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Designing Real-World Laboratories for the Reduction of Residential Energy Use

Articulating Theories of Change

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Real-world laboratories (RwLs) hold potential for transdisciplinary research that considers the context of changing households' energy practices. Taking into account stakeholders' understandings of what would work where, how and why helps to recognize the contextual conditions for the transferability of RwL results.

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Abstract

Reducing residential energy use and carbon dioxide emissions is a policy concern across Europe. One of the approaches to address this problem, real-world laboratories (RwLs), has recently gained prominence as a means to generate both sustainability change and social knowledge. Yet RwLs are context-bound, and transferability is an issue for scaling up change. Drawing on Realistic Evaluation (RE) and Theories of Change (ToC), this paper analyses researchers' and practitioners' views on the role of contexts and change mechanisms in the outcomes of interventions targeting residential energy use. The results show that extracting the underlying logic of RwL designs could help to identify where and when these designs are likely to be transferrable. This contribution has implications for the design of future RwLs, given that RwLs have until now rarely articulated their ToC.

Keywords

context dependence, real-world laboratory, residential energy use, Theories of Change, transferability

Reducing CO_2 emissions from energy use, particularly in residential buildings, is a sustainability challenge for developed countries. Most current approaches to this problem are embedded in scientific and technological innovations and involve the adoption of new technologies, for example, improving the efficiency of household appliances or retrofitting homes with more efficient heating systems (Tweed 2013). In real-life conditions, such improvements often underperform because socio-cultural and other contextual conditions of consumption are often disregarded (Shove 2014, Gram-Hanssen and Georg 2018). While technological advances certainly have a role to play in reducing household energy use, they should be just one aspect of an integrated and transdisciplinary approach that considers the interaction between technologies, buildings and their occupants' practices (Maréchal and Holzemer 2015, Tweed et al. 2015).

Exemplifying one type of transdisciplinary approach, real-world laboratories (RwLs) have emerged as a new form of societal knowledge production *for* (rather than *on*) transformative change (Parodi et al. 2016 b). RwLs create practice-based knowledge through attempts to transform practices and learn from this process. Following Beecroft and Parodi (2016), we define RwLs as research-oriented, long-term, transformative and transdisciplinary change initiatives focusing on sustainability in a specific context. A particularity of RwLs is the possibility to integrate nonscientific knowledge into the research process (Jahn and Keil 2016). Compared to related concepts such as product-testing living labs, RwLs focus

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on sustainability and aim at producing societally relevant knowledge across several socio-technical domains or sectors (Parodi et al. 2016 b).

RwLs are typically conducted at a particular site of collaborative experimentation. Since their aim is to contribute to broader sustainability transformation beyond this context, it is important to understand the context dependence, and conversely, the transferability of findings and lessons learned. Previous research on household energy use corroborates the importance of context for the success of interventions (Davies et al. 2014) and highlights the myriad internal and external factors and conditions influencing residents' actions and choices (Gram-Hanssen 2010, Shove and Walker 2010, Fast and Mabee 2015). In other words, the transferability of interventions is complicated by variations in material conditions, institutional structures, and social norms across Europe (Laakso and Heiskanen 2017). Such variation occurs, for example, in indoor comfort standards (Chappells and Shove 2005, Gram-Hanssen 2011), residents' propensity to regulate temperatures (Urban and Ščasný 2012), patterns of hot water use (Browne et al. 2013), and renewable energy investments (Heiskanen and Matschoss 2016). Hence, interventions that target changes in consumption patterns, such as reducing household energy use, need to take account of individual (skills, habits), social (cultural conventions, social norms), and material (infrastructure, technologies) factors and their dynamics (Shove and Walker 2010, Strengers and Maller 2015). Following RwL principles, the inclusion of diverse stakeholders in the research process – such as academics, policy makers, practitioners and end-users – can help bridge the gap between science, policy, and practice, and enhance the development of contextually appropriate solutions for problems such as reducing CO_2 emissions from households.

