Chapter 14
The Practice of Innovative Energy Systems Diffusion in Neighbourhood Renovation Projects: A Comparison of 11 Cases in the Netherlands

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Abstract The diffusion of clean energy technologies is important to foster Green Growth. In the Netherlands the housing sector has considerable potential to increase energy efficiency by applying innovative energy technologies (IES). In this chapter we aim to answer the question of which factors explain the successful application of IES in neighbourhood renovation projects. Our research involves a comparative design, looking at 11 case studies. Comprehensive data collection was carried out, including 70 semi-structured interviews. We found that in only 3 out of 11 cases were IES successfully applied. Ambitions were reduced as the projects progressed. The main results of the analysis identify three factors that are positively related to IES application: policy instruments, housing associations' organizational characteristics, and inter-organizational collaboration. The results of our analysis suggest that more policy efforts are needed to deploy IES in residential areas over a wider scale. This is important to facilitate Green Growth.

Keywords Built environment • Climate change mitigation • Public housing • Renewable energy technologies • Sustainable cities

14.1 Background and Problem Definition

Accelerated development and wider diffusion of clean technologies and related knowledge are key strategies to foster green growth. There is considerable potential for further development and deployment of renewable energy, energy efficiency

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and other low-carbon technologies. Applying these measures brings important advantages: increased energy security, reduced energy costs, and an improved environment. It will be critical to tap into this potential to green both the energy sector and other sectors that consume great amounts of energy (OECD 2010).

The built environment is one such sector, which theoretically provides ample opportunity for significant energy conservation. The application of such technical measures as insulation and innovative, high-yield heating systems means that the energy efficiency levels of dwellings can be dramatically improved. Similar to other OECD countries, the built environment in the Netherlands accounts for approximately one-third of total domestic greenhouse gas emission. Of this, the majority comes from the residential sector where it primarily stems from decentralized combustion of natural gas (in houses) and combustion of coal in power plants for generating electricity. In Dutch houses gas is used for space heating, water heating and cooking. Electricity is used for lighting and domestic appliances.

The housing stock in the Netherlands is rather old. The energy quality of these old houses is dramatically poorer than those that have been built more recently. To a large extent this is because legislation on energy efficiency was only implemented after 1975. Before then there were no standards prescribing insulation and the installation of high-yield condensation boilers (Jong et al. 2005). Since 1975, regulation of the energy quality of new houses has gradually become more ambitious, even though it only impacts houses in their construction phase. Legislative standards and subsidies are largely responsible for both increased energy efficiency and the adoption of innovative energy system (IES) in new-built houses. However, little effort has been made to encourage the adoption of IES in the current housing stock. By 'innovative energy systems' we mean renewable energy technologies and energy efficiency technologies that clearly differ from conventionally used technologies to improve the energy performance of houses.

Technically speaking, adequate solutions are available to solve the problem. Domestic energy conservation up to a level of 90% is currently feasible (Trecodome 2008). However, it is the owners and occupiers who decide whether the application of such technical measures is desirable. When owners or occupiers consider renovating their homes they hardly prioritize energy efficiency, especially when energy costs are but a small part of the total cost of living (Sunnika 2001; Lulofs and Lettinga 2003; SenterNovem 2005). Moreover, the owners and occupiers have needs that are perceived as more urgent in regard to other issues, such as comfort, health, and a return on investment.

Renovation projects in residential areas are an opportunity to target the installation of IES in large numbers of houses, since the estates are commonly in single ownership and they offer economies of scale. Nonetheless, this implies that it is important to target efforts on local stakeholders in order to negotiate trade-offs. These efforts can influence decision making by house owners and occupiers.

In this chapter we aim to answer the question of which factors explain the appliance of IES in renovation projects in residential areas. Our focus lies on residential areas characterized by relatively low-value houses, predominantly owned by semi-public housing associations. We assume that six factors are relevant to explain the retrofitting of IES: the influence exercised by policy instruments (more specifically in the domain of climate policy), the influence exercised by local governments, the influence exercised by housing associations (who own housing property), the influence of collaborative efforts between actors, cognitive cohesion between actors, and the influence of contextual factors.

We apply both qualitative and quantitative research methods in a comparative design. Our analysis is relevant in the context of the urgent policy challenge of meeting the 2020 Dutch climate mitigation goals, which include a 14% renewable energy share in the total energy mix, and 46–50% energy conservation in the built environment.

Our paper is structured as follows. Section 14.2 presents a literature review of IES as they are currently applied in residential areas. Next, Sect. 14.3 describes the institutional context, presenting a list of the main actors, their interests, resources, and the ways in which they interact with each other. Section 14.4 presents a theoretical framework. The research design and methodology are addressed in Sect. 14.5. Section 14.6 reports the results of the analysis. The final section addresses the conclusions of the empirical study, as well as the position of this research in relation to Green Growth.

14.2 Policy Instruments and the Application of IES in Residential Areas

Since the First Oil Crisis of 1973, many programs have been implemented in an attempt to conserve energy in the residential sector. Since the late 1970s experiments in The Netherlands started with the utilization of renewable energy technologies, such as wind and solar energy. Although the environmental and long-term economic benefits are known, many uncertain factors – such as long development times, uncertainty about market demand, social gains and the need for change at different levels of organizations and the wider social and institutional context – hinder their widespread adoption. In fact, a whole range of factors work against the introduction and diffusion of alternative energy technologies. The appropriate conditions for new markets are hardly present and clearly hamper the diffusion of environmentally preferable technologies (Kemp et al. 1998). This is also true of the built environment, especially in residential areas.

