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Advisory Report

on barriers and solutions in European regions introducing Passive House technology with renewable energy supply

IEE PassREg

PASSIVE HOUSE REGIONS WITH RENEWABLE ENERGY

Deliverable D4.6

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1. Table of content

2. ABOUT THIS ADVISORY REPORT

2.1. Reason and purpose

Earlier in the PassReg project a Map of Missing Links was created, D4.5, in which barriers were identified that play a crucial role in the different PassReg regions in the transition process towards the large scale roll-out of the Passive House building technology with suitable supply of renewable energy. Frontrunner regions have shown that success in the transition process depends on a complex of factors, which influence each other. In the aspiring regions it became clear that similar or other factors played an important role in reaching the goals set. The Map of Missing Links aimed to identify these factors, and to be a starting point for finding patterns and indicating a promising roadmap to overcome barriers and create the synergy needed for a successful transition.

To make the enormous amount of information gained in the PassReg project more easily accessible and to facilitate implementation, in this advisory report we set up a structured overview for identifying barriers and solutions. This overview is a good starting point for any region to develop their own specific roadmap, or to assess where they stand now, concerning the transition. In this advisory report we also give a rough analysis of the findings with the explicit purpose to further help the PassReg regions or new regions aiming for a transition towards PH standard with RES. This advisory report does not aim to be complete, but to be practical. More detailed information however can be found in other PassReg documents, listed in the references at the end of this document.

2.2. Sources of information for this advisory report

The content of this report has mainly been derived from the D 4.5 PassReg report Map of Missing Links, and from the D4.9_D4.10 PassReg report on the evaluation of 19 interviews, conducted around November 2014 by the PassReg partners with relevant stakeholders in their region. In these interviews the partners revisited the missing links (barriers) with several stakeholders, inventorying possible new barriers and discussing implemented and suggested solutions. The interviews gave extra insight in the progress made during the project and in the nature of the links that are still missing. Although the content of the interviews is of course subjective in nature, the different viewpoints reviewed together do give an interesting overview. Many similarities as well as differences could be identified in the processes of the different regions. Some scientific work on human behaviour, transition management, market development and market barriers has been used to interpret the results and structure the overview. Sources are named in the text and included in the references.

3. OVERVIEW FOR IDENTIFYING BARRIERS AND CREATING SOLUTIONS

3.1. Creating a basis from science for the overview and analysis of results

Three scientific models have been used to analyse and organize the material from PassReg and create a structured overview of barriers and solutions. These models will be explained in this paragraph. They can help us decide intelligently on the course of action for each region, interpret

results and manage the transition in progress. The choice for these models has mainly been inspired by research results summarized in Mlecnik's recent thesis on innovation development for highly energy efficient housing (Mlecnik, 2013, p. 34-36):

> *The **crucial barrier** for property owners to close the gap between their current energy use and what is technically feasible is not found within the realm of technology and economy, but of society and individuals. Decisions and rationality of individuals are heavily influenced by psychological and environmental factors.*

This implies that to overcome the crucial barrier, specific attention should be given to strategies that address human psychology, especially the aspect of motivation (Jensen, 2005), and to environmental factors- the larger context that influences human behaviour. Although many models might have been chosen to interpret the PassReg results, the three described below have been selected because of their ease of use and because of the experience of the author of this advisory report with these models.

The first model mainly focusses on individual behaviour and how this is determined from physical, mental and spiritual factors within the individual. It is widely used by psychologists, trainers, coaches and consultants throughout the world for helping individuals as well as groups or organizations to change their behaviour, their culture and their daily reality. The second model focusses on a very high-over viewpoint of what it generally takes to reach a transition of an existing system to a new system, such as in this case the transition of the current system of the building sector (including all relevant stakeholders like government, businesses and end-users) to a new system, being a highly-energy efficient building sector. The third model is very specific for the building sector and describes a possible pathway for transition in the form of an integrated, multi-player approach to stimulate adoption of highly energy-efficient housing.

3.1.1. A model of human behaviour and behavioural change

All behavioural change, whether from consumers or suppliers, can be explained with the model below, figure 1 , developed by Dilts (2006) and Bateson (2000). It describes how individual behaviour is influenced in a predictable way by someone's knowledge and skills (most concrete level), beliefs and values (deeper level), identity (again deeper level) and ultimately someone's mission (deepest, most fundamental, spiritual level). Many people are not conscious of the levels deeper than the knowledge and skills-level. Everybody however has mental activity on all levels and is influenced by all levels. This model can be applied to individuals as well as groups with a certain shared culture, for example certain market segments or certain types of suppliers. In personal, organizational or cultural change processes, this model can help build a smart strategy for achieving success.

Figure 1 Model of Human Motivation and Behaviour

As this model shows, to change behaviour permanently it is not enough to give someone the knowledge and skills for it. Because if someone doesn't have the beliefs or values to support it, this person will not apply the knowledge and skills. This has profound consequences for our strategy to build a market of consumers and suppliers. This means for example that, although it is important that builders learn the skills of passive building, to get them to apply it, they will probably have to change some beliefs and values. And to get consumers to buy passive houses, they will probably need to change some beliefs and values.

This could, for example be the builder's belief that natural ventilation is the only way for a healthy indoor climate and the belief that building less precise guarantees good natural ventilation (this is an example of a common belief of traditional builders in The Netherlands). If they keep this belief, they will not build airtight, no matter how skilled they are in doing it.

