Appendix 3.4

State of the art insurances schemes and transition paths

contract n° 30-CE-0464094/00-38

January 2015

Contributors:

Kim Haugbølle (SBi)

Stefan Christoffer Gottlieb (SBi)

Thomas Dunand (Hannover Re)

Sabine Bernard (Hannover Re)

Table of contents

1 State of the art insurances schemes and transition paths

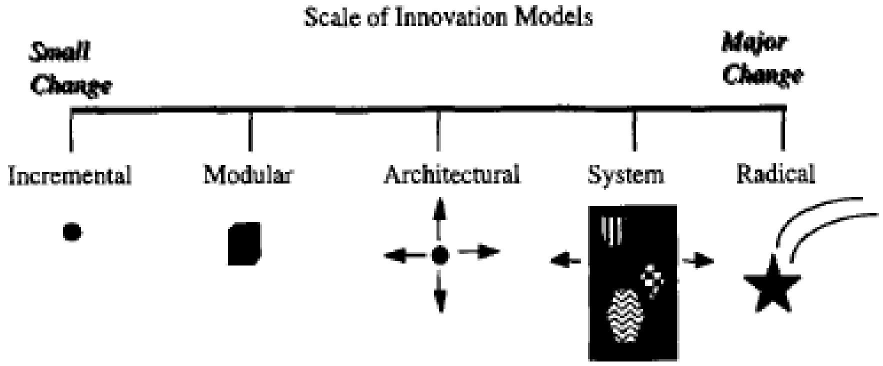
1.1 Innovation models

As part of the ELIOS project WP3 on construction and insurance regimes, a literature review has been conducted, highlighting different innovation models that can be used to qualify the discussion of how (if possible) new insurance schemes can stimulate innovation and the use of sustainable solutions in construction. We focus three ways in this review, highlighting models that operate on different scales, i.e. macro (sector perspective), meso (company perspective) and micro (learning perspective). We start, however, by highlighting different types of innovation in order to put the subsequent models into context.

1.1.1 Types of innovation

Slaughter (1998) distinguishes between five different types of innovation in construction. The focus here is to guide selection and implementation strategies by construction companies; however the framework can also be used in the planning and carrying out of strategies to identify, acquire, develop and implement construction innovations (Slaughter, 1998: 226). Hence this framework can be used as a starting point for understanding the successful development of insurance schemes that could support cross border services and the cover of building sustainability performances

Figure 1: Innovation models for construction (Slaughter, 1998: 229)



According to Slaughter (1998) a wide range of different benefits arise from construction innovations, including economic growth, market growth, social benefits, increased technical feasibility and a series of intangible benefits such as e.g. improved reputation.

The benefits from construction innovation differ from those in the manufacturing sectors of national economies that hitherto have received the greatest attention. Here it is often assumed that innovations are generated by an internal R&D organization that according to Nelson and Winter (1982 in Slaughter, 1998) chooses from among a set of promising research pathways, and that innovation can be exploited through large scale mass production (Slaughter, 1998: 227). In contrast, construction innovations rely on markedly different dynamics in that the nature of the construction industry differs from the nature of the manufacturing industries in important ways (cf. Slaughter, 1998; Winch, 1998; Gann and Salter, 2000; Engwall, 2003). This has e.g. to do with the temporary nature of projects, the difficulties in coupling business and project processes, and issues arising from systems integration.

1.1.1.1 Models of construction innovation

The different types of innovation models proposed by Slaughter (1998) take the starting point in this idiosyncratic nature of construction activities. Thus, the organizing principles for the models are (i) the magnitude of change from current state-of-the-art associated with the innovation; and (ii) the expected linkage of the innovation to other components and systems.

An *incremental innovation* is defined as "*..a small change, based upon current knowledge and experience.*" (Slaughter, 1998: 227). In contrast, or rather at the other end of the innovation spectrum, is the *radical innovation*, which can be seen as a breakthrough in science or technology that according to slaughter often changes the nature and character of an industry. Making this distinction, Slaughter also pointed to the deduced fact that radical innovation occur very seldom, whereas incremental innovation occur constantly.

In addition, Slaughter also identified *modular*, *architectural* and *system* innovations. A modular innovation "*…entails a significant change in concept within a component, but leaves the links to other components and systems unchanged*" (Ibid., 1998: 228). An architectural innovation reverses the logic. It is an innovation that involves a small change within a component but a major change in the links to other components and systems.

Finally, Slaughter identified system innovations. These types of innovations can be "*…identified through their integration of multiple independent innovations that must work together to perform new functions or improve the facility performance as a whole*" (Ibid., 1998: 228).

Slaughter further argued that the five innovation models can provide the basis for a strategy to incorporate innovations into specific projects. As it is argued: "*Using the attributes of the magnitude of change and the linkages to other components and systems, companies can predict and plan for different types of activities depending upon the type of innovation involved.*" (Ibid., 1998: 228). These types of activities are presented in summarised form in the below table.

Types of innovation	Timing of commitment	Coordination with project team	Special resources	Supervision organizational level	Supervision type	Supervision competency
Incremental	At any time	None	None	At locus of improvement	Notification	Specific product or process
Modular	At design / selection	None	For concept change	At design level	Notification, review	Technical competency
Architectural	At design-to-implementation stage	Among affected parties	For complementary changes	At affected system level	Notification, agreement, review	System competency
System	At conceptual design stage	With all project team members	For integration of set of innovations	To top engineering management level	Project scope, agreement, review	Technical and system competency
Radical	At technical feasibility stage	With top management from all involved organizations	For breakthrough	At top management level	Project objectives and scope	Specialized technical competency

Table 1. Specific activities for implementation by type of innovation (Slaughter, 1998: 230)

Whilst it is plausible that the five innovation models can provide the basis for a strategy to incorporate innovations into specific projects, the conceptualisation has several shortcomings in relation to the specific purpose of the ELIOS 2 project.

First of all, while the ELIOS 2 project indeed deals with construction innovation, in the form of eco-technologies, the focus is not on implementation on specific projects, nor on innovation *per se*. Rather, emphasis is placed on the governance of innovation processes and technology uptake across different European countries.

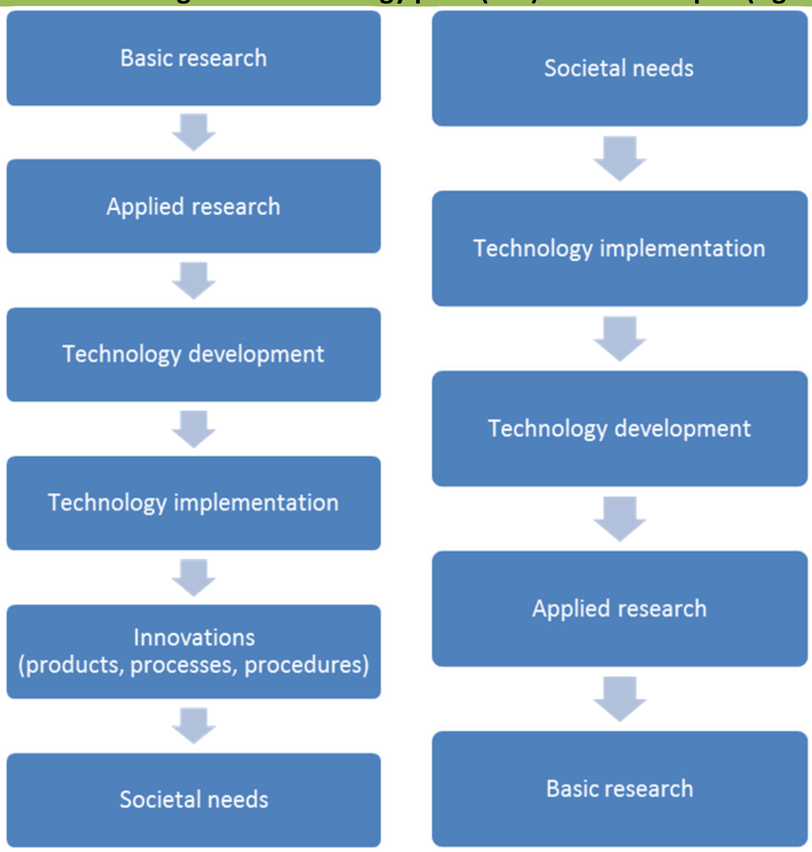
This gives rise to two further points that should be addressed in a theoretical framework that are able to handle the question of how new insurance schemes can be used to stimulate innovation and the use of sustainable solutions in European construction, namely: (i) the nature of innovation *processes*; and (ii) the notion of context and systemic innovation.

1.1.2 Innovation processes

Slaughter's (1998) study deals first and foremost with the nature of different types of innovation. As illustrated in Table 1, while Slaughter does address some issues relating to the implementation of innovations, she does not present an explanatory model of the processes of innovation, i.e. how a new technology is diffused and anchored in existing practices.

Traditionally, the innovation process literature has made a distinction between two basic models for technological innovation being (i) technology push; and (ii) market pull mechanisms as illustrated below.

Figure 2: Technology push (left) and market pull (right) innovation models



The technology push model works with the assumption that it is basic research that constitutes the foundation for the development of new technologies and innovation, whereas the market pull model assumes that it is customer and societal needs in general that frames the process and drives the development of new technologies. In both cases, however, the models describe the process of innovation as a rational, sequential development process, and as such the models have been criticized of conveying a simplified view on the relationship between science and technology. In particular, the models have received much criticism from the literature on the history of technology and from science and technology studies, which promote a much more complex relationship between science and technology as will be discussed later.