Based on exploratory case studies in urban renewal projects in the Netherlands, Van der Waals et al. (2003) claim that environmental goals – such as energy efficiency – are considered of secondary importance by local stakeholders. Moreover, great policy ambitions that were been set in the start of a project remain unfulfilled when the project is finished. The lack of useful and adequate policy instruments on the local level was mentioned as the main reason (Van der Waals et al. 2003; Hoppe et al. 2010). For instance, in contrast to newly constructed buildings, there are no legal standards for the renovation and maintenance of the existing stock (Hoppe and Lulofs 2008). This, however, is not just a Dutch problem as it also applies to other Western European countries (Elle et al. 2002). Moreover, owner-occupiers in the existing residential sites are expected to act voluntarily and to cooperate with other actors. All levels of government try to encourage IES by implementing economic policy instruments and providing adequate information (Hoppe and Lulofs 2008). In this regard, covenants are also implemented but can be considered as only little effective, since only those parties are attracted who are already motivated and involved, and compliance by local actors is rather poor (Balthasar 2000; Van der Waals et al. 2003). Evidence from Swiss policy evaluation shows that close cooperation between different (levels of) government does benefit program effectiveness (Balthasar 2000). In the Netherlands intergovernmental governance is used as an incentive to improve local climate policy efforts. However, there are only moderate indications of its effectiveness (Arentsen 2008; Hoppe and Lulofs 2008).

More information on policy strategies and instruments is provided in Sect. 14.3, which addresses the institutional context of renovation projects in residential areas. We discuss this topic because we believe that without understanding the basic rules and power relations in local institutional contexts any analysis of the effectiveness of policy instruments would be useless.

14.3 The Institutional Context of Renovation Projects in the Netherlands

In order to understand the environment in which the energy efficiency of existing houses can be improved it is necessary to gain insights in the roles of the local actors, their interests, the resources they possess and exchange, and the ways they interact. Opportunities for the application of innovative energy systems in the current housing stock lie in large-scale renovation projects in relatively old, post-War neighbourhoods.

The houses and their environments are often characterized by poor-quality, obsolete physical construction. An additional characteristic is that the poor-quality buildings are accompanied by a poor-quality social structure. The neighbourhoods are characterized by a high degree of unemployment, above-average crime rate and a large proportion of ageing residents. Renovation projects are primarily meant to improve both social and physical structures in neighbourhoods. The application of innovative energy systems is considered not more than a secondary objective in that endeavour. The houses in the neighbourhood are for the most part owned by one or more former public or semi-public housing associations. Until 1995 housing associations in the Netherlands were public or semi-public institutions, largely financed by central government. In 1995 they were liberalized, receiving financial decision-making autonomy and large lump-sums of money from national government. However, the housing associations maintained their key public goal of providing quality housing to those in society who cannot afford to buy their own home (Koffijberg 2005).

A lot of decision making is involved when a large-scale neighbourhood or building block renovation plan is being scheduled. Agreements are often laid down in covenants that cover agreements of intent between local governments and housing associations. Local governments are able to exercise influence and encourage the housing associations to take up energy efficiency goals, by making tradeoffs, while strategically using urban renewal subsidies and legal permits. Nonetheless, the local authority remains firmly dependent on the willingness of housing associations to cooperate. Housing associations have the most significant resources since they own the housing stock and have the financial reserves to make the investments required. Additionally, in renovation projects, legal consent is required from the tenants who live in the houses. The legal standard is that at least 70% of the tenants must approve the renovation project plans. This statutory approval rate gives the tenants some room to negotiate with their housing association. It is not surprising, therefore, that housing associations take great pains to persuade their tenants to get their plans approved. However, local governments and tenants have few means to negotiate with housing associations in order to encourage them to install technical equipment that would significantly improve energy efficiency in the houses. The power imbalance is key to the housing association's advantage when decision-making is at stake. In the end the housing associations decide – whether or not and if so, how much – to invest in energy efficiency (Hoppe and Lulofs 2008).

Parts of the post-War neighbourhoods also contain private home owners. The owner-occupiers are often former tenants of the housing association. The housing associations sold them their houses in the years prior to the renovation project. When renovation projects are scheduled and many owner-occupiers reside in the neighbourhood, the housing association(s) and municipality are often inclined to have them participate in the project. Compared to the public housing occupants, the owner-occupiers can only participate if they decide to invest their own funds (housing associations make the investments for their tenants, and are often only compensated by a small monthly rent increase, if they are compensated at all). Loans and mortgages are often so high that (low income) owner-occupiers have problems acquiring them. Access to loans and mortgages represents a serious barrier to persuading house owners to invest and participate in the neighbourhood renovation project (Clinch and Healy 2000). Even when national government offers additional means to further encourage this group – by fitting 'meters' in houses to measure energy usage, information campaigns, provision of insulation packages, energy audits, 'green mortgages', and subsidy schemes – the actual effect is marginal. In short, there are several institutional barriers that hamper the large-scale adoption of technical equipment to encourage energy efficiency in existing housing (Hoppe and Lulofs 2008).

