (this project looks into the specific sub-criteria that can characterise some policy package best practices that encourage for DR projects to become widespread). In order to assist in defining DR and coming up with a robust set of DR criteria GBPN convened a steering group of stakeholders who are actively working with "DR"s globally or more specifically in certain regions. GBPN collaborated with these experts to come up with a clear, transparent and harmonised definition of a deep energy efficiency building improvement.

[2] Find out more about the DR Criteria project at: http://www.gbpn.org/laboratory/more-and-deeper-renovation

BACKGROUND STUDY ON DR

DR Context in the EU

In order to identify existing definitions GBPN conducted a desk study on current state of the play and looked at existing projects and definitions. The main part of the experience was found in European Union (EU) and the United States (US). The recast of the EU's Energy Performance of Buildings Directive (EPBD) (Directive 2010/31/EU) is one of the most ambitious in the world in terms of renovation of buildings. However, it does not mention the term "deep renovation". The EPBD lays down the application of minimum requirements to the energy performance of existing buildings; building units and building element that are subject to major renovation. A "major renovation" in the EPBD means the renovation of a building where:

(a) The total cost of the renovation relating to the building envelope or the technical building systems is higher than 25% of the value of the building, excluding the value of the land upon which the building is situated; or
(b) More than 25% of the surface of the building envelope undergoes renovation.

This definition identifies a "window of possibility" for a "deep renovation". The minimum energy requirement will be set by the individual member state; however, this must be based on the EPBD Article 4 that states a minimum energy performance requirements "are set for building elements that form part of the building envelope and that have a significant impact on the energy performance of the building envelope when they are replaced or retrofitted, with a view to achieving cost-optimal levels". This does not prescribe deep renovation but provides an opportunity to renovate with energy performance as a priority, including for building envelope elements that are retrofitted or replaced.

Deep Renovation is, however, mentioned in the EU's recent adopted Energy Efficiency Directive (EED) (2012/27/EU) from 2012 in Article 5. This obliges member states to renovate 3% of the total floor area of public buildings. These renovations must meet at least the minimum energy performance requirements that it has set in application of Article 4 of the EPBD (stated above). This applies to all buildings over 250 m^2.

Article 4 in the EED requires member states to establish a "a long-term strategy for mobilising investment in the renovation of the national stock of residential and commercial buildings, both public and private. This strategy must encompass "policies and measures to stimulate cost-effective *deep renovations* of buildings, including staged deep renovations".

On the 30th of July 2012, the European Parliament published a report on the "on the proposal for a directive of the European Parliament and of the Council on energy efficiency and repealing Directives 2004/8/EC and 2006/32/EC**".** In this report the European Parliament published a proposed definition for deep renovation (Amendment 28, Article 2, paragraph 1, point 27.a) (European Parliament, 2012). The commission proposed, "*'deep renovation' means a refurbishment that reduces both the delivered and the final energy consumption of a building by at least 80% compared with the pre-renovation levels."*

The buildings community, stakeholders and politicians in the EU are beginning to take an interest in deep renovations. Other definitions of deep renovation that GBPN have come across during its research are:

- RENOVATE EUROPE - Deep renovation can achieve a reduction in energy consumption of between 60% and 90%, for the majority of Europe's buildings. When this building renovation takes place, all available energy saving technologies must be incorporated (RenovateEurope, 2013).
- EURIMA & Laustsen - Energy performance reductions can be classified systematically as factor 2, 4, 6 or 10 renovations, indicating energy consumption reductions of 50%, 75%, 84% or 90%, respectively, compared to pre-renovation performance (EURIMA, 2011).
- IEA - Deep renovation: Deep renovation is the renovation that doesn't lock the savings potential. Deep renovation is achievable only if the overall energy performance of the building is considered when designing the renovation programme (Saheb, 2012).

- ROCKWOOL's "potential" DR definition: Normally, deep renovation is undertaken in conjunction with a major renovation of the building or buildings and/or as part of the standard 30-40 year renovation cycle, using a cost-optimal approach. In poorly performing buildings, energy performance can often be improved by a factor of four, or between 65% - 95%, compared with pre-renovation levels, primarily by reducing final energy consumption." (Bowie, 2012).

DR Context in the US

The US Department Of Energy (DOE) promotes energy technology and innovation in the US. The DOE have set a "Better Buildings Initiative" challenge that pushes for a 20% reduction of energy across a portfolio of commercial and industrial buildings by 2020.

The DOE has designed "Advanced Energy Retrofit Guides" (AERGs) for existing buildings in order to assist building stakeholders in the selection of energy efficiency improvements. Within these guides they claim "deep retrofits can reduce a building's energy use by over 50%. Deep retrofit projects combine many O&M and standard retrofit measures in an integrated whole-building design approach".

"Deep" Retrofit in the US is supported by some influential organisations whose missions are to stabilize and reverse the emissions that the 'Building Sector' contributes to. Some descriptions of "deep" retrofits in the US:

- NEW BUILDINGS INSTITUTE– Conventional retrofits typically result in savings of only 15% to 25%, whereas recent deep retrofits showed 30% to 60% savings in a wide range of projects (NBI, 2012).
- THE ROCKY MOUNTAIN INSTITUTE - We define deep energy retrofits as a whole-building analysis and construction process that achieves much larger energy cost savings– sometimes over 50% reduction–than those of conventional, simple retrofits and fundamentally enhances the building value (RMI, 2012).
- 1000 HOME CHALLENGE - "Deep retrofits take a whole-building approach, addressing many systems at one time. Projects are strategically implemented over time, with the goal of achieving multiple energy-saving benefits from each project. Deep retrofits are most effective for buildings with poor overall efficiency and a variety of systems nearing the end of their useful life (Wiggington, 2012).

