GOVERNANCE INSTRUMENTS FOR ENERGY NEUTRAL HOUSING DEVELOPMENTS

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ABSTRACT

Netherlands has set national energy targets for year 2020 following the European Union vision. In this context at the local level Eindhoven Municipality has set its ambition to go energy neutral in housing sector by 2020 and decided to develop new energy neutral housing areas. Lack of strict regulations and appropriate forms of support aimed at relevant stakeholders involved has attributed to the lack of acceptance for energy neutral housing in the current housing market. Further lack of a defined role for municipality to promote stakeholder participation has affected the realization of energy neutral housing developments. Market research shows that Denmark and UK have introduced several effective regulatory and support instruments to promote their energy ambitions in housing sector. Especially, Danish municipalities have played a unique role to promote stakeholder participation in energy efficient housing developments. These instruments found from Denmark and UK experiences are prioritized for Eindhoven scenario by stakeholder groups of Municipality, project developers, Energy consultants and consumers regarding their preferences using Analytical Hierarchy Process. Using scenario analysis a proactive participatory role is found essential for the Eindhoven municipality to promote stakeholder participation in energy neutral housing development process.

Key words: Energy Neutral Housing, Governance instruments, Analytical Hierarchy Process, Scenario analysis

INTRODUCTION

The European Union, under the Kyoto protocol, has set ambitious targets for greenhouse gas emissions reduction in order to limit the rising global temperature. At the same time, the EU has adopted equally ambitious targets for its future energy supply. It aims to meet these targets through a range of policy instruments at the Union, Member State and even sub national level. (Böhringer, et al., 2009). To foster the speed of developments to reach the targets EU has adopted certain policies and legislations aimed at the three energy targets: carbon emissions, energy efficiency and renewable energy sources.

In European Union buildings account for 40 % of the energy demand and about one thirds of green house gases of which about two-thirds are attributed to residential and one-third to commercial buildings (EC Green-paper, 2000). The households represent 63% of total energy consumption of the buildings sector. Electricity consumption in the household sector has grown by 12.5% since 2000 (Enerdata, 2007). Further households energy demand is expected to increase by 0.6% per annum between 2000 and 2030. This is attributed to the growing number of households, around 40 million, in this time period.

Member states, as per the EU regulations on Carbon emissions, renewable energy sources and energy efficiency, have outlined their own energy ambitions for year 2020 and set them as national level targets (EU Commission, 2008). The energy ambitions are spread over three layers of governance as observed in EU member states namely the Central government, Regional government and Local government (municipality). The municipalities play an important role in the planning and regulation of built environment as the European spatial planning system outlays certain building performance responsibilities to be fulfilled at the local level (DTU, 2009).

Sustainable urban development has developed in the past a few decades in the Netherlands to a mature subject of policy, research and innovation with various titles, such as low carbon city, energy neutral city, etc. In the same context, at the local level, Eindhoven municipality has expressed its vision for 2040 to become an energy-neutral in all sectors, and aims to go energy neutral in the built environment, specially housing sector, by 2020 (Gemeente Eindhoven, 2009).

Practical realization of energy efficient housing developments requires a transition in existing systems and ways of doing in the building sector. This is currently not happening in the building sector due to a deadlock in supply and demand. The construction companies do not offer developers to build energy efficient buildings as they cannot identify sufficient demand from consumers and thus developers complain about the reluctance of construction companies to come up with viable solutions (Rohracher, 1991). Lack of acceptance for energy efficient homes or buildings in the current market is attributed to lack of strict regulations and appropriate forms of support for the stakeholders involved in housing sector and the end user – customers. Lack of organized and structured process to be followed in the planning, development and realization phases has further lead to poor collaboration and communication between various stakeholders.

The potentiality of municipalities to promote energy efficient buildings through municipal governance is large, since municipalities typically have a powerful local planning role in terms of developing local urban areas and authorizing local building projects. However, short of strict regulations and appropriate forms of support aimed at relevant stakeholders involved has attributed to the poor acceptance for energy neutral housing in the housing market. Further, deficient in a defined role for municipality to promote stakeholder participation has affected the realization of energy neutral housing developments.

This paper is about the research that has been done to investigate what kind of regulatory and support instruments are needed to regulate the interests of various stakeholders towards energy neutral housing developments and what role should municipality play to promote collaboration among stakeholders and realize energy neutral housing developments. The paper is structured as follows. First, Market research shows that local governments in Denmark & UK have introduced several effective regulatory and support instruments to promote their energy ambitions in housing sector. Especially, Danish municipalities have played a unique role to

promote stakeholder participation in energy efficient housing developments. Second, the instruments found from these best practices are then prioritized for Eindhoven scenario as per stakeholder group preferences using Analytical Hierarchy Process analysis on the data collected from experts representing Municipality, Project developers, Energy consultants and consumers. Using scenario analysis on a case study of Blixembosch Noord Oost energy neutral housing development project, a proactive participatory role is found necessary for the Eindhoven municipality to promote stakeholder participation in energy neutral housing development process. Consequently, the detailed recommendations on implementation are given to the local government.

