Analyzing the Decision Making Process of Property Owners in the Built Environment under Different Renewable Energy Policies

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Abstract

Climate change and fossil fuel depletion are the main triggers for the current transition in the urban energy system. The high cost of capturing and transforming renewable energy (RE) resources into usable and clean energy is the main barrier for promotion of these resources. As a result, appropriate policy measures and tools for removal of market barriers are inevitable. In a descriptive study, this paper elaborates the decision making process of property owners at the micro level for adoption of RE technologies as a reaction to the energy policies. Initially, since to date there is no concrete framework for describing how policies flow in urban areas, the Policy Flow Cycle (PFC) as a general framework of the study is developed. An inventory of the most important existing RE policies as the main triggers of the PFC and a general categorization of them to establish a framework to describe their mechanisms and key features are provided. Property owners and their characteristics as a core of the PFC and decision making process are described in detail. The decision making process of property owners is presented for adoption of energy technologies based on the two reasoning approaches: pure-rational and non-rational.

1. Introduction

To date, fossil fuels like coals, petroleum, and natural gas are our most import energy sources. Increasingly, we are confronted with the consequences of large-scaled combustion of these fossil fuels in electricity generating stations, combustion engines, and heating systems. The most obvious consequences can be found when looking at the extreme changes in our climate and the numerous accidents that occur during the extraction and transportation of these fuels. Since the demand for fossil fuels is still growing and also the reserves are increasingly difficult to extract, it is to be expected that the consequences will become more profound in the near future. In addition current oil and gas reserves are unevenly spread around the world; a large share of the worldwide reserves is concentrated in countries which are liable to political and social instability. Without a rigorous change, of course, western countries will become more and more dependent on unpredictable regimes in North Africa, Central Asia, and the Middle East. Regarding the importance of a stable energy supply for the social life and economy e.g. (Rifkin 2009), this involves risks; major international conflicts are related to the availability and distribution of energetic reserves. Transformation towards a sustainable energy supply will contribute to achieve global peace.

It is time to launch a fundamental course of change respect to our energy supply. The drivers for such a change originate in broad societal targets and ambitions that are materialized in renewable energy (RE) policies and formulated at local, national and cross-border levels. For instance, at the local level, municipality of Eindhoven wants to be energy neutral in 2040 or at regional or cross-border level, the European Commission has formulated major objectives for future energy systems (CoEC 2008a) and (CoEC 2008b). Starting point for a truly lasting sustainable energy supply is based on renewable and inexhaustible energy sources. Wind, solar, biomass or geothermal are indigenous and home grown. These sources are often free and they just need to be captured efficiently and transformed into electricity, hydrogen or clean fuels. However, converting these resources to appropriate fuels such as electricity or heating require high investments in renewable energy technologies (RETs) which is considered as a main obstacle facing the diffusion of these technologies. As a result for promotion of RETs various economic and political interventions are essential, such as legislations, incentives, energy targets and ambitions, guidelines for energy conservation, subsidies and taxation (Saidur et al. 2010).

This study focuses on the built environment. The building sector alone accounts for almost 40% of the total energy demand. Fulfilling any RE ambitions requires a substantial transformation of the existing building stock. The current effort of municipalities and city councils is limited to financially support individual owners when implementing energetic measures. Such actions which aimed to motivate individual owners to adopt energetic measures only have limited success. In reaction, city councils begin to realize that they have to develop and support large scaled integral transformation plans at the city level. Implementing energy transformation on a city level requires developing and applying appropriate energy strategies and policies. Even more important is the insight in the possible consequences of these measures on the various urban levels and in time. In order for cities to be able to make more efficient, economical and sustainable choices on future energetic developments, it is important to have an estimate of what the required investments and estimated effects of different sustainable energy policies (Shahidehpour et al. 2003). The possible consequences of sustainable energy policies on the urban energy supply and demand and urban spatial developments should be studied in detail. Hence the main focus of this paper initially will be on identifying the appropriate energy policies that can be applied on city level for promoting of RETs and after that examining their effects on the built environment. Since to date there is no concrete framework for describing the process of energy policy flow in urban areas which depicts how policies are developed, formulized and finally applied on urban areas, the Policy Flow Cycle (PFC) as a general framework for this study is presented and described in detail. Property owners, their reactions to the energy policies and their decision making process are a crucial parts of the PFC.

