

**Sustainability transitions in developing countries
Stocktaking, new contributions and a research agenda**

Hansen, Ulrich Elmer; Nygaard, Ivan; Romijn, Henny; Wieczorek, Anna; Kamp, Linda M.; Klerkx, Laurens

DOI

[10.1016/j.envsci.2017.11.009](https://doi.org/10.1016/j.envsci.2017.11.009)

Publication date

2017

Document Version

Final published version

Published in

Environmental Science & Policy

Citation (APA)

Hansen, U. E., Nygaard, I., Romijn, H., Wieczorek, A., Kamp, L. M., & Klerkx, L. (2017). Sustainability transitions in developing countries: Stocktaking, new contributions and a research agenda. *Environmental Science & Policy*. <https://doi.org/10.1016/j.envsci.2017.11.009>

Important note

To cite this publication, please use the final published version (if applicable).
Please check the document version above.

Copyright

Other than for strictly personal use, it is not permitted to download, forward or distribute the text or part of it, without the consent of the author(s) and/or copyright holder(s), unless the work is under an open content license such as Creative Commons.

Takedown policy

Please contact us and provide details if you believe this document breaches copyrights.
We will remove access to the work immediately and investigate your claim.



Sustainability transitions in developing countries: Stocktaking, new contributions and a research agenda

ARTICLE INFO

Keywords:

Sustainability transitions
Inclusive development
Inclusive innovation
Developing countries
Niche development
Socio-technical regimes
Geography of transitions

ABSTRACT

An increasing number of studies have analysed the scope for, and the barriers to, transitions toward sustainability in the context of developing countries building on analytical perspectives from the sustainability transitions literature. This paper introduces a special issue on sustainability transitions in developing countries, which takes stock of this emerging field of research and presents new empirical research that contributes to further advancement of our understanding of the conditions in which sustainability transitions are likely to take place in developing countries and what is involved in these transformative processes. This introductory paper presents the five papers contained in the special issue. The first paper comprises a review of the existing literature on the subject, and the other four papers present new empirical research. The key findings of the papers are discussed in relation to previous research in the field specifically related to four crosscutting themes: (i) global-local linkages and external dependencies; (ii) stability and non-stability of regimes; (iii) undemocratic and non-egalitarian nature of regimes; and (iv) nurturing the development of niches versus the execution of individual projects. The introductory paper concludes by presenting a research agenda, which aims to provide promising avenues for future research on sustainability transitions in developing countries.

1. Introduction

The idea for this special issue originated at the International Sustainability Transitions Conference in 2015 at SPRU, Sussex University, where the guest editors of the special issue convened a special session on sustainability transitions in developing countries. This session attracted much interest from participants at the conference and it became clear that within the sustainability transitions community a number of researchers were engaged in research activities in developing countries with a basis in theories from the sustainability transitions literature. This interest has continued to increase since then with the emergence of various fora in the transitions community dedicated to research on sustainability transitions in developing countries and special sessions at subsequent IST conferences.

With this special issue we aim to provide some consolidation of this emerging field of research, by taking stock of key findings from previous studies, presenting new empirical research that contributes to further advancement of our understanding of sustainability transitions in developing countries, and stimulating interest and critical discussion among researchers engaged in research projects on sustainability transitions in the developing world. The findings presented in the papers contained in this special issue are also of high practical relevance for stakeholders involved in the practicalities and problem-solving aspects of sustainability transitions in developing countries, including policy makers, government agencies, planners, donors, private businesses and industry and NGOs.

In this introductory paper, we start by highlighting some of the main structural differences between developed countries and developing countries, which may influence the manner in which transitions toward sustainability unfold in the latter as opposed to the former. Subsequently, the key findings of the individual papers compiled in this special issue are presented and discussed in relation to previous studies in this field. Finally, we present a research agenda for the field of transition studies in the context of developing countries.

2. Sustainability transitions in developing countries

While the notion of “developing countries” is contested both theoretically and politically, not least due to its implicit normative assumption of these countries being in a state of under-development, the existence of a pre-determined trajectory of progress, and a definite meaning of progress itself (Escobar, 1995), we use the concept here to emphasise that in spite of large differences across this broad category, there are some common social, cultural, economic and political conditions in these countries, which differentiate them from so-called “developed countries”.¹ These similar conditions include for example a weaker state apparatus, less efficient bureaucracies, higher levels of political and economic instability, less transparency in legal proceedings and enforcement of legal frameworks and relatively high levels of economic and social inequality (Lachman, 2012; Ramos-Mejía, 2018). Furthermore, developing countries typically rely on foreign sources of technology, knowledge and financial resources to a greater extent than developed countries – with external donor interventions playing a role especially in the least developed ones – and they are typically characterised by less advanced industrial processes, a dominance of low-tech (primary) sectors, reliance on extended family ties and clientelism, and employment in the informal sector (Viotti, 2002; Bell, 2007).