ENERGY NEUTRAL HOUSING DEVELOPMENTS

An energy-neutral housing community is defined as a residential area where the net total energy used in all housing related processes and activities is generated within the district or community using renewable energy sources. The typical features of energy neutral housing community are high energy efficient houses (high levels of insulation, air sealing etc), reduced carbon emissions and production of heat and electrical energy required by the home from decentralized renewable energy sources within or surrounding the community (NAHB, 2006). Energy neutral housing developments are different from other construction projects because of the additional energy issues related to them like the type of technology, design for efficiency, and generation of electricity within the community etc. In energy neutral and efficient housing developments the Local governments (i.e., Municipalities) play an important role in promoting and facilitating the process. Moreover, for employing energy neutral and efficient housing developments other stakeholders such as project developers, energy consultants and prospective owners and customers are also important (ENPIRE, 2009). The development process of energy neutral housing developments is broadly classified into planning, implementation and realization phases.

To promote energy efficient housing development, the municipalities' have to deal with various issues due to the complexity in the governance functioning of the local processes. As a result the municipalities of member states have combined a number of policy instruments and approaches in their planning practices in order to cope with the challenge of mobilizing changes among local stakeholders. Some of the applied instruments are originated within traditional planning frameworks based on the ideas of regulation and support, whereas other instruments represent more innovative methods of facilitation (CONCERTO, 2009). Regulation is the strongest singular means to ensure that specific improved energy requirements are complied with in practice. Certain requirements are made directly binding for stakeholders involved in the building sector through a specific law passed by national government or municipality in its local plans (such as building code). Support instruments are important since developing this new type of building involves some uncertainty of risks and losses to the stakeholders acting as prime movers. With financial support like economic subsidies and facilitation support like information on new technology, demonstration programmes etc the idea is to compensate for

the challenges involved in being prime mover and innovator to foster the transition process (Maj-Britt, et al., 2009).

The potentiality of municipalities to promote energy efficient buildings through municipal planning practices is large, since municipalities typically have a powerful local planning role in terms of developing local urban areas and authorizing local building projects. Besides having the authorities to promote energy efficiency at the local level, municipalities also prove to have interests in doing so, since it could promote the local economy. To promote these interests there is a need for strict national level and local level policies and governance instruments which are aimed at regulating and supporting this transition in housing sector.

The Dutch policy instruments have failed to instigate the adoption of energy efficiency and measures for energy neutral developments. The research conducted by Beerepoot (2007) shows that a broad scale adoption of energy efficiency measures fails to occur in the existing Dutch housing sector, which has related to the lack of structural cooperation between different actors in the mainly project-based building sector. The energy neutral housing ambition of Eindhoven is being affected due to lack of strict regulations and support instruments, lack of effective collaboration between stakeholders which has resulted in lack of market demand for energy neutral houses (Bekering, 2009). The research conducted by Hans (2008) on Groningen's CO_2 neutral ambitions shows that serious investments and/or collaborations of all stakeholders is necessary for such projects to become practically feasible. Thus the Eindhoven municipality now is aiming to actively cooperate with all actors and stakeholders that can contribute to achieve the goal of energy neutrality between 2035 and 2045. The municipality is looking for the pioneer examples, which are actively taking place as the latest developments, especially the developments proven successful in practice.

Energy neutral homes have proven to benefit residents of lower energy costs, with even better quality and comfort of home (IEEE spectrum, 2010). Despite the advantages of energy saving measures for the house owners and consumers, the steps taken so far by the local government, such as Eindhoven municipality, have not been successful in promoting them. Achieving energy neutral homes is technically proven possible and case study, concerning the development of Blixembosch Noord Oost, has shown that this is also financially feasible (Petra Rovers, et al. 2009). However the role of the municipality involved in the redesign of development process are still needed to actually achieve the realization of energy neutral homes. There is a need for municipality to promote energy neutral ambitions in housing sector through local means. This implies that greater attention is needed towards supporting and encouraging a new role for municipality in planning and regulating practices.

GOVERNANCE INSTRUMENTS

Market research showed that local governments in Denmark and UK have introduced several effective regulatory and support instruments with diverse characteristics to promote their energy animation in house sector. Danish regulatory and support instruments are focussed on

improving the energy efficiency of households and promoting renewable energy usage in housing sector through community owned cooperative farms. UK on the other hand has employed numerous financial support instruments like renewable heat incentive; LCBP grants, reduced VAT and Stamp duty etc. to promote carbon reduction by using micro-generation technology and decentralized energy sources.

Combining the strengths from these practices, we can categorize these successful instruments for energy neutral housing into four main instruments: 1) regulating and supporting energy efficiency measures, 2) carbon reduction and micro-generation measures, 3) promoting usage of renewable energy measures and 4) financial incentives and supports. Each main instruments includes more detailed the sub instruments as described in the following. The tree structure of the instruments is shown in figure 1.