14.4 Theoretical Framework

Several theoretical insights are useful in showing us how to perceive and explain the phenomenon of energy conservation in the existing housing stock. These theoretical insights have their origin in a variety of disciplines, such as environmental economics and environmental psychology, diffusion-of-innovation studies, science-and-technology studies and policy implementation. The last two fields are especially useful thanks to their emphasis on the application of innovative measures and their relatively widespread use in local settings.

Insights from diffusion-of-innovation studies allow us to examine the processes that underlie the dissemination and acceptance of innovative concepts in social communities (e.g., Rogers 1962; Granovetter 1973, 1978; Burt 1987). Innovative measures need to be accepted and adopted if we are to approach a sustainable society, which also involves the replacement of fossil fuels by sustainable alternatives. It turns out that this is rather difficult, however, since conventional technologies, such as those surrounding fossil fuels, are ‘locked in’ by means of a cluster of socially accepted system factors that represent barriers to innovative alternatives, such as sustainable energy carriers (Unruh 2000). Traditionally, innovation studies – and to a lesser degree science-and-technology studies – focus on the supply side of the market and initiating processes of diffusion and change, in contrast to the demand side of the market, seeking to maintain a process of diffusion and change. The diffusion process is further complicated by the fact that the early market customers have already adopted the concept – the so-called exemplary minority (Bressers 1989) – whereas mainstream market customers still remain to be convinced. Moreover, the adoption of IES is considered a co-evolutionary process, involving opportunities and barriers deriving from both technological and social factors (Dosi 1982).

It is very difficult to convince the majority of potential adopters. Conventional behaviour and the existence of institutional barriers (many due to poor integration of climate policy with sectoral policies) limit further adoption. A facilitating institutional setting is considered a precondition for continuing the process of acceptance. There are several strategies that encourage the process of acceptance, some of which have been incorporated in policy strategies and instruments. Such incentives are widely implemented in contexts where one has to deal with serious setbacks with several competing constraints originating in traditional policy domains, such as housing and spatial planning. This means that the successful implementation of policy instruments aimed at the diffusion of innovative or sustainable energy equipment is seldom self-evident.

Policy implementation studies examine the factors that explain the effectiveness of policy implementation and its products. Implementation studies originate from the 1970s and are characterized by a broad range of theoretical developments (O’Toole 2000). During the 1990s attention became centred around a few topics, such as ‘policy networks’ (Marsh and Rhodes 1992; Bressers 1993; Dowding 1995; Smith 1997; Klijn 1996; Börzel 1998; Bressers and O’Toole 1998), ‘network management' (De Bruijn and Ten Heuvelhof 1995; Kickert et al. 1997), and the prospect that the horizontal 'governance' model would come to replace the hierarchic-traditional 'government' model (Bressers and Kuks 2003). In order to encompass the broad continuum of theoretical developments in environmental implementation studies, Bressers (2004, 2009) developed the Contextual Interaction theory, which assumes that the choice and implementation of policy instruments depends on the cognition, motivation, and resources of local actors, the distribution of power between them, and the way they interact with each other in a local policy arena. Furthermore, the theory places strong emphasis on contextual factors. It also holds that environmental policy is seldom prioritized in the list of preferences held by local actors in the local context. The study presented here uses many elements of the Contextual Interaction theory. The relevance of the theory to the domain of energy conservation in existing housing sites is that it involves the implementation of a type of environmental policy, in this case as an incentive to encourage energy conservation. The Contextual Interaction theory facilitates a systematic analysis of environmental policy implementation processes.

The insights presented in the previous sections led us to choose an approach that applies a number of theoretical viewpoints. We preferred a multi-theoretical approach to a mono-theoretical one since we assume that a multi-theoretical approach will lead to a larger explained variation. For that reason, it is useful to specify several clusters of independent variables in order to test them at a later stage. We aim to discover which cluster of independent variables delivers the most powerful explanations. We present a graphical view of our research model in Fig. 14.1.

All clusters of variables are subdivided into a number of different items. These items are used as indicators of the specific explanatory model of the particular independent variable. The six clusters of independent variables concern: (1) the use of policy instruments in the domain of climate policy; (2) organizational characteristics of the local government; (3) organizational characteristics of the housing association; (4) inter-organizational collaboration between actors; (5) cognitive cohesion; and (6) physical, economic and institutional characteristics of the project context. This last cluster was added to the research model as a contextual component along with the other variables, which are more theoretically oriented. Without specific knowledge of the project context it is useless to analyse the outcome of policy implementation processes. Contextual factors are used as control variables; hence the dotted line in Fig. 14.1.

Below we survey the main hypotheses in the research model. The hypotheses concern the main propositions in the analytical framework. Since the main independent variables might be operationalized as clusters comprising a number of indicators, the sub-set items are mentioned, too.

– The greater the number of policy instruments in the climate policy domain that are being implemented in the local project arena, the more likely that IES will be applied in the renovated housing stock. The variable comprises the following items: the presence of local or regional energy conservation covenants, the use of subsidy schemes, and the use of communicative policy instruments.