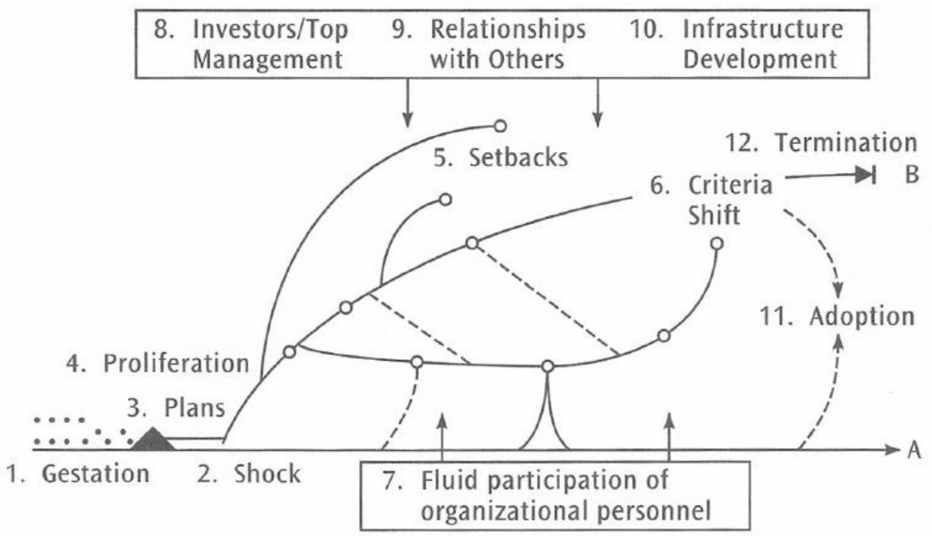
1.1.2.1 Innovation as a journey

In contrast to the simplified linear models of innovation, Van de Ven et al. (1999) have proposed an alternative understanding of the innovation process, invoking the notion of an innovation journey. This understanding in grounded in a series of studies conducted as a part of the so-called Minnesota Innovation Research Program (MIRP). Here a diverse range of innovation projects were followed over the course of 10 years with the aim to develop a new process theory of innovations. Although very diverse, the MIRP researchers identified some basic similarities in the way in which innovations developed. A total of five key concepts characterizing innovation processes were defined:

- *Ideas*, being about important ideas or strategies that participants in an innovation project use to describe the contents of innovation at any given time.
- *People*, is about the people, actors or groups involved in an innovation project, the roles they play, and the activities they are performing at any given time.
- *Transactions*, deal with the formal and informal relationships between participants in an innovation project, other firms and groups.
- *Context*, includes external events outside innovation project in larger organizations, industry or society, as participants in an innovation project believe affect innovation.
- *Outcomes*, include events that give visible results and coded as positive, negative or a mixture thereof (Davies and Harty, 2011).

The MIRP project sought to identify how changes occurred in these five concepts throughout the innovation process, and provided the framework for the developed process model).

Figure 3: The innovation Journey (Van de Ven et al., 1999: 25)

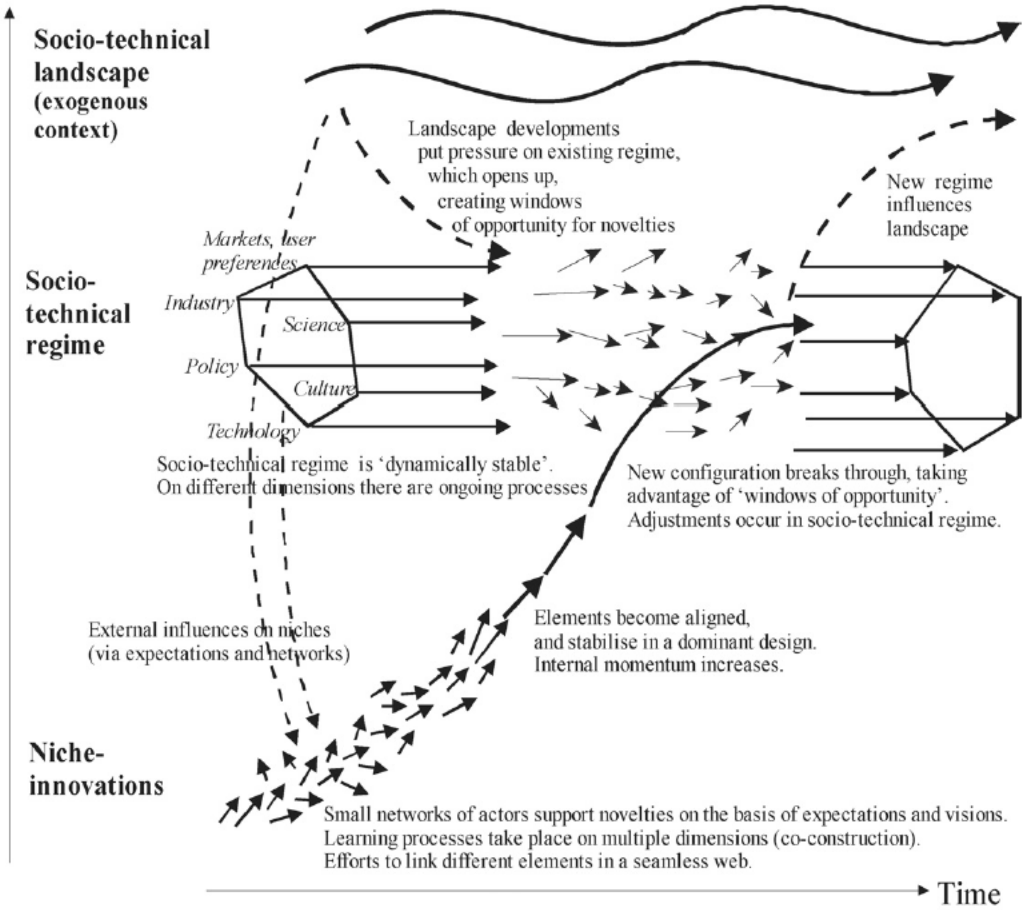


The model shows the common features of the observed innovation projects and their processes. Overall, the innovation process is described as a highly unpredictable and uncontrollable 'journey' that develops in a non-linear and dynamic fashion. This journey does not traverse fixed, incremental stages, but is, on the other hand, not completely random. Figure 3 illustrates the main elements of this process. This is an extremely complex and very chaotic process that the involved actors do not have the full picture of. It is shown how an original idea quickly gemmates and generates many new ideas and activities that can develop in both divergent, parallel and convergent directions. The process is further characterized by the fact that the targets, and thus the criteria that determine whether the innovation is a success or a failure change over time. Unexpected events often lead to developmental relapse or mistakes, causing the process to differ from expectations. Shifting priorities in society and changes in the organizations' environment are also argued to have indirect effects on the innovation process to such an extent that innovations rather than replace the existing order completely often become integrated within existing institutionalized structures. Whilst highlighting the importance of contextual and systemic factors in the innovation process, the innovation journey approach does not offer a theoretical understanding *per se* of the dynamics at play. In order to do so, we turn to transition theory and strategic niche management in the chapter below.

1.1.3 Context and systemic innovation

Transition theory deals with fundamental changes in how societal functions such as transportation, communication, housing, feeding etc. are fulfilled (Geels, 2002). Although focusing on technological transitions (TT), transition theory does not involve only issues of technological changes, but also: "*…changes in elements such as user practices, regulation, industrial networks, infrastructure, and symbolic meaning*" (Geels, 2002: 1257). Many studies have been conducted of such technological transitions and systemic change, drawing on various theoretical positions, including evolutionary economics, actor-network theory and science and technology studies to mention a few. Combining various insights from these different fields, a distinct multi-level perspective (MLP) on technological transitions has recent years emerged (cf. Kemp et al., 1998; Rip and Kemp, 1998; Geels, 2002; Smith et al., 2005; Ørstavik, 2014). According to the MLP perspective, transitions come about as a result of frictions between processes at three different levels: (i) landscape, (ii) regime; and (iii) niches as illustrated below.

Figure 4: Multi-level perspective on transitions (Geels and Schot, 2007: 401)



At the niche-level, technological innovations build up "*..internal momentum, through learning processes, price/performance improvements, and support from powerful groups*" (Geels and Schot, 2007: 400). At the landscape level, changes create pressure on the regime, and finally the destabilization of the regime creates windows of opportunity for niche innovations to break through and become part of the mainstream market.

On this basis, the MLP is concerned with understanding how this process occurs, and consequently how novel technologies and niche innovations can penetrate existing institutionalized structures and become accepted on a wider market.

The important point of the multi-level perspective is according to Geels (2002: 1261):

> *"…that the further success of a new technology is not only governed by processes within the niche, but also by developments at the level of the existing regime and the sociotechnical landscape. 'It is the alignment of developments (successful processes within the niche reinforced by changes at regime level and at the level of the sociotechnical landscape) which determine if a regime shift will occur' (Kemp et al., 2001, p. 277). Changes at the landscape level, for instance, may put pressure on the regime, and create openings for new technologies."*

Thus, the basic assumption of innovation, and innovation dynamics, in the MLP perspective is that existing societal functions can be said to form a relatively stable socio-technical configuration (or regime) in which incumbents are locked into fixed and stable positions leading to issues of path dependency and incremental innovation, as only innovations conforming to existing market requirements become selected and included in the regime. Niche innovations thus tend to exhibit relatively low technical performance, and are also often cumbersome and expensive (Geels, 2002: 1261) preventing diffusion into the existing regime. The question is then how new novel technologies can make their way onto the market and contribute to a transition.

1.1.3.1 Niche management

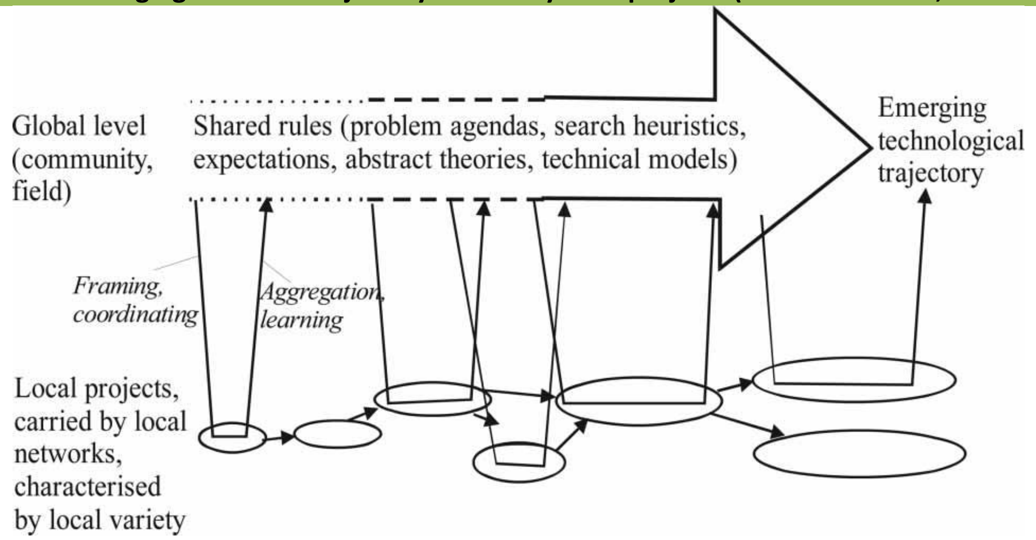
Combing insights from the multi-level perspective and the innovation journey understanding of innovation processes, Schot and Geels (2008) *i.a.* further elaborate the so-called the strategic niche management (SNM) perspective that addresses the problem of how to bridge the 'valley of death' between R&D and market introduction. Following Mokyr, Schot and Geels (2008) describe new technologies as 'hopeful monstrosities':

> *"They are 'hopeful', because product champions believe in a promising future, but 'monstrous' because they perform crudely. As Rosenberg (1976, 195) argues: 'most inventions are relatively crude and inefficient at the date when they are first recognised as constituting a new invention. They are, of necessity, badly adapted to many of the ultimate uses to which they will eventually be put.' This means that new technologies cannot immediately compete on the market against established technologies. This problem is pivotal for many new technologies with sustainability promise for energy, transportation, agriculture, etc."* (Schot and Geels, 2008: 538-539).