Energy efficiency

To regulate and facilitate the reduction of energy consumption in households, EU has passed EPBD (EU, 2002) which asks its member nations to impose strict regulations to decrease their energy dependence on fossil fuels. Denmark and UK have implemented the following more detailed instruments in order to decrease the energy consumption (kwh/m^2) in house sector. Stricter building codes have enforced stricter energy consumption limits for new housing developments, and aim to increase the energy efficiency of housing. Energy efficiency obligations for energy companies force them to reduce energy consumption in households by providing advice, energy audits, subsidies etc. For example, reduction targets have been set as 2.95 PJ (0.7% of total energy usage) for 2006-09 in Denmark. Mandatory energy labelling/EPC are used to label a house based on its energy efficiency. These labels are generally from A-G, where A means most efficient and G means no efficiency at all. Easements, which are a process where municipality can impose legal regulation on the land it owned. It can be used to make energy performance requirements lawfully binding (compulsory) for those who buying and building on that piece of land. This Instrument is supported by a planning and building regulation act in Denmark. Collaboration with material manufactures and building demonstration houses is both technologically and economically effective. Project developers and municipalities are making collaborations (contracts) with material manufacturers for building demonstration houses. The developers try to show customers the latest technology that can be used in houses to increase energy efficiency or make low energy consumption. Material and appliance manufacturers try to advertise the new products and agree to supply these new technologies for low price. This type of arrangement guarantees very low material/technology costs for developers and also acts as a promotional activity for manufacturers. For example, Velux and Rockwool (manufacturers) have such contracts for a few projects in Denmark.

Carbon reduction and micro-generation

Renewable energy sources have been found to be the most efficient way to reduce carbon emissions in energy production. UK has employed several regulatory and support instruments and at the same time promoted a micro-generation approach to curb its carbon emission and

head for carbon free from 2020. Micro-generation means the small-scale production of heat and/or electricity (generation of a capacity of less than 50 kW) from a low-carbon source. These sources are very close to the final consumption points (households), generally on roof-tops or backyard, in order to reduce the losses from energy transport. The stricter building code for sustainable buildings makes it mandatory to use decentralized micro-generation technology for building zero carbon/low energy buildings. Obligations for households make sure that housing communities are required to generate electricity from onsite renewable. Merton rule (2003) in UK has set 10% renewable generation obligation for developments larger than 1000m^2. Obligations for energy suppliers ensure them to reduce carbon emissions. For example, UK's carbon emission reduction target (CERT) requires energy suppliers to reduce carbon emissions in households by providing subsidies for energy saving measures for consumers. Eased out planning permit certifies that strict planning/building regulations normally required for installing domestic micro-generation technologies in households are removed. Under certain fixed conditions there is no need to get permission for installations. This has avoided the planning costs for owners and therefore indirectly increased the installations. Micro-generation certification scheme and demonstration programs take care of the assurance of quality, and service and products is provided to consumers by certifying the installers through a certificate scheme supported by national commission, which is currently running in UK.

Renewable energy technology

New forms of energy generation from renewable sources using different technologies are observed in Denmark and UK, which have been highly effective and have proven their worth. Community owned energy generation is promising. Decentralized renewable energy generation in a community by forming cooperatives, e.g., wind cooperatives and district heating plants, are observed in Denmark. Potential for large scale generation is high due to large combined investments from community and low liability for each individual of the community. Grid independence is efficient in case of onsite renewable generation using private wire. Electricity can be sold directly to customers rather than exporting to the grid first and then back to customers. A private wire system simply connects the generation plant located on site with the existing on site electricity network. It avoids unnecessary distribution charges and energy losses. Thus green electricity can be supplied at a cheaper price. Micro-generation technology shows the potential of the small-scale production of heat and/or electricity (generation of a capacity of less than 50 kW) from a low-carbon sources using technologies like solar collectors, photovoltaic cells, micro-wind, micro-hydro, heat pumps, biomass, micro combined heat and power (micro CHP) and small-scale fuel cells. Electronic energy monitoring systems and SMART meters provides control. Different from electronic energy monitoring system where one person with a PC can monitor and control the energy consumption in all buildings, smart meters have a visual display allowing customers to see exactly how much electricity and gas they are using individually and relay the data to energy firms automatically.

Financial support

Financial support means support in terms of monetary benefits for the households (consumers) to adopt energy saving, carbon reducing and micro-generation techniques. Modified and newly

targeted financial schemes that have encouraged households to generate renewable energy and improve energy efficiency are discussed in this section. Feed in tariffs (FIT) with a constant tariff system for producer for a period of 20-25 years is currently used in UK. The benefits from feed in tariff for an average household using 4500kwh/year with 2.5 kW of solar PV have been calculated as £830. Domestic Green Loans are loans attached to properties rather than individual. In UK if a family moves away from the property before payback on the loan, then the next occupants will be responsible for the repayments (as they also enjoy the benefits). As a consequence, more families are willing to utilize the loans for renovation and micro-generation technologies. Reduced VAT and stamp duty exemption are also applied in UK. In UK, VAT on all micro-generation technologies used in households has been reduced from 17.5% to 5% and stamp duty for zero carbon houses with a real estate value below £ 500.000 is exempted. Renewable heat incentive is also introduced in UK. In UK, the Renewable Heat Incentive (RHI) provides financial support for a range of technologies, including air and ground-source heat pumps (and other geothermal energy), solar thermal, biomass boilers etc for new houses.

