SONNET – Social Innovation in Energy Transitions

Co-creating a rich understanding of the diversity, processes, contributions, success and future potentials of social innovation in the energy sector

GA#: 837498 / Funding type: RIA

Research report on Participatory Incubation and Experimentation the Netherlands and Flanders, Belgium

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement no. 837498

About SONNET: SONNET is a research project that aims to develop an understanding of diversity, processes, contributions and future potential of social innovation in the energy sector. It is co-funded by the European Commission and runs for three years, from 2019-2022. The SONNET consortium consists of 12 partners across Europe, including academics and city administrations. For more information, please visit our website: https://sonnet-energy.eu

Suggested citations:

Fraaije, M. & Wittmayer, J.M. (2020): Participatory Incubation and Experimentation in the Netherlands and Flanders (Belgium). Research Report, SONNET: EU Horizon 2020 Grant agreements no: 837498

Acknowledgements:

Cover photo: Ecovillage SIE-I Aardehuizen, taken by Florian de Graaf, Spectral Energy Solutions. The authors wish to thank the experts in the field that were happy to share their knowledge via an interview. They extend their thanks to colleagues who have spent time to read and comment on draft versions of this report, including Lina Nurali, Gijs Diercks and Sabine Hielscher.

Date: *February 16th, 2021*

Authors: *Maria Fraaije, Julia M. Wittmayer (in alphabetical order)*

Contact person: *Maria Fraaije, fraaije@drift.eur.nl*

1 Foreword

SONNET (Social Innovation in Energy Transitions) brings diverse groups together to make sense of how social innovation can bring about a more sustainable energy sector in Europe. The project aims to co-create a rich understanding of the diversity, processes, contributions, successes and future potentials of **social innovation in the energy sector** (**SIE**). We define SIE as combination of ideas, objects and/ or actions that change social relations and involve new ways of doing, thinking and/ or organising energy. As part of this work, we make use of an embedded case study approach to build a better understanding of the development of diverse SIE-fields (e.g. participatory incubation and experimentation, framings against specific energy pathways, local electricity exchange) over time. Our research questions that frame the case study work are:

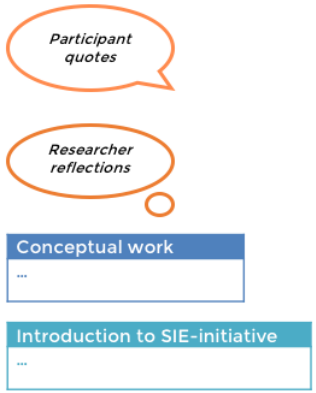
- How do SIEs and SIE-fields emerge, develop and institutionalise over time?
- How do SIE-field-actors and other field-actors interact with the 'outside' institutional environment and thereby co-shape the SIE-field over time?
- What are the enabling and impeding factors for SIE-field-actors and other field-actors to conduct institutional work and change the 'outside' institutional environment?

A SIE-field is an arena/space that includes a specific SIE as well as SIE-field-actors working on it and other field-actors enabling and/or impeding it. In this arena/ space these actors take one another and their actions into account and have a shared (but not necessarily consensual) understanding of a SIE and of their relationship to other actors. They recognise (but not necessarily follow) shared norms, beliefs and rules. SIE-fields are often not homogenous but are composed of actors with diverse and contradictory aims and interests. An example: The UK cooperative energy field includes SIE-initiatives and SIE-field-actors (e.g. Brighton Energy Co-op, Cooperative UK, Community Energy England, UK Government, City of Brighton), who have a shared understanding of an SIE, which exists as 'organising under cooperative principles to generate renewable energy'.

The structure of this report is as follows. Section 2 provides a summary of the SIE-field relevant for this report and lists some key insights. Section 3 outlines the boundaries of the SIE-field and shows how it has been studied in the country context. Section 4 shows a visual development of the SIE-field. Section 5 tells the historical development of the SIE-field over time, including analytical/ interpretive reflections from the SONNET researchers and quotes from the actors involved in the field developments. Section 6 outlines key research findings, providing answers to the three research questions. Section 7 outlines

recommendations for policymakers based on the findings. Finally, Section 9 outlines the methodological approach and includes a more detailed timeline of the SIE-field and its actors.

The following boxes are used within the report:



2 Participatory Incubation and Experimentation the Netherlands and Flanders, Belgium

In SONNET, we investigate the development of the SIE-field called 'participatory experimentation and incubation', i.e. multi-actor, collaborative formats that aim to experiment with and/or try out novel energy solutions in specific local settings. This report analyses formats that bring together actors from different societal spheres to collaborate (rather than to have a dialogue only) in a project-like setting. To qualify, a collaboration needs to be considered by at least one of the actors as an 'experiment' meaning that it aims at testing, investigating or trialling a specific solution and/or clearly aims at learning from putting certain solutions in practice. To be included in this report, the experimentation clearly focuses on energy topics (such as electricity, heat, (bio)gas) and takes place locally in the Netherlands or Flanders (Belgium). We focus on the Dutch context and include reflections with regards to the developments in Flanders, Belgium. We have traced at least seven different collaborative multi-actor experimentation formats over the last twenty years.

Key insights

For the SONNET project, 'Participatory Experimentation and Incubation' is particularly interesting because through its specific focus on changes in how and by whom collaborative experimentation and incubation is engaged in, it reveals a number of important issues for social innovation in energy transitions. In particular, it illustrates that:

- In the Netherlands, collaborative multi-actor experimentation in energy is strongly linked to national innovation policies. It thus **takes place in a strongly institutionalised and resilient setting** where science, state and market actors foster economic progress through market-based mechanisms.
- Next to this dominant innovation paradigm and its existing collaborative multi-actor formats, other collaborative multi-actor experimentation formats emerged. These put **different emphasis in terms of modes of innovation** and actors engaging in experimentation and incubation: a) from a focus on technological innovation to also experiment with governance arrangements, business models and behavioural aspects; and b) from a focus on classic triple-helix collaboration (between market, state and science, e.g. transition experiments, Topsector R&D pilots, smart grid testbeds) to also include civil society actors such as associations, local governments, cooperatives as well as citizens or users (e.g. Living Labs, regulatory sandboxes, gas-free neighbourhood testbeds).
- Considering the strong belief in progress through technology and market, **this change in focus of experimentation and in actor involvement has a long way to go in terms of institutionalisation**. This report traced first signs

including new discourses and beliefs around who should be experimenting and how; new roles for local governments as active participants, funders and initiators of different formats; and a more explicit orientation of national innovation policy towards environmental and societal agendas (e.g. mission-oriented R&D policy to tackle climate and energy challenges)..

- While learning is a key element of such collaborative multi-actor experimentation formats – **the uptake of lessons learned remains difficult, especially in temporary formats such as many Living Labs**. This comes hand in hand with the near absence of collective activities among SIE-field actors, early signs of network building among SIE-field- actors (e.g. the Urban Living Lab Summit).

3 Introduction to Participatory Incubation and Experimentation the Netherlands and Flanders, Belgium

This report investigates the development of the SIE-field and its social innovation in energy (SIE, see analytical box SIE changing social relations below) that we refer to as 'participatory experimentation and incubation'. This stands for multi-actor, collaborative formats that aim to experiment with and/or try out novel energy solutions in specific local settings. It includes formats that bring together actors from different societal spheres to work together (rather than to have a dialogue only) in a project-like setting. To qualify, a collaboration needs to be considered by at least one of the actors as an 'experiment' meaning that it aims at testing, investigating or trialling a specific solution and/or clearly aims at learning from putting certain solutions in practice. Such experimentation focuses on energy topics (such as electricity, heat, (bio)gas) (not including transport) and is researched in Germany, Poland and Netherlands (with additional reflections for Flanders, Belgium).

The innovation history ensuing in section 5 covers the development of several multi-actor collaborative experimentation formats in the Netherlands during the period between 2000 and 2020 (see table 1 for an overview of those formats). This includes formats originating from and being funded by the Dutch government and therefore mirroring changes in the emphasis of each Research & Development (R&D) policies (e.g. transition experiments, Topsector R&D formats, smart grid testbeds, regulatory sandboxes, testbeds gas-free neighbourhoods; see Table 1). In our analysis, these are joined by more locally originating formats, such as Living Labs (e.g. technical and societal Living Labs; see Table 1). The main storyline in this innovation history is situated in the Dutch context and includes reflections with regards to the developments in Flanders, Belgium. Specifically, we have chosen the development and implementation of the fourth Dutch National Environmental Policy Plan in 2001 in the Netherlands as a starting point for the innovation history, since it signifies a proliferation of energy-related experiments – framed as transition experiments and set in a context of learning processes for structural societal changes, i.e. energy transitions.

SIE changing social relations
In SONNET, social innovation is defined as combinations of ideas, objects and/or actions that change social relations and involve new ways of doing, thinking and/or organising energy (Avelino et al., 2019; Pel et al., 2020; Wittmayer, Hielscher, Rogge, & Avelino, 2020). In 'participatory experimentation and incubation', we analyse the combinations of: experimenting with and learning from (i.e. action)

novel energy solutions including new technologies, funding mechanisms or governance structures (i.e. objects) in formats that draw upon new ideas of collaboration between actors (i.e. ideas). We refer to these as 'multi-actor collaborative experimentation formats' and in the context of the Netherlands and Flanders, these formats have been referred to as Living Labs, city labs, pilots, trials, testbeds, experiments, transition experiments or arenas over the last two decades. The main changes that we traced for these formats in the innovation history outlined in chapter 5, refer to the actors collaborating, the roles that these actors take and the main parameter of the experiment (see Table 1).

Especially in the Netherlands, there is a long history of collaboration across different societal domains (often referred to as 'poldering'). Therefore, collaboration across different actors also in experimentation and incubation could be considered as more of the same. However, the innovation history in section 5 shows in more detail that this collaboration around experimentation and incubation is not open to all. Rather, it concerns institutionalised interests of the government, market and science, leading also to a top-down implementation (e.g. in the National Environmental Policy Plan (NL: Nationaal Milieubeleidsplan, NMP4)) in the Netherlands) of a techno-optimistic market driven idea of progress. We see that certain trends and events and their interpretation lead to contestations of this institutionalised collaboration system. For example, through inclusion of other actors (e.g. associations, citizens), through new roles (e.g. municipalities funding their own experimentation) or a shifting focus of the parameter for experimentation (e.g. going beyond technology).

Before we outline the innovation history of 'participatory experimentation and incubation' in more detail (section 5), the following paragraphs are meant to embed this history in a number of broader developments in the last decades of the 20th century: the recognition of the scale and interrelatedness of social and environmental problems (e.g. Brundtland report, Agenda 21), the recognition of the importance of the local level (as e.g. in Local Agenda 21) and the move towards multi-actor collaborations in addressing these problems (as e.g. in science and in R&D policy).

The run-up to the end of the 20th century, saw environmental concerns increasingly being put on the political agenda. A hallmark is the 1987 Brundtland report 'Our Common Future', which discussed human development and environment as interconnected issues (World Commission on Environment and Development, 1987). It was one of the groundworks for ensuing international attempts focusing on sustainable development, such as the first United Nations Conference on Environment and Development (UNCED) (also known as Earth Summit) in Rio in 1992. The latter culminated in the Agenda 21, which is a non-binding action plan of the United Nations (United Nations Conference on Environment and Development (UNCED), 1992). Both reports emphasised two issues. On the one hand, the fact that many of the problems are interconnected. In this regard, the Brundtland report was talking about 'interlocking crises' concerning environment,

development and energy. On the other, they recognised the need for the collaboration of actors from different societal spheres to address these challenges. In addition, the Agenda 21 specifically pointed out the role of local governments as "the level closest to the people" and considered their participation and cooperation as "decisive" in addressing the problems outlined since these often originate locally (United Nations Conference on Environment and Development (UNCED), 1992). Local authorities therefore were expected to start consultation and consensus building processes in their constituencies. Such Local Agenda 21 processes were taken up across Europe (Coenen, 2009; Lafferty, 1999; Selman, 2000)

Table 1 Summary of the various formats present over time.

Format (phase)	Actor constellation	Main parameter of the experiment	Narrative / vision aim	Example
Transition experiments (A)	National government Local governments Businesses Academia	Technological innovation	To see how a new energy system behaves in a specific practical situation and how the surrounding area reacts to this new system.	Nationally funded collaboration between energy supplier Essent Warmte B.V., a local government and a B.V. of local farmers to generate heat for a new local district in Zeewolde municipality[1].
Topsector R&D pilots (A, B)	National government Businesses Academia	Technological innovation	To generate innovations and rapid uptake in market to stimulate the Netherlands to become one of the top five global knowledge economies.	Collaboration between wood processing company Houtindustrie Schundel BV, heatpower BV, InnoEnergy and Eindhoven University of Technology to experiment with novel power from micro-heat generator to increase flexibility of electricity system.[2]
Technical Living Labs (B, C)	Users Local governments Knowledge institutes Local energy stakeholders Businesses	Technological innovation	To facilitate a speedy uptake in the market of technological innovations.	Collaboration between WoonFriesland, Bouwgroep Dijkstra Draisma, YES!Delft, The Green Village and De Bewonersraad Friesland to test energy performance of housing retrofit solutions.[3]
Societal Living Labs (B, C)	Citizens Societal actors Local governments Technical knowledge institutes Local energy stakeholders Businesses	Behaviour Governance arrangements Business models Networking	To realise sustainability through participation and activated local citizens and businesses,	SIE-I Stadslab2050 experimenting with solutions to stimulate behaviour change around energy savings in a commercial neighbourhood. (Also SIE-I Buiksloterham)
Smart grid testbeds (B)	Local governments Housing cooperations Local energy stakeholders	Technology	To find the potential of smart grid technology in the Netherlands (Lammers & Diestelmeier, 2017).	Collaboration between energy supplier Eneco, grid operator Stedin, city of Rotterdam, housing cooperation

[1] https://www.rvo.nl/subsidies-regelingen/projecten/poldergas-voor-polderwijk accessed 11/10/2020
[2] https://www.Topsectorenergie.nl/sites/default/files/uploads/Energie%20en%20Industrie/Brochure%20projecten%20TKI%20Energie%20en%20Industrie%20NL.pdf accessed 11/10/20
[3] https://www.thegreenvillage.org/projects/dreamh%C3%BBs accessed 11/10/20

				Woonbron and the World Nature Federation to experiment with prosumerism in Heijplaat district, Rotterdam.[4]
Regulatory sandboxes (B, C)	National government Associations Project developing companies Real estate companies Research centres	Governance, Technology	To investigate the potential of new governance structures around smart-grid technologies (Lammers & Diestelmeier, 2017).	The housing association and ecovillage Aardehuizen experiments with local energy generation and storage to reduce grid congestion.
Testbeds Gas-free Neighbourhoods (C)	Municipalities Societal actors Knowledge institutes Local energy actors	Technology Participation principles	To test solutions to realise gas-free neighbourhoods in local settings and scaling-up solutions nationally.	The municipality of the Hague experiments with gas-free apartment buildings in the district of Bouwlust/Vrederust.[5]

"If you look back 30 years, this word [innovation] was hardly used, the focus was on research and development or the like, or research. Gradually, more attention was given to ensuring that you would work more in practice instead of in a factory or in a laboratory" (interviewee 2)

A parallel development also in the last decades of the 20th century has it that science increasingly oriented towards producing relevant knowledge (Hessels, van Lente, & Smits, 2009). Mode-2 knowledge production (Gibbons et al., 1994; Nowotny, Scott, & Gibbons, 2001), for example, describes the emergence of a knowledge system with heterogeneous locations, principles, practices and actors. Post-normal science (Funtowicz & Ravetz, 1994; Wesselink & Hoppe, 2011) as another example is a prescriptive approach proposed as a way to deal with issues surrounded by uncertainty, urgency, high stakes and value diversity – such as the interlocking crisis outlined above. These trends illustrate the increasing acknowledgement of the complexity, uncertainty and interrelatedness of what has been termed as wicked or persistent problems (Grin, Rotmans, & Schot, 2010; Rittel & Webber, 1973; Schuitmaker, 2012) and the emergence of and need for other approaches to knowledge development. This is also when 'Sustainability Science' as a new research field marks its birth with an inaugural publication in Science (Kates et al., 2001), and thinking around fundamental societal change started to make use of the concepts of transition and transformation (Grin, Rotmans, & Schot, 2011; O'Riordan, 2001; O'Riordan & Voisey, 1998; Rotmans & et al, 2001).

This comes along with a broader move towards letting go of linear models of innovation (Godin, 2006): starting with basic research, going to applied research, product development and diffusion. Increasingly traditional research and development policy (focusing on subsidies, regulation and intellectual property rights) was supplemented by innovation policy focused towards bringing actors together and stimulating private-public partnerships (Schot & Steinmueller, 2018). This included an increasing focus on including consumers and users in product development (Ballon, Pierson, & Delaere, 2005; Kaulio, 1998) but also the rise of triple-helix collaborations between universities, governments and industries which focused on situated knowledge and innovation generation, diffusion and use (Etzkowitz & Leydesdorff, 1995; Ranga & Etzkowitz, 2013). In the

[4] https://www.rvo.nl/sites/default/files/bijlagen/Proeftuinen%20intelligente%20netten%202011-2015.pdf accessed 10/11/20
[5] https://www.rijksoverheid.nl/documenten/convenanten/2019/05/22/den-haag-bouwlust---aanvraag-en-convenant-proeftuin-aardgasvrij-wijk accessed 10/11/20

Netherlands, this change in thinking was influenced by a number of programmes and networks in policy, technological innovation and sustainable development– an example of the latter was the Dutch National Initiative for Sustainable Development (NIDO) that focused on pushing sustainable development of different sectors through bottom-up processes (Loorbach, 2007).

It is in this context of interrelated social and ecological problems, calls for and emergence of different ways of knowledge production including multi-actor collaboration, that we track the emergence and development of the SIE-field of participatory experimentation and incubation in energy in the Netherlands and Flanders. In doing so, we zoom in on **two SIE-initiatives** exemplary for the living lab format, which develops knowledge through citizen engagement in real-life settings (Living Labs as defined by Maas et al., 2017a). One is **Living Lab Buiksloterham**, which brought together citizens to self-organise and build an energy efficient neighbourhood in Amsterdam after the financial and economic crisis of 2008/09. Living Lab Buiksloterham is one of the more established, well documented and ongoing Living Labs in the Netherlands. The second exemplary SIE-initiative is **Stadslab 2050**, the living lab approach of the city of Antwerp which heralds several trajectories focusing on energy topics (next to a broader climate change agenda). In Stadslab2050 businesses, citizens and local energy stakeholders have experimented with ways to i.e. decrease the energy consumption of shops. In the Netherlands, national R&D policy opened up to including societal actors – such as associations through a format referred to as 'regulatory sandboxes' in 2015. This allowed associations to apply for a formal experimental status, granting them rights of the grid operator, such as local exchange of electricity. A third SIE-initiative has been studied that is exemplary for this format, the **Aardehuizen, an ecovillage in Olst**. Formalised as a housing organisation, 26 households work together to reduce regional grid congestion by peakshaving electricity (i.e. through installing a local battery and exchanging energy locally).

