Stagnation in the Dutch Energy Transition of the Existing Housing Stock: An Analysis of Underlying Bottlenecks and Current Practice

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Getting current housing stock completely energy neutral is an important part of the climate goals for 2050. Serious number of houses have to be renovate to more sustainable conditions. Therefore, the energy transition of the current housing stock needs and wants to gain momentum, yet stagnation in the transition is observed. Three bottlenecks are recognized by important stakeholders (the industry regime): i) deficit of financial resources, ii) difficulty in choice for sustainable alternatives, and iii) laboriously progress in creating support base amongst residents. However, bringing forward serious improvements to these bottlenecks seems difficult despite recognition. This paper further investigates these bottlenecks through case study and expert interviews. Case study is used to investigate bottlenecks on practice level and to serve as input for expert interviews. Interviews were used to further amplify results and to seek for further bottlenecks. Results are compared with theory of transition management, as transition management proposes important starting points needed to make progress in the energy transition. Results indicated that recognized bottlenecks indeed play important roles in stagnation. Economies of scale supported by standardization and industrialization are seen as most promising solutions to relieve bottlenecks. The industry regime incorporates these solutions in their strategy by adopting integrated neighbourhood-oriented approaches. This paper debates that the current strategy constitutes towards a fourth bottleneck. Results show that current stakeholders are not yet able to think outside their current position in the supply chain. Therefore, solutions brought forward are only located within the existing industry and supply chain regime, as stakeholders assume that interrelations in the supply chain remain unchanged. The Dutch financial rewarding system and tax system appear to be important underlying causes of the fourth bottleneck. Both systems support the main train of thought of the incumbent regime leaving no room for niche movements and new business models. However, transition management argues that the contrary is needed. Experimenting on smaller scale by niche movements to identify new business models should eventually lead to easier upscaling in the energy transition. Therefore, this paper concludes that steering towards smaller niche movements is needed in order to overcome stagnation in the energy transition of the existing housing stock. **Keywords:** Bottlenecks; Business Models; Energy Transition; Existing Housing Stock; Industry Regime.

1 Introduction

The climate goals of Paris (2015) have been issued to prevent further global warming and decrease the effects coupled to global warming. The Dutch government has translated these goals in 2018 (final approval in 2019) into the climate agreement ('Het Klimaatakkoord'). Strong ambitions are set, with the goal of 95% reduction of CO_2-emissions in 2050. This effectively brought the energy transition in the Netherlands to a start. In general, the term energy transition refers to a significant structural change in an energy system (World Energy Council, 2014). Historically, these changes have taken place several times and have been mainly driven by the demand for and availability of different fuels (Smil, 2010). However, the current transition differs as it is mainly driven by acknowledging global carbon emissions must be brought to zero.

Acknowledging global carbon emissions must be brought to zero has strong implications for the built environment, as the built environment contributes largely to energy usage and CO_2-emissions. Buildings account for 40% of the total final energy consumption in the EU of which more than 80% is caused by heating and domestic hot water (European Commission, 2011). Important part of the built environment is the existing housing stock. In terms of CO_2-emissions, the housing stock is responsible for 36% of total emissions (Ebrahimigharehbaghi, Qian, Meijer, & Visscher, 2019). Therefore, the existing housing stock is a key target of decarbonisation policies (Eker, Zimmermann, Carnohan, & Davies, 2018). This is also highlighted in the Dutch climate agreement, in which substantial targets are set inducing major impact for the existing housing stock: in 2050 full energy neutrality should be reached in the entire built environment. Effectively, seven million houses have to be renovated towards more sustainable conditions and should be disconnected from the natural gas network (Rijksoverheid, 2019).

These numbers (i.e. houses that have to be renovated to more sustainable conditions) urge for a quick commence of the energy transition in the existing housing stock. The transition needs and wants to gain momentum, yet it is observed that progression in the transition stalls (EIB, 2021). Just 8.000 houses were disconnected from the natural gas network in 2020, considering a report of the Dutch 'Planbureau voor de Leefomgeving' (planning bureau for the living environment) (PBL, 2020). This number stands in stark contrast to the seven million mentioned before. Although ambitions are set, the pace of renovating houses to more sustainable conditions is too slow to accomplish the goals set for 2050. Bottlenecks that contribute to stagnation are identified in several reports. Despite recognition of bottlenecks, important stakeholders (together the industry regime) seem unable to come up with the right solutions to overcome stagnation. In other words, current practice of the industry regime is unsuccessful in overcoming bottlenecks and thereby stagnation in the energy transition.

Against this backdrop, this paper provides an extensive analysis of current bottlenecks and approaches adopted by the regime to overcome bottlenecks in practice through a case study and expert interviews. These results are compared with (parts of) the theory of transition management to seek further bottlenecks causing stagnation in the energy transition, as transition management provides insights in the organization needed to make progress in the energy transition. It is important to gain clear insight in current and further bottlenecks, since the main driver of the current energy transition are policies instead of economics (Blazquez, Fuentes, & Manzano, 2020). Therefore, far-reaching knowledge of underlying causes of stagnation is needed to give recommendations to steer with policies.

The second section of this paper describes further background and literature for this research. Thereafter, the third section elaborates on the methodology used in this paper to come up with the results. Next, the fourth section brings forward the results and gives a brief analysis of results. The fifth section is the discussion of results. Lastly, the sixth section concludes the paper by briefly describing the most important findings and conclusions.

2 Background and Literature Review

This section provides additional background and literature needed for the research. Identified bottlenecks and important stakeholders are described and a brief introduction to transition management is given. Based on this information, the methodology could be composed in the third section.

2.1 Identification of bottlenecks

Several documents and reports about the Dutch general progress and pilot projects have been written. They already give some explanations as to why the energy transition currently stagnates. In general, three bottlenecks are experienced as the main reasons for stagnation in projects in which the existing housing stock is renovated to more sustainable conditions (Figure 1): i) deficit of financial resources, ii) difficulty in choice for sustainable alternatives, and iii) laboriously progress in creating support base amongst residents. This section gives a brief overview of the most important findings.

