Standardization and Green Economic Change

– the Case of Energy Efficiency in Buildings

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Abstract

This paper investigates the role of standardization for green economic change using energy efficiency in buildings as a case. Innovation research on standards tends to focus on the competition between competing emerging standards as well as the economic impacts of these. The idea pursued here is rather to analyse longitudinal trends in the standardisation process itself, seeing these as important constituents of modern economic change. The paper traces more specifically changes in the thematic *direction* of the standardization process over time. The analysis seeks to capture when, where and how energy efficiency becomes an issue in standardization work using buildings as a case. The paper seeks more specifically to investigate the rise of building related standards generally over time as well as in different technical areas and geographic regions.

The hypothesis pursued in this paper is that the rise of the green economy can only take place accompanied by considerable institution formation in the form of standards. In this sense, the presence of standards may be seen as an important indicator on the maturity of the greening of the economy. The paper presents early empirical work and contributes as much to formulating a research agenda and provide methodological clarifications as presenting solid findings. The paper

feeds more fundamentally into an evolutionary economic understanding of (green) economic change.

Introduction

This paper investigates the role of standardization for green economic change using energy efficiency in buildings as a case. Innovation research on standards tends to focus on the competition between competing emerging standards as well as the economic impacts of these. This paper takes a different stance. The idea pursued here is rather to analyse longitudinal trends in the standardisation process itself, seeing these as important constituents of modern economic change. The paper traces more specifically changes in the thematic *direction* of the standardization process over time. This research question is parallel to core evolutionary economic research into the determinants of the rate and direction of technological change (Dosi, 1982, Nelson and Winter 1982). But here we focus explicitly on the associated institutional changes rather than the technology development itself. The analysis seeks in short to capture when, where and how energy efficiency becomes an issue in standardization work using buildings as a case.

The hypothesis pursued in this paper, to be elaborated on in the next section, is that the rise of the green economy is of such a paradigmatic character that it can only take place accompanied by considerable institution formation in the form of standards (Andersen, 1999, 2012). In this sense, we suggest the presence of standards may be seen as an important indicator on the maturity of the greening of the economy. The paper represents early, explorative work and contributes primarily to clarifying research questions and highlighting methodological possibilities and limitations. Early (low-hanging) empirical findings are presented.

The paper aims more specifically to trace empirically:

A) The evolution over time in energy efficiency building standards globally. The research question related to this is to inquire into the overall maturity – institutions wise - of the green economy, and the rate and development of green economic change over time. At a later stage these findings could be compared to related innovation activities in energy efficiency in buildings.

B) In which building technology areas the energy efficiency agenda has started and how it has spread. The research question we address here is whether the agenda has started at building component or building levels or more fundamental/generic metric levels and to discuss possible implications of this for the development and path creation of the standards. Also, can we identify areas where the energy efficiency agenda has not been taken on?

C) Trends in the regional development and diffusion of energy efficiency building standards. The research question is if we can trace over time whether the energy efficiency agenda starts nationally or more internationally? Can we further trace how quickly the agenda or sub-agendas have consolidated internationally? Finally, can we identify which nations and regions have taken the lead in these processes?

These research questions indicate that important and neglected findings on trends and dynamics in green economic change may be found by studying standardization processes. In this way, we may consider seeing the standardization analysis as a kind of throughput innovation indicators that inform us importantly on longitudinal trends in innovation and economic change.

The paper applies evolutionary economic theory (Nelson and Winter, 1982) in order to understand (green) economic change and the processes of eco-innovation. So far evolutionary perspectives on eco-innovation are few (Rennings 2000, Schiederig 2012, Andersen, 2012). A basic assumption in evolutionary theory is that innovation is time and space dependent and subject to path dependencies. Positive feedback mechanisms on historical events lead to increasing returns and trajectories that create lock-ins on the system (industry, national or regional) level (Dosi, 1982;

Arthur, 1994). While the role of institutions for innovation is a core emphasis in innovation systems research (Lundvall, 1992, 2007; Nelson 1993), standardization processes are seldom specifically studied as part of wider studies of economic change. The essence of innovation systems thinking is the co-evolution of organizations, knowledge, technologies, institutions and markets over time, but most emphasis is placed on either informal institution formation or the role of policies on innovation, whereas formal standards receive less attention. We emphasize here that in modern innovation systems innovation is becoming still more institutionalised. Formal standards and labels are today key economic institutions and they none the least act as facilitators of efficient R&D (standards) but also efficient markets and trade (both standards and labels) (Blind and Jungmittag (2008). Hence, in understanding long run processes of economic change, the study of standardization processes makes up a natural element.

Buildings have been chosen as case because they are a main energy user and early have been subjected to standardization. National and international building codes have played and still play a key role for building innovation. The construction sector is fairly low tech and very home market oriented meaning that national standards have been important for a long time. Also, the complexity of buildings make them an interesting object for standardization. Buildings are the main user of energy accounting for around 40% of EU energy requirements, and 32 % at the world level (IEA, 2012). Also, indicators on energy efficiency innovation in buildings are quite poor. The new IEA energy progress report states that ‘Assessing the progress of energy efficiency in buildings is a challenge. Data on the deployment of energy efficient technologies are limited, and many different technologies and components contribute to the overall energy performance of buildings. Progress is therefore evaluated by reviewing building energy codes, improvements in appliance efficiency, and deployment of solar thermal and heat pump technologies for heating and cooling. This assessment remains largely incomplete until further global data collection enables better analysis of efficiency in the buildings sector' (IEA 2012 p. 38).