The SNM approach, Schot and Geels (2008) argue, suggests that sustainable innovations journeys can be facilitated by creating technological niches that allow actors to experiment with the co-evolution of technology, user practices, and regulatory structures. Shot and Geels further demonstrate that niche internal dynamics have to be understood vis-à-vis niche external process, thus linking the MLP with processes of strategic niche management (SNM). Thus, even though niches are perceived as crucial for bringing about regime shifts, they cannot do this on their own as ongoing external processes are also important.

SNM works with the assumption that*: "Niche development can then be conceptualised as progressing at two levels simultaneously: the level of projects in local practices and the global niche level. Sequences of local projects may gradually add up to an emerging field (niche) at the global level"* (Schot and Geels, 2008: 543) as illustrated below:

Figure 5: Emerging technical trajectory carried by local projects (Schot and Geels, 2008: 544)



The idea is that any development may start with one or a few projects, carried by local networks of actors. If learning processes, then, in local projects are compared and aggregated, cognitive rules at the more global niche level may gradually become more articulated, specific and stable (Geels and Schot, 2008: 543) until the niche breaks into the existing regime, under the right external conditions.

1.1.3.2 Construction / insurance regimes and pathways for eco-technologies

In the light of the ELIOS-project, this SNM model and the MLP understanding can contribute by elucidating how eco-technologies (as technological niches) can penetrate existing construction regimes and contribute to technological transitions.

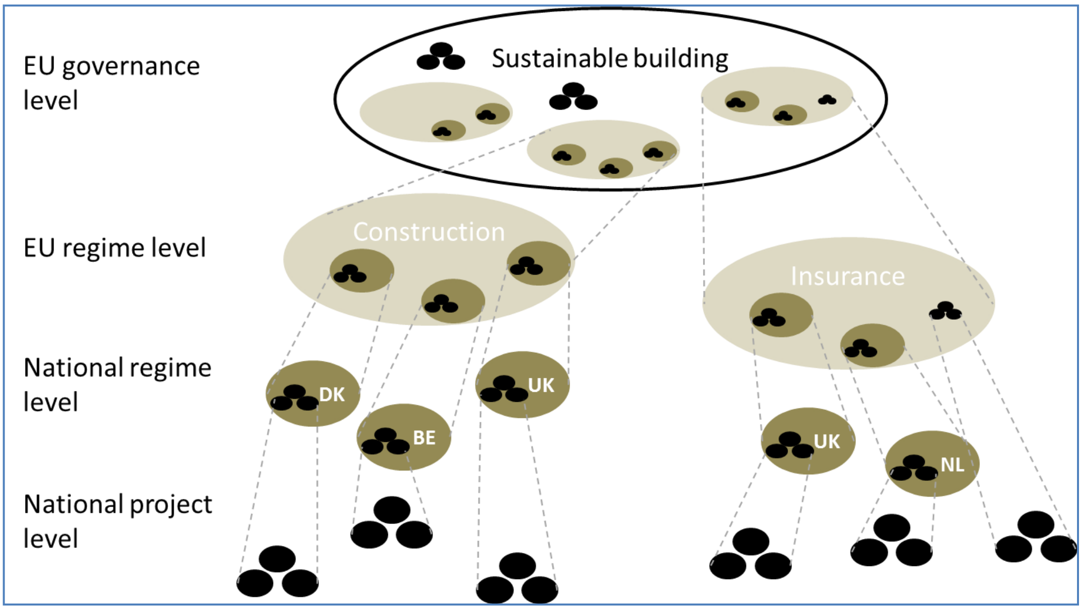
1.2 Construction and insurance regimes

An overall objective of the project is to achieve concerted change on construction insurance regimes and sustainable innovation in Europe.

A transition towards increased levels of sustainable innovation in construction is, however, not only a question of aligning national interests, but also a question of aligning highly discrete and durable systems of construction, sustainability and insurance within the individual member states.

Applying a socio-technical approach, combining contributions from transition theory and institutional theory, the analysis will be conducted as two distinct yet interrelated analyses; a horizontal respectively vertical analysis of regimes development and transformation as illustrated in Figure 6 below.

Figure 6: Levels of analysis (adapted after Seyfang and Longhurst, 2012)



The vertical analysis aims at providing an understanding of the interplay and co-development of national regimes of insurance, sustainability and construction within the individual national context.

The analysis will result in a typology of various national construction regimes based on their technological, historical, social, political, cultural and economic characteristics. The analysis will be conducted in order to identify main similarities and differences between the various national construction regimes that may function as drivers or barriers towards a common European insurance policy implementation, which is the focus of the horizontal analysis.

The horizontal analysis, thus, will focus on the interplay between national and supra-national regulation and on the dynamics of adaption and circulation of insurance schemes in Europe.

1.2.1 From Construction Business Systems to Regimes

The preliminary findings indicate that national regimes of construction vary markedly from country to country in the EU. Winch (2000, 90) has distinguished between three types of systems / regimes:

- The Anglo-Saxon system is characterised by "a greater reliance upon liberal market values, relatively low levels of state regulations…."
- The corporatist system depends more on "…negotiated coordination between the 'social partners', greater willingness to intervene in the market to protect social values… "
- "The 'étatique' system has more extensive coordination of the economy by the state relatively high level of worker protection … and a desire to promote national champions in various industrial sectors"

To this, a fourth regime typology may be relevant for the Eastern European countries, where the development of new state/market relations has been under development since the early 1990's.

Not only do these national regimes of construction and insurance differ on some dimensions, they might also be contradictory and even detrimental in terms of their functioning. In addition, the preliminary findings also indicate that the distinctiveness or idiosyncrasies of the different national construction regimes have impact on the actual uptake of new technologies and policies. In essence, this entails that policy and technology implementation follow different transition pathways dependent on the regime level characteristics.

Winch's (2000) typology of Construction Business Systems (CBS) constitutes, however, quite a broad framing and conceptualisation for understanding different cultural and systemic factors that are important to understand when discussing issues of how actors and structures are interrelated and not least, how change can be brought about in highly institutionalised organisation fields. Thus, for the purpose of the following analysis, we intend to describe the Danish corporatist construction business system drawing on concepts from institutional and transition theory to enable a richer understanding of these issues.

Thus, the following section constitutes a description of the Danish construction and insurance regime based on Gottlieb (2010), Jensen et al. (2011), Thuesen (2011) and Brahe et al. (2013). The objective is to describe the characteristics and modus operandi of the Danish construction and insurance regime as a starting point for the further analysis of differences of regimes in the EU and hence the challenges of harmonizing insurance and liability schemes across member states.

1.2.2 The Danish construction system

In a historical analysis on the constitution of the Danish construction sector, Gottlieb (2010) argued for the need to understand the current practices and systemic configuration of the sector in a historical perspective, i.e. as a result of a development process that have taken place over generations. This type of historical awareness is crucial in understanding the conditions for how new technologies or practices can gain prominence, including the role of existing systemic factors in promoting or resisting institutional change.

In essence, Gottlieb (2010) argued that the current Danish construction regime can be seen as the result of a development process taking place in the intersection between three highly institutionalised regimes or systems of interaction (see also Gottlieb and Haugbølle, 2013) and that the introduction of new technologies or practices depends on the ability to understand and manage contradictions in and between these regimes.

The three regimes comprise:

- Building customs and practices
- Rationalisation
- Negotiation

In the following analysis, the three regimes will briefly be described (based on Gottlieb (2010) and Jensen et al. (2011)) followed by a summary of their central characteristics using the nomenclature from the MLP framework.

1.2.2.1 Building customs and practices

Gottlieb's (2010) analysis of the Danish construction sector started by exploring the notion of the 'building sector' in the medieval and pre-industrial eras, using the figure of 'building customs and practices' as the diagrammatical point-of-entry. He discussed the guild and crafts-based roots of the building sector with special emphasis on the management and organisation of work. In doing so, it was shown that apprenticeship, and the close relation to a specific type of building material within a craft, was instrumental in ensuring *coherence* as the governing principle in a sociality predicated on a variety of different practical rationalities and performative practices.

Moreover, it was demonstrated that guilds as an institution represented a form of organised community in relation to a specific craft, and that they were formal associations of specialised artisans whose authority was backed by superior political sanction.

A cornerstone in the guild system was the so-called guild statutes, which represent the earliest form of (state-)centralised regulations in Danish construction. The guild statutes can be said to comprise a constitution of the sociality of craftsmen, i.e. guidelines for the conduct, norms, and practices of belonging to a community and being a craftsman. The statutes played a very important role, as they regulated the workmanship, the formal festivities, and the social intercourse. Much traditional building is thus carried out in absence of any formal methods of quality control. And in the absence of formalities there must be something else that ensures sound building – methods that are internal to the craft system itself, being:

- Control of entry to the trade
- Sanctions for poor work
- A recognised training system

These three elements together can be seen as constituting the first insurance system in Danish construction. Thus, entry to trade was a prominent mechanism in the traditional feudal or city state society. In cities it was only possible to work as craftsman if you were a journeyman employed at a master artisan or a master artisan yourself. The master artisan had to be a member of a guild, which in turn required him to be part of the bourgeoisie and carry a trade license. The guild was a professional community, which had a primary protectionist role to play in ensuring that only members of the guild could perform their trade in the cities. This entry control was vigorously enforced with severe precautions in case of violations. Upon admission into the guild, the master artisan accepted to serve the king, the city and the guild according to the commands of the guild master. At the same time he however also accepted, the first competition provisions of the trade.

Despite their seemingly monopolistic position, the guilds (and also the magistrate and the city council) kept strict control with both the price and the quality of work. In paragraph 4 in the coppersmiths' guild statutes it is thus stated that if the master artisan is found to be un-cheap or negligent, he has to pay a penalty to the guild as well as to the poor (cf. Kieser, 1989: 553).