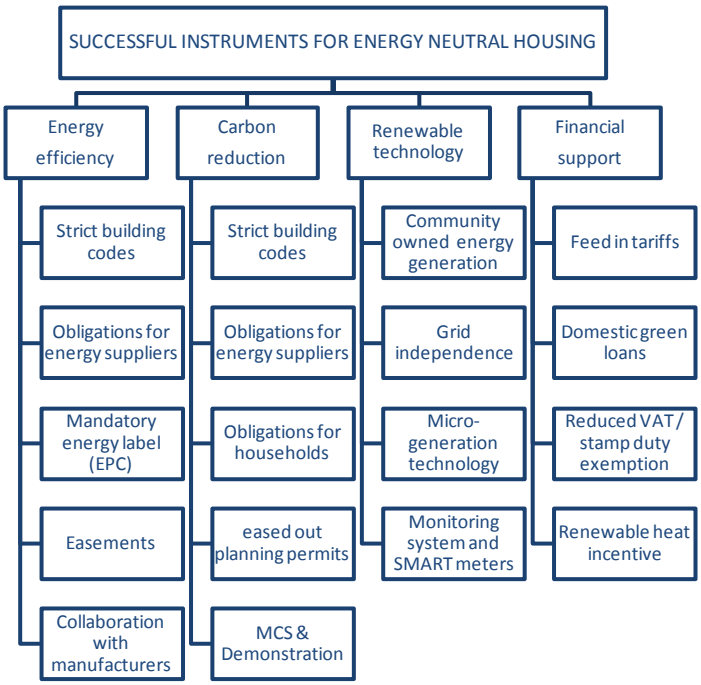

Figure 1, Hierarchical tree structure of instruments

GOVERNANCE ROLE

Further the Danish municipalities have promoted stakeholder participation in energy efficient housing developments by playing a proactive participatory role in the planning, implementation and realization phases of the projects. By playing a pro-active role and effectively participating in all phases of the project Danish municipalities have helped to successfully realize such developments. By taking a proactive role, the municipalities were able to regulate the developers to build energy efficient homes by bringing the local plans to effect as the owner of the land, planning authority and also as approval authority. By participating in the

implementation phase and realization phase the Danish municipalities were able to promote effective collaboration between stakeholders.

They have satisfied the interests of different stakeholders by playing a participatory role i.e. the diverse stakeholders and their interests are engaged together in reaching for a consensus on a plan and its implementation. This was possible since municipality was able to understand the difficulties faced by the developers and customers in relation to the new concepts of energy efficient homes. They have used unique facilitation support instruments like collaboration with manufacturers, micro-generation certificate scheme, and model houses etc. to encourage the project developers and house owner's participation in developments. The highlights of role played by Danish municipalities in all phases are shown in the figure 2. The experiences of Danish municipalities also show that the role played by municipalities has an effect on the type of instruments employed in the development process of the energy efficient housing projects.

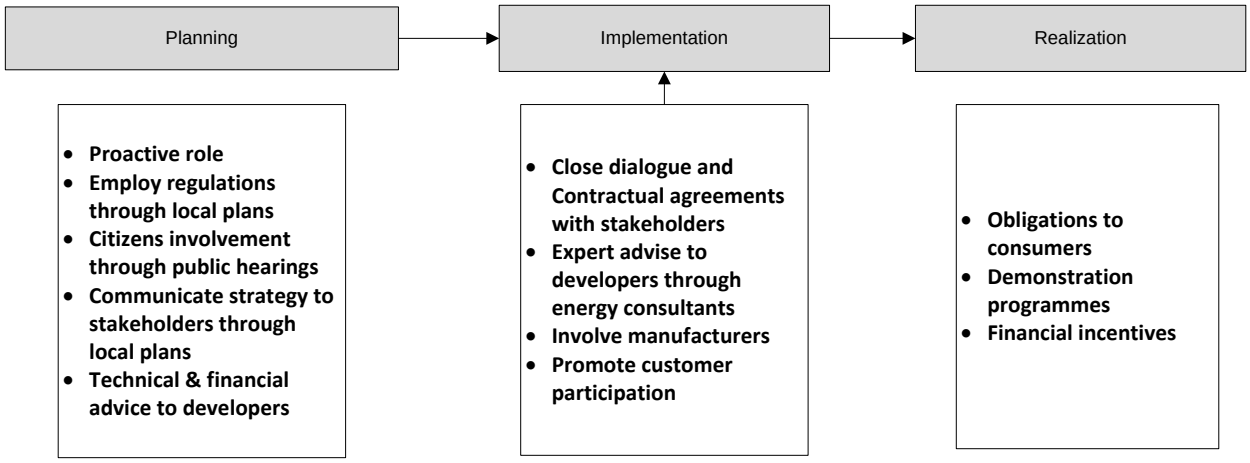

Figure 2 Highlights of participatory role played by Danish municipalities

PRIORITIZE STAKEHOLDERS' PREFERENCES USING ANALYTICAL HIERARCHY PROCESS (AHP)