The ensuing innovation history is constructed along three overlapping phases: from 2000 to 2013 the focus in the SIE-field was on triple helix experimentation involving market, state and science (phase A) , from 2009 onwards we see a rising role for cities and civil society (phase B), and lately, the SIE-field is in a phase of taking stock and reorientation (from 2017 onward, phase C). It is constructed as a meta-analysis of existing developments and has a number of practical and methodological limitations that we reflect on in Annex 1.

'Outside' institutional environment shaping the development of the SIE-field

The SIE-field is nested within a larger institutional environment of rules, norms and cultural beliefs. In SONNET, we refer to this as the 'outside' institutional environment and we are interested in the shocks and trends within this environment that unsettle the SIE-field, and thereby co-shape its direction. (Hielscher et al., 2020; Wittmayer, Hielscher, et al., 2020). To construct the innovation history of the 'participatory experimentation and incubation' field, we have taken a number of outside developments in delineating the three phases of development.

Both, the first and third phase have been co-shaped by the **raising environmental concerns** throughout the last three decades or so. The first phase of experimentation outlined in this report, using transition experiment format, was initiated in the energy sector in the wake of the Dutch National Environmental Policy Plan in 2001. The latter being inspired by ongoing efforts and studies testifying to long term systemic thinking in environmental discourse. Also, the last phase, the one of taking stock of the SIE-field and reorientation, is related to heightened environmental pressures leading to the adoption of the Paris Agreement in 2016 and ensuing climate agreement in the Netherlands in 2019. It might lead the way to more mission-oriented innovation policies and associated experimentation and incubation.

The second phase that we distinguish can be related to the **financial crisis and recession** in 2008-2011. The recession, and the accompanied governmental budget-cuts, led in the Netherlands to an overall decentralisation of governmental tasks towards municipal level. The welfare state was retreating, 'making space' for and demanding from citizens to step up. This trend of increasing responsibility for citizens on a broad array of public questions has been summarised under the term 'participation society' (equivalent to the UK's Big Society) in the Netherlands, but often was not appropriately resourced. The King's speech in 2013 is exemplary in summarising the dominant narrative: "*It is undeniable that in our current network and information society people are more empowered and independent than before. Combined with the need to reduce the government deficit, this leads to the traditional welfare state slowly but surely changing into a participatory society. Everyone who can, is requested to take responsibility for his or her own life and environment*."[6] (Throne speech, 2013).

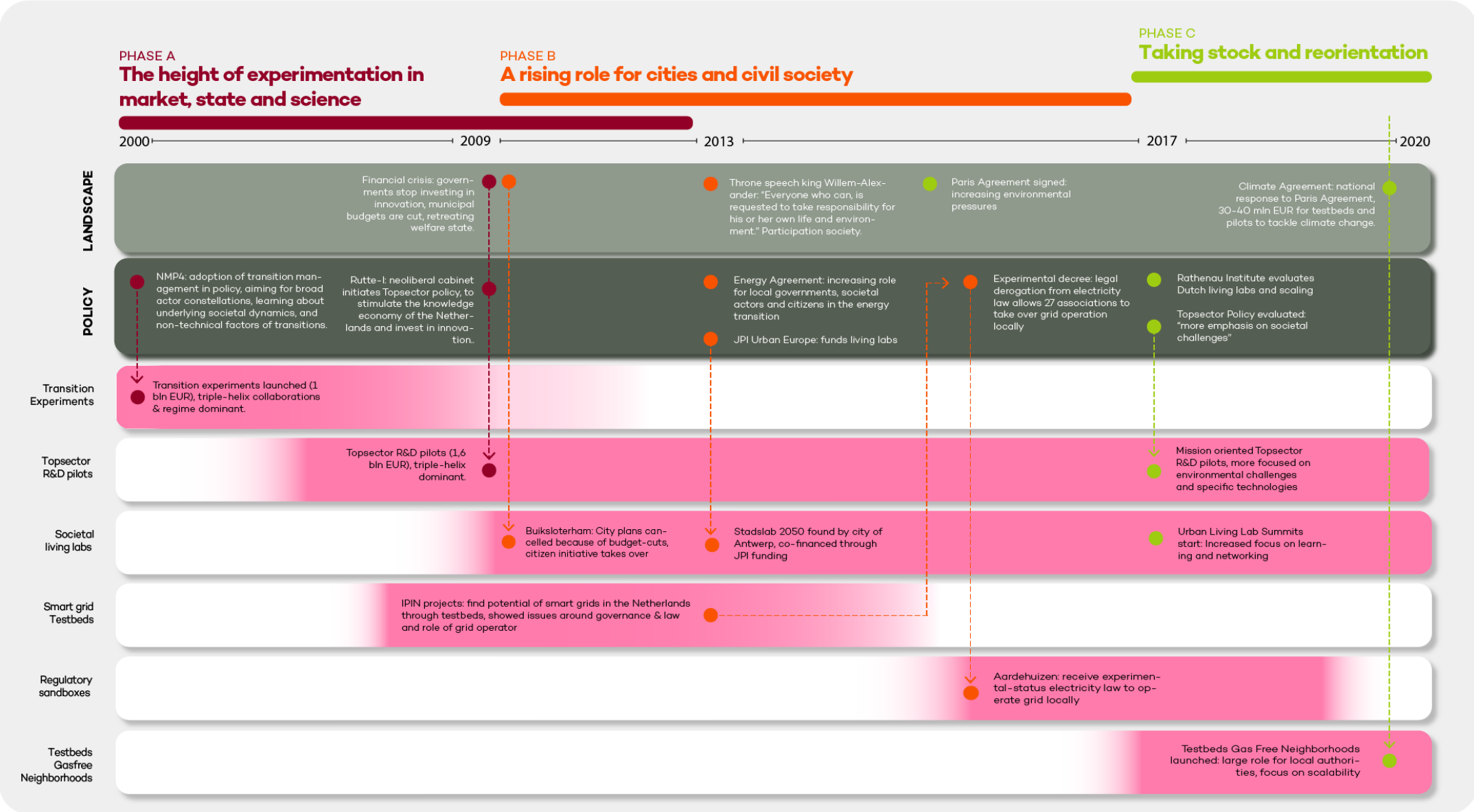
The financial crisis led to two institutional changes: the notion in the King's throne speech that '*everyone who can, is requested to take responsibility*' (change in normative institutions), and large-scale cuts in governmental budgets (change in regulative institutions). The latter budget-cuts affected the SIE-field in two ways. On the one hand, the governmental budget-cuts led to a decrease of funding for innovation and R&D and innovation between 2008-2011. Subsequently, with the advent of a new government, the Netherlands was to become one of the top 5 knowledge economies of Europe and a testbed for innovation. To this

[6] Original Dutch quote: "Het is onmiskenbaar dat mensen in onze huidige netwerk- en informatiesamenleving mondiger en zelfstandiger zijn dan vroeger. Gecombineerd met de noodzaak om het tekort van de overheid terug te dringen, leidt dit ertoe dat de klassieke verzorgingsstaat langzaam maar zeker verandert in een participatiesamenleving. Van iedereen die dat kan, wordt gevraagd verantwoordelijkheid te nemen voor zijn of haar eigen leven en omgeving."

end, the Topsector Policy was installed. It, aimed at bringing actors from science, governments and business together to generate innovations and to accelerate the uptake of technology. It resulted in about 2100 triple-helix R&D projects with 1,6 billion euros of funding. On the other hand, tight municipal budgets also created space for and the 'participation society' frame demanded citizens and bottom-up activity - opening space for quadruple helix constellations. For example, the citizen-led SIE-I Living Lab Buiksloterham experimented with sustainable living in their neighbourhood, because municipal plans for the area had to be put on hold (see also box on the SIE-I Buiksloterham).

4 Timeline of Participatory Incubation and Experimentation in Flanders (Belgium) and the Netherlands

This is a visualisation of the innovation history of participatory incubation and experimentation in Flanders, Belgium and the Netherlands. An overview of the listed events can also be found in Annex 2.



5 Emergence and development of Participatory Incubation and Experimentation in Flanders (Belgium) and the Netherlands over time

PHASE A: The height of experimentation involving market, state and science (triple-helix) (2000-2013)

In 2001, recognising the trends outlined in the introduction (section 3), the fourth Dutch National Environmental Policy Plan (NMP4) adopted the concept of transitions and transition management (Ministerie van Volkshuisvesting Ruimtelijke Ordening en Milieubeheer, 2001). It outlined that persistent problems, such as climate change needed to be addressed through fundamental changes in societal systems. For the energy system, the aim was a 40-60% reduction in carbon dioxide emissions by 2030 (as compared to 1990) (Ministerie van Volkshuisvesting Ruimtelijke Ordening en Milieubeheer, 2001). There were different ingredients to such a transition approach, an important one in the context of this report being the promotion of experimentation with alternative practices.

Such **transition experimentation was to be different from earlier experimentation** in three ways. Firstly, while earlier experimentation had focused on demonstrating the success of certain approaches, transition experiments were to be oriented towards **learning about underlying societal dynamics** and future pathways and part of broader societal learning processes (Kemp & Rotmans, 2009). Secondly, transition experimentation was to acknowledge the important role of technology while taking account of its interrelation with **social and cultural factors**. The importance of such non-technological factors had been shown in earlier Dutch programmes on sustainability and innovation (Vergragt 2005 in (Kern & Smith, 2008)). Thirdly, the transition management approach envisioned a **broader actor constellation** than previously engaged in the energy sector at the time. Before liberalisation of the energy sector in 1998, the energy system was highly centralised. After liberalisation, the sector was structured around market actors selling electricity, and public organisations involved in grid operation and regulation. The transition management approach of the NMP4 envisioned a radically different composition of the actors involved in the energy sector: civil-society and uncommon suspects were to be included. Together, they were to collaboratively envision radically novel energy futures, which were to be explored through a range of experiments.

In **implementing the transition approach in the energy sector**, the Dutch Ministry of Economic Affairs took the lead. It created seven energy transition platforms, each with 10-15 individuals from the private and the public sector, academia and civil society. They came together to develop goals for 2020 and pathways towards those goals (Kemp, 2012; Kemp & Rotmans, 2009; Kern & Smith, 2008; Smith & Kern, 2009a). In the following years, transition experiments were to practically explore those pathways. The government funded transition experiments through the 'Unique Chance Scheme' (Dutch: Unieke Kansen Regeling), granting 118.3 million euros of subsidy between 2004 and 2007 (Kemp, 2012). Besides government funding, a remaining 957.8 million investment was sourced from market parties in this time period (Kemp, 2012). In order to be eligible for this funding, transition experiments had to be part of an official transition pathway, involve stakeholders and have learning goals (Kemp & Rotmans, 2009; D. A. Loorbach, 2007). In the period between 2004 and 2007, 48 experiments were selected as part of seven energy transition platforms (new gas, chain efficiency, green resources, sustainable mobility, greenhouse as energy resource, sustainable electricity, built environment). These experiments started in 2005 and their aim was "*to see how a new energy system behaves in a specific practical situation and how the surrounding area reacts to this new system*" (Ministry of Economic Affairs, 2004a p. 19 in Kern and Smith 2008). An example of such a transition experiment was experimentation with the use of mine water for heating and cooling in Heerlerheide centre in the province of Limburg in 2008. The experiment was part of the platform of the built environment (Smith & Kern, 2009, p.92). In the experiment, (warm) water from the closed down mines is used to heat local businesses and households. After initial years of experimentation, the project was formalised into an energy supplier Mijnwater B.V in 2013, and sold to Limburg's Energy Fund (NL: Limburgs Energie Fonds) in 2018 to, in their own words, "grow to a sizeable energy company."[7] Another example of such a transition experiment was a nationally funded collaboration between energy supplier Essent Warmte B.V., the municipality of Zeewolde and a company of local farmers to generate heat for a new local district in Zeewolde[8]. This experiment was part of the transition platform New Gas, which envisioned that *the "energy transition in the natural gas sector means that the entire natural gas chain will become more sustainable"* (Smith & Kern, 2009, p.91). The main actors involved across all transition platforms were science, market and state actors (Smith & Kern, 2009b) – and thus focusing on what has become known as triple-helix collaboration (Etzkowitz & Leydesdorff, 1995). Specifically, twelve actors from state, 36 from business, nine from NGOs, and 16 from science participated across all energy-related transition platforms (from table 2 in Smith & Kern, 2009).

[7] NL: "in 2018 werd de ambitie uitgesproken om te groeien tot een energiebedrijf van formaat." https://www.mijnwater.com/mijnwater-nu/ accessed 21/01/21
[8] https://www.rvo.nl/subsidies-regelingen/projecten/poldergas-voor-polderwijk accessed 11/10/2020

These transition experiments and the transition approach in which they had been embedded have received critical appraisals. These often relate to the gap between underlying theoretical concepts and their implementation by Dutch policymakers, as reflected on by Kemp & Rotmans (2009). To start with, the strategic system change ambition got watered down while the focus was on creating sustainable energy businesses (Loorbach, 2007). For example, the final decision on whether an experiment was granted was taken by the Ministry of Economic Affairs based on criteria such as "*costs and benefits of the experiment, likelihood of business investment, strength of demand, and chances of technical success*" (Ministry of Economic Affairs 2004a, p. 29, Energy Transition Taskforce 2006, p. 14 in Smith and Kern 2009). Exemplary of the wider implementation of the transitions approach, these fall short of the expectations raised by a transitions approach with a focus on structural change where one might expect criteria that allude to institutional learning or social innovations (Kern & Smith, 2008; Paredis, 2013). Rather, it has been raised that "*transitions policy perpetuates technocratic routines in energy policy*" (Smith & Kern, 2009a) and that it fell short on democratic grounds with no broad civic dialogue about desirability and future directions in sight (Hendriks, 2009). Due to the high involvement and representation of business and industry, next to government and the occasional scientist and only low involvement of intermediary organisations and NGOs (D. A. Loorbach, 2007), it has been referred to as "*highly corporatist approach*" (Hendriks (2008), p.196 chapter 9 of Kemp, 2012).

While the implementation of a transition approach to the energy transition was directed by the Ministry of Economic Affairs, the researchers involved in the development of the fourth Dutch National Environmental Policy Plan further developed the thinking and grounding of concepts such as system innovation and sustainability transitions. A loose network formed in 2000, and eventually was formalised in 2005 as the Dutch Knowledge Network on System Innovations and Transitions (KSI). Eleven universities and research institutes aimed to develop scientific knowledge and societal practices around system innovation and transitions. These were funded through the Decree on Subsidies Investments Knowledge Infrastructure scheme (NL: Besluit Subsidies Investeringen Kennisinfrastructuur, BSIK). The BSIK was based on the proceeds from natural gas resources from the Ministry of Economic Affairs. These proceeds were intended for strengthening the knowledge infrastructure (Van der Hoeven, 2010). With its 85 researchers, it stood at the cradle of what has developed today into a vibrant and global community of scholars united in the Sustainability Transitions Research Network (STRN) (Grin et al., 2011). This network and research funding have led to a **further spread of thinking around reflexive and experimental forms of governance** (D. Loorbach, 2010; Sengers, Wieczorek, & Raven, 2019; van Buuren & Loorbach, 2009) **and has developed transition experiments as a specific form of innovation project** (Sengers et al., 2019; Van den Bosch, 2010). In close collaboration with other BSIK-funded programmes, transition experiments in different sectors (excluding energy since that was covered by the

energy transition programme) were implemented – these experiments also brought together multiple actors, namely government, business and research institutes (Avelino, 2011).

"[..] now suddenly [VIA became] the signboard of the Flemish Government, [...] and of course, everybody started thinking: what is that, transition? Now it's not an experiment anymore, because it is suddenly in the spotlight" (Interviewee 6).

Exchanges with researchers from the KSI-network inspired policy and research in **Flanders**, where the third Environmental and Nature Policy Plan 2003-2007 included a transition management approach and thus a focus on experimentation. This approach was considered to "*remedy some of the problems in environmental policy-making, in particular a lack of a long-term sustainability perspective that meant a break with existing trends, and a lack of integration with industrial and innovation policies*" (Paredis, 2013). Under influence of the newly elected sustainability-oriented government, two larger experimentation programmes were started to ensure long-term environmental policy, one on sustainable living and housing (Duwobo) in 2004 and one in waste management (Plan C) in 2006. These programmes sparked enthusiasm for the approach, as it showed that "*you can work on the long term, you can get new actors around the table*" (interviewee 6).

Around 2006, the Flemish government was looking for a long-term approach for multiple policy areas. As a consequence, a sector-spanning policy was developed: the Flanders in Action, or VIA programme (NL: *Vlaaanderen in Actie*). Inspired by the experimentation with a transition approach in the Netherlands, this policy was retrofitted to a transition approach in 2010. In this policy, transition experiments were a means to realise the new future vision of the programme. Whereas the exact amount of subsidisation is not clear, and data is mainly available on the programme as a whole (rather than zooming in on the energy transition programme or the actual projects), it is evident that VIA was substantial in size. Between 2006 and 2009, VIA included 300 "*captains of society*" to discuss 21 socio-economic goals (Paredis, 2013b, p.118). In the end, VIA resulted in 337 projects. However, these projects did not lead to the desired changes as envisioned before: *"The series of projects were mainly an internal administrative affair to realise the governmental declaration, but the connection with activities from and involvement of societal partners had been lost"* (Paredis, 2013; p.119). According to interviewee 6, the lack of effect of these 337 projects was an important reason for policy makers to retrofit their policy to a transition management approach after 2010, hoping this would lead to more results (more radical, long-term solutions involving stakeholders). These developments led to a renewed VIA programme, now oriented on realising "breakthroughs" to become more competitive, growth-oriented and technologically advanced (Paredis, 2013).