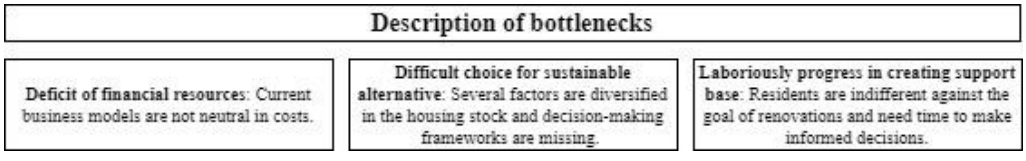

Figure 1 - Concise description of bottlenecks

First of all, a deficit of financial resources contributes significantly to stagnation of the transition. Renovation focused on improving sustainability have to be cost-neutral considering the climate agreement. Although the financial business case for projects in the Dutch energy transition can be approached through several ways (e.g. differences in inclusion of indirect return), most of the calculations show that renovations to create more sustainable conditions in houses are overall not viable (PBL, 2020). Furthermore, general costs are often higher than expected, causing that financial feasibility comes into question (Dutch Ministry of Interior and Kingdom Relations, 2020) (EIB, 2021). Therefore, the energy transition is not neutral in costs at the moment with current business models. This implies larger investments are needed, larger than one would expect with cost neutrality. Municipalities and housing corporations often lack financial power/budget to cope with these investments.

Secondly, it is difficult to choose a suitable sustainable alternative (e.g. heating network, heating pump, etc.) to apply on larger scale in a certain residential area. The fact that the challenge of sustainability is significantly bigger for the existing housing stock than for new constructions, is an important reason for the second bottleneck. This emerges from the dependency of the choice for an alternative on several factors, which are highly diversified in the existing housing stock (De Leeuw, 2020). These factors include the type of house, age, condition and even geographical location (Rotmans, 2019). Furthermore, municipalities experience a lack of clear decision-making frameworks. Hereby, they are not able to create a clear view of optimal technical solutions (Dutch Ministry of Interior and Kingdom Relations, 2020).

Lastly, progress in creating support base amongst residents appears to be laborious, which becomes an even bigger bottleneck in upscaling of projects (Dutch Ministry of Interior and Kingdom Relations, 2020). Residents are often indifferent against the goal of renovations (e.g. whether it is focused on general renovation or a renovation with the purpose of increasing sustainability) and they often need a decent amount of time to get used to the idea of renovation and to make informed decisions (Blomsterberg & Pedersen, 2015) (PAW, 2020). Hereby, organising support base amongst residents is a significant challenge in almost all pilot projects currently running or in preparation (EIB, 2021). Various stakeholders struggle with this bottleneck as legal options are currently lacking (Dutch Ministry of Interior and Kingdom Relations, 2020).

In addition to these bottlenecks, noting existence of cohesion between bottlenecks is important. Bottlenecks should not necessarily be considered separate from each other, as bottlenecks can mutually reinforce each other. Furthermore, the problem of the 'weakest link' applies: all things have to be right in order to reach sufficient progress and results, and this condition is rarely met (EIB, 2021). This further underlines the importance of interfaces between bottlenecks.

One last comment should be depicted about these bottlenecks, which underlines the relevance of this research. The identified bottlenecks are extensively described in several reports. This implies that policymakers, national government and other parties in the incumbent regime recognize these bottlenecks, yet are unable to significantly relieve them. This gives reason to believe that a more complex and profoundly nestled bottleneck exists preventing the regime from overcoming stagnation.

2.2 Actors at regime level

This section provides a brief elaboration on the incumbent industry regime, as it later on justifies decisions for the methodology and furthermore gives grip to results. Stakeholders were identified based on a preliminary stakeholder analysis. The energy transition in the existing housing stock consists of a complex playing field, in which many (non-coordinated) actors are involved (Kivimaa & Martiskainen, 2018). In this extensive playing field, several stakeholders are currently taking dominant roles and are part of the incumbent regime (Figure 2). This paper mainly considers the client side for the industry regime, because contractors are currently only involved to a limited extent in the energy transition of the existing housing stock.

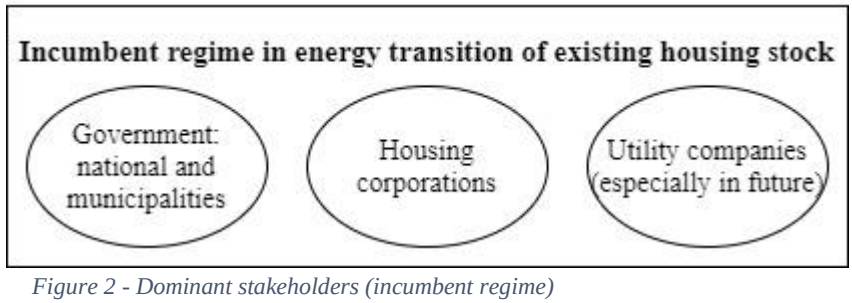

Figure 2 - Dominant stakeholders (incumbent regime)

First of all, governmental bodies have dominating roles in the energy transition. Especially the national government and municipalities are important stakeholders. Logically, the national government is responsible for national policy frameworks influencing the energy transition. Municipalities are put forward to take direction through current policies by the national government (Dutch Ministry of Interior and Kingdom Relations, 2020). Municipalities should take the lead and are ultimately responsible for decisions made in Dutch pilot projects to disconnect entire residential areas from natural gas (Rotmans, 2019). Furthermore, although they are partly dependent on housing corporations as they usually do not own dwellings, municipalities set the regional regulations for renovations at existing residential areas and are therefore an actor to take into account. Regulations and policies are a key instrument to secure sustainable developments in a top-down manner and to avoid long-term lock-in effects (Hohmann, 2019).