Yeomans (2001: 3) gives an example from Britain in which the guilds were under an obligation to seek out and destroy any materials or work that was defective. He argues that this quality control function, which originally was carried out in exchange for having entry to the craft restricted, eventually broke down making it necessary for clients to control their own people to supervise work on their own buildings. This is to some extent also the case in Denmark; however it is also worth noting that the fixed schedule of wages, i.e. the price lists composed by the guilds (and today by the different trade organisations) constituting the most central element of the piece rate system, still contains the clause that the stipulated prices only apply to well-performed work and that the craftsmen bear full responsibility and risk being sanctioned in the form of deductions in their piece rate if they deliver inferior work, which has to be redone.

In Seligman (1887: 64-67, 71) we find a similar line of reasoning for the function filled by the guilds. He suggests that the control of entry was the condition *sine qua non* of exercising any supervision over craftsmen for the purposes of avoiding any mischievous practice as well as to prevent fraud and public deception. This view is further supported and substantiated by Kieser (1989: 549-552) who argues that guilds were initiated by offices created by the town magistracies for two reasons: 1) to ascertain that the taxes were paid to the town and church, and 2) to protect the poor from any exploitation and manipulation by the craftsmen and merchants.

From the 1850s onwards, as a part of the increasing urbanisation, a series of laws were passed to ensure i.a. the quality and structural safety of the many new dwelling, however, as early as in 1731 a semi-public fire fund (d'assurance contre l'incendie) to prevent a recurrence of the economic problems associated with the Great Fire of Copenhagen in 1728. In 1761 membership of the state fire insurance scheme became mandatory. According to Engelmark (1983) the urban development of Copenhagen was subjected to three building laws from respectively 1856, 1871, and 1889, which were further supplemented with a series of supporting provisions. With the law of 1856, the City of Copenhagen was subjugated to the first collective set of building regulative requirements. This law was much stricter than the previous, scattered building regulations – and it was furthermore accompanied with a reorganisation of the building authorities to ensure a more effective implementation.

Prior to the passing of the law of 1856 for the City of Copenhagen the building legislation consisted on a variety of different statutes, considerations and standards spread out on many different local authorities. Engelmark argues that the 1856 building law was considered quite restrictive at that time even though it only contained few considerations, which had not previously been covered by existing regulations. One of the most important innovations introduced with the law was the requirement of compulsory construction permit application regardless of size or type of construction activity.

Engelmark (1983: 42-43) highlights three conditions in his discussion of the great impact of this law for the built environment of Copenhagen and not least its quality. First, that all significant provisions relating to building activities were collected in one law, thus making the procurement process transparent. Secondly, the provisions relating to structures and materials, formulated on the basis of the state-of-the-art theoretical-technical knowledge, were sufficiently precisely formulated to be appropriate and adequate to be in use for the particular type of buildings for more than 100 years. Engelmark thus argues that the Copenhagen building code of 1939 contains the almost exact same provisions on the design of outer walls, beams, and roofs as the law of 1856. The reason for this continuity Engelmark attributes to the fact that no major changes occurred within the typically used building techniques. The third and last condition for the success of the 1856 building law was that the law was followed by a re-structuring of the organisational set-up of the building authority and the establishment of an effective administrative practice focusing on the supervision of ongoing projects (Engelmark, 1983: 43).

Dimension	Characteristics
Technology	Wood (1100), Bricks (1500-1600)
Industry	Craft-based traditions based on a certain relationship to materials.
Market	Cathedral Crusade: Cathedrals as driver for the development of new practices and technologies.
Insurance	Guild supervised. Quality through well-proven technologies. Sanctions for poor work.
Policy	Very weak public regulation.
Culture	Guild as organised community. Strong culture pertaining to the different crafts. Professionalization through apprenticeship.
Techno-scientific knowledge	Tacit, embodied knowledge, rules of thumbs, limited planning and use of drawings.

Table 2. Defining elements in building customs and practices. Thuesen et al. 2011 (Based on Gottlieb, 2010).

1.2.2.2 Rationalization

Based on this understanding, Gottlieb (2010) illustrated how the gradual emergence of 'a building sector' form the 1940s onwards instigated a process of unification by functional differentiation. The leitmotif in these efforts was the scientification of the art of building; a process which to a great extent was driven through by the state in its newfound role of *public construction client*.

Thus, as also argued by Jensen et al. (2011), in the years after the Second World War the Danish construction industry was for the first time problematized as a sector in the sense that it is known today. The background for this sector-oriented problematization was the post-war housing shortage. The housing shortage was estimated by the Ministry of Internal Affairs in 1946 to be 48 000–53 000 housing units, which positioned the shortage as an irrefutable and imperative policy problem. In order to cope with this societal challenge, the Ministry of Housing was established in 1947 (Bertelsen, 1997; Boligministeriet, 1997) and the Danish Building Research Institute was established in the same year to provide the necessary scientific underpinnings for the development activities to the ministry.

With the establishment of these institutions, the industry became institutionalized as an independent regulatory entity, and on behalf of the societal interest the state was accorded the right to intervene in the affairs of the industry (Møller, 1954), as it was both de facto and de jure in a position to encode the activities of the industry with a new set of sectorally defined opportunities and necessities in order to initiate a fundamental reorganization of the existing identities, interests and rationalities.

The strategic imperative acting as the matrix for a new dispositive of building was that of rationalisation and would, as Villadsen (2004) phrases it, take the form of the schematic "correspondence/divergence" – a schematic that at one and the same time *shapes* and *is shaped by* the practices of building (*Ibid*., 2004). It was shaped by the practices of building in that the rationalisation efforts first and foremost took as its starting point the early notion of building customs and practices. It accepted every *individual* element of the existing complex of building; however only to subject these to an all-encompassing or omnipresent gaze of stratification, normation and correspondence. In this process of strategic codification elements were emptied; were stripped of content bar their 'name' in order to be prepared for this schematisation – a schematisation that can be observed in its most diagrammatic form in the phase model.

The schematic also shaped the practices of building. Bricks, bits and pieces were standardised and modularised and different actors were continuously shaped and reformed for them to be able to claim a specific place in the sociality of the sector. The client's demands for fixed price and time prompted the architects and engineers to safeguard their work, transforming the architect from shop steward to adversary. The technical development coupled with this functional differentiation deprived the building sector the skilled craftsman, and *uni-directional coordination and control* emerged as the nexus between the different parts of the apparatus. Thus, the main assumption in the debate concerning the rationalization of construction sector was that the housing shortage could never be met if traditional configurations of technologies, methods, practices and regulations were not transcended. Only by replicating the rationalization of the manufacturing industries on a sectoral scale could the housing shortage be solved. Observed in the light of the production methods of the manufacturing industries, the existing organization and operation of the sector was accordingly seen as a highly irrational assemblage of bricks, bits and pieces that were only held together by the age-old traditions of the crafts (Dansk Ingeniørforening, 1951, p. 14). And such a system could not be optimized sufficiently to deal with the societal housing shortage.

Instead, based on three core principles of rationalization, listed below, a broad series of coordinated interventions were initiated to develop the tools, processes, materials, professional and identities of the industry:

- the establishment of a centralized point of planning and control capable of integrating the entire construction process
- a new division of work which separated planning from execution
- calculative optimization

These interventions can be observed most notably in the manner in which sector rationalization was promoted in the 1950s through development schemes focusing on the furtherance of so-called non-traditional construction (Indenrigs- og Boligministeriet, 1953; Kjeldsen, 1954). Here the aim was: (1) to decrease the level of skilled labour employed on housing projects; and (2) to introduce new planning methods. In the 1960s this scheme was followed by the so-called 'assembly quota' prescribing increases in the use of prefabricated and factory-produced building elements, along with continuous development of planning tools and methods (Gottlieb, 2010). These schemes were implemented through large-scale public demand in social housing and were furthermore backed up by a series of regulatory interventions and developments, ranging from the harmonization of local building regulations to the introduction of a 'Modular Agreement for the Building Industry' (Komiteen for Byggestandardisering (KBS), 1958) laying down the principles for a national system for the coordination of measurements in buildings in order to ensure compatibility between prefabricated components (Munch-Petersen 1980, p. 15).

Dimension	Characteristics
Technology	Concrete (in-situ and pre-fab.), standardized products, phase models, tolerances, mechanisation of work, plans.
Industry	Unskilled labour, planning engineers, general contractors, concrete factories.
Market	Large housing market
Insurance	?
Policy	Strong governmental regulation (Ministry of Housing). Circulars, contracts.
Culture	Separation of design and construction.
Techno-scientific knowledge	Scientific management, Establishment of the Danish Building and Urban Research Institute, CERT/PERT.

Table 3. Defining elements in rationalization. Thuesen et al. 2011 (Based on Gottlieb, 2010).

1.2.2.3 Negotiation

Gottlieb (2010) then discusses the development in the 1990s onwards. A development that saw the rise of a re-activation of the sociality of the sector; a re-activation that, based on the problematisation of the phase model, was mediated by a different regulatory governance strategy than in the 1940s onwards – being a governance strategy founded on governmental development programmes and active experimentation rather than on legislation and direct decrees. Retrospectively observed it can be argued that the sectoral stratification efforts of the 1950s onwards had been so successful that it had resulted in a de facto lock-in situation in which the uni-directional and unequivocal circumscription of space had deprived the individual actors any room for maneuver for agency. Thus many of the efforts associated with the development period in the 1990s could in this respect be seen as strategic attempts to 'repair' on a series of the inexpediences of the highly rationalized construction process; an attempt to break-down functional differentiation and its derivative – the focus on central control and coordination.

Gottlieb (2010), however also demonstrated that even though a series of attempts were made to introduce new technologies, materials and working practices throughout the 1990s, in the form of e.g. (i) a flexible wooden building system for multi-story housing projects; (ii) an industrialised steel and plaster cast building system; and (iii) a building technical development centered on installations and wet rooms, ambitions were not realized – most notably due to the insufficient demand and the fact, that new the new technologies did not have the strength to penetrate the market and provide a robust and low risk alternative to existing institutionalized building systems and practices.

