Multiple institutional dynamics of sustainable housing concepts in Denmark – on the role of passive houses

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Multiple Institutional Dynamics of Sustainable Housing Concepts in Denmark—On the Role of Passive Houses

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Abstract

One of the central challenges of sustainable transition is the changing of the buildings. This involves social, cultural, political, and regulatory dynamics. Critically using transition theory conceptualization of a world of dynamics, the paper reviews institutional theory and actor network approaches in an attempt to better account for contemporary developments in Europe, encompassing EU reforms as well as multiple competing concepts. The emergence of "passive houses" in Denmark is used as a case of transition dynamics. The concept was developed in Germany and imported into Denmark. It is a technological niche, encompassing technologies, players, improvisation, and early customers. Passive houses have entered into fierce competition with other future institutions such as LEED (Leadership in Energy and Environmental Design), DGNB (German Sustainable Building Council)/green building council, and active houses. Passive houses were at the outset a well-developed upcoming institution with design principles, software, certification and numerous reference buildings, strong enough to be a challenger institution. They are promoted by a characteristic alliance of architects, consulting engineers, a few clients, and an architect school, whereas the other concepts exhibit their specific actor alliances. Yet passive houses experience barriers such as the reputation of being expensive and non-user friendly, and are currently surpassed by the other concepts.

Keywords

Passive houses, transition theory, Denmark, sustainable building

Creating a sustainable society will demand major transitions implying social choices. Even setting the goals is demanding. Being able to define sustainability is about what to develop, what to sustain, and for how long. Sustainability transition is characterized by relying on the large body of internationally negotiated consensus on development and environment. Here the focus is on climate change mitigation in housing and building, encompassing sustainable housing concepts such as passive houses, active houses, and energy classes 1 and 2 (the latter two driven by EU-regulation, EU 2002). The paper analyses the passive house as upcoming institution and its competition with other concepts in the Danish context. The technical definition of a passive house according to the Darmstadt criteria (Passivhaus Institute 2012) encompasses four central properties: (1) The specific space heating demand should be lower or equal to 15 kWh per m^2 per year; (2) the heating load should be ≤ 10 W/m; (3) the tightness of the building envelope

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should be tested with a pressure test showing air changes of ≤ 60% of the total house volume per hour; and (4) the specific cooling demand should be ≤ 15 kWh per m^2 per year and the total specific primary energy demand ≤ 120 kWh per m^2 per year.

The theoretical framework combines institutional theory and actor network theory. Institutional theory is used to address deinstitutionalization, emerging institutions and multiple competing institutions (Dover and Lawrence 2010; Meyer and Höllerer 2008; Suddaby 2010; Thornton, Ocasio, and Lounsbury 2012) of sustainable housing, and actor network theory (ANT) to understand the heterogeneous actor dynamics (Pipan and Czarniawska 2010) in this domain. Combining these theories is unusual and not unproblematic. To underpin the endeavor, the authors refer to multiparadigmatic approaches and argue that the combination of institutionalist and ANT can bring a fruitful understanding of the transition processes and challenge the case of passive houses. This places the contributions in prolongation of previous institutional theory contributions (Fuenfschilling and Truffer 2011; Munoz 2011) as well as ANT contributions to transition theory (Garud and Gehman 2012).

In the analysis of the emerging sustainable buildings in Denmark, the paper places passive houses as one among several competing concepts, niches, actor alliances, and institutions. From this perspective, sustainable buildings are part of a multifaceted landscape of future institutions around an existing regime of built environment. The dominant housing/building institutional regime is challenged from various niches—institutions to be—and from the socio-technical landscape through EU initiatives. The future passive house institution is analysed showing the processes, experienced barriers, and limited adoption. This is juxtaposed with other upcoming sustainable building institutions and their competition. Combining these dynamics leads to the view that sustainable housing concepts/institutions are only viable in windows of time; and that the contribution of the passive house institution is more of a stepping stone towards low carbon housing, than a final solution.

METHOD

The paper adopts an interpretive sociology framework. The theoretical position is a merger of institutionalism and ANT. The main contention about the combination of institutional theory and ANT is that they can supplement each other. Institutional theory has its strength in understanding social structure, whereas ANT provides an interactional understanding of change processes agency as heterogeneous assemblages of human and non-human elements. The two types of theory are characterised by important differences in their ontology and epistemology. ANT does not accept structures of the type institutional theory proliferates and institutional theory would understand materiality as an object of social interpretation and assignment of meaning, not as active part as ANT would. Moreover institutionalist theory thinks at levels, i.e., micro, meso, macro something ANT rejects, insisting on placing phenomena at one common level. The combination carried out here however exploits that the two types theories have blind spots or grey areas (Gioia and Pitre 1990), where the combination does not "activate" the incommensurability that their combination in principle would involve: ANT is used here for the agency part of building transition alliances, whereas institutional theory is used for the structural elements in play and for enriching the range of possible elements and process features in the actor network building of the transition process. ANT is quite open and multiple when it comes to conceptualise the processes and the heterogeneous assemblages. Referring to multiparadigmatic contributions (Gioia and Pitre 1990; Lewis and Grimes 1999) presented how the combination can be done by associating two theories in a sequential,

parallel or synthesised manner. Gioia and Pitre (1990) argued for "transition zones" between paradigms, areas where they do not overlap and where it makes sense to use them in tandem. Thornton et al. (2012) claimed that institutionalist theory still, after recent years development of institutional entrepreneurship, lacked a proper conceptualization of agency, which was where ANT was used. Garud and Gehman (2012) provided a meld between ANT and narratives in a conceptualization of sustainable transition.