The international data available on energy efficiency in buildings are limited to improvements in the energy efficiency of the building stock[1]. There are only a few attempts to link this to developments in specific building technologies, both at the overall building level and for building components[2]. For EU households only, availbale data state that energy efficiency improved by 1.1%/year since 1990. Space heating and large appliances experienced the greatest energy efficiency improvement close to 1.5%/year, each compared to an improvement of 2.1%/year in industry and 0,8%/year in transport3. Despite the registered improvements in energy efficiency, energy demand from the buildings sector is expected to more than double by 2050 globally, mainly due to population growth and rise in wealth and thereby changing occupancy structures (IEA, 2012).4

2. Green economic change and standards

The 'green economy' is a quite recent phenomenon, only becoming recognized as an important policy concept and economic vision from the mid zeroes (UNESCAP 2006; OECD 2011; UNEP 2012). Until then the environment was still largely considered a burden to business (Kemp and Andersen, 2004; Andersen, 2009, 2012).This paper takes as a starting point that the greening of the economy is a techno-economic paradigm change having economy-wide disruptive effects (Andersen, 1999, 2009, 2012). Green economic change, then is not just about the growth of a given environmental sector but rather the co-evolution of eco-innovations, green business models, green

[11] See IEA data at http://www.sustainablebuildingscentre.org/pages/beep

[2] The lack of more technological indicators related to buildings is to some degree sought met by a recent European initiative, the BPIE data hub launched in February 2013. http://www.buildingsdata.eu/bpie The data are based on a big survey from 2010-2011 to EU member states .See the report BPIE (2011) European Buildings under the Microscope'. The analyses are, however, mainly country wise rather than international, the data have a varied character and some countries are lacking

[3] Data from the ODYSSEE MURE project see http://www.muredatabase.org/query1b_mr.asp and http://en.wikipedia.org/wiki/Energy_efficiency_in_europe

[4] Average OECD occupancy in the residential sector dropped from 2.9 in 2006 to 2.6 in 2009 while the size of households increased. In the United States, average household size increased from 166 m2 to 202 m2 between 1990 and 2008, while China's urban houses increased in size from 13.7 m2 to 27 m2 per occupant between 1990 and 2005 (National Bureau of Statistics, 2007 and IEA 2012).

markets and green market supporting institutions (Andersen, 2009, 2012) . Green economic change is fundamentally about environmental issues becoming a new value proposition and a still more important selection criterion in economic activity (Andersen, 2006, 2009, 2012). There is a general lack of statistics and indicators on eco-innovation and hence we know little of trends and dynamics in the greening of the economy (Kemp and Arundel, 1998; Horbach 2005; Andersen, 2006; Kemp and Pearson, 2007; OECD 2011; United Nations 2011; UNEP 2012; EIO, 2012).

The hypothesis pursued in this paper is that the rise of the green economy is of such a paradigmatic nature that it can only take place accompanied by considerable institution formation in the form of standards. In this sense, the presence of 'green' standards may be seen as an important indicator on the maturity of the greening of the economy in different technical areas as well as geographic regions.

The hypothesis is supported by an argumentation on the specificities of eco-innovation. We have earlier argued that there are some special characteristics of eco-innovation which make up core constituents of evolutionary eco-innovaiton theory. These are important to understand the processes of green economic change. We argue that eco-innovations are characterized by:

1. Being extraordinarily systemic (value chain/life cycle assessment, recycling, SCP).
2. Having unusually high information costs (credence characteristics, relativity, complexity).
3. Having a strong normative element (inherently good to be green).
4. Being more open than 'general' innovations.
5. The environmental potential is in part technology dependent.
6. The technical infrastructure and physical planning is important.
7. Policies such as regulations and fiscal incentives play a very important role.
8. The carrying capacity/resilience of the local biosystem matters.

(See Andersen and Faria 2015, and also Andersen 2006, 2008 for earlier versions).

It is especially characteristic 2, the unusual high information costs, which are important for the standardization process but also characteristic 3, the normative element which means that the risk of green washing and distrust in a companies green performance set high requirements for credibility, verification and standardization. Also the highly systemic nature of eco-innovations suggest a high need for standardization to achieve sufficient coordination between the involved agents.

While others have argued that the green economy is a paradigmatic change (Freeman, 1996), the nature and trends in green economic change processes over time have been little studied.

3. Standards and labels

Formal standards are targeted norms articulated in a document, achieved through a consensus process by a recognized organ, the standardization bodies. International standards play a key role for innovation in providing harmonized, compatible solutions and access to world markets. Standards provide rules, guidance or characteristic features often related to products or processes but may go beyond these and e.g. refer to terminology, and measurement methods (Gürtler 2011). Labels are, on the other hand, information codes which may be certified or not, directed at the market or stakeholders which inform about the properties of a product or firm. Concerning energy efficiency, energy- and eco-labels are both relevant. Standards and labels represent interesting data sources because they potentially relate to the entire innovation process and any type of business functions and products including service products. They hence have the potential to capture also less science based innovation as well as market side aspects.

Innovation research on standards tend to focus on the competition between competing emerging standards as well as the economic impacts of these, often related to IPR issues and trade restrictions (Blind and Jungmittag (2008), Blind (2011), Bekkers et al. (2012). The idea pursued here is rather to view longitudinal trends in the standardisation process as an indicator of changes in the innovation process itself; more specifically, changes in the thematic *direction* of the standardization process are sought captured. The analysis below seeks to analyze when, where and how energy efficiency becomes an issue in Danish and international standardization work using buildings as a case. This entails looking beyond single standardization cases and instead highlighting the uptake of new themes and issues across a wide spectrum of standardization activities. The standardization processes themselves may further reflect important features of how national and regional (e.g. EU) innovation systems work. They could be seen as a key indicator of the level and quality of institution formation in national and regional innovation systems.

The explorative work undertaken so far has also investigated methodological opportunities and challenges in using standards for such longitudinal quantitative studies. The institutional set up and processes related to particularly standardization are highly complicated and a detailed account goes beyond this paper. Here only some main features will be given and sought illustrated via the building case below. The analysis takes a starting point in Danish standardization work seeking to put this into an international perspective.

Labels are included as these may be seen as derived from standards, as the more formalized or important labels most often are supported by standards e.g. using their definitions or measurement recommendations. Labelling is, however, only briefly looked into, presenting some overview of available data within building relevant core labels.