PROCESS

In order to define a deep renovation there are certain components that need to be explored. For example: How deep is deep? What are the maximum / minimum 'deep' targets? Should a deep target be set as relative or absolute? When searching for ways to define a deep definition the GBPN research team came across numerous conditions that were in need of clarification.

A tiered research approach was taken to clarify and harmonise the definition of a DR (two webinars and an online survey with a group of experts). The webinar series gave attendees a chance to deepen discussions and express their opinions.

GBPN sought to seek consensus on topics that arose either during the research or the webinar by designing a questionnaire. The questionnaire encompassed different parts of a DR definition. The survey was completed online with the same group of experts who attended the webinar. The purpose of this was to refine what the experts consider to be a DR, find out where the similarities and differences between the experts and regions and, finally, come up with a clear DR definition. The final webinar presented the findings of the questionnaire and gave the experts a chance to discuss the DR definition.

This research work brings frontend experts together; GBPN selected the experts based on their expertise and interest in the development of policy actions to up scale DR. The tiered process includes the same core group of experts to ensure that harmonisation is gradually increased and that a common framework for future collaboration is developed. Within this group, the experts were active in six regions of the world. Thus far, this process has brought together thirty international DR specialists.

The First Webinar

The first webinar allowed for all conditions found within a deep renovation definition to be explored. After summarising the GBPN research the participants provided expert opinion on the prerequisite conditions for the definition of a deep renovation.

The results of the first webinar supported our research findings: there is no clear regional or global deep renovation definition. These findings led us to further investigate the definition of deep renovation and the GBPN designed a 'Deep Renovation Definition Questionnaire'.

The Questionnaire

GBPN established a "Deep Renovation Definition Questionnaire to target the issues and ambiguities that arose during the research and webinar. This was sent out to the same group of experts. The questionnaire was completed by 23 of the 30 experts, responding from different regions and sectors. These experts were asked a series of different questions relating to the definition. The questionnaire allowed for the essential conditions of a deep renovation to be defined individually by each expert. The final conditions considered within the DR Questionnaire were:

- Absolute and relative targets
- Energy demand and energy consumption
- Energy or CO_2 savings
- Primary or final energy
- Type of final use to be included
- Level of relative targets
- Final consumption after renovation
- Best term for DR.

Although there were some areas of agreement there were also issues where further clarity was required. The results – the agreed definitions and the problematic areas – were presented during the second webinar.

The Second Webinar

The second webinar presented the findings of the questionnaire with the aim of resolving any unsolved issues. This webinar drew many conclusions from the questionnaire; however it also brought to light further complications when defining a deep renovation, these included:

- Saving targets: building type
- Saving targets: building vintage
- Savings target: individual building or group of buildings
- Saving targets: local climate
- Staged deep renovation.

Further discussion on these questions will take place in the laboratory of "More and Deeper Renovation" at the GBPN.org website.

DR RESULTS

The questionnaire looked more closely at some of the definitions, which were presented in the first webinar. In particular it aimed to clarify the different terms of DR and how these were perceived in the GBPN regions and in the rest of the world.

Geographically, the 23 experts are active in six different regions around the world: China, Europe, India, Latin America, South-East Asia and US. Approximately one-quarter of the experts were active in more than one region. Almost 80% of the respondents work in the EU and 40% in the US.

Question 1. Should policies set absolute or relative targets for savings?