Given these cultural and structural differences between developing and developed countries, the ways in which transitions toward sustainability take place in the context of low-income developing countries are likely to differ from those in their western high-income, industrialized counterparts (Lundvall et al., 2009). Accordingly, the study of transition issues in a developing-country context is unlikely to entail a straightforward task of transferring theoretical and conceptual frameworks from their place of origin to a significantly different empirical context (Verbong et al., 2010; Lachman, 2012). For example, the key concept of ‘innovation’, which features so prominently in the sustainability transitions literature, may need to be understood differently from the conventional western view, which revolves around the development of radically new technologies mainly based on R&D. Indeed, in the context of developing countries, innovation may often include less formalised ‘shop-floor’ based activities as has been expressed in concepts such as ‘frugal innovation’, ‘grassroots innovation’ and ‘inclusive innovation’, which utilize local assets and involve indigenous knowledge systems located outside R&D laboratories (Arocena and Sutz, 2010; Foster and Heeks, 2013; Fressoli et al., 2014; Knorringer et al., 2016; Pansera and Sarkar, 2016; Swaans et al., 2014; Hermans et al., 2016). Consequently, sustainability transitions in developing countries need to be analysed, managed and supported with a greater level of critical reflectiveness than has been the case hitherto. This special issue contributes to providing such reflections by presenting analyses on how specific conditions in developing country contexts influence the pathways of sustainability transitions in developing countries.

3. Crosscutting themes addressed in this special issue

The papers contained in this special issue focus on attempts to foster transitions toward sustainability across a variety of empirical contexts, ranging from water harvesting in Jordan to Jatropha-based biofuel in Ghana and urban sanitation in Kenya. The papers use different theoretical lenses applied in the sustainability transitions literature, such as the multi-level perspective on socio-technical transitions (MLP), the strategic niche management perspective (SNM), the transition management perspective (TM) and the technological innovation systems perspective (TIS) (see Markard et al., 2012), but also make use of literatures on institutional theory (Wood and Gough, 2006), participation and community development (Uphoff et al., 1998), and global value chains (GVC) (Gereffi et al., 2005). Key characteristics of the papers are presented in Table 1, and these will be discussed in relation to how they build on and contribute to advancement of the existing understanding of how transitions toward sustainability are likely to take place in developing countries, and conditions that promote and constrain them. The following discussion is organised around four themes addressed in the papers: (1) global-local linkages and external dependencies, (2) stability and non-stability of regimes, (3) undemocratic and non-egalitarian nature of regimes, and (4) nurturing the development of niches versus the execution of individual projects.

3.1. Global-local linkages and external dependencies

The conventional approach in using the MLP in a developing country context involves depicting regimes with national features, landscape dynamics with global features, and niches with sub-national or local features (see e.g. Hansen and Nygaard, 2014). However, as has been pointed out previously, regimes do not necessarily remain confined within national boundaries, but can span local, regional and global spatial scales through actor relations and institutions that may either enforce or destabilise them (Raven et al., 2012). Similarly, the development of niches is not necessarily confined to unfolding exclusively at the local or sub-national level, but can also reach a global scale (Rock et al., 2009; Coenen and Truffer, 2012; Fontes et al., 2016).

The realisation of this international ‘embeddedness’ of regimes and niches has been pointed out in studies undertaken in developing countries, such as Berkhout et al. (2011:378), who found that “*sustainability experiments and niches are often set within global flows of knowledge and technology*”. Similarly, Verbong et al. (2010:280) stressed that in India, “*the development of the gasification niche has taken place within a more international context*”, in which “*Indian companies created links not only to local or national networks but also to more global networks*”. Further, Wiecek et al. (2015) mapped the presence of transnational linkages in niche-level experiments in the solar PV technology sector in India while Sengers and Raven (2015) showed the significance of international linkages in mobility policies in shaping the development and diffusion of bus rapid transfer systems from Brazil to the rest of the world. Finally, Manning and Reinecke (2016) highlight the importance of transnational standard setters in influencing local transitions. While it is evident from these studies that niches and regimes are structurally situated within various kinds of external dependencies and transnational linkages, it is less clear how these linkages operate and function with regard to influencing key niche and regime-level processes locally. A number of papers in this special issue contribute to shedding new light on this issue.

Firstly, Nygaard and Bolwig (2018) show the significance of foreign investors and multinational companies in the development of a local niche for biofuel in Ghana based on the utilisation of Jatropha. Making use of the global value chain perspective, they draw attention to how and why

¹ Some authors use the notion ‘Global South’ or ‘low income countries’ instead of ‘developing countries’, but in this editorial we decided to use the term developing countries because of its more widespread use. Like the category Global South, the category of developing countries has never been clearly defined, and changes over time. The World Bank uses the term developing countries to refer to low and medium income countries, with reference to per capita GNI, and the OECD uses a similar but slightly different categorization. A subcategory is the Least Developed Countries, which are defined by the United Nations as the countries with the lowest levels of per capita income and socio-economic development (<http://www.oecd.org/dac/stats/historyofdaclistsofrecipientcountries.htm>). From the above it is evident that there are large differences across developing countries and across developed countries, which means that the categorization should be understood as a continuum.