This paper is structured as follows; section 2 describes the general framework of the study in terms of Policy Flow Cycle in urban areas. In section 3 based on literatures, an inventory of existing RE policies and general categorization of them to describe their mechanisms and key features are presented. The property owners and their characteristics are introduced in section 4. In section 5 the adoption decision making process of owners is elaborated based on two approaches; pure-rational and non-rational. In section 6 conclusions and recommendations for future research are included.

2. Policy Flow Cycle

Figure1 shows the Policy Flow Cycle (PFC) in urban areas. It demonstrates the flow of policies stepwise in urban areas. Policies generally can be understood as political, management, financial, and administrative mechanisms arranged to reach explicit goals (Page 1998). As shown, PFC depicts how energy policies is developed, analyzed and evaluated in several stages, including: Agenda Setting, Policy Analysis, Policy Formulation and Instrument development, Launching and Issuing, Owner Adoption, Implementation and Assessment of Results and finally Feedback to Policy Makers. The proposed approach is consistent with Lasswell Policy Cycle, a standardized version of policy flow cycle includes, agenda setting, policy formulation, adoption, implementation and evaluation stages (Turnbull 2008). PFC is heuristic, iterative and normative – meant not to be diagnostic or predictive. Cyclical models are typically characterized as unresponsive and unrealistic, but the environments that policies seek to influence or manipulate are generally complex adaptive systems that need heuristic, adaptable and iterative approaches.

PFC is the main framework of this study which portraits the flow of developing and issuing of energy polices and decision making of owners regarding adoption of energy technologies in urban environment.

Each step is briefly explained below.

Agenda setting (Issue identification)

Municipality and city council based on the national or regional ambition and plan for promotion of renewables and mitigation of climate change impacts, developes local RE targets for the city.

Policy analysis

Municipalities materialize their RE targets and ambitions through policies. In general they apply any changes in the urban environment through political, management, financial, and administrative mechanisms. Planners and designers based on the energy ambitions develop future transformation plans for the city.

Policy formulation and instrument development

Policy makers develop appropriate policy tools based on the energy targets and future plans to realize the transformation plans.

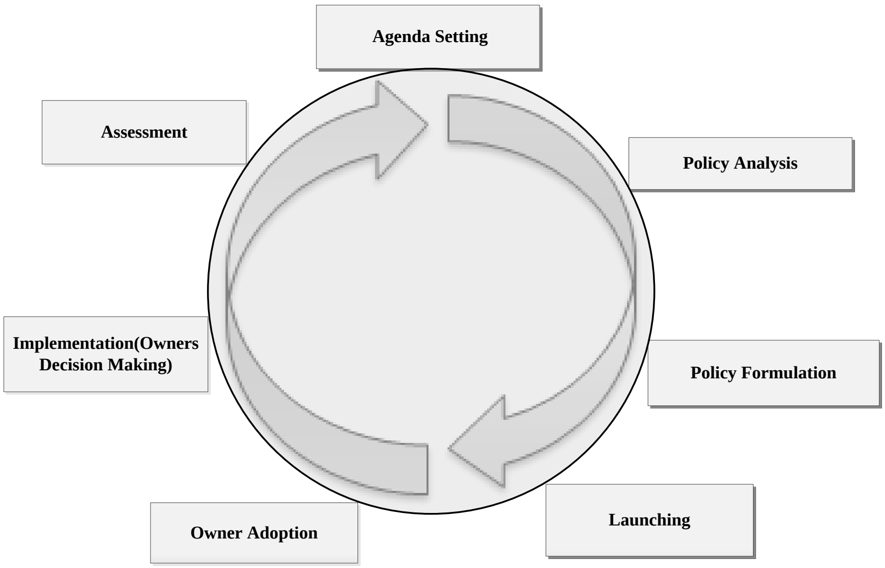

Fig. 1. Policy Flow Cycle (PFC)

Launching and issuing a policy

Once a policy has been developed, it is issued to the city residents. Along with the policies, extra information that is needed to understand and makes policies attractive for resedents are provided, generally in the form of maps or brochures.

