Title: *Energy Conservation in Existing Housing Sites; a Comparative Case Analysis in the Netherlands*

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Abstract:
The housing sector in the Netherlands is responsible for a significant fraction of primary energy use and CO_2 emissions. Great energy conservation opportunities are to be found in the existing housing stock, especially in large renovation projects on existing sites. Energy conservation savings of up to 90% are technically feasible. Despite this, there is little empirical evidence available about processes that influence the achievement of energy conservation goals in such locations. Moreover, no systematic, bottom-up research on the matter is available. This paper attempts to answer questions about the factors – size, direction and significance – that explain variation in the degree of energy conservation. Four main propositions were tested, comprising the following variables: actor characteristics, policy instruments, inter-organizational collaboration and context. The study used a comparative research design. Data were collected from eleven existing housing sites where renovation projects had been executed, involving 70 personal interviews, a survey, and the collection of project documents. A mixed methods approach was applied for data analysis. The results show that interorganizational, collaborative efforts, policy instruments and the presence of wealthy housing associations have a positive influence on energy conservation outcomes. The mean energy conservation was slightly less than 40%, and outcomes varied between 26.5% and 69.8%. Strikingly, planning does not have a beneficial influence and the actual outcome is lower than predicted. The results are useful for national and local government policy makers, as they clearly argue that ambitious policy goals should be tempered.

1. Background and problem definition

In the Netherlands the built environment is responsible for 33-40% of total greenhouse gas emissions. About 60% of these emissions are due to the residential sector (VROM, 2005). Greenhouse gas emissions in the residential sector are primarily caused by decentral combustion of gas (in houses) and combustion of coal in power plants. In Dutch houses gas is used to for space heating, water heating and cooking. Electricity is used for lighting and to drive domestic appliances. The Netherlands has a rather old housing stock. The energy quality of these old houses is lower than those that have been built more recently. To a large extent this is due to the fact that legislation on energy efficiency was only implemented after 1975. Before that time period there were no norms that prescribed insulation and the installation of high yield condensation boilers (De Jong et al., 1975). Due to the fact that many houses were built in the post-War era until the early 1970s, a large fraction of the houses are relatively old and therefore of low quality in terms of energy efficiency. The solution of replacing the old houses is seriously hampered by the fact that the annual housing turnover ratio is less than 1% (CBS, 2008). This also has consequences for policies aimed at improving energy efficiency in Dutch housing by just replacing old houses with new ones. If a substantial reduction of GHG emissions in the residential sector is to occur, it means adequate measures should be targeted on the existing housing stock. This is not a totally new insight, since even in 2000 the Ministry of Housing had noted that approximately two-thirds of greenhouse gas emissions in the total housing stock should be achieved in the existing housing stock (VROM, 2000).

Technically speaking, sufficient solutions are available now to solve the problem. Energy conservation in houses of up to 90% of the original use are currently feasible (Trecodome, 2009). However, a lot of attention needs to be paid to the interests of the owner and occupants, when such technical measures are applied. When the residents/owners think about renovating their homes they hardly prioritize energy efficiency, especially in cases where energy costs are but a small part of the total cost of living (Sunnika, 2001:114-5; SenterNovem, 2005:14; Lulofs and Lettinga, 2003: 21). Moreover, attention has to be paid to the needs the owners and occupants have in regard to other issues, such as comfort, health, and their return on investment. In brief, implementing energy conservation measures in existing houses is anything but easy.

In this paper the central question concerns the factors that explain the variation in the energy conservation achieved as between existing housing sites. This paper studies especially housing locations in post-war neighborhoods. These are characterized by relatively low-value houses, predominantly owned by public and semi-public housing associations. We seek the explanation of the research question in five factors: the influence exercised by policy instruments, the influence exercised by housing associations, the influence exercised by local governments, collaboration efforts between actors, and contextual factors. The central research question is analyzed by applying a comparative research design. Both qualitative and quantitative methods are used to answer the research question.

The paper is structured as follows. Section 2 presents a literature review of the factors that influence energy conservation in the existing housing stock. The review zooms in on both national and local policy programs and instruments. Next, section 3 describes insights in the institutional arena, comprising a list of the main actors, their interests, resources, and the ways in which they interact with each other. Section 4 looks at relevant theoretical insights. In the following section the insights mentioned are used to design an analytical framework, which is then used as a research model in remaining parts of the paper. The research design and methodology are presented in section 6, and section 7 reports the results of the comparative analysis. Finally, section 8 reports the main conclusions of the empirical study.

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2. Literature review of energy conservation in the existing housing stock

A literature review was conducted to afford an insight into the causal mechanism that underlies energy conservation in the existing housing stock.

National energy conservation policy programs often contain a 'policy mix' that comprises different policy instruments in which economic incentives are facilitated by communicative instruments, such as information campaigns, education, marketing and energy audits (NIP, 1988; Clinch and Healy, 2000; Balthasar, 2000; Lulofs and Arentsen, 2001). Programs have often been characterized by decentral subprograms and the incorporation of counter-cyclic economic policy objectives to stimulate employment. In general, policy objectives were formulated ambitiously. However, they were realized only partially. Unfavorable macro-economic developments and government changes were the main causes of discontinuity in energy conservation programs (NIP, 1988). Deteriorating economic prospects lead to both decline in program budgets and decline in the purchasing power of the house owners and occupants (Clinch and Healy, 2000), and therefore a decrease in the up-take of appliances to further energy conservation.

Experiences with legal standards showed that they were especially effective when facilitated by other policy instruments, such as information campaigns and economic incentives (Balthasar, 2000). Subsidy schemes often suffered from problems and a lack of clarity when other sectoral policies were involved. Sectoral conflicts were also blamed for problems in fine tuning between different layers of government (NIP, 1988). Other studies obviously demonstrated the beneficial effects of subsidy schemes on energy conservation (Ecofys, 2004; Vermeulen and Hovens, 2005). Experience with covenants had two main thrusts. First, no direct evidence exists for the beneficial effects of the instrument. Secondly, covenants did improve the degree of collaboration between actors and helped to stimulate the learning capability of actors, albeit over the long term (Balthasar, 2000). The projects in which covenants turned out to have stimulating effects were characterized by participation by actors distinguished as 'early movers' (Van der Waals and Vermeulen, 2003). Successful covenants were also distinguished by close collaboration between various tiers of government, as well as the involvement of local communities (Balthasar, 2000). Nonetheless, a program evaluation in the Netherlands pointed out that the instrument's effectiveness was rather poor (Ecofys, 2004). Information campaigns were only effective when house owners and occupants were frequently reminded of the central policy message and when the implementing agencies paid careful attention to the specific ways in which they approached their target group (Henryson, Håkansson and Pyrko, 2000). Little attention has been paid on the effects of other communication policy instruments. However, Van der Waals (2000) revealed empirical evidence about the effectiveness of process management and the presence of 'change agents'.