3. Analysis of labels in buildings

Concerning labelling in the building area related to energy efficiency, which includes energy labels and the somewhat broader eco-labels, there is generally a lack of overview over these. A recent

OECD analysis generally on eco-labels have remedied this somewhat but is not detailed in the building area (Gruère, 2013). The analysis is primarily based on the database 'Ecolabel indeks' which does take a broad look in energy and eco-labels and does have a search function for building products but the data are poor and many building relevant labels are missing[5] . The review made here is primarily based on available data on webpages of core eco-labelling bodies and consultancy with experts from these organizations mainly during 2013 but also some in 2014 and 2015[6]. The findings are that there are generally few international labels in the building area but somewhat more national labels, many of these of a temporary or recent nature. Particularly lacking are systematic longitudinal analyses about their emergence or market penetration (Gruère, 2013). Generally , the focus of energy and eco-labels are predominately on small consumer products which in the energy area largely means appliances[7]. Overall, relatively few labels are oriented towards buildings and even fewer at building components or –technologies; this also goes for the important EU flower and the Nordic Swan. However, in recent years there is a marked increase in the labelling of entire buildings, where the Swan label and the Green Building Council schemes are experiencing rising success.

The best indicators on energy efficiency related to buildings are policy indicators. The last years have seen the rise of several new international policy indicator initiatives related to buildings, see noticeably BPIE, IEA, WEC and MURE[8]. These are relevant for tracking developments in the implementation of mandatory and voluntary labels but does not include their market penetration. The most important international label related to energy efficiency in buildings is the Energy Performance Certificate (EPC) on buildings. Derived from the central EPBD (Energy Performance

[5] http://www.ecolabelindex.com/ecolabels/?st=category,building_products
[6] Telephone interviews were made mainly during spring 2013 with the Nordic Swan label in Sweden and Denmark, the German Blaue Engel, the German Passiv Haus organizations, the DGNB (Danish Green Building Council) organization..
[7] See e.g. http://wec-indicators.enerdata.eu/,http://www.ecolabelindex.com/ecolabels/, http://www.muredatabase.org/index.htm
[8] http://www.buildingsdata.eu/bpie-data-hub, http://wec-indicators.enerdata.eu/, http://www.muredatabase.org/query1b_mr.-asp, http://www.sustainablebuildingscentre.org/pages/beep.

of Buildings) directive from 2002, it is mandatory since 2006 to implement Energy Performance Certificates in EU countries. There are analyses on the implementation and distribution of EPBD standards including the EPC but so far mainly in the form of national reports rather than quantitative international analyses[9]. There is quite a varied level of implementation rate and speed so far within EU countries. Denmark has been among the initiators of this scheme together with the Netherlands. Denmark is also among the pioneering countries starting already in 1997 and has also one of the most extensive systems (Hansen et al. 2013). In time EPC is expected to provide good data on energy efficiency innovation in buildings within the EU countries but it is likely to take quite some years before the data quality will improve sufficiently across EU countries[10](CENSE 2012).

It is interesting to notice that behind the EPC scheme and the related energy inspections of boilers and ventilation systems in buildings, which together make up the main initiatives of the EPBD, lies no less than 596 CEN standards which have been implemented in Denmark related to the EPBD directive so far, illustrating the immense complexity of these tasks and the need for European coordination[11].

New Danish analyses show that after a very long difficult introductory period for the EPC, there are finally signs of positive economic effects on the Danish building market; buildings with a high energy performance achieve better prices (Hansen et al. 2013).

4. Standards and energy efficiency in buildings

Shortly on standardization

The pillars of the standardization system are the National Standardization Bodies (NSB), in Denmark Danish Standards (DS). These are the main point of access for stakeholders to the

[9] See the EU network Concerted Action, http://www.epbd-ca.eu/country-information

[10] http://www.epbd-ca.eu/country-information

[11] Own analysis based on CEN data.

international standardization organizations. Standardization processes have changed a lot over time, and have generally grown in importance especially in EU. More and more standards are developed at the international level, for Europe mainly CEN, CENELEC, ISO and IEC)[12]. There is a close co-operation between international, regional and national standards bodies.[13]. New standards are developed in so-called technical committees (TC) or subcommittees (SC) or for more preliminary or new work, in Working groups (WG).

Standard analysis on energy efficiency – methodological issues

Longitudinal studies of trends in standardization are very few. The literature on the development of energy saving standards is very scars and possibly loosely founded, claiming that Poland and North America were pioneering this work in the 1960s and 1970s, although early standards were ‘weak’and little applied (Wiel and McMathon, 2005). These findings are somewhat surprising given that Western European countries generally are considered early movers in the energy efficiency area (XX). In the attempt to uncover the emergence and development of energy efficiency issues in standards two types of standardization analysis are here suggested. These are standardization data where the information is relatively easily accessible electronically via the web pages or documents from the standardization organizations. In this paper we use information from the core relevant international standardization organizations (CEN/CENELEC, ISO/IEC) as well as, as a start, Danish Standards as an example of national standardization bodies. Interviews with two members of Danish Standards in 2013 has facilitated the identification and interpretation of the standards.

[12] For Denmark the most important ones being CEN, the European standardization organization, and CENELEC, covering electronic products, the global ISO and IEC, the latter covering electronic products. Since the so-called ‘New Approach’ in 1985 a large part of EU legislation is implemented via harmonized standards which has led to a marked rise in European standardization.

[13] CEN and ISO have a very close technical cooperation; since the Vienna Agreement from 1991 new standards projects are jointly planned between them. CEN further cooperates extensively with other national and regional standardization bodies worldwide.

1)The first set of indicators tracks changes in the thematic orientation of the committees, i.e. the evolution and transformation over time of energy efficiency or energy performance issues in Technical Committees, Sub Committees and Working Groups in different standardization bodies. The challenge is to identify the relevant committees/groups. Some are related to EU directives, noticeably the EPBD, (Environmental Performance of Buildings Directive) and therefore per definition relevant to the theme pursued, others more generally dealing with energy efficiency, noticeably the EuP (Ecodesign of products Directive dealing exclusively with energy efficiency issues of energy using products).