As such, the Flemish government started using a transition approach around 2010, and set up experiments involving businesses, governments, social partners and civil society organisations. However, the latter two were underrepresented. Like the Dutch transition experiments, the experiments within the Flemish VIA programme were critiqued for their large

involvement of energy incumbents, and lack of civic dialogue. In the words of interviewee 6, "*I have always felt like that [the VIA programme] was very shielded, and that people didn't want too many prying eyes and participation, because there were many interests that accompanied it*." This was due to several factors. Firstly, the VIA experiments were placed in the spotlight of the Flemish government. This spotlight led to a larger involvement of regime players in the experiments, resulting in a lack of civic dialogue and public participation. In the words of interviewee 6, *"when you centralise it in the policy, then you can't say that you can only bring frontrunners to the table. Then regime players of course want to play a big role."* In 2014, the new Flemish government by the nationalists New Flamish Alliance (NL: Nieuw-Vlaamse Allliantie, NVA) changed VIA to a new programme: Vision 2050 (NL: *Visie 2050*). According to interviewee 6, this vision 2050 was "*watered down*" from the VIA programme: the original VIA goals had been decreased in force and clarity. Moreover, interviewee 6 perceives energy transition policy-making as "*closed-off*" and "*customised for the big energy providers: Engie and Electrabel*" (interviewee 6). Multiple interviewees mark that this lack of innovation in national energy policy can partly be explained by the unresolved national debate on their large nuclear dependency (interviewee 5, interviewee 7A, interviewee 9). Currently, nuclear energy makes up half of the Belgian electricity mix (48% in 2018[9]).

In the meantime, the **political climate in the Netherlands changed**. With the election of a new Dutch government in 2010, the energy transition experiments were replaced by an innovation policy focusing on excelling in specific sectors, including the energy sector (NL: *Topsectorenbeleid*) rather than on small-scale experiments (interviewee 3). The **Topsectorenbeleid**, as stated on its website, was to bring actors from science, governments and business together to generate innovations and the rapid uptake of technology in the market to stimulate the knowledge economy of the Netherlands. To this end, each Topsector had at least one **collaborative learning and experimentation program, the 'topconsortia for knowledge and innovation'**, or TKIs (NL: *Topsector voor kennis en innovatie*). According to the website about the policy,[10] in these TKIs "*entrepreneurs and scientists are looking for ways to bring innovative products and services to the market. They do this with fundamental research, industrial research, experimental development or a combination of these. The TKI ensures that the network is formed, that knowledge is shared and that projects are managed*." Each TKI involved at least three businesses and three publicly financed research organisations. The TKIs were financed by the involved businesses and subsidised by the Ministry of Economic Affairs (for every Euro invested by businesses, the Ministry gave Euro 0,30). The energy sector had five affiliated TKIs: TKI Biobased Economy, Energy and Industry, New Gas, Urban Energy and Wind at Sea. Between 2012 and 2017, more than 2100 **R&D pilots projects** were realised. These received approximately 1,6 billion

[9] https://www.nucleairforum.be/actualiteit/nieuws/elektriciteitsmix-belgie-2018-het-overzicht accessed 20/10/2020
[10] https://www.Topsectorenergie.nl/ accessed 17/12/20

euros of funding, 750 of which were granted from public sources (i.e. subsidies) (RVO, 2018). An example of such a Topsector pilot project, is the Fieldlab Sustainability Factory (NL: Fieldlab Duurzaamheidsfabriek) situated in the so-called 'learning park' (NL: leerpark) in the city of Dordrecht. This is a collaborative format between market, education and government to stimulate innovation and education within the energy transition. In the pilot, companies rent spaces within the factory to work on innovative technologies for the energy transition, students receive technical training, and the local government finances the building (van den Haak & Endert, 2016).

In 2009, just before the formal launch of the Topsectorenbeleid, the Dutch Ministry of Economic Affairs instated a 'taskforce smart grids' (NL: taskforce intelligente netten') that was to evolve into the Innovation Programme for Smart Grids (IPIN, NL*: innovatie programma voor intelligente netten*). In 2011, twelve smart grid pilot projects were installed, carried out by the Netherlands Enterprise Agency (NL: *Rijksdienst voor Ondernemend Nederland, RVO*) **– as smart grid testbeds**. They were mostly technology oriented, focusing on the development of new services and products around smart grids. While the IPIN documentation paid attention to the problematic dominance of grid operators, and noted the importance of changing roles of actors in the energy system, in nine out of twelve IPIN projects, the grid operator became the dominant actor in the project (Lammers & Diestelmeier, 2017).

Policies and policy making

SONNET studies the effect of policies on the SIE-field, the policy making conditions enabling the SIE-field, and the roles of SIE actors in the policy making process. Moreover, SONNET is interested in studying how these policies represent and empower the actors within the SIE. In the innovation history up to here, the main influence comes from national environmental policy and innovation policy - all these come with dedicated funding streams. In the upcoming phases, policies on municipal level - mainly from a sustainability or environmental perspective - will gain importance. For a selection of the policies and which experimental formats emerged from them, see the table below.

Table 2 Overview of the policies which led to various experimental formats.

Phase	Policies	Goals	Policy context	Level	Affiliated experimenting format
A	**NMP4 (NL), VIA (FL)**	Environmental protection	Environmental policy	National	Transition experiments

A	**Innovation Programme Smart Grids, IPIN (NL)**	Technical innovations in smart grids	R&D and innovation policy	National	Smart grid testbeds
A-C	**Topsector Policy (NL)**	Technical innovations for rapid market uptake	R&D and innovation policy	National	R&D pilots
B, C	**VERDUS Surf funding NWO (NL)**	Address issues such as urbanisation, spatial planning, mobility and transport	Research funding	National	Living Labs
B, C	**JPI Europe funding**	Create attractive, sustainable and economically viable urban areas	Research funding	European	Living Labs, SIE-I Stadslab2050
B, C	**Sustainability vision city of Antwerp (FL)**	Become an exemplar sustainability-oriented city	Environmental policy	Local	Living lab, SIE-I Stadslab2050
C	**Experimental decree (NL)**	Governance and legal aspects of smart grids and local electricity exchange	R&D and innovation policy	National	Regulatory sandboxes, SIE-I Vve Aardehuizen
D	**Program Gas-Free Neighbourhoods (NL)**	Gas-free solutions to roll-out in other neighbourhoods	R&D and innovation policy, environmental policy	National	Gas-free Neighbourhood testbeds

Since especially the national policies come with major funding schemes, they do put a rather strong mark on how the SIE-field develops. The focus of these policies has changed to also allow actors that are traditionally not seen to play a role in energy production, consumption or distribution to experiment with new activities and responsibilities. However, it is less clear in how far results and also the learnings from the experiments lead to actual changes in regulations, policy or laws (see also institutional work box).

The Netherlands traditionally has a **strong science-policy interface**, considered as "*social processes which encompass relations between scientists and other actors in the policy process, and which allow for exchanges, co-evolution, and joint construction of knowledge with the aim of enriching decision-making*" (van den Hove, 2007). In the 2000s, this interface led to the integration of transition experiments in the energy transition programme (as part of NMP4) (Kemp & Rotmans, 2009; Taanman, 2011). In the words of interviewee 9:

> *"So, in the Netherlands we are simply close to each other with policy and knowledge. That is very different from other countries. So, there was a lot of dialogue. All kinds of sustainable programs were also created there."*

PHASE B: A rising role for cities and civil society (2009-2017)

During this phase, we trace the development of two main multi-actor collaborative formats. First, there is explicit experimental space in national innovation policy in relation to the Dutch Energy Agreement: **regulatory sandboxes** allow derogation from national law on grid operation. Second, there is increasing experimentation activity in cities to address energy-related issues and climate change in the broadest sense through emerging **living lab formats**. These collaborative experimentation formats changed the actor configurations of the SIE-field – important new actors being cities (such as Amsterdam or Antwerp), other types of research institutes (e.g. AMS, University of Maastricht, DRIFT) and many informal or formal community organisations or civil society organisations (such as the Aardehuizen Olst association or the experiments in the living lab Buiksloterham).

Broadened R&D pilots in the context of the Dutch Energy Agreement

In 2012, the Social and Economic Council (SER) of the Netherlands **evaluated Dutch energy policy** on request of the Ministry of Economic Affairs. It concluded that there was a lack of continuity, cohesion and predictability in energy policy leading to investment insecurity, and a lack of innovation and investment in large energy transition projects (Smelt and Bolhuis, 2018). As a remedy, the SER facilitated a dialogue: more than 100 people from diverse organisations joined the deliberation tables at the beginning of 2013, including societal organisations, financial actors, state actors and market players from small businesses and energy companies (Smelt & Bolhuis, 2018). The proposed long-term solutions and ambitions were being calculated by an external party to understand their effects – this increased trust in the achievability of the agreement (Smelt and Bolhuis, 2018). In September 2013, the **Energy Agreement was signed by 47 organisations**.

However, while the agreement was drawn up in a dialogue with and also signed by civil society actors, as a classic example of the Dutch 'polder' tradition[11], its experimentation still prescribes a large role for market players (i.e. energy suppliers): *"It*

[11] Poldering is the Dutch tradition of concensus-based decision making. The word 'polder' is based on the Dutch dry land below sea level.

is important that market parties research [..] applications of power-to-gas (both hydrogen and methane) and dual firing technology and start concrete pilot projects to gain practical experience."[12] *(Energieakkoord 2013, p89).* With the aim being for the Netherlands to become a "*testing ground for innovation and energy efficiency for internationally operating industrial companies*"[13] (Energieakkoord, 2013, p.57), the Energy Agreement is in line with the research & development focus and knowledge economy ambitions of the Topsector Policy.

The Energy Agreement prescribed several experimental formats: energy suppliers experimenting with variable energy tariffs in 2014, grid operators experimenting with variable transport tariffs and energy cooperatives experimenting with legal barriers for crowdfunding as a financial basis for financing their cooperatives. The Energy Agreement envisioned that any obstacles found in the experiments "*will be removed by the market and government together*"[14] (Energieakkoord, 2013; p.85).

Emerging Living Lab format in the urban context

While Dutch innovation policies continues its triple-helix experimentation (see phase A), initiatives in both Flemish and Dutch cities increasingly also address energy transition topics. In the words of interviewee 6, *"this doesn't stop people and organisations to try and organise their own things […] such as citizens starting a wind cooperative, or a city like Gent that choose to try and promote renewable energy and energy savings as much as possible"*[15]. The **'Living Lab' approach** became popularised. This approach has roots in user-centred product innovation (Kaulio, 1998; Cooper, 1980; Eriksson et al, 2006; Schumacher & Feurstein, 2007). According to the Rathenau Institute, a publicly funded Dutch research organisation, Living Labs tackle complexity by involving people in the 'wild world':

> "*Living Labs can be seen as an answer to the need to do better justice to the complexity of the world in the experimental setting. This can be done by having research take place more in the 'wild' world, and by involving more people in the experiment*." (Maas, Van den Broek, & Deuten, 2017b).

"And then again, JPI, because they have ongoing projects and they really pushed for this concept. And you basically could not get money there without somehow involving living lab approaches in your projects." (Interviewee 1)

[12] NL: "Het is van belang dat marktpartijen onderzoek doen naar deze toepassingen van power-to-gas (zowel waterstof als methaan) en dual firing-technologie en concrete pilotprojecten starten om praktijkervaring op te doen."
[13] NL: "[…] wanneer Nederland voor internationaal opererende industriële ondernemingen wil uitgroeien tot een proeftuin voor innovatie en energie-efficiëntie, hetgeen bijdraagt aan het ontstaan van een aantrekkelijk investeringsklimaat."
[14] NL: "Gevonden belemmeringen worden door markt en overheid samen weggenomen."
[15] NL: "Dit weerhoudt mensen en organisaties er niet niet van om hun eigen dingen te organiseren [...] zoals burgers die een windcoöperatie starten, of een stad als Gent die ervoor kiest om zoveel mogelijk hernieuwbare energie en energiebesparing te promoten."

The **Joint Programming Initiative (JPI) Urban Europe funded dozens of Living Lab projects via national research funding institutions** (The *Nederlandse Organisatie voor Wetenschappelijk Onderzoek*, or NWO in the Netherlands and *Fonds Wetenschappelijk Onderzoek*, or FWO, in Flanders) starting in 2012. The ambition of JPI Urban Europe is "*to address the global urban challenges of today with the ambition to develop a European research and innovation hub on urban matters and create European solutions by means of coordinated research*"[16]. While the first calls were more general, the calls between 2014-2016 and in 2020 focused specifically on the energy transition and also on smart grids in cities or neighbourhoods. To differentiate those Living Labs focusing on technology as parameter for experimentation – which is the majority in the Netherlands, from those focusing on governance arrangements or business models, we refer to the latter as societal living lab. An example of the latter, which also received funding by JPI Urban Europe (via the URB@Exp[17]) is the SIE-I Stadslab2050 in Antwerp, found in 2013 (see box Stadslab2050).

Stadslab2050 (Antwerp, Belgium)

Stadslab2050 was found by the municipality of Antwerp in 2013, as part of their sustainability vision. The goal was to aid in making Antwerp CO_2 neutral by 2050. The initiative is funded by the Flemish government and the city of Antwerp. Incidental funding is acquired through EU-funded (research) projects. According to the Flemish government:

> *"Working on a sustainable city requires a different approach, in which experimentation and innovation are key words. Moreover, it is not a task for the city government alone. It requires a unique partnership between government, companies, residents and organisations in the city. Stadslab2050 is a platform for everyone who is involved in sustainable processes in the city."*[18].

[16] https://jpi-urbaneurope.eu/about/intro/ accessed 2.10.2020
[17] https://jpi-urbaneurope.eu/project/urbexp/, accessed 11/12/2020
[18] NL: "Werken aan een duurzame stad vraagt een andere aanpak, waarin **experimenteren** en **innoveren** sleutelwoorden zijn. Het is bovendien geen taak voor de stedelijke overheid alleen. Het vraagt een uniek samenwerkingsverband tussen overheid, bedrijven, bewoners en organisaties in de stad. Stadslab2050 is een platform voor iedereen die met duurzame trajecten in de stad bezig is." https://www.antwerpenmorgen.be/nl/projecten/stadslab-2050/over, accessed 11/12/20

Figure 1 Image a co-creation session at SIE-I Stadslab2050[19]

As such, Stadslab2050 aims to engage with a range of local and regional actors. In 2014, the city lab collaborated with a policy maker from the municipality to launch the programme 'energy for the heart of Antwerp' (NL: Energie voor het Antwerpse Hart), which focused on energy savings in the tertiary sector. The goal of the programme was, amongst others, "*Let [citizens] know through campaigns in our city that sustainability is not a goat's wool sock story, but a harsh economic reality that we all benefit from*."[20] The main actors involved in the project were the city of Antwerp, the grid operator Eandis (now: Fluvius) and a triple-helix networking organisation Smart Grid Flanders (now: Flux50). Whereas the programme did not lead to any immediate changes in the behaviour of actors involved, interviewee 7B notes that *"a few years later you see that when there is a renovation plan, then suddenly you hear: oh we should really do something about these store doors. So, agenda-setting, that we do a lot, but causally solve something one on one, I have never seen that before."*[21] One of the conclusions of the city lab programme was that structural change was facilitated by new ways of organising, thinking and financing:

[19] https://twitter.com/StadsLab2050/status/1207959033010933760/photo/1 accessed 30/10/2020
[20] NL: ""Laat [burgers] via campagnes in onze stad weten dat duurzaamheid geen verhaal van geitenwollen sokken is, maar een harde economische realiteit waar we allemaal van profiteren."https://stadslab2050.be/energie/wie-plaatst-mee-een-versnelling accessed 17/8/20
[21] NL: "Een paar jaar later zie je dat als er een verbouwingsplan is, dan hoor je ineens: oh we moeten echt iets aan die winkeldeuren doen. Dus agendasetting, dat is iets wat we veel doen, maar causaal iets één op één oplossen, dat heb ik niet eerder gezien."

"The fragmentary realisations along the way are good, are beautiful and are important because they prove the steps forward in demonstrable results, but the big changes are taking place in the way we organise ourselves, how we think about energy, provide subsidies […]. We already experienced that during this Stadslab2050 process."[22]

Aside from local projects, Stadslab2050 is involved in various learning networks and projects, especially internationally. The city lab fits in a broader narrative of the local council, which embedded the importance of experimentation in its council decision (NL: collegebesluit) in 2012 and 2016. Moreover, interviewee 7B states that he finds support in the fact that their narrative of local experimentation through city labs is embedded in European policy, and that the EU is "*really pulling the cart*"[23].

Co-financed by EU-H2020 research funding as part of the SONNET project, the Antwerp Stadslab has started a trajectory focusing on addressing energy poverty in Antwerp through setting up five experiments. These experiments include finding new collaborations to facilitate consumption of cooperatively generated PV electricity for social housing tenants (Stalinsstraat, and Collectief Goed/ZuidtrAnt), finding new business models to lease energy-saving refrigerators to low-income households (Papillon) and integrating multiple energy services of the municipality (Ecohuis). These experiments all focus on developing new collaborations and business models for energy production, consumption, savings and distribution for low-income households to address energy poverty. Whereas Stadslab2050 engages in regulative institutional work in the water and material sector, interviewee 7B stated that "*in energy this is much harder, maybe also because it is less at a local level*." Only recently, Stadslab2050 became involved with a city lab trajectory around energy poverty in 2020: Gelijkstroom, which is subsidized by the SONNET project and the municipality of Antwerp. While the experiments are still running, Gelijkstroom has resulted in a thematic call on social innovation in the energy transition as part of the climate fund of the municipality of Antwerp (NL: klimaatfonds). This fund had existed for a while before Gelijkstroom started. Due to a reformation of the fund, the project leads of the Gelijkstroom trajectory saw the opportunity to suggest a thematic call on social innovation in the energy transition in the project fund. The cabinet thought this to be a good idea. As such, the city of Antwerp will launch a thematic call for projects on social innovation in the energy transition in 2021. In total, 60.000 euros has been budgeted for social innovation in energy projects.

Stadslab2050 notes that they currently face issues with continuity. Because of a shift in political climate, "*there is too little support*" on a political level for the brand Stadslab2050. The Stadslab2050 will be integreated in the overarching climate policy of the city, and the brand Stadslab2050 will disappear. In the words of interviewee 7B, such continuity issues due to shifting political climates are

[22] NL: "De fragmentarische realisaties onderweg zijn goed, mooi en belangrijk omdat ze de stappen voorwaarts aantoonbaar bewijzen, maar de grote veranderingen vinden plaats in de manier waarop we ons organiseren, hoe we denken over energie, subsidies verstrekken [...]. Dat hebben we al ervaren tijdens dit Stadslab2050-traject. " https://stadslab2050.be/energie/wie-plaatst-mee-een-versnelling accessed 17/8/20

[23] NL: "trekt echt de kar"

more common throughout Europe: *"The 'Mindlab' of the Danish has dropped a year or a year and a half ago. They had a fantastic lab where everybody looked up to, and with a shift in politics that has been changed to a technical lab. […] It has an end date."*[24]

These JPI funding calls led to a proliferation of 'Living Labs' in the Netherlands, and to a certain extent Flanders. It also resulted in "*many initiatives relabelling themselves as Living Labs*" (interviewee 4). An example of the latter is the Living Lab Buiksloterham, which started to use the label around 2015 (See box Living Lab Buiksloterham).