Households turned out to be difficult to approach due to information gaps, the unwillingness to discount long-term benefits, and a lack of acceptance of the high transaction costs involved with investments in energy conservation in one's house

(Clinch and Healy, 2000). It is notable that low income households were especially difficult to approach (Clinch en Healy, 2000; Van der Waals en Vermeulen, 2003). Nevertheless, projects were also mentioned in which the occupants were aware of the benefits of energy conservation, both prior and subsequent to the application of the technical measures. These projects achieved energy conservation figures of up to 45% (Hekkanen, 1999). The studies also showed that both suppliers and contractors experienced problems as they had to adapt to a sudden market demand (Clinch and Healy, 2000).

Lastly, it may be useful to mention that research in other fields of environmental policy show that policy instruments are not often implemented independently. Rather, they are implemented together with other (types of) instruments and even seem to be effective only when they form part of a ‘policy mix’ (Bressers and O’Toole, 2005).

3. The institutional context

In order to grasp the environment in which efforts are made to the improve energy efficiency of current houses it is necessary to gain some insight into the roles of the local actors involved, their interests, the resources they possess and exchange, and the ways they interact. Opportunities for large scale energy conservation in the current housing stock lie in large-scale renovation projects in relatively old, post-War neighborhoods. 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 neighborhoods are characterized by a high degree of unemployment, above average crime rate and a high proportion of ageing population. The population on average also has a relatively low socioeconomic status. Renovation projects are primarily meant to improve both social and physical structures in neighborhoods. Energy conservation is considered not more than a secondary objective in that endeavor. The houses in the neighborhood are for the greater part owned by one or more former public or semi-public housing associations. The housing associations manage the houses with the public objective of delivering quality housing for housing consumers who do not have the means to buy houses themselves. 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. However, they maintained their key public task of providing quality housing to those who cannot afford to buy their own house (Koffijberg, 2005).

A lot of decision-making is involved when a large-scale neighborhood or building block renovation plan is being scheduled. Agreements are often laid down in covenants that cover in agreements of intent between local governments and housing associations. Local governments are able to exercise influence and encourage the take-up of energy conservation appliances by making trade offs with housing associations, with a strategic use of urban renewal subsidies and legal permits. However, the local authorities remain strongly 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. Moreover, in renovation projects, legal consent is required from the tenants who live in the houses. The legal standard holds that at least 70% of the tenants must the renovation project plans. The legal 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 approve their (and the local authority's) plans. However, speaking relatively, local governments and tenants have few means to negotiate with housing associations in to order to encourage them to install technical appliances that significantly improve energy efficiency in the houses. The power balance is key to the advantage of the housing association. In the end the housing associations decide whether or not and how much to invest in energy efficiency.

Parts of the post-war neighborhoods also contain private house owners. These are often former tenants of the housing association, which sold them their houses in the years prior to the renovation project. When renovation projects are scheduled and many owner-occupants resident in the neighborhood, 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) house owners have problems acquiring them. This means that access to loans and mortgages represents a serious barrier to persuading house owners to invest and participate in the neighborhood renovation project (Clinch and Healy, 2000). Even when national government offers additional means to further encourage this group, the actual effect is marginal. In short, several institutional barriers exist that prevent large-scale adoption of technical appliances to stimulate energy efficiency in existing housing (Hoppe and Lulofs, 2008).

4. Theoretical framework

Several theoretical insights are useful to show us how to perceive and explain the phenomenon of energy conservation in the existing housing stock. These theoretical insights originate from different disciplines, such as environmental economics and -psychology, diffusion of innovation studies, and policy studies. This last field is especially useful due to its emphasis on the implementation of environmental policies.

From environmental economics and psychology we learn that innate mental shortcomings and individualistic considerations seriously limit human beings from recognizing signals that indicate stepwise deteriorating conditions, eventually leading to environmental catastrophe, such as climate change. It is due to these limitations that human beings are not able to adequately anticipate such hazards (Forrester, 1969; Ornstein and Ehrlich, 1989). This capacity also limits man's ability to organize sufficient collective action to prevent such disasters from occurring (Olson, 1965). However, without sufficient policy pressure we cannot expect that innovative measures and solutions to environmental problems will become accepted by the majority of mankind.

Insights from diffusion of innovation studies allow us to look into the processes that underlie the dissemination and acceptance of innovative concepts in social communities (e.g., Rogers, 1962; Granovetter, 1973; Granovetter, 1978; Burt, 1987). The acceptance and adoption of innovative measures is necessary to approach a sustainable society, which also involves the replacement of fossil fuels by sustainable alternatives. This turns out to be rather difficult because 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). The focus in diffusion of innovation studies – and to a lesser degree sociotechnical studies – traditionally lies on the supply side of the market and getting processes of diffusion and change going, as compared to the demand side of the market and keeping a process of diffusion and change going on. The latter is more complicated due to the fact that the early market customers have already adopted the concept, whereas the mainstream market customers still need to be convinced to adopt the concept. As Bressers (1989) has already stated, it’s much more difficult to convince the late majority than to convince the exemplary minority. Conventional behavior and the existence of institutional barriers (such as sectoral policies) limit further adoption. A facilitating institutional setting is considered a precondition for continuing the process of acceptance. Several strategies exist that encourage the process of acceptance, some of which have become part of policy strategies and instruments. Such incentives are implemented broadly in settings where they have to deal with serious setbacks when competing with several constraints that have their backgrounds in traditional policy domains. This means that successful implementation of policy instruments aimed at the diffusion of innovative or sustainable energy appliances is seldom self-evident.