Table 1
Papers contained in the special issue.

Paper	Empirical setting	Theoretical lenses	Data sources
Wieczorek (2018)	Literature review	MLP, TM, SNM	Scopus and Web of Science
Ramos-Mejía et al. (2018)	Conceptualization	MLP, institutional theory	Selected papers
Nygaard and Bolwig (2018)	Biofuel (Jatropha), Ghana	MLP, GVC, hype cycles	Seven firm case studies, field visits, interviews, documents
Sixt et al. (2018)	Water harvesting, Jordan	TIS	Interviews, documents
Van Welie and Romijn (2018)	Urban sanitation in slums, Kenya	TM, process approaches, community development	Case study, NGO project, interviews, documents

foreign investors were involved in the boom-and-bust cycle of events that occurred during a relatively short period of niche development. In doing so, they illustrate the typical high dependency of external interests on niche development in a developing country in Africa and the volatility of such interests (see also Hansen and Nygaard, 2013). In particular, foreign investors were shown to have played a crucial role in driving and impeding the establishment of local production of Jatropha-based biofuels for the global export market. Van Welie and Romijn (2018) analyse how a donor-funded development project, carried out by a Dutch NGO, Kenyan NGOs and Dutch water utilities, tried to build a niche for improved urban slum sanitation technologies in Kenya. Using the concept of transition arena and the notion that regime actors need to be involved in transition processes (Loorbach, 2010), the paper concludes that although the Dutch NGO succeeded in involving local communities in capacity building, awareness raising, and processes of empowerment, the NGO and the Dutch water utility partners did not succeed in engaging frontrunners who could effectively engage with and influence regime players. As a result, the aspirations of realising a sustainability transformation were far from being achieved. The role of foreign donors is also analysed in the paper by Sixt et al. (2018), in a case focused on the transition toward sustainable water harvesting in Jordan. In this case, the foreign donors were found to have promoted the use of advanced and expensive water harvesting technology from abroad rather than locally available and simpler, low-cost technology. The preferential treatment of a particular technology by foreign donors in this case was generally found to have been detrimental to the development of an economically viable model for local farmers. The above studies contribute to a recent stream of research in the sustainability transitions literature that has raised critical concerns about how and to what extent foreign donors can engender transitions in the developing world (see also Marquardt et al., 2016; Tigabu et al., 2017). This literature illustrates the usefulness of incorporating complementary analytical perspectives from the development studies literature, such as the literature on planned interventions (see e.g. Hansen and Nygaard, 2013) and process approaches to development projects (van Welie and Romijn, 2018).

3.2. Stability and non-stability of regimes

It is a fundamental assumption in the MLP/SNM frameworks that the relative stability of niches and regimes is critical to the understanding of mechanisms leading to transitions, and that regime instability is a vital precondition for sustainability transitions. It is therefore of special interest that regimes in developing countries are generally found to be less stable and often in a state of flux compared to their counterparts in developed countries (Wieczorek, 2018). This is mainly due to lower political and economic stability, weaker and inefficient government administrations and a lack of effective enforcement of government regulations, which give rise to a higher importance of informal or so-called ‘twilight institutions’ (Lund, 2006). This includes non-state actors that execute important governance tasks by providing key services that in developed countries are typically undertaken by government agencies.

Theoretically, weaker, less stable formal governance regimes in developing countries could favour niche development and regime change. However, contrary to expectations, a number of transition studies conducted in developing countries have shown that the instability of such regimes often comprises a major impediment to niche development. Verbong et al. (2010:279), for example, argued that in the case of the development of a biomass gasification niche in India “unstable (and highly dynamic) regimes can also create barriers for niche development”. Similarly, Herslund et al. (2017:8), stressed that the “instability of the urban planning regime in Dar es Salaam [...] means that the regime suffers from a type of paralysis when it comes to dealing with urban development. It is too weak and fragmented to [...] support and coordinate [...] niche activities emerging from the local level.” Further, van Welie and Romijn (2018) pointed out that the city of Kisumu’s main regime actors, i.e. the municipality and the public sanitation utility, showed considerable capability weaknesses. This impeded them from participating effectively in the planning and operationalisation of non-sewerage based niche solutions for Kisumu’s slum areas.

An immediate question emerges in relation to the weaknesses of formal regimes: what implications do changes in the relative degrees of stability of niches and formal regimes have for niche development and transitions? A number of papers in this special issue contribute to address this question. Based on a review of the literature, Wieczorek (2018) argues that a certain degree of regime stability may be necessary for niches to flourish in developing countries (see also Verbong et al., 2010). This observation is supported by Nygaard and Bolwig (2018), who find that the overall political stability (energy regime stability) along with the weakness of the transport fuel regime in Ghana were at first an important precondition for the attraction of foreign investors for biofuel production, but also that the fossil fuel regime stability, which materialised as hindering support to develop a national biofuel market, turned out to be one of the reasons for the failure of niche development. In contrast, Sixt et al. (2018) found that the highly stabilised water regime did indeed comprise an insurmountable obstacle to niche development, as it was oriented to a technology using groundwater to supply irrigation systems, which had a whole system of infrastructure, regulations, norms, values, as well as science support connected to it.