The empirical material is a case study of the development of passive house in Denmark using a mixed method combining quantitative and qualitative data (Bryman and Bell 2007). The qualitative analysis of competing concepts included the content of the concepts, how they differentiated from each other, the role of materiality, and the actor alliances. Quantitatively, a mapping of the development over time of sustainable housing concepts and their emergence is carried out using desk research, Google, Infomedia (Danish Newspaper database), and other press articles. The Google search of the presence of the concept covers a period from 2000 to 2012 in Denmark. Search words were found in an iterative manner as some search words created hits that were overly polluted with other data. For example, "*energi klasse 1 huse*" and "*lavenergiklasse 1 huse*" ("energy class 1 houses" in Danish) were used followed by manual subtraction of hits of product classes of household appliances which continued to pollute the hits. Similar strategies were applied for the other concepts. Nevertheless the Google count was considered as merely indicative with low validity and limited thrustworthiness (Bryman and Bell 2007).

Other material used to underpin the analysis includes university researches and publications, consultancy reports, students' works and master theses supervised by the authors. First-hand data collection includes participation in architects and engineers' workshops on the topic. The trustworthiness of results is achieved through triangulation, by the comparison of information collected through different channels (Bryman and Bell 2007). A lot of the material used in the description is in Danish, and it not referenced.

Limitations of the paper on the empirical part involve that the competition of the concepts is not thoroughly mapped. Moreover on the theoretical side, the further implications of combining institutional theory and ANT are not discussed here.

THEORETICAL FRAMEWORK: TRANSITION THEORY

The transition theory literature is currently being developed as a response to the societal challenges of climate change (Markard, Raven, and Truffer 2012). It encompasses looking at the drivers, emerging actor constellations, technologies and barriers in play.

This section develops the transition theoretic framework referring to a type of transition theory which possesses theories for understanding the transition paths in contemporary society, yet is not using the label. They are institutional theory (Greenwood, Suddaby, and Hinings 2002; Scott 2001; Røvik 1996; Thornton et al. 2012) and ANT (Akrich, Callon, and Latour 2002; Latour 1993, 1996, 2005). Hereby the arguments depart from "classical" transition theory, which are using this label, namely the Multi Level Perspective (Geels 2005, 2011) and the Technological Innovation System (Jacobsson and Bergek 2011). In brief, the multi-level perspective views transition as a dynamic of an upcoming niche challenging an incumbent regime and technological innovation system is defined as "a dynamic network of agents interacting in a specific economic/industrial area under a specific institutional infrastructure and involved in the generation, diffusion, and utilization of technology" (Carlsson and Stankiewicz 1991: 93). In the authors' view, these "classical" transition theories feature some important limits that need to be conceptualised differently in four distinct manners:

(1) Both models implicitly and explicitly operate

with different levels of aggregation. Geels (2011) claimed that these levels can be appropriated to concrete contexts (as a response to Genus and Coles 2008). The idea of levels risks producing illusions on separate worlds with different dynamics. According to Geels (2005), niches were protected from forces of competition and the landscape level was beyond the influence of the players. Such division of dynamics is however refuted by many reported studies of the Schot and Geels (2008). The problem of the notion of a landscape beyond influence is parallel to Latour's (2005) critique of sociology for inventing overarching concepts that mystify social processes unnecessarily;

(2) At the outset, the "classical" theories encompassed a relatively high number of recognized dynamic in transitions. Something that can be seen as a necessary response to the complexity of transition. As the theories have matured, more dynamics have been added (Geels 2011; Jacobsson and Bergek 2011; Schot and Geels 2008);

(3) Even if (human) agency and materiality are recognised, it still remains unclear what the distinct contribution of agency is. For example, the influence on the direction of search (Jacobsson and Bergek 2011) is one of the more agency-oriented elements. There are also other elements of (human) agency but when it comes to role of materiality both approaches assume human manipulate materiality into technologies and products, but disregards that opposite dynamic from hybrid associations of human and non-human elements (Latour 1993);

(4) There is a tendency to view transition as a modification of a linear process, and focus on singular change. The question occurs: what happens after a niche technology has changed the previous incumbent regime (Geels and Schot 2008) and once the technological innovation system is established? In other terms, transition theory lacks meta-cycle concepts. It is on this background that the authors find it fruitful to turn to other types of social scientific contributions in an attempt to conceptualise transition toward a sustainable society as agency changing and establishing institutions.

Institutionalist theory advocates non-rational, cultural socially constructed explanations of societal order and change. Scott (2001: 48) defined institutions as:

> Social structures that have attained a high degree of resilience… [institutions] provide stability and meaning to social life… Institutions are transmitted by various types of carriers, including symbolic systems, relational systems, routines, and artifacts. Institutions operate at different levels of jurisdiction, from the world system to localized interpersonal relationships. Institutions by definition connote stability but are subject to change processes, both incremental and discontinuous…

Scott (2001) and others (Thornton et al. 2012) conceptualised institutions as consisting of three types of elements: cultural cognitive, normative, and regulative. Even if institutionalist theory departs from explaining organisational homogeneity and stability (Dimaggio and Powell 1983), most recent contributions are interested in institutional change, including the discourse on institutional entrepreneurs (Garud, Hardy, and Maguire 2007; Munoz 2011), and also to some extent deinstitutionalisation, diversity of institutions and societal and other non-organisational change (Thornton et al. 2012).