The third theoretical tradition concerns the implementation studies within the discipline of policy studies. Implementation studies look at factors that explain the effectiveness of policy implementation and its products. Implementation studies originate from the 1970s (especially in the key publication by Pressman and Wildavsky, 1973) and during this period it was characterized by a broad range of theoretical developments involving a wide variety of independent variables. O’Toole (2000) mentions a ‘cornucopia’ of independent variables and sectoral twists between paradigmatically divided scholars concerning explanations of policy implementation and its products. Theoretical interest in the matter declined during the 1980s (Hill and Hupe, 2000), although some fields were further elaborated. In particular, theoretical progress was made on the phenomenon of policy instruments in environmental policy (e.g. Bressers and Klok, 1987). The 1990s saw a revival of interest in implementation studies. Special attention was paid to a number of theoretical concepts, 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 was 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 (1998, 2004, 2008) 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 domain. Furthermore, the theory lays a strong emphasis on contextual factors. It also holds that environmental policy is seldom prioritized in the list of preference 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 for 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 stimulate energy conservation. The Contextual Interaction theory facilitates a systematic analysis of environmental policy implementation processes.

5. Analytical framework and hypotheses

The insights presented in the literature review of previous energy conservation policies led us to choose an approach that applies multiple theoretical points of view. It will therefore be useful to name several clusters of independent variables in order to test them at a later stage. This does not involve competing theories or explanations, because this might lead one to think that such theories are contradictory, which is not the case. On the contrary, we believe that theoretical points of view rather compensate each other. We aim to discover which cluster of independent variables deliver the most powerful explanations. We present a graphical view of our research model in figure 1.

[insert figure 1 about here]

All variables clusters are subdivided by a number of different items. These items are used as indicators for the specific explanatory model of the particular independent variable. The five clusters of independent variables concern: (1) the use of policy instruments in the domain of energy policy, (2) characteristics of local governments, (3) characteristics of housing associations, (4) interorganizational collaboration between actors, and (5) physical, economic and institutional characteristics of the project context. This last cluster was added to the research model as a contextual component next to the other variables, which are more theoretically oriented. Without specific knowledge of the project context it is useless to analyze the outcome of policy implementation processes. Below we present an overview of the main hypotheses in the research model. The hypotheses concern the main propositions in the analytical framework. Since the main independent variables will be operationalized as scales constructed of 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 better the degree of energy conservation in the renovated housing stock will likely be. 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.

- The more the organizational characteristics of local governments favor energy conservation, the better the degree of energy conservation in the renovated housing stock will likely be. The variable comprises the following items: orientation toward environmental problems, the presence of formal energy conservation policy, personal capacity, the presence of advocates of the subject, the degree of organizational tuning, the political orientation of the local officials, the size of budget on the subject as provided by national government, and size of the municipality.

- The more the organizational characteristics of housing associations favor energy conservation, the better the degree of energy conservation in the renovated housing stock will likely be. The variable comprises the following items: orientation toward environmental problems, the presence of formal energy conservation policy, personal capacity, the presence of advocates of the subject, the degree of organizational tuning, the financial position (company capital) and size of the housing stock owned.

- The more interorganizational collaboration efforts that are undertaken, the better the degree of energy conservation in the renovated housing stock will likely be. The variable comprises the following items: the presence of opinion leaders, the frequency of visits to professional meetings on the subject, size of the project configuration over time, degree of cohesion on environmental subjects, and degree of cohesion on the adoption of technical innovations.

- The more contextual factors that favor energy conservation, the better the degree of energy conservation in the renovated housing stock will likely be. The variable comprises the following items: 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, balance in the public housing market, initial energy quality of houses on location, type of house, number of renovation houses on site, address density, degree of public participation in the project, and degree of institutionalizing of subject in project management.

6. Research design and methodology

In this research the dependent variable is the degree of energy conservation. The cases relate to substantial renovation projects at existing housing locations. The research domain is The Netherlands. The sample is not randomly selected. The number of cases (eleven) is too small for formal statistical generalization. However, due to the case selection method – cases most resembling the population of interest with regard to background variables – it is useful to explore whether it is possible to generalize to a sample of 33 housing locations, present in a national monitored dataset. These sites were monitored in the so-called "EPL Monitor" by SenterNovem, the national energy agency (SenterNovem, 2007). The agency aimed to select representative sites. In case of the criterion 'geographical spread over the country' the agency did indeed succeed. We tried to go a step further to check for significant differences in 14 background variables. The result was that no significant dissimilarities were found between the sample of eleven cases and the sample of sites monitored by national government[i]. Because the study comprised a case study design we applied the following phases in our research: research design, case study protocol, data collection, data analysis and reporting. To carry out the research in a valid and systematic way, a case study protocol was designed (Yin, 2003).

Prior to data collection on the eleven case studies, a series of semi-structured interviews was conducted involving practicing experts. Subsequently, two pilot case studies were also conducted. The series of interviews comprised data collection using a semi-structured questionnaire presented to nine program advisors at the SenterNovem energy agency (national government). These professionals were involved in local projects and were tasked with promoting energy efficiency among local stakeholders. Consequently, these professionals were pre-eminent in their possession of the knowledge and experience required in this phase of the research to inform the researcher about the validity of his questionnaire and the constructs used in the research model. Secondly, and even more importantly, they introduced the researcher to cultural and contextual issues that are important in understanding the processes in the local arena. In order to validate the research model and design, the collected interview data were further analyzed, applying a quasi-inductive approach and using software for qualitative data analysis (QSR NVivo). The use of this program facilitated the systematic analysis of qualitative data.

Questionnaire development also followed a stepwise approach. This held for both the semi-structured questionnaire and the quantitative questionnaire designed for multiple regression analysis. For content validation issues both questionnaires had to be tested. First, the questionnaires were assessed by academic staff. Secondly, the questionnaires were completed and assessed by respondents in the pilot studies. After the questionnaires were returned, comments and analysis of the answers provided reasons for redesign. After this stage the questionnaires were ready for data collection in the eleven cases of interest. Conducting the entire research investigation lasted from May 2007 through to October 2008.