Indicators suggested to measure Danish/national prominence are: A) the secretariat function, (hold by a given national standardization body). B) for ISO only, the status of participation i.e. partipating (P), observing (O),and non participating (N) status of member countries of the committees and groups. There is no such registration in CEN where all 33 national members are supposed to be P.

2) *The second set tracks the number of standards dealing with energy efficiency* related to buildings and building components across the core standardization organizations (CEN/CENELEC, ISO/IEC). The analysis seeks to identify when we see changes in (energy efficiency related) standardization activity but also the diffusion of the energy efficiency themes between the technological building areas and by whom. Did energy efficiency emerge in e.g. insulation materials, windows, in measurement metrics or at the building system level and how did it diffuse and grow? The analysis is important to track standards outside the core building and energy efficiency oriented technical committees.

More studies could be done e.g. looking into the set of participants in the committees but these have not been pursued so far.

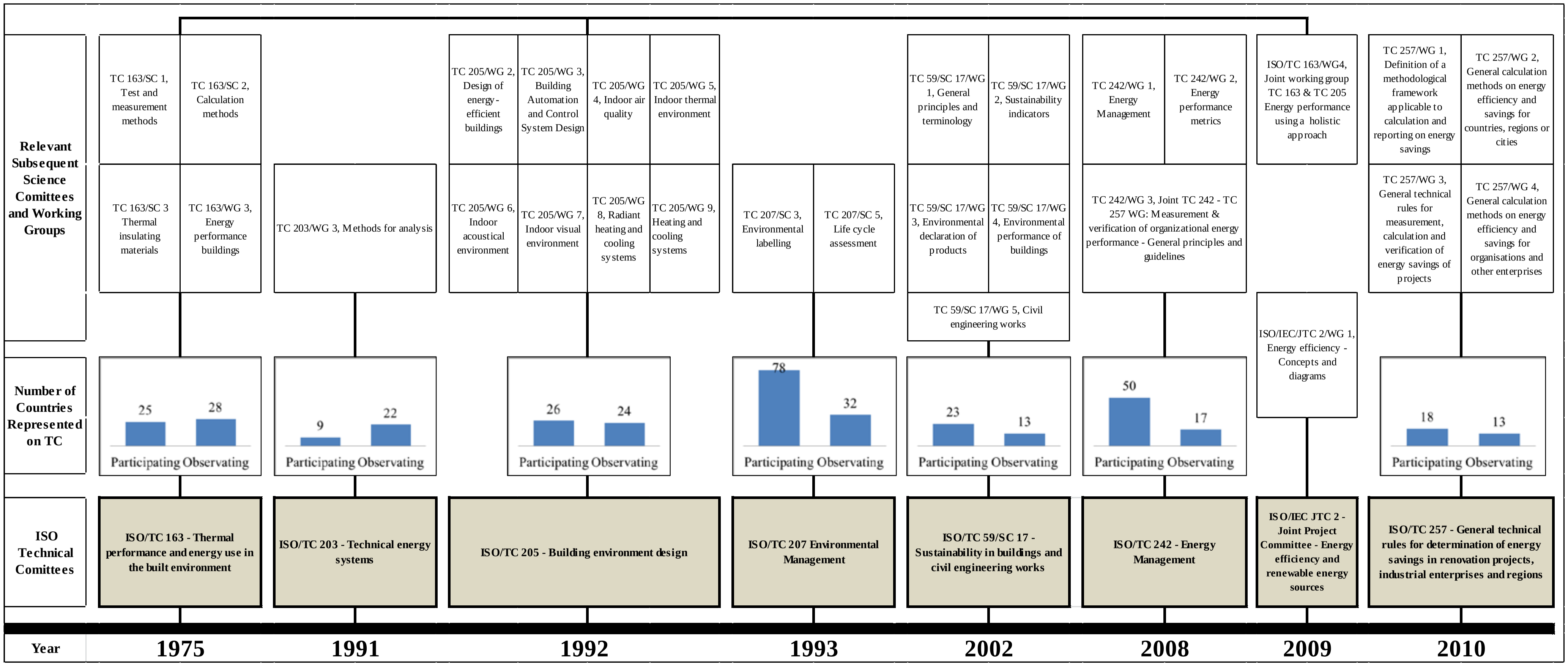
Methodological limitations

It has shown to be difficult, and for the time being impossible, to track the history, i.e. the pioneering role of specific countries, due to the general lack of historic registration in the national standardization bodies. Only recently extinct standards are preserved. More in-depth studies into national archives may remedy this. The thematic search at the level of standards (used also to identify relevant committees) is quite difficult and very time consuming because of: A) Lack of standardization codes (known as ICS) on energy efficiency and lack of key words in the standardization bodies. Both thematic, title, related ICS codes and search by directives have been used to identify the relevant standards; these, however, need ideally to be complemented by expert verification due to discrepancies in the data before findings are rigorous enough to be used. B) Lack of search tools and software available – data have to be extracted by hand, except for CENELEC. Finally, parts of particularly CEN electronic (web) data are often difficult to access in practice as webpages do not function, despite the fact that they in theory are accessible. Due to these limitations analyses are not yet available at the level of standards (i.e. track two suggested).

Some early findings on the standardization process

Figure 1 sums up the main findings on the rate and direction on the energy efficiency related building standards. The figure illustrates the evolution of core identified ISO technical committees related to energy efficiency in buildings from the emergence of the first committees in the 1970s until 2012. CEN data are unfortunately lacking due to difficulties in getting the time of establishment of their committees. The absence of CEN data means that only parts of the international trends are being captured by now; we cannot trace the role of EU countries known for their early and strong environmental policies, versus more international trends as intended.

Figure 1. The evolution of ISO Technical Committees working with energy efficiency in buildings



Source: Own source, based on ISO data.