If we take an example from a consumer point of view, it could be the value of reliability that stops them from applying the behaviour of buying a passive house. Consumers might perceive a passive house as an innovation, which therefore has a lot of risk in it, which therefore is unreliable and these consumers therefore refuse to learn about it, let alone buy one.

When providing people with the necessary skills and knowledge does not lead to other behaviour, it can be safely concluded that interventions are needed at a deeper level. This model shows the consecutive steps to go deeper and influence people's motivation.

One can argue that a shortcut in behavioural change can be created by changing laws and this way prescribing certain behaviour. This could be true. There is a risk however, if the motivation is not internalised by builders or consumers. That is the risk of "just complying to the rules" instead of thinking for yourself, which makes behaviour of blaming and complaining (or "sueing") very likely, when things go wrong, instead of taking responsibility and improving. For this reason it can be argued that in the case of passive houses, even if policies or laws are changed in the favour, it is still

important to invest in means to increase the intrinsic motivation of consumers and suppliers. This model can help decide on a course of action.

An example of a solution to create this intrinsic motivation with consumers, suppliers and policymakers is to create and implement a strategic marketing and communication plan, based on deep understanding of the different target audiences and how their behaviour is influenced. Some very creative examples of this are found in Belgium, where a keen youtube campaign titled “I visited a passive house” has helped create a different image for passive houses with the broader public. This video has been viewed over 35.000 times until now and can be found at https://www.youtube.com/watch?v=ms9piTYk2Os. One of the goals of the campaign was to make the passive house concept appear less complex and more attractive to the public, to create a less boring and more “sexy” image for it. This should motivate people to investigate further and maybe eventually adopt the concept. Another, again Belgium, example is the Ice-challenge. On a main downtown street in Antwerp and in Brussels two big blocks of ice are placed right beside each other in a make-shift construction: one in an isolated (“passive”) one, the other in a non-isolated one. People passing by can bet on how much ice is left in each of the containers after 40 days. This promotional event stimulates people to think and learn about energy saving ánd communicates passive house principles.

It doesn’t have to be this creative to be successful however: most PassReg regions have chosen to do tours to exemplary projects, either in their own country or even abroad, for building professionals and/or for politicians and policy makers. These have been selected by many regions as being among the most successful solutions to overcome the barrier of a lack of motivation, mostly because these tours showed possibilities and demystified certain false beliefs about passive houses. The contact with actual users of the buildings was mentioned as the best part by some. In other words, it worked on a deeper level of the human mind than just rationally by providing knowledge: it stimulated all kind of senses and emotions and it changed things in the level of beliefs and norms. The same goes for open house events for the general public, like home-owners. Especially enthousiastic residents of passive houses can be very convincing to people who still have doubts, or who have never heard of passive houses before (which is still common in most regions). Somehow these physical confrontations with the actual buildings ánd their residents do wonders for the beliefs and norms around passive houses, and this way give a strong impuls towards different behaviour.

3.1.2. A definition and a model of transition

A definition and its implications

The experiences and results of the PassReg project can be interpreted as dynamic processes that are part of a large scale transition towards a sustainable society, including sustainable building. When transition is approached from the science and perspective of complex systems, it can be defined as a fundamental change in structure, culture and work-practices of the system (Rotmans and Loorbach, 2009). Structure in this definition means the institutional, economical and physical organisation of the system. Culture means the set of shared mindsets, values and paradigms. And work-practices mean routines, rules and behaviour. From this point of view transition towards a new system can only take place if all three areas are addressed and reformed sufficiently, using an integrated approach that takes into account the interaction between the different areas. To put it in another way: We need to overcome organisational, technical ánd mental barriers to achieve our goals. We

need to change our thinking, our acting and our organising. That is the basis of any strategy and action plan aimed to change the status quo.

A model and its implications

Research on successful transitions in history has shown some patterns. First of all there are similar phases, as depicted in the left part of figure 2 below. It always starts with a predevelopment phase, in which a lot of experimenting takes place, but little visible societal change. Then follows a take-off phase, in which the change process takes off and the structure of the system starts to shift. After take-off, in the acceleration phase, changes in different areas and at different levels of scale take place that show synergy. Then, in the stabilisation phase, the speed of societal change levels off, leading to a new equilibrium. Many transitions start off this path, but still fail in the end, because they do not reach stability and do not manage to create a new equilibrium or a new order of things, a new regime. They then become nothing more than a temporary hype or a niche market.

For the Passive House or NZEB with RES-transition this new equilibrium could for example mean that in a specific country or region the building standard in regulations is PH/NZEB, that all newly-builts or renovations are calculated and certified with PHPP, all main stakeholders in the building sector embrace PH/NZEB as the standard way of working, that PH/NZEB materials are readily (locally) available and of high quality, that working with high quality standards is embedded in the culture of builders and buyers, that schools teach the NZEB-methods of building as the standard and that prices of PH/NZEB are accepted as competitive. In other words, PH/NZEB is no longer a niche but part of the regime.

Each transition phase requires a different approach to further stimulate progress of the transition. Roughly stated: during the predevelopment phase the emphasis is on search and experiment, during take-off it is on selecting and facilitating, during acceleration it is on scaling up and facilitating and during the stabilisation phase it is on bedding in and anchoring. More about this can be found in Rotmans and Loorbach, 2010. It is informative, when deciding on a regional roadmap, to establish in which phase of transition the region is. For a region in the predevelopment phase it can be especially useful to pay most attention now to searching for pioneering customers that are willing to participate in building a passive house with RES and evaluating and communicating the results thoroughly. Also pioneering suppliers should be found that are willing to invest in learning about and applying PH principles and practices. It is of no use to already invest in large scale marketing or in trying to embed the principles as standard regulation. This can only backfire the transition, because the players and circumstances are not yet ready for these specific interventions. A region already in the acceleration phase might focus more on networking and collaboration activities and on market penetration.