6.1. Data collection

The data collection encompassed the collection of different kinds of data. When the study started, only quantitative data were available from the previous study on ambition-setting and energy conservation on existing housing sites (Hoppe, Bressers and Lulofs, in press). Moreover, data on the dependent variable – achieved energy conservation – were not yet available. After the case selection stage and the pilot study stage were finalized, contact was made with persons involved in the nine housing sites of interest. We partially applied the ‘snowballing’ method to get in contact with other key persons in the cases. Subsequently, dates were set for in-depth interviews. Forty on-site interviews were conducted and 30 telephone interviews. The on-site interview sessions took on average two hours, the telephone interviews half an hour. Additional documentation on the cases was partially traced before the interviews were conducted, but also after access was provided by the interviewees. Project documents involved: formal policy documents, advisory reports, annual reports, specific information papers, websites, feasibility studies and geographical maps of project locations. The project documents provided both information about the project itself and the key organizations involved.

The number of interviewees per case numbered on average between five and six persons, ranging from three to eight. The group of interviewees predominantly featured persons from the following professions: project manager at the housing association, project leader in the local authority (urban renewal, property development), policy associate on environmental or energy/climate affairs in the local authority, or energy associate at 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 in the projects of interest on the subject of energy conservation; (2) they were often involved in the project for relatively long periods, which made them very knowledgeable and experienced; and (3) they possessed good networks with many contacts that were of interest to the researcher. Finally, it is noteworthy that most interviewees were males in the age category 40-50, with higher education (most frequently in civil engineering).

6.2.Data treatment

The quest for comparison of eleven cases meant that analysis by qualitative means alone was out of the question. The number of cases required a predominantly quantitative analysis, which means that data treatment was tremendously important to the comparative analysis.

First of all, the interview recordings were written down in transcription reports. The decision was made to do this in near-literal transcription reports in order to make full use of the richness of the data collected. One of the advantages of this decision was that it was also possible to use the data in later stages of the study when advanced insights required a fresh interpretation of the transcription reports. After data collection, transcription reporting, supplementing ambiguities in data sources and story lines, case histories were reconstructed. The reconstruction of a case history took a week on average. Inconsistencies in story lines meant that additional data collection was required, which meant re-contacting former interviewees. Further comments had to be processed in the case histories. After finishing the case chronologies the phase of quantitizing qualitative data began (however, many quantitative data was already present from the cases). Ten-point scales were constructed and scores were assigned per case. In this way an inter-case matrix was created, which meant 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 validity reasons and the reliable assignment of scores. In order to carry out this process in a trustworthy manner, all score assignments were accommodated with textual argumentation. Subsequently, the score assignment was replicated.

Because the scores on the dependent variables were not clear per case, data needed to be collected, which required the collection of construction-technical data on specific construction elements in renovation activities that influence energy performance in houses. Following that, specific software was required to calculate energy performance. The software program used (OEI 2.1) is the same one that was also used in the calculation of feasibility reports during the planning stages (in all but three cases). The program had been developed in 2003 by the SenterNovem agency to help local actors conduct energy-audits of their specific locations. The reliability of calculations was assessed by discussing extreme outcomes with persons involved with the local projects.

6.3.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 in order to compare the cases and judge which variables correlated significantly with the degree of energy conservation. Qualitative and quantitative methods were used to compensate, meaning that ‘mixed methods’ have been applied, a methodology from an epistemological pragmatic stance (Johnson and Onwuegbuzie, 2004). The objective of applying both qualitative and quantitative methods in comparative research is to aim for confirmation of analytical results (triangulation), improvement of the researcher’s interpretation, and optimization of the sample (inter alia).

Because a comparative analysis of eleven cases with qualitative data only was impossible, the decision was made to conduct a quantitative analysis. This required the quantification of qualitative data and the creation of an inter-case matrix (case x variable) by adding already quantitative data. This treatment made multiple regression analysis possible, although the small number of cases corresponds to poor statistical power and therefore little opportunity for statistical generalization. The small number of cases also means that a confidence interval of 90% is used for correlation and multiple regression analysis. The tests are one-tailed, because we assume we know the direction of the correlations from the hypotheses mentioned earlier in section 5. The multivariate analysis makes it possible to determine which independent variables correlate most closely with the dependent variable. Scaling was applied to calculate the scores per independent variable (cluster). To take care of construct- and statistical validity, scales were designed that had to meet the criterion of Cronbach's alpha (Cronbach, 1951). In essence, this particular test has to be carried out every time a scale consists of multiple items (Carmines and Zeller, 1979).

Subsequently, a crisp-set qualitative analysis (csQCA) was conducted to identify the necessary and sufficient conditions that underlie the presence of high energy conservation outcomes in renovation projects on existing housing sites. The method also helps to identify combinations of conditions that underlie the occurrence of the phenomenon of interest. The method was developed during the 1980s by the sociologist Charles Ragin in an effort to bridge the gap between 'variable oriented' comparative research traditions and 'case oriented' ones (Ragin, 1987). Although the method contains elements of both qualitative and quantitative research, it is generally regarded as qualitative. The method also requires a constant dialogue between (quantitative) analysis and data (case histories). csQCA requires data to be coded as dichotomies, where '1' means presence and '0' absence. This holds for data on both dependent and independent variables. We decided to assign projects with energy conservation outcomes higher than 40% as 'high energy conservation outcome cases' ('1').

7. Results

This section presents the results of the comparative analysis. We have chosen to present the results in stages. In first place, an overview is created by presenting descriptive statistics, involving means, extremes, range, standard deviations and skewness of distribution. Furthermore, important data per case are presented in an inter-case-matrix. Subsequently, the results of the bivariate correlational analysis and the multiple regression analysis are presented. Finally, the results of the qualitative comparative analysis (csQCA) are reported, together with arguments about whether quantitative and qualitative analysis confirmed each other, or not. To start the overview of the results, a geographic map of The Netherlands is presented in figure 2, which contains the locations of the sites studied.

[insert figure 2 about here]

7.1. Descriptive statistics

An overview of important numeric data per case is presented in table 1. The data include the number of houses renovated, the type of house, the ambition set for energy conservation (in EPL-scale points), the scale of the energy performance achieved (in EPL-scale points), the actual energy conservation achieved (in EPL-scale points), and the relative energy conservation achieved (in percentage points). The table is structured in descending sequence according to the category ‘relative energy conservation achieved’).