An important development that, however, did take place in the transition from the predominantly rationalized construction regime in the late 1980s and 1990s was the implementation of a national Quality Assurance and Liability Reform. According to Bonke and Levring (1996: 11), during the 1980s extensive studies revealed both basic technical faults as well as severe managerial malfunctions in the industrialised building process. This coupled with a strongly rising number of defects in buildings of only 15 - 25 years of age led to an increased focus on the measures being taken to assure a sufficient level of quality in construction – the process of the Quality Assurance and Liability Reform, which was put into operation by the Ministry of Housing in 1986. The philosophy of the reform, as described by Bonke and Levring (1996: 11), was: *"…to urge the actors of the building process to identify the optimal balance between the total cost for the project, the management cost and the cost of correcting defects. It is widely accepted that the construction process during the previous period had developed into a position far from this point of cost optimisation*." The reform, which has later been included in the 1992-version of the general conditions for building works consisted of a wide spectrum of instruments, e.g. (Bonke and Levring, 1996: 11):

- Formal procedures for the documentation of quality in design and execution.
- Unification of periods of liability for all parties involved in the project.
- The establishment of the Building Defects Fund (da. Byggeskadefonden).
- Manuals for care and maintenance.
- 5-years inspection.

Especially the establishment of the Building Defects Fund in 1986 has had a profound impact on the quality in the Danish construction industry. The Fund comprises approximately 210.000 publicly subsidised housing estates, youth housing, and housing for the elderly, privately owned co-operative housing associations, and co-operative house shares. In 2011 the Fund had a holding of 220 million Danish kroner. The Fund covers all building defects claims for the first twenty years and, as such, the oldest buildings comprised by the Fund are no longer covered by the Fund. The buildings, which are covered by The Building Defects Fund, comprise some 40% of all construction of residential housing schemes since 1987.

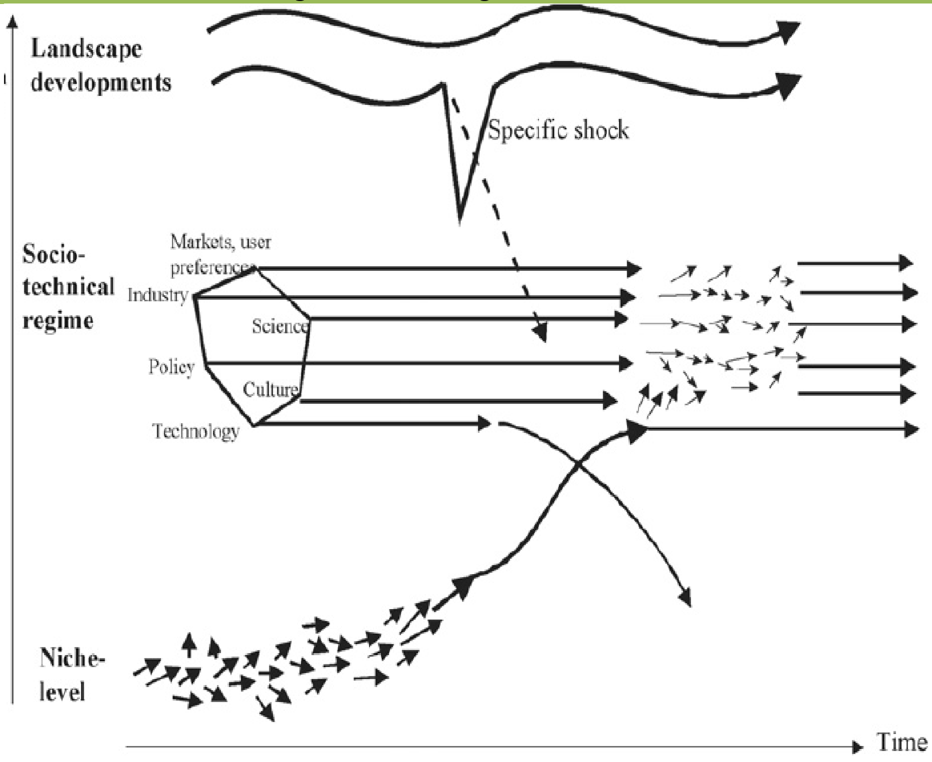
Dimension	Characteristics
Technology	Many new different materials. Competing system products, however concrete as dominant technology.
Industry	Unskilled labour, planning engineers, general contractors, concrete factories.
Market	Individualised market, however consumers lock-in to traditional concrete and brick technologies.
Insurance	Unification of periods of liability for all parties involved in social housing projects projects
Policy	Deregulation through the abolishment of a Ministry of Housing. Construction as a resource area
Culture	Separation of design and construction.
Techno-scientific knowledge	Partnering, LEAN, BIM, etc. as alternative visions for the future sociality of construction.

Table 4. Defining elements in negotiation. Thuesen et al. 2011 (Based on Gottlieb, 2010).

1.2.2.4 Summarising findings on the Danish construction regime

Despite recent developments we would argue that the current Danish construction regime to great extent is moulded in the image of the rationalised construction industry that was formed the 1940s onwards. Thus, observed in the light of the MLP model and Geels' typology of transition pathways we get the following picture of the different transition pathways and the dynamics of change between these three epochs or systems of construction.

Figure 7: Technological substitution



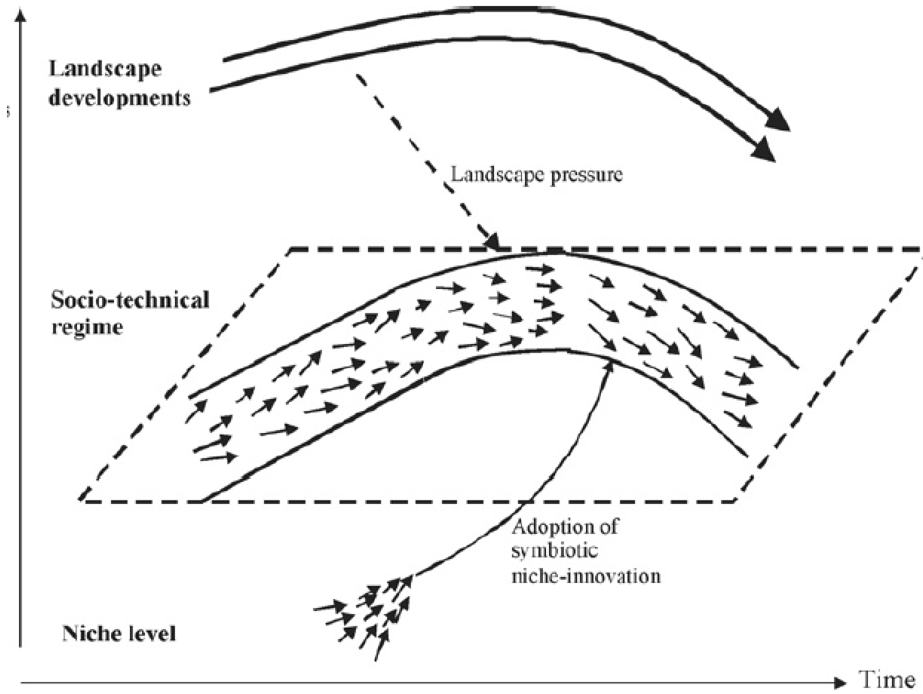
Reiterating, Geels and Schot (2007: 409) claimed that: "*If there is much landscape pressure […] at a moment when niche innovations have developed sufficiently, the latter will break through and replace the existing regime. This pathway assumes that radical innovations* <u>*have*</u> *developed in niches, but remain stuck because the regime is stable and entrenched.*" Further: "*Without landscape pressure, this remains a reproduction process. It becomes a technological substitution path when a 'specific shock' 'avalanche change' or 'disruptive change' exerts much landscape pressure on the regime. This pressure leads to major regime tensions, and windows of opportunity for niche-innovations. Niche-innovations can use these windows, because they have stabilised and gathered internal momentum*" (Ibid. 2007: 409-410).

An example of this, we would suggest, is the developments that took place around WWII leading to the emergence of a rationalized, industrialized construction regime. Here the acute housing problems coupled with the wartime shortages in skilled labour and traditional construction materials constituted a specific landscape shock that rendered the regime open for the uptake of a new developed niche-technology (reinforced concrete elements) that had been used for decades in road and bridge building. As, demonstrated, the uptake of this new technology also gave rise to a series of additional changes in the Danish construction regime, as new policies, production technologies, roles and scientific knowledge emerged to support and further strengthen the use of reinforced concrete in house building.

In contrast, the developments that took place from the 1990s onwards can much better be seen as following a so-called transformation pathway, in which a moderate landscape pressure, not least prompted by the abolishment of the Ministry of Housing, lead to a continuous process of *modifying the direction* of development paths and innovation activities in the sector.

This is illustrated e.g. by Jensen et al. (2011: 671) who argued that "*From the early 1990s the industry was once again problematized from a sectoral point of view. This sectoral problematization was [however] radically different from the sector problematization of the immediate post-Second World War years and it generated a set of very different theorization dynamics*."

Figure 8: Transformation pathway



Most notably, Jensen et al. (2011) demonstrated that in the 1990's, the sector was no longer framed as the means to cope with a critical societal need but rather as an inefficient economic entity with an unsatisfactory high consumption of societal resources due to a series of interconnected weaknesses such as low productivity, poor innovation, poor collaboration and organizational fragmentation.

Jensen et al. (2011) further show that this new sectoral problematization generated a series of representations each claiming to identify the underlying root cause, which could explain the various symptoms. In contrast to the sector development agenda of the post-Second World War period that was monopolized by the logic of rationalization, multiple-sector representations were theorized as a response to the sector problematization of the 1990s, however none of these has radically replaced existing practices in the socio-technical regime.

Rather, we have seen that the most radical of the proposed niches (e.g. system deliveries) have had the most difficulties in gaining wide support and uptake in the industry, whereas the more "symbiotic niche-innovations" that do not offer a whole new conceptualisation of what it means to do construction but rather offer to supplement and existing practices and sort out the worst of the current inexpediences (such as e.g. partnering and the local Danish version of LEAN (LPS)) have been able to gain industry-wide accept.

Therefore, it is much more difficult to observe the direct or deduced effects of these niche-innovations on a sectorial scale.

1.2.2.5 Insurance as a regime internal response

What is interesting in the above description of the historical constitution and development of the Danish construction industry is that insurance, more than representing a vehicle or mechanism of change emerges as a consequence of regime internal dynamics.

Thus at a niche level it is the proliferation of new production technologies breaking into the regime level that propels the need for insurance schemes to evolve and adapt to newfound needs.

This is also argued by Bunni (2003: 7) who suggests that "*Insurance developed and spread as a result of society's needs and demands*".