The contributions to understanding institutional change provide concepts for how an existing institution would be deinstitutionalised and delegitimised, and how a future institution would develop through gaining legitimacy and more (Greenwood et al. 2002). Legitimacy is not given but has to be formed through conscious actions by various organisations and individuals in a socio-political process. Gaining legitimacy would involve cognitive, normative as well as regulative aspects. The most commonly described strategy for obtaining legitimation is to conform to established institutions. However, deinstitutionalisation and reinstutionalisation, as described by Greenwood et al.

(2002), is another means of attaining it. If legitimacy is attained for a technological innovation, this would support obtaining resources for its further development, and it would generate demand and give actors in the institution political strength. For example, Bergek, Jacobsson, and Sandén (2008) argued that attaining legitimacy was a prerequisite if new industries were to be formed around renewable technologies, as the incumbent energy production regimes might otherwise actively counter them. Greenwood et al. (2002) pointed at several steps in gaining legitimacy. They assigned early legitimacy as being value-oriented "moral" legitimacy. If the emerging products and practices cannot be referred to existing institutions, functional superiority has to be established, labelled "pragmatic" legitimacy. At a later stage, the legitimation might solidify and become cognitive (Greenwood et al. 2002).

As touched upon above, institutionalist theory even go beyond the first/single stabilisation of a new institution, through the discussion on concept cycles and deinstitutionalisation. Røvik (1996) raised issues with the assumptions of evolutionary economics claiming the selection and adaption assumes that a given concept/institution would be substituted only by one which was technically superior. Røvik pointed out that the decay of concepts would also occur through other mechanisms. For example, concepts that become institutionalized and therefore widespread, would lose their social differentiation elements, and become "normal". As a result, leading players would lose interest. Røvik (1996) pointed out that a process of obsolescence would occur where actors through reinterpretation created a socially constructed impression of the concept as "*passé*". He described it as a social contagion leading to trickle down effects. This leads to a gradual fading of obsolete institutions/concepts as a compromise between rationality and fashionableness.

As argued by institutional entrepreneur contributions (Garud et al. 2007), institutional theory is in need of conceptualising agency. According to the version of institutional logics perspective of Thornton et al. (2012), this could be done in a Giddens like structure agency dualism. Thornton et al. (2012) were critical toward the institutional entrepreneurship contributions for trying to, yet not being able to, solve the agency problem.

Institutionalist theory tends, as Geels in early versions, to understand transition as a competition between a dominant and a challenger social dynamic (DiMaggio and Powell 1983). Some contributors to institutional theory do however extent this original dualism (Dover and Lawrence 2010; Scott 2004). Scott (2004) demonstrated competition between professionalism and managerialism and two different state regulation approaches to healthcare. Scott (2004) distinguished between powerful rhetorics of market and equal access to healthcare. These two institutions were after all implementred to a limited degree as a third institution, the professional of the doctors, prevailed. Meyer and Höllerer (2010) contended that many competing labels in an institutional environment enabled negotiation of meaning and thereby shaping of future institutions. The institutional logic perspective extends these approaches and argues for multiple orders of institutions and multiple dynamics driving their changes (Thornton et al. 2012). This approach proceeds to argue for an inter-institutional system of multiple orders of institutions and with a loose coupling between them.

Summarising institutionalist theory offers conceptualisations of central dynamics of transitions. This includes regulatory, normative and symbolic aspects and spans from the multinational phenomena to the individual. There is an appreciation of a possible role for agency and concepts for change processes. Moreover there is some understanding of institutions in competition. However institutional theory also possesses weaknesses. Even if some contributions operate with multiplicity, the particular contribution would be to view the process of

institutional change (transition) as a competition and coexistence of multiple emerging institutions. This also involves taking distance to the ideas of interinstitutional systems and leaving it for empirical analysis to investigate whether there is one or more institutions in play and if and how far they are interrelated.

The institutional logic perspective operates with a level thinking close to Geels (2005, 2011). Moreover the opening for agency in the contribution should not mean a fall back to a belief in the knowledgeable individual alone (Giddens 1984), as transition does span the abovementioned areas and narrowing agency down to individuals is too limited. Rather a network and interaction oriented concept such as ANT would apply.

ANT

ANT understands change/transition as a process with a social constructivist approach (Akrich et al. 2002; Latour 2005). ANT would view the emergence of a sustainable building concept as the building of a heterogeneous assemblage of material and immaterial elements over a series of negotiations enrolling actors and materiality (Latour 1987, 2005). The concept would interest (attract) actors and they would impact the concept in a mutual shaping process. This process would go through obligatory points of passages where certain features would come to be obligatory for the further development. Below, the authors first carry out a review of ANT contributions before continuing to present the main concepts of sociology of translation (Callon 1986).

ANT has been used in several empirical areas relevant to the present argument. At least three contributions discuss transition toward sustainability (Callon 1986; Garud and Gehman 2012; Pohl, Styhre, and Elmquist 2009). Other important areas are innovation studies (Akrich et al. 2002; Pohl et al. 2009), organisation studies (Alcadipani and Hassard 2010; Harrison and Laberge 2002), and public policy and management (Pipan and Czarniawska 2010; Young, Borland, and Coghill 2010). Actually all these are relevant here, since focus is on transition processes, the active role of devices/actants and networked concepts, in a process where public regulation is enacted as actor as well. In the classical ANT studies of innovation processes, such as Law and Callon (1992), emphasis was on the emergent processes of associating human and material elements and the lack of ex ante importance of resources or other features. Moreover, devices and materiality of various kinds are assigned an active role, signalised through the notion of actant (Christensen and Skærbæk 2007, 2010; Latour 1993). In this ANT view, the interest centres on how actors strive to stabilise a concept. Concepts used here include fact building and purification (Christensen and Skærbæk 2010). Similar concepts would apply to the design of a sustainable house.