[insert table 1 about here]

Table 2 gives an overview of descriptive data on nine key categories of the eleven sites of interest. On average the sites feature 440 houses subject to renovation activity. The location with the smallest number of houses subject to renovation featured 100 houses (Tannhäuser), whereas the largest site featured 1,628 houses subject to renovation activities. The standard deviation is rather large (459), due to the fact that the distribution of the category is very right-asymmetric (2.071). Most cases are close to the mean, whereas one site (Prinsenhof) has many houses. The average energy conservation is 39.7%. The site with smallest amount of energy conservation achieved showed a value of 26.5% (Atol- en Zuiderzeewijk). The site with the largest amount of energy conservation achieved a value of 69.8% (Groot Kroeven). In the latter case the innovative concept of passive renovation (the renovation variant to passive housing) had been applied, a technology that features extreme insulation standards and the use of passive solar energy. The technique has been applied only rarely in the Netherlands, most often in renovation locations. The differences in types of houses is also worth mentioning. On seven sites the houses were family houses built between the 1930s and the 1970s. On four sites the dwellings were apartment buildings, built in the 1960s. When selecting the cases it was not possible to pay attention to variance in the type of housing. Nonetheless, the variance analysis did not show significant difference with a larger sample of housing site according to the type of house. The average investment per house was rather high at € 62,383 (given the fact that € 100,000 is sufficient to built a new family house). The investments ranged between the extremes of € 25,000 and € 105,078. This too is quite a variation. The last category in the table refers to exploitation term lengthening. This category is part of the table for the following reason: lengthening the exploitation term is often used by housing associations as a means to compensate for less profitable investments (equipment to encourage with energy efficiency is often considered to lie in this category). Exploitation term lengthening was 34 years on average, which is more than half a lifetime of a house in the Netherlands Except for two categories, few skew distributions were found. In particular, the category ‘energy conservation achieved’ (in EPL-scale points) is hardly skew distributed. For that reason this category is used as the dependent variable further on in the analysis.

[insert table 2 about here]

7.2. Results of the correlation analysis

This section surveys the results of the bivariate correlation analysis. The most important results are presented in table 3. The table is organized according to the clusters of variables in the analytical framework (see figure 1).

[insert table 3 about here]

Due to the small number of cases we paid careful attention to further investigating the significant correlations that resulted from the analysis. This means that scatter plots were checked. In case the correlation depended too much on two cases or fewer, the decision was made that correlation was doubtful. This often led to the conclusion that the independent variable was no longer suitable for further inquiry in the multiple regression analysis to be conducted in the next research phase.

The following correlations withstood the close investigation of the scatter plots:
- energy conservation * frequency of visits to discussion meetings;
- energy conservation * involvement of process manager by national government;
- energy conservation * size of the project configuration over time;
- energy conservation * scale on interorganizational collaboration;
- energy conservation * financial position of the housing association;
- energy conservation * organizational fine tuning within housing associations;
- energy conservation * scale on characteristics of housing associations;
- energy conservation * presence of local or regional covenants;
- energy conservation * use of communicative policy instruments;
- energy conservation * scale in policy instruments;
- energy conservation * exploitation term lengthening of houses on site;

7.3. Expected correlations that did not result from the correlation analysis
A number of correlations that for theoretical reasons were expected to result from the analysis, were not found. This is explained below.

In the variable cluster on *instruments from climate policy* it was striking that *subsidies* did not correlate significantly with the degree of energy conservation achieved. The explanation inheres in the argument that subsidies are not provided to projects in which the most far-reaching, innovative energy efficiency techniques are applied. On the one hand, evidence from the case studies showed that high energy conservation figures were achieved on sites where substantial subsidies were absent. On the other hand, rather low degrees of energy conservation were achieved on sites to which substantial subsidies had been provided. Another argument for this finding is that government agencies would rather provide subsidies to sites on the basis of expected absolute energy conservation numbers and CO_2 emissions avoided, than relative numbers that might feature the highest relative decline in fossil energy use or CO_2 emissions avoided.

In the variable cluster on *characteristics of housing associations* several items were found that did not correlate with the dependent variable, even though theoretical expectation predicted so. *Orientation towards the environment* and *formal policies* did not correlate. Case evidence teaches us that housing associations do care about environmental issues, like energy efficiency, but they prefer to focus on the application of innovative sustainable energy systems in new construction and project development rather than energy conservation in their existing housing stock. In their annual reports, housing associations do mention the existing stock in regard to maintenance activities and the replacement of conventional heating boilers by high yield condensation boilers. However, this does not find a reflection in energy conservation in renovation projects. Maintenance and renovation are also considered as two different items in accounting terms, which is the way housing associations manage their business. Nor were significant correlations found with regard to *personnel capacity* and the presence of *energy advocates*. The argument here might be that housing associations are more concerned with energy efficiency in new houses rather than the old stock. Investment in new houses is considered profitable whereas investment in old houses is considered a waste of capital.

Several items in the variable cluster *characteristics of local governments* were also identified that did not correlate significantly with energy conservation. Many items correlated negatively, but were not significant. It could be argued that the cluster variable did not correlate due to the local government's relative lack of involvement in the project's implementation stage. The significant (negative) correlation – which did not withstand the scatter plot inspection test – of the budget provided by central government to stimulate local climate policy (BANS) was unexpected. A qualitative argument for the direction of the correlation lies with the emphasis local governments seem to place on the realization of energy efficiency goals in new construction sites. The evidence from the case supports this finding. The sites with poor levels of energy conservation realized in the existing stock were also those where local governments were particularly active in promoting district heating and sustainable energy for new construction sites, and where large sums in central government funding were available (such as the municipalities of Lelystad and Apeldoorn). By contrast, high energy conservation rates were achieved in municipalities where the local governments were relatively poorly supplied by national government budgeting on local climate policy (such as the municipalities of Roosendaal, Uithoorn en Kerkrade). Another finding related to this phenomenon is that revitalization of housing sites often involves both the renovation of old houses and the construction of new ones. When formulating energy efficiency objectives this has the side-effect that lofty ambitions are set especially for those areas where new construction is planned, rather than the parts containing houses that are scheduled for renovation. The energy efficiency ambitions set for houses that are to be renovated are moderate or even mediocre. This effect was displayed in five of the sites studied (Tannhäuser, Binnenstad-Oost, Nieuwstad, Espels, Prinsenhof). In these cases the energy conservation in the existing houses was moderate (close to the statistical mean of 39.7%), while the new construction nearby or on the specific locations featured housing blocks which had heat pumps installed or were connected to collective district heating facilities.