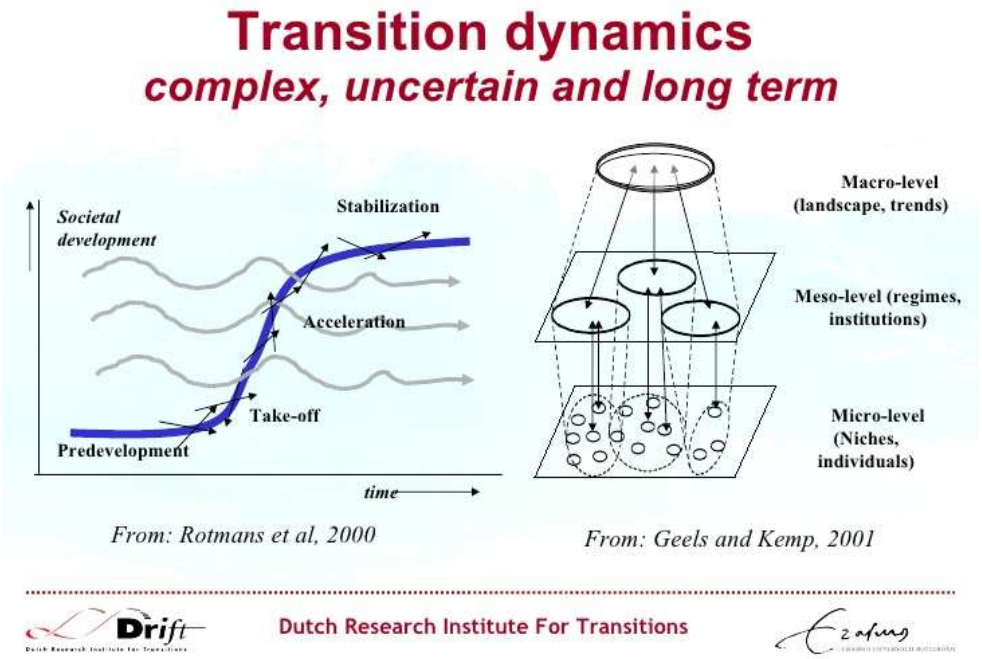

Figure 2: Models for Transition Dynamics

The right half of Figure 2 above, depicts three levels of scale which are very relevant for the success or failure of a transition. Success can only be achieved when dynamics at all three levels interact in a certain way. At the micro-level dynamics are fast, at the macro-level dynamics are slow and the meso-level is a kind of buffer between. We can look at the passive house movement as a micro-level niche, as are several other sustainable building concepts, that is trying to transform the existing regime of traditional builders and institutions. This takes place in a macrolevel context of economic crises, societal changes, globalization, ecological crises et cetera. History has shown three common patterns for transition (De Haan en Rotmans, 2011):

1. Coming from below: Niches arise from below, form clusters, scale up and become a niche-regime that pushes aside the old regime.
2. Coming from above: Because of radical changes from outside, a fast mega-change, a change of regime will be forced.
3. A hybrid pattern: Niches arise from within the existing regime and break through. They form a niche-regime within the dominant regime. Together they grow towards a new regime.

Research has shown that the most common pattern is the hybrid pattern. This means that it is very important for a transition to succeed, that space for innovation arises within the existing regime. Mental, organisational, institutional and legal space is needed for radical transformation. This means that interaction between the meso and the microlevel, between the regime and the niches is crucial. In practice, this often means that individual, influential people in the dominant regime that have a vision on the needed transition, eventually are of crucial importance (Rotmans, 2014). They can for example be inspired and educated by people and organisations active in the niche. This need for collaboration between large companies and regional innovators is also specifically addressed and confirmed in research by Mlecnik (2013, p. 317, see also next paragraph). For the case of PH/NZEB implementation this means that it is important to connect SME's with large companies and to find players in these large organizations that can eventually change the game of the regimes. In making a regional strategy or roadmap this can be considered and translated into specific actions to be taken.

3.1.3. Mlecknik's Integrated Approach to eliminate adoption barriers for highly energy-efficient housing

In his thesis for receiving his doctorate, Erwin Mlecnik, who has been highly involved in the Belgium transition towards NZEB, has created a model to specifically guide transitions towards NZEB. It organizes the actions to be taken, by two axes.

The first axis contains what Mlecnik has identified as the three main types of barriers to transition: lack of motivation, lack of knowledge and lack of competencies. The order is not coincidental: lack of motivation precedes lack of knowledge, because why would you want to acquire knowledge if you are not motivated to do so? And lack of knowledge precedes lack of competencies, because you first need to understand what PH and NZEB with RES is about, before you can decide on which competencies you need to acquire to apply it in your own situation.

The second axis describes the main players to be influenced to make the transition work. These are also the players that should be involved in creating the transition: enterprises (supply) and end-users (demand), and policy-makers of energy and policy-makers of innovation, including networks that stimulate innovation. These four types of players can all make a difference in the transition, by using their assigned tasks, their influence and their specific perspective to enhance the acceptance and implementation of PH/NZEB.