The instruments, found from market research on Denmark and UK, are employed to achieve the local energy ambitions successfully in their respective housing sectors. The effectiveness of the instruments may vary widely depending on the contextual condition of local environment and the government in terms of the development and implementation of energy ambitions of different regions. Therefore, when we consider applying those instruments in the Dutch context, especially in the municipality of Eindhoven, we need to get insight of the preferences of various stakeholders that involved in the process in order to compose an effective package of instruments.

Analytical Hierarchy Process (AHP) analysis provides a proven, effective means to deal with complex decision making and can assist with identifying and weighting alternative regarding selection criteria, analyzing the data collected for the criteria and expediting the decision-

making process. It offers a way to integrate complexity, set the right objectives, establishes their priorities and determines the overall value of alternative solutions. It uses a multi-level hierarchical structure of objectives, criteria, sub criteria and alternatives. The pertinent data are derived by using a set of pair wise comparisons. These comparisons are used to obtain the weights of the decision criteria, and the relative performance measures of the alternatives in terms of each individual decision criterion.

With the given decision problem of finding the prioritized instruments for energy neutral housing in Eindhoven, AHP can be used to find the preferences of the instruments (performance criteria) found from the research and thus find the relative importance of one instrument over the other regarding the goal of achieving energy neutral housing. This way the optimized package of preferred instruments for Eindhoven case can be found out.

Based on the tree structure shown in figure 1, a survey questionnaire is designed to find the preferences of the instruments using pair wise comparison approach. Pair wise comparisons are used to determine the relative importance of each instrument in terms of its performance towards energy neutral housing development (Fu, 2009). Taking into account the high level 4 main instruments and the low level 18 detailed instruments, in total 38 questions are framed for the questionnaire.

In this survey approach the respondents have to express their opinion about the assessment of one single pair wise comparison at a time. The questionnaire is sent to 50 different experts representing stakeholder groups of Municipality, Project developers, Energy consultants and Consumers. Among them 25 respondents (19 customers, 2 Energy consultants, 3 Project developers and 1 Municipality) completed the questionnaire. The responses made by the respondents are converted into a numerical value determined for pair wise comparisons in the AHP according to the scale of set values: {9, 8, 7, 6, 5, 4, 3, 2, 1, 1/2, 1/3, 1/4, 1/5, 1/6, 1/7, 1/8, 1/9} (Saaty, 1980). The type of question used in the questionnaire and the assigned numerical values used to convert the answers of respondents can be seen in table 1.

Sample: To achieve energy efficiency in housing developments in Eindhoven how important are the instruments A and B in relation to each other? A. Energy efficiency; B. Carbon reduction	
A and B are equally important	(1)
A is slightly more important than B	(3)
A is absolutely more important than B	(5)
B is slightly more important than A	(1/3)
B is absolutely more important than A	(1/5)

Table1 Sample survey question and the assigned numerical value

To find the priority weights of instruments from the responses the mean value of all responses is calculated for each of the 38 questions. Further reciprocal and normal matrixes are used to compute priority vectors i.e. the priority weights of the instruments. The obtained priority weights are used to rank the instruments in the order of descending weights and thus the

relative importance of one instrument over another can be determined. The overall prioritized instruments for Eindhoven and the priority weights of the instruments for each stakeholder group (i.e. customers, Energy consultants, Project developers and Municipality) are found out. The various priority weights of regulatory and support instruments as preferred by individual stakeholder group are reported in table 2.

Main Instrument	Sub-Instrument	Municipality	Project Developer	Energy Consultants	Customer
Energy efficiency		**0.541**	**0.414**	0.247	0.282
	Building code	0.460	0.254	0.323	0.240
	Obligation for supplier	0.155	0.242	0.263	0.258
	Mandatory E. label/EPC	0.250	0.216	0.161	0.174
	Easements	0.044	0.129	0.139	0.170
	Collaboration	0.092	0.158	0.114	0.158
Carbon reduction		0.260	0.107	0.134	0.198
	Building code	0.469	0.252	0.328	0.243
	Obligation for households	0.142	0.119	0.126	0.201
	Obligation for supplier	0.259	0.348	0.216	0.231
	Planning permits	0.079	0.143	0.100	0.184
	MCS & Demonstration	0.050	0.138	0.129	0.141
Renewable technology		0.140	0.196	0.134	0.243
	Community generation	0.058	0.357	0.573	0.330
	Grid independence	0.499	0.181	0.099	0.220
	Micro-generation	0.161	0.162	0.233	0.285
	Electronic monitoring	0.282	0.300	0.190	0.164
Financial support		**0.059**	0.283	**0.486**	0.277
	Feed in tariffs	0.081	0.181	0.262	0.257
	Domestic green loans	0.560	0.322	0.087	0.201
	Reduced VAT/stamp duty	0.279	0.178	0.248	0.276
	Renewable heat incentive	0.081	0.319	0.403	0.265
Note that the numbers in bold show a clear diverse, which reflect different interests of the stakeholder groups.					