We see the first committee emerging after the oil crisis in the mid 1970s directed at the energy performance of buildings. This illustrates the quite early attention to the role of energy efficiency in buildings for solving the at the time just emerging energy crisis.

This is followed by a sixteen year gap until more recent relevant committees and subgroups evolve and spreads in the 1990s. This timing fits with the early rise of corporate green strategies and green markets (Andersen, 1999, Ulhøi and Madsen, 2000). A part of the explanation may also be the introduction of the so-called 'New Approach' in 1985 a large part of EU legislation is implemented via harmonized standards which has led to a marked rise in European standardization which is likely to have influenced wider ISO standardization.

We see a change in the agendas of the committees, the energy efficiency agenda becoming still more complex and systemic, expanding from technical to organizational (management systems) and moving towards a more holistic, systemic perspective on buildings energy performance. This is specifically sought addressed in the ISO JTC joint working group on a 'holistic approach' established in 2009.

In all, 81 energy efficiency & building related ISO and CEN TC/SC/WG have been identified, of which some of course are more central to the building related energy efficiency agenda than others

Regional trends in standardization

In ISO data it is possible to distinguish between participating member countries, observatory members and non-participants which can be used as proxies for different countries degrees of involvement in the standardization process. The difference between participating and observing countries, is, however, in practice often not that great. The real significant factor is therefore the degree of non-participating countries[14] .

Figure two below uses ISOs participation levels on main committees identified as relevant for energy efficiency in buildings. Unfortunately, it is difficult to get longitudinal data on this, so only a 2013 analysis is presented in the following graphs.

Especially Northern European countries have a high level of participation in the committees working with energy efficiency.

Figure 2. European and selected countries participation level in ISO committees 2013

Code	Description	DK	SN	NO	FI	GE	BE	AU	SW	UK	FR	NL	IT	SP	PL	US	CH	IN	JP	BR	AT
ISO/TC 163	Thermal performance and energy use in the built environment	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Yellow	Yellow	Yellow	Green	Green	Green	Green	Red	Yellow
ISO/TC 205	Building environment design	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Red	Green	Red	Green
ISO/TC 203	Technical energy systems	Red	Green	Red	Yellow	Yellow	Red	Yellow	Green	Green	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Green	Red	Green	Red	Red
ISO/TC 59/SC 17	Sustainability in buildings and civil engineering works	Yellow	Green	Green	Green	Green	Green	Yellow	Yellow	Green	Green	Green	Green	Green	Yellow	Green	Green	Yellow	Green	Yellow	Green
ISO/IEC JTC 2	Joint Project Committee - energy efficiency and renewable energy sources	Yellow	Green	Green	Green	Green	Yellow	Green	Yellow	Green	Green	Green	Green	Green	Yellow	Green	Green	Red	Red	Green	Yellow
ISO/TC 257	General technical rules for determination of energy savings in renovation projects, industrial enterprises and regions	Yellow	Green	Yellow	Green	Green	Red	Red	Yellow	Green	Green	Green	Green	Green	Yellow	Green	Green	Green	Green	Green	Red
ISO/TC 242	Energy Management	Green	Green	Green	Green	Green	Yellow	Red	Yellow	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green
ISO/TC 207	Environmental Management	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green
ISO/TC 115	Pumps	Green	Green	Red	Green	Green	Green	Yellow	Red	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Red
ISO/TC 77	Products in fibre reinforced cement	Yellow	Red	Red	Yellow	Green	Red	Green	Yellow	Red	Green	Green	Red	Green	Red	Green	Green	Yellow	Green	Green	Green
ISO/TC 160	Glass in building	Yellow	Red	Yellow	Yellow	Green	Green	Yellow	Green	Green	Green	Green	Green	Yellow	Yellow	Green	Green	Yellow	Green	Red	Green
ISO/TC 162	Doors and windows	Yellow	Yellow	Green	Green	Green	Green	Red	Green	Green	Green	Green	Green	Green	Yellow	Green	Green	Yellow	Green	Red	Green

Notes: Countries: DK - Denmark; SN - Sweden; NO - Norway; FI - Finland; Ge - Germany; BE - Belgium; AU - Austria; SW - Switzerland; UK - United Kingdom; FR - France; NL - Nederlands; IT - Italy; SP - Spain; PL - Poland; US - United States; CH - China; IN - India; JP - Japan;   AT- Australia.

Green	Participating
Yellow	Observating
Red	Neither participating nor observating

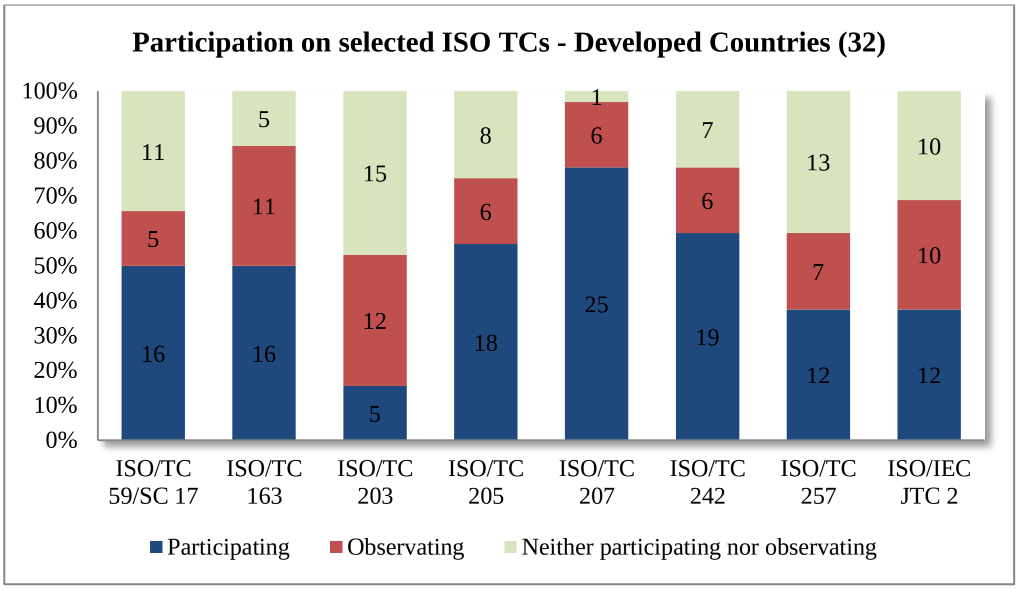
Source: Own source, based on ISO data

If we look into the global participation in these processes we see some marked changes between developed, BRICS and developing countries. Figure three to five below show that it is clear that

[14] According to interview with XX, Danish Standards

poorer and smaller developing countries are significantly less involved in the standardization process than the richer countries[15].