Mlecnik has identified the most successful type of action for each type of player to overcome each type of barrier, based on innovation theory and on practical experiences and research in The Netherlands and Belgium. Applied collectively these actions strongly stimulate the adoption of highly energy-efficient housing. Figure 3 is the visualisation of his model.

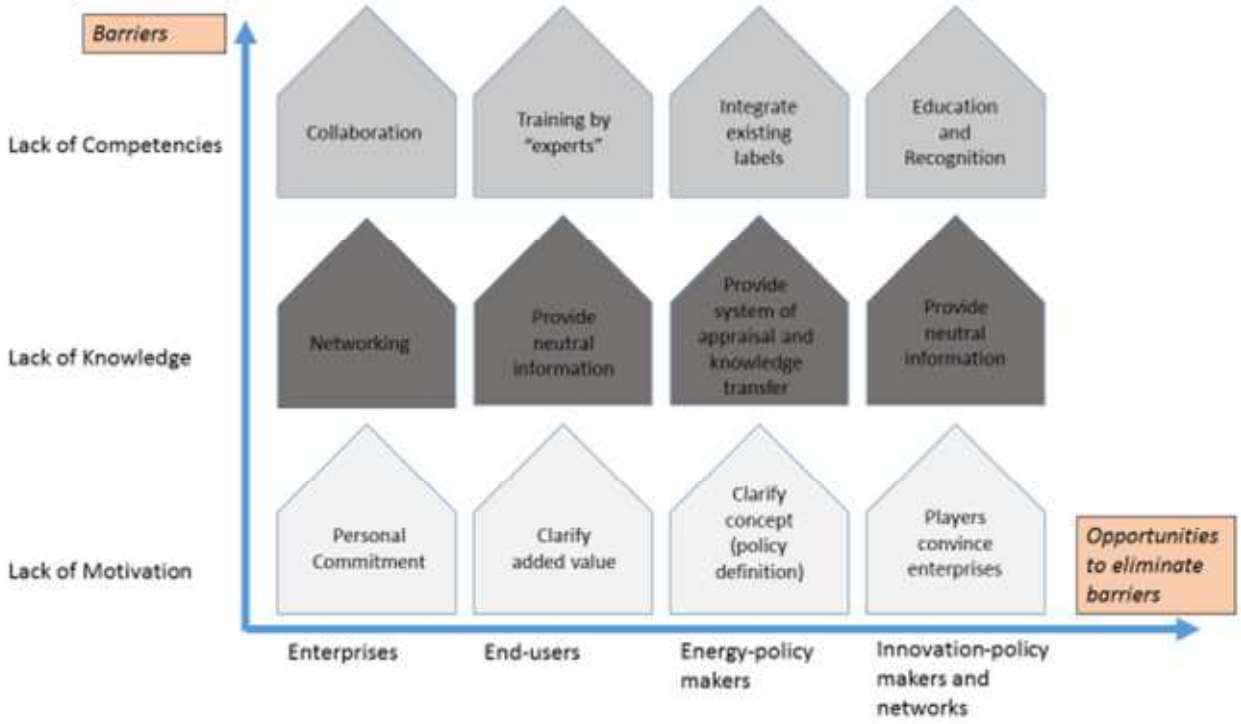

Figure 3: Mlecnik's Integrated approach for eliminating adoption barriers for highly energy-efficient housing

Based on these results, Mlecnik offers two recommendations for the focus of regional masterplans, to be developed by policymakers with passive house networks (p.336), illustrated with some related issues. Although in this document these recommendations are not further used for the overview or analysis, they are very relevant for regions creating a roadmap, so we decided to mention them here anyway:

Master Plan Recommendation 1:
Makers of innovation and energy policy should support specific change agents.
1. Energy policy and innovation policy should be integrated for the construction sector.
2. Enterprise collaboration and multi-player networking should be stimulated.
3. Funded innovation agents should guide committed SMEs and suppliers.
4. Funded change agents should guide potential adopters in each step of their decision-processes.
5. In some cases, these change agents could also combine their communication activities with the role of enterprise innovation agent.

Master Plan Recommendation 2:
Quality assurance schemes for highly energy-efficient housing need to be introduced or revised
1. Potential adopters should be persuaded according to non-energy benefits.
2. The quality of demonstration projects should be assured.
3. A pool of experienced actors should be developed.
4. End-users should be provided with detailed information.
5. Indoor comfort and the proper performance of building services should be guaranteed.
6. A system of appraisal for nearly zero-energy housing should be defined, using available labels, e.g. passive house.
7. An educational programme should be developed, particularly for highly energy-efficient housing renovation.

3.2. An overview of barriers and solutions

While researching for the main barriers, the missing links, and possible solutions to overcome them, a general picture evolved. This picture is based on the experiences and daily reality of the participating regions during the PassReg project. Even though barriers and possible solutions were often evaluated differently in importance by each region, many similarities were found and this can be helpful for other regions to identify the status quo and decide on the best course of action. Therefore in this paragraph the main, generalized, solutions are listed in the table below, organized by the theme of the barriers they are addressing. This table can serve as an overview, even a checklist, to determine the starting point or status quo with stakeholders, by any region in or outside of Europe. It can be a guideline for the development of a roadmap with regional solutions. It is based on information from D4.5 and D 4.9_4.10. In the next paragraph a short analysis is made of this overview and some further recommendations for the application of the results. In Chapter 4 some points are highlighted as recommended solutions for any aspiring region to start with in their roadmap. Chapter 5 concludes on this with a recommendation for future research.