Secondly, housing corporations appear to take dominating roles in the Dutch energy transition, as a large part of the existing housing stock exists of public housing. In 2019, almost 30% of the existing housing stock was owned by housing corporations (CBS, 2020). Therefore, housing corporations are considered as important stakeholders in the market, given that they, apart from

their societal commitment, can implement renewable energy renovations on a potentially large scale (De Jong, 2019). This argument is also used by national government, as they impute a role as a starter motor to housing corporations for the energy transition of the existing housing stock (Rijksoverheid, 2019).

Lastly, also utility companies are considered an important stakeholder, especially for the future. They can potentially bring improvements to the challenge of making energy supply more affordable, more reliable and above all low in emissions (Robeco, 2021). However, utility companies are currently unable to make a difference in the energy transition. Utility companies are currently fairly restricted in their investments, which constrains their flexibility to become important investors and actors of the energy transition (TNO, 2019).

2.3 Transition management

In general, energy transitions are multidimensional, complex, non-linear, non-deterministic and uncertain phenomena and, therefore, they are difficult to characterize (Blazquez, Fuentes, & Manzano, 2020). They require a transformation of actors and their conduct, of markets, and a change in existing regulations and policies (Sovacool & Geels, 2016). This shows the complexity involved with energy transitions. Furthermore, the current transition is more than only technical solutions, as also economic consequences and social aspects play important roles (TNO, 2021). As such, the current energy transition can be defined as a system transition. Transition management proposes principles that guide such a transition.

The deliberative process to influence governance activities in such a way that they lead to accelerated change directed towards sustainability ambitions is defined as transition management (Loorbach & Rotmans, 2010). In transition management, both actors at regime level and those involved in niche experiments are addressed (Voß, Smith, & Grin, 2009). The incumbent regime is defined a conglomerate of structure (institutional and physical setting), culture (prevailing perspective), and practices (rules, routines, and habits) (Rotmans & Loorbach, 2009). Niche is a structure formed by a small group of agents that deviate from the regime and that might build up a new regime that is able to break down and replace the incumbent regime (Rotmans & Loorbach, 2009). Strategic action is needed for creating linkages between niches and between niche and regime, thereby helping induce a transition (Kemp & Loorbach, 2006). This leads to one of the

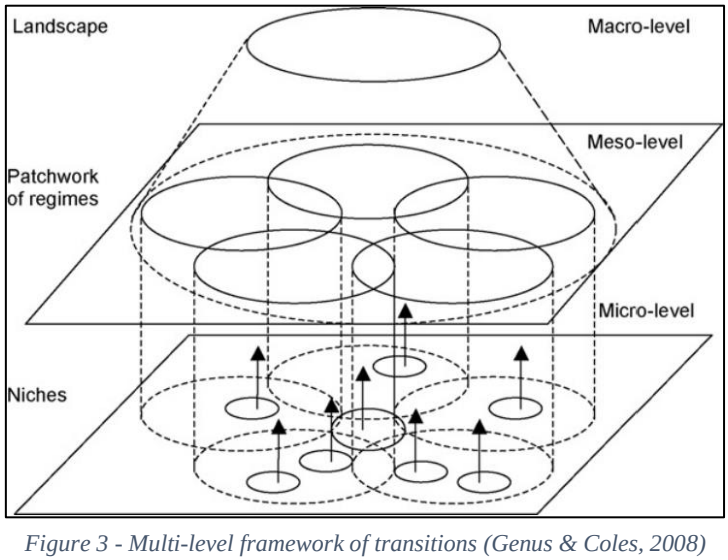

Figure 3 - Multi-level framework of transitions (Genus & Coles, 2008)

most important principles of transition management in order to achieve progress: empowering niche and frontrunners. Empowering niche and frontrunners contains providing them with resources, such as knowledge, finances, competences, lobby mechanisms, exemptions of rules and laws, and space for experimenting (Voß, Smith, & Grin, 2009).

The process of change in a transition considering transition management shows the importance of the principle that niche and frontrunners should be empowered. In system transitions, change happens as the result of processes operating at multiple scales considering transition management (Loorbach D. , 2010) (Loorbach, Frantzeskaki, & Avelino, 2017). Figure 3 gives an overview of this multi-level framework. External pressures, for example climate change, occur at landscape level. Following, the landscape puts pressure on the incumbent regime. This causes tension within the regime and enables increasingly competitive changes in niches to gain importance (De Haan, 2010) (Kemp, Schot, & Hoogma, 1998). As mentioned, transition management relies heavily on these latter market forces and decentralized decision making (Kemp, Rotmans, & Loorbach, 2007). It is important to create room for niche movements and experiments on small scale, since a small initial change in the system may have great impact on the system in the long run (Rotmans & Loorbach, 2009). Thus, to break through and cause a drastic change, innovations in the niche have to struggle against the selection pressures exercised by dominant regimes (Proka, Hisschemöller, & Loorbach, 2018).

Policies being key in the current energy transition is an important takeaway, because policies are the main difference between the current and past energy transitions. This does not imply that technology is not playing a significant role in the transition, but it is not the main driver of the shift that is taking place (Blazquez, Fuentes, & Manzano, 2020). This is an important remark, as it means that government on multiple levels plays a crucial role in steering the transition. Their role might suppress the niche to come up with the drastic changes needed. Thus, policies are necessary to pressure the regime and change the selection environment to create market pull for green innovations (Kern & Smith, 2008). In the absence of such policies, a transition to sustainability cannot be achieved (Kemp & Rotmans, 2004).

3 Methodology

This section explains the methodology of this research. Figure 4 below gives an overview of the design of the methodology. The design is further elaborated on after the figure.