Studies of public sector change mobilising ANT view government and regulation as merely an element in the emergent actor network (Young et al. 2010: 1209; Wessells 2007), in contrast to political science approaches. Wessells (2007: 353, 355) advocated a need for a multiactor, multimodal perspective on governance, which ANT was responding to (see also Arnaboldi and Azzone 2010). Pipan and Czarniawska (2010: 250) in their study juxtaposed central government processes with local ones, found local translations, and did assign law reforms as a certain framesetting role. Similarly Christensen and Skærbæk (2010) found an important central alliance between a government commission and consultants in the networking processes of local government bodies.

BASIC CONCEPTS OF TRANSLATION

To understand the process of change/transition, the sociology of translation (Callon 1986) is used as the basic framework (Alcouffe, Berland, and Levant 2008; Harrison and Laberge 2002). According to Callon

(1986), there were four main moments of translation:

(1) Problematisation;

(2) Interessement;

(3) Enrolment;

(4) Mobilisation.

Problematisation involves construction of the problem, i.e., formulating the problem and proposing solutions (Harrison and Laberge 2002). At the same time, this also involves "interdefinition of actors" (Callon 1986). The actors and the problematisation—"a double movement"—evoke actors and define their identity in such a way to establish themselves as part of the emerging network of relationships that they are building (Callon 1986).

Interessement is defined as a set of actions through which the already involved actors and materials (hybrids denoted actants) (Latour 1993) impose and stabilise the identity of other actors in an effort to promote the pursuit of the objectives and goals that have been attributed to them (Harrison and Laberge 2002). The invited new actor may submit or define his identity, aims, projects, and interests differently. This involves negotiation and may be done through coercion. In this way, the emerging network is trying to build alliances and destroy competing associations (Harrison and Laberge 2002).

Enrolment consists of defining a role and ensuring that it is played by the actor to whom it is proposed (Harrison and Laberge 2002). It is concerned with the distribution and assignment of roles in the network involving human, material and hybrid elements. Enrolment can be viewed as the result of successful interessement (Callon 1986; Harrison and Laberge 2002). It designates the device by which a set of interrelated roles are defined and attributed to actors who accept them (Callon 1986).

Mobilisation of allies is the moment in which ordering takes place (Harrison and Laberge 2002). The actants of the network are ordered in a way that makes it possible for a spokesman, i.e., somebody/something that represents the network, to be established (Akrich et al. 2002). Innovation might become irreversible or the opposite, and the network begins to fall apart (Harrison and Laberge 2002). The further strengthening involves a range of intermediaries: meetings, contracts, education information, privileged status, etc. (Harrison and Laberge 2002). The actors are enabled and constrained in a network of links whose consensus limits each actor (Alcouffe et al. 2008; Callon 1986; Harrison and Laberge 2002).

ANT embraces a possible symmetry between failure and success (Akrich et al. 2002: 123). It is thus impossible to predict in advance whether a change process will succeed or not or partially stabilise. ANT emphasises the importance of staying flat in his critique of context, meaning that one should stay close to the immediate processes of translation of actants, rather than look for abstractions such as context or hierarchy (Latour 2005). As concept for links between such parallel domains of flat analysis, Latour (2005: 174) suggested the notion of "clamps". In sum, ANT views a sustainable housing actor network as a heterogeneous association of devices actors, intermediaries, companies, technologies and more. A range of concepts for analysing this process are offered of which some are used below.

SYNTHESIS OF THE TWO MAIN CONTRIBUTIONS, ANT AND INSTITUTIONAL THEORY

ANT and institutional theory are mobilised here to understand the rise and possible fall of sustainable housing concepts, focusing on passive houses. Institutionalist theory provides a series of dynamics involving regulatory, normative and symbolic aspects and the role of legitimacy. Moreover it provides an understanding of the interplay between old and new institutions. Finally, the multiple institutions understanding is added. ANT is used to understand the building of alliances around the concepts and the role

of materiality. Here ANT emphasises the interaction between human actors and materiality, and the social construction of the market. It would also help thinking of materialisation as a more dynamic process. Building of legitimacy, viewed as an intermediary, is included in the actor network building concept of future institutions aiming at institutionalisation.

CASE: FIRST PASSIVE HOUSES, THEN COMPETING FUTURE INSTITUTIONS IN DENMARK

Below the case of passive houses develops as a future institution within sustainable housing with an emerging heterogeneous alliance of companies, architects, and materialised houses followed by a presentation of the competitors.

The Central European Development of Passive Houses

The early development toward passive houses, i.e., with such a low energy that does not require active warming, can be traced back to the period of 1975-1990 in a number of countries, e.g., Austria, US, Sweden, Denmark, and Germany. From the early 1990s, the development around Institut Wohnen und Umwelt, Darmstadt, took precedence. The first batch of houses built according to Darmstadt standards, such as those in Dörpe and Kranichstein (Hinz and Werner 1994), were used to develop a standard for passive houses, incorporating specific design parameters, energy consumption calculation softwares (PHPP) and tests. By the year of 2000, around 100 passive houses had been built according to these standards (Passivhaus Institute 2012). The Darmstadt institute database portfolio of passive houses as of early 2012 encompasses 1,753 projects. And 1,586 of these are in Germany, 33 in Austria, 12 in Denmark, and 10 in Switzerland. The vast majority of these projects are single family houses.