Next to SIE-Is relabelling themselves as Living Labs, JPI Europe was putting 'Living Labs' as *"co-creative workshops and collaborative formats*" on the European research agenda. Following on from this, the Dutch Research Council NWO started their funding programme VerDuS SURF, 'connecting sustainable cities' (NL: *verbinding van duurzame steden*) in 2016. While the Living Lab format was no requirement, it was stimulated by the programme manager who suggested to use this format to research consortia (interviewee 4). As such, many of the consortia started to integrate Living Labs in their proposals. However, they also struggled with the format, since promises were hard to keep: *"[…] you also see that a few of those projects […] especially in that start-up phase, have enormous struggles because then you quickly start making promises as a research consortium that you cannot deliver at all"*[25] (interviewee 4). Interviewee 2 similarly noted that *"[…] the impression was that people stumbled quite a bit. The government wanted it, so everyone wrote it in the grant application, but it didn't quite work out."* A potential difficulty for Living Labs to deliver results, is that the consequences of taking on a living lab approach aren't always foreseen in the process: "*What you sometimes see happening now: [...] an entire neighbourhood is labelled a Living Lab, for example, but that of course also has quite a few consequences for people who live in that neighbourhood or use it. All of them are suddenly involved. And at the same time such an area is demarcation, but that does not make it an experimental environment."*[26]

"[in the] preparation of those applications, [this programme manager] always suggested consortia to think of Living Labs. Yes, if that is of course done by the lender, it still has an influence. So that's why all those projects there also work with Living Labs." (Interviewee 4)

[24] NL: ""Het 'Mindlab 'van de Denen is een jaar of anderhalf jaar geleden opgeheven. Ze hadden een fantastisch lab waar iedereen naar opkeek, en met een verschuiving in de politiek is die veranderd in een technisch lab. [...] Het heeft een houdbaarheidsdatum."
[25] NL: ""[...] je ziet ook dat een paar van die projecten [...] zeker in die opstartfase enorme worstelingen hebben, want dan ga je als onderzoeksconsortium al snel beloftes maken die je helemaal niet kunt waarmaken."
26 NL: "Wat je nu soms ziet gebeuren . Is dat dan een hele wijk bijvoorbeeld als Living Lab wordt bestempeld maar dat heeft natuurlijk ook nogal wat gevolgen voor mensen die in die wijk buurt wonen of daar gebruik van maken . Die zijn dan ook opeens allemaal betrokken en tegelijkertijd is zo'n gebied afbakening zeg maar dat maakt het nog geen experimentele omgeving ."

In the Netherlands, networking and coalition building around the Living lab format emerged slowly. Only few Dutch Living Labs (currently four, and 11 in Belgium) are connected the European Network of Living Labs (ENOLL)[27]. This network started in 2006. According to interviewee 1, ENOLL represented an *"older understanding of the living lab concept, because they are coming a bit more from this user integrated innovation and user focused product development."* In its current set-up, it was mainly seen as 'networking' organisation. The Amsterdam Metropolitan Solutions (AMS) institute - established by the municipality of Amsterdam in 2013, with the objective to "*help us solve metropolitan questions*" (interviewee 2) - did not join because they *"do not see what [the AMS institute] can get out of it, besides networking"*[28] (interviewee 2). The AMS itself assembles the expertise from different technical universities across the country and beyond (Delft University of Technology, Wageningen University of Life Sciences and the Massachusetts Institute of Technology).

Buiksloterham (Amsterdam, Netherlands)

[27] See https://enoll.org/network/living-labs/, accessed 11/12/20
[28] NL: "[…] zie niet wat [het AMS-instituut] eruit kan halen, behalve netwerken."

"In the end they got there, so indeed the city council said: 'Okay then you are now a living lab.' But otherwise it was actually an empty shell. So then they could call themselves that, but then there was nothing attached to it, no budget attached to it, no authority attached to it." (Interviewee 4)

Figure 2 Image of SIE-I the Ceuvel area in Buiksloterham Living Lab, Amsterdam[29]

In 2009, as the concept of Living Labs was gaining recognition in the Netherlands, an initiative in the Buiksloterham area of Amsterdam emerged. In the wake of the financial crisis of 2008, and the resulting cuts in municipal budgets, a housing development project in the North of Amsterdam had been cancelled due to a lack of funds. At the same time, several city makers and civil society actors had started to gain interest in the local area. In the absence of municipal initiatives, these city makers started to develop ideas and plans for activities for that unused territory. For example, the area of De Ceuvel started to experiment with self-sufficiency, by testing whether electricity could be exchanged locally. In the words of interviewee 3:

> *"I think the municipality was more than happy that there were a couple of enthusiasts who wanted to do something there themselves. So, in that sense, […] they were happily supporting them because [they thought that] at least there was happening something, and maybe we can get something out of it." (interviewee 3)*

In 2017, the residents of the area sat together to share ideas and create a neighbourhood vision for Buiksloterham from their perspective. The residents envisioned sustainable housing, exchanging energy and energy savings. These citizens collaborate with housing corporations, the municipality of Amsterdam, the water company to realise their vision. Other players develop new technologies in Buiksloterham that might be applied beyond the area. The area has its own, citizen-run website, which includes sections on local news and planning of the local area. Whereas the Buiksloterham living lab is often considered one of the leading Living Labs of the Netherlands, the SIE-I was not framed as a living lab from its inception. In the words of interviewee 4:

> *"At a certain point those city makers […] started calling themselves Living Lab Buiksloterham because they also had to institutionalise themselves. But they were also very actively looking for such a Living Lab status. Just say that they could actually give more of a label to everything they did and for a kind of recognisability." (interviewee 4)*

However, this label did not formally offer anything, but was merely an "*empty shell*" (interviewee 4). The formalisation also led to the fact that "*a lot of the initiators from the very beginning […] find it difficult to continue to recognise themselves […], or they think it is there now and then we can do something else*" (interviewee 4). In the view of interviewee 4, this often occurs with initiatives: "*a kind of maturity that you can achieve of which it is difficult to take that step at a given moment and then also continue to have meaning.*"

New roles for civic actors: Regulatory sandboxes for associations

[29] https://amsterdamsmartcity.com/visit/book-a-tour-around-the-ceuvel accessed 30/10/2020

In the meantime, the Dutch Topsector Policy's IPIN projects on smart grids ended in 2015. These technology-oriented projects had brought government, business and science together, with a large role for grid operators. These smart grid testbeds showed that legal limitations on issues such as re-bundling market and grid activities, peer-to -peer electricity exchange, dynamic electricity prices, and network tariffs were found to be major barriers to install smart-grids (Lammers & Diestelmeier, 2017). One of the main outcomes of the IPIN projects were that legal problems and new forms of governance would need to be addressed in order for smart-grids to be implemented in the Netherlands (Lammers & Diestelmeier, 2017).

These rising concerns about legal barriers around smart-grid developments seem to have influenced the development and implementation of the 'Electricity Law Experimentation Decree' (NL: Experimenten Electriciteitswet 2015-2018). This experimental status made *"individual exemptions to Article 16, third paragraph of the Dutch Electricity Act, which exclusively assigns the task of grid operation to the designated system operators*" (Lammers & Diestelmeier, 2017b; p.216). The decree made it possible for the Ministry of Economic Affairs to grant selected (housing) associations[30] a formal experimental-status. This status allowed associations to derogate from the electricity and gas act of 1998, and to take up tasks that are legally reserved to be conducted by the grid operator. In particular, the decree was used by associations to carry out peer-to-peer grid management (in i.e. the SIE-I Vve Aardehuizen, see also box below on the Aardehuizen). The goal of this Experimentation Decree was to reveal which adjustments to the legal framework were needed to facilitate the energy transition.

Besides legal innovation, the Experimentation Decree aimed to find new modes of governance. The IPIN projects had shown that the grid operator was a leading actor in all projects, being a potential threat to actually finding these new modes of governance (Lammers & Diestelmeier, 2017). Thus, the experimentation status was only made available for housing associations and energy associations. The requirement was that these associations had to be controlled by their members, impeding grid operators and energy suppliers to control the experiments (decree article 7(1)j as cited in (Lammers & Diestelmeier, 2017)). In contrast to the other formats discussed in this case study, this regulatory sandbox format specifies a large role for a single actor: associations. We still consider it in this case study for two reasons. Firstly, whereas the experiments are indeed carried out by associations, the facilitation, learning and reflection is done by the Ministry of Economic Affairs, the Netherlands Enterprise Agency (NL: Rijksdienst voor Ondernemend Nederland, RVO) and societal learning platforms such as Generated HERE (NL: *HIER Opgewekt*). Secondly, companies, research centres, or real estate

"[the experimental status] doesn't force the grid operator to cooperate. [the grid operator] has remained passive thus far and has not reacted on simple requests. Important goals like energy saving, increasing decentral energy generation, peakshaving, and storage can also be executed without the experiment

30 In the Netherlands, an association is a legal form which is not allowed to make profit for their members. The asosciation must have a specific goal they are persuing, such as knowledge sharing, charity or collective purchases by tenants of a house (housing association, NL: vereniging der Eigenaren, VvE).

companies were important collaborators or lead-actors in many projects (Lammers & Diestelmeier, 2017). Therefore, we consider these regulatory sandboxes a multi-actor formats.

A total of 27 projects were granted formal experimental status, including the housing association Aardehuizen in Olst.

Vve Aardehuizen (Olst, the Netherlands)

Figure 3 Image of the SIE-I Aardehuizen in Olst, an ecovillage of 23 households in the Netherlands. Photo: Florian de Graaf.

Aardehuizen Olst is an ecovillage of 23 households, formalised through a housing association (NL: *VvE*) and a neighbourhood of the city of Olst, the Netherlands. The main motivation of the inhabitants is *"building, working, and living in harmony with nature, in*

connection with each other and to inspire the world"[31]. The inhabitants live in earthships (NL: Aardehuizen), which are built from local and/or reused materials and are 79% energy neutral through solar panels. In addition, they are experimenting with a smart-grid and battery to increase their self-sufficiency. Their decision-making is based on sociocracy.

In 2017, the Aardehuizen became part of the **regulatory sandbox agreement from the RVO**. Consequently, the Aardehuizen were legally allowed to operate their local electricity grid. The formal experimental-status gave them the right to take up the role of local electricity exchange. **It did not, however, provide them resources** (funding, network, knowledge) to do so, **nor did it enforce other actors to collaborate**, without whom the experiment would not be able to succeed. This is a crucial difference, which will be reflected upon later in this paragraph and in the 'power' analytical box elsewhere in this case study. Whereas the merits of the experimental status were low, applying for the status and updating it regularly cost time and energy (it is "a *bureaucratic challenge*" interviewee 12).

The Aardehuizen wished to apply their newly acquired experimental-status to be able to solve grid congestion[32] issues, by installing a local battery, and by experimenting with exchanging electricity locally. This experiment faced two main issues. Firstly, **lack of financial aid**. As such, the Aardehuizen had to acquire funding for their project elsewhere. However, the costs of the local battery and grid were only partially covered by a subsidy. They were left with the cost of 25.000 euros for peripherals (such as wiring).

Secondly, **lack of cooperation of the grid operator**, which eventually led to large difficulties in realising the experiment. In the words of interviewee 12: "*it's not like the Netherlands Enterprise Agency [RVO] calls Enexis [the grid operator] or something*". For example, the Aardehuizen requested to gather user-data in a central phase transformer outside the neighbourhood. This request was denied by the grid operator. Instead, user-data were extrapolated to a virtual transformer. This delayed the data so much, that the exchange of electricity was not possible. Moreover, the Aardehuizen did not have the appropriate data reading devices in 3 out of the 24 households. The Aardehuizen requested the grid operator to get three devices without external readability (as the households did not want to share their data due to privacy reasons). These requests were not accepted, which made it impossible to the Aardehuizen to gather the required data necessary for local electricity exchange. In the words of interviewee 12, *"based on their societal function and their role of facilitating the energy transition, you would expect a more pro-active role of the grid operator."*

The lack of cooperation from the grid operator came unexpected. This is because peakshaving by private individuals would be profitable to them. As such, interviewee 11 stated that he "*had expected that Enexis (and the other regional grid operators) to look*

[31] https://www.aardehuis.nl/nl/ accessed 10-09-2020

32 Grid congestion occurs when too much electricity is generated, congesting the local electricity grid. The problem occurs more because of variable wind/sun-based generation of electricity being unpredictable in their generation hours. Solutions are a local exchange of electricity (through i.e. a smart-grid), electricity storage in batteries, or the change of use patterns by end-users (i.e. using the washing machine when the electricity generation is high).

"We allow experimentation to see which parts of the law work against the energy transition at the moment. If the minister sees that a "collective" with a legal right for grid operation can absorb renewable electricity much better, then she (he) can change the law." (Interviewee 11)

more actively for opportunities to limit hard investments (grid reinforcement)"[33].The grid operator itself is not allowed to invest in local storage because of legal restrictions. In the words of interviewee 11, "*[…] grid operators may not trade in electricity because they manage a collective good (the networks). If they acted, they would out-compete the other suppliers and producers […]. The network operators themselves also see this as a problem, because making networks heavier is much more expensive*."

Interviewee 11 noted that "*it seems like they [the grid operator] don't feel like a partner in the experiment*."[34] An employee of the grid operator was involved in the experiment through a co-creation workshop for a European project PROSEU. However, this employee was not able to help the Aardehuizen in their experiment. He was part of the innovation department of the grid operator, and not a member of the strategic management. Interviewee 11: "*It used to be the case that the large network operator did not consider local initiatives, now it seems that the more innovative parts of this organization cannot convince the rest. Unfortunately, the result is the same, namely that there is no cooperation [between the grid operator and initiatives]*."[35] Interviewee 12 concurs and stated that this contact person was "*well-wishing, and willing to think along, but also indicated that he had no power to make the decision on [his] requests, like replacing the electric meters and monitoringshardware for user profiles on neighbourhood level*."[36] In turn, Interviewee 12 reflected that "*to get experimental things done with an organisation like a grid operator, it often depends on talking to the right person at the right time. […] For this, Enexis is difficult to understand for a private individual or group of private individuals*."[37]

In conclusion, **while the experimental-decree gave the Aardehuizen the right to experiment, it did not give them resources (funding, network, knowledge) nor did it approach the problem within the wider actor system**. The latter resulted in a lack of cooperation from the grid operator, thereby impeding experimentation.

Institutional work conducted by SIE-field- actors and other field-actors

33 NL: "verwacht dat Enexis (en de andere regionale netbeheerders) actiever zouden zoeken naar mogelijkheden om harde investeringen (netverzwaring) te beperken."
34 NL: "Het lijkt er op dat zij zich geen partner in het experiment voelen."
35 NL: "Was het vroeger zo dat de grote netbeheerder lokale initiatieven niet zag staan, nu lijkt het er op dat de meer innovatieve onderdelen van deze organisatie de rest niet kan overtuigen. Helaas is het eindresultaat dan hetzelfde, namelijk dat er geen medewerking wordt verleend."
36 NL: "was welwillend en meedenkend, maar gaf ook aan dat hij niet zelf kon besluiten over mijn verzoeken, o.a. over het vervangen van elektrameters en over monitoringshardware voor verbruiksprofielen op wijknivo."
37 NL: "om experimentele zaken gedaan te krijgen bij een organisatie als de netbeheerder hangt het vaak af van de juiste persoon spreken op het juiste moment. Daar heeft het wellicht ook aan ontbroken. Voor een particulier of groep particulieren is Enexis daarin lastig te doorgronden."

SONNET studies the institutional work of actors, defined as the activities of SIE-field-actors and other field-actors that aim to create, maintain and transform regulative, normative and/ or cultural-cognitive institutions. (Hielscher et al., 2020; Wittmayer, Hielscher, et al., 2020). In this analysis we identify the various activities by SIE-actors in creating, maintaining or transforming institutions relying on the typology of institutional work by (Fuenfschilling & Truffer, 2016).

Transition experiments: unchanged cultural-cognitive beliefs

In the 2000s (NL) and early 2010s (FL), **advocacy work** by academic other field actors led to the large-scale **regulatory institutionalisation** of transition experiments within national environmental policy. Both NMP4 (Netherlands) and VIA (Flanders) envisioned a large role for civic dialogue and societal actors in experimental formats, but became dominated by vested interests of large regime actors (i.e. Shell, as discussed in Paredis, 2013b; Smith & Kern, 2009a). Consequently, the energy system remained dominated by these regime actors and existing unchanged **cultural-cognitive beliefs around roles** within the energy system.

SIE-I Aardehuizen: advocacy to change cultural-cognitive beliefs

The SIE-I Aardehuizen were part of a regulatory sandbox experiment provided by the national government. The regulatory sandbox experiments provided a space for associations to do institutional work, this is, to transform regulatory institutions around the governance of grid operation. The SIE-I struggled to realise their experiment and thereby transform these regulatory institutions. This was partly because they could **not construct interorganisational networks** and were confronted with a **lack of access to resources.** The Aardehuizen attempted to involve the grid operator in the project to link the local experiment to the wider grid, but this did not materialise in practice (see also box on SIE-I Aardehuizen). Moreover, they lacked the resources (monetary /knowledge/network) to fully execute the work necessary for regulatory change (see also box on SIE-I Aardehuizen). However, the Experimentation Decree allowed the Aardehuizen to engage in **advocacy institutional work** (i.e. news coverage, blogs and project websites) and to spread their **beliefs** around peak-shaving and grid management.

SIE-I Buiksloterham: labeling to broadcast beliefs

The use of certain labels, such as 'living lab' or 'experimental status' helped in the institutional work of **constructing identities and to relate actors to one another.** The SIE-I Buiksloterham for example drew on the living lab label to build an identity but this did not come with any other resources. Thus, in a similar fashion as the SIE-I Aardehuizen, the living lab status helped the SIE-I Buiksloterham to **share their beliefs** around their methodology and project to a wider audience, it did not provide a means to changeregulatory institutions.