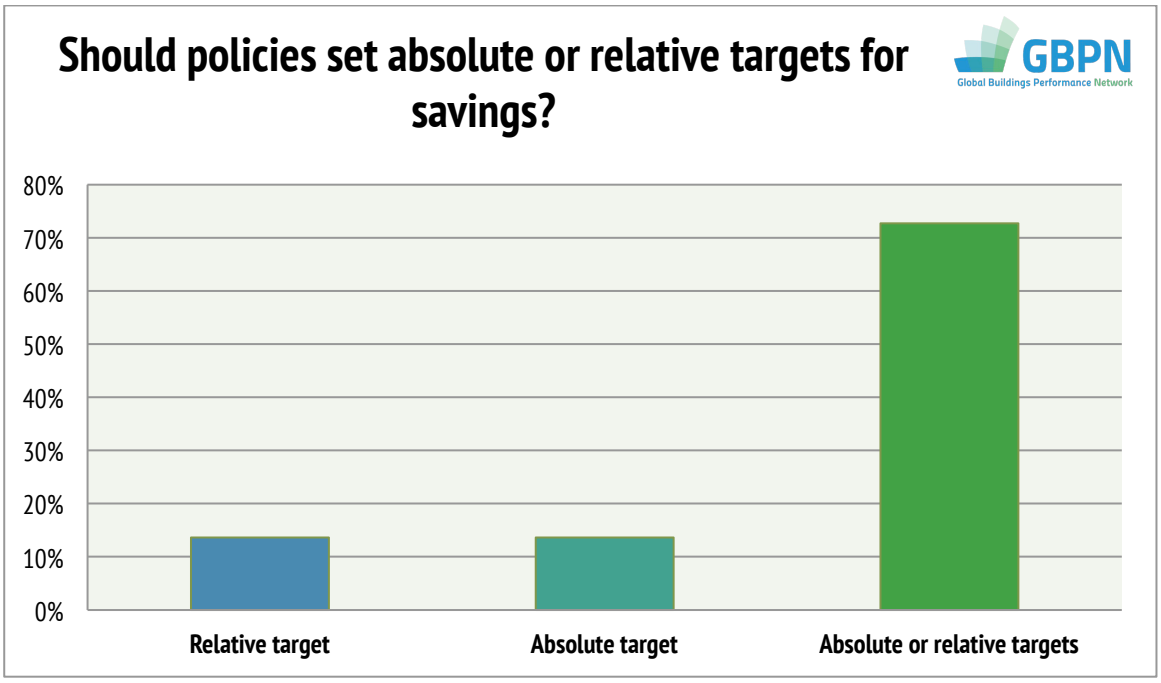

Figure 1: Findings: Absolute or Relative Targets in per cent.

Around 75% of the respondents think that policies should set both relative and absolute targets. However, many experts mentioned that defining an appropriate relative and absolute target is challenging due to the differences in building types, geographies, climate zones, etc.

Question 2. Should the targets be based on energy demand or energy consumption?

The energy consumption, which is the amount of energy consumed in the form in which the user acquires it, will reflect behavioural/occupancy loads, degree-days and other effects on the energy consumption of the building, as well as design flaws.

The energy demand data (amount of energy required by the systems installed in a building to maintain the habitable conditions of the indoor environment), is easier to obtain, and indicates what the theoretical or designed energy demand (or use) would be under normal conditions, even before the building is taken into use. Demand and consumption are closely related and usually show a certain convergence.

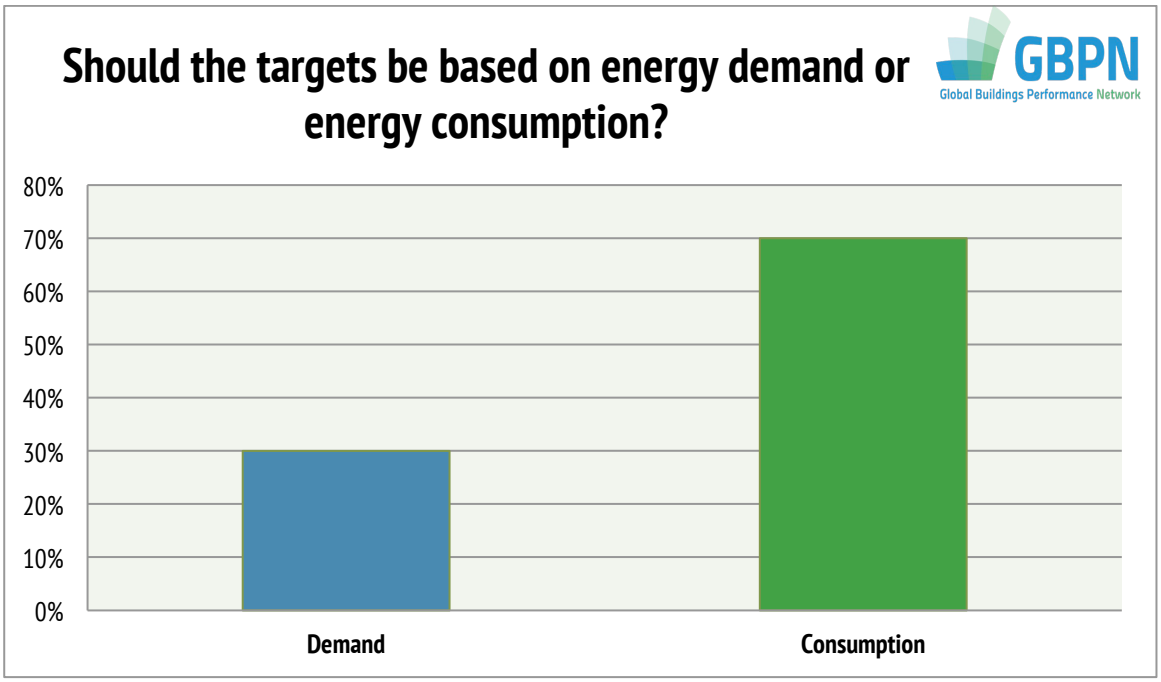

Figure 2: Findings: Energy Demand or Consumption.

Both energy consumption, which is the measured or metered values and the energy demand, which is the estimated or calculated energy are worth considering when defining the targets.

The general opinion of the experts is that targets should be expressed in terms of consumption. However, all experts agree that this is more difficult to quantify as in order to accurately calculate the building's consumption, the installation of smart meters is required. Furthermore, in the EU, tenant consumption data is not open sourced; this is seen as being controversial as it effectively depends on user behaviour (even a very efficient building used incorrectly can have a large energy consumption).