Very important for the interpretation of identified barriers and solutions, is that the regions involved in PassReg discovered that no single barrier or solution is enough to make the transition to towards PH/NZEB with RES. The transition depends on a complex of factors, which all have to be addressed properly for an upward spiral to be created. This observation is consistent with scientific evidence on transitions, as explained in paragraph 3.1. This means that any region aspiring to make the transition a success, has to plan and execute a diverse range of actions on several different playing fields.

Tabel 1: Overview of the main (generalized) barriers and solutions as found within the PassReg project.

1. Regulation and Political Agenda *Barrier of lack of political will, motivation for transition* *Barrier of lack of knowledge with policy makers and public servants* *Barrier of lack of stakeholder consensus* *Barrier of lack of clear direction, clear vision, clear targets* *Barrier of lack of overview, insight in progress towards vision and targets*		
	Structure	
1.1	Presence of a Stable and Continuing Policy on Energy Efficiency and RES, including an effective relationship between national and regional policies	
1.2	Presence of an Integral Strategic Regional Action Plan, a roadmap, involving all relevant regional stakeholders	
1.3	Presence of Incentives or Funds supporting a High standard of Energy Efficiency with RES in buildings	
1.4	Presence of examples of PH/NZEB with RES in government and public buildings	
1.5	Presence of Tax Remissions related to Guaranteed NZEB Performance	
1.6	Presence of a Clear Definition on NZEB and its Measurement Instrument(-s), using the Trias Energetica as the guiding principle	
	Culture	
1.7	Regular study-tours and excursions to educate and inspire policymakers and public servants through examples of successful projects and happy inhabitants.	
	Work-practice	
1.8	Presence of Regulations demanding a High Standard of Energy Performance and Delivered Quality of the Systems	
2. Business Case and Financing *Barrier of lack of a real, economical market for PH/NZEB with RES*		
	Structure	
2.1	Presence of Financial Mechanisms supporting Market Development for NZEB with RES	
2.2	National Economy: General Income is high enough for investments in general	
	Culture	
2.3	Habit of evaluating and calculating issues from a long-term perspective instead of short term (e.g. lifecycle costing instead of initial investment costing).	
	Work-practices	
2.4	Presence of Integral and Functional Tendering, like tendering based upon the DBFM method, leading to a high standard energy performance	
2.5	Presence of Rental and Leasing Contract Including Heating and Cooling Costs	
2.6	Presence of a Higher Valuation of Property with NZEB standard and/or RES	
2.7	Use of Investment- and Decision Models supporting sustainable NZEB design and investment (e.g. LCC and/or DBFM-methods)	

2.8	Use of Financial Arrangements and Contracts based on guaranteed NZEB Performance	
3. Knowledge *Barrier of insufficient knowledge base* *Barrier of unaccessibility of knowledge base*		
	Structure	
	Culture	
	Work-practices	
3.1	Presence of Best Practice Examples of PH/NZEB with RES and an accessible source of information on this	
3.2	Presence of an Accessible Regional Source of Information about Adaptation to Climate, to Traditional Architectural Values and other Local Conditions	
3.3	Presence of an accessible source of information on PH Solutions for Building Services	
3.4	Presence of an accessible source of information on PH solutions, tools and aids for planning and design	
3.5	Presence of an Integrated Approach to Designing and Building	
3.6	Presence of a streamlined PH-consulting scheme for house owners and investors	
4. Capacity building *Barrier of lack of interest, motivation to embrace PH/NZEB with RES* *Barrier of unfamiliarity of suppliers with PH/NZEB with RES* *Barrier of resistance of suppliers to change the local building tradition* *Barrier of lack of dissemination of specific necessary knowledge per market segment*		
	Structure	
4.1	Training facilities present	
	Culture	
4.2	Presence of a Dissemination Strategy for PH Knowledge, including a strategy for change management of local building traditions where necessary	
	Work-processes	
4.3	Availability of Training according to PH principles	
4.4	Availability of Informational/Educational Material for Building Industry	
4.5	Availability of Informational/Educational Material for Public Building Owners	
4.6	Availability of Informational/Educational Material for Private Investors	
4.7	Availability of Informational/Educational Material for Building Certifiers	
4.8	Availability of Informational/Educational Material for Manufacturing Industry	
4.9	Availability of Informational/Educational Material for Political Decision Makers and Public Servants	
4.10	Availability of Informational/Educational Material for Designers	
5. Applied Products *Barrier of lack of local, cost-competitive products for PH with RES* *Barrier of lack of a local market for products for PH with RES*		
	Structure	
5.1	Presence of Incentives for the Industry to Increase the Local Availability of products suitable for PH with RES	
	Culture	
	Work-practices	
5.1	Local Development and Availability of Products suitable for PH with RES	