Figure 3. Participation of developed countries in relevant ISO TCs 2013



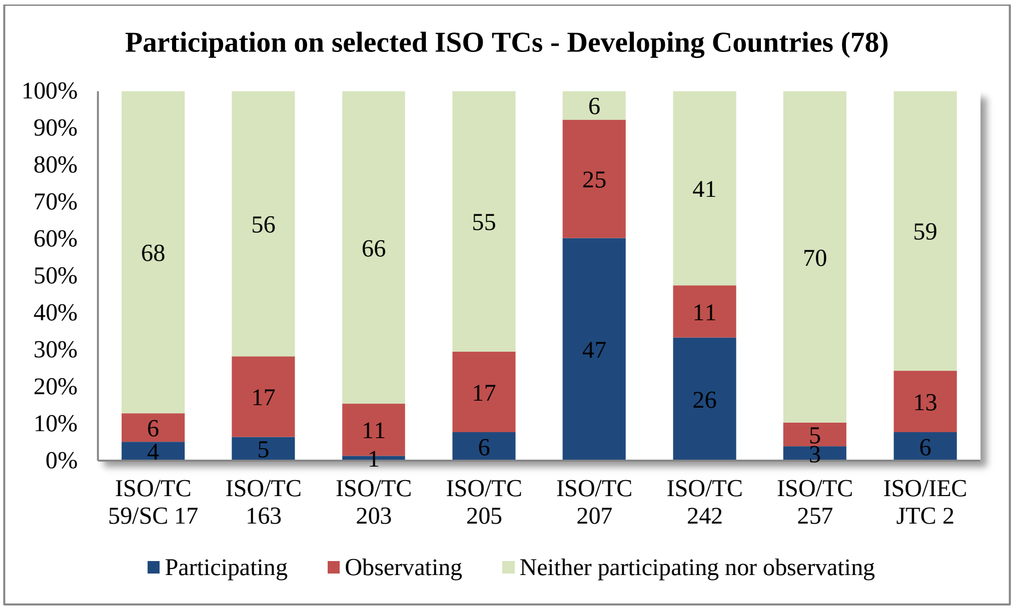
Source: Own source passed on ISO data.

The developed countries show a high degree of participation in all the relevant TCs.

The high level of developing countries which have no participation in these standardization activities is particularly noticeable in figure four below. It is interesting to notice that the developing countries are considerably more active in the management area, i.e. environmental- and energy management, rather than the technical areas, but more studies could be done on this.

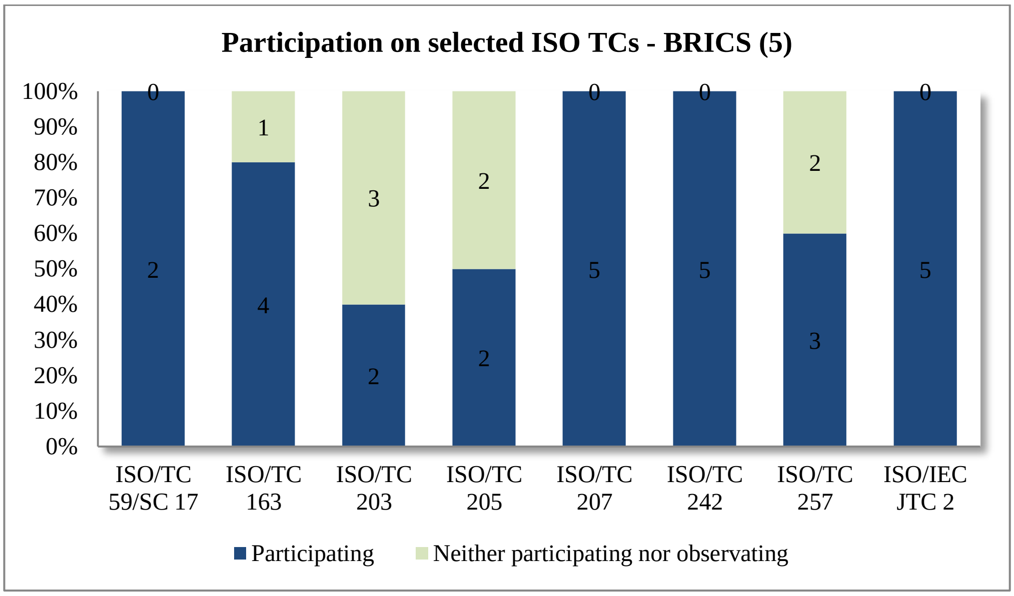
Figure 4 Participation of developing countries 2013

[15] Developed and developing countries as defined by IMF.



Source own source.