SIE-I Stadslab2050: shifting cultural-cognitive and normative institutions

The SIE-I Stadslab2050 also mainly engages in **shifting norms and cultural-cognitive beliefs**. In the words of interviewee 7B, "*you always see three things come to exist: there's knowledge build-up […], network is build up, and mostly that network stays intact after the projects […] and one layer, you see a shift in mindset […]"*[38]. **In the SIE-I Stadslab2050 projects, a change in norms, discourse and cultural-cognitive beliefs often emerges in project participants. Regulatory changes often occur at a later stage and as a consequence of these normative changes.** An example of institutional work is a water innovation project for the Garden Streets in 2017 (NL: Tuinstraten). The project did not initially lead to regulatory changes. Rather, it led to a change in discourse in the city department: 'designing with water' became the norm. This resulted in a new innovation project Antwerp breaks out (NL: Antwerpen Breekt Uit) and Climate Resilient Roofs (NL: Klimaatrobuuste Daken). In the end, the learning trajectory of the experiments gave incentive to re-evaluate the citizen premiums for roof innovation, thus resulting in regulatory changes. In another project 'fashion flows' on textile and the circular economy, the project led to an increase in knowledge amongst associated partners, resulting in an online tool[39] and a change in discourse: textile is considered an important resource by the partners[40], rather than a waste stream. To realise these changes in institutions, the city lab actively engaged potential partners, provided financial support to experiments, created a network through active communication and events and actively promoted self-reflection amongst associated partners on their role in the transition after the trajectory.

Whereas the SIE-I engages in regulative institutional work in the water and material sector, interviewee 7B states that "*in energy this is much harder, maybe also because it is less at a local level*." Only recently, the Stadslab2050 became involved with a city lab trajectory around energy poverty in 2020: Gelijkstroom, which is financed by the European Union's research and innovation programme Horizon 2020 through the SONNET project and the municipality of Antwerp. While the experiments are still running, initial results show that the project resulted in a thematic call on social innovation in the energy transition as part of the project fund of the municipality of Antwerp (NL: projectenfonds). This fund had existed for a while before Gelijkstroom started. Due to a reformation of the fund, the project leads of the Gelijkstroom trajectory saw the opportunity to suggest a thematic call on social innovation in the energy transition in the project fund. The cabinet thought this to be a good idea. As such, the city of Antwerp will launch a thematic call for projects on social innovation in the energy transition in 2021 (interviewee 7A).

In sum, institutional work by bottom-up and local SIE-field-actors mainly occurs on a **normative or cultural-cognitive level**. Whereas national policy plans and initiatives might broadcast ambitious plans to transform regulatory institutions through integrating local civil society, societal and municipal actors, the latter actors are often not empowered through resources, network or authorisation to put in the required effort to do this transformational work (i.e. SIE-I Stadslab2050, Buiksloterham and Aardehuizen). A more

38 NL: "Je ziet altijd drie dingen ontstaan: er wordt kennis opgebouwd [...], het netwerk wordt opgebouwd, en meestal blijft dat netwerk intact na de projecten [...] en een laag daarboven zie je een verschuiving in mindset [...] " (Interviewee 7b)
39 www.close-the-loop.be/nl accessed 25/1/2021.
40 See also https://www.ovam.be/circulaire-mode-en-textiel-0 accessed 25/1/2021.

general point that warrants further research is to which extent certain experimental formats such as Living Labs or regulatory sandboxes, are actively **mimicking** existing triple-helix formats such as transition experiments or Topsector R&D pilots. Thus the extent to which they strategically combine new practices (the inclusion of users or citizens) with existing ones (a focus on technology, and on business, state and academic actors in the lead) to ease their adoption and thus the creation of new institutions; or whether this is more a process that could be understood following the ideas of **'institutional isomorphism'**, that new formats in a certain system tend to assimilate over time; or whether it is optimisation of existing formats. With the exception of the last phase, the relative lack of concerted action by experiments including educational efforts, which might also be due to their temporary character, does stand in the way of broader influences and on embedding such new ways of doing, thinking and organising.

"A lot of these experiments were stuck to 2-4 year project boundaries, and so long as the funding was there [...] but then afterwards the continuity was often not given And then they basically stopped and a lot of the insights and learnings basically were gone." (Interviewee 11)

PHASE C: Taking stock and reorientation (2017-now)

In phase A and B, transition experiments and living lab formats received large amounts of national funding. However, after project funds ended, the different labs faced issues of continuity (interviewee 1) – being faced with the dissolution of the project frame and possible loss of learnings. In an environment that focuses on innovation and experimentation through project-structure, concerns about continuity are a well-known phenomenon (for an example from the social domain, see (Giltay Veth, 2009). Simultaneously, the signed Paris Climate agreement and the environmental pressures it stands for, also put Dutch innovation policy and the different multi-actor collaborative formats it promoted under pressure. From 2017, the SIE-field went into a phase of taking stock and reorientation.

Power and power relations (power to + power over + power with)
SONNET studies the power relations that enable or impede the SIE-field and vice versa. SONNET builds on Avelino (2017) in understanding power as the relational and structural (in)capacity of actors to mobilise resources and institutions to achieve a goal. SIEs can refer to the resources being mobilised and/or the goals being aspired (D1.2). SONNET distinguishes between "power to mobilise SIE-related resources and/or to achieve SIE-related goals (incl. (in)equality and in/exclusion), power over others in SIE-related processes (including dependency, oppression & exploitation), and power with other actors to achieve collective (SIE-related) goals" (Wittmayer, Hielscher, et al., 2020) **Power to**

The primary goal of the experiments discussed in this case study is to **foster innovation**, **in some shape or form.** This innovation might be technical (i.e. in the Topsector R&D pilots, smart grid IPIN projects, technical Living Labs) or social, such as developing new governance arrangements or legislation (i.e. societal Living Labs, and the regulatory sandboxes). What all these experiments share is a goal to create resources to change the current dominant way of doing, thinking or organising the energy system. While the experiments might aspire for innovation, they might end up reproducing existing structures and institutions. To explain this thought, we delve into the power typology of Avelino on the "*nature of the power exercise in relation to stability and change*" (Avelino, 2017; p.509). Here, Avelino proposes the distinction between **reinforcive, innovative and transformative power**. According to Avelino, *"innovative power is the capacity of actors to create new resources"*, whereas *"transformative power is the capacity of actors to develop new structures and institutions*" and reinforcive power "*is the capacity of actors to reinforce and reproduce existing structures and institutions*" (Avelino, 2017; p.510). Seen through the lens of this typology, the experiments discussed in this case study aim to exercise innovative or transformative power (that is, the results of their experiment, test bed, or living lab are to be new resources, institutions or structures).

Whereas indeed, on the one hand, they possess the power to create new resources (and thus innovative power**), they experience difficulty to realise change in the system and thus their transformative power remains limited**. An example is the SIE-I Aardehuizen. The formal experimental-status gave them the right to take up the role of local electricity exchange. It did not, however, provide them resources (funding, technology, network, knowledge) to do so, nor did it enforce other actors to collaborate, without whom the experiment would not be able to succeed. In particular, the lack of cooperation of the grid operator was deemed problematic by the Aardehuizen. The grid operator did not cooperate in requests for certain approaches towards rerouting their data management, nor did they provide the necessary devices for reading the data quickly enough for local electricity exchange. This eventually resulted in a lack of experimentation. As such, the SIE-I did not fully had the power to experiment.

Power over

In this SIE-field, 'power over' occurs within experimental formats (i.e. differences in knowledge amongst experimenting actors), or between the experimental format and their context (i.e. dependency on outside funding).

The latter relation, between the experimental format and their wider context, comes back in several instances in the case study. In the words of interviewee 7A, "*these types of projects will always need public funding*." As experiments often need funding, resources, political will or network from outside, governments often have power over experimental formats. For example, the cabinet of the city of Antwerp has power over SIE-I Stadslab2050, a change in political climate led to the disappearance of Stadslab2050 as a brand in the city of Antwerp. Instead, the brand of the SIE-I Stadslab2050 became absorbed in the wider climate policy of the city (see also the box on SIE-I Stadslab2050). Similarly, the Ministry of Economic Affairs has power over the SIE-I Aardehuizen, because they control

the amount of experimental space that is provided within the electricity law. Lastly, public funding agencies like JPI and NWO have power over living lab formats, as they provide the funding necessary to carry out the experiment.

These observations relate to the notion of the pilot paradox, where the ingredients that initially allowed the experiment to be successful, eventually lead to their discontinuation (van Buuren et al., 2018). Experiments thrive on the empowering resources granted by external parties, but their dependency on these factors also lead to their discontinuation when funding periods end.

Power with

This SIE-field assumes a certain level of 'power with' from the get-go: multi-actor configurations experiment for a shared goal. Moreover, collaborations are facilitated by top-down induced learning networks. Transition experiments and Topsector R&D pilots have been accompanied by national learning and reflection programs, such as the TKIs of the Topsector R&D pilots making space for experiments to learn, reflect and network. Similarly, the Testbeds Gas-free Neighbourhood are accompanied with learning and reflection networks that allow exchanges between testbeds. An open question of this study remains the extent to which these programmes and networks are considered helpful and for which end. Also, not every living lab sees the benefit of networking for the sake of networking (i.e. AMS institute not seeing the relevance of international networks such as ENOLL, interviewee 3) – we currently see some attempts towards more bottom-up organisation of lessons and learnings (e.g. the Amsterdam Living Lab Summit).

Having witnessed the development of many Living Labs across the Netherlands, the Rathenau Institute (charged with providing insights on the societal aspects of science and technology) initiated two evaluations of the phenomena in 2017 and 2020 (Maas et al., 2017b; van den Broek, van Elzakker, Maas, & Deuten, 2020). According to interviewee 3, these reports arose from the feeling that "*if you put money into it, you can also ask yourself: what do we get for that in return? And in which way does it contribute to the public goals and the private goals? In particular because of the large promises that were made*." [41] (interviewee 3). The first report took stock of Living Labs in the Netherlands: it provided an overview of the variety of Living Labs in the Netherlands, the actors involved and their contributions (Maas et al., 2017a). The second report specifically **focused on scaling up** to increase the impact of Living Labs and go beyond "local enthusiasm":

[41] NL: "Als je er geld in stopt, kun je je ook afvragen: wat krijgen we daarvoor terug? En op welke manier draagt het bij aan de publieke doelen en de private doelen? Vooral vanwege de grote beloftes die zijn gedaan."

"The aim of this study is to help prevent Living Labs from getting stuck in local enthusiasm. We want to do this by developing a perspective on upscaling of experimental solutions from Living Labs to innovations that are applied in multiple places by multiple users."[42] (van den Broek et al., 2020)

However, the focus on upscaling is not considered unproblematic. According to the work of interviewee 10, it is not about scaling up, but rather about "*anticipating barriers to the further spread*" of solutions originating from living lab experimentation (interviewee 1). Referred to as Living Lab 2.0 (i.e. in the special issue forthcoming by Wolfram, Ravetz, & Scholl, 2020), this perspective on Living Labs prescribes them as being oriented on "*experiments and outcomes, and that you cannot forecast them*" (interviewee 1).

Contestations and relations between actors

SONNET studies the contestations and relations of actors in the SIE-field over time. SIE-field contestations can occur amongst SIE-initiatives and other field-actors over field structures and processes (Fligstein, 1997).

A first contestation concerns the **different ideas about the approach, method, vision and participants of Living Labs**. According to Maas and colleagues (2017), Living Labs can be characterised as 'co-creation testing environment in real-life spaces' (Maas et al., 2017a). However, this is but one approach. The contestations can be exemplified by two SIE-field- actors: the AMS institute and the Living Labs they facilitate and the SIE-I Stadslab2050. The AMS institute follows the tradition of the Urban Living Labs (ULL). According to Steen & Van Bueren (2017), ULLs are aimed at formal learning, involve public actors, private actors, users and knowledge activities, and take place in a real-life use context of the innovation (Steen & van Bueren, 2017). These Living Labs are often centred around solving societal issues through technology. The SIE-I Stadslab2050 is oriented at solving socio-environmental problems through co-creation with citizens, focusing mainly on behavioural and institutional change.

There are also different perspectives on the **scope of the experiments**. On the one hand, experiments should be focused on **scaling up**, increasing in size, and becoming relevant beyond an immediate local area. For example, the Rathenau Institute wanted to "*help prevent Living Labs from getting stuck in local enthusiasm"* (van den Broek et al., 2020). Similarly, the Testbeds Gas-free Neighbourhoods envisioned national roll-out after local experimentation. However, **other perspectives encourage context specificity of experimentation.** In the words of interviewee 4, experiments need to be *"innovation[s] that fit in its context in all forms:*

[42] NL: "Het doel van dit onderzoek is om te voorkomen dat Living Labs vastlopen in lokaal enthousiasme. Dit willen we doen door perspectief te ontwikkelen op het opschalen van experimentele oplossingen van Living Labs naar innovaties die op meerdere plekken door meerdere gebruikers worden toegepast. "

up to and including the people who live there, culture, institutions, physical environment and conditions." According to interviewee 4, this context specificity is increasingly lost. This is partly because of the depolitising nature of experimentation: labelling something as a living lab *"depoliticises and that shows decisiveness. […] Then the question is: what do you realise in that? When you do not specify that properly, political accountability also becomes complicated. That is why it is also a safe choice."* To this, interviewee 4 adds: *"what you sometimes see happening now […] an entire neighbourhood is labelled a Living Lab, […] but that does not make it an experimental environment."*

"Funding is always in projects and it is therefore very difficult to get hands on [learning between different Living Labs] for this and even at ministries, but also in scientific funding, there is still a lot of focus on implementation and outcomes and there is very little very little attention actually to be able to address issues at this level." (Interviewee 4)

Living Labs also started to address issues around the continuity of their experiments. Whereas the Living Labs of the start of the decade had focused primarily on learning within their project, the end of the decade was characterised by increasing attention on learning between projects. In the words of interviewee 4, "*we [living lab researchers] are currently also busy by just seeing each other in between and just exchange and develop knowledge together*"[43]. However, as stated by interviewee 4, funding for these informal learning meetings was lacking and proved a barrier to realise such exchanges. As more formal learning opportunity between Living Labs, the Urban Living Lab Summit was organised by the AMS institute - for the first time in 2019 with the intent to provide a yearly learning platform. The idea of the summit was to "*explore tools that are used [in Living Labs] and ways to standardise them*" (AMS institute, 2020). Invitees to the summit were actors, who were working in Living Labs and wanted to take part in knowledge sharing: researchers, municipalities, and businesses.

"In this way we try to find many people that are actually busy with designing the questions and the implementation, of: how do you actually do that, a Living Lab? Because on a more abstract level there are more people who can reflect upon it. But it's mainly the 'feet in the clay', from that perspective, that's where we seek the collaboration." (Interviewee 4)

Not only the Living Labs format was evaluated, also the R&D Topsector Policy (2011-2017) underwent an assessment in 2017. This evaluation stated that the policy *"[would have to] put more emphasis on societal challenges and pioneering solutions"*[44] (Janssen et al., 2017; p.101). As such, the policy was renamed into 'Mission driven Topsector and Innovation policy' (NL: Missiegedreven Topsectoren- en Innovatiebeleid) in 2019. This policy reinstated the experiments and pilots of the previous years, but with a larger focus on tackling energy and climate challenges through investing in "key technologies" that would form a solution to multiple environmental pressures (Ministry of Economics and Climate, 2019). According to Mona Keijzer, State Secretary of the Ministry of Economic Affairs and Climate Policy: "*by jointly establishing 25 missions within these themes, our entrepreneurs from SMEs to large companies and knowledge institutions can immediately think along and then get started with the solutions*"[45] In line with the public-private financing partnership of the previous Topsector Policy, business, knowledge institutes and governments are to collaboratively invest €4,9 billion euros in innovation. Dutch

[43] NL: "Nu ook bezig om tussentijds gewoon elkaar op te zoeken en uit te wisselen en gewoon gezamenlijk kennis verder te ontwikkelen."
[44] NL: "[zal] meer nadruk [moeten] leggen op maatschappelijke uitdagingen en baanbrekende oplossingen"
[45] NL: "Door binnen deze thema's samen 25 missies op te zetten, kunnen onze ondernemers van MKB tot grote bedrijven en kennisinstellingen direct meedenken en vervolgens aan de slag gaan met de oplossingen."

innovation policy thus became more oriented towards certain missions, in line with a broader trend towards transformative innovation policy (Diercks, Larsen, & Steward, 2019; Schot & Steinmueller, 2018).

Key changes in the SIE-field over time

SONNET also studies the key changes in the emergence and development of the SIE-field or in its relationship with the 'outside' institutional environment. We consider a SIE-field as "an arena/space that includes a specific SIE as well as SIE-field-actors working on it and other field-actors enabling and/or impeding it." (Hielscher et al., 2020). We have identified two key changes in the development of the 'participatory experimentation and incubation' field in the Netherlands and Flanders. These concerns both the multi-actor collaborative formats and the closely related actor composition of the SIE-field refers to the diversity and roles of SIE-field- actors and the main parameters for experimentation (see Table 1).

Starting in the 2000s, the SIE-field mainly comprised businesses, national government and (technical) universities. The main multi-actor collaboration formats can be categorised as triple-helix configurations (i.e. Etzkowitz & Leydesdorff, 1995) – driven by collaboration of business, science and government. The triple-helix format dominated the transition experiments of the 2000s (i.e. discussed in Kern & Smith, 2008; Paredis, 2013b; Smith & Kern, 2009), the transition experiments of the VIA policy in Flanders of 2009-2014 and the Topsector Policy's R&D pilots of 2011-2020. These formats - often heavily funded by market and state subsidy – dominate experimentation in the energy system until approximately 2013. This is in in line with what (Diercks et al., 2019) consider a narrow perspective on both the innovation process and the policy agenda

The first change is an increasingly prominent role for local governments, citizens and users, civil society and non-profit actors, who also became SIE-field-actors or led SIE-initiatives, around that time. This plays into the then apparent trend of decentralisation and a retreating state (see analytical box on outside institutional environment). Municipalities, energy stakeholders and civil society started to experiment in Living Labs (i.e. SIE-I Stadslab2050, SIE-I Buiksloterham). Municipalities played a large role in Living Labs; two third of the Living Labs in the Netherlands involved a municipality also as funders (Maas et al., 2017a). Around this time, associations, grid operators, and national governments started to experiment through an experimental decree, which created regulatory sandboxes and allowed associations to take up certain responsibilities of grid operators (i.e. see box on SIE-I Aardehuizen). This is in line with what (Diercks et al., 2019) consider a broad perspective on the innovation process in terms of actors, activities and mode of innovation.