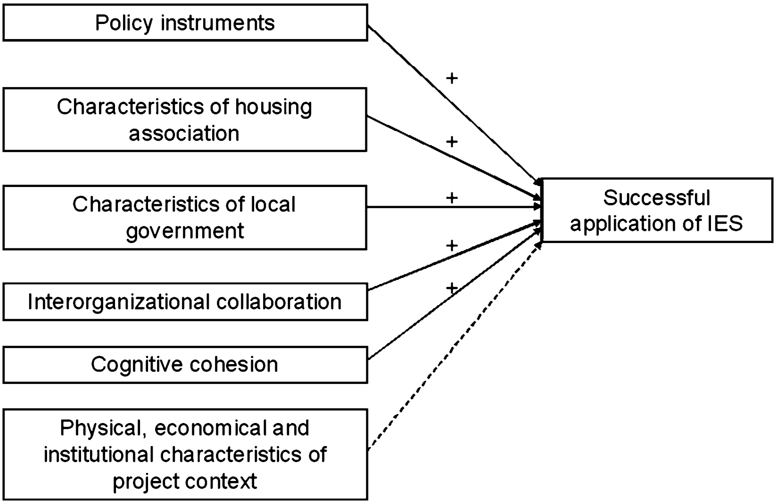

Fig. 14.1 Graphical presentation of the research model

- The more the organizational characteristics of the local authority favour energy conservation, the more likely that IES will be applied in the renovated housing stock. The variable comprises the following items: orientation toward environmental problems, the presence of formal energy conservation policy, personal capacity, the presence of advocates of energy conservation in housing, the degree of organizational tuning, the political orientation of the local officials, the size of the appropriate budget provided by national government, and the size of the municipality.
- The more the organizational characteristics of housing associations favour energy conservation, the more likely that IES will be applied in the renovated housing stock. The variable comprises the following items: orientation toward environmental problems, the presence of formal energy conservation policy, personal capacity, the presence of advocates of energy conservation in housing, the degree of organizational tuning, the financial position (company capital) and the size of the housing stock owned.
- The more inter-organizational collaboration efforts that are undertaken, the more likely that IES will be applied in the renovated housing stock. The variable comprises the following items: the presence of opinion leaders, the frequency of visits to professional meetings on the subject, and the size of the project configuration over time.
- The more cognitive cohesion that exists between organizations, the more likely that IES will be applied in the renovated housing stock. The variable comprises the following items: cohesion in respect of the environment and sustainable development, cohesion related to the adoption of technological innovation, and cohesion in respect of the national climate policy strategy.

The ‘project context’ cluster comprises the following control variables: division of ownership rights in houses on site, total investment per house, lengthening of the exploitation term per house, type of heating system, distance to city heating facility, equilibrium in supply and demand in the market for public housing, initial energy quality of houses on location, type of house, number of houses to be renovated on site, address density, degree of public participation in the project, and degree to which energy conservation policy is institutionalized in the project’s management structure.

14.5 Methodology

In order to answer our research questions we conducted a comparative analysis comprising 11 case studies. We focused on the retrofitting of IES in local neighbourhood refurbishment projects. In this section we describe important aspects of our research design and methodology: data collection, data treatment, and data analysis.

14.5.1 Data Collection

When the study started, only quantitative data were available from a previous study on ambition-setting and energy conservation on existing housing sites (Hoppe et al. 2011). After the case selection and a pilot study were finalized, we contacted persons involved in the housing sites of interest. We made partial use of the ‘snowball’ method to contact other key persons in the cases, after which dates were set for in-depth interviews. Forty on-site interviews and 30 telephone interviews were conducted. Some additional documentation on the cases was traced before the interviews were conducted; more was found after access was provided by the interviewees. The project documents found included formal policy documents, advisory reports, annual reports, specific information papers, websites, feasibility studies and geographical maps of project locations.

The group of interviewees featured predominantly persons from the following professions: project manager at the housing association, project leader in the local authority (urban renewal, property development), civil servant dealing with environmental or energy/climate affairs in the local authority, and energy associate in the housing association. The high incidence of these professions was beneficial to the researcher for three reasons: (1) most interviewees were involved in decision making on the subject of energy efficiency in the projects of interest; (2) they were often involved in the project for relatively long periods, meaning they were very knowledgeable and experienced; and (3) they possessed good networks with many contacts of interest to the researcher. Finally, it is worth noting that most interviewees were males in the age category 40–50, with higher education (most frequently in civil engineering).

14.5.2 Data Treatment

The quest for comparison of 11 cases meant that analysis by qualitative means alone was out of the question. The number of cases also required quantitative analysis. Hence, data treatment was of great importance to the comparative analysis.

The recorded interviews were written down in transcription reports. It was decided to use near-literal transcription reports in order to make full use of the richness of the data collected. After data collection, transcription reporting, supplementing ambiguities in data sources and story lines, case histories were constructed. After the case histories were completed, qualitative data were quantitated (however, many quantitative data were already present in the cases). Ten-point scales were constructed and scores were assigned per case. A data matrix was thus created, meaning that careful attention had to be paid to case histories and case-specific data in order to fill in the data reliably. A code document was designed for construct validation and reliable score assignment. This process had to be carried out in a reliable manner, so all score assignments were augmented with textual argumentation. Subsequently, the score assignment was replicated to check reliability and consistency.