Question 3. What kind of savings should DR policies include? (Energy or CO_2)

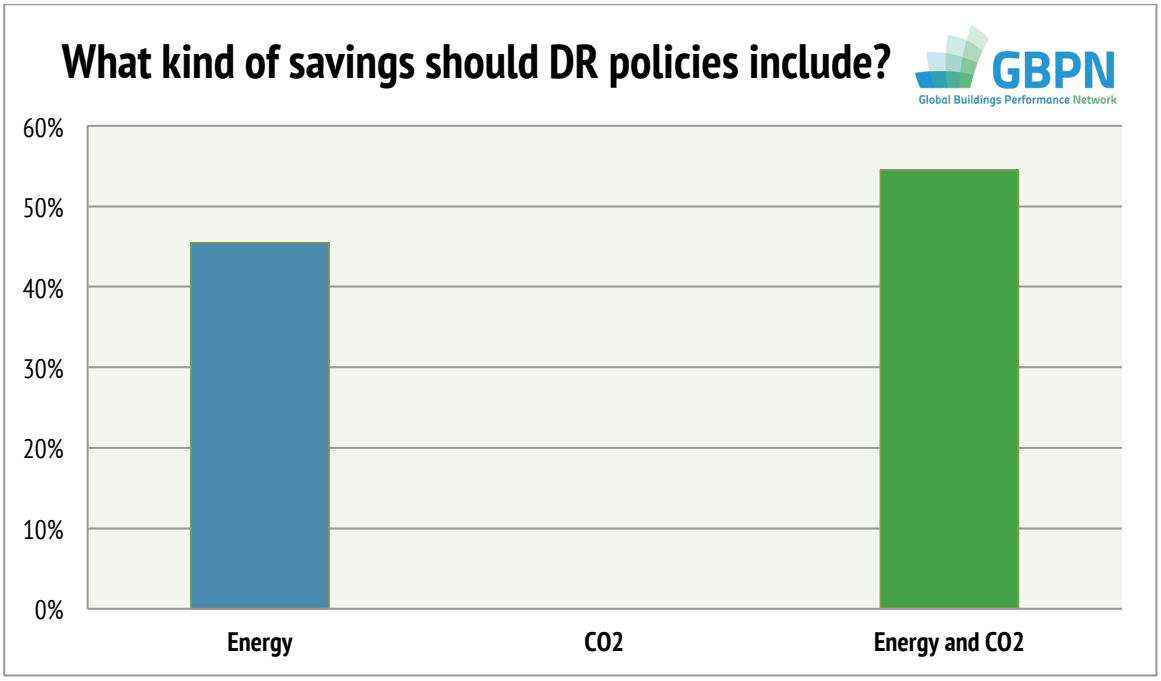

Figure 3. Findings: Energy or CO_2 savings.

Most experts consider that the main focus of DR should be based on the energy performance or a combination of energy performance and CO_2 emissions. The only way for the building sector to meet ambitious CO_2 targets is to drastically reduce the energy required by the building stock.

Question 4. The energy target should apply to… (Primary or final energy)

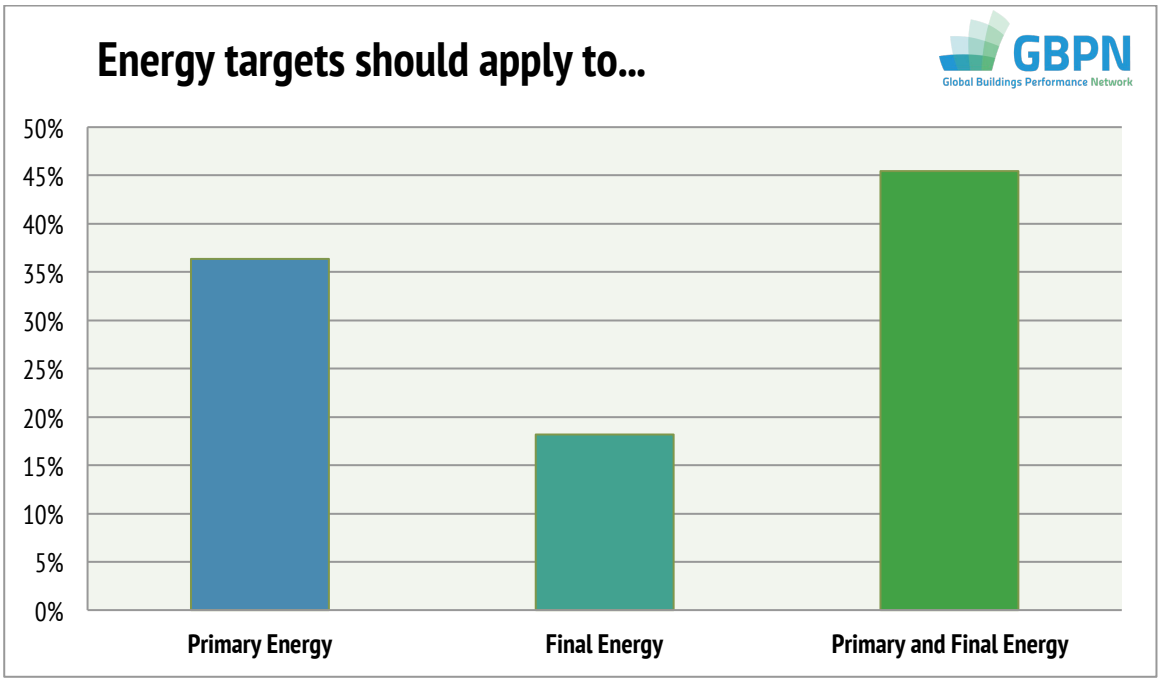

Figure 4. Findings: Primary Energy or Final Energy Targets.

Almost 50% of the experts would consider using both final and primary energy in the definition of DR. The other results showed that most experts consider primary energy targets before final energy targets. A sensible approach would be to link:

- Final energy use to the building, in order to encourage efficient design and operations; and
- Primary energy to associated carbon emissions in order to encourage carbon free generation and efficient distribution on the part of the utilities.

Question 5. Energy use should include… (HVAC/DHW/Appliances/Lighting).