6. PR, Marketing and Communication *Barrier of misconceptions on and lack of awareness of benefits of PH with RES with policy makers, civil servants, consumers and suppliers* *Barrier of lack of demand from consumers* *Barrier of lack of supply* *Barrier of lack of political will and motivation to facilitate the transition* *Barrier of costs and lack of appropriate manpower to execute strategies on PR, marketing and communication*		
	Structure	
	Culture	
6.1	Presence of a Solid Marketing and Communication Strategy To Create Demand for PH/NZEB with RES, taking into account different consumer segments and their specific characteristics	
6.2	Presence of a Solid Marketing and Communication Strategy to Create Supply for PH/NZEB with RES, taking into account different supplier segments and their specific characteristics	
6.3	Presence of a Solid Marketing and Communication Strategy to create political will and motivation to facilitate the transition towards PH/NZEB with RES	
	Work-practices	
6.4	Availability of Resources needed to Implement Marketing and Communication Strategy	
6.5	Presence of Measurement of Progress in Actual Implementation of Marketing and Communication Strategy	
7. Quality Assurance *Barrier of insufficient delivered quality* *Barrier of lack of experts capable of doing quality assurance* *Barrier of lack of infrastructure to perform quality assurance* *Barrier of improper use and maintenance of PH/NZEB with RES*		
	Structure	
	Culture	
	Work-practices	
7.1	Presence of a well-functioning regional infrastructure for Quality Assurance (tests, specifications and/or other specific methods)	
7.2	Availability of sufficient PH/NZEB solutions for Quality Assurance in region (quality performance criteria sets, descriptions and procedures)	
7.3	Presence of a sufficient amount of experts to perform quality assurance on PH with RES	
7.4	Presence of Monitoring of PH projects with RES in terms of building physics, indoor climate, costs, energy performance et cetera	
7.5	Presence of requirements of quality performance in contracts for PH with RES	
7.6	Training Provided for Maintenance Teams, Tenancy Managers and Home Owners on Management and Use of PH with RES	

3.3. Analysis of the overview: more attention needed for structural and cultural factors?

When roughly analysing the barriers and solutions from the perspective of the definition of a transition, as explained in paragraph 3.1.2, it quickly becomes clear that all three aspects of the system, structure, culture and work-practices, are represented in the total set. But they are not equally addressed.

Most attention in the PassReg project has flowed to the barriers and solutions concerning work-practices.

Work-practices are of course a very valuable starting point. Relatively little attention however, has yet flowed to the barriers and solutions concerning structure and culture. This might be because their influence is harder to recognize. In paragraph 3.1 the Dilts and Bateson model was explained, which can be compared to the transition model. Cultural and structural factors can be placed in the logical levels of mission, identity and beliefs and values. These are deeply hidden levels of motivation of behaviour and often hard to discover ánd hard to change. Structural and cultural aspects might be seen as strong drivers behind the work-practices, but often going unnoticed because of our focus on the actual situation. Also they are often hard to change. The above point is illustrated further, when the data from the interviews (reported in D4.9), are analysed in a similar way. The barriers that are identified as not fully resolved after the PassReg project by at least four stakeholders (these data are highlighted in Appendix 1), show a reversed image:

Most of the barriers identified as *unresolved* after the passreg project are in the domains of structure and culture.

An example of these unresolved barriers is the barrier of the lack of skills on the supply side. This seems like work-practice, but it is explained by the interviewees as a result of a lack of demand (culture) and a lack of local training facilities (structure). So these should be fixed before the main barrier of lack of skills can be overcome. Other barriers mentioned often are the lack of financial mechanisms supporting NZEB (structure) and the lack of political will and bureaucracy (culture) and the lack of a clear NZEB definition (structure).

When analysing the interviews it is also interesting to look at the implemented solutions that were identified by the interviewees as most successful in the PassReg period. These are mainly found in the categories of "Capacity Building" and "PR, Communications and Marketing":

The solutions chosen by most interviewees as *most successful*, mainly addressed culture: mindset, values and paradigms.

The best example of these successfully implemented solutions targeting mindset, values and paradigms, is the use of beacon projects, including monitoring results (feasibility, applicability, costs, performance) and actual consumer experiences (meeting with the users of the building), as a subject for study tours, training days, specific regional PR and other dissemination activities organized around these projects. According to 15 of the 19 interviewees this greatly impacts the awareness, motivation and skills of government officials, market parties and consumers, concerning Passive Houses. The quote of one of the interviewed stakeholders is representative for many interviewed stakeholders:

"…I was in Brussels where we visited Passive Houses and could visually verify the technical solutions and materials in use. The main thing is that we were able to talk to occupants of the buildings, because that gave us the confidence that "the future house" is exactly the Passive House…"
Quote of Jānis Volks, manager logistics and infrastructure department Rēzekne Municipality (LV)

Another nice example is this quote:

"We will also look to raise awareness with the general public about Passivhaus with RES – currently there is little awareness about Passivhaus so there is no commercial demand. However, we have seen examples of regional demand (in London) where there is more awareness and knowledge and a new Passivhaus apartment block sold out very quickly (before they were even built)." Quote of David Jaques, Housing Development Manager for Cardiff Council on the barriers for Wales (UK).

When applying the model of Dilts and Bateson concerning human behaviour, it is clear that any structural change in behaviour (like buying a passive house instead of a traditional building) is preceded by a change of mind-set, for example beliefs and values. Since, as noted before, structure and culture can be seen as important drivers for the work practices, it can be concluded that:

To ultimately succeed in the transition towards PH/NZEB with RES, the structural and cultural aspects have to be addressed and changed along with the work-practices, because they drive the work-practices from a deeper level.