The variable cluster on *the project context* also features several items that were expected to correlate with the degree of energy conservation in existing houses. The first item to mention that did not correlate was the *initial energy performance of houses*. A previous study found evidence that this item correlated closely and negatively with ambition-setting for energy conservation. The explanation for this correlation was found in the calculating behavior of local governments and the way they approached and interacted with local actors (Hoppe, Bressers and Lulofs, in press). Nonetheless, the item does not seem to correlate in any way with the degree of energy conservation achieved. For example, the greatest degree of energy conservation achieved occurred on a site (Groot Kroeven) where the initial energy performance of the houses was already high (contrary to the prediction on which ambition-setting was based). However, the site is a perfect example of a case where the project's implementation contrasted strongly with the original planning and early project objectives. Another notable finding was the fact that *investment per house* did not correlate with the degree of energy conservation achieved. Nor did *public participation* (of tenants) correlate significantly. From a theoretical stance it was expected that tenants would be interested in significant energy efficiency improvement of the houses in which they live. However, this would require them to discount the long-term benefits of the application of technical measures that reduce their annual energy costs. Due to the fact that the housing association usually calculates a small monthly rent increase for their tenants, tenants were affected negatively, since they emphasize short-term costs over long-term benefits (even when the net effect clearly favors the long term benefits). Tenants often only perceive a rise in living costs and thus a decline in personal purchasing power. The cases also show that tenants are actually inclined to stick with conventional systems, even when information about direct benefits are offered on innovative and sustainable energy systems. Finally, it is useful to mention that the sites' distance from potential district heating facilities did not correlate significantly. It was expected that the distance would be of interest to local actors in the planning stage and that connection to city heating would be a serious alternative to consider. However, district heating was only implemented in two cases (Bijvank and het Lang). In this case the houses were already connected to the dictrict heating system. In six other cases, connection to district heating facilities was considered, but abandoned when the project plans evolved. So they were never considered as a serious option. However, connection was considered in one case. This did not materialize as the district heating facility could not be built. The legal permit for the facility was not granted (Tannhäuser case).

[insert table 3 about here]

7.4. Results of the multiple regression analysis

This section reports the results of the multiple regression analysis. Three significant regression coefficients were identified: interorganizational factors ($\beta = .456$; $p = .043$; contribution to $R^2 = .443$), characteristics of the housing association ($\beta = .466$; $p = .032$; contribution to $R^2 = .185$), and the use of policy instruments from climate policy ($\beta = .428$; $p = .051$; contribution to $R^2 = .164$). The model explains 79.2% of the variance (adjusted $R^2 = 70.2\%$). The F-value of the model is 8.866 and $p = .009$. Table 4 presents a summary of the results of the analysis. When applying the methodological restriction that an analysis of eleven cases allows only two independent variables, the analysis outcome is reduced to two significant variables: 'interorganizational factors' and 'characteristics of the housing associations'. Nevertheless, this model still explains 62.8% of the variance ($F = 6.74$; $p = .019$).

[insert table 4 about here]

7.5. Crisp-set qualitative analysis and triangulation of analysis results

Finally, a crisp-set qualitative analysis (csQCA) has been conducted to create insights in necessary and sufficient conditions that underlie the phenomenon of degrees of energy conservations achieved greater than 40%. The 'cut-off point' selected was 40% for two reasons. First, this is near the statistical mean of the energy conservation levels actually achieved. Second, because 40% energy conservation can be considered ambitious in terms of project planning and policy making. For instance, in local and regional covenants energy conservation ambitions only seldom exceed 30% (in the cases there was one exception, where the ambition was set at 40%). In four out of eleven cases energy conservation degrees of more than 40% were achieved (Groot Kroeven, Eygelshoven, Europarei en Prinsenhof). The analysis led to the identification of two necessary – but not sufficient – conditions: (1) the presence of sufficient policy instruments from the climate policy field, and (2) a sufficient degree of interorganizational collaboration. When both these conditions were present in the cases that were studied, energy conservation levels exceeding the 40% mark were also found. The items underlying the two variables mentioned were subjected to further in-depth analysis. It turned out that 'interorganizational collaboration' was essentially a phenomenon of frequent visits of discussion meetings. This can be interpreted as evidence of the encouraging effect of particular meetings devoted to sharing knowledge and experience. In the case of 'policy instruments from the field of climate policy' it turned out that both covenants and communicative policy instruments were effective. Covenants were especially effective in initiating projects and creating an arena where actors could collaborate and make appointments. This result also shows that such appointments were followed up by commitment. Communicative policy instruments played an important role in creating awareness, a necessary condition for later success in achieving ambitious levels of energy conservation. Strikingly, the presence of substantial subsidies turned out to be neither a necessary nor a sufficient condition in the achievement of ambitious levels of energy conservation in existing housing sites.

Triangulation aims to find a correspondence between the results of more than one research design. Basically, the aim is to confirm the results of the one research design using the results of the other. In case of the present study this would mean the confirmation of a quantitative analysis (multiple regression) by a qualitative analysis (csQCA). With regard to results leading to the effects of the variables 'interorganizational collaboration' and 'use of policy instruments from the field of climate policy' confirmation is achieved. This does not hold for the variable 'characteristics of the housing association', though, which is only supported by the quantitative analysis. The absence of correspondence led to further in-depth qualitative inquiry. We looked at the way the scale had been constructed (financial capital and size of the housing stock) and re-analyzed the occurrence of high levels of energy conservation (csQCA) for both items. It turned out that financial capital was a necessary but not a sufficient condition. Following this additional analysis it is valid to add the condition 'financial capital of the housing association' to the list of necessary but not sufficient conditions. This also confirms the results as between the quantitative and qualitative analysis with regard to the positive effect of the condition 'characteristics of the housing associations' on the degree of energy conservation achieved in existing housing sites.