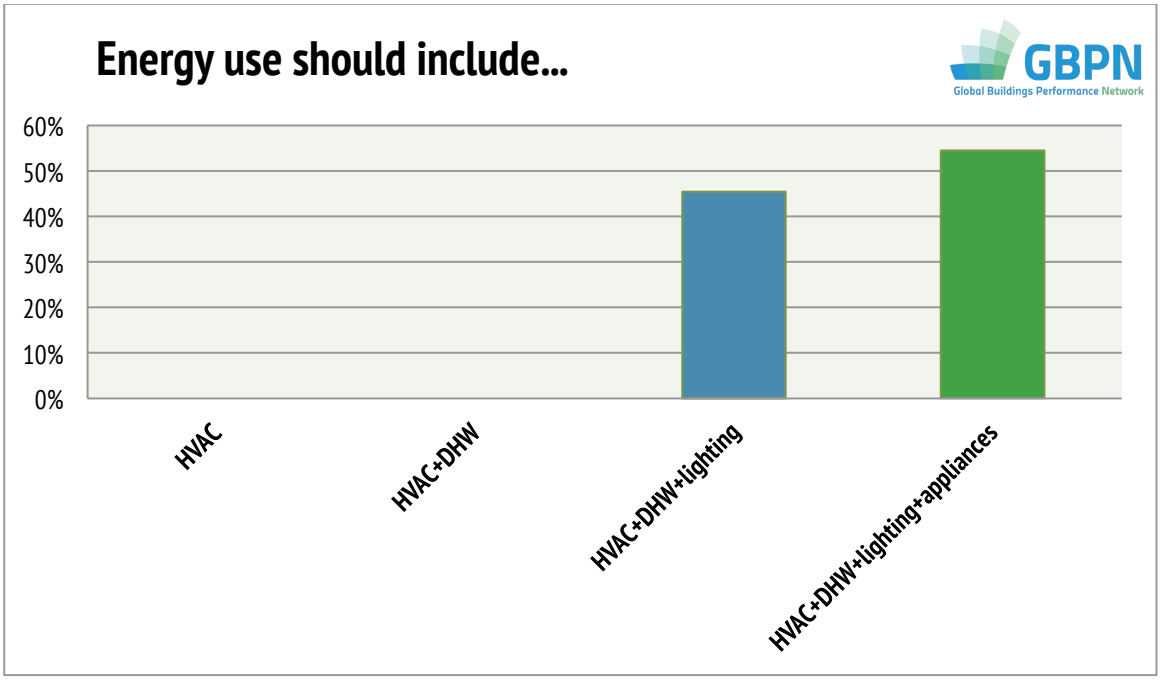

Figure 5. Energy Use Should Include

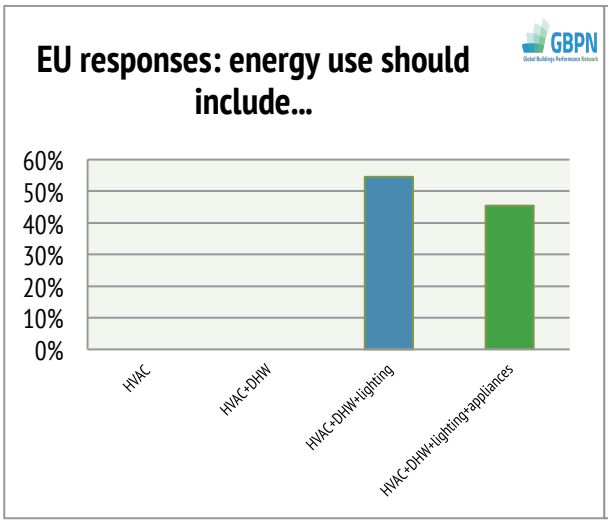

Figure 5.1. EU Energy Use

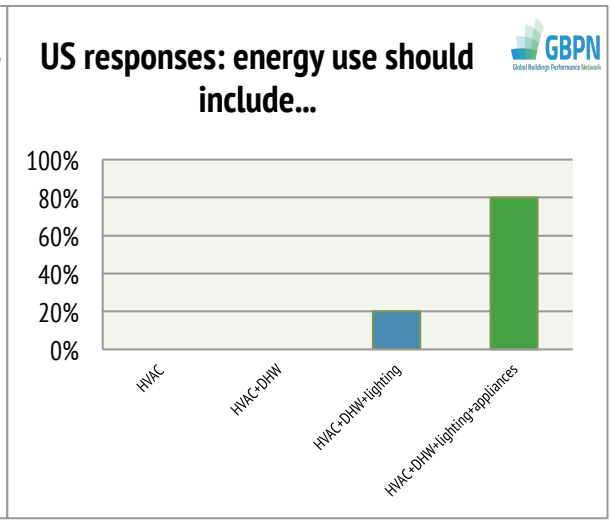

Figure 5.2. US Energy Use

The majority of experts consider that loads from HVAC, DHW, lighting and appliances should be considered in the definition. However, the results show large regional differences. Most European experts consider the definition of the 'energy performance of a building' to be as stated in the EPBD: "the calculated or measured amount of energy needed to meet the energy demand associated with a typical use of the building, which includes, inter alia, energy used for heating, cooling, ventilation, hot water and lighting". The US experts consider all energy uses of a building, including appliances.