Table 2 Preferred priority weights of individual stakeholder groups

SCENARIO ANALYSIS FOR THE ROLE OF MUNICIPALITY REGARDING VARIOUS INSTRUMENTS

To find the effect of the various preferences of stakeholder groups and validate the role played by Danish municipalities for Eindhoven municipality a scenario analysis is conducted. This analysis is used to explain the effect of various preferences of different stakeholder groups found from the survey and the possible outcome when the role of Danish municipalities is adopted by Eindhoven municipality and implemented in the Netherlands. The scenarios are developed and reflected on the project context of Blixembosch Noord Oost energy neutral housing development using Global scenario analysis method. Global scenario analysis offers the decision-makers an outlook into distinctive future environments that have different implications for long-term operating decision and options analysis (Ratcliffe, 2000).

The project of Blixembosch Noord Oost located nearby the new road junction A50/A58 (Ekkersrijt), which covers an area of about 18 hectares. The Eindhoven municipality decided to construct energy neutral homes in this area and granted this land to developers to make it an energy neutral community with approximately 450 homes. This project is part of the "Energie Neutral Brainport Wonen". Hurks Vastgoed South and Rabo Bouwfonds are the two project developers involved. The Municipality Eindhoven is the primary promoter for the project and the organization of Brainport Foundation promotes cooperation between companies, knowledge institutions and Municipality (Creative energy, 2009). The objective is to achieve energy-neutral homes with improved living quality and lower monthly energy costs. All the energy needed for living in the new district will be sustainable and generated by facilities within the neighbourhood. Therefore, besides an improved comfort the ambition is also about lower housing costs, less burden on the environment (less CO_2 emissions) and less dependence on rising energy prices. The energy targets have been set as: 0.55 of Epc; 45% Carbon reduction and Renewable energy. The project (shown in figure 3 on the right) is still in the planning stage where the final master plan (on the left) is being developed and the municipality will also sell plots for individual construction.

Figure 3 The project of Blixembosch Noord Oost energy neutral housing development

Based on the research on Danish municipalities, an assumption is made for analyzing the scenarios that, the role played by the municipality in the planning, implementation and realization phases, will result in the employment of specific type of instruments. As a consequence, it will promote stakeholder participation and collaboration, which indirectly determine the outcome of the project. Two scenarios are developed in this analysis. The first scenario assumes that the municipality adopts an existing housing development process and used as a benchmark. In the second scenario it is assumed that the municipality adopts the role of Danish municipalities for the development process and employ similar instruments. The outlay of the scenarios is shown in figure 4.

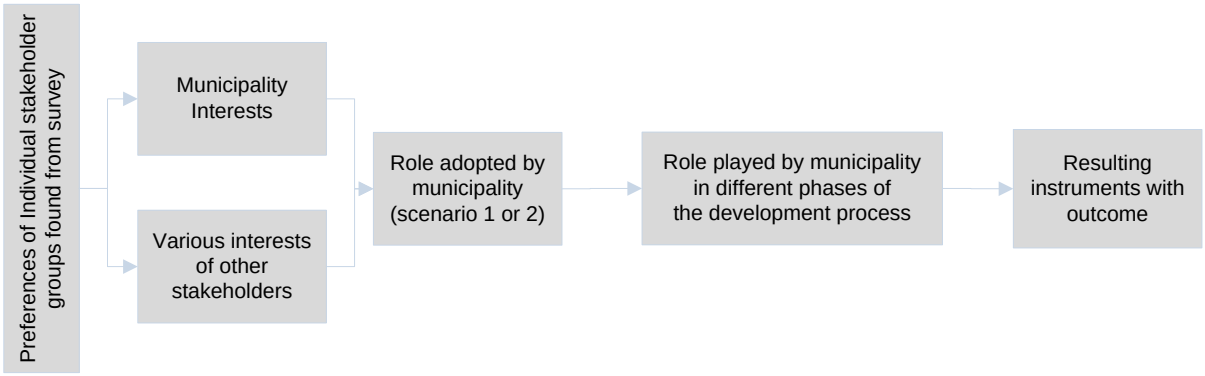

Figure 4 The outlay of scenario analysis

As a consequence of the role played by municipality in different scenario, different instruments are deployed. The outcome of the scenario is determined by adding the weights of the resulting instruments used in the scenario. These weights are the averages of preferred instruments weights of involved stakeholders' group found from the survey (table 2).

The scenario of present governance role showed an appreciation outcome value of 0.457 and the scenario of participatory governance role of the municipality gave an outcome value of 0.731. This clearly suggested that to promote energy neutral housing developments the Eindhoven municipality needs to play a participatory role in terms of actively participating in all the phases of project development.