1.3 International comparisons

Based on the above description of the Danish construction regime and the co-development of construction and insurance, we will highlight some of the main characteristics of the French and UK regimes in order to contrast the findings and point to some general observations and issues that have to be taken into account in the development of recommendations for policy convergence of insurance schemes in the EU.

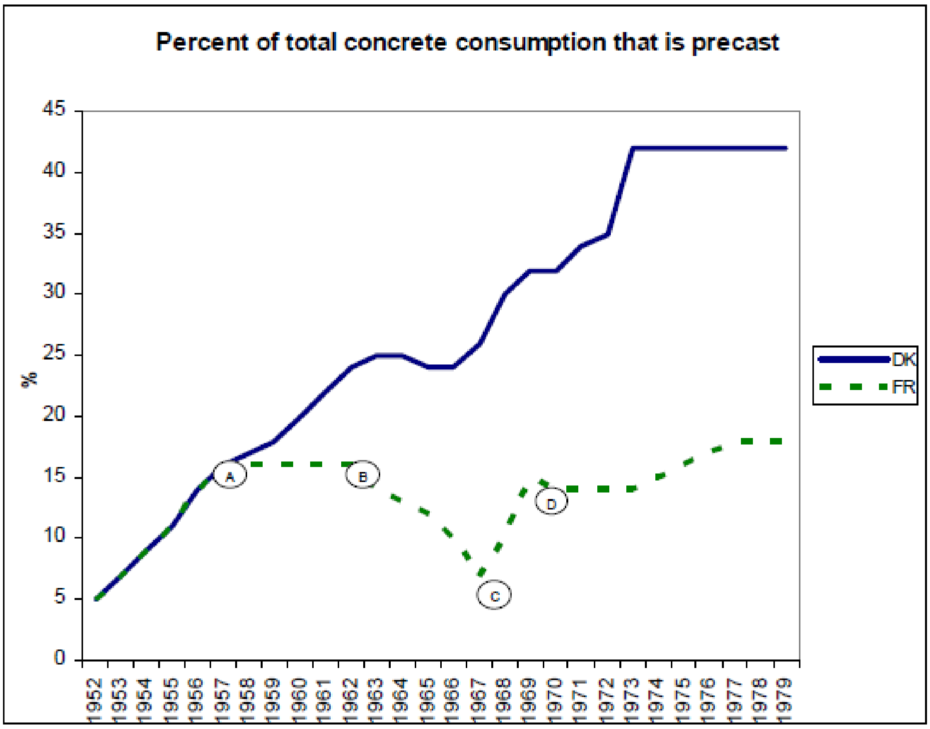
1.3.1 France

Whereas we could claim the hegemony of a rationalised concrete regime in Denmark, the situation in France is somewhat different. In a comparative analysis of the diffusion and institutionalization of prefabricated concrete elements, in France and Denmark during the post-war construction period, Boxenbaum and Daudigeos (2010) demonstrate two things in particular.

First, that "*…the relative pace of diffusion was determinant for institutionalization*" (Ibid., 2010: 1) of prefabricated concrete elements as a new dominant technology rather than other competing technologies at that time. In the foregoing analysis of the Danish construction regime, we have demonstrated how the diffusion was supported by various legislative and market changes.

Second, Boxenbaum and Daudigoes (2010) demonstrate that there is a marked difference in the diffusion of prefabrication between Denmark and France, where prefabrication, in the period between 1958 and 1967, gained prevalence in Denmark while it first stabilized and then lost prevalence in France. This is illustrated in the figure below.

Figure 9: The prevalence of prefabrication in Denmark and France, 1952-1979 (Boxenbaum and Daudigeos, 2010: 8)



Boxenbaum and Daudigeos (2010. 8-9) advance the following theoretical suggestions or explanatory factors for the differences in the diffusion in Denmark and France: "*The most obvious theoretical explanation is that of the rational actor. This explanation would have it that the first experiences with prefabrication in the early 1950s produced objectively better results in Denmark than in France. […] For instance, construction professionals in France might have selected cast-in-place techniques for their next construction project after having encountered poorer results with prefabrication than their colleagues did with cast-in-place techniques. Meanwhile, their equally rational colleagues in Denmark, having encountered better results with prefabrication than with cast-in-place techniques, might have made the opposite choice."* This rational agent explanation is however deemed unlikely and unsorted by empirical evidence. Other explanations are therefore propounded, ranging from landscape pressures (the decolonization in France leading to the Fifth Republic), to regime internal support in the form of legislative sanctioning, subsidy schemes, techno-scientific mobilization and much more.

What we however in conclusion can learn from this short comparative analysis is that even though the same new technology is introduced and initially diffuses in a similar fashion in two different countries, the cultural socio-technical and the climatic context of the diffusion environment plays a crucial role in determining the relative success (i.e. institutionalization) of the said innovation.

The system of insurance and liability in France

According to Campagnac (1996), France is one of the countries in Europe where the client is the most protected by the legal and institutional system, the risk of default of the contractors and the effects of building failures. Campagnac argues that this is to do with combination of articles relating to the contractor's liability and to guarantee and insurance schemes. In France contractors are subject to a series of liabilities, including:

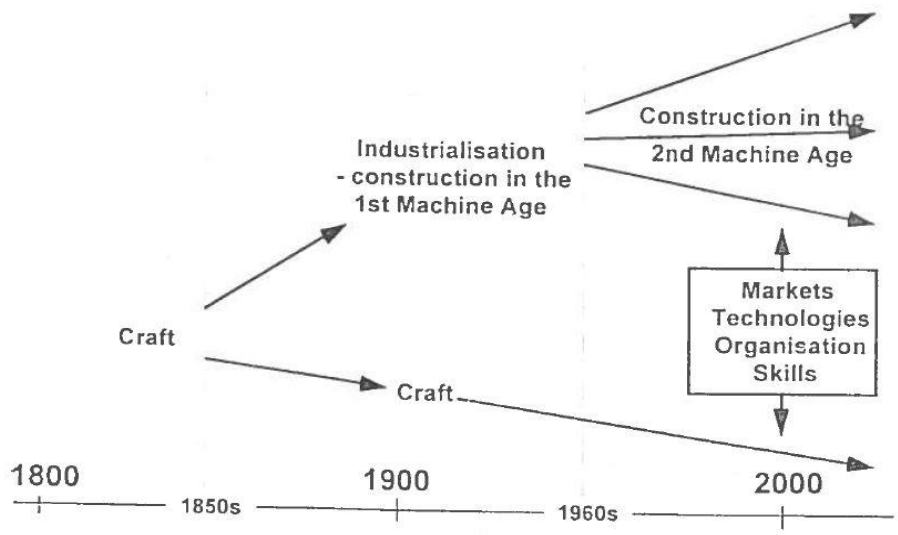
- The contractual liability
- The decennial liability
- The biennial liability
- The annual liability

We refer to Campagnac (1996: 21-24) for a description of the different types of liability, and note only at this point the general relationship between the construction regime and the legal (insurance) regime in France. Here Campagnac (1996: 25) argues for a reciprocal relationship between law and economics. The essence of the argument is that no economic strategy proves sustainable if it does not attain a minimum of legitimacy from the environment or institutional field in which it is embedded. Especially the proliferation of diverse and increasingly more complex arrangements between actors in the industry accelerate the development of legal instruments, including the need for insurance and liability schemes.

1.3.2 United Kingdom

In a thorough historical account, Gann (1993) has analysed UK attempts to modernize the construction industry and the production of buildings. Gann used this historical account to illustrate different distinct trajectories of development in the industry, which each operates with its own systemic rationale and entails different and distinct modes of technology diffusion and innovation dynamics.

Figure 10: Industrial divides in construction (Gann, 1993: 76)



Gann operated with two stages in the industrialization of construction, the so-called first and second machine age.

The first was concerned mainly with the development of new technologies for structural element, for facades and for the fabric of buildings.

In the second era, the trajectory of industrialization divided into several paths, due to the circumstance that construction was influenced by alternative approaches to raising productivity and expanding markets adopted by firms in other sector.

According to Gann (1993: 76) each path of development is characterised by differences in markets, technologies, organisation of production and skills, such that the industries operating within the craft trajectory are distinct from those in the industrialised trajectory. The characteristics of these different technological trajectories are illustrated in Figure 10.

These two technological divides are illustrated in the figure above. The characteristics of these different technological trajectories are illustrated below:

Table 5. Paths of development, 1850s to 1960s and 1970s onwards (Gann, 1993: 62, 75).

	Craft	Old Industrial	New Industrial
Process	Handicraft	Assembly	Adaptable assembly
Markets	Small scale traditional markets: residential and repair and maintenance	Large scale projects – new markets: construction of infrastructures, mass-housing, schools, hospitals, slum clearance	Mainly large projects: new sophisticated buildings
Product	Bespoke, made from basic materials	Standardised, made from factory produced components	Complex, made from components sourced internationally
Type of firm	Small, local, with directly employed labour	Large, national or international, using specialist low-skilled sub-contractors	National and international coordinating very specialised firms
Competition	From other local firms	From national and international construction firms	From international construction firms and firms form other sectors
Skills	Craft trades demarcated by skills associated with the use of particular materials, some shift towards multiskilling	Specialised, narrow technical skills – fragmentation of old craft skills, growth of new skills associated with new materials and techniques	Specialist and general
Learning	Cumulative	Application of scientific knowledge, short formal training	Interactive
Innovation	Unstructured, informal	Structured, formal R&D	Large-scale R&D, flexible solutions
Technological change	Incremental changes, adaptation of 'tried and tested' techniques based on the use of traditional materials	Major changes such as prefabrication and the use of new material, construction plant and equipment	ICT
Organisational change	Minor adaptations to traditional craft forms	Adoption and adaptation of forms used in manufacturing sectors, standard contracts	Experimentation with different forms of contract and new relationships

Thus, according to Gann (1993) today we have in the UK at least three different forms of organising work: those based on traditional craft practices, those associated with the industrial techniques used in the first machine age, and those emerging after the latest boom in construction activity.

Insurance in UK and the role of NHBC

An important player in the industrialised paths of development in the UK, has been NHBC, the National House Builders Registration Council, which was incorporated on 17 November 1936 and

"*…created to combat unsatisfactory building practices prevalent in UK housebuilding in the aftermath of inter-war government slum clearances*" (Howard, 2011: 25).

Beyond its role as Latent Defect insurer, NHBC also plays an important role as certifier. Historically, NHBC was created to increase quality in the construction through the establishment of a set of "requirements" in order to get their certification, which is needed to be insured. Of course those requirements focus on "workmanship" and "installation" problems, but also filled some gaps in design codes.