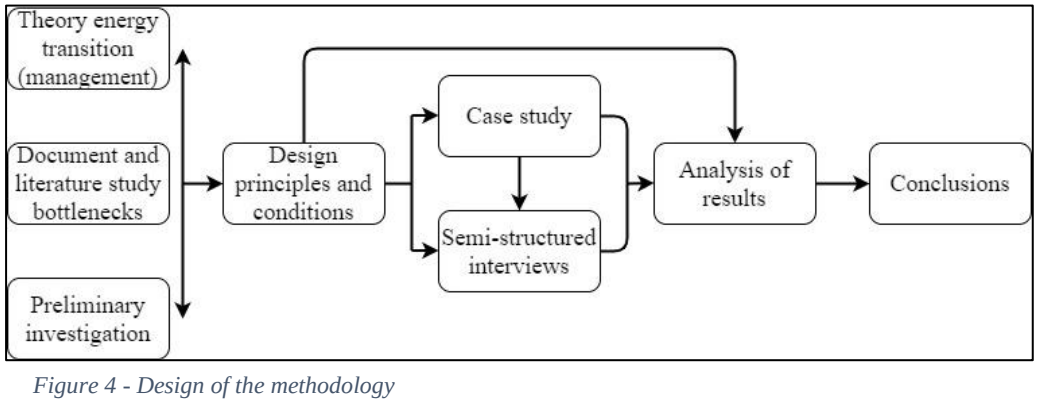

Figure 4 - Design of the methodology

Extensive background of known bottlenecks in practice is needed to be able to compare results with (parts of) the theory of transition management. Therefore, in this paper important focus is

given on known bottlenecks in the energy transition of the existing housing stock. This paper studies several cases to fully understand the extent of underlying bottlenecks causing stagnation in the energy transition in practice. In total, eight cases were investigated. In all cases, stakeholders (try to) apply a so-called neighbourhood-oriented approach. In this approach, entire neighbourhoods are renovated towards more sustainable conditions. Cases differ whether they have been granted subsidies and on the stakeholder that takes direction (municipality or housing corporation). Cases are compared with literature, documents and other reports (section 2.1) to create an extensive view on bottlenecks. Potential differences and similarities between theory and practice are documented. Most of the studied cases were part of so-called neighbourhood-oriented approaches, because these cases provided the most information and documents to investigate potential bottlenecks. Other initiatives were difficult to incorporate in the case study, as limited information was available on these initiatives. Findings of the case study were also used as input for semi-structured interviews.

As mentioned before, the results of this study must be compared with (parts of) the theory of transition management to seek further bottlenecks stagnating the energy transition. Semi-structured interviews with experts are used to amplify results to enable comparison with transition management and thereby to identify new bottlenecks. Therefore, experts were consulted in order to confirm findings of the case study and to complement results with other initiatives than so-called neighbourhood-oriented approaches with municipalities and housing corporations in the lead (see previous paragraph). Furthermore, current viewpoints on possible solutions/improvements for bottlenecks and approaches embraced by stakeholders to overcome stagnation were discussed with experts. This makes it possible to investigate why current approaches are unable to overcome stagnation. Findings of a brief stakeholder analysis and identification of dominant stakeholders (section 2.2) justified interviews with municipalities and housing corporations, as they are currently dominating stakeholders and in the lead. In total, six experts were extensively consulted. Three of them were working at a municipality and three were working at a housing corporation. All of them were actively involved in (projects within) the energy transition of the existing housing stock. Questions of the interviews were based on results of the literature and case study. Experts were interviewed by following a structured outline, but with addition of some probing questions if more information was required and to leave room for discussion. Interviews had a duration of one to one and a half hour(s). The interviews were fully transcribed as base material for analysis. Thematic analysis was used to identify common themes (topics, ideas and patterns of meaning) that came up repeatedly during the interviews. This was compared with results of the literature and case study in order to amplify data for further analysis of results.

4 Results and analysis

This section describes the results of this research. The data was gathered through the methodology mentioned in the previous section. Section 4.1 elaborates on the findings of the case study and interviews with experts. Section 4.2 further analyses the results of section 4.1. The analysis gives the most important input for the discussion section, following this section. Table 1 gives a summarization of the (analysis of) results concerning the bottlenecks.

Table 1 – Summarization of results concerning bottlenecks

Bottleneck		**Result**
i)	Deficit of financial resources	*Confirmed*

ii)	Difficulty in choice for sustainable alternatives	*Confirmed*
iii)	Creating support base amongst residents	*Confirmed*
iv)	Stuck in industry regime	*Identified*

4.1 Results

The three main bottlenecks were indeed confirmed with the case study and expert interviews. Section 4.1.1 up to and including section 4.1.5 extensively describe the bottlenecks on practice level. Experts were also consulted on their view towards relieving bottlenecks. Section 4.1.6 describes solutions and approaches embraced by important stakeholders in order to relieve bottlenecks. Together, the results give a profound description of bottlenecks on practice level and underlying causes, which is needed for further analysis of the results in section 4.2.

4.1.1 Deficit of financial resources

A deficit in financial resources plays indeed a major role in stagnation of the Dutch energy transition, as this bottleneck comes forward in almost every case and was mentioned by all interviewees. Stakeholders even struggle to get a conclusive business case in pilot projects that have been granted subsidies by the national government (De Goeijen, 2020) (De Voogt, 2020). The origin of this bottleneck is twofold: on the one hand installations are too expensive to achieve the far-reaching sustainability needed to disconnect houses from the natural gas network and on the other hand the available budget at both municipalities (especially smaller municipalities) and housing corporations is too low to cope with the investments needed to guarantee housing cost neutrality as obligated by the Dutch national government (Rijksoverheid, 2019). This is further complicated by uncertainty in future natural gas tariffs. If no subsidies are granted, sustainable alternatives have to be paid from general resources by municipalities. These resources are often insufficient. Housing corporations also struggle with their budget, as they are legally fairly limited to earn investments back by rent. Concluding, a deficit of financial resources plays a major role in stagnation of the energy transition.