If we plot the solutions presented throughout the PassReg project on the model that is created by Mlecnik (2013) and described in paragraph 3.1.3, it seems that little solutions mentioned in the interviews or even the overview explicitly concern networking and collaboration, which Mlecnik presents as two of the main proposed actions to engage enterprises in the transition. Frontrunner Brussels has had much success with this approach. Interviewees from only two aspiring regions (in Italy and The Netherlands) mentioned the importance of networking opportunities between stakeholders and only one of those, region Arnhem-Nijmegen, has presented the set-up of a professional networking organisation and the development of a methodology to work multidisciplinary from beginning to end of a project, as some of the main regional solutions and success factors. In the map of missing links it is found however that presence of an integrated approach in design and building is missing in many regions. It is possible that the lack of attention for this category of solutions is related to the transition phase the aspiring regions are in (see paragraph 3.1.2): networking and collaboration may become more important when growing from the pre-development phase, through take-off to the acceleration phase. Just the same, it seems safe to conclude that:

Developing and applying more structural and cultural solutions in the field of networking and collaboration by and between enterprises (and other relevant stakeholders) might further enhance the transition towards PH/NZEB by addressing barriers of lack of knowledge and lack of competencies. Adding these to the overview might enhance its effectiveness, especially when the transition phase can be taken into account also.

The above, rough analysis seems to show that it is indeed valuable for regions to get a firmer grip on the structural and cultural barriers and solutions in addition to the work-practice barriers and solutions: to research these barriers and find ways to implement promising solutions. Especially in the earlier phases of the transition, where awareness is still low and old structures are dominant. Because of the intimate interaction of the three domains, structure, culture and work-practices, this attention to culture and structure will facilitate the implementation of the solutions concerning work-practices.

4. SOME “MUST-HAVE” SOLUTIONS FOR YOUR ROADMAP

Although each region should develop its own specific roadmap, involving its own specific stakeholders, some guidelines can be derived from the PassReg experiences. Especially when these are combined with lessons learned in the general science of behavioural change and transition management. Another PassReg deliverable is specifically focussed on how to create a roadmap, within PassReg often called a successmodel, which is the PassReg Succes Guide (see references). However, out of all of the data in this report we would like to emphasize a few solutions that have been pointed out by many stakeholders as being critical for creating success in any region. These should be part of the strategy or roadmap of any (new) aspiring region.

1. **Create a clear definition of NZEB, with the trias energetica at its base.**
2. **Create an incentive system (policy, finance and legislation) that stimulates NZEB.**
3. **Make lifecycle costing the standard.**
4. **Build and build on exemplary projects, use them in a variety of dissemination activities.**
5. **Raise awareness and knowledge through a keen marketing and communication strategy, segmenting specific target groups like suppliers, policy makers and end-users.**
6. **Use experiences of frontrunners and successful aspiring regions to be inspired and learn from.**
7. **Create local training facilities.**
8. **Create opportunities and structures for multidisciplinary networking and collaboration.**

5. MAIN RECOMMENDATION FOR FUTURE RESEARCH

To improve on the overview as illustrated in Table 1, in the near future more research should be directed towards discovering the specific structural and cultural barriers for the transition towards building according to PH principles with RES, in addition to the barriers in work-practices. Then efforts should be made towards creating, implementing and monitoring more, promising solutions to overcome these specific barriers.

6. REFERENCES

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7. APPENDIX 1 Main Barriers Unresolved after PassReg

In D4.9_4.10 there is a complete list of barriers that interviewees identified as not fully resolved after the PassReg project. The interviewees considered the most relevant barriers at the present stage of the development of the regions they represented. The numbers between brackets refer to the specific interviews, as listed in D4.9_4.10. Highlighted in blue are the barriers that were mentioned by four interviewees or more and therefore seem to be relevant for a larger proportion of the researched regions.

Barriers in the field of "Regulation & political agenda"

- Lack of stability and continuity of national and local policies. (I04, I05)
- Lack of political will and bureaucracy. Slow and complex decision-making processes at governmental institutes and the lack of awareness of government officials of the potential of Passive House technology to serve their goals. (I02, I04, I05, I06, I07, I14)
- Lack of clear definitions of NZEB and related targets/definition of NZEB. The definition of NZEB of some member states does not set an optimal building performance prior to the production of renewable energy. This complicates and even prevents the large-scale introduction of cost-efficient and healthy NZEB's based on Passive House approach. (I04, I12, I13, I16)
- Limited political scope of regions. Often there is a big gap between the national regulations and regionally preferred (higher) standards. (I04, I07, I16)
- Officials in municipality do not have enough capacity and time to stimulate the inhabitants towards NZEB (-retrofit). (I15)
- Lack of effective financial solutions/stimuli/funding mechanisms to improve energy efficiency in construction, especially concerning the coverage of higher capital costs to build a NZEB. (I01, I02, I05, I06, I12, I13, I15, I16, I17, I19)
- Lack of consensus and unity between stakeholders. (I14)
- Lack of "incentive" to pursue Passive House standard beside other more recognised labelling-methods, such as BREEAM. (I17)

Barriers in the field of "Business case & financing"

- The low income of the citizens and high building costs prevent from any investments in the building stock. The realization of beacons and NZEB-projects on larger scale depends on supportive funding/subsidies. (I05, I06, I09, I10, I12)
- Lack of awareness of the advantages and appropriate valuation and commercial demand of NZEB's. Investors base their decision generally not on life cycle analysis, which is essential for an appropriate valuation of NZEB concepts (I01, I07, I10, I14, I15, I16)
- Retrofitting on larger scale helps resolving the barrier of initial costs. Complicated ownership structure of the building stock prevent from deep renovations to Passive House standard of whole complexes, rows or districts. (I04, I05, I06, I07)
- Lack of financial mechanisms to support the development of the market. (I01, I05, I06, I12)
- Lack of a real market with supply and demand for NZEB's. Developing the market leads to availability of cost competitive certified Passive House products and experiences with design and construction. (I01, I05, I06, I10, I19).
- Pricing for unknown risk by developers and contractors and lack of competitive edge (I01).
- Lack of affordable integrated NZEB concepts for better acceptance by the end-consumer (I15)
- Current procurement processes are not optimized for energy efficient construction. (I8)