8. Conclusion

Despite the technical opportunities to achieve significant energy conservation levels (up to 90%) in the existing housing stock, little has been achieved recently. Often conventional appliances and energy systems are applied for a number of reasons that have to do with different barriers that block the adoption of more innovative and sustainable alternatives. In this paper we have tried to answer the following research question: which factors explain the variation in the energy conservation achieved between existing housing sites. We looked for five theoretical explanations: the influence exercised by policy instruments, the influence exercised by housing associations, the influence exercised by local governments, collaborative efforts between actors, and contextual factors. The central research question was analyzed using a comparative research design. Eleven sites were investigated as separate case studies. Both qualitative and quantitative methods have been utilized in the analysis.

A comprehensive data collection exercise was conducted to enable the comparative analysis. A case history was written for every case. It was possible to conduct a comparative analysis using existing quantitative data, additional data from a survey and quantified data from the case histories. Descriptive statistics and bivariate correlations were investigated first. This led to the insight that the average relative degree of energy conservation was 39.7%. Achieved levels of energy conservation varied between 26.5% and 69.8%. Actual, achieved energy conservation outcomes were below the ambitions set in earlier stages of renovation projects. Subsequently, a regression analysis was used to determine which independent variables have the closest correlation with the degree of energy conservation achieved. Finally, a qualitative analysis was conducted, aimed at confirming the results of the previous quantitative analysis.

The correlation analysis (concerning both variable scale and sub-scale items) resulted in a number of significant correlations. Significance of correlations had to be confirmed by checking the scatter plots, with the rule that significance was no longer valid if two cases or fewer explained the correlation. The cluster 'policy instruments in the field of climate policy' was significant, and also comprised two significant sub-items: regional or local covenants and communicative instruments. The cluster 'characteristics of the housing association' also was significant and comprised two significant sub-items: organizational fine-tuning and financial position. The cluster 'interorganizational collaboration' was also significant and comprised three significant sub-items: frequency of visits to thematic meetings, size of the project configuration over time, and involvement of a process manager from national government. The last item's validity was doubtful, however. The cluster 'project context' did not correlate significantly, but comprised one significant sub-item: the exploitation term lengthening of houses. To sum up: three variables were identified as correlating significantly and positively: 'policy instruments from the field of climate policy', 'characteristics of the housing association', and 'interorganizational collaboration'.

Several propositions could not be confirmed by the correlation analysis. These involved correlations with sub-items from all groups of variables. With regard to the cluster 'characteristics of the housing association' this involved: orientation towards the environment, formal climate policy, size of the housing stock. The cluster 'characteristics of the local government' comprised the following items that did not correlate significantly: formal climate policy, and size of budget facilitated by national policy to stimulate local climate policy (BANS). The subsidies policy instrument did not correlate significantly, the reason being that subsidies are provided by national government not on the basis of relative energy conservation but absolute decline in energy use or CO_2 emissions avoided. Finally, it should be mentioned that ambitions were not reflected in project outcomes. This can be interpreted as stating that planning simply did not work, although ambitions might have been high in the early planning stages of projects.

The multivariate analysis resulted in the identification of three significant variables. Policy instruments from the field of climate policy, characteristics of the housing association, and interorganizational collaboration all correlated positively with the degree of energy conservation in houses on existing housing sites. The model explained 79% of the variance. Interorganizational collaboration explained 44%, characteristics of the housing association 19%, and policy instruments 16%. When the methodological standard for the number of independent variables and number of cases is applied, only two variables remain: characteristics of the housing association and interorganizational collaboration. This model still explains 63% of the variance.

Finally, a qualitative analysis was conducted to check whether the same results were found as in the previous (quantitative) analysis. This meant that a crisp-set qualitative analysis (csQCA) had to be conducted. This resulted in the identification of two necessary but not sufficient conditions: (1) the presence of sufficient policy instruments from the field of climate policy, and (2) the presence of a sufficient degree interorganizational collaboration. Further examination of the cases led to the identification of a third condition that can be classified as necessary but not sufficient: the presence of a wealthy housing association (concerning the amount of the firm's capital). This finding confirms the result from the quantitative analysis.

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10. Figures and tables

Figure 1. Research model.

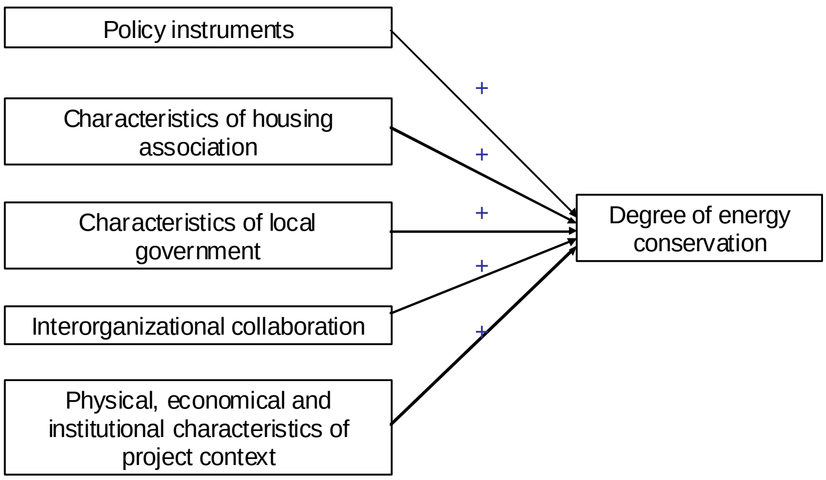

Figure 2: Geographical map of The Netherlands with the locations of the sites studied.

Table 1: Key numeric data per site:

#	Name of site	Name of town	Number of dwellings	Dwelling type	Ambition of energy performance enhancement (in EPL)	Height of ambition (in EPL)	Realized energy performance enhancement (EPL)	Degree of energy conservation
1	Groot Kroeven	Roosendaal	246	Family house 1960s	0.13	7.06	2.44	69.8%
2	Eygelshoven	Kerkrade	300	Family house 1950s	1.50	5.85	2.40	51.1%
3	Europarei	Uithoorn	635	Appartment 1960s	4.30	4.99	2.20	50.2%
4	Prinsenhof	Leidschendam-Voorburg	1628	Appartment 1960s	3.50	4.60	2.14	43.8%
5	Hogewey	Weesp	258	Appartment 1960s	1.50	5.00	1.40	35.0%
6	Espels	Leeuwarden	117	Family house pre-War	-	5.48	1.55	34.%
7	Binnenstad-Oost	Helmond	121	Family house pre-War	2.20	5.18	1.73	32.9%
8	Tannhäuser	Apeldoorn	100	Appartment 1960s	2.70	4.77	1.39	32,9%
9	Bijvank het Lang	Enschede	854	Family house 1970s	-	6.40	1.70	30.5%
10	Nieuwstad	Culemborg	200	Family house 1970s	3.30	5.13	1.26	30.1%
11	Atol- en Zuiderzeewijk	Lelystad	380	Family house 1960s	-	5.54	0.92	26.5%

Table 2: Descriptive statistics.