A second key change concerns the focus of the experimentation. While the main share of national R&D policy still focuses on technologies and their market readiness, we have also seen experimentation with governance arrangements, new roles and activities

of energy actors or business models. With the current strengthened link of R&D policy with broader environmental missions - this might open a further re-orientation from technological to social and institutional innovation and from economic growth to sufficiency. This then is in line with a broad perspective on the policy agenda in terms of policy objectives, domains and logics (Diercks et al., 2019).

In the meantime, in 2019, several Ministries initiated a **national climate agreement** as a response to the Paris Climate Agreement of 2016. The goal of the agreement was to find a "*package of measures with the widest possible social support, which has the active support of as many contributing parties as possible and which will achieve the political reduction target of 49% by 2030*" (*Klimaatakkoord*, 2019; p.2). Like the energy agreement, the climate agreement was to emerge from a collaboration of actors across all societal spheres – focusing discussions on a number of sectors with each their 'table' for negotiation - in Dutch poldering fashion. Allegedly, this would lead to "*continuity and acceleration in the energy transition*"(*Klimaatakkoord*, 2019; p.6). Next to the traditional parties such as the Ministry of Economic Affairs and Climate Policy, the waterboards, the major energy companies, grid operators and a technical university, the Electricity sector table also included environmental organisations, a start-up and an interest organisation for citizen- and community driven energy production. As a result, demonstrations, pilots and experiments are to be subsidised for a total worth of 30-40 million euros. A taskforce innovation was responsible for the cross-cutting innovation agenda, the KIA (NL: *Kennis- en Innovatieagenda*). The KIA integrated the innovation agendas of the climate agreement, as well as that of the Topsector Energy.

"[There is still] a lot of innovation and cost reduction needed. That is why we are starting with Natural Gas-Free Neighbourhoods and an innovation program to systematically learn and experiment, so that a cost-effective upscaling and roll-out can take place after this cabinet term." (Klimaatakkoord, 2019, p.19)

The climate agreement was characterised by a large focus on regions, neighbourhoods, cities and civil-society, and an exemplary innovation programme **is 'Program Testbeds Gas Free Neighbourhoods' (NL: Proeftuin Aardgasvrije Wijken, PAW),** in which 27 testbeds experiment with gas-free heating solutions. The partners involved are 31 municipalities, societal actors, knowledge institutes and energy actors. This programme emphasizes the importance of upscaling and rolling-out the knowledge acquired after the project ends (Klimaatakkoord, 2019; p.19). The programme is assisted by a learning network, which is aimed at 'inventing the wheel together': *"As a knowledge and learning program we connect municipalities with each other. Local learning within living labs does not automatically contribute to an acceleration of the transition process. That is why we make learning experiences and knowledge accessible to all municipalities. We often do this by organizing meetings for policy officials, but also for administrators and council members. […] This is how we invent the wheel together, instead of*

each individually." 46 (Aardgasvrijewijken.nl, n.d.). PAW is planned to receive 435 million euros of funding in its running time between 2019-2028 (van Elburg et al., 2018). An example is the testbed gas-free Neighbourhood Pendrecht, Rotterdam. The project aims to connect all houses in the neighbourhood to a local heat grid. The project is managed by 4.5 FTE of the municipality of Rotterdam, and involves housing corporation Woonstad, energy supplier Nuon, program managers from the National Programme of Rotterdam South (NL: Nationaal Programma Rotterdam Zuid, NRPZ) and Housing Association 010 (NL: Vereniging van Eigenaren 010, VVE010). The project has received a national government contribution of 6 million euros[47]. An evaluation on the Pendrecht testbed in 2019 states that "*the board [of the municipality] thinks it to be crucial that the municipality is a learning organisation*" (PAW, 2019; p.1). The lessons learned in the testbed will be shared in the national programme.

In sum, this phase is characterised by an attitude of taking stock and reorientation: problems with continuity in Living Labs led to an increase in sharing lessons learned and increasing focus on scaling-up local experiments. This focus on scaling-up were further accelerated by increasing environmental pressures formalised in the Dutch Climate Agreement in 2019, leading to the inception of 27 Gas Free Neighbourhood testbeds.

Inter-field interactions

SONNET studies the phenomenon of inter-field interactions between various SIE-fields, and how these have enabled or impeded the SIE-field. A particularly related SIE-field is that of *Participatory Energy Dialogues* (Wittmayer, Fraaije, Hielscher, & Avelino, 2020). This SIE-field is characterised by organised dialogues between actors on (sustainable) energy, initiated by community or public actors. The boundaries between this SIE-field and participatory experimentation and incubation are very thin at times, since there are formats that combine a dialogue aspect with an experimentation and incubation aspect. The 'transition arena' as a format for example, combines dialogue as a way to formulate a narrative and theory of change with actual transition experimentation on the ground - monitoring activities keep these two aspects connected and advises for changes in one or the other (D. Loorbach, 2010; Wittmayer & Loorbach, 2016)

[46] NL: "Als Kennis- en leerprogramma verbinden we gemeenten met elkaar. Lokaal leren binnen proeftuinen draagt niet automatisch bij aan een versnelling van het transitieproces. Daarom maken we leerervaringen en opgedane kennis toegankelijk voor álle gemeenten. We doen dit veelal door bijeenkomsten te organiseren voor beleidsambtenaren, maar ook voor bestuurders en raadsleden. Hierbij differentiëren we naar de fase waarin gemeentes zich bevinden. Zo vinden we samen het wiel uit, in plaats van ieder apart." (Aardgasvrijewijken.nl, n.d.)

[47] https://www.aardgasvrijewijken.nl/proeftuinen/proeftuin+pendrecht/default.aspx accessed 21/01/2021.

Especially important for the development of the participatory experimentation and incubation SIE-field were the dialogues that have been organised for the energy agreement in 2013, as well as the climate agreement in 2019. Firstly, these inter-field interactions have **broadened the diversity of actors** involved in multi-actor experimentation. The energy agreement included actors from societal spheres, civil-society, and decentralised energy suppliers. This was different from the more traditional triple-helix configurations of the Topsector Policy. The climate agreement wanted to follow this 'broad support' of the energy agreement, and included actors from diverse societal spheres: from incumbents to niche-players and those representing societal actors (Nijpels, 2019). Moreover, the agreement stressed the importance of residents' active involvement: "*the cabinet supports the possibility for residents to participate in local energy projects.*" (Klimaatakkoord, 2019, p.16). Secondly, the climate agreement had increased the focus of the SIE- field to **regions, neighbourhoods and cities.** In this way, the multi-actor formats emerging from the climate agreements specified a large role for **municipalities experimenting in their local environment**. Exemplary experiments are those as part of the Program Testbeds Gas Free Neighbourhoods (NL: *Proeftuin Aardgasvrije Wijken*). In these testbeds, 31 municipalities, societal actors, knowledge institutes and energy actors (niche and regime) are involved ("Overzicht van Partners, Green deel Aardgasvrije Wijken," 2017). In line with the overall attitude of scaling-up, the project emphasises the importance of rolling-out the knowledge acquired after the project ends.

Other closely connected SIE-fields are those in the 'doing' and 'cooperation' category of the SONNET typology of SIE (Wittmayer, Fraaije, et al., 2020), since these focus on addressing real-life challenges in their local settings - e.g. by founding an energy cooperative or collaborating in bulk purchase or for collectively building houses. The question arises where does 'experimenting' end and 'implementation' start? This boundary is not a clear one, since also those initiatives do have learning as one of their aims but are less specifically oriented at trialling something that is a complete novelty, since the risk and costs of failure are arguably higher with less dedicated experimentation budget available. One instance where such a difference between 'experimenting' and 'implementation' is vague, is in the case of the SIE-I Aardehuizen in Olst. The Aardehuizen were marked an official 'experiment' by the national government (see also analytical box on SIE-I Aardehuizen). However, in conversation with the initiative, and from their documentation, they don't portray themselves as experimenters, but rather as implementation oriented.

Regulative, normative and/ or cultural cognitive institutions

SONNET studies the institutions that have shaped the SIE- field. These include regulative institutions (laws, rules, standards, and policies), normative institutions (norms and value systems) and cultural-cognitive institutions (shared conceptions of reality, binding expectations, common beliefs) (Hielscher et al., 2020; Wittmayer, Hielscher, et al., 2020).

Regulative institutions play an important role in shaping the SIE- field. In particular, environmental and innovation policy have had a large impact on the SIE- field. Examples are the transition policy of the 2000s, the Topsector Policy of the 2010s in the Netherlands and the VIA policy in Flanders. These policies incentivise the collaboration of market, science and state actors in experiments and innovation.

A main **cultural-cognitive institution** is that of **techno-optimism**. Techno-optimism is when technological innovation is key in solving persistent societal problems (i.e. climate change). The Topsector Policy R&D pilots and the Technical Living Labs are exemplary of this. According to interviewee 3, many living lab formats are optimistic about the potential of technology in the Netherlands, *"without awareness of how difficult it is to get a new technology to develop, and to make a technology really useful to the new problems that those technologies pose."*

Perceptions of actor roles are subject to normative ideas. These norms were especially robust in the 2000s, when the transition experiments of the NMP4 and VIA policies envisioned a large role for societal actors, the experiments became dominated by large incumbents. In later stages of the innovation history, an increasing involvement of prosumers, associations and societal actors in the energy transition started to shift these perceptions.

6 Summary, synthesis and conclusions

6.1. How do SIEs and SIE-fields emerge, develop and institutionalise over time?

This innovation history has outlined the emergence, development and institutionalisation over the last twenty years of the SIE-field of actors working on or enabling/impeding different collaborative multi-actor formats for experimentation and incubation with novel energy solutions in specific local settings in the Netherlands and Flanders. The development of the SIE-field has been described along three overlapping phases, each of which stands for a change in the actor constellation of the SIE-field as well as a change in the formats used for experimentation and incubation. Through our approach, we thus explored critical shifts in the understanding and practice of multi-actor collaborative formats. On the one hand, societal shocks (such as the financial and economic crisis) have been decisive windows of opportunities for certain actor constellations to push the boundaries of existing ways of doing, thinking and organising incubation and experimentation. On the other hand, ensuing pressure of ongoing trends (i.e. environmental pressure) also played a role in shifting understanding and practice of multi-actor collaborative formats. However, these latter influences only become influential once institutionalised (i.e. Paris Agreement, Energy Agreement and Dutch Climate Agreement). Our approach also shows that the multi-actor collaborative formats are not developing in a linear manner, rather they meander. An example are the transition experiments, which were preceded as well as followed by R&D-oriented triple-helix orientations. Thus, the concept of 'innovation' is contrived: innovation is not necessarily positive, new, or radical. Rather, it is a difference in thinking, organising or doing as compared to the previous main dynamics.This innovation history starts with the fourth Dutch National Environmental Policy Plan (NMP4) in 2001, which signifies a proliferation of energy-related experiments – framed as transition experiments and set in a context of learning processes for structural societal changes, i.e. energy transitions. This NMP4 and the ensuing energy transition policy that installed many transition experiments was influenced by developments in what SONNET refers to as 'outside' institutional environment during the last decades of the 20th century: the recognition of the scale and interrelatedness of social and environmental problems (e.g. Brundtland report, Agenda 21), the move towards multi-actor collaborations to address such problems (as e.g. in science and in R&D policy) and the recognition of

the importance of the local level in addressing them (as e.g. in Local Agenda 21). The NMP4 and the energy transition programme were certainly also shaped by learnings from innovation programmes before the turn of the century as well as from an emerging network of scientists giving shape to the concept of structural systemic change, i.e. transitions (D. Loorbach, 2007).

During this **first phase of experimentation and incubation (2000-2013)** the formats used were transition experiments, in which business, state and science were collaborating towards addressing a 40-60% reduction in carbon dioxide emissions by 2030 (as compared to 1990) (Ministerie van Volkshuisvesting Ruimtelijke Ordening en Milieubeheer, 2001). These formats thus followed a triple-helix approach and had the ambition to be part of a broader societal learning process, to combine technology with social and cultural factors and to involve broader actor constellations and thus increase actor diversity in the energy sector. However, in the implementation, these experiments maintained dominant institutions rather than challenging those or creating new ones: with a focus on business solutions, efficiency and technology, it remained a technocratic (Smith & Kern, 2009b) and "corporatist approach" (Hendriks (2008), p.196 chapter 9 of Kemp, 2012). Also, after the financial crisis of 2007 and the ensuing recession, the Dutch government continued with this approach and triple-helix collaboration in formats such as Topsector R&D pilots and smartgrid testbeds. This phase is thus testimony to formats that focus on a strong collaboration between public actors, (technical) universities and (large) energy business.

The start of the **second phase of experimentation and incubation (2009-2017)** was identified in the aftermath of the financial crisis and the following recession. This crisis made space for and demanded citizens and civil society at large to take up new tasks and responsibilities that had hitherto been taken up by the now financially struggling state – often without additional funds or resources (e.g. Tonkens, Grootgegoed, & Duyvendank, 2013). Since the decentralisation of several tasks in the social domain also fell in this timeframe, local levels of governance increasingly became more important players. During this phase, new collaborative multi-actor formats emerged allowing local governments, citizens and users, as well as non-profit organisations to take up a role in experimentation – this meant that also the composition of the SIE-field changed since these new actors started playing a role and new SIE-initiatives, working on such formats emerged. The

emergence of Living Labs as a collaborative multi-actor format was driven by local municipalities and researchers, often with national research funding (e.g. from NWO) that was channelled via international programmes (e.g. EU Joint Programming Initiative Urban Europe). We differentiate between Living Labs that have a focus on developing and implementing technology and others that start to address issues and questions around appropriate business models and governance arrangements of energy related challenges, such as energy poverty or decentral grid management. While the latter Living Labs were the strongest in broadening the scope of the SIE-field and its actor constellations, also national innovation policy started to include new actors, namely those that are motivated by environmental concerns (rather than or in addition to profit orientation): energy cooperatives and associations. The 2013 Energy Agreement led to experimentation by energy cooperatives with crowdfunding and the 'Electricity Law Experimentation Decree' (NL: Experimenten Electriciteitswet 2015-2018) allowed associations to take up tasks that had been reserved to grid operators. Both were meant to learn about legal and regulatory barriers.

The **third phase (2017 – now)** is marked by an increasing push for reflection, learning and stock taking, which is set against a background of heightened environmental pressures leading to the adoption of the international Paris Agreement in 2016 in the context of the United Nations Framework Convention on Climate Change, and the ensuing climate agreement in the Netherlands in 2019. Especially the living lab formats are now evaluated linked to discussions of mechanisms for sharing learnings, scaling up results or anticipating drivers and barriers. Addressing those issues means addressing open questions towards the further institutionalisation of these formats. It is too early to fully understand the implications of the re-evaluated national R&D and innovation policy, the 'Mission driven Topsector and Innovation Policy' which is to be closely linked to the implementation of the Dutch Climate Agreement and was adopted in 2019. Its focus on 'key technologies' and on triple-helix experimentation suggest a continuation of rather than a radical reorientation from earlier experimentation formats. Notwithstanding, actors who entered the SIE-field during the second phase have become more established as has the broadened focus on social innovations next to a steadied focus on global climate and energy problems. A point in case is the currently running neighbourhood scale experimentation to arrive at gas free heating systems, which is financed by national Innovation policy and puts local governments in the driving seat of experimentation.

6.2. How do SIE-field-actors and other field-actors interact with the 'outside' institutional environment and thereby co-shape the SIE-field over time?

The SIE-field (and its actors) – participatory experimentation and incubation - are nested within an 'outside' institutional environment linked to an energy system that is constituted by formal and informal institutions that shape the activities of actors within the SIE-field. We want to understand how dominant institutions (regulative, normative and cultural-cognitive elements) within the 'outside' institutional environment influence the emergence and development of multi-actor collaborative formats for experimentation.

There are a number of key institutions that have been shaping the development of the SIE and the SIE-field over time. Firstly, national innovation policies (regulatory institutions). These enabled many of the multi-actor collaborative formats that have been studied in this innovation history (see Table 1) by providing funding as well as a learning programme and access to networks. They also mainly kept the status quo of both the innovation process with regards to who could be incubating or experimenting and how (i.e. triple helix constellations focusing on technological innovation) as well as the focus of the policy agenda, in terms of policy objectives, domains and logics (i.e. economic growth) (cf. (Diercks et al., 2019). Over the last twenty years, Dutch innovation policy has been rather resilient and only when presented with a broader societal shock (e.g. financial crisis) or the institutionalisation of broader societal pressures (e.g. through the Dutch Energy Agreement, or the Dutch Climate Agreement) has it opened up towards a broader understanding of who experiments and incubates with what as well as on the overall goals of such a policy.
Secondly, the SIE-field has been shaped by raising environmental concerns (change in cultural-cognitive institution) - which manifest in discourses, international agreements, and policies such as the Dutch National Environmental Policy Plan 4 (2001), Energy Agreement (2013), international Paris Agreement (2016), or the Dutch Climate Agreement (2019). While in 2001, environmental concerns kick-started the energy transition programme with its focus on transition experiments, the latter two

provided impetus for a more mission-oriented innovation policy - and thus the opening up to a policy agenda that is more oriented twoards societal questions rather than economic growth or technological development only. Whether this mission-orientation will lead to drastic changes in the SIE-field remains to be seen.

Thirdly, in addition, the international financial crisis and ensuing recession of 2008-2011 including governmental budget-cuts and an overall move towards the decentralisation of governmental tasks towards municipal level (change in regulative institutions), let to an increasing responsibilisation of municipalities and citizens (change in normative institution). The Dutch King's speech of 2013 is exemplary in summarising the dominant narrative of a 'participatory society'. Tight municipal budgets created space for and the 'participation society' frame demanded citizens and bottom-up activity - opening space for quadruple helix constellations - or more important roles for citizens and societal actors in energy experimentation in cities. This all while on the national level, the budget cuts first let to a decrease in innovation budget, and then to the instatement of an ambitious Topsector Policy with a continued focus on triple-helix experimentation in a techno-modernist paradigm. The resilience of regulatory institutions, but also the existing dominant actor network remain a challenge for the continuation and build-up of multi-actor collaborative formats that have societal agendas and include a broader array of actors with a focus on forms of innovation other than technological innovation. The extent to which these relatively new actor constellations will be able to steady and draw attention to social innovations in the energy system remains to be seen. There are promising formats (e.g. societal Living Labs) to experiment with changing roles of energy actors (e.g. grid operators) through new institutional arrangements including practices such as cooperative energy production, organisational forms such as business models, finance mechanisms or services, or new discourses and ideas such as divestment or advocacy.

6.3. What are the enabling and impeding factors for SIE-field-actors and other field-actors to conduct institutional work and change the 'outside' institutional environment?