The aim of this paper is to elaborate a process for the identification of contextually sensitive RwL designs for engaging households in reducing residential energy use. Specifically, this paper studies how the perspectives of Realistic Evaluation (RE) and Theories of Change (ToC) allow us to articulate plausible intervention-context-outcome combinations to identify RwL engagement designs that could be transferable to other contexts. Our research question is explorative: does a ToC approach allow for a structured combination of the experiential knowledge of practitioners with scientific evidence to design RwLs that are better suited for multi-site implementation? To assess what is likely to work across European contexts, we articulate researchers' and practitioners' ToC concerning the role of contexts and change mechanisms in sustainable change initiatives[1]. These were selected from a database of initiatives addressing household home energy use in the *ENERGISE* project[2], with a focus on changes in social (rather than physical) structures (see Schäpke et al. 2017).

Conceptual Framework

RwLs aim to "generate solution-oriented knowledge through experimentation in real-world contexts and to initiate sustainability transformations" (Bernert et al. 2016, p. 253) by creating the site and scientifically studying it (Wagner and Ertner 2016). RwLs are thus situated sites of research and learning, based on transdisciplinarity, sustainability, and transformation. The RwL approach builds on stakeholder and public engagement in sustainability experimentation (Parodi et al. 2016 a). Engaging end users in the research process facilitates the inclusion of experiential, nonacademic expertise and the exchange of tacit knowledge, which is embedded in relationships and transferred through shared experiences (Weichselgartner and Kasperson 2010). Hence, it is fair to assume that any results produced in RwLs may derive as much from *favourable/unfavourable contexts* as from the *particular interventions or change mechanisms* applied (Pawson and Tilley 1997). This makes learning across contexts laborious and fragmented (Schäpke et al. 2017).

Our conceptual approach to identify ways to engage households in RwLs focusing on household energy use draws on Pawson and Tilley's (1997) approach to intervention theory, *Realistic Evaluation (RE)*. Like RwLs, RE aims to extract generalizable lessons from analyses of real-life interventions. RE views intervention outcomes as the product of both (generative and generalizable) *mechanisms* and the *contexts* where they are deployed (Mason and Barnes 2007, Pawson and Tilley 1997). By context, we mean not only geographical locations (such as countries) but also social rules, norms and relationships.

RE usually draws on external analysis. It can also be combined with a deliberative, inclusive approach to analysis by extracting and analysing practitioners' ToC (Blamey and Mackenzie 2007). ToC focus on articulating the intervention theory of relevant stakeholders, that is, people involved in planning, funding or implementation. Interviews are conducted to elicit stakeholders' understandings of what they hope to achieve, and how and why the intervention is expected to work, both in terms of intervention mechanisms and contextual features. The focus is on their views on actions planned, on long, medium, and short-term outcomes, and on how and why actions are likely to lead to those outcomes in the particular context (Blamey and McKenzie 2007).

Combining the RE, ToC and RwL approaches allows us to reveal different, perhaps conflicting influences on change strategies and activities by constructing narrative theories of implementation and possible consequences (cf. Mason and Barnes 2007). This approach thus iteratively combines the experiential knowledge of those involved in implementation with formal logical analysis and scientific evidence, and thus offers a knowledge-building approach to analysing initiatives for change (Mason and Barnes 2007). >

1 We use the term "initiative" to refer to projects that aim to change households' energy use patterns. These are usually based on some kind of directed change attempt, which we term interventions. Where such initiatives and interventions are guided by an attempt towards knowledge creation, we consider them relevant categories of RwLs.

2 The *European Network for Research, Good Practice and Innovation for Sustainable Energy (ENERGISE)* is funded by the European Commission in the framework of the *H2020* programme (GA 727642).