	N	Range	Minimum	Maximum	St. mean	Standard deviation	Skewness
Energy conservation ambition (in EPL)	8	4.17	.13	4.30	2.3913	1.33803	-.309
Height of achieved energy performance (in EPL)	11	2.46	4.60	7.06	5.4545	.73741	1.174
Achieved energy conservation (in EPL)	11	1.52	.92	2.44	1,7391	.49758	.047
Achieved relative energy conservation (in %)	11	43.30	26.50	69.80	39.72	12.88	1.430
Niumber of renovation houses	11	1,532	100	1,632	440.09	458,72	2.071
Exploitation term lengthening	11	40	15	55	33.86	11,80	.390
Investment per renovation house	11	80,078	25,000	105,078	62,383.73	31,121.29	.407

Table 3: Presentation of bivariate correlations.

Cluster ‘interorganizational collaboration‘.

Naam indicator	r	p
Opinion leadership	.301	.184
Frequency of visits to thematic meetings	.760	.003**
Involvement of process manager of the national government	.796	.002**
Size of the project configuration over time	.668	.012*
Cohesion towards environment and sustainable development	.176	.302
Cohesion towards technological innovation adoption	.111	.373
Scale ‘interorganizational collaboration’[ii]	.665	.013*

Cluster ‘characteristics of the housing association’.

Naam indicator	r	p
Orientation towards the environment	-.011	.487
Formal climate policy	-.372	.130
Personnel capacity	.005	.494
Presence of energy efficiency advocates	-.028	.468
Organisational fine-tuning	.653	.015*
Financial position	.750	.004**
Number of houses in property (size of stock)	.487	.064
Scale ‘characteristsics of the housing association’[iii]	.529	.047*

Cluster ‘characteristics of the local authority‘.

Naam indicator	r	p
Orientation towards the environment	-.188	.290
Formal climate policy	-.045	.447
Personnel capacity	-.058	.432
Presence of energy efficiency advocates	.017	.480
Political orientation of the officials	.371	.131
Size of the municipality	-.117	.366
Financial support by national government	-.580	.031*
Membership of Climate Treaty	-.147	.333
Organisational fine-tuning	.060	.431
Scale ‘characteristsics of the local authority’[iv]	-.143	.338

Cluster ’policy instruments from the domain of climate policy’.

Naam indicator	r	p
Use of subsidies	.307	.179
Presence of local or regional covenants	.551	.039*
Use of communicative policy instruments	.689	.009**
Scale ‘policy instruments’[v]	.563	.036*

Cluster ‘project context’

Naam indicator	r	p
Initial energy quality of houses	-.209	.268
Distribution of ownership properties	.179	.299
Investment per house	-.009	.489
Amount of houses	.321	.168
Share of new construction houses	-.053	.439
Exploitation term lengthening of renovation houses	.504	.057
Distance to district heating facility	-.489	.063
Type of heating system	.182	.296

Institutionalization of energy efficiency in decision-making process	.213	.265
Degree of public participation	-.194	.284
Balance in public housing market	.291	.193
Support by urban renewal policies	-.447	.084
Address density	.056	.435
Scale 'project context'[vi]	.108	.376

Table 4: Results of the multiple regression analysis.

Name of variable	β	Significance	D.F.	F	R^2	Adj. R^2	Contribution to R^2
Interorganizational collaboration	.456	.043	10	8.866	.792	.702	.443
Characteristics of the housing association	.466	.032					.185
Policy instruments	.428	.051					.164

[i] The following variables were checked for significant differences in means between sample and sites in national monitor dataset: size of the municipality (F = ,841; d.f. = 32; p = ,366); local authority's financial support provided by national government (F = ,022; d.f. = 32; p = ,882); size local authority's urban renewal budget (F = 3,863; d.f. = 29; p = ,059); amount of houses on site (F = ,172; d.f. = 32; p = ,682); ambition formulated for energy performance of site (F = ,436; d.f. = 28; p = ,515); share of houses on site to be newly constructed (F = ,464; d.f. = 32; p = ,501); amount of houses on site to be newly constructed (F = 2,402; d.f. = 32; p = ,131); type of energy provision (F = ,000; d.f. = 32; p = 1,000); local authority's score on national sustainable development index (F = ,059; d.f. = 29; p = ,810); local authority's collaboration efforts towards local actors (F = 1,289; d.f. = 29; p = ,266); political orientation of local officials (F = 3,242; d.f. = 32; p = ,081); mean financial value of dwellings on site (F = ,242; d.f. = 32; p = ,626); address density on site (F = 2,555; d.f. = 32; p = ,120); participation of site in national urban renewal program '56 wijken' (F = 1,292; d.f. = 32; p = ,264). The confidence level used was 95%.

[ii] Cronbach's alpha = .658. Items: opinion leadership, frequency of visits to thematic meetings, size of the project configuration over time, cohesion towards environment and sustainable development, and cohesion towards adoption of technical innovations.

[iii] Cronbach's alpha = .968. Items: amount of houses in property and cash reserve.

[iv] Cronbach's alpha = .809. Items: personnel capacity, organisational fine-tuning, size of municipality, Financial support by national government, formal climate policy, orientation towards the environment, Political orientation of the officials.

[v] Cronbach's alpha = .780. Items: presence of local and regional covenants, and use of communicative policy instruments.

[vi] Cronbach's alpha = .734. Items: exploitation term lengthening, investment per house, Initial energy quality of houses, distribution of property rights, type of heating system, institutionalization of energy efficiency in decision-making process, distance to district heating facility.