As mentioned in the introduction, a passive house according to the Darmstadt criteria (Passivhaus Institute 2012) encompasses four central technical properties: the specific space heating demand, the heating load, tightness of the building envelope (the skin of the building), the cooling demand and the total specific primary energy demand.

The Context of Danish Building

The oil crises in 1974 precipitated the Danish building sector on a coordinated path of improving insulation and reducing the energy consumption (Marsh, Larsen, and Kragh 2010). From 1975 to 2000, a 19 percent reduction of heat consumption was realized, and an improvement was mitigated by a 69 percent growth in energy consumption due to more intensive uses of household appliances and IT (Marsh et al. 2010). A bundle of planning, fiscal, and regulatory policy initiatives were taken in this period. Therefore energy planning in Denmark changed from oil to natural gas and district heating, produced by centralized combined heat and power plants (Marsh et al. 2010). Until around 2002, Danish regulations were ahead of those from EU. Afterwards new building regulations have been implemented in Denmark largely following EU directives and have substantially tightened the demands on energy consumption. The EU directive on building performance (EUBD) (EU 2002) was implemented in 2006, introducing two energy classes: 1 and 2, also called 2015 and 2010 referring to the years when they become obligatory. The Building Regulation 2010 (BR 2010), from august 2011 installed a third class “BR 2020” with even stricter demands. These reforms have been accompanied by a range of initiatives such as Directive No. 2010/31/EU on the energy performance of buildings, and the directive No. 2009/28/EC demanding national renewable energy plans, initiatives of developing sustainable skills amongst construction workforce, financial and fiscal arrangements. In summary, between 1974 and 2002, Denmark as a national state had a broad alliance of actors pushing for energy

Table 1. Building Activity (2007-2011)

	2007	2008	2009	2010	2011
Commenced new build in mil. m²	10.6	9.15	6.30	5.15	4.75
Commenced housing buildings	26,000	17,000	10,000	10,500	11,500

Note: Source: Denmark Statistics.

savings and accompanying technologies; whereas from 2002 and onwards the initiative shifted to the EU. The reform tempo has been quicker over the past 10 years than previously. Similar to many other countries, the Danish housing sector had a serious bubble that burst in 2008 (see Table 1).

The Story of Passive Houses in Denmark

The interest for passive houses occurs in the above sketched context. There has been a strong tendency in Danish building to gather around one common solution supported by law with occasional subsidies (Marsh et al. 2010). This continued even after the EU taking over the initiative, but now with implementation of EU legislation as the key driver. The passive house community is a niche environment that distinguishes itself from other parts of the industry. Especially the architectural community in Denmark second largest city, Aarhus, has been important in constituting this early interested group as the architect school, local architects and alliances of architects, consulting engineers and contractors commenced following the German development from around 2000. In 2005, the consultancy Ellehauge and Kildemoes obtained funding for the EU-project "Promotion of European Passive Houses" together with a range of European partners. Promoting passive houses as a well-documented sustainable solution, Ellehauge and Kildemoes created a website, commenced educational activities, and arranged study visits to Germany and Austria. The project was finalized in 2007. The website transferred to a new association for passive houses in Denmark. One active person in this niche community, the architect Olav Langenkamp, designed and built his own villa according to passive house criteria and got it certified. The house was completed in 2008 as the first passive house in Denmark. When building the house Langenkamp had to use German suppliers to get components that would be certifiable. The contractor was therefore a German company, Ökologischer Holzbau Sellstedt (Langenkamp.dk, Passivhus.dk).

ISOVER, a French global insulation manufacturer, initiated a project of 10 passive houses "Komforthusene". The idea was to let building sector actors tender for the various houses to obtain as much experience with passive houses as possible. Another goal of the project was to experiment with indoor climate and develop documentation, involving Aalborg University in a three-year long measurement program. By September 2008, eight out of the 10 planned passive houses, "Komforthusene", were inaugurated by the Minister of Climate. The last two houses participating to "Komforthusene" did not obtain the label passive houses once their constructions were achieved. Through these early projects, the passive houses got the reputation of being expensive. A later evaluation report (ISOVER 2010) showed that the "Komforthusene" was indeed more expensive to build with an additional cost of 6%-12%, but it also demonstrated that these extra expenses were compensated within 15 years thanks to their low energy consumption. Besides being expensive, these early trials all share the dependence on German suppliers.