Figure 5 Participation of BRICS countries 2013

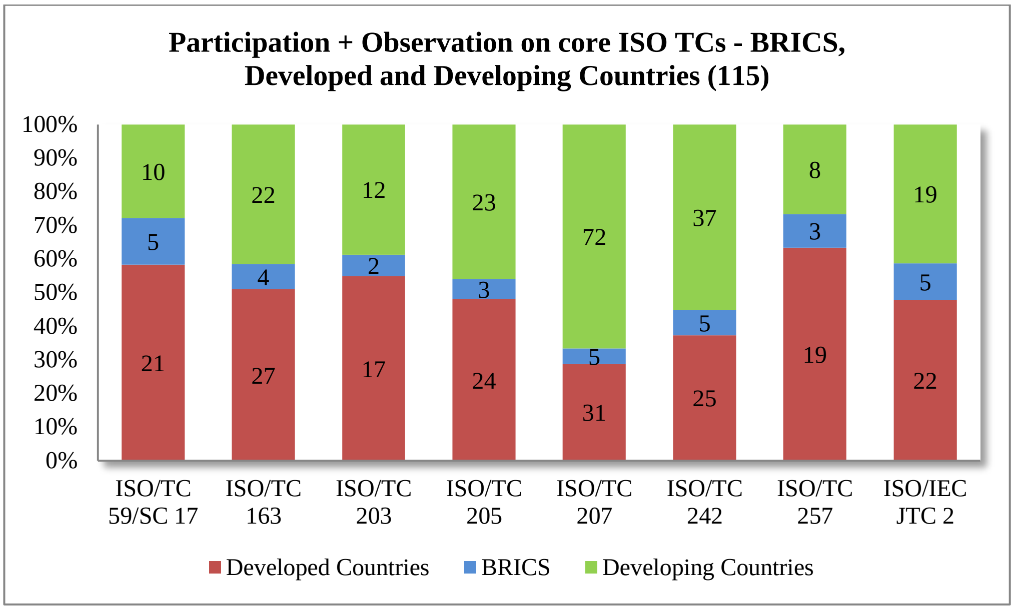


Source Own source

The BRICS countries (Brazil, Russia, India. China and South Africa), are naturally only a very small sample. In comparison to the developing countries, they are very well represented in these standardization activities which might be seen as an indicator of the globalization of the green economy.

The overall distribution of participation and observation active countries as opposed to non-participating looks like this:

Figure 6. **Participation + Observation on core ISO TCs - BRICS, Developed and Developing Countries (115) 2013**



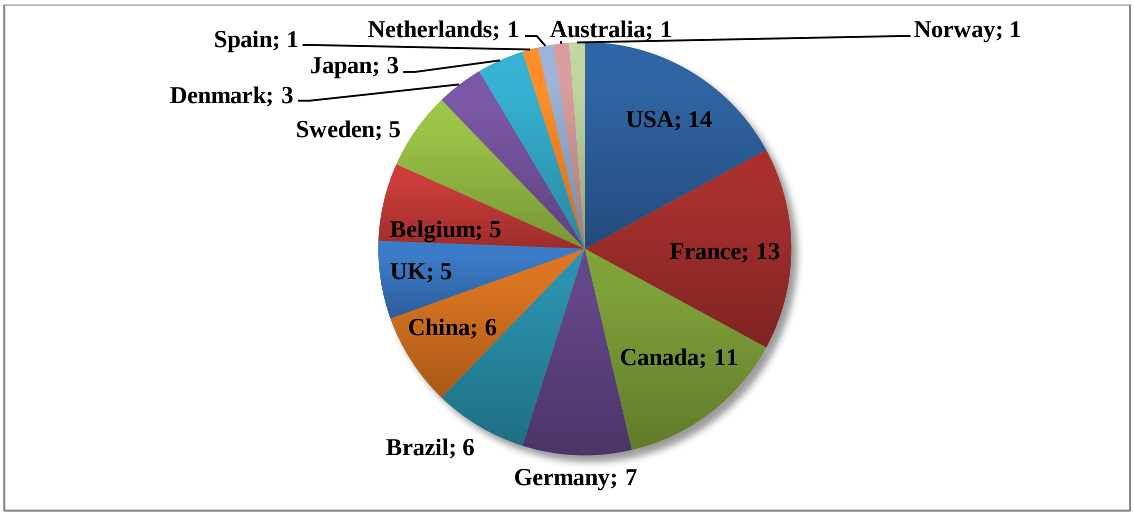
Source: own source based on ISO data.

While the dominating role of the much fewer developed countries in these ‘green’ activities is clear, it is still interesting to see that the developing countries do take part in these processes to quite some degree.

The time of entry of BRICS and developing countries into these activities could be further looked into though such data are not easily extracted.

If we look at the important secretariat function of the committees as a proxy of core national involvement, we can get a more full analysis, as also CEN data are available here. In all we can trace 81 energy efficiency & building related ISO and CEN TC/SC/WG. It is interesting to notice that while Western European countries dominate, two BRICS countries play quite important roles, respectively China and Brazil, illustrating the rising roles of these countries for (green) economic change. Denmark, Belgium and Sweden are well represented for small countries; these are all countries with a cold climate, illustrating the role climate aspects may have for the energy efficiency agenda.

Figure 3 Measuring national prominence 2013 – distribution of countries holding the Secretariat of the 81 energy efficiency & building related ISO and CEN TC/SC/WG



Source: Own source based on ISO and CEN data.

More longitudinal similar data would be interesting but is hard to access. In depth qualitative analyses of these standardization processes, highlighting the core committees, the core standards and actors, are likely to bring considerable more information in important ways.

Conclusions

This paper has undertaken early empirical analyses and some first methodological clarifications seeking to link up standardization processes with overall green economic change. The analysis shows that it is in fact possible to trace the uptake and wider diffusion of energy efficiency issues over time and space, or the lack of this uptake, across all kinds of technologies, products and business practices. Standards do present interesting international solid and comparative data very relevant to the analysis of complex, pervasive changes of the economic process. There are some methodological problems and limitations, particularly concerning very long term analyses. More detailed analysis than undertaken here is cumbersome as many data are not easily available electronically. Also, the energy efficiency and construction area is a difficult case; other themes where ICS codes are available are likely to be much easier.