4.1.2 Difficulty in choice for sustainable alternatives

Difficulty in choice for sustainable alternatives is often considered a bottleneck in practice, as confirmed by cases and interviews. In general, choosing a sustainable alternative appears to be difficult, since technical development of alternatives is often not yet sufficient and at the same time technology is improving too quickly for clear choices. Furthermore, this bottleneck is especially a challenge for the existing housing stock, as literature and reports already pointed out. However, interviewees argue that in practice this bottleneck entails bigger impact for private homeowners than for public housing, as types of houses are usually more varying in the private housing stock.[1] Every type needs possibly a different set of measures in order to achieve optimal sustainability. This hinders a clear choice for the application of a sustainable alternative.

In addition to literature, interviews showed this bottleneck will come more explicitly forward in the near future, as most projects for sustainability improvements are in early preparation and are therefore only in an exploratory phase of options. Furthermore, in multiple cases this bottleneck is not encountered, since those projects were chosen, amongst other things, because of an obvious choice for a sustainable alternative. Interviewees state that in later stages of the energy transition, this bottleneck might become a problem, as they will possibly encounter projects later on in which the choice for an alternative might be less obvious.

[1] Hengelo – De Nijverheid, one of the Dutch experimental gardens, gives an excellent example of significant variation in the private housing stock. This residential area alone already includes 17 different types of houses (Municipality of Hengelo, 2020).

4.1.3 Laboriously progress in creating support base amongst residents

Laboriously progress in creating support base amongst residents and homeowners has multiple causes. In addition to literature, the facts that residents frequently lack knowledge of matter (for example why it is needed to disconnect from natural gas), do not sufficiently get involved by important stakeholders in the preparation of projects and often have limited feeling with the increase of living comfort they might enjoy after a renovation cause a lack of support base in practice. Other causes for a lack of support base have often common ground with previous bottlenecks and lie on the interfaces between bottlenecks, as further explained in section 4.1.4. Besides, intensive contact with residents is needed to overcome these causes. As this contact is intensive and time consuming, the bottleneck becomes presumably more significant during upscaling phases of gasless projects.[2]

4.1.4 Interfaces between bottlenecks

Literature already pointed out the importance of interfaces between bottlenecks. Cases and interviews showed indeed that interfaces often play important roles in stagnation of projects. Figure 5 summarizes the interfaces between bottlenecks.

Figure 5 - Summarization of interfaces between bottlenecks

Interviewees argued that the choice for a certain sustainability alternative would be easier if business cases were conclusive. In some cases, high costs of gasless alternatives eventually even led to total renouncing of those alternatives, which will result in renovated houses that must be renovated again before 2050 to apply further sustainability measures. As this induces a form of procrastination, these kinds of decisions logically imply that the goals of 2050 might come into question.

Support base amongst residents is dependent on financial resources for an important part, as shown by the results of this research. A lack of support base only arises if residents experience negative consequences. Financial consequences are unsurprisingly part of the most important

[2] This was confirmed by a project in Purmerend, where indeed this bottleneck caused significantly more stagnation during the phase of upscaling.

negative consequences, since sustainability measures for tenants often result in an increase in rent and for private homeowners result in a significant initial investment.

The last surface between bottlenecks lies between a difficult choice for alternatives and a lack of support base. Several cases and interviews with experts show residents often have different views on the alternative to choose compared to each other and to other stakeholders. Furthermore, residents regularly have trouble accepting results of independent researches into optimal sustainable alternatives, as these are often commissioned by municipalities and housing corporations. This logically results in a lack of support base amongst residents.

To conclude, experts claimed interfaces between a deficit of financial resources and other bottlenecks are experienced as most important or at least a more conclusive business case might help the most in overcoming stagnation in the energy transition.

4.1.5 Important side note: capacity of labour force

As projects for sustainability improvements in the existing housing stock are currently scarce compared with the set task for 2050 and are mostly only in preparation, it is expected more bottlenecks will arise in coming years. This subject was, therefore, briefly discussed with experts. The main bottleneck probably arising in coming years is a shortage in the capacity of labour force. Capacity of contractors and installers will most likely not be sufficient to cope with upcoming upscaling within the energy transition. Estimates show around 25% extra capacity is needed in the Dutch construction industry in order to cope with ambitions set for 2030 and 2050 (ING, 2018).

It was striking all interviewees mentioned that capacity in labour force is probably a bottleneck arising in coming years. Because all stakeholders mentioned this preview, this paper felt the urge to state this as a kind of side note. Furthermore, the regime already tries to tackle this foreseen problem within solutions and approaches brought forward, as explained in the next section. However, because this bottleneck does not exist yet, this paper does not identify it as a bottleneck, implying that the newly identified bottleneck of this paper is numbered as the fourth bottleneck playing an important role in the energy transition.

4.1.6 Approaches embraced by the regime

As already indicated in the literature study, results of this research confirm the industry regime recognizes the presence of several bottlenecks. This is an important observation, since recognition by stakeholders results in approaches embraced to (attempt to) overcome stagnation.

Stakeholders especially focus on relieving the financial bottleneck. More financial resources or lower costs can contribute significantly in overcoming stagnation in the energy transition, since it has a positive effect on the other two bottlenecks. Furthermore, interviewees claim it would create room for innovations, which are for example needed to prepare for the expected lack of capacity of labour force in the near future. Therefore, relieving the financial bottleneck is a strong point of focus of the current regime. Interviewees mention several affairs might contribute in overcoming stagnation. Especially economies of scale through collective alternatives together with standardization and industrialization should relieve bottlenecks significantly considering experts. This view is in accordance with the national view and the view of several general reports: considering a report of PBL, in particular neighbourhood-oriented approaches might benefit from economies of scale (PBL, 2020). This is also highlighted in national policy, in which economies of scale are an important pillar to come to upscaling within the energy transition (Dutch Ministry of Interior and Kingdom Relations, 2019). Also standardization and industrialization are expected to relieve bottlenecks through a decrease in

construction costs and less capacity needed (ING Economisch Bureau, 2020) (ABN AMRO, 2015) (Yasin & Rjoub, 2017).