These considerations also apply to the 2009

Table 2. Hits in Danish on the Internet of Selected Competing Concepts

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Concepts												
Passive house	107	64	51	125	207	411	661	1,694	2,577	3,302	4,830	2,792
Active house		2	0	0	0	4	11	39	90	173	322	253
Energy class 2				4	145	157	387	659	1,230	5,010	7,520	11,200
Energy class 1	108	39	44	126	337	311	540	925	1,810	5,980	8,979	12,294
DGNB							6	7	68	143	713	741
LEED						8	27	90	216	214	401	258
BREEAM						7	26	89	227	259	605	329

Notes: DGNB: Deutsche Gesellschaft für Nachhaltiges Bauen (German Sustainable Building Council); LEED: Leadership in Energy and Environmental Design; BREEAM: Building Research Establishment Environmental Assessment Method.

dormitory project "H2 College" (Bertelsen and Koch 2011). The dormitory encompasses 66 apartments, in two blocks built as passive houses, with a hydrogen conversion installation and thermal (earth) heating. A building association Fruehøjgaard is the client and Aarhus Arkitekterne, the consulting engineer NIRAS, and Ökologischer Holzbau Sellstedt were respectively the architects, consulting engineers and contractor. Over 2009-2010 various component suppliers started engaging in passive house projects. In 2010 for example, the Danish window manufacturer Rational was part of a vocational training school, built as a passive house.

By the summer 2012, there are 100 engineers and architects certified passive house designers meaning that they took a specific education and are able to design passive houses and one consultant company "Passivhus.dk" accredited to certify the buildings.

In summary, the development of passive houses mobilized both small grassroot players as well as larger players in the industry. Most of the Danish passive house projects occur as part of publically financed demonstration and/or innovation projects with the intention of first communicating the values and qualities of passive houses to a wider audience of possible future clients; and second underpinning this by supporting the legitimization process by providing formalized knowledge about the design, the costs, the building process, etc. A less controllable part of the communication is that the passive houses appear expensive and difficult to live in as the indoor climate is controlled with complex equipment.

THE CONCEPTS COMPETING WITH PASSIVE HOUSES

From 2005 and onwards, an increasing number of sustainable housing concepts have emerged. An European survey from 2009 has identified 17 different terms in use to describe such buildings used across Europe, among which the terms are low energy house, high-performance house, zero carbon house, zero energy house, energy savings house, energy positive house, 3-litre house, etc. (EU 2009). All are focusing on different scopes, calculation methods and norms for low energy. In Denmark in particular, the preparation activities before the United Nations Climate Summit, Copenhagen (COP 15) in 2009 seemed to have initiated a number of projects attempting to exploit the marketing options related to the summit. Table 2 depicts the attention to the various concepts on the Danish part of the internet.

The concepts introduced and materialised are entered in Table 3 covering housing found in Denmark. The year of introduction, as provided in the left hand column, is taken to be when the first realised

Table 3. Sustainable Building Concepts (2005-2012) Materialised Buildings

Concept/year of introduction in DK	Found estimated number of projects	Actors (examples)	Examples
Passive house, Darmstadt criteria/2008	20		H2 College (dormitory), Komforthusene
Active house (Velux group)/2009	3	Velux	Lystrup, Cph.
DGNB/2012	2	Green Building Council Danmark, Ramboll, Ålborg University	Ramboll Headquarter (HQ), Company house NCC, KPMG Domicil
Svanemærket (Nordic Ecolabel)/2011	2	Odense Kommune, pluskontoret, Køge kommune, Det grønne hus (Agenda 21)	2 kindergartens, Fremtidens Parcelhuse, Køge
BREEAM/2010	> 6 large projects	Grontmij DK	Vestas HQ, Sillebroen shopping center, Grontmij HQ
LEED/2010	> 7 larger projects	COWI, KPC, Sjælsø	FN-city, UL International Demko HQ
EU Green House/2008	7	NCC	Skejby Company House I-III (also BREEAM)
Energy class 2 (EUBD 2002)/ 2010	> 4 large projects		KPMG, Flintholm City Court Kolding, Christian Union HQ, Industriens Hus,
Energy class 1 (EUBD 2002)/2006	9 large and small projects and 7 under construction	Arkitema, KAB, Ramboll, Pihl, Lind and Risør, and many others	Stenløse Syd, Multimediehus, Navitas
Other concepts: Sabro, ZERO+, lavenergi, BR 2020	8		Sabroe, Sønderborg Zero, Vordingborg

Notes: ZERO+ is a low energy housing concept; KPMG and COWI are consulting companies; NCC and KPC are contractors; UL International Demko is a company; KAB is a social housing company; and Lind and Risør is a bungalow developer. Source: desk research.

building occurs. The list is not exhaustive but gives an impression of a veritable cacophony of concepts and indicates a limited breakthrough of sustainable building concepts compared to the overall building activities in the same period (see Table 1).

The year of introduction of concept is counted for the year where the first building is finished. Usually press coverage and emerging actor network would commence long before and some concepts never materialize into realized buildings.

Energy class 1 was announced by the EU in 2002. Several years before the passive houses were first built in Denmark, the first energy class 1 buildings, the Stenløse Syd project, was erected (2005-2008) encompassing 400 dwellings including housing and villas as well as a kindergarten and an elderly home. Designed as show case by EU program Concerto, a range of small players in the villa market were mobilized to the project, also involving the local municipality and a social housing company. The blower door testing of airtightness received extra joint attention, resulting in reported and documented good results assembled by a participating university. The project scale has been downsized following the last economic crisis but it is still undergoing. In 2010-2012, several large office and institutional buildings were designed according to energy class 1, which continue to grow on all market segments

parallel to the passive houses.

The EU energy classes (EU 2002) were introduced in Danish law in 2006. From 2006 to 2010, using energy class 2 would imply going ahead of regulatory demands. A Danish investigation indicates that 10% of all new houses did so in 2007-2009.