Another regime-related issue that has to be pointed out relates to typical multiplicity of regimes in developing countries. By focusing solely on formal governance regimes and its weaknesses, we could overlook major reasons for barriers to niche development and regime change. This is illustrated well in a study about the introduction of a new metering system in the Bangkok motorcycle taxi regime in which Sengers and Raven (2014: 464) found that ‘informal transport regimes are not only omnipresent and highly significant, but they might persist, change and proliferate in surprising ways’. In other words, the informal governance regime was found to be strong, pervasive, and highly resilient, especially in the face of systemic weaknesses of the formal governance regime. This is likely to be a general phenomenon across the developing world. Informal regimes tend to be deeply rooted in these societies. However, few sustainability transition studies so far have taken full account of the implications of regime multiplicity that characterises developing-country settings.

3.3. Undemocratic and non-egalitarian nature of regimes

The economic and political order of the western democracies in Europe, such as the Netherlands and Germany, provided the empirical context for the research that enabled theories within the sustainability transitions literature to emerge. In these western countries, the government and the functioning of the state are underwritten by a high level of trust and political legitimacy, enabling the public sector to operate an expensive social welfare system based on tax revenues. This context differs greatly from developing countries, which generally are prone to elite capture, non-transparent political decision making processes, relations based on clientelism and patronage, and no independent judiciary. Accordingly, there is often a low level of popular trust in the political and legal system. The fact that a lot of economic activity is not part of the formal sector also implies a low level of tax collection and a correspondingly low ability to provide basic services to eradicate poverty and inequality. The existence of institutions that foster inequality and lack of democratic decision-making processes implies that sustainability – in the limited sense of “green” – transitions could be achieved without yielding any social and democratic benefits. Swilling et al. (2016), for example, show that the increasing use of renewable energy technologies in South Africa is not proceeding in a just and inclusive manner and should rather be seen as a continuation of rent seeking motives in politics mainly to the benefit of the networks of the ruling elites. Such a transition is therefore deeply entrenched in the existing socio-political order and the prevailing power relations of the main regime actors (Baker et al., 2014). Similarly, with reference to infrastructure planning in the South, Furlong (2014:145) pointed at “the importance of historical and contemporary practices of injustice in the perpetuation of sociotechnical inequality, including colonial and contemporary forms of discriminatory planning”. Further, Newell and Phillips (2016:47) showed that the benefits of the transition toward renewable energy in Kenya is highly unequally distributed and is proceeding “without disrupting existing power relations in the energy system. [which means that the] .prospects appear remote for a ‘just transition’ in Kenya, in which energy pathways are shaped by the needs and preferences of the poor majority.

A number of papers in this special issue contribute to illuminate in further detail how the prevailing undemocratic political systems and the high level of social and economic inequality influence the extent and manner in which transitions to sustainability take place in developing countries. Sixt et al. (2018) show that informal interaction mechanisms, in particular the so-called *Wasta*, influenced decision making in relation to water harvesting in Jordan. In this case, personal connections to upper levels of government were used to keep systems of subsidies in place, which contributed to sustaining the existing regime practices. Such informal mechanisms of power were shown to have hindered trust in government and negatively impacted investments in niche practices as it reduced legitimacy for new technologies. Similarly, Nygaard and Bolwig (2018) show that direct connections to powerful government representatives in Ghana were central for some actors in order to mobilise access to land and sources of financing for the development of *Jatropha*-based biofuel plants (see Nygaard and Hansen, 2016, for a similar observation in Senegal). This shows the importance of clientilistic relationships as a means to access resources, which inevitably contributes to furthering social exclusion and marginalisation of actors without influential connections of power. Further, van Welie and Romijn (2018) show that contrary to the intention, the adoption of a participatory process in a low-income setting led to the exclusion of some local stakeholders from the decision making process, which eventually derailed the niche development effort. Ramos-Mejía et al. (2018) point to the role of poverty, and, with reference to Swilling and Annecke (2012), they call for ‘just transitions’ and bringing the poverty-alleviation agenda into sustainability transitions theory, discourse and practice. Hence, sustainability transitions in developing countries should ultimately be considered in the light of a large group of social actors in need of basic resources to sustain their survival, placing the requirements of equality and inclusion at the centre of attention. It is perhaps not surprising therefore that social interaction in developing countries is often characterised by distrust, contestation and struggle over the limited resources available (Romijn and Caniëls, 2011). This was also pointed out by Hansen and Nygaard (2014) who showed that a persistent lack of social actor network and cooperation constituted a key limiting factor for the development of a biomass waste-to-energy niche in Malaysia. In this case, the prevailing distrust and lack of cooperation were prevented by efforts undertaken by local subsidiaries of foreign companies involved in niche experiments as a means to prevent valuable knowledge from diffusing to local competitors. These observations are in stark contrast to research undertaken in a European context, which often emphasises the harmonic, consensual and inclusive processes underlying niche development. For example, this was the case in the development of the wind power niche and the biogas niche in Denmark, which was greatly supported by a longstanding democratic tradition of the formation of cooperatives in the agricultural sector and the appertaining willingness to cooperate and share knowledge across niche actors (Kamp et al., 2004; Raven and Gregersen, 2005).