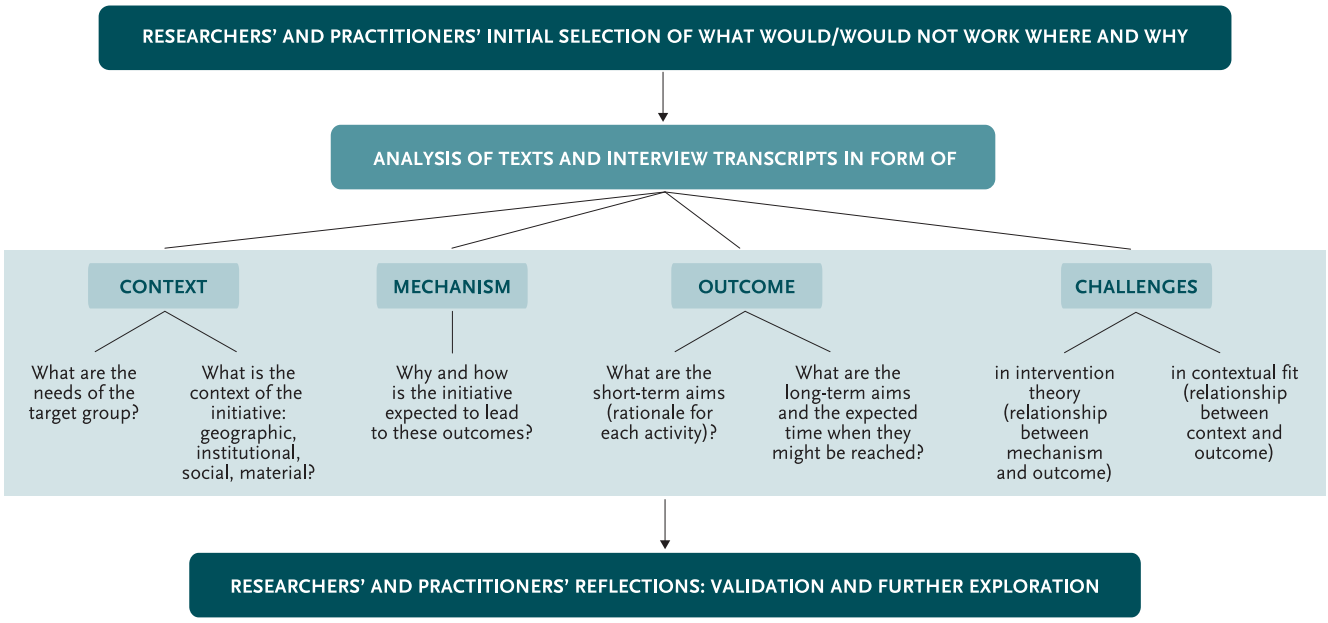

FIGURE 1: Methodological approach to analysing context-mechanism-outcome combinations based on stakeholders' Theories of Change.

Materials and Methods

As stated above, one example where cultural contexts are likely to vary between countries and groups is residential energy use. Here, RwLs focus on learning about particular combinations of technical and social measures, for example, the co-creation of feedback schemes for energy use, the experimentation with new energy practices, or the testing and co-development of technical devices (Schäpke et al. 2017). However, opportunities for households to change their energy practices vary greatly – across and within countries – for example, between urban and rural dwellers, wealthy or poor households, and according to dwelling type and tenure (Laakso and Heiskanen 2017). If RwLs attempt to produce knowledge to reduce energy use across Europe, they will need to grapple with such contextual differences.

To articulate relevant ToC on how households can be engaged in changing energy practices, we have modified the approach by Mason and Barnes (2007) (figure 1). This approach, originally for the evaluation of ongoing projects, allows us to uncover ways in which experienced researchers and local expert practitioners view context-mechanisms combinations, and specifically, the influence of national, local and target group-specific factors on the functioning of intervention mechanisms in and across contexts.

While many RwLs aim at co-designing, testing, and adapting new technical solutions, we focus on the social aspects of interventions, addressing the ways in which physical and social elements are combined to engage households in changing energy practices (see Schäpke et al. 2017), which we in the following term "engagement designs". We drew on a database of 512 sustainable energy initiatives from eight countries (Denmark, Finland, Germany, Hungary, Ireland, the Netherlands, Switzerland, and the UK) collected in the *ENERGISE* project (Jensen et al. 2017). Members of the *ENERGISE* consortium, comprising experienced researchers from several European countries, were asked to select three cases from the database that they expected would work for their specific target group, as well as three cases they expected would not work, and explain why. This rendered a selection of 24 engagement designs that were considered likely or unlikely to work in several contexts, as well as their justifications, that is, researchers' initial (not fully articulated) ToC concerning context-mechanism-outcome combinations.