Question 6. If a relative energy savings target were considered, what should this target be? (Compared to the status before the renovation)

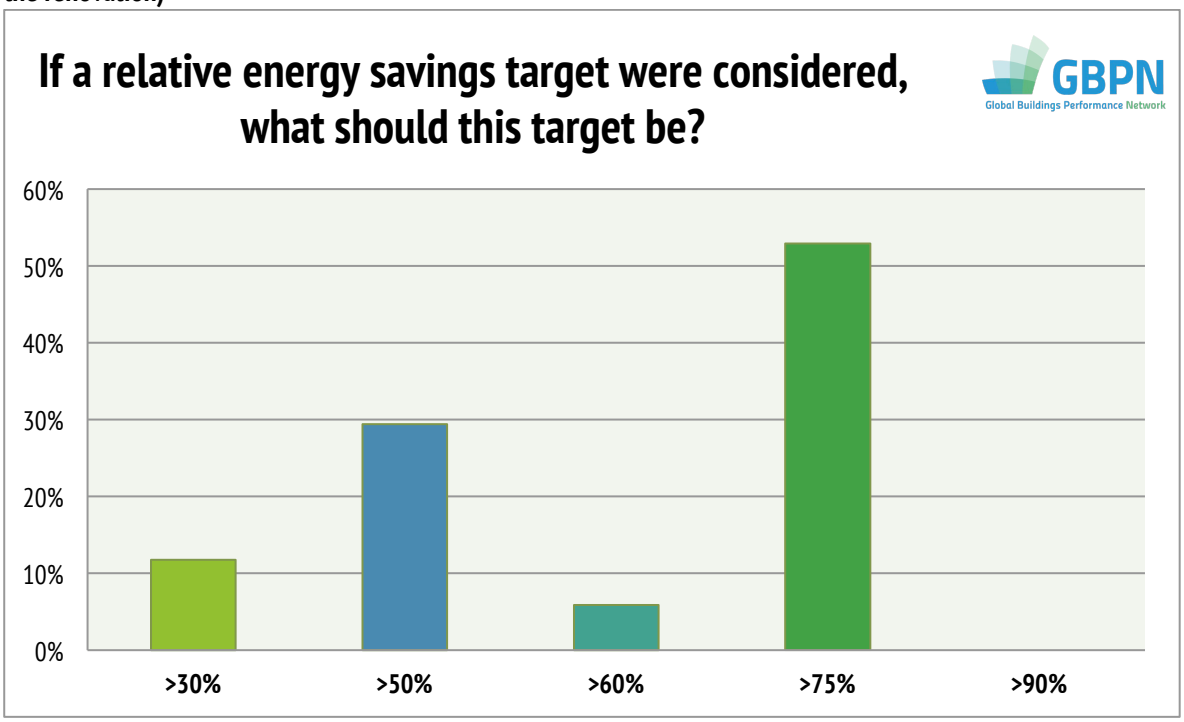

Figure 6. Relative Energy Saving Target

Almost 60% of the participants in the survey think the relative target should be higher than 75% and most of these are Europeans.

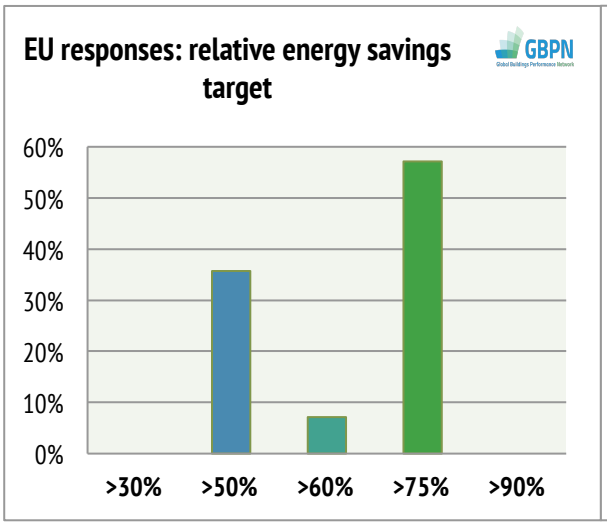

Figure 6.1. EU Relative Savings Target

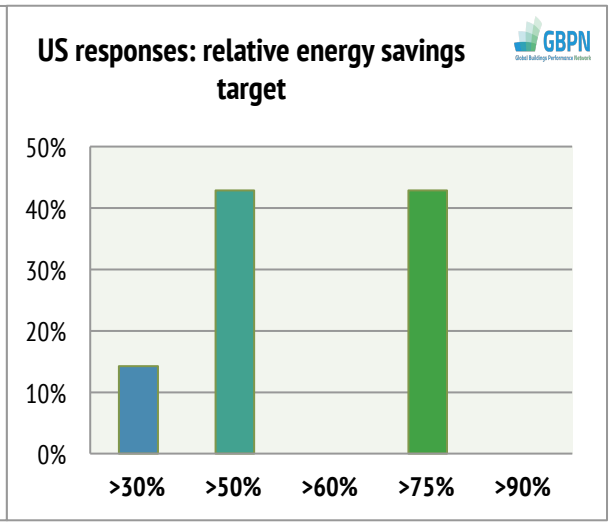

Figure 6.2. US Relative Savings Target

About one-third of the respondents think relative targets should be set as a minimum of 50% whilst having mechanisms available to go deeper. These respondents suggest that the target should be set depending on the vintage and condition of the building.

All the experts who selected a minimum relative target of 30% were from the US, whilst most European experts called for more than 75% (all European experts wanted a reduction of more than 50%). The regional differences were also aligned with the differences in the terms of a DR definition (renovation and retrofit).