14.5.3 Data Analysis

Data analysis in the comparative research design was characterized by phasing, the use of different types of research methods, and the use of different types of data. The analysis featured both qualitative and quantitative methods to allow the cases to be compared. Qualitative and quantitative methods were used to compensate, meaning that ‘mixed methods’ have been applied, a methodology that derives from an epistemologically pragmatic stance (Johnson and Onwuegbuzie 2004). The objective of applying both qualitative and quantitative methods in comparative research is to confirm analytical results where possible (triangulation), improve the researcher’s interpretation, and optimize the sample (inter alia).

The qualitative analysis features crisp-set qualitative comparative analysis (csQCA). QCA (Ragin 1987, 2000) is a method designed to bridge the divide between variable-oriented and case-oriented comparative research designs. Variable-oriented case analyses suffer from the disadvantage that the analysis is narrowed down to a limited number of variables, whereas cases often provide a ‘thick description’ with a large number of variables. Variable-oriented case analyses leave little room for specific cultural and historical aspects. The disadvantage of case-oriented analyses is that causal patterns cannot be compared between cases. QCA positions itself between the complexity of case-oriented approaches and the generalization of variable-oriented ones. The method is of particular importance when one wants to compare causal patterns with a medium-sized number of cases (10–50). Both qualitative and quantitative data can be applied. After coding the data into binary data – either present (‘1’) or non-present (‘0’) – a data matrix is developed. In QCA a data matrix is called a ‘truth table’. Truth table analysis allows researchers to make statements about necessary and sufficient conditions that arise if a certain dichotomous social phenomenon is to occur. QCA also enables the researcher to make statements about combinations of conditions that enable the occurrence of a social phenomenon under investigation. QCA results – i.e., such causal patterns as are found – enable the researcher to either develop theories or to test or build upon existing theories. Here QCA is applied in light of the richness of information on the cases and because the dependent variable is a dichotomy: an innovative energy system is either applied (‘1’) or not (‘0’). The software package fsQCA 2.2 (Ragin et al. 2007) was used to compute the analysis.

Bivariate correlations were computed to confirm the results from the QCA. The small number of cases ($n = 11$) necessitated the use of a 90% confidence interval. Since we predicted the direction of the correlations, one-tailed tests were computed. Regression analysis could not be performed because of the dichotomous dependent variable.

14.6 Results

This section presents the results of the comparative analysis. We have chosen to present the results in stages. First, important data are presented per case in an inter-case matrix. Second, reasons for non-adoption of IES are addressed. Third, the results of the QCA are presented. Finally, the results of the confirmatory analysis with bivariate correlations are presented thereafter. To start the overview of the results, a geographic map of The Netherlands is presented in Fig. 14.2, showing the locations of the sites studied.

14.6.1 Case Characteristics

The important characteristics are summarized per case in Table 14.1. The data include the number of houses renovated, the type of house, and the estimated energy conservation achieved (as a percentage). It also presents information on innovative energy systems that were part of the planning stage of projects and actual application in the realization stage of the project. Table 14.1 is structured in descending sequence according to the category ‘estimated degree of energy conservation’.

The site with the smallest amount of energy conservation achieved had a value of 26.5% (Atol-en Zuiderzeewijk), while the site with the largest amount of energy conservation achieved had a value of 69.8% (Groot Kroeven). In the latter case the

Fig. 14.2 Images of locations of cases studied in the Netherlands

innovative concept of passive renovation (the renovation variant of passive housing[1]) had been applied, a technology that features extreme insulation standards and the use of passive solar energy. Besides the Groot Kroeven case IES were only successfully applied two other cases: Europarei and Hogewey.

[1] 'Passive housing' is an integral concept that combines several measures that improve energy efficiency of houses. It combines high quality insulation, mechanic ventilation with heat re-capture, orientation towards the sun. Sometimes, solar heating and solar PV systems are installed in addition. The standards are high: the limit is 15 kWh/m^2 floorspace annually.

Table 14.1 Key characteristics in cases

#	Name of site	Name of town	Number of dwellings	Dwelling type	Estimated degree of energy conservation (%)	IES (ambition)	IES (actually implemented)
1	Groot Kroeven	Roosendaal	246	Family house 1960s	69.8	Several options considered	Passive housing standards applied
2	Eygelshoven	Kerkrade	300	Family house 1950s	51.1	Several options considered	None
3	Europarei	Uithoorn	635	Apartment 1960s	50.2	Solar heating	Solar heating and air heat pump
4	Prinsenhof	Leidschendam-Voorburg	1,628	Apartment 1960s	43.8	Several options considered	None
5	Hogewey	Weesp	258	Apartment 1960s	35.0	Several options considered including heat pumps/geothermal	Fleece wall and decentral cogeneration
6	Espels	Leeuwarden	117	Family house pre-War	34	None	None
7	Binnenstad-Oost	Helmond	121	Family house pre-War	32.9	None	None
8	Tannhäuser	Apeldoorn	100	Apartment 1960s	32.9	City heating from biomass plant	None
9	Bijvank het Lang	Enschede	854	Family house 1970s	30.5	City heating for heating water	None
10	Nieuwstad	Culemborg	200	Family house 1970s	30.1	Several options considered	None
11	Atol- en Zuiderzeewijk	Lelystad	380	Family house 1960s	26.5	None	None

14.6.2 Reasons for Not Applying IES

In 8 out of 11 cases IES were not applied. In five of those cases IES were originally planned but the application failed to make it through to the installation phase. Table 14.2 summarizes the reasons for non-application of innovative energy systems. IES in the successful cases, originally planned but not implemented, are also addressed. Although a list of reasons for non-implementation is given, there is no similar list for implementation. The analysis of successful implementation involves QCA and is addressed in the next section.