3.4. Nurturing the development of niches versus the execution of individual projects

Driven by recent market liberalization in most developing countries and donors’ inspiration from the innovation system literature (Lundvall et al., 2002), donor cooperation has to a large extent moved from a project approach to a programme approach (Martinot et al., 2002; Nygaard and Hansen, 2015). Yet, individual projects for demonstration of specific technologies are still widespread and often part and parcel of NGO initiatives aimed at achieving a number of wider development goals. Also, in donor programmes aiming at diffusion of new technologies, subsidy levels have often reached 90%, with the justification that the intervention should also contribute to a number of other development goals (see e.g. Nygaard, 2010). These practices of individual demonstration projects or heavily subsidized programmes result in a pattern of diffusion of technologies that is different from diffusion patterns of niche technologies in the European context, in which niche experiments have been studied by a number of sustainability transition scholars over time to reveal emerging connections between individual experiments into coherent niches (Schot and Geels, 2008).

In the context of developing countries, Verbong et al. (2010) analysed a large number of niche experiments in small scale biomass gasification in India supported by a mix of donor and government initiatives. Wieczorek et al. (2015) analysed a large number of small-scale solar PV experiments, many of which had a strong ‘socio-economic’ problem framing, and which were only partly financed by donors. Similarly, Kamp and Vanheule (2015) showed that in the case of small-scale wind turbines in Kenya, a number of partly donor initiated niche-level experiments emerged successively over time albeit in a highly disconnected manner, which means that the niche has remained fragmented, essentially comprising a range of isolated, short term and one-time experiments. Based on these studies it appears that niche formation in developing countries is often confined mainly to the level of single experiments rather than extending to the nurturing of a niche itself as an overarching platform for experimentation, which may allow for knowledge exchange, actor network formation and alignment of expectations to take place within the niche. The prevailing focus on individual projects both in the academic literature and in actual implementation in developing countries may be the result of donors’ small budgets and short term horizons in their interventions, and the heavy reliance on the transfer and import of already developed technologies from abroad as opposed to the development of the technologies domestically (Hansen, 2011). However, in the context of developing countries, the exact

nature of the interplay between individual projects and the broader framework conditions at a systemic level remains largely unaddressed. Some of the papers in this special issue contribute to shedding some light on the issue.

With a focus on a single NGO project [van Welie and Romijn \(2018\)](#) illustrate the limited ability of individual projects – however ‘scalable’ and ‘replicable’ they may be according to the donors involved – to induce more structural changes at the level of entire sanitation systems (i.e. the existing slum sanitation regime). Such structural changes could however be imaginable in the case of a prolonged programme-based approach with initiatives at various scales, including a variety of interconnected and coordinated experiments, which could aim at building momentum at the niche level rather than the project level ([Sengers et al., 2016](#)). An example of this is provided by [Nygaard and Bolwig, \(2018\)](#), who illustrate how early experiments funded by donor organisations, along with an international hype of *Jatropha*, led to important private investments in plantations and refineries, which was almost entirely delinked from donor and NGO activities at niche and regime level, and therefore raised high expectations of the potential for a future transition. This calls for greater attention on how individual experiments may eventually form part of a cumulative process of niche development, and how, as shown by [Nygaard and Bolwig \(2018\)](#), and also highlighted by [Sixt et al. \(2018\)](#), experimentation activities are central aspects of the formation of innovation systems. Forging interlinkages with other functions in the systems are equally important, such as building and nurturing networks, ensuring alignment of expectations, creating legitimacy in the emerging niche and promoting market formation.

4. Toward an agenda for further research

Based on the above and the review by [Wieczorek \(2018\)](#) included in this special issue, it is evident that the literature on sustainability transitions in developing countries is a burgeoning field of research with an increasing number of papers, spanning across a variety of empirical settings, analytical frameworks used and key areas of interest. In this introductory paper, we have attempted to consolidate this emerging field of research and to provide new insights in order to advance upon the existing knowledge. Nevertheless, further research is clearly needed and we propose four avenues of further research to be pursued.