According to Howard (2011) NHBC represented an important voluntary venture into self-regulation and consumer protection by the industry. Thus, as well as inspecting and certifying new homes as being fit for purpose, the council also operated a register of approved house-builders prepared to build in accordance with a model specification.

In terms of consumer protection, registration with NHBC included a warranty: "*…for buyers of certified homes that required builders to rectify defects arising from non-compliance with specifications during a two year period from date of purchase.*" (Ibid. 2011: 25). In 1965, this evolved into the ten year concept of the Buildmark warranty, which covers over 80 % of new UK houses, giving home owners assurance and redress if things go wrong (Howard, 2011: 26).

1.3.3 Summary

This brief description of the evolution and configuration of the Danish, French and UK construction industries has two important lessons to convey.

First, that transitions from one regime or 'machine age' to another is prompted by different precipitating jolts (Greenwood et al., 2002) and vehicles of transformation. Thus, the transition from craft to industrialisation in the first machine age was prompted by more or less the same overall landscape changes and processes as in Denmark, whereas the transition to industrialisation in the second machine age in the UK according to Gann (1993: 63-70) was marked especially by a construction boom in the start of the 1970s and the Ronan Point collapse, which prompted designers and architects to criticise the use of standardised heavy concrete systems and search for alternative paths for industrialised construction.

Second, the cases also illustrate that it is difficult to talk about regimes in the singular form even within individual member states. A regime is thus not a homogenous entity, as the preliminary analysis of the Danish and UK construction industries. It has been shown that even though we can speak about evolutionary dynamics and technological trajectories, there are still competing sector socio-technical configurations present, and that in order to implement new policies or technologies, these competing representations have to be taken into account. This is essentially a question of governance and strategic niche management that will be addressed in the following work in WP3.

In the end, this description of the organization of the different existing consumer protection systems, through incentives toward quality of the construction, has highlighted the importance of differences, and most important, that those differences are market/culture specific, and the result of an evolution. It is shown that some systems are based on a legal framework others on a market driven trend, some systems offer very few protections while others are extensive (Table 6).

Insurance can be viewed only as an element (systemic approach), maybe the final one, in the consumer protection framework. It is closely linked to the other elements involved in the construction quality chain and cannot be considered alone.

Table 6: **Overview of construction and insurance regimes in three European countries**

Level	Denmark	France	UK
EU Landscape	Policy convergence or harmonized insurance regimes?		
National construction regime	Corporatist system	Étatique system	Anglo-Saxon system
Techno-scientific knowledge	Strong administrative and technical continuity surrounding concrete technologies in DK. The adoption of standard measures, modules, planning techniques and specialized engineering education have played an important role in institutionalizing concrete as the de facto standard building technology in Denmark	Prevalent development of concrete technologies in the theoretical corpus, disseminated through “Engineering Schools” (e.g. invention of prestressed concrete by Freyssinet). Historical know-how of various craft skills with developments of new techniques (narrow join bricks). Absence of planned management techniques, with implementation plans carried out during construction.	Mixed. Comprising application of scientific knowledge as well as of short formal training. Specialised, narrow technical skills. Fragmentation of old craft skills, growth of new skills associated with new materials and techniques
Industry/Infrastructure	Complete existing infrastructure for the use of concrete in construction comprised of quarries, cement plants, concrete elements factories, transport and on-site production facilities.	Concentration of activity on large international companies, with lots of subsidiaries, whether for contractor activity (Vinci, Bouygues, Eiffage) or manufacturing (Lafarge)	Large number of privately owned companies, driven by a relatively high proportion of self-employment and number of small and micro businesses.
Policy and regulation	The national construction policy conducted in DK favours extent concrete construction principles, through a strict legislation pertaining requirements for acoustics, climate, fire and structural safety.	Complex set of regulations, now largely harmonized under Eurocodes. Regulation doesn’t need to be strictly enforced as the different responsibilities (of contractors or designers) are regulated by the insurance sector through the compulsory liability guarantees.	A great reliance upon liberal market values, relatively low levels of state regulations.
Insurance	Legally compulsory Building	Legally compulsory	Market driven widespread

	Defect Insurance for original owners of dwellings with a purpose of sale or rental, and for cooperative housing associations	decennial insurance of all construction works, and of all companies taking part in the construction process.	decennial insurance of construction works, requested by investors.
Technology	Well-anchored network of proven roles and technologies to support and sustain pre-fabricated concrete as the dominant construction principle, including: norms, standards, element fitters, masons concrete production engineers, factory workers, etc.	Historical predominant use of concrete in the form of blocks (breezeblock / cinderblock), regional use of bricks and more recently increased use of aerated concrete (Siporex) and wood under the pressure of Thermal Regulation evolutions (RT2005 and RT2012)	Mainly pre-cast as dominant technology until Ronon Point collapse, with an increasing move towards the use of complex products made from internationally sourced components.
Culture and markets	Strong cultural-cognitive legitimacy surrounding the use of concrete technologies among both professionals and end-users. More than 70 years of continued development have constituted concrete as the dominant construction principle in Denmark. Eco-technologies such as e.g. wood is almost non-existent in multi-story buildings and there is a marked reluctance among home owners to reside in a wooden detached house.	Segmented markets: • Individual Housing: built by specific entrepreneurs (CMI) in blocks, bricks, wood or aerated concrete • Multiple dwellings: made in concrete by local contractor (subsidiaries of large companies or SMEs) • Large projects: other construction works built by few large contractors	Three types of markets: • Small scale traditional markets: residential and repair and maintenance • Large scale projects – new markets: construction of infrastructures, mass-housing, schools, hospitals, slum clearance • Mainly large projects: new sophisticated buildings
Niche level	Sustainable eco-technologies		

References

Bauindustrie Bayern (2015), Building Enterprises Prequalification
http://www.bauindustrie-bayern.de/im-brennpunkt/praequalifikation.html

Bertelsen, S. (1997) *Bellahøj, Ballerup, Brøndby Strand. 25 år der industrialiserede byggeriet*, Hørsholm: Statens Byggeforskningsinstitut

Boligministeriet (1997) *Byggepolitik – bedre og billigere byggeri*, december 1997, København: Boligministeriet

Bonke, S. and Levring, P. (1996) *Fascicule 10: The Contracting System in Danish Construction: Pinning Down Autonomy*, London: Le Groupe Bagnolet, Bartlett School of Graduate Studies, University College London

Boxenbaum, E. and Daudigeos, T. (2010) How the social construction of a new technology affects its institutionalization: Lesson from prefabrication, *Constructions matter - Managing Complexities, Decisions and Actions in the Building Process*, Copenhagen Business School, May 5-7 2010.

Brahe, A., Frederiksen, D.J., Hyttel-Sørensen, R. Larsen, A.D. & Kristiansen, T.S (2013) Business plan for Cross Laminated Timber, Aalborg University

Bunni, N.G. (2003) Risk and Insurance in Construction, 2nd Edition, Spon Press: London and New York

Campagnac, E. (1996) *Europe: Conduite des projets de construction, Fascicule 8: Les stratégies ensemblières à l'épreuve de la réglementation des marches publics en France.* Paris: Groupe Bagnolet

CEBC (2006), Building Control Report - issue 2: building control systems in Europe, June 2006

Dansk Ingeniørforening (1951) *Forslag til forenkling af boligbyggeriets udførelse og organisation*, Udarbejdet af Dansk Ingeniørforenings rationaliserings-udvalg, København: Dansk Ingeniørforenin

Davies, R. and Harty, C. (2011) Building Information Modelling as Innovation
Journey: BIM Experiences on a Mayor UK Healthcare Infrastructure Project,
Proceedings of the 6th Nordic Conference on Construction Economics and Organisation – Shaping the Construction/Society Nexus, volume 2, 233-245

De Decker Thomas (2013), Dissertation for master science degree Tecnico Lisboa: building control systems and technical control activities in Belgium, Germany and the United Kingdom, July 2013

Deman Jonas (2013), Dissertation for master science degree Tecnico Lisboa: building control systems and technical control activities in Belgium, the Netherlands, Sweden and France, July 2013

Engelmark, J. (1983) *Københavnsk etageboligbyggeri 1850-1900, En byggeteknisk undersøgelse*, SBI-rapport 142, Statens Byggeforskningsinstitut, Hørsholm

Engwall, M. (2003). No project is an island: linking projects to history and context. *Research policy*, *32*(5), 789-808

ENHR (2011), Energy efficiency in housing management - conclusions from an international study, July 5-8, 2011
http://www.enhr2011.com/sites/default/files/paper-nieboer-ws11.pdf

European Accreditation (2015), Members
http://www.european-accreditation.org/ea-members

European Commission - Directorate General for Internal Market and Services (2012), DG MARKT/2010/22/E, The functioning and usability of the Points of Single Contact under the Services Directive - State of Play and Way Forward, January 21, 2012
http://ec.europa.eu/internal_market/services/docs/services-ir/study_on_points/final_report_en.pdf

European Commission - Commission Interpretative Communication (2000), Freedom to provide services and the general good in the insurance sector, February 16, 2000
http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:32000Y0216(01):EN:HTML

European Commission - Directorate General JRC (2010), Financing Energy Efficiency: Forging the link between financing and project implementation, May 2010
http://ec.europa.eu/energy/efficiency/doc/financing_energy_efficiency.pdf

European Commission (2015), Points of Single Contact
http://ec.europa.eu/internal_market/eu-go/
http://ec.europa.eu/internal_market/eu-go/index_en.htm

European Co-Operation for Accreditation (2015), Members
http://www.european-accreditation.org/ea-members, European Accreditation

European Foundation for the Improvement of Living and Employment and Working Conditions (2000), Sustainable Development - The Role of Local Environmental Initiatives in Job Creation, EF/00/13/EN
http://edz.bib.uni-mannheim.de/daten/edz-ma/esl/00/ef0013en.pdf

European Parliament and of the Council (2003), Directive 2002/92/EC, Insurance Mediation, January 15, 2003
http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:32002L0092:EN:HTML

European Parliament and of the Council (2008), Regulation (EC) No 593/2008, June 17, 2008
http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2008:177:0006:0016:en:PDF

European Parliament and of the Council (2009), Directive 2009/138/EC, Taking-up and pursuit of the business of Insurance and Reinsurance (Solvency II), November 25, 2009
http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2009:335:0001:0155:EN:PDF