14.6.3 Results of the Empirical Analysis of the Application of IES

Qualitative comparative analyses of the different variable clusters were conducted to identify the causal drivers behind the phenomenon that IES were applied.

Results on the cluster 'instruments of climate policy'

Two conditions were identified as necessary but not sufficient in case IES were applied: subsidies and communicative policy instruments. Case histories provide the insight that IES might also be applied without subsidies, but only after IES had previously been applied successfully after subsidies had been used. Positive experiences from subsidized projects taught that housing associations learned to perceive and appreciate the benefits of IES, in such a way that application without subsidy became feasible. Moreover, subsidies were necessary as stepping stones, but after experience was gained, housing associations dared to invest the total amount themselves and subsidies were no longer necessary. A sufficient degree of information was also necessary, as demonstrated by energy audits and information from national government. Covenants had little impact, although they clearly had beneficial supportive functions in some cases.

Results on the cluster 'organizational characteristics of the housing association'

Two necessary but not sufficient conditions were found in case IES were applied: the presence of 'advocates' and staff specialized in energy affairs. In all three cases in which IES were applied, a highly motivated, influential project manager was in charge of operations in the renovation projects. In addition, combinations of conditions were identified that preceded the application of IES. Most include alignment between departments, financial reserves and formal energy policy. Alignment between departments within the housing association and formal policy that were involved when IES were not applied, however. Further investigation led to an explanation stemming from recent reorganizations, mergers, and the increasing scale of the housing associations.

Table 14.2 Reasons for not applying IES

Reason for non-application of IES	Frequency and case(s)
The establishment of a biomass plant near the project location was cancelled. As the whole plan was based on connecting pipelines from the plant (city heating) to the housing block, failure was assured when plans to construct the biomass plant were put on hold when a permit was not granted.	1 (Tannhäuser)
A lack of trust occurred between the local authority and the housing association leading to the loss of 'renewable energy' as an item on the project agenda.	1 (Nieuwstad)
Tenants did not favour the maintenance of a collective heating system. They were afraid that the energy costs were not to be divided proportionally. This led to a decision in favour of individual heating systems, which were unsuitable for IES application.	2 (Prinsenhof, Hoegewey)
Advice deriving from the energy audit was never seriously taken into account. The advice was regarded as symbolic only.	2 (Eygelshoven, Binnenstad-Oost)
Tenants feared an increase in their monthly rents which was a reason for their housing association to renounce any options to apply renewable energy systems. Moreover, the housing association did not want to make any uneconomic investments.	1 (Bijvank het Lang)
The renovation project had been delayed in the initiation stage, and the tenants were tired of waiting. Speeding up the project did not leave any room for the procedure to get the legal permit to use ground water in order to apply heat pumps for geothermal energy.	1 (Hogewey)
The application of innovative energy systems was never a serious consideration for the project planners. The ambition was never better than the conventional measures being applied. The housing association also did not have the financial means to make such an investment.	2 (Atol- en Zuiderzeewijk)
A bad experience with the application of an energy efficient system in a previous project led to a 'deadlock' concerning application of similar systems. Concerns regarding poor financial feasibility were the main reason.	1 (Prinsenhof)
The application of a biomass-fired energy generation plant in residential areas was not considered a feasible option by decisionmakers.	2 (Hogewey, Groot Kroeven)

Results on the cluster 'organizational characteristics of the local government'

Three necessary but not sufficient conditions were found for non-application of IES: specialized staff in energy affairs, fine-tuning between departments within the local government, and intergovernmental policy support (the so-called 'BANS' scheme). These conditions also correlate strongly between themselves. Strikingly, the intergovernmental scheme – designed to encourage the design and implementation of local climate policy – rather hinders than encourages the application of IES in existing residential areas. Further investigation in the case histories teaches that IES are considered feasible in sites with newly constructed houses, but not so much in existing areas. In this context many other predominantly social project goals are afforded greater weight. Secondly, there is an easier and quicker return on investments from developing and selling new houses than renovating existing ones, which are perceived as unprofitable. Moreover, IES were successfully applied in renovation projects in small-sized municipalities in which the local authorities showed little ambition for the implementation of local climate policies. This result may be perceived against the background of complex institutional problems that go hand in hand with neighbourhood revitalization projects in post-War urban areas (for further elaboration see Hoppe and Lulofs 2011).

Results on the cluster 'inter-organizational collaboration'

Two necessary but not sufficient conditions were identified in case IES were applied: presence of 'opinion leaders' and frequent visits to thematic meetings. These meetings concern recent developments in renewable energy technologies and energy-efficient systems, and involve both experts and practitioners. In our cases they were organized by national, regional governments or NGOs, and enabled 'cross-fertilization' of innovative ideas and experiences. Without the combination of the presence of a highly motivated, authoritative person close to the decision making organ (the opinion leader), and frequent visits to thematic meetings, important information is not diffused, which is critical to the application of IES.