Finally, some experts expressed difficulty in responding to this question as they felt that there are too many variables, i.e. where these targets are set, the age of the building stock, the type of construction, and what is possible in terms of efficiency and renewable requirements.

Question 7. What should the final energy consumption (absolute target) be after a deep renovation?

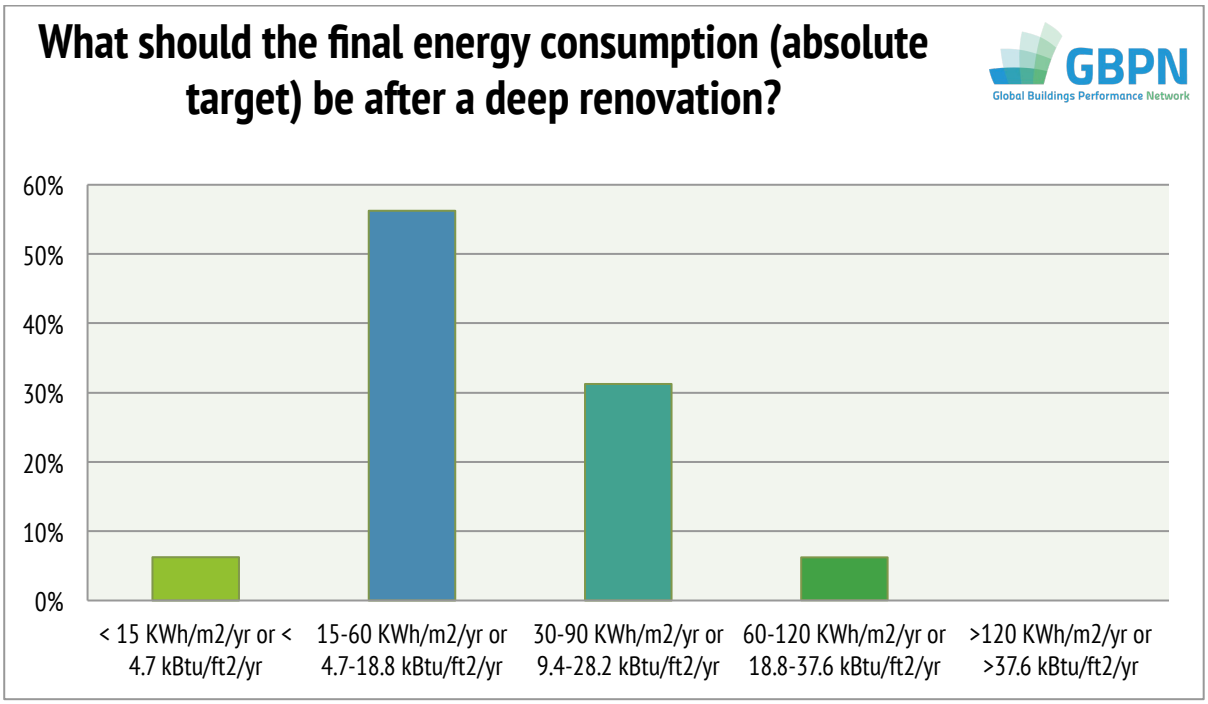

Figure 7. Final Energy Consumption: Energy Target.

Around 90% of the respondents thought the absolute target should be less than 80 kWh/m^2/yr. Almost 60% of the respondents thought that an absolute target should be between 15-60kWh/m^2/yr.

Question 8. Which title do you find the most appropriate? And how would you like to see DR (deep retrofit/ renovation/refurbishment) defined?

While the nuances between the three titles are not significant for almost 20% of the experts, the other 80% think there are some clear differences. "Deep Renovation" is the term used the most in Europe. Furthermore, the EU Energy Efficiency Directive[3] mentions the term "Deep Renovation" and includes measures that focus on the building shell. In the US, most of the respondents use the term "Deep Retrofit" and include measures focusing mainly on the systems. Out of the 23 experts, nobody used the term "Deep Refurbishment". The second webinar concluded the analysis – that the term used in the US is "deep retrofit" and the term used in the EU is "deep renovation".

It is agreed by all experts that the appropriate level at which to prescribe a relative or absolute target depends on a wide range of issues such as the type of the building, its climate and use, the loads considered and the choice of which metric (final/primary or demand/consumption) is used to describe performance.

[3] More information on the EED available here: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2012:315:0001:0056:EN:PDF

DEEP RENOVATION DEFINITIONS

Based on the findings collected in the research, the webinars and the questionnaire some definitions relating to deep renovations were established. These definitions are provided below.

Deep Renovation or **Deep Energy Renovation** is a term for a renovation that captures the full economic energy efficiency potential of improvement works, with a main focus on the building shell, of existing buildings that leads to a very high-energy performance. The renovated buildings energy reductions are 75% or more compared to the status of the existing building/s before the renovation. The primary energy consumption after renovation, which includes, inter alia, energy used for heating, cooling, ventilation, hot water and lighting after the deep renovation of an existing building is less than 60 kWh/m^2/yr. (GBPN / Definition often used in Europe).

Deep Retrofit or **Deep Energy Retrofit** implies replacing existing systems in a building with similar ones that are of higher quality and performance, which leads to a better energy performance of an existing building. The primary energy consumption includes energy used for heating, cooling, ventilation, hot water, lighting, installed equipment and appliances. After the deep retrofit the buildings energy reduction is 50% or more compared to the status of the existing building/s the retrofit. (GBPN / Definition mainly used in US).