Next, the consortium members collected feedback on their selection of engagement designs and justifications by interviewing expert practitioners in their country (total $n=40$). The feedback was analysed through an inductive, albeit literature-informed process where five categories of engagement designs (see below) emerged from sorting the responses in terms of contexts, mechanisms, outcomes, and opportunities and challenges identified regarding different context-mechanism-outcome combinations (figure 1). Moreover, six aggregate categories of contextual conditions emerged from this process (related to target groups, pre-existing motivations, time commitment, external support, social networks and the institutional/built environment).

The results, in the form of the combined categories of initiatives that might work in several countries, as well as their ideal or less beneficial contextual conditions, were then subjected to discussion, validation and further elaboration in a workshop involving members of the *ENERGISE* consortium ($n=19$) and expert panel members, including practitioners and policy-makers ($n=6$). This process served as a way to critically assess initial ToC, as well as to expand and elaborate on them. Our analysis of why particular interventions are likely to work is thus based on the ex-

TABLE 1: Five categories of real-world laboratory (RwL) engagement designs to change household energy practices. The examples listed had not always been intended or classified as real-world laboratories by the project promoters.

CATEGORY	DESCRIPTION	EXAMPLE
needs-based tailored support	Packages of measures (tools, technical support, advice) are adapted to address specific barriers to more sustainable practices in the target group.	*Project ZERO,* Sønderborg, Denmark: households received energy consultations at home, improvement opportunities and costs were identified and action plans defined. Households were connected with qualified craftsmen and financial institutions.
pioneering practices	Volunteer households are selected to act as examples in trying out more sustainable practices, supported by measures to create awareness, competence and offer new materials.	*CONSENSUS Washlab,* Ireland: five households tested measures to reduce hot water consumption in showers with metering and timing devices, awareness-raising, advice and water-conserving hygiene products.
challenge, competition, game	Households are engaged through a game or competition where people experiment with new practices while working towards an objective (e. g., 10% energy savings), with the best performers receiving some kind of recognition.	*Student Energy Race,* Duwo, the Netherlands: student houses compete for who can save the most energy. The student housing that saves the most energy on a percentage basis wins a prize.
learning by doing	Households are engaged through devices or "kits" for metering/controlling energy use or DIY materials and instructions for home energy improvements.	*DIY Insulation Workshops, Energiaklub,* Hungary: households were able to rent tools for insulating doors and windows to reduce energy loss due to poor insulation, and thus reduce energy costs. Networks of NGOs provided instructions.
peer-to-peer learning	Peer advisors are engaged to demonstrate and spread good practices and use of new technology/devices in sustainable energy use.	*Open Home Energy Walks,* Finland: residents with progressive energy solutions were visited, with opportunities to view installations, ask questions and learn how users have adapted their practices.

pert judgement of practitioners and scientists (drawing on perspectives from several disciplines) combined with formal logical analysis both within feedback sessions and workshop deliberations and in the subsequent analysis of the transcripts of these sessions (cf. Mason and Barnes 2007).

Five Categories of Ways to Engage Households and Relevant Contextual Conditions

As a basis for discussing relevant ToC, we identified five categories of approaches for engaging households in changing energy practices (used in RwLs and other kinds of initiatives): *needs-based tailored support; pioneering practices; challenge, competition, game; learning by doing; peer-to-peer learning.* Researchers and practitioners believed that the five categories might work in several countries – and indeed, are used in some form in several countries (table 1).

The categories are somewhat overlapping and nonexhaustive. Moreover, interventions sometimes combine engagement designs from several categories, for example, combining *learning by doing* with *peer-to-peer learning* to increase the impact. Nonetheless, the categories refer to commonly used interventions aiming to influence energy use in real-world settings, and in RwLs, to produce knowledge by learning from such interventions. The underlying mechanisms are also somewhat different. While *needs-based tailored support* aims to adapt energy saving opportunities to existing practices, supporting their gradual change (see, e. g., Schubert et al. 2016), *pioneering practices* and *challenge, competition, game* aim to challenge existing practices by creating a temporary time and space where established practices are provisionally disrupted to facilitate individual and collective learning. The difference between these two categories, in turn, is that in *pioneering practices,* the crafting of new practices is placed centrally, often with the aim to develop new products and services in an RwL-type context, whereas *challenge, competition, game* leave the changes of practices to participants, and often only measure outcomes in terms of energy saved.