Results on the cluster 'cognitive cohesion'

No necessary or sufficient conditions were found in this cluster. Only a combination of the conditions concerning (high) environmental orientation and (high) adoption of technical innovations orientation preceded successful application of IES.

Results on the cluster 'contextual factors'

Two necessary conditions were identified. In the first place, policy support from urban renewal policy disabled successful implementation of IES. IES were not implemented in locations where local or even national government had any influence on the locus of urban renewal policies. On the contrary: locations where IES were successfully applied were all similar in their lack of large neighbourhood revitalization plans, with a concomitant lack of government influence, which meant that housing associations exercised greater independence.

Second, relatively large investments per house renovation facilitated the application of IES. This can be interpreted as a 'sunk costs' argument. When the opportunity occurs, additional IES measures can be taken to improve the house. Because a large investment is being made anyway, the burden of the additional measure is relatively light. By contrast, lengthening the term of exploitation – a measure that is often mentioned to make investments profitable – does not influence the more widespread application of IES.

It is striking that tenant participation could not be identified as a necessary condition. For example, in the Prinsenhof case tenants were asked to vote whether to maintain the collective heating system or not. In multi-story buildings maintenance of the collective heating system is a precondition for applying IES, and is even cheaper than the alternative of individual heating systems. Although the housing associations presented information that actually demonstrated the significant financial benefits of the collective systems (€10 per month), the tenants outvoted the alternative of maintaining the collective system. Furthermore, several combinations of causal, context-related items were found that militated against the installation of IES: address density, a (large) number of houses on-site, and the (large) share of newly built houses on-site.

14.6.4 Confirmatory Analysis with Bivariate Correlations

The results from the qualitative comparative analysis were investigated by computing bivariate correlations in order to confirm or disconfirm the results. Because QCA does not allow for scaling techniques, the separate underlying items of the variables in the box were analysed. The results of the analysis are presented in Table 14.3.

The results of the confirmatory analysis are presented in Table 14.4. Except for one item, all results from the QCAs were confirmed.

14.6.5 Interpretation of the Results

No condition was found that was both necessary and sufficient. Interpretation of the analysis of non-application of IES provides two further results of interest. Some statements need to be made when addressing the clusters of variables. First, the clusters 'instruments of climate policy', 'organizational characteristics of the housing association' and 'inter-organizational collaboration' contained significant items that correlate positively with the application of IES. This is in conformity with our expectations. The cluster 'characteristics of the local authority' did have significant items, but contrary to the directions we hypothesized. These results are surprising, and may disprove the interpretation of the degree to which local authorities exercise an influence over the local application of IES in renovation projects in existing residential areas. We did not identify significant items in the cluster 'cognitive cohesion'. However, a combination was found that positively correlates with the application of IES. Finally, the cluster on contextual factors had two significant items, one in the positive and one in the negative direction.

In summary, IES were not applied in the absence of a sufficient degree of collaboration, in the absence of a sufficient number of policy instruments, in the absence of energy efficiency advocates and sufficient personnel capacity at the housing association, and when positive organizational characteristics towards energy efficiency of local governments were present. The latter is in contrast to our expectations. One might expect that government organizations with plenty of staff, formalized energy policy plans, and intergovernmental budgets for local climate policy would be more likely to have IES installed, but our results do not confirm these views. Necessarily, this finding needs further elaboration.

Table 14.3 Bivariate correlations

Indicator name	r	p
Cluster 'policy instruments from the domain of climate policy'.		
Use of communicative policy instruments	.465	.075
Presence of local or regional covenants	−.056	.435
Use of subsidies	.759	.003**
Cluster 'organizational characteristics of the local government'.		
Financial support by national government (BANS)	−.639	.017*
Political orientation of the officials	−.227	.251
Orientation to the environment	−.562	.036*
Membership of climate treaty	−.542	.043*
Size of the municipality	−.477	.069
Organizational fine-tuning	−.659	.014*
Personnel capacity	−.412	.104
Formal climate policy	−.304	.182
Presence of energy efficiency advocates	−.116	.367
Cluster 'organizational characteristics of the housing association'.		
Financial position	−.083	.404
Organizational fine-tuning	−.088	.399
Number of houses in property (size of stock)	−.303	.182
Formal climate policy	−.194	.284
Presence of energy efficiency advocates	.717	.006**
Orientation towards the environment	.132	.350
Personnel capacity	.453	.081
Cluster 'inter-organizational collaboration'.		
Frequency of visits to thematic meetings	.597	.026*
Size of the project configuration over time	.473	.071
Opinion leadership	.607	.024*
Cluster 'cognitive cohesion'.		
Cohesion towards the national climate policy strategy	.076	.422
Cohesion towards environment and sustainable development	−.309	.178
Cohesion towards technological innovation adoption	.155	.325
Cluster 'project context'		
Exploitation term lengthening of renovated houses	.016	.481
Distance to district heating facility	−.218	.259
Support by urban renewal policies	−.761	.003**
Number of houses	−.086	.401
Equilibrium in public housing market	−.403	.109
Institutionalization of energy efficiency in decision-making process	−.231	.247
Initial energy quality of houses	.286	.197
Degree of public participation	.364	.136
Type of heating system	.256	.224
Distribution of property ownership	.348	.147
Address density	−.225	.253
Share of newly built houses	−.341	.152
Investment per house	.754	.004**