The focus of policymakers and national government on integrated neighbourhood-oriented approaches comes also forward in practice. Stakeholders seize the mentioned improvements put forward by the national government. Important stakeholders embrace or contemplate mainly integrated approaches in order to apply and stimulate these solutions, as indicated by results.[3]

In integrated approaches, residential areas are tackled as a whole in order to improve sustainability and disconnect the existing housing stock from the natural gas network. Involved stakeholders work closely together and the search for the optimal collective solution is elapsed jointly. As mentioned, the national government steers mainly towards these approaches through policies, as the largest grants in the area of sustainability are currently given for these integrated approaches. In most integrated approaches currently seen and steered towards, the primary cooperation is between the municipality, housing corporation(s) and in most cases involved residents. Residents are mostly part of the cooperation to ensure early involvement in the process in order to gain support base, but their voice in important decisions (for example in trade-offs between sustainable alternatives) seems limited. Since the Dutch climate agreement appoints municipalities to take direction, municipalities often take the lead in these cooperations. Interviewees mention that if further progress is made in the energy transition, integrated approaches with market parties in the lead might also be expected. These are, however, currently barely seen. Besides, when municipalities and housing corporations are in the lead, they consider involvement of market parties in the primary cooperation as undesirable. Involvement of market parties is indicated as main argument for excluding market parties, as their involvement might propagate wrong signals to residents in particular. Municipalities and housing corporations think that connection with market parties implies they already made certain choices.

4.2 Analysis of results

The second part of the fourth section is an extensive analysis of the results described in the previous part. It starts with the identification of a fourth bottleneck based on the given results. This bottleneck might play an even more important role than previously described bottlenecks and further explains toughness of the energy transition. Further analysis also shows why it is important to relieve this bottleneck and explains what underlying causes of the bottleneck are. Together it gives input for the discussion section, which follows afterward.

4.2.1 Identification of fourth bottleneck

A few observations stand out given the results. First of all, the main train of thought is that ‘making volume’ will eventually lead to needed innovations and relief of bottlenecks. This comes clearly forward considering the solutions and improvements proposed by regime parties. All approaches are focused on renovating large amounts of houses in order to achieve economies of scale through collective solutions. These amounts must be supported by standardization and industrialization of the execution processes. The main focus of the Dutch national government is also on large volumes, as they mainly reward so-called neighbourhood-oriented approaches.

[3] Despite strong focus on integrated approaches, also segmented approaches were mentioned by experts, in which municipalities and housing corporations individually improve sustainability of the housing stock. This approach is embraced if housing corporations have developed individual portfolio strategies or perennial maintenance plans, or if municipalities lack financial power to embrace integrated approaches for the energy transition of their entire city. Nonetheless, this approach still focuses on collective advantages and direction is still taken by municipalities and housing corporations.

Results of this paper indicate that the train of thought of the incumbent regime does not hint towards other conceptions in short term.

Secondly, the incumbent regime is reluctant in involving market parties. It is remarkable that in all approaches embraced, the incumbent industry regime (municipalities and housing corporations) remains in the lead leaving no room for niche movements. The same applies to new business models, as new business models are not yet included in the mindset of the regime. Integrated approaches that are currently experimented with, leave municipalities in the lead of a primary cooperation between the municipality, housing corporation(s) and involved residents. Several interviewees even mentioned that in this cooperation market parties should importunately not be involved.[4] Thus, results show that currently the incumbent regime is in the lead leaving limited to no room for niche movements and new business models.

Concluding, it appears that (the) approach(es) used by the incumbent regime are all current practice. All approaches are already experimented with in practice, yet the results of this research show that the business model that is part of those approaches ('making volume') impedes progress in the energy transition. Furthermore, results reveal that new approaches, new business models or involvement of market parties are not part of the mindset of the regime. Hereby, this paper identifies a fourth bottleneck that is even more complex and profoundly nestled than recognized bottlenecks. Current stakeholders are not (yet) able to think outside their current position in the supply chain as indicated by results. Therefore, solutions brought forward are only located within the existing industry and supply chain regime, as stakeholders assume that interrelations in the supply chain remain unchanged. A global overview of the structure towards identification of the fourth bottleneck is shown in Figure 6. This paper argues that this bottleneck is even more important than known bottlenecks and might be the main bottleneck preventing the regime and the energy transition as a whole from overcoming stagnation. The next sections substantiate this belief.

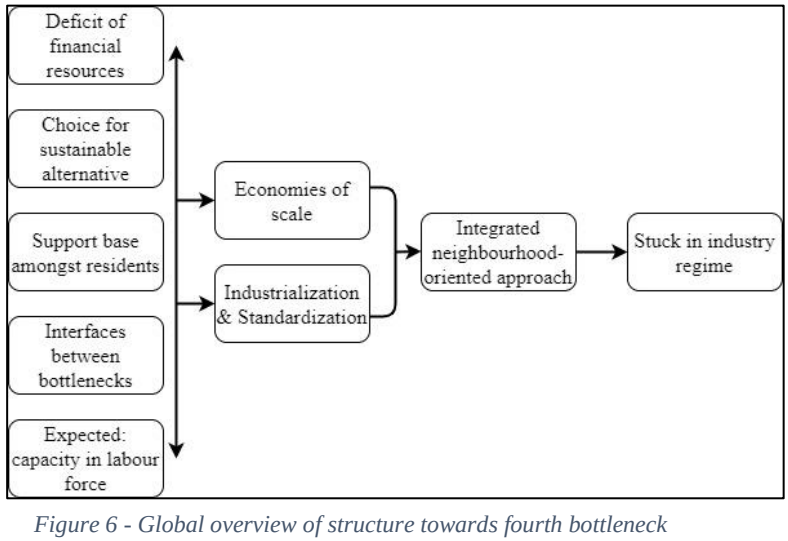

Figure 6 - Global overview of structure towards fourth bottleneck

[4] In segmented approaches, municipalities and housing corporations are operating separately from each other, but both are still the stakeholders that take direction in this approach.