Barriers in the field of "Knowledge"

- Lack of varied concrete examples and consequently lack of experiences with NZEB in regions. (I01, I02, I05, I06, I11)

- Lack of examples in different kinds of weather and architectural/cultural backgrounds. (I02)
- The apparent contradiction of attitudes to preserve architectural background and the integration of innovative technologies. (I02)

Barriers in the field of "Capacity building"

- Lack of skills on the supply side (including practicing PHPP-calculation). Lack of local training facilities and also the demand for it. Lack of actual projects to develop these skills and to raise demand for it. (I01, I02, I05, I06, I08, I09, I13, I14, I17, I18)
- Local building traditions: change is hard for organizations but implementing affordable and high quality NZEB's requires fundamental change for most players. This goes for designers as much as for constructing parties. (I01, I02, I05, I06, I08)

Barriers in the field of "Applied products"

- Passive House is a niche market in the region. Therefore there is a lack of local cost-competitive (certified) Passive House products. (I01, I17)

Barriers in the field of "PR and marketing"

- Lack of a solid marketing & communication strategy towards the market, and lack of resources for implementing this strategy. Hard to rival other more recognised standards or concepts. (I01, I04, I05, I06)
- Lack of awareness of the benefits of NZEB and misconceptions at the demand-side: e.g. fear of extra costs and scepticisms in functional performance of Passive House buildings. (I01, I09, I14, I15)
- The task to retrofit city quarters to higher energy standards and implementation of decentralised renewables remains a great challenge. Campaigns are effective, informational sources are developed. Solutions are needed for motivation of more divers retrofit projects, complex urban quarter solutions and "diversified holdings". (I07, I09)

Barriers in the field of "Quality assurance"

- Lack of experts with a high level of knowledge, professionalism and accuracy. Selection process for designers and contractors must be thorough to achieve quality in Passive House projects. (I08)
- Training of maintenance teams and tenancy managers is needed to ensure they understand new building methods and services in order to prevent the risk of wrong management and use of buildings. (I01)

8. APPENDIX 3: Solutions identified as "best"

In D4.9_4.10 there is a complete list of solutions that interviewees identified as "best" after the PassReg project. The interviewees considered the most relevant solutions for the present stage of the development of the regions they represented. The numbers between brackets refer to the specific interviews, as listed in D4.9. Highlighted in blue are the solutions that were mentioned by four interviewees or more and therefore seem to be relevant for a larger proportion of the researched regions.

Best solutions in the field of "Regulation & political agenda"

- Local government selling land below market value in a partnership program to developers to enable better energy performance. (I01)
- Local government initiating beacon-EnerPHit renovations. (I09, I12, I13)
- (The efforts for) political adaptation and compulsorily application of PHPP-calculation. This has great potential impact for the acceptance of Passive House approach in NZEB's. (I16)

Best solutions in the field of "Business case & financing"

- Energy performance contracting by ESCo's help to overcome economical barriers. (I12, I13)
- Convincing examples of feasible projects. (I11)
- Tyrol's examples of centralized RE-power plants have a better efficiency in use and maintenance than individual concepts and therefore are cost-effective. (I01, I07)
- Integral design and construction approaches with multidisciplinary teams help reducing initial costs with and lead to higher quality. (I14, I16)

Best solutions in the field of "Knowledge"
- Adaptation of Passive House principles to specific (Mediterranean) weather conditions. (I02)
- The PassREg SOS database with solutions for designer, builder and owner. (I02, I14)
- Informational material for EnerPHit renovations. (I11)

Best solutions in the field of "Capacity building"
- Establishing an institute for training suppliers (craftsmen, contractors, designers et cetera) in Passive House principles and techniques (I14)
- Beacons that allow the industry to learn and to set an example for others to follow (I01, I03, I05, I06, I08, I10, I11, I12, I13, I16, I18, I19)
- Initial trainings on NZEB-design (I03, I05, I12, I13, I16, I17, I18, I19)
- Training for specific target groups such as suppliers. (I04, I12, I13)
- Applying Passive House approach to existing buildings. (I11, I13)

Best solutions in the field of "Applied products"
Solutions in the field of "Applied products" where not considered as "best solution" by the interviewees.

Best solutions in the field of "PR and marketing"
- Application of NZEB-approach in beacon projects, sometimes first NZEB-building in region: impact on awareness, motivation and skills of government officials, market parties and consumers. (I03, I05, I10, I11, I12, I13, I14, I16, I17, I18, I19)
- Passive House and RE convince by operation: profitability, energy results and comfort have been proved and published. A follow-up on projects helps to avoid misconceptions by technical start-up difficulties or wrong usage by un-instructed costumers. Monitoring on projects provides convincing PR material. (I02, I05, I07, I11, I12, I13, I14)
- Study tours, training days and other dissemination activities were very effective in bringing on the right discussions, increasing confidence in other regions, raising awareness and motivation of local leaders, suppliers and citizens. Meeting users of the buildings was specifically valued. (I01, I02, I03, I05, I07, I11, I13, I14, I15, I16, I19)
- Awareness rising laboratories on energy saving and renewable energy at schools (I12, I13)

Best solutions in the field of "Quality assurance"
The interviewees did not consider solutions in the field of "Quality assurance" as "best solution".