Firstly, there is a need to engage in discussion at a more fundamental level about the basic ontological assumptions of the theoretical frameworks in the transitions literature with regard to application in a developing country context. In particular, given the highly different causal mechanisms of change at play, additional research could help to clarify and generate greater awareness of how western-based perspectives influence the manner in which we study and understand how transitions toward sustainability unfold in developing countries. Such an endeavour could benefit from establishing a closer link to more bottom-up oriented approaches developed with a basis within developing countries, such as the emerging literatures on frugal innovation and inclusive innovation ([Onsongo and Schot, 2017](#)) as well as extensive older literature about successes and failures in participatory rural development projects and programmes in these countries (e.g., [Korten, 1980](#); [Uphoff et al., 1998](#)). As presented above, the existing empirical evidence indicates that the trajectories of niche development and transitions indeed differ from the patterns observed in a European context. This raises questions about the appropriateness of the conceptual frameworks (i.e., MLP, SNM, TIS, TM) adopted and points to the importance of ensuring a critical dialogue between the empirical data and the theories.

Secondly, subsequent research could analyse in greater detail the different nature and composition of regimes in developing countries. In particular, how informal institutions play a more significant role in developing countries in the absence of formalised and enforced regulation, and how these informal regimes function. Further, additional research could address the varying degrees of stability of regimes by analysing in detail how regimes are stabilised and destabilised over time. This involves a more nuanced understanding of institutions and institutional change. Attempts in this regard have recently been published at a conceptual level by [Fuenfschilling and Truffer \(2014\)](#) and applied empirically on the rural electrification regime in Kenya by [Pedersen \(2017\)](#). More research along these lines would provide interesting insights.

Thirdly, given the highly transnational nature of experiments, niches and regimes in developing countries, additional research could benefit from analysing in greater detail the role of various transnational actors, such as donors, multinational companies, consultancies and foreign investors, in local processes. As suggested by [Sengers and Raven \(2015\)](#), this would help to unravel how the global becomes entangled with place-specific networks, institutions and infrastructures locally. A key question involves addressing the conditions under which transnational linkages either promote or impede local niche-level processes, which places an emphasis on the context-specific conditions and the exact nature of global relations for transition processes in particular localities. Making a link with the global value chain (GVC) literature (e.g. [Gereffi et al., 2005](#)) would be beneficial for looking into this issue. And, as suggested by [Hansen and Coenen \(2015\)](#), addressing such global spatial aspects could also benefit from the inclusion of insights from the economic geography literature.

Fourthly, much research has focused on innovation in developing countries as being confined mainly to analysing the movement of technical artefacts across space ([Hansen, 2011](#)). This has to some extent also been the case in research undertaken in developing countries adopting theoretical perspectives from the transition literature (see e.g. [Schmidt and Dabur, 2014](#)). There is however a need to focus more on the knowledge dimensions of technologies and how the transfer of technology relates to learning and capability development for successful local societal embedding. This would allow niche development and sustainability transitions to be considered as fundamentally linked to processes of structural change, local (industrial) development and development processes more broadly.

References

- Arocena, R., Sutz, J., 2010. Weak knowledge demand in the South: learning divides and innovation policies. *Sci. Public Policy* 37, 571–582.
- Baker, L., Newell, P., Phillips, J., 2014. The political economy of energy transitions: the case of South Africa. *New Political Econ.* 19 (6), 791–818.
- M. Bell, 2007. Technological Learning and the Development of Production and Innovative Capacities in the Industry and Infrastructure Sectors of the Least Developed Countries: What Roles for ODA? Background Paper, The Least Developed Countries Report United Nations Conference on Trade and Development (UNCTAD).
- Berkhout, F., Wieczorek, A., Raven, R., 2011. Avoiding environmental convergence: a possible role for sustainability experiments in latecomer countries? *Int. J. Inst. and Econ.* 3 (2), 367–385.
- Coenen, L., Truffer, B., 2012. Places and spaces of sustainability transitions: geographical contributions to an emerging research and policy field. *Eur. Plan. Stud.* 20 (3), 367–374.
- Escobar, A., 1995. *Encountering Development. The Making and Unmaking of the Third World*. Princeton University Press, Princeton.
- Fontes, M., Sousa, C., Ferreira, J., 2016. The spatial dynamics of niche trajectory: the case of wave energy. *Environ. Innov. Soc. Trans.* 19, 66–84.
- Foster, C., Heeks, R., 2013. Conceptualising inclusive innovation: modifying systems of innovation frameworks to understand diffusion of new technology to low-income consumers. *Eur. J. Dev. Res.* 25, 333–355.
- Fressoli, M., Arond, E., Abrol, D., Smith, A., Ely, A., Dias, R., 2014. When grassroots innovation movements encounter mainstream institutions: implications for models of inclusive innovation. *Innov. Dev.* 4, 277–292.
- Fuenfschilling, L., Truffer, B., 2014. The structuration of socio-technical regimes —Conceptual foundations from institutional theory. *Res. Policy* 43 (4), 772–791.
- Furlong, K., 2014. STS beyond the ‘modern infrastructure ideal: extending theory by engaging with infrastructure challenges in the South. *Technol. Soc.* 38, 139–147.