An important aspect that arose when considering the underlying ToC was the potential of different types of mechanisms to create large-scale change and find innovative solutions to the issue addressed, an important concern in RwLs. While n*eeds-based tailored support, pioneering practices* and *challenge, competition, game* could involve metering, feedback, or calculations of savings, *pioneering practices* was seen to entail an effort to create new services and solutions rather than simply quantitatively reduce energy use. It was thus considered to offer greater opportunity for change, as one practitioner with experience from both kinds of interventions commented: "I am wondering which is more interesting for people: is it monitoring and saving or the development of a completely new practice, a service which makes people's lives easier? Not a financial incentive but a concrete new way of organizing one's life. (...) Introducing a new practice and service (like the smart phone), which makes people's lives easier. (...) This is critical for whether 100,000 people decide to copy the pioneers!" (Practitioner, Finland)

The interviewee suggests that there are ways to promote sustainable lifestyles that do not require monitoring, financial incentives or environmental motivations. He argues that engaging households in testing *pioneering practices* could increase well-being and thus ideally lead to transformations where the new practices are normalised. Such cases, he says, would have inbuilt mechanisms for diffusion if they succeed in transforming social practices. >

TABLE 2: Context-mechanism-outcome combinations of real-world laboratory engagement designs identified in the participants' Theories of Change.

CATEGORY	CONTEXT	MECHANISM	EXPECTED OUTCOME
needs-based tailored support	■ particularly fitting for vulnerable groups (low-income households, elderly, people with disabilities, non-nationals), but can also fit middle-class or busy parents ■ opportunity to "piggy-back" on other initiatives (e.g., community, school, social) ■ external support, benefits from problem awareness	■ identification of needs, opportunities and obstacles for energy saving specific to the participant group ■ focus on tailoring support on the basis of identified needs to make energy saving easy and fitting into existing practices ■ engagement of wide, supportive network of stakeholders	■ 1. reduced energy demand among groups in specific circumstances and/or ■ 2. social benefits such as reduction of fuel poverty and better living conditions
pioneering practices	■ engages volunteers, usually with a green and/or technical interest ■ diffusion might benefit from the involvement of celebrities, yet exemplars might preferably be similar to potential adopters ■ diffusion depends on the presence of interested channels (media, product developers)	■ challenging and reshaping social norms and existing household practices by testing and showcasing new variants ■ breaking barriers and finding solutions to difficult lifestyle changes ■ showcasing that alternative, low-carbon lifestyles are doable	■ new practices initially developed/adopted by a small group of volunteers ■ information for product/service development ■ impacts depend on whether the new practices diffuse – via social networks, media, companies or public service providers
challenge, competition, game	■ targets volunteers ■ usually applied in a context where participants recognise peers and can compete on a level playing field ■ has been applied in diverse contexts: students, neighbourhoods, streets, etc. but requires volunteers	■ engages participants through fun, entertainment or rewards (feedback and gratification) ■ challenges practices by creating a temporary space where everyday conventions do not apply	■ permanently reduced energy use through experiences gained during challenge/competition/game period
learning by doing	■ requires context with openness for energy activism by lay people (not everything is automated or expert-controlled) ■ requires motivated participants with basic capacity to use tools or devices	■ Material engagement with meters or DIY home improvements empowers participants to become active and creates energy awareness.	■ enhanced skills and competences, and permanently reduced energy use (also via spill over to domains not originally targeted, e.g., political activity)
peer-to-peer learning	■ requires existing groups of peers underpinned by trust, familiarity and a sense of similarity ■ can be dominated by strong characters and unequal power dynamics	■ social modelling via relevant exemplars, opportunities for discussion and reproduction of practices ■ social normalisation, i.e., reshaping of what is considered normal practice ■ diffusion in social networks	■ permanently reduced energy use via social diffusion of new practices

The last two categories build on concepts in nonformal education. Yet uncovering the ToC, we found that for *learning by doing* the material and embodied engagement with new tools, and the performance of actions like metering or home repairs are expected to serve as an entry point for broader learning processes, including empowerment of participants and the development of new identities as energy-aware citizens. In *peer-to-peer learning,* other people (peers) are the point of engagement for participants: the example they set is expected to contribute to replication, social normalisation, and diffusion of more sustainable practices.