European Parliament and of the Council (2010), Directive 2010/31/EU, Energy performance of buildings, May 19, 2010
http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32010L0031&from=EN

European Renewable Energy Council (2015), Smart E Buildings Glossary http://www.erec.org/fileadmin/erec_docs/Projcet_Documents/Smart-e_Buildings/Glossary_Final.pdf

EUESCO (2011), Energy Performance Contracting in the European Union
http://www.euesco.org/fileadmin/euesco_daten/pdfs/euESCO_response_concerning_EPC.pdf
http://iet.jrc.ec.europa.eu/energyefficiency/european-energy-service-companies/energy-performance-contracting

Fédération Française des Sociétés d'Assurances (2015), Decennial liability insurance - A guide designed for European Builders, 2015
http://www.ffsa.fr/sites/upload/docs/application/pdf/2012-01/ffsa_a5_an_page_simple.pdf

Fédération Française des Sociétés d'Assurances (2015), How decennial liability insurance works, 2015
http://www.ffsa.fr/sites/jcms/c_51299/how-decennial-liability-insurance-works?cc=fp_7202

Fédération Française du Bâtiment (2013), La couverture du défaut de performance énergétique : la FFSA affine sa position, January 17, 2013
http://www.construction21.eu/france/articles/fr/la-couverture-du-defaut-de-performance-energetique--la-ffsa-affine-sa-position.html

Fedesco (2015)
http://www.fedesco.be/

FIEC - European Construction Industry Federation (2011), Qualification procedures in Europe - update 2011, November 2, 2001
http://www.fiec.eu/en/themes-72/qualification-of-construction-enterprises.aspx

Financial Times (2014), Smart meters deliver benefits and costs, June 24, 2014

Gann, D. M., and Salter, A. J. (2000). Innovation in project-based, service-enhanced firms: the construction of complex products and systems. *Research policy*, *29*(7), 955-972

Geels, F.W. (2002) Technological transitions as evolutionary reconfiguration processes: a multi-level perspective and a case-study, Research Policy, 31 (2002), 1257–1274

Geels, F.W. and Schot, J. (2007) Typology of sociotechnical transition pathways, Research Policy 36(2007), 399–417

Gobierno de España - Ministerio de Fomento (1999), Ley de Ordenación de la Edificación, Ley 38/1999, November 5, 1999
http://www.fomento.gob.es/mfom/lang_castellano/direcciones_generales/arq_vivienda/edificacion/calidad/orden_edificacion.htm

Gottlieb, S.C. (2010). The constitution of partnering: a Foucauldian analysis of dispositives, space and order in Danish construction. Kgs. Lyngby: Technical University of Denmark

Gottlieb, S.C. and Haugbølle, K. (2013) Contradictions and collaboration: partnering in between systems of production, values and interests, Construction Management and Economics, (31)2, 119-134

Greeninvestmentbank (2015)
http://www.greeninvestmentbank.com/

Greenwood, R., Suddaby, R., & Hinings, C.R. (2002). Theorizing change: The role of professional associations in the transformation of institutionalized fields. *Academy of Management Journal*, 45(1): 58-80

Heritage and Local government of Ireland, Guide to the building control system

Holzinger Katharina and Knill Christoph (2005), Causes and conditions of cross-national policy convergence, Journal of European Public Policy, vol. 12:5, October 2005, 775-796
http://www.gsi.uni-muenchen.de/lehreinheiten/ls_emp_theo/forschung/dokumente/knill_holzinger_2005.pdf

Howard, T. (2011) *Diamond Jubilee, NHBC 75th anniversary*, Housebuilder (April 2011), 25-26

ICEA - Investigación Cooperativa entre Entidades Aseguradoras y Fondos de Pensiones (2008), El seguro decenal en 2007, July 16, 2008
http://www.icea.es/es-ES/noticias/Noticias/Noticias0708/decenal_16_7_08.aspx?Source=%2Fes-es%2Fnoticias%2Fnoticias%2Fnoticias0709%2Fdecenal_01_07_09.aspx%3Fsource%3D%252fes-es%252fnoticias%252fnoticias%252fnoticias0511%252flossegurosdeingenieriaobtuvieronunvolumendenegociode420millonesdeeurosen2010.aspx%253fsource%253d%25252fes-es%25252fnoticias%25252fnoticias%25252fnoticias0512%25252fdia_16_05_2012%25252flossegurosdeingenieria.aspx

Indenrigs- og Boligministeriet (1953) *Cirkulære nr. 114 af 18. august 1953 om statslån til utraditionelt byggeri*, København: Indenrigs- og Boligministeriet

Instituto de Ciencias de Construcción Eduardo Torroja (2015)
www.ietcc.csis.es

Insurance Europe Publications (2012), How Insurance Works, April 17, 2012
http://www.insuranceeurope.eu/publications/publications-web

Insurance Europe Publications (2014), European Insurance in Figures, December, 2014
http://www.insuranceeurope.eu/uploads/Modules/Publications/statisticsno50europeaninsuranceinfigures.pdf

Javier Lopez y Garcia de la Serrana, Garantías por Danos materiales ocasionados por vicios y defectos de la construcción, Revista de responsabilidad civil y seguro

Jensen, J.S., Gottlieb, S.C., & Thuesen, C.L. (2011). Construction sector development: Frames and governance responses . Building Research and Information, 39(6), 665-677doi: 10.1080/09613218.2011.621710

Joao Branco Pedro (2010), Tehnical regulations in EU countries: a comparison of their organization and formulation, OTB Delft University of Technology & Laboratorio Nacional de Engenharia Civil

Johnson Hugh (2015), Building control

KBS (1958) Modulordning for byggeindustrien – grundlæggende principper, *Dansk Standard 1010, 1. udgave*, Komiteen for Byggestandardisering (KBS), København: Dansk Standardiseringsråd

Kemp, R., Schot, J. and Hoogma, R. (1998) Regime shifts to sustainability through processes of niche formation: the approach of Strategic Niche Management, *Technology Analysis and Strategic Management*, 10(2), 175–195

KFW (2015)
https://www.kfw.de/kfw.de-2.html

Kieser, A. (1989) Organizational, Institutional, and Societal Evolution: Medieval Craft Guilds and the Genesis of Formal Organizations, *Administrative Science Quarterly*, **34**(4), 540-564

Kjeldsen, M. (1954) Om utraditionelt byggeri, *Boligbyggeriets produktionstekniske problemer*, Boligministeriets Produktivitetsfondsudvalg, København: Teknisk Forlag

Knill Christoph (2005), Introduction: Cross-national policy convergence: concepts, approaches and explanatory factors, Journal of European Public Policy, vol. 12:5, October 2005, 764-774
http://www.gsi.uni-muenchen.de/lehreinheiten/ls_emp_theo/forschung/dokumente/knill_2005.pdf

Le Moniteur (2013), Premières propositions dévoilées pour booster la garantie de performance énergétique, April 23, 2013

Munch-Petersen, J.F. (1980) *Politiske og teknologiske initiativer, IHF Report No. 149.* Danmarks Tekniske Universitet, Lyngby

Møller, S. (1954) Byggemyndighedernes erfaringer med ny byggemetoder. 1, *Boligbyggeriets produktionstekniske problemer*, Boligministeriets Produktivitetsfondsudvalg, København: Teknisk Forlag

PCR (2011), Country reports: the Netherlands, Belgium, Sweden, February 2011

Planning Portal (2015), UK Government's online planning and building regulations resource for England and Wales
http://www.planningportal.gov.uk

Rip, A.,Kemp, R. (1998).Technological change. In: Rayner, S., Malone, E.L. (Eds.), Human Choice and Climate Change. Battelle Press,Columbus, OH, pp. 327–399.

Royal Institution of Chartered Surveyors (2015)
www.rics.org

Seligman, E.R.A. (1887) Two Chapters on the Mediaeval Guilds of England, *Publications of the American Economic Association*, **2(**5), pp. 9- 113

Seyfang, G. and Longhurst, N. (2012) Grassroots innovations and complementary currencies – testing niche theories in the social economy, *IST 2012 – International Conference on Sustainability*

Transitions, Track D: Niche Regime Interactions, August 29-31, 2012, Technical University of Denmark, Denmark, pp.2-28

Slaughter, E.S. (1998) Models of Construction Innovation, *Journal of Construction Engineering and Management,* **124**(3), 226-231

Smartgrids - CRE (2011), Visite du Green Office Bouygues Immobilier, January, 2011
http://www.smartgrids-cre.fr/index.php?p=smarthome-bouygues

Smith, A., Stirling, A. and Berkhout, F. (2005). The governance of sustainable socio-technical transitions. *Research Policy*,34, 1491–1510

Solarif (2015), Solar Insurance & Finance
http://www.solarif.nl/sites/all/bestanden/fck/brochure%20Performance%20output%20warranty.pdf

Sustainable Energy Authority of Ireland (2013), A guide to Energy Performance Contracts and Guarantees
http://www.seai.ie/Your_Business/Public_Sector/Energy_Performance_Contacts_and_Guarantees.pdf

Thuesen, C. L., Koch, C., Monrad, D., Henriks, M., Lambrecht, J. F., & Hall-Andersen, H. (2011). *Styrkelse af dansk byggeris innovationssystem*. Technical University of Denmark (DTU)

Turner (2015), Subcontractors
http://www.turnerconstruction.com/subcontractors

Van de Ven, A., Polley,D., Garud, R. & Venkataraman, S. (1999) *The Innovation Journey*. New York: Oxford University Press.

Villadsen, K. (2004) *The Genealogy of Social Work - a History of the Struggle to Set Poor People and Outcasts Free*, English Summary of symposium lecture given at the International Summer School 2004 (Aug. 3rd to Aug. 13th 2004) at the Department of Psychology and Educational Studies, Roskilde University. Localised Feb. 19th 2008 at: http://www.ruc.dk/paes/forskerskolen/ program/info/summer_school/ 2004/lectures/kaspar_v/

Winch G.M. (2000), Construction business systems in the European Union, *Building Research and Information,* (18), 88-97

Visscher Henk and Meijer Frits, Certification of building control in the Netherlands, OTB research institute for Housing, urban and mobility studies Delft University of technology

Yeomans, D. (2001) The characteristics of traditional construction, paper presented at ISCARSAH meeting in Istanbul, July 11 – 13, 2001

Ørstavik, F. (2014) Innovation as re-institutionalization: a case study of technological change in housebuilding in Norway, *Construction Management and Economics*, 32(9), 857-873