RECOMMENDATIONS

The successful instruments found from research are focussed on promoting energy efficient and carbon neutral housing developments. For promoting energy neutral developments in Eindhoven a combination of these instruments is necessary. Though some of these instruments exist already, there is still a need to strengthen or widen their scope to promote energy neutral housing developments effectively. It is interesting to see how Eindhoven can learn to adopt these instruments following Denmark & UK experiences. Based on the findings, the prioritized instruments that adopted and improved to successfully achieve energy neutral housing developments are shown in the table 3.

The results from the survey scenario analysis revealed that promoting stakeholder interests rather than self-interests should be the main priority for municipalities in energy neutral developments. Such development projects are still in its early realization stages and thus pose great technical and implementation difficulties for stakeholders. To facilitate stakeholders' interests, the municipality should extend their role of governance and fulfil responsibilities using the recommended regulatory and support instruments.

Instrument	Situation in Denmark and UK	Present situation in NL	Recommended improvements
Building code for energy efficiency	Denmark has a minimum requirement of 85kwh/m^2 at present with energy ambition of 75% reduction by 2020. UK has a sustainable building code focused on carbon neutral buildings.	With energy neutral ambitions by 2020, currently an EPC of 0.8 (100kwh/m2) is mandatory. There is still no definition for low/zero energy buildings.	Set the current requirement needs to be lower than EPC 0.8. Set up stricter building code with strict definitions for energy neutral houses/buildings.
Energy obligations for companies	Energy targets have raised some difficulties in the scope of employment.	Currently focussed on transport sector only	Learn from the drawbacks of Danish obligations.
Renewable Heat incentive	UK has introduced renewable heat incentive i.e. grants for purchasing renewable heat sources for new and existing households.	Grants are available, but only for houses built before 2008.	Extend RHI to newly constructed houses to encourage installation of more renewable heat sources in the new developments.
Community owned energy cooperatives	In Denmark wind farms and solar farms owned by community members supply majority of renewable energy.	Though some examples exist in the Netherlands the concept is still not promoted well.	Develop community owned renewable generation concept following Danish share based investment model that can ensure large scale energy generation with low investments for user.
Reduced VAT/Stamp duty	UK has fixed only 5% VAT on purchase of all micro- generation technologies used in housing and exempted stamp duty for carbon neutral homes worth less than £500.000.	Reduced VAT (6%) on certain energy efficient renovation material only. No stamp duty exemption is possible.	Extend VAT exemption for new houses as well as micro-generation technology to promote renewable energy. Exemption of stamp duty on energy neutral houses can be attractive incentive for customers.
Feed in Tariff & Micro-generation technology	UK FIT is designed to benefit household owners though generation and Export tariff.	There are still no clear FIT rules for household producers.	Implement FIT to promote micro-generation which indirectly promotes renewable energy and carbon reduction.
Domestic green loans	UK offers green loans fixed to the property rather than the users.	Low interest loans are available for purchasing green technology and energy efficient renovation.	Set up fix loans for properties rather than individuals to ensure that individuals don't have to think of payback period for their investments.
Easements	Denmark has successfully reformed its Planning Act and the Building Regulation in 2006 to employ this regulation in its local plan.	No strict enforcement exists to regulate land buyers to build energy neutral buildings.	Make energy neutral requirements mandatory in its land allocation plans when the next revision of local planning comes. This will legally regulate the private developers to build energy neutral houses.
Collaboration with manufacturers	In Denmark energy efficient construction projects have collaborated with material manufacturers like Velux, Rockwool and Danfoss.	Energy neutral housing development projects are quite expensive and developers don't have good knowledge of the latest technology.	Provide technology assistance, expertise and also costs of construction / renovation can be reduced. They can also market the projects better as it also helps for their advertising.
Grid Independent (Private wire)	Local councils have implemented private wires to supply electricity at reduced tariffs.	Policies don't grant the freedom to employ private wires.	Allow sale of electricity without distribution charges. Perfectly suitable for degeneration of renewable energy.
EPC	The laws have made it impossible to get a house without an EPC.	Initially failed in implementation due to improper organization.	More effort in promote modified EPC implementation strategy, for example reducing the costs for getting the epc.

Table 3 Implementing the prioritized instruments for Eindhoven

The active participation of municipality in all the phases of the project is necessary to ensure success in energy neutral development projects. In the planning phase, municipality should be proactive and regulate energy neutral requirements effectively through its land allocation plans. Energy neutral ambitions should be propagated to local citizens during the planning stages and prospective customers should be involved in all the project phases. They can provide technical and financial advices to project developers in attempt to reach contract agreement. In the implementation phase, municipality could promote innovative partnership between stakeholders and local businesses, and involve manufacturers as stakeholders. They can provide technical assistance through energy suppliers and promote existing renewable technology by

developing model houses for demonstration to attract consumers. In the realization phase, municipality can support obligations with financial incentives and facilitate stakeholder participation through certifying schemes to earn consumer trust.