Each of the categories is to some extent generalizable, and is based on typical programme designs found in more than one country. Yet we did find context-mechanism combinations that are amenable to producing expected outcomes, and ones that were found – on the basis of the participants' experiences, and elaborated in their ToC – to be less amenable (table 2). Examples and details in table 2 are viewpoints raised in the practitioner feedback sessions and the workshop, that is, experience-based explanations for how and why context can support or undermine the working of the mechanism.

The mechanisms within each category were identified as relying on different contextual conditions in order for them to work. In *needs-based tailored support,* the context is the participants' *problem,* even though the nature of that problem can range from social exclusion and vulnerability to a busy life stage. Pre-existing environmental motivation is not essential for this form of engagement. Practitioners argued that problems can also be "unearthed", for example, with energy audits revealing the potential for saving energy, but they found that it is easier to gain engagement if people suffer concretely from their energy use (e.g., high fuel bills, draughts). Nonetheless, it was generally agreed that the starting point for such interventions is a fine-grained analysis of the problem and its context, and the production of tailored solutions. Since the RwL participants' living environment is typically unsupportive of resolving the problem, these initiatives aim to introduce multiple sources of support by providing expert, technical and financial services.

In *pioneering practices,* the households involved are a small group of volunteers. Practitioners agreed that participation requires interest in disrupting practices and challenging conventions (and

TABLE 3: Summary of how contextual conditions might inform real-world laboratory choice of household engagement format.

CONTEXTUAL CONDITIONS		BEST FITTING CONTEXTUAL CONDITIONS FOR THE RWL ENGAGEMENT APPROACH	
target group	heterogeneous	NB, LbD	P2P, PP, CCG — homogeneous
participants have pre-existing environmental motivation	nonessential	NB, CCG	LbD, P2P, PP — essential
time commitment required from participants	negligible		NB, P2P, LbD, CCG, PP — significant
dependence on institutional and physical characteristics of the built environment	low	NB, PP	CCG, P2P, LbD — high
support for participants from external actors (tech experts, service providers)	nonessential	P2P, CCG	LbD, PP, NB — required
existence and nature of relevant social networks among participants	nonessential	NB	CCG, PP, LbD, P2P — required
diffusion relies on	external support	NB, CCG	PP, LbD, P2P — existing social networks

NB: needs-based tailored support, LbD: learning by doing, P2P: peer-to-peer learning, PP: pioneering practices, CCG: challenge, competition, game

hence significant effort and time), as well as a relatively high degree of environmental motivation. As the pioneer group is small, this intervention type relies on the diffusion of lessons learned – via further development of relevant products and services, but also via some form of social diffusion, for example, by encouraging participants to share experiences in (social) media. Both forms of dissemination suffer from uncertainty, as some people might not be keen to share their everyday experiences, or their experiences might not interest the public. Consequently, some initiatives have sought to engage celebrities as pioneers, though it was noted that in order for the exemplars to be relevant, pioneers should be similar to those who are expected to learn from their practices. Hence, the existence of social networks surrounding the households engaged in pioneering practices is a critical condition for the mechanism to work.

Challenge, competition, game relies on a somewhat different context, even though the mechanism resembles that of pioneering practices. Challenges are rolled out to a large group of participants, like students or neighbourhoods. Practitioners recognised that the target group needs to be homogeneous in some aspects to create a level playing field and a relevant social context for competing in, for example, energy savings. Usually, no particular practices are prescribed, suggested, or even analysed. While *pioneering practices* often involves *serious* testing, *challenge, competition, game* deploys an element of fun, rapid feedback and gratification from progress toward targets. This also implies requirements concerning support for participants, including communications and awards that resonate well with participants. We noted initiatives where competitions had backfired: pre-existing environmental motivation is not required, but participants should recognise the social context and be willing to compete or participate in games.

Learning by doing aims to empower participants through practical engagement, but it also requires a context where there is room for empowerment. A pre-existing environmental motivation is beneficial, but this intervention is particularly likely to engage people who have the skills and propensity to engage with technical equipment or crafts. It also requires a physical/institutional context where there is openness for engagement in energy by lay people – for example, no fully automated systems or expert-dominated contexts. Examples of inappropriate contexts were identified: DIY renovations might be discouraged in modern buildings controlled by facilities management experts. Individual heat metering is difficult to apply in buildings with central heating and no individual billing (common in many new EU member states and the Nordic countries). Where the basic conditions for DIY engagement and related forms of energy citizenship are lacking, the mere introduction of meters or tools may not be sufficient.