* significant at .05 level
** significant at .01 level

Table 14.4 Results of confirmatory analysis between QCA and correlational analysis (plus direction regarding the correlation)

Variable cluster	Items identified csQCA as necessary conditions	Confirmatory analysis
Instruments of climate policy	Subsidies (+)	Confirmed
	Communicative instruments (+)	Confirmed
Organizational characteristics of the housing association	Advocate for energy efficiency (+)	Confirmed
	Staff specialized in energy affairs (+)	Confirmed
Organizational characteristics of the local authority	Intergovernmental scheme BANS (−)	Confirmed
	Internal alignment between departments (−)	Confirmed
	Staff specialized in energy affairs (−)	Not confirmed
Inter-organizational collaboration	Opinion leadership (+)	Confirmed
	Frequent visit of thematic meetings (+)	Confirmed
Cognitive cohesion	None	–
Contextual factors	High investment per house (+)	Confirmed
	Urban renewal policy support (−)	Confirmed

14.7 Conclusion

In this chapter we have tried to answer the question of which factors explain the application of innovative energy systems in renovation projects in residential areas. This issue is quite important as the diffusion and deployment of clean technologies in large energy consuming sectors is important to reduce substantial GHG emissions and therefore contributes to achieving green growth. In our study we sought six theoretical explanations: the influence exercised by policy instruments, the influence exercised by housing associations, the influence exercised by local governments, collaborative efforts between actors, cognitive cohesion between actors, and contextual factors.

Policy instruments were found to be of prime importance to the appliance of innovative energy systems. Subsidies and communicative policy instruments were necessary but not sufficient conditions. Covenants were neither necessary nor sufficient. Rather, they arose out of previous projects and local experiments. The analysis showed that *housing associations* were primarily involved with social issues (their prime business). When the application of IES was at stake the executive board demanded that external finance, such as subsidies, be acquired. The privatization, starting in 1995, might be the reason why the housing associations discount every investment harshly. However, this trait can be combined with the application of IES if two conditions are met: there has to be a highly motivated and influential project manager, and there has to be a staff specialized in energy affairs. Although the adoption of corporate social responsibility standards among housing associations is rising, the application of IES can be considered more a personal motivation by individual managers within housing associations than one that derives from the executive board following a formal policy document or CSR statement. Furthermore, in our cases IES were only installed when relatively small-sized housing associations were involved. This might be an indication that larger ones have too many other concerns to worry about, given the size of their organization and the housing stocks they manage. The role of *local governments* was rather limited, as they only exerted an influence in the planning stages of projects or played minor, supportive roles. Strikingly, the successful projects were all located in relatively small municipalities within which lay only local governments with small staffs that likewise lacked the capacity to pay much attention to local climate policy, including the installation of IES in residential areas. *Tenants* turned out to be little concerned with the energy efficiency of their homes. In some cases they actively preferred conventional, suboptimal systems over more energy-efficient alternatives, even though additional information was provided on direct financial benefits. The reason for this lies in a fear of increased direct energy costs, unequally divided costs among tenants in the building block, and distrust of the housing association's plans. With regard to *inter-organizational collaboration* it can be stated that without the presence of a highly motivated, authoritative person close to the decision making (the opinion leader), combined with frequent visits to thematic meetings, important information is not diffused, which is critical to the application of IES. Two *contextual factors* were important: a large total investment per dwelling, and policy support for urban renewal activity. The latter exerts a negative impact, indicating that urban areas troubled by a plethora of social problems do not provide optimum conditions for meeting environmental goals such as the application of IES.

In sum, three variables exercised a rather positive influence on the application of IES: policy instruments (climate policy), housing associations' organizational characteristics (but only in terms of energy efficiency advocates and personnel specialized in energy affairs), and inter-organizational collaboration.

Although innovative renewable energy and energy efficiency technologies offer great opportunities to improve energy performance in houses in residential areas (and hence decrease GHG emissions), our research results can be perceived as highly sceptical of the deployment of such technologies in the housing sector in the Netherlands. There appears to be a great divide between ambition setting and goal achievement at the local level. Apparently, the goals set are too ambitious and the current policy mix is inadequate to gain commitment from key actors. Harvesting the technical potential of energy efficiency is far from being an accomplished goal. Future research and policymaking should devote careful attention to the way local actors should be addressed in order to gain commitment (from both households and housing associations), and to see how local authorities may actively facilitate the project of furthering energy efficiency in housing renovation sites, and not just by setting ambitious goals. Furthermore, systematic, in-depth comparison of local level projects, as well as international comparative analyses are necessary to assist the Dutch national government, the European Union and the OECD to develop strategies that encourage the 'greening' and better energy performance of domestic housing in current residential areas.

It is up to them to provide policy incentives that foster the further deployment of clean energy technologies in the domestic housing sector. This is important since the greening of energy usage is a significant element of green growth.

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