Institutional work refers to the activities of SIE-field-actors and other field-actors that relate to creating, maintaining and transforming regulative, normative and/ or cultural-cognitive institutions. Institutional work by SIE-field-actors can be said to have mainly occurred on a **normative or cultural-cognitive level** - such as through the **co-creation of labels** such as 'living lab' or 'experimental status', through which identities were constructed and actors found each other. By drawing on the living lab label, the SIE-I Buiksloterham for example build an identity and connected to a broader societal phenomena. This came at the expense of losing some of its participants who did not identify with this broader living lab phenomena, while not being connected with financial or other resources. In a similar fashion as the SIE-I Aardehuizen and its status as 'regulatory sandbox', the living lab status mainly helped the SIE-I Buiksloterham to share a methodology and their project to a wider audience. In doing so, they were enabled by broader trends towards decentralisation, the increasingly important role of citizens and producer-consumers, and environmental concerns. The SIE-I Stadslab2050 illustrates that institutional work on changing discourse and beliefs (on e.g. fashion or circular economy) can indeed be fruitful. If enabled through the continuation of the living lab as a programme (rather than as a one-off project) and the embedding In the local administration, such work on discourses can at a later stage lead to regulatory changes.

SIE-field-actors in large parts did not succeed to **transform regulatory institutions**. Whereas national policy plans and initiatives were ambitious in their aims to transform the innovation process through integrating local civil society, societal and municipal actors, the latter actors were often not empowered through resources, network or authorisation to put in the required effort to do this transformational work (i.e. SIE-I Stadslab2050, Buiksloterham and Aardehuizen). For example, advocacy work from other field-actors at the science-policy interface in 2000 (NL) and early 2010s (FL) led to the setting up of large-scale 'participatory experimentation and incubation' format, namely transition experiments, as part of national environmental policy (NMP4 and VIA policy plans). Enabling factors were the increasing societal concerns about the environment but also the existing experiences with policy programmes that focused on learning in relation to addressing environmental concerns in the Netherlands. While both, NMP4 and VIA, envisioned a large role for civic dialogue and societal actors in their multi-actor collaborative formats, they became dominated by vested interests of large regime actors (i.e. as discussed in Paredis, 2013b; Smith & Kern, 2009a).

Consequently, in practice, the energy system remained dominated by energy incumbents and cultural-cognitive beliefs around roles within the energy system largely remained unchanged. We see similar dynamics at work in the set-up of regulatory sandboxes with regards to grid operation in 2015. There is also a clear link from the learnings from the Smart Grid Testbeds (the IPIN projects, 2009) to the formulation of the regulatory sandboxes in 2015. On paper, these provided a space for associations to change regulatory institutions around the governance of grid operation - but also this did not materialise in practice. The Experimentation Decree enabled the Aardehuizen to engage in advocacy institutional work (i.e. news coverage, blogs and project websites) and to fuel a discourse around peak-shaving and grid management. However, it did not allow them to transform regulatory institutions nor material practice. They could not construct interorganisational networks: the grid operator was not involved in the project, nor could they access necessary resources**.**

Thus, while there were windows of opportunity, such as those related to environmental concerns and their manifestation in international agreements and actual policies, the financial crisis manifesting in budget cuts and decentralisation policies, or changing discourses in relation to rights and responsibilities of citizens - these all open up a window of opportunity for the SIE-field to change, for new actors to enter and for new formats to establish. However, the institutionalisation of new actor roles and relations in experimentation formats as well as in the results of the experimentation remains a much more difficult task in the Dutch context. This also might relate to the lack of concerted collective action. The SIE-field shows an astonishing lack of educational efforts, networking, lobbying and advocacy on the part of those experimenting with innovation processes or policy agenda that are outside the dominant and resilient paradigm of Dutch innovation policy. Rather, it seems that the resilience of this paradigm can also be connected to the tight networks that have been forming over decades and that are held together by such collective learning and networking activities between and across projects in dedicated fora. To this end, we need to understand the extent to which certain experimental formats such as Living Labs or regulatory sandboxes, might be actively **mimicking** existing triple-helix formats such as transition experiments or Topsector R&D pilots: thus the extent to which they strategically combine new practices (the inclusion of users or citizens) with existing ones (a focus on technology, and on business, state and academic actors in the lead) to ease their access to resources.

Overall, the move towards a mission-oriented innovation policy on paper enables those experimentation formats with a broader policy agenda to come along. However, the innovation process itself has not yet opened up to include actors beyond the state, market and science. Especially, the co-financing element might impede actors with less possibility to secure access to money, such as energy cooperatives or associations to take part. It also might impede the development of innovations that are not technological but more focused on the governance of the energy system. .

7 Recommendations for our city partners, national and EU policy makers and SIE practitioners

This section provides several implications and considerations of our innovation history, for which we have taken the decision to cover a longer time period at the expense of more in-depth analysis of specific aspects.

SONNET city partners

- When, and ideally before, engaging in 'participatory experimentation and incubation' clarify your underlying assumptions regarding how societal change occurs and what kind of experimentation (whom to involve, which aspects to focus on, which resources to provide/use) supports you in bringing closer an energy transition that you aim for.
- Network, and get in contact with other cities that are engaging in 'participatory experimentation and incubation' to share lessons about process and results, to lobby and to advocate for taking different mechanisms (technological innovation, social innovation) and directions (competitiveness, climate change, ..) into account.
- Experiment strategically - 'participatory experimentation and incubation' bears the promise to change social relations including power relations and actor roles. Take those on board that

have much to gain from the city's strategic energy vision and take those on board that have much too loose - to see how their role(s) can and need to change.

National and EU policy makers

- Despite certain changes, the SIE-field of 'participatory experimentation and incubation' is quite inert in its focus on triple-helix-formats for technological innovation boosting economic progress. In a longer line of past openings, the current discourse and activities around 'mission-driven innovation policy' provide a new window of opportunity that can be ceased to address the systemic, and thus interrelated, deeply seated and value loaden, challenges in the energy domain. To this end, design a policy and accompanying programmes that puts forth a broader understanding of the actors and modes of innovation as well as of the policy agenda (i.e. broader societal agenda) than what is currently known.
- The innovation history shows that the more innovative policy approaches didn't come from the heart of the innovation policy regime (i.e. the Dutch Ministry of Economic Affairs) - rather innovation *governance* is coming from a broad network of actors. Therefore, supporting social innovation and maximising the potential of mission-driven innovation to go beyond market-focused mechanisms for economic growth, could mean that its design, support, implementation and evaluation should not be solely centred in one ministry - but should include other actors as well.
- Provide resources and opportunities for the SIE-field to diversify in terms of actors and modes of innovation, since to tackle systemic societal problems, knowledge from different spheres of society as well as more than technological innovation is needed.
- When facilitating initiatives to experiment, it is important that resources are offered in tandem: knowledge, funding, rights and materialities. Equally important is the acknowledgement of the involvement of the wider regime around an SIE. This case study shows that isolated experimentation faces large difficulties, as energy transition issues are rarely isolated and requires the active involvement and proactive dedication of those actors in power.

SIE-field-actors, including cities, associations, Living Labs, societal initiatives and organisations

- Network and get in contact with other SIE-field-actors engaging in 'participatory experimentation and incubation' to share lessons about process and results, to lobby and to advocate for taking different mechanisms (technological innovation, social innovation) and directions (competitiveness, climate change, ..) into account.
- Make use of the destabilising nature of shocks (i.e. financial crises, the corona pandemic, ...), as these shocks often provide an entryway for those socially innovative ideas, practices and objects that are 'ready' to enter the predominant regime (i.e. the example of living lab Buiksloterham, after the financial crisis).
- Link your narrative of change to broader societal discourses and visions (e.g. Paris Climate Agreement) to clarify what you have to offer to address urgent societal challenges and which institutions are standing in the way of these efforts.

8 List of references

Aardgasvrijewijken.nl. (n.d.). Kennis- en leerprogramma - Programma Aardgasvrije Wijken. Retrieved March 22, 2021, from https://aardgasvrijewijken.nl/kennis-+en+leerprogramma/default.aspx

AMS institute. (2020, June 22). Urban Living Lab Summit 2020. Retrieved October 21, 2020, from https://www.ams-institute.org/events/urban-living-lab-summit-2020/

Avelino, F. (2011). *Power in Transition. Empowering Discourses on Sustainability Transitions. PhD-Thesis*. https://doi.org/10.2307/3158436

Avelino, F. (2017). Power in Sustainability Transitions: Analysing power and (dis)empowerment in transformative change towards sustainability. *Environmental Policy and Governance*, *27*(6), 505–520. https://doi.org/10.1002/eet.1777

Avelino, F., Wittmayer, J. M., Pel, B., Weaver, P., Dumitru, A., Haxeltine, A., ... O'Riordan, T. (2019). Transformative social innovation and (dis)empowerment. *Technological Forecasting and Social Change*, *145*, 195–206. https://doi.org/10.1016/J.TECHFORE.2017.05.002

Ballon, P., Pierson, J., & Delaere, S. (2005). Test and Experimentation Platforms for Broadband Innovation: Examining European Practice. In *SSRN Electronic Journal*. https://doi.org/10.2139/ssrn.1331557

Brundtland, G. H. (1987). *Our common future*. Oxford: Oxford University Press.

Coenen, F. (2009). Local agenda 21: 'Meaningful and effective ' participation? *Public Participation and Better Environmental Decisions: The Promise and Limits of Participatory Processes for the Quality of Environmentally Related Decision-Making*, 165–182. https://doi.org/10.1007/978-1-4020-9325-8_10

Diercks, G., Larsen, H., & Steward, F. (2019). Transformative innovation policy: Addressing variety in an emerging policy paradigm. *Research Policy*, *48*(4), 880–894. https://doi.org/10.1016/j.respol.2018.10.028

Etzkowitz, H., & Leydesdorff, L. (1995). The Triple Helix -- University-Industry-Government Relations: A Laboratory for Knowledge Based Economic Development. *EASST Review*, *14*(1), 14–19.

Fuenfschilling, L., & Truffer, B. (2016). The interplay of institutions, actors and technologies in socio-technical systems - An analysis of transformations in the Australian urban water sector. *Technological Forecasting and Social Change*, *103*, 298–312. https://doi.org/10.1016/j.techfore.2015.11.023

Funtowicz, S. O., & Ravetz, J. R. (1994). The worth of a songbird: ecological economics as a post-normal science. *Ecological Economics*, *10*(3), 197–207. https://doi.org/10.1016/0921-8009(94)90108-2

Gibbons, M., Limoges, C., Nowotny, H., Schwartzmann, S., Scott, P., & Trow, M. (1994). *The new production of knowledge. The dynamics of science and research in contemporary societies.* London: Sage Publications Ltd.

Giltay Veth, D. (2009). *Het rendement van zalmgedrag*. The Hague.

Godin, B. (2006). The Linear Model of Innovation. *Science, Technology, & Human Values*, *31*(6), 639–667. https://doi.org/10.1177/0162243906291865

Grin, J., Rotmans, J., & Schot, J. (2010). *Transitions to sustainable development: new directions in the study of long term transformative change*. New York: Routledge.

Grin, J., Rotmans, J., & Schot, J. (2011). On patterns and agency in transition dynamics: Some key insights from the KSI programme. *Environmental Innovation and Societal Transitions*, *1*(1), 76–81. https://doi.org/10.1016/j.eist.2011.04.008

Hajer, M. (2011). *De Energieke Samenleving : Op Zoek Naar Een Sturingsfilosofie Voor Een Schone Economie*. Retrieved from www.pbl.nl/sites/default/files/cms/publicaties/Signalenrapport_web.pdf

Hendriks, C. M. (2009). Policy design without democracy? Making democratic sense of transition management. *Policy Sciences*, *42*(4), 341–368. https://doi.org/10.1007/s11077-009-9095-1

Hessels, L. K., van Lente, H., & Smits, R. (2009). In search of relevance: The changing contract between science and society. *Science and Public Policy*, *36*(5), 387–401. https://doi.org/10.3152/030234209X442034

Hielscher, S., Wittmayer, J. M., Durrant, R., Avelino, F., Betz, R., Brugger, H., … Winzer, C. (2020). *Methodological guidelines for case study analysis. (Deliverable 3.1). SONNET: Grant Agreement 837498*. Brighton.

Janssen, M., Hertog, P. den, Korlaar, L., Groot-Beumer, T., Steur, J., Rienstra, Y., … Erven, B. (2017). *Evaluatie Topsectorenaanpak Deel 1-Hoofdrapport* (Part 1). Retrieved from https://www.dialogic.nl/file/2017/08/evaluatie-topsectorenaanpak-deel-1-hoofdrapport.pdf

JPI Urban Europe. (2012). The first JPI Urban Europe pilot call. Retrieved December 20, 2020, from https://jpi-urbaneurope.eu/calls/jpi-ue-call-1/

Kates, R. W., Clark, W. C., Corell, R., Hall, J. M., Jaeger, C. C., Lowe, I., … Svedin, U. (2001). Sustainability Science. *Science*, *292*(5517), 641 LP-642. https://doi.org/10.1126/science.1059386

Kaulio, M. A. (1998). Customer, consumer and user involvement in product development: A framework and a review of selected methods. *Total Quality Management*, *9*(1), 141–149. https://doi.org/10.1080/0954412989333

Kemp, R. (2012). The Dutch Energy Transition Approach. In P. D. R. Bleischwitz, P. D. P. J. J. Welfens, & Z. Zhang Ph.D. (Eds.), *International economics of resource efficiency* (Vol. 91, pp. 187–214). https://doi.org/10.1017/CBO9781107415324.004

Kemp, R., & Rotmans, J. (2009). Transitioning policy: Co-production of a new strategic framework for energy innovation policy in the Netherlands. *Policy Sciences*, *42*(4), 303–322. https://doi.org/10.1007/s11077-009-9105-3

Kern, F., & Smith, A. (2008). Restructuring energy systems for sustainability? Energy transition policy in the Netherlands. *Energy Policy*, *36*(11), 4093–4103. https://doi.org/10.1016/j.enpol.2008.06.018

Klimaatakkoord. (2019). Den Haag.

Lafferty, W. M. (Ed.). (1999). *Implementing LA21 in Europe. New initiatives for sustainable communities*. Oslo: ProSus.

Lammers, I., & Diestelmeier, L. (2017). Experimenting with law and governance for decentralized electricity systems: Adjusting regulation to reality? *Sustainability (Switzerland)*, *9*(2). https://doi.org/10.3390/su9020212

Loorbach, D. (2007). *Transition Management. New Mode of Governance for Sustainable Development. PhD-Thesis*. Rotterdam: Erasmus University Rotterdam.

Loorbach, D. (2010). *Transition Management for Sustainable Development: A Prescriptive, Complexi...*: . *23*(1), 161–183.

Loorbach, D. A. (2007). *Transition Management. New Mode of Governance for Sustainable Development. PhD-Thesis*. Rotterdam: Erasmus University Rotterdam.

Maas, T., Van den Broek, J., & Deuten, J. (2017a). *Living labs in Nederland | Rathenau Instituut*.

Maas, T., Van den Broek, J., & Deuten, J. (2017b). *Living labs in Nederland | Rathenau Instituut*. Retrieved from https://www.rathenau.nl/sites/default/files/Living labs in Nederland.pdf%0Ahttps://www.rathenau.nl/nl/kennisecosysteem/living-labs-nederland

Ministerie van Volkshuisvesting Ruimtelijke Ordening en Milieubeheer. (2001). *Een wereld en een wil. Werken aan duurzaamheid. Nationaal Milieubeleidsplan 4*.

Ministry of Economics and Climate. (2019). Missies voor de toekomst | Topsectorenbeleid. Retrieved October 21, 2020, from https://www.topsectoren.nl/missiesvoordetoekomst

Nijpels, E. (2019). *Overdracht van Energieakkoord naar Klimaatakkoord* (p. 7). p. 7. Retrieved from https://www.ser.nl/-/media/ser/downloads/thema/energieakkoord/energieakkoord-naar-klimaatakkoord.pdf?la=nl&hash=639C6018AF58623CBC123AFB31857E4D

Nowotny, H., Scott, P., & Gibbons, M. (2001). *Re-Thinking Science. Knowledge and the Publics in an Age of Uncertainty*. Cambridge: Polity Press.

O'Riordan, T. (Ed.). (2001). *Globalism, localism and identity: fresh perspectives on the transition to sustainability*. London: Earthscan.

O'Riordan, T., & Voisey, H. (Eds.). (1998). *The Transition to Sustainability. The Politics of Agenda 21 in Europe*.

London: Earthscan.

Overzicht van Partners, Green deel Aardgasvrije Wijken. (2017, July 31). Retrieved October 21, 2020, from https://www.greendeals.nl/sites/default/files/2020-03/GD212 Overzicht partners Aardgasvrije Wijken.pdf

Paredis, E. (2013). *A winding road. Transition management , policy change and the search for sustainable development. PhD-Thesis*. Gent: Universiteit Gent.

PAW. (2019). *Pendrecht Rotterdam Verslag reflectieve monitor*. Retrieved from https://www.rijksoverheid.nl/onderwerpen/aardgasvrije-wijken/documenten/convenanten/2019/02/26/rotterdam---convenant-over-grootschalige-proeftuin-met-een-aardgasvrije-wijk

Pel, B., Haxeltine, A., Avelino, F., Dumitru, A., Kemp, R., Bauler, T., … Jørgensen, M. S. (2020). Towards a theory of transformative social innovation: A relational framework and 12 propositions. *Research Policy*, *49*(8), 104080. https://doi.org/10.1016/j.respol.2020.104080

Ranga, M., & Etzkowitz, H. (2013). Triple Helix Systems: An Analytical Framework for Innovation Policy and Practice in the Knowledge Society. *Industry and Higher Education*, *27*(4), 237–262. https://doi.org/10.5367/ihe.2013.0165

Rittel, H. W. J., & Webber, M. M. (1973). Dilemmas in a General Theory of Planning*. *Policy Sciences*, *4*, 155–169. https://doi.org/10.1080/01636609209550084

Rotmans, J., & et al. (2001). More evolution than revolution. *Foresight*, *3*(1), 1–17.

RVO. (2018). *Terugblik in cijfers 2012-2017*. Utrecht.