4.2.2 Arguments for relieving the identified bottleneck

As mentioned before, the current business model applied in the energy transition of the existing housing stock impedes progress in the Dutch energy transition. Business cases are often inconclusive, as on the one hand technology is too expensive and on the other hand regime parties lack financial power/budget to support further progress in the energy transition. The efficiency of regime parties falls short as their investments are non-market driven. Innovator-municipal governments claim they need a stable, long-term-oriented rewarding system for investments in large energy transition projects, which cannot be sufficiently covered by the current temporary, discontinuous and experimental character (Tambach, Hasselaar, & Itard, 2010); a character that, given the results, is still unchanged a decade later. Furthermore, also for housing corporations feasibility can become a problem: housing corporations often cope with incomplete ownership, their budget is dependent on rent and they need 70% of the tenants to agree with their plans (Schilder, 2019). Besides, private owners play a major role in sustainable improvements. This also impedes progress of the energy transition, since private owners are reserved in their investments in energy efficiency measures. Although less ambitious homeowners might experience financial advantages (Mulder & Van Heel, 2020), the overall picture is that investments are not yet viable for private homeowners (PBL, 2020) (TNO, 2019). From a financial point of view, private homeowners will only invest if measures are profitable (ING, 2019). As it is not obligated for private homeowners to invest in sustainability for their homes until at least 2030 (ING, 2019), most of them will not make any investments in energy saving measures, since current business models do not offer sufficient stimulation for investments. All in all, this paragraph shows that the current business model is insufficient in stimulating progress in the energy transition, especially if the incumbent regime remains in the lead. This urges to seek new business models (Blazquez, Fuentes, & Manzano, 2020). Therefore, it is important to relieve the identified bottleneck, as relieving the bottleneck will give room to new business models. Otherwise identified solutions will be located within the existing industry and supply chain regime, as stakeholders will assume that interrelations remain the same if this bottleneck is not surmounted to a certain extent.

4.2.3 Underlying causes of identified bottleneck

This section focuses on the underlying causes of the identified bottleneck. Understanding of underlying reasons and mechanisms to the fourth bottleneck is needed to come up with solutions and improvements to this bottleneck in order to relieve it. The previous sections indicated that mainly the incumbent regime remains in the lead in approaches currently seen or contemplated, leaving no room for niche movements and other initiatives. In particular financial factors induced by national government contribute to the inability to deviate from current practice.[5] Currently, main grant schemes for renewable energy mostly benefit regime parties (Proka, Hisschemöller, & Loorbach, 2018). This is also revealed in the results, as national government steers (with grant schemes) mostly towards integrated approaches, in which the main cooperation consists of regime parties. Consequently, these are the approaches experimented with the most. Other initiatives have benefited to a far lesser extent from grant schemes. A lack of financial support from public authorities and the time and effort to apply for loans and grants are barriers that withhold Dutch homeowners in applying energy saving measures (Ebrahimigharehbaghi, Qian, Meijer, & Visscher, 2019), which further underlines the constraints experienced by niche

[5] These factors are known causes for bottlenecks and play already a role for several years. In 2010, scholars already established that the financial rewarding system constrains sustainable investments and that a change in the system is needed (Tambach, Hasselaar, & Itard, 2010). A change that nowadays still has not taken place yet, as current practice revealed in the results show that financial factors still play a significant role.

movements induced through the national government. This is confirmed by a recent general report that performed research on lessons learned from the few citizens' initiatives that are currently running in the Netherlands. Although these initiatives should play a crucial role in the transition, they lack financial strength. Banks see them as risky products and national policy frameworks fall short in inducing an equivalent to current practice (Participatiecoalitie, 2021). In addition, the Dutch tax system induces barriers for circular and sustainable innovations, because the system rewards unsustainable enterprising (Mulder, 2020). Causing pollution is still as 'cheap' as it was decades ago. This impairs especially niche movements, since it forms a barrier for sustainable innovations (Mulder, 2020).

Thus, it can be concluded that several factors, but especially financial factors induced by policies (as the Dutch financial rewarding system and tax system), are significant in constraining niche movements.[6][7] Therefore, scenarios in which other stakeholder than municipalities and housing corporations play a vital role are not seen yet. The aforementioned explanations contribute to the inability to deviate from current practice. Hereby, new approaches and business models through niche movements are not introduced, which leads to the identified bottleneck.

5 Discussion

In this section, it is discussed how transition management through policy change helps in overcoming the identified bottleneck. Previous sections showed that currently regime parties are in the lead and taking direction, leading to the application of a business model that is insufficient in creating progress in the energy transition. This paper argues that this constitutes to a fourth bottleneck. Theory of transition management can be compared to the current situation of the energy transition in order to point out how this bottleneck can be relieved.

As mentioned, the current main train of thought of regime parties is that 'making volume' leads to quick commence of the energy transition and induces innovations needed to commence. However, from a transition management point of view the contrary is needed. Transition management argues that experimenting on smaller scale by niche movements in order to identify new business models should eventually lead to easier upscaling in the energy transition. Section 2.3 shows the process that leads to progress in energy transitions through empowering niche movements and frontrunners. Empowering niche and frontrunners contains providing them with resources, such as knowledge, finances, competences, lobby mechanisms, exemptions of rules and laws, and space for experimenting (Voß, Smith, & Grin, 2009).[8] This paper debates that empowering niche movements and frontrunners can be regulated by policies for an important part. Government support for R&D and mandates to transition to sustainable energy supplies can help accelerate a supply side energy transition (Solomon & Krishna, 2011), but bringing about a

[6] Other factors also contribute to the fourth bottleneck. Local initiatives are constrained, as the dominant knowledge base in the transition to gasless heating is still high temperature district heating. This is held by actors operating within the regime. Local initiatives may prefer low temperature options, which are sustainable, but still "too innovative"; as such, such endeavours are largely ignored by major energy consultants (Proka, Hisschemöller, & Loorbach, 2018).