Deep Refurbishment or **Deep Energy Refurbishment** means to bring something back to its original good state and if such a process should be deep it will include a very substantial improvement of the energy use and will bring the building beyond the original energy efficiency.

Deep Reduction or **Deep Energy Reduction** is a term used in US for a deep renovation or a deep refurbishment, which aims at more than 75% reduction in energy use in comparison with that prior to the improvement[4].

Zero-Carbon-Renovation: A deep renovation with large-energy consumption reductions, where the energy needed to supply the resisting need is carbon neutral

Zero-Energy-Renovation: A deep renovation with large-energy consumption reductions, where the energy needed to supply the resisting need is supplied as renewable energy on site.

Some definitions based on relative targets can support the clarification of deep renovation projects and can help to separate the level of ambition in DR projects.

Factor Two or Factor 2 Renovation: A renovation with energy consumption reductions of 50% compared to pre-renovation performance.

Factor Four or Factor 4 Renovation: A deep renovation with energy consumption reductions of 75% compared to pre-renovation performance.

Factor Six or Factor 6 Renovation: A deep renovation with energy consumption reductions of 84% compared to pre-renovation performance.

[4] This is a definition commonly used by the Thousand Home Challenge, find more information at: http://thousandhomechallenge.com/

Factor Ten or Factor 10 Renovation: A deep renovation with energy consumption reductions of 90% compared to pre-renovation performance.

Normally, DR actions take place at national level or in a local context. Special attention should therefore be given to the translation of the previous terms into different languages.

CONCLUSION

DR Definition Findings

The project compellingly concluded that there is the need for a better, clarified and more harmonised definition of DR. When establishing best practice criteria for packages and policies for deeper renovation is was found that this needed to be based on a deep definition.

The term, conditions and general definition of a DR varies significantly amongst the regions, even more specifically between the EU and US. India and China 's building stock is relatively new compared to that of the EU and US. For this, deep renovation discussions are at an early stage in these regions and they have no common definitions. .

A clear distinction was found between the terms deep renovation and a deep retrofit; experts from the EU found that renovation was the term most commonly used, whereas experts from the US found that retrofit was the term used. Generally, the definition relating to a deep renovation aimed for the deepest reductions of all the terms, these improvements mainly concern the building envelope. The definition of a retrofit focuses mainly on the building's mechanical systems.

Deep renovation is the term used to describe a deep improvement in the EU. A deep renovation mostly focuses on heating, cooling, ventilation and hot water and the general understanding is that this should be improved by at least 75% and / or have a primary energy consumption after renovation of less than 60 kWh/m2/yr.

Deep retrofit is the term used to describe a deep improvement in the US. In the US there is no clear definition of an energy renovation used consistently throughout the US building sector. Most commonly deep renovation in the US demands an improvement in the range of 30% – 50%, however, this is based on full energy consumption including all plug load.

The relative targets or the final energy consumption after a deep renovation project will range within the values mentioned in the previous definitions depending on climate zones, loads and type of buildings and should be specified at local level. Most experts agree that it is necessary to include both absolute and relative targets as well as targets for energy use and carbon emissions when accurately defining a deep renovation. A limitation arose when trying to define an absolute target as it was found that the question was insufficiently detailed and therefore caused inaccuracy in the results.

The amount of collaboration throughout the initial steps of this project shows that the DR community are in need of more information and are committed to finding ways to share knowledge between regions. Considering the level of interest in the GBPN "DR" project and participation from such a variety of stakeholders and regions, it is apparent that this subject is considered of high importance to the building community. However, even though there is a strong interest in the subject, the experts explained that there is a lack of good DR databases where experts can share and discuss relevant case studies. The GBPN laboratory on "More and Deeper Renovation" plans to provide a forum for this kind of discussion.

Further Collaboration & Research: Laboratory on "More and Deeper Renovation"

The GBPN have established a knowledge platform for continuing collaboration: the "Laboratory on More and Deeper Renovation". The platform consists of a discussion forum and an interactive research tool where project results and findings can be presented, discussed and clarified. This platform will be part of the GBPN website and open to all interested in the topic.

The laboratory will comprise of different subsections that are organised into themes, these will be used to discuss current topics in detail. The laboratory's subsections will be used to introduce different topics that will help to upscale and deepen renovations, GBPN propose some of these topics:

- DR definitions
- Best practice DR criteria for building projects
- Best practice policy packages that support up scaling DRs
- Barriers & Costs of DR projects

These topics will change over time as the research develops. All material gathered from the website during discussions (including comments, feedback and information) will be used to enhance GBPN's on-going research.

The next step for GBPN is to use the information and advice gathered in the collaboration forums of the laboratory, the DR definitions and further research to develop criteria for selecting best practices for individual projects or groups of buildings. GBPN will then identify and analyse best practices in DR policy packages that support the upscale of deep renovations.

The GBPN call for action and collaboration from different global and regional actors involved in deep renovation. The knowledge platform is an online space that:

- Encourages anyone interested in deep renovation to become involved and share his or her knowledge and ideas.
- Supports DR policy development and informs how we can begin to implement deep renovations globally.
- Contain material not only from the GBPN network but also from other organisations and partners.

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About GBPN The Global Buildings Performance Network (GBPN) is a globally organised and regionally focused network whose mission is to advance best practice policies that can significantly reduce energy consumption and associated CO_2 emissions from buildings.