Schot, J., & Steinmueller, W. E. (2018). Three frames for innovation policy: R&D, systems of innovation and transformative change. *Research Policy*, *47*(9), 1554–1567. https://doi.org/10.1016/j.respol.2018.08.011

Schuitmaker, T. J. (2012). Identifying and unravelling persistent problems. *Technological Forecasting and Social Change*, *79*(6), 1021–1031. https://doi.org/10.1016/j.techfore.2011.11.008

Schumacher, A., & Feurstein, B. (2007). Living Labs - a new multi-stakeholder approach to user integration. In R. . Gonçalves, J. . Müller, K. Mertins, & M. Zelm (Eds.), *Enterprise Interoperability II* (pp. 281–285). https://doi.org/https://doi.org/10.1007/978-1-84628-858-6_31

Selman, P. (2000). A sideways look at Local Agenda 21. *Journal of Environmental Policy & Planning*, *2*(1), 39–53. https://doi.org/10.1080/738552353

Sengers, F., Wieczorek, A. J., & Raven, R. (2019). Experimenting for sustainability transitions: A systematic literature review. *Technological Forecasting and Social Change*, *145*, 153–164. https://doi.org/10.1016/j.techfore.2016.08.031

Smelt, E., & Bolhuis, W. (2018). De totstandkoming, borging en monitoring van het Energieakkoord. *Tijdschrift Voor Gezondheidswetenschappen*, Vol. 96, pp. 223–225. https://doi.org/10.1007/s12508-018-0171-9

Smith, A., & Kern, F. (2009a). The transitions storyline in Dutch environmental policy. *Environmental Politics*, *18*(1), 78–98. https://doi.org/10.1080/09644010802624835

Smith, A., & Kern, F. (2009b). The transitions storyline in Dutch environmental policy. *Environmental Politics*, *18*(1), 78–98. https://doi.org/10.1080/09644010802624835

Steen, K., & van Bueren, E. (2017). The Defining Characteristics of Urban Living Labs. *Technology Innovation Management Review*, *7*(7), 21–33. https://doi.org/10.22215/timreview1088

Taanman, M. (2011). Working in the Science-Policy Interface: Transition Monitoring in the Dutch Energy Transition Program. In G. Verbong & D. Loorbach (Eds.), *Governing the Energy Transition: Reality, Illusion or Necessity?* (pp. 251–276). New York: Routledge.

United Nations Conference on Environment and Development (UNCED). (1992). *Agenda 21*. New York.

van Buuren, A., & Loorbach, D. (2009). Policy innovation in isolation? Conditions for policy renewal by transition arenas and pilot projects. *Public Management Review*, *11*(3), 375–392. https://doi.org/10.1080/14719030902798289

van Buuren, A., Vreugdenhil, H., van Popering-Verkerk, J., Ellen, G. J., van Leeuwen, C., & Breman, B. (2018). The Pilot Paradox. *Innovating Climate Governance*, 145–165. https://doi.org/10.1017/9781108277679.011

Van den Bosch, S. (2010). *Transition Experiments: Exploring societal changes towards sustainability. Doctoral dissertation*. Erasmus University Rotterdam.

van den broek, J., van Elzakker, I., Maas, T., & Deuten, J. (2020). *Voorbij lokaal enthousiasme. Lessen voor de opschaling van living labs*. Den Haag.

van den Broek, J., van Elzakker, I., Maas, T., & Deuten, J. (2020). *Voorbij lokaal enthousiasme: lessen voor de opschaling van living labs*. Den Haag.

van den Haak, M., & Endert, S. (2016). *Leren door te doen: 20 vernieuwende initiatieven uitgelicht*. Retrieved from https://issuu.com/pbt-netwerk/docs/061217_pbt_llo_pilotboekje_binnenwe

van den Hove, S. (2007). A rationale for science-policy interfaces. *Futures*, *39*(7), 807–826. https://doi.org/10.1016/j.futures.2006.12.004

Van der Hoeven, D. (2010). *Verbreden, verdiepen, opschalen. KSI tussen wetenschap en transitiepraktijk*. Rotterdam: Kennisnetwerk Systeeminnovaties en transities (KSI).

van Elburg, J.-C., Dijkzeul, A., Kleiwegt, E., Reijerman, F., Willemsen, W., & Knoote, B. (2018). *Tussentijdse evaluatie Programma Aardgasvrije Wijken*. Rotterdam, Den Haag.

van Oranje, W.-A. (2013). *Troonrede 2013*. Retrieved from https://www.rijksoverheid.nl/documenten/toespraken/2013/09/17/troonrede-2013

VerDuS. (n.d.). Smart Urban Regions of the Future. Retrieved December 20, 2020, from https://www.verdus.nl/programma/surf/

Vlaamse Overheid. (2013). Stadslab 2050 Antwerpen: we experimenteren samen een toekomst. Retrieved December 20, 2020, from https://overheid.vlaanderen.be/communicatie/participatie/stadslab-2050-antwerpen-we-experimenteren-samen-een-toekomst

Wesselink, A., & Hoppe, R. (2011). If post-normal science is the solution, what is the problem?: The politics of activist environmental science. *Science Technology and Human Values*, *36*(3), 389–412. https://doi.org/10.1177/0162243910385786

Wittmayer, J. M., Fraaije, M., Hielscher, S., & Avelino, F. (2020). *Report on preliminary typology of social innovation in the energy sector. (Deliverable 1.1) SONNET: Grant Agreement 837498*. Rotterdam.

Wittmayer, J. M., Hielscher, S., Rogge, K. S., & Avelino, F. (2020). *Report on SONNET's initial conceptual framework. (Deliverable 1.2). SONNET: Grant Agreement 837498*. Rotterdam.

Wittmayer, J. M., & Loorbach, D. A. (2016). Governing transitions in cities: Fostering alternative ideas, practices and social relations through transition management. In D. A. Loorbach, J. M. Wittmayer, H. Shiroyama, J. Fujino, & S. Mizuguchi (Eds.), *Governance of Urban Sustainability Transitions. European and Asian Experiences* (pp. 13–23). Springer.

Wolfram, M., Ravetz, J., & Scholl, C. (2020). Beyond urban living labs: the making of transformative urban innovation systems. In *Urban Transformations*. Retrieved from https://www.biomedcentral.com/collections/urbanll

World Commission on Environment and Development. (1987). Report of the World Commission on Environment and Development : Our Common Future. In *Report of the World Commission on Environment and Development: Our Common Future*.

9 Annex 1

Methodology

This section outlines the methodology of this case study, including a demarcation of the system boundaries, the document review, and the interviews conducted. It also includes a list of interviewees, and the restrictions of the research due to covid-19.

System boundaries

We started the work on this SIE-field through the entry point of 'Living Labs' and the 'participatory experimentation and incubation' formats that are driven by societal actors – and after a certain point in time broadened this out to include the main lines of national innovation policy. In uncovering the different mechanisms over time, we decided to go for an innovation history that is slightly longer (covering about 20 years) at the expense of examining institutional work in detail. Also, we needed to make decisions on which collaborative multi-actor formats to analyse in more depth and focused thus on exploring those that are more broadly recognized while they push existing understandings of the innovation process. Based on these considerations, we did not dive in detail into incubation and experimentation that takes place in fablabs or makerspaces (e.g. Smith et al. 2015), or what we have termed technical Living Labs.

Selection of SIE-Is

We chose initiatives based on their level of representativeness for a certain collaborative multi-actor format that pushes the existing understanding of the innovation process in the Netherlands, the variety of actors involved or driving the SIE-I and level of ease in accessing information and interviewees. In detail, the SIE-Is were selected because:

- Living Lab Buiksloterham is an iconic and long-standing living lab in Amsterdam, the Netherlands, driven by societal actors;
- Stadslab2050 is an example of a successful city-driven lab in the Flemish context. Through the involvement of Antwerp in SONNET, we could gain access to interviewees more easily;
- VVE Aardehuizen is an example of an actor being engaged in a Dutch innnovation policy scheme; the regulatory sandboxes of 2015. Through the involvement with the Aardehuizen in another research project[48], we could make use of earlier interviews with them (with consent).

Document review and interviewing processes

We iteratively engaged in rounds of interviews and document review. We reviewed ca. 20-30 documents and interviewed 12 interviewees by snowballing through policy documents, interviews, SIE-I websites. Policy documents were retrieved from https://www.rijksoverheid.nl/documenten, whereas documents on specific programmes, projects or initiatives were retrieved from their respective websites. Rather than providing an overview of the documents here, we have cited documents throughout the text using footnotes and references. Documentation on the SIE-I Stadslab2050 was retrieved through interviewee 7B, as their information was no longer available on their website. The documents used are cited in footnotes or as references. Documentation on the SIE-I Buiksloterham was received from second-hand sources (SIE-field actors rather than SIE-I actors).

We conducted the review in two rounds. A first round was meant to gain an overview on the phenomenon with a focus on Living Labs. We chose this focus as an entry point to understanding the SIE-field since it is a prominent phenomenon in the Netherlands and Flanders and recognised by actors in the SIE-field. To uncover what other formats are present and increase the comparability of this Dutch/Flemish case study with the case studies in other SONNET countries (Germany and Poland), we then included other formats that were more driven by national innovation policy. The second round of reviews and interviews was then meant to increase our understanding of national innovation policy including its different 'participatory experimentation and incubation' formats. Considering the long time frame we covered, we focused our attention on documents and interviews that could provide us with a birds eye view on the developments.

List of interviewees

We selected interviewees based on different criteria:

[48] Aardehuizen was part of a Living Lab organised as part of the EU-funded PROSEU project, see www.proseu.eu

1) Prominence & visibility in the SIE-field
2) Expertise – both in-depth about certain aspects as well as bird's eye views
3) Access feasibility

We found 10 interviews through either document and website reviews or through snowballing from other interviewees. Interviews 11 and 12 were initially part of the EU-project PROSEU (under grant agreement N°764056), and allowed us to use their previously supplied interviews for this case study.

Code interview	Empirical description of case	Type of actor according to SONNET	Date of interview	Duration of interview	Interviewer
Interviewee 1	Senior Researcher on Living Labs	SIE-field actor	19.5.20	45 minutes	M. Fraaije, J. M. Wittmayer
Interviewee 2	Leender Verhoef, Program Lead - Living Labs, Amsterdam Institute for Advanced Metropolitan Solutions (AMS Institute)	SIE-field actor	28.5.20	60 minutes	M. Fraaije
Interviewee 3	Timo Maas, former researcher at Rathenau Institute	SIE-field actor	4.6.20	60 minutes	M. Fraaije, J. M. Wittmayer
Interviewee 4	Ellen van Bueren, Professor of Urban Development Management, TU Delft	SIE-field actor	30.6.20	60 minutes	J. M. Wittmayer, M. Fraaije
Interviewee 5	Frank Nevens, Sustainability Transitions Researcher, Ghent University	SIE-field actor	8.7.20	60 minutes	M. Fraaije
Interviewee 6	Associate Professor, Ghent University	SIE-field actor	21.7.20	60 minutes	M. Fraaije

Interviewee 7A	Jana Deforche, European Officer Urban Development, City of Antwerp	SIE-I actor	20.7.20	120 minutes	M. Fraaije, J. M. Wittmayer
Interviewee 7B	Gert Vandermosten, Coordinator Stadslab2050, City of Antwerp	SIE-I actor	20.7.21	120 minutes	M. Fraaije, J. M. Wittmayer
Interviewee 8	Mellany Doldersum, project manager living lab life extension, program bridges and quay walls, City of Amsterdam	SIE-I actor	20.7.20	60 minutes	M. Fraaije
Interviewee 9	Derk Loorbach, Professor of Socio-Economic Transitions, Erasmus University Rotterdam; & Director, DRIFT	SIE-field actor	21.7.20	60 minutes	M. Fraaije
Interviewee 10	Christian Scholl, Assistant Professor, Maastricht University	SIE-field actor	27.8.20	60 minutes	M. Fraaije
Interviewee 11	Karel Haverkorn van Rijsewijk, consultant experiments energy ("sandbox"), Netherlands Enterprise Agency (RVO)	SIE-I actor	*n/a*[49]	60 minutes	M. Fraaije (PROSEU)

[49] This is based on e-mail correspondence between Maria Fraaije and the interviewee as part of the EU-project PROSEU (under grant agreement N°764056).

Interviewee 12	Ferdi Hummelink, Coordinator energy team, Vve Aardehuizen	SIE-I actor	*n/a*[50]	60 minutes	M. Fraaije, F. Avelino (PROSEU)

Practical limitations

In engaging with this case study, there are a number of important framework conditions. Firstly, the work on this innovation history was resourced to take no longer than about 30 working days and secondly, the SIE-field work took place in the context of the COVID19-pandemic and ensuing restrictions on life and work. The main consequences of these conditions were:

a) No opportunity for participant observation limiting the depth of observation;
b) All interviews took place online using teleconferencing software;
c) The innovation history of 'participatory experimentation and incubation' is situated in the Netherlands, and includes reflections on Flanders as a second, far less pronounced storyline.

10 Annex 2

Detailed SIE-field timeline

DATE/ TIME	TYPE OF EVENT	DESCRIPTION OF EVENT	QUOTE & SOURCE e.g. document, interviewee
PHASE A: The height of experimentation involving market, state and science (triple-helix) (2000-2013)			
1990s	Trends	Recognition of the scale and interrelatedness of social and environmental problems (Brundtland report) Recognition of the importance of the local level (Agenda 21) Move towards multi-actor collaborations in addressing these problems	(Brundtland, 1987; Selman, 2000)
1990s/2000s	Trend	Science increasingly oriented towards producing relevant knowledge	(Hessels et al., 2009)
2000s	Trend	Transition thinking	Interviewee 3, (Kemp & Rotmans, 2009)

[50] This interview was part of the EU-project PROSEU (under grant agreement N°764056) in 2019, and carried out by Maria Fraaije and Flor Avelino.

		Emergence and take up of sustainability transition thinking across policy and science in the Netherlands and beyond	
2002-2003	SIE-field event	Discovery transition management and interaction between Dutch and Belgian researchers/policy	Interviewee 6
2004	Policy event FL	Start of process: Duwopo (duurzaam wonen en bouwen) and PlanC as transition management experiments on local scale.	Interviewee 6
2001	Policy event NL	Dutch Ministry of Economic Affairs start using transition management approach in energy transition	(i.e. Smith & Kern, 2009a)
2005	SIE-field event	DRIFT for transition is found – developing and applying transition management as a learning and experimentation process for sustainability transitions using the 'transition arena' as a multi-actor collaborative format	Interviewee 9
2008/ 2009	External shock	Financial-economic crisis	Interviewee 3, Interviewee 9
2009	SIE-I event	Destination plan for Living Lab Buiksloterham Amsterdam realised	Interviewee 3
2009-2014	Policy event / trend FL	The height of transition thinking in policy/politics in Flanders BE, with a focus on materials transition (building on duwobo & plan C projects), but energy transition was explicitly mentioned as one of 11 transitions within VIA.	Interviewee 5
2011	Policy event NL	End of transition pathways approach Energy transition – with the new government Rutte.	Paredis 2013
2011	Policy event NL	Introduction of Topsectorenbeleid, an inovation policy focusing on excelling in specific sectors, including the energy sector	
2011	Policy event NL	Smart Grid pilot project (IPIN) started to investigate the potential of technological options (until 2015) – as a follow up of the Taskforce Smart Grids established in 2009	(Lammers & Diestelmeier, 2017)
PHASE B: A rising role for cities and civil society (2009-2017)			
2011	SIE-field Event	Essay on "de energieke samenleving" by Maarten Hajer gains influence along with an increasing focus on the role of citizens.	interviewee 3, (Hajer, 2011)
2013	SIE-field Event	17/09, Throne speech of king Willem Alexander (NL), on the 'participation society'.	Interviewee 3 (van Oranje, 2013)

2012/ 2013	Policy event	The Joint Programming Initiative (JPI) Urban Europe, funded by the European Union's Horizon 2020 research and innovation programme, launches pilot calls for urban Living Labs in Europe	(JPI Urban Europe, 2012)
2013	Policy event, NL	Dutch Energy Agreement following an evaluation of Dutch energy policy by the Social and Economic Council (SER) of the Netherlands in 2012	(Smelt and Bolhuis, 2018
2013	SIE-I event, FL	Stadslab2050 founded, bringing together diverse actors (i.e. citizens, entrepreneurs, ...) to set up innovative projects and solve sustainability questions around a.o. energy transition. Linked to a broader sustainability vision of the City of Antwerp	(Vlaamse Overheid, 2013)
2013	SIE-I event	Municipality of Amsterdam provides funding for the establishment of Amsterdam Metropolitan Solutions (AMS) institute, building on the trend of Living Labs, aiming to create a community of practice around Living Labs.	Interviewee 2
2014	Policy event, FL	The new ruling party NVA reframed 'Vlaanderen in Actie', the Flemish progressive first step towards multi-actor experimentation policy, towards 'Visie 2050'.	Interviewee 5, Interviewee 6
2015	Policy event NL	Experimentation Decree allows experimental derogation from specific provisions of the Dutch Electricity Act with regards to decentralised renewable energy generation	(Lammers & Diestelmeier, 2017)
2016	Policy event, NL	The research programme VERDUS Surf is launched, aiming to find an 'innovative knowledge infrastructure for vital and resilient cities'. The program requires researchers to collaboratively investigate together with policy makers and other societal partners	(VerDuS, n.d.)
2017	SIE-I-event	Aardehuizen become part of the regulatory sandbox agreement under the Experimentation Decree of 2015	Interviewee 11
PHASE C: Taking stock and reorientation (2017-now)			
2017	SIE-field-event	Rathenau Institute writes first report taking stock of the development of Living Labs in the Netherlands.	(Maas et al., 2017a)
2018	Policy event	Program Gas-Free Neighourhoods started	
2019	Policy event	Launch of 'Mission driven Topsector and Innovation policy' (NL: Missiegedreven Topsectoren- en Innovatiebeleid) after an evaluation of the Topsector Policy in 2017.	
2017-2019	SIE-field event	AMS institute launches MSc programme 'MSc MADE', an educational program to develop metropolitan solutions through Living Labs, and a summer school on Living Labs for PhD students	Interviewee 2

2019	SIE-field event	Dutch Climate Agreement is negotiated and signed	(*Klimaatakkoord*, 2019)
2019	SIE-I event	Stadslab2050 starts a Living Lab 'Gelijkstroom' on energy poverty in Antwerp in the context of the SONNET EU funded project	Interviewee 7A
2019	SIE-field-event	First Urban Living Lab Summit was organised by the AMS institute to provide an opportunity to those engaged with Living Labs to learn from one another	Interviewee 2
2020	SIE-field event	Rathenau Institute writes second report focusing on how Living Labs in the Netherlands can scale up	(van den broek, van Elzakker, Maas, & Deuten, 2020)
2018	Policy event	Program Gas-Free Neighourhoods started	