- Gereffi, G., Humphrey, J., Sturgeon, T., 2005. The governance of global value chains. *Rev. Int. Political Econ.* 12 (1), 78–104.
- Hansen, T., Coenen, L., 2015. The geography of sustainability transitions: review, synthesis and reflections on an emergent research field. *Environ. Innov. Soc. Trans.* 17, 92–109.
- Hansen, U., Nygaard, I., 2013. Transnational linkages and sustainable transitions in emerging countries: exploring the role of donor interventions in niche development. *Environ. Innov. Soc. Trans.* 8, 1–19.
- Hansen, U., Nygaard, I., 2014. Sustainable energy transitions in emerging economies: the formation of a palm oil biomass waste-to-energy niche in Malaysia 1990–2011. *Energy Policy* 66, 666–676.
- Hansen, U., 2011. An empirical case study of the transfer of GHG mitigation technologies from Annex 1 countries to Malaysia under the Kyoto Protocol's clean development mechanism (CDM). *Int. J. Technol. Trans. Commercialisation* 10 (1), 1–20.
- Hermans, F., Roep, D., Klerkx, L., 2016. Scale dynamics of grassroots innovations through parallel pathways of transformative change. *Ecol. Econ.* 130, 285–295.
- Herslund, L., Backhaus, A., Fryda, O., Jørgensen, G., Jensen, M., Mtwangi, T., Limbumbab, T., Liu, L., Mguni, P., Mkupasi, M., Workalemahu, L., Yeshitela, K., 2017. Conditions and opportunities for green infrastructure – aiming for green, water-resilient cities in Addis Ababa and Dar es Salaam. *Landscape Urban Plan* (in press).
- Kamp, L., Vanheule, L., 2015. Review of the small wind turbine sector in Kenya: status and bottle necks for growth. *Renew. Sustain. Energy Rev.* 49, 470–480.
- Kamp, L., Smits, R., Andriess, C., 2004. Notions on learning applied to wind turbine development in the Netherlands and Denmark. *Energy Policy* 32 (14), 1625–1637.
- Knorringa, P., Peša, I., Leliveld, A., Van Beers, C., 2016. Frugal innovation and development: aides or adversaries? *Eur. J. Dev. Res.* 28, 143–153.
- Korten, D., 1980. Community organization and rural development: a learning process approach. *Public Adm. Rev.* 40 (5), 480–511.
- Lachman, D., 2012. Developing countries more in need of energy system transition research. *Acad. J. Suriname* 3, 284–291.
- Loorbach, D., 2010. Transition management for sustainable development: a prescriptive, complexity-based governance framework. *Governance* 23 (1), 161–183.
- Lund, C., 2006. Twilight institutions: public authority and local politics in africa. *Dev. Change* 37 (4), 685–705.
- Lundvall, B., Johnson, B., Andersen, E., Dalum, B., 2002. National systems of production, innovation and competence building. *Res. Policy* 31 (2), 213–231.
- Lundvall, B., Joseph, K., Chaminade, C., Vang, J., 2009. *Handbook Of Innovation Systems And Developing Countries. Building Domestic Capabilities in a Global Setting*. Edward Elgar, London.
- Manning, S., Reinecke, J., 2016. A modular governance architecture in-the-making: how transnational standard-setters govern sustainability transitions. *Res. Policy* 45, 618–633.
- Markard, J., Raven, R., Truffer, B., 2012. Sustainability transitions: an emerging field of research and its prospects. *Res. Policy* 41 (6), 955–967.
- Marquardt, J., Steinbacher, K., Schreurs, M., 2016. Driving force or forced transition? The role of development cooperation in promoting energy transitions in the Philippines and Morocco. *J. Clean. Prod.* 128, 22–33.
- Martinot, E., Chaurey, A., Lew, D., Moreira, J., Wamukonya, N., 2002. Renewable energy markets in developing countries. *Annu. Rev. Energy Environ.* 27, 309–348.
- Newell, P., Phillips, J., 2016. Neoliberal energy transitions in the South: kenyan experiences. *Geoforum* 74, 39–48.
- Nygaard, I., Bolwig, S., 2018. The rise and fall of foreign private investment in the jatropha biofuel value chain in Ghana. *Environ. Sci. Policy* (this issue).
- Nygaard, I., Hansen, U., 2015. The conceptual and practical challenges to technology categorisation in the preparation of technology needs assessments. *Clim. Change* 131 (3), 371–385.
- Nygaard, I., Hansen, U., 2016. Niche development and upgrading in the PV value chain: the case of local assembly of PV panels in Senegal. *EU-SPRI Conference Lund. Book of abstracts*, pp. 247–248.
- Nygaard, I., 2010. Institutional options for rural energy access: exploring the concept of the multifunctional platform in west africa. *Energy Policy* 38 (2), 1192–1201.
- Onsongo, E., Schot, J., 2017. Inclusive innovation and rapid sociotechnical transitions: the case of mobile money in Kenya. *SPRU Working Paper Series (SWPS 2017-07)*. Sussex University.
- Pansera, M., Sarkar, S., 2016. Crafting sustainable development solutions: frugal innovations of grassroots entrepreneurs. *Sustainability* 8, 1–51.