In 2008, NCC introduced an office house following the EU green building standard. EU originally launched this program for non-residential housing in 2004. The idea being to introduce a standard ahead of regulation as the main content is that the building should consume 25% less energy than the legislative demand at any time. NCC decided to market the office building following the EU standard in a context of crisis on the market. Their concept, company house, was building on renting out to several businesses and after the first erection in 2008, more followed.

In 2009, Velux, the multinational windows manufacturer, introduced a new concept in Europe: the "active house". This concept directly targeted the legitimacy of passive house claiming that low energy consumption was not ambitious enough, the houses should actively produce energy. Velux allied with architects engineers, contractors and universities to realize five houses before the COP 15 meeting in Copenhagen. However, the concept was taken seriously by a new association "Active House Alliance" that was inaugurated in June 2010. Velux however has recently renamed their concept advertised now as Model Home 2020.

From 2009 to 2010, energy class 2, part of the 2002 EU regulation, received attention in Denmark reinforcing the legal demands for the energy performance of new buildings. Several large projects such as Sorcer in Hillerod associating the municipality, Cowi and the Danish Technical University under the umbrella of Concerto, were part of this new wave. The project was realized one year before the class became obligatory. Ørsted School, for example, realized as a public private partnership is a green building certified.

In 2010, the Green Building Council in Denmark was formed following similar initiatives in other countries involving consultancy companies such as Ramboll and Ålborg University. The council first carried out a comparison of different concepts, and later, the Green Building Council Denmark became a proponent of an accommodated version of the German concept DGNB. This modified certification was launched in 2012 introduced in pilot building projects involving ATP Ejendomme (Estate player), MT Højgaard (contractor) and Velux again. Nine auditors and seven certificates have already been attributed. In 2010, the American BREEAM and British LEED concepts were introduced in Denmark targeting the larger projects. These concepts do not only focus on energy consumption but also assess the environmental performance of the totality of the building, from construction to maintenance. Over 2010-2012, a series of projects have been launched referring to those two standards with, in a Danish context, heavy weight players such as COWI, Carl Bro/Grontmij, Sjælsø, KPC on board. Vestas head quarter and Sillebroen shopping center are highly profiled projects.

Importantly in 2010 the preparations commenced for BR 2020, a voluntary energy class beyond the two previously implemented. This involved all the central players in Danish construction and the new norm was introduced in October 2011. When BR 2020 will become law in 2020, it will mean a reduction of 75% compared to 2006 rules.

The description given is not exhaustive but provides an impression of a veritable proliferation of concepts even if several have not been accounted for here (such as Svanemærket and ZERO+). It also indicates a limited breakthrough compared to the overall building activities in the same period (see Table 1). Besides the choice of one concept is not disqualifying the others; some of the projects are subscribing to more than one concept (for example, the Green Lighthouse in Copenhagen, which holds both LEED and DGNB certification).

DISCUSSION

Below the authors first discuss the emerging of a possible future institution of passive houses in Denmark and then move on to the dynamics of the competing future institutions.

The built environment regime in Denmark has continued over the last 10 years to be relative conservative in "following the rules". As a discourse passive houses interested a handful of architects and consulting engineers around 2000 developed as a contesting future institution. This early community shares features with other grassroot developments of renewable energy, such as wind turbines (Steen et al. 2008 as cited in Foxon, Köhler, and Oughton 2008). Obligatory point of passage was an accommodation of the design principles from Germany to Danish building standards. An important actant here was the PHPP calculation program that had to be negotiated versus the Danish BR06 software. The alliance developed based on accumulating knowledge of the concept and the EU project obtained by Ellehauge and Kildemose solidified the alliance in the absence of actual building projects. The study trips to Germany done by this alliance involved a problematization of the cost since the German houses were subsidised to lower prices. So even if the German passive house institution possessed moral and cognitive legitimacy the alliance did not materialise into buildings, even if 2005-2007 was a peak of building activities in Denmark (see Table 1). Instead education as certified passive house designer was central for the network. It is characteristic that it is a fiery soul architect, building his own house that commenced the materialisation. Olav Langenkamps house materialised as the first realisation in 2008. Soon after followed the ISOVER initiated comfort houses. Here the intended 10 houses were reduced to eight as the last two did not comply with the Darmstadt criteria. Besides through media coverage and building sector word of mouth, the houses got the reputation of being too expensive, to be untight, to use more energy than calculated and suffer from poor indoor climate. This involves a contestation of the institutional becoming and a partial loss of legitimacy for it. By spring 2012, these issues were documented by the evaluation project carried out by Ålborg University: only six of the original 10 comply with Darmstadt criteria. This evaluation meant to contribute to the cognitive legitimation of the concept, and its theorisation (Greenwood et al. 2002) thus ended up contributing to the contestation of the concept and underlining need for improvement. Passive houses both private houses and public institutions continued to be built in 2009-2011, however there are 5-10 projects per year. From 2009, the alliances are stabilised and the interest is growing with research and funding, an annual Nordic passive house conference, as well as more educated designers. This discursive stabilisation is also indicated by the internet hits in Table 2. However by 2012, it appears to be a decrease in finalised houses. Over 2011 and 2012, three finalised passive house buildings were found, compared to six in each of the years of 2009 and 2010. In other words, there continue to be considerable distance between rhetoric and materialisation of passive houses. There is no Danish realisation before 2008 and then only a handful is realised. The continued economic crisis and a stand still on the housing market, the loss of moral and cognitive legitimacy due to indoor climate issues and price probably create reverse salience in the network building as the attention turns to the competing sustainable housing concept.