Among the empirical findings that emerge, based primarily on ISO data only, we see the long gestation period from the first committee on energy efficiency standards until a breakthrough nearly 15 years later with multiple committees emerging, we see the rise of a still more complex energy efficiency and related sustainability agenda and still more actors taking place in the process, noticeably the recent rise of the BRICS countries as important actors but still with the developed countries dominating the standardization processes. We need more detailed analysis, though, to fully answer the raised research questions, none the least to trace the leaders in the standardization processes for energy efficiency in buildings. But the findings presented already clearly demonstrate the very substantial amounts of standards that have evolved related to the green economic change processes, thus confirming the hypothesis that standards form very important part of these processes.

References

Andersen, M.M., (1999) *Trajectory Change through Interorganisational Learning. On the Economic Organisation of the Greening of Industry*, Copenhagen Business School, PhD. Series, Copenhagen.

Andersen, M. M. (2002) “Organising Interfirm Learning – as the Market Begins to Turn Green”, in de Bruijn, T.J.N.M. and A. Tukker (eds.), Partnership and Leadership – Building Alliances for a Sustainable Future. Dordrecht: Kluwer Academic Publishers, pp.103-119.

Andersen, M.M. (2006) *Eco-Innovation Indicators*, European Environment Agency, Copenhagen.

Andersen, M M. (2009). Combating Climate Change through Eco-innovation - Towards the Green Innovation System. in *Innovative Economic Policies for Climate Change Mitigation* (1st ed., pp. 37-58). Lulu.com.

Andersen, M.M. (2012) 'Into the Green Economy – Evolutionary Perspectives on Green Economic Change', Paper for the Schumpeter Conference, Brisbane 2-5 July 2012.

Arthur, W. B. (1989) "Competing Technologies, Increasing Returns, and Lock-in by Historical Events," The Economic Journal, 99, pp. 116-131.

Arundel, A., R. Kemp, and S. Parto (2004) "Indicators for Environmental Innovation: What and How to Measure", in D. Annandale, J. Phillimore and D. Marinova (Eds.) International Handbook on Environment and Technology Management (ETM), Edward Elgar, Cheltenham.

Blind, K. & Jungmittag, A. (2008). The impact of patents and standards on macroeconomic growth: a panel approach covering four countries and twelve sectors. *Journal of Productivity Analysis, 29*(1), 51-60.

Blind, K. (2011). An economic analysis of standards competition: The example of the ISO ODF and OOXML standards. *Telecommunications Policy, 35*(4), 373-381.

BPIE (2011) European Buildings under the Microscope, BPIE, http://www.bpie.eu/eu_buildings_under_microscope.html

Dosi, G. (1982). "Technological Paradigms and Technological Trajectories: A Suggested Interpretation of the Determinants and Directions of Technological Change", *Research Policy,* 11, pp.147-162.

EIO. (2012). Closing The Eco-Innovation Gap An economic opportunity for business, EIO.

EIS (2010) European Innovation Scoreboard (EIS) 2009, Bruxelles: European Commission

Gruère, G. (2013) A CHARACTERISATION OF ENVIRONMENTAL LABELLING AND INFORMATION SCHEMES, ENVIRONMENT WORKING PAPER No. 62, OECD, Paris.

Gürtler, G. (2011). Standardization –challenge and opportunity, Austrian Standards Plus, Vienna.

Hansen, A.R., O. M. Jensen and J. Kragh (2013) Sammenhæng mellem energimærkning og salgspris, Netværk for energirenovering SBi 2013:06, Statens Byggeforskningsinstitut, Aalborg Universitet

HORBACH, J. (ED) (2005) *INDICATOR SYSTEMS FOR SUSTAINABLE INNOVATION*, PHYSICA VERLAG, HEIDELBERG.

IEA (2012) *Tracking Clean Energy Progress*, OECD/IEA, Paris CEDEC.
Kemp, R and Andersen, M. M. (2004) "Strategies for eco-efficiency innovation", Strategy paper for the Informal Environmental Council Meeting, July 16-18 2004 Maastricht, VROM, Den Haag.

Kemp, R. and Arundel A. (1998) *Survey Indicators for Environmental Innovation*. IDEA report, STEP Group, Oslo.

Kemp, R. And P. Pearson (2007), Final Report of Measuring Eco-innovation (MEI project), Bruxelles, http://www.merit.unu.edu/MEI/

Langlois, R.N. (1992), 'Transaction Cost Economics in Real Time', *Industrial and Corporate Change*, **1**, pp.99-127.

Lundvall, B-A (1988) 'Innovation as an interactive process: from user-producer interaction to the national system of innovation', in Dosi, G *et al.* (1988), *Technical Change and Economic Theory*, Pinter Publishers, London

Lundvall, B-A (ed.) (1992), *National Systems of Innovation: Towards a Theory of Innovation and Interactive Learning*, Pinter Publishers, London

Lundvall, B. (2007). National Innovation Systems—Analytical Concept and Development Tool. *Industry & Innovation*, *14*(1), 95-119.

Nelson, R.R. and S. Winter (1982). *An Evolutionary Theory of Economic Change*, Cambrige, MA: Harvard University Press.

Nelson, R. (1993) *National Systems of Innovation: A comparative analysis*, Oxford University Press, New York

UNEP. (2011). *Towards a Green Economy: Pathways to Sustainable Development and Poverty Eradication*. *Sustainable Development* (p. 631). UNEP/GRID-Arendal.

Perez, C. (2000) "Technological Revolutions, Paradigm Shifts and Socio-Institutional Change".In E. Reinert (ed.), *Evolutionary Economics and Income Equality*. Aldershot: Edward Elgar.

UNEP. (2011). *Towards a Green Economy: Pathways to Sustainable Development and Poverty Eradication*. *Sustainable Development* (p. 631). UNEP/GRID-Arendal.

UNESCAP (2006) Green Growth at a Glance, the way forward for Asia and the Pacific, United Nations, ST/ESCAP/2407.

United Nations. (2011). *Working towards a Balanced and Inclusive Green Economy: A United Nations System-wide Perspective*. Geneva: United Nations.

Wiel,S and J.E. McMahon (2005) *Energy efficiency Labels and Standards: A Guidebook for Appliances, Equipment and Lighting*, CLASP, Washington D.C, USA.