- Pedersen, M., 2017. Rural electrification through private models: the case of solar-powered mini-grid development in Kenya. *Exploring the Hybrid Nature of Private Business Models and the Interplay Between New Players and Existing Structures in the Kenyan Rural Electrification Regime*. Technical University of Denmark (Ph.D. dissertation).
- Ramos-Mejía, M., Franco-García, M., Jauregui-Becker, J., 2018. Sustainability transitions in the developing world: challenges of sociotechnical transformations unfolding in contexts of poverty. *Environ. Sci. Policy* (this issue).
- Raven, R., Gregersen, K., 2005. Biogas plants in Denmark: successes and setbacks. *Renew. Sustain. Energy Rev.* 11 (1), 116–132.
- Raven, R., Schot, J., Berkhout, F., 2012. Space and scale in socio-technical transitions. *Environ. Innov. Soc. Trans.* 4, 63–78.
- Rock, M., Murphy, J., Rasiah, R., Seters, P., Managi, S., 2009. A hard slog not a leap frog: globalization and sustainability transitions in developing Asia. *Technol. Forecast. Soc. Change* 76 (2), 241–254.
- Romijn, H., Caniëls, M., 2011. The *Jatropha* biofuels sector in Tanzania 2005–2009: evolution towards sustainability? *Res. Policy* 40 (4), 618–636.
- Schmidt, T., Dabur, S., 2014. Explaining the diffusion of biogas in India: a new functional approach considering national borders and technology transfer. *Environ. Econ. Policy Stud.* 16 (2), 171–199.
- Schot, J., Geels, F., 2008. Strategic niche management and sustainable innovation journeys: theory, findings, research agenda, and policy. *Technol. Anal. Strateg. Manage.* 20 (5), 537–554.
- Sengers, F., Raven, R., 2015. Toward a spatial perspective on niche development: the case of Bus Rapid Transit. *Environ. Innov. Soc. Trans.* 17, 166–182.
- Sengers, F., Wieczorek, A., Raven, R., 2016. Experimenting for sustainability transitions: a systematic literature review. *Technol. Forecast. Soc. Change*. <http://dx.doi.org/10.1016/j.techfore.2016.08.031>. (in press).
- Sixt, G., Klerkx, L., Griffin, T., 2018. Transitions in water harvesting practices in Jordan's rainfed agricultural systems: systemic problems and blocking mechanisms in an emerging technological innovation system. *Environ. Sci. Policy* (this issue).
- Swaans, K., Boogaard, B., Bendapudi, R., Taye, H., Hendrickx, S., Klerkx, L., 2014. Operationalizing inclusive innovation: lessons from innovation platforms in livestock value chains in India and Mozambique. *Innov. Dev.* 4, 239–257.
- Swilling, M., Anneck, E., 2012. *Just Transitions: Explorations of Sustainability in an Unfair World*. United Nations University Press, South Africa.
- Swilling, M., Musango, J., Wakeford, J., 2016. Developmental states and sustainability transitions: prospects of a just transition in South Africa. *J. Environ. Policy Plan.* 18 (5), 650–672.
- Tigabu, A., Berkhout, F., van Beukering, P., 2017. Development aid and the diffusion of technology: improved cookstoves in Kenya and Rwanda. *Energy Policy* 102, 593–601.
- Uphoff, N., Esmann, M., Krishna, A., 1998. *Reasons for success. Learning from Instructive Experiences in Rural Development*. Kumarian Press, West Hartford.
- van Welie, M., Romijn, H., 2018. NGOs fostering transitions towards sustainable urban sanitation in low-income countries: insights from transition management and development studies. *Environ. Sci. Policy* (this issue).
- Verbond, G., Christians, W., Raven, R., Balkema, A., 2010. Strategic Niche Management in an unstable regime: biomass gasification in India. *Environ. Sci. Policy* 13 (4), 272–281.
- Viotti, E., 2002. National Learning Systems A new approach on technological change in late industrializing economies and evidences from the cases of Brazil and South Korea. *Technol. Forecast. Soc. Change* 69, 653–680.
- Wieczorek, A., Raven, R., Berkhout, F., 2015. Transnational linkages in sustainability experiments: a typology and the case of solar photovoltaic energy in India. *Environ. Innov. Soc. Trans.* 17, 149–165.
- Wieczorek, A., 2018. Sustainability transitions in developing countries: major insights and their implications for research and policy. *Environ. Sci. Policy* (this issue).
- Wood, G., Gough, I., 2006. A comparative welfare regime approach to global and social policy. *World Dev.* 34 (10), 1696–1712.

Ulrich Elmer Hansen, Ivan Nygaard
Technical University of Denmark, Denmark

Henny Romijn, Anna Wieczorek
Eindhoven University of Technology, The Netherlands

Linda M. Kamp
Faculty of Technology, Policy and Management, Delft University of Technology, The Netherlands

Laurens Klerkx*
Knowledge, Technology and Innovation Group, Wageningen University, The Netherlands
E-mail address: laurens.klerkx@wur.nl

* Corresponding author.