CONCLUSION & DISCUSSION

Eindhoven needs to focus primarily on improving energy efficiency in households. There is a need for employing stricter building regulations. This needs to be complemented with strong financial support in terms of renewable heat incentives, feed in tariffs and tax/stamp duty rebates. Further community generation should be prioritized for new housing areas. Stakeholders prefer strict building codes to have clear regulated use of micro-generation at household level to reduce carbon emissions. Good collaboration with technology and material manufacturers is necessary to provide technical support and reduce financial burden for project developers.

Research shows that community owned generation is highly preferred for Eindhoven. This is a compulsory requirement for energy neutral housing developments since it reduces the financial burden on the consumers by allowing cooperative investments. Eindhoven municipality should learn from the Danish wind cooperatives established on share basis investments. Currently financial incentives are available to install micro-generation technology and energy efficiency measure in existing houses. Municipality should consider extending the financial incentives for new houses as well. This study only considers the preferences of stakeholder groups to evaluate the instruments required for Eindhoven scenario. More studies to evaluate these instruments in terms of legal, financial and technical feasibilities are needed to be carried out. The instruments and the role of municipality are discussed with the focus only private energy housing developments. The same research can be carried out in case of social housing or housing renovation projects.

REFERENCES

1. Beerepoot, M. (2007). Energy policy and technical change in the residential building sector, Delft University Press, ISBN 978-1-58603-811-3, pp.240.
2. Bekering, J. (2009). Presentation: Gemeente Eindhoven, Geïntegreerde Aanpak Koude Warmte Opslag, Nationaal Congres Warmtepompen, Bussum 1, 7 September 2008.
3. Böhringer, C., Rutherford, T. and Tol, R. (2009). The EU 20/20/2020 targets: an overview of the EMF22 assessment, Energy Economics 31 (2009) S268–S273.
4. CONCERTO (2009). Class 1 Cost-effective low-energy advanced sustainable solutions, http://www.concertoplus.eu/cms/index.php?option=com_content&view=article&id=165&Itemid=182&lang=nl, last accessed May 20, 2011.
5. CREATIVE ENERGY, (2009). Op Weg Naar Energieneutraal, www.naarenergieneutraal.nl, last accessed May 20, 2011.
6. EC Green-Paper (2000). Towards a European Strategy for the Security of Energy Supply, Commission of the European Communities, COM 769, Brussels, November 2000.

7. Enerdata (2007). Global energy intelligence, http://www.enerdata.net/enerdatauk, last accessed on May 20, 2011.
8. ENPIRE (2009). Final Guidelines on the Process, http://www.enpire.eu/, last accessed May 20, 2011.
9. EPBD, EU (2002). On the energy performance of buildings. Directive (2002/91/EC) of the European Parliament and of the Council, Official Journal of the European Communities, Brussels.
10. EU Commission (2008). The EU's Target for Renewable Energy: 20% by 2020, Volume I: Report, Published by the Authority of the House of Lords.
11. Fu, H. (2009) Using AHP to analyze the priority of performance criteria in national energy projects. Proceedings of International Conference on Pacific Rim Management, 19th Annual Meeting, San Francisco, California, USA.
12. Gemeente Eindhoven (2009). Programma Wonen 2010-2015- met een doorkijk naar 2020, Gebiedsontwikelling, October 2009.
13. Hans, I. (2008). Groningen energy neutral? A scenario study, http://ivem.eldoc.ub.rug.nl/ivempubs/dvrapp/EES-2008/EES-2008-47M/, last accessed May 20, 2011.
14. IEEE spectrum, (2010). Denmark's Net Zero Energy home. http://spectrum.ieee.org/green-tech/buildings/denmarks-netzeroenergy-home, last accessed May 20, 2011.
15. Maj-Britt, Q., Birgitte, H. et al (2009). Municipalities as promoters of energy efficient buildings : Idea catalogue for proactive planning practices, Kgs. Lyngby, Denmark, Technical University of Denmark (DTU), pp.87.
16. Merton rule (2003). What is the Merton rule? http://www.merton.gov.uk/environment/planning/planningpolicy/mertonrule/what_is_the_merton_rule.htm, last accessed May 20, 2011.
17. NAHB (2006). The potential impact of zero energy homes, NAHB research centre, February 2006.
18. Ratcliffe, J. (2000). Scenario building: a suitable method for strategic property planning? Dublin Institute of Technology.
19. Rohracher, H. (1991). Managing the technological transition to sustainable construction of buildings: a socio-technical perspective. In: Technology Analysis & Strategic Management, Vol. 13, no. 1, pp. 137-150, Taylor and Francis Ltd.
20. Rovers, P., Blokhuis, E.G.J., Han, Q. and Schaefer, W.F. (2009). The price of building energy-neutral residential areas. In Yildiz, H.T. (Ed.), Revitalising Built Environments: Requalifying Old Places For New Uses, (pp. 1-9). Istanbul: IAPS - CSBE.
21. Saaty, T. (1980). The analytic hierarchy process. New York: McGraw- Hill.