[7] A further constraint is the relative weakness of the niche relating to the huge power differences that feature the Dutch energy (sub)system. Controlling the niche and keeping it small is justified by denying citizens' ability to make a difference in the energy transition (Proka, Hisschemöller, & Loorbach, 2018). These explanations contribute to the inability to deviate from current practice and approaches.

[8] Stimulating innovations, however, does not necessarily mean that attention to the regime should be completely abandoned. Although a focus on regime incumbents risks incremental innovation rather than contributing to structural change, regime incumbents can also be innovative if their engagement in the energy transition process helps them to redefine their interests and to think more long term (Kern & Smith, 2008).

transition is something more than only innovation support. Stronger climate policies are needed in order to decrease physical risks from runaway global warming in which tipping points are crossed (ING Research, 2020). For achieving a transition to a low-carbon economy, environmental taxes and other carbon reducing policies are needed (Kemp R. , 2010).

Instruments, such as taxes, can create a 'more level playing field' in which different practices and technologies compete (Kern & Smith, 2008). This creates room for niche and frontrunners. Who bears the costs and if those costs are affordable is for a big part dependent on tariffs of energy and rent, both regulated by the government. Changes and alterations in tariff regulation can guarantee better affordability, but can also create a more level playing field (TNO, 2019). A tax system that minimalizes pollution and usage of raw materials and fossil fuels, and that stimulates innovations and taking care of a decent planning, design and execution of the transition, might help in achieving the goals set for 2050 (Mulder, 2020).

Besides, grant schemes are also important in empowering niche movements and frontrunners. New business models are already arising (Wolf, 2020), but based on the results of this paper it appears that the current policy climate seems to frustrate these models. Policy changes are needed to create room for these models and movements, and to incorporate them in grant schemes. Other stakeholders than the incumbent regime (as for example private investors) can become important financiers of the energy transition by inventing new and needed financial instruments (Financial Focus, 2021). Grant schemes should stimulate new initiatives. Instead of focusing on 'making volume' through (integrated) neighbourhood-oriented approaches, more focus should be given to smaller initiatives that experiment with new business models on smaller scale, as transition management shows that this is important to overcome stagnation in the energy transition.

Since tariffs, the tax system and financial reward system are regulated by the Dutch national government through policies, this paper debates that the national government is able to relieve the identified bottleneck for an important part through policy change. This will lead to more room for niche movements and frontrunners, which should result in new business models considering theory of transition management.

6 Conclusion and Policy Implications

The Dutch existing housing stock should be completely energy neutral in 2050. Around 7 million houses have to be renovated to more sustainable conditions to achieve this goal. These numbers ask for a quick commence of the energy transition. However, several bottlenecks currently prevent further progress. These bottlenecks could already be identified based on several published documents and general reports. Regime parties recognize these bottlenecks, yet are unable to provide significant improvements and solutions to the bottlenecks. Therefore, this paper investigated existing bottlenecks to a further extent to get a more comprehensive view on these bottlenecks and to seek reasons that cause the inability to overcome stagnation induced by those bottlenecks.

Case study and interviews with experts indeed confirmed the existence and recognition by important stakeholders of bottlenecks. These bottlenecks are i) a deficit of financial resources, ii) difficulty in choice for sustainable alternatives, and iii) laboriously progress in creating support base amongst residents. These three bottlenecks together with interfaces between those three play major roles in causing stagnation in the energy transition of the existing housing stock.

In addition, this paper identified a fourth bottleneck, which might play an even more important role than known bottlenecks and explains toughness of the energy transition. The fourth

bottleneck is that current stakeholders are not yet able to think outside their current position in the supply chain. Therefore, solutions brought forward are only located within the existing industry and supply chain regime, as stakeholders assume that interrelations in the supply chain remain unchanged. It is important to relieve the identified bottleneck, as relieving the bottleneck will give room to needed new business models. The predominant train of thought in the current regime is that 'making volume' will result in innovations by itself. However, from a transition management point of view the contrary is needed. Transition management argues that experimenting on smaller scale by niche movements in order to identify new business models should eventually lead to easier upscaling in the energy transition. Therefore, this paper concludes that steering more towards smaller niche movements is needed to overcome stagnation in the energy transition of the existing housing stock.

Empowering niche movements and frontrunners can be regulated by policies for an important part. Altering tax systems can induce a 'more level playing field', which creates room for niche and frontrunners, as different practices and technologies are able to compete with each other. Adjustment of grant schemes might further support empowerment of niche movements and frontrunners. Grant schemes should stimulate new initiatives and new business models in order to make progress in the energy transition. Instead of focusing on 'making volume' through (integrated) neighbourhood-oriented approaches, more focus should be given to smaller initiatives that experiment with new business models on smaller scale. Since these systems (i.e. the tax and financial rewarding system) are regulated by the Dutch government through policies, the Dutch government can induce relief of the fourth bottleneck by policy change. Policy change should work towards a policy climate that rewards small initiatives instead of constraining niche movements and frontrunners (which seems the case in the current policy climate). This should result in new business models considering transition management, which is needed in order to overcome stagnation in the Dutch energy transition of the existing housing stock.

Lastly, some recommendations for future research are proposed. This research strongly focused on the incumbent regime. Results can be elaborated with data from utility companies. Although some will propagate that they are already part of the regime, their voice and participation is currently fairly limited in the energy transition. As such, they were not included in the methodology of this research. However, their position might change in the future and sources underline their importance for energy transitions. The same accounts for smaller initiatives that are not part of the incumbent regime. Their involvement is currently low, but their involvement is important in order to successfully pass the energy transition. Especially statements within the discussion of this research can be further substantiated by incorporating views of frontrunners. In addition, future research might focus on the way the Dutch tax system and grant schemes can be shaped in order to empower niche movements and frontrunners.

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