The other voluntary normative sustainable housing concepts (active house, LEED, BREEAM, DGNB, etc.) suffered from the same marginalisation vis-à-vis the built environment regime, even if large players such as NCC, MTH (contractors), Ramboll, COWI (consulting engineers), CF Møller, Arkitema (architects) and Velux (Windows manufacturer) contributed. This is also indicated by the internet hits in Table 2. Only a few buildings have materialised.

The moral legitimacy has not sufficed even if supported by cognitive and functional arguments of cost effective energy consumption.

However, the institutions carried by regulatory dynamics are in stark contrast to the voluntary. "Energy class 1" was early a strong brand on the internet (see Table 2) and the future institution encompassed early materialisation in Denmark in the Stenløse project. Also "energy class 2" enjoyed attention especially by 2006 when announced as future legislation. As energy class 2 became obligatory by 2010, all new built houses have followed that set of rules from 2010 and on, whereas energy class 1 by 2012 receives interest from players that want to anticipate its becoming of the rule by 2015. Several of these concepts have been harsh competitors for the passive houses, but the most important factor seems to be the impact of the legislation.

The voluntary (normative) and regulatory types of sustainable building institutions do carry a number of similarities both in their technical content and in their actor alliances. There is overlap of design demands, actors and the common obligatory physical tests such as the demands for airtightness.

It appears to be the contours of a bundle of several upcoming institutions within sustainable buildings. The elements of the bundle are however not similar enough to view it as one institution of sustainable houses. Neither can it be interpreted as an interinstitutional system (Thornton et al. 2012), as the relations between the future institutions are too vague and their contents too different

Several of the concepts encompass an alliance with public institutions and public funding, large companies showing support, and universities either participating in the design or the assessment of the project. It does not appear to cause problems for many actors to support several institutions at a time. Thornton et al. (2012) argued that this support to more institutions by one actor was a more general phenomenon of how actors would relate to institutions.

Also as BR 2020 is now perceived as the future obligatory point of passage (obligatory legislation), slight changes of content and labelling are carried out. Velux, for example, changed "active house" into "home model 2020", involving a similar principle but new name, while also being part of various certification projects, all at the same time.

The multiple embarking could be seen as a marketing stunt toward new markets for the large companies, be it architects, consulting engineers, contractors or suppliers. It does underline a weakness in a combined institutional ANT analysis as they tend to downplay the commodity feature of future institutions and concepts. Concepts of sustainable housing should be understood as a commodity on a market as well. This market for sustainable housing is clearly characterised as being hybrid public-private as public subsidies playing a major role.

The analysis of the passive house upcoming institution shows slow and hesitant processes, involving public support as the lever for development. It took 16 years from the first realised passive house outside Darmstadt in 1994, to realise the roughly 20 Danish projects in the sample presented here. Indeed, all were built after 2006. As the niche commenced to produce material results, a key experienced barrier turned out to be the initial price of the houses. As a direct result, the passive house concept has experienced limited adoption, keeping it at the niche level. This is despite of its German origin and backup, which provides well established knowledge, legitimate institutions, design procedures, and more. When the passive house development is juxtaposed with other sustainable building niches and their competition is mapped, it becomes clear how voluntary concepts that go beyond what is specified in the legislation have been introduced in succession over time, e.g., passive, active, DGNB. But it is also clear that the early compliance with future legislation,

especially energy class 1, has tended to dominate these voluntary steps. There are tendencies of segmentation, where LEED, BREEAM, DGNB, etc., are used for office buildings, whereas passive house, active house, Svanemærket and ZERO+ mostly are used for single family houses and smaller buildings such as kindergartens.

The empirical material demonstrates how the EU processes create regime dynamics that are more prevalent for the development of sustainable buildings than the future voluntary institutions. Usually it is expected that regime driven institutions would conserve existing ways of working (Geels 2005; Markard and Truffer 2008). This is evidenced by the far bigger number of projects built according to the required levels set out in the official regulations during the investigated period. In the Danish setting, the restructuring of government responsibilities into a Ministry of Climate, Energy and Building can even be viewed as one of the more important dynamics in late 2011 apart from the central EU initiatives discussed above. Seen from a grassroot perspective, the commodification of a type of house, using a certificate is less interesting than promoting sustainable buildings in a broader sense. There will therefore be a tendency for grassroot engagement to move from one promising future institution to the next, especially if the approaches get influenced by too many commercial players.

CONCLUSIONS

This paper has investigated the introduction of passive houses as a possible future institution within the Danish built environment. The analysis showed a slow process, costs and technology barriers, limited adoption, and recently an apparent decrease. Roughly 20 projects over the last six years have been realised. The institution has not been able to exploit its basis in formalised knowledge and cognitive legitimisation to become a contester institution. When juxtaposed with other future sustainable building institutions, it appears that the voluntary normatively based is small and weak. Rather than just being about niche technologies, it is the voluntary early adoption of future regulatory demands that is prevalent as energy class 1 proliferates as a strong contester of the existing built environment institution. Therefore, government policymaking as the "regime internal" dynamic contributes more convincing to institutional change than contesting small future institutions does, which is counter to theories of classical transition theory (Geels 2005, 2011). Compliant with the theoretical framework, there are multiple dynamics in play. These combined dynamics between sustainable housing institutions and the regime internal dynamic through EU-regulation lead to the conclusion that sustainable housing concepts are only viable in fairly confined windows of time, and that the contribution of the passive house institution probably is of temporary character toward low carbon housing.

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