Peer-to-peer learning is dependent on the social context. It was agreed this usually requires existing communities of peers underpinned by the requisite trust, familiarity and a basic sense of similarity. Yet within this social network, there also needs to be some difference, that is, someone to learn from. At least some participants need to have an existing motivation, usually environmental, to share their experiences in peer networks. However, it was noted that existing social networks can also be dominated by unequal power relations, and controlling the "message" that is diffused can be complicated. Emergent mechanisms of replication, social normalisation and diffusion are thus reliant on the compliance of participants, and on the predictability and integrity of information flows within social networks.

Since RwLs strive for, but struggle with, control over contextual conditions (Parodi et al. 2016 b), it is helpful to summarise how >

particular designs for engaging households depend on contextual conditions (table 3). These contextual conditions are grouped under conditions related to target groups, pre-existing motivations, time commitment, external support, social networks, and the institutional/built environment. The list of conditions is nonexhaustive, but suggestive for RwL design. As shown above, engagement designs can be identified where participants' environmental motivation is not essential for the mechanism to work. Conversely, several engagement designs rely on social networks among participants, while others require specific kinds of social networks for their diffusion and the creation of long-term outcomes.

Implications for the Design of Real-World Laboratories

This paper contributes to RwL research by articulating ToC in European initiatives on household energy use, and unravelling contextual and context-interdependent explanations for outcomes. Our results show that practitioners often find appropriate context-mechanism-outcome combinations intuitively, but there are also examples where measures had been applied in inappropriate contexts with disappointing results (e. g., Heintze et al. 2015, Laakso and Heiskanen 2017). Hence, we feel there is value in articulating the context-dependence of outcomes as summarised in table 3, which can contribute to RwL design in several ways. First, it helps highlight in which contextual conditions specific engagement designs have proven to be most successful, thereby also indicating that if these conditions are not met, the design of the RwL may require re-consideration or modification. Second, it can also assist by providing inspiration for how RwLs could be adapted to context. Third, the analysis provides ideas for possible combinations of RwL design elements depending on contextual conditions.

The ToC approach is usually applied with people working collectively on one change initiative, having personal experience of the related mechanisms and contexts (Mason and Barnes 2007). Our study drew on more distal experiences of people analysing several initiatives at once. Moreover, while academics and practitioners were involved in the conversation, prospective target groups or other stakeholders were not included. This might translate to a more generic type of change theory.

Nonetheless, our findings have implications for the design of RwLs which draw on a combination of lay, practitioner, and scientific knowledge, co-created and adapted to a specific context (Parodi et al. 2016a, Schäpke et al. 2017). From the perspective of transferability, it is important to understand the context dependence of outcomes (Krohn et al. 2017). Each of the basic designs identified is dependent on certain contextual conditions. Extracting the underlying logic and context dependence of such engagement designs can help identify where and when previous designs are likely to be transferrable. For example, the pioneering practices design has relied largely on "green" motivations, openness to change, and a desire to disrupt one's practices. If we use this design to develop solutions for more sustainable energy practices, these solutions might not "fit" other groups in society, for example, groups that already struggle with the disruptions brought about by economic austerity, who might benefit more from a needs-based tailored approach. In these cases, it may be useful to consider modifying the general design to better cater for the needs indicated by the context. While RwLs also aim to challenge and change their context, this can be more realistically achieved when the dependency of outcomes on mechanisms, but also on the context, is well understood.

More work is needed to understand how to fit mechanisms to contexts and contexts to mechanisms in order to create pathways for scaling up sustainability change. The ToC approach could also be combined with other approaches to address the societal impact of RwLs (Stelzer et al. 2015). We also recognise that complete RwL designs are more diverse and complex than the idealised engagement categories that we identified. However, our demonstration of a new perspective on change initiatives offers a framework for further work towards replicating designs and thus creating the conditions for large-scale transformation across Europe.

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