Owner adoption

Property owners are the crucial part of the PFC. Policies are realized in reality through changes that occur on properties by owners. In other words, all changes happen in the urban area through owners. Each owner has their own preferences regarding how to react to the energy policies.

Implementation

A policy is intended to affect the real world, by guiding the decisions that are made. Owners based on their pereferences decide how respond to the policies. Property characteristics, RET attributes and socio-demographic characteristics of owners affect the decision making process of owners to adopt appropriate ETs.

In the last step of the policy cycle, urban authorities and policy makers assess the consequences of applied policies based on the predefined indicators. Due to the nature of complex systems such as cities, it may not be possible to assess all possible impacts of a given policy. Indicators such as RE production, cost and environmental impact of policies will be employed to assess the effectiveness of policies. Based on indicators, corrective actions and required changes will be done for reformulation of policies and their mechanisms for amplifying intended effects and lessening the side effects or unintended consequences.

3. Energy Policies

As mentioned and demonstrated in the PFC, the main focus of this research is on the development and formulation process of renewable energy (RE) policies in urban areas and elaborating the adoption decision making process of owners as a consequence of applying energy policies. Energy policy, as the main trigger of PFC should be considered in detail. Based on PFC, energy policies are developed and formulated by city council and municipality to realize RE ambitions and city future transformation plans. RE ambitions represent commitment of municipalities for supplying part of total primary energy with renewables. Municipalities realize energy ambitions through policies and they are the principal driver for promotion of RE generation.

As of 2011, 119 countries have some form of national renewable energy ambitions and renewable support policies. There is also a wide range of policies at provincial and local levels (IEA 2006). The International Energy Agency (IEA) estimates that nearly 50% of the global electricity supply will need to come from renewable sources in order to halve carbon dioxide emissions by 2050 and minimize significant, irreversible climate change impacts (IEA 2007). Growth of renewables is strongest where and when the policy-makers have established favorable policy frameworks.

RE policies at local levels are diverse and constitute a major part of the policy landscape. Several hundred cities around the world have adopted relevant goals and RE promotion policies. These institutions promote RETs with policy tools such as legislation, regulation, financial incentives and public financing strategies to meet their RE ambitions. In the following, an inventory of the most important existing RE policies is provided. The policy inventory is made based on the literature and field surveys. In addition a general categorization of policy tools to establish a framework to describe their mechanisms and key features is also presented.

3.1. Inventory and General classification of RE Policies

Literature shows that policy measures for the removal of market barriers and promotion of RETs have been explored in several studies, e.g., different supporting mechanisms of RET projects in different countries can be found in (Martinot et al. 2002; Martinot et al. 2001; Martinot and McDoom 1999). Also policy measures taken by IEA countries have been discussed in (IEA 2007; IEA 2006). Generally, a mix of instruments is essential and are the key to success (Sawin 2004). Some policy measures already exist and are widely used, such as, Eco-tax, Carbon offset, Subsidies, Feed-in tariff, Net-metering, RE certificates and RE payments. These policies encourage investments in new RETs and have been implemented in many countries.

RE support mechanisms have gone through many changes; even in present times the system is constantly evolving to achieve efficient implementation of renewables. In policy analyzing, because of the differences in the design of implementation mechanisms, different levels of effectiveness is expected. In this study the policy list is presented independent from the energy technologies or spatial and temporal scales, in order to establish a flexible framework consistent with the PFC. The policy inventory is set up based on the variety of sources such as; journal papers, online databases and governmental and nongovernmental websites.

Table 1 shows the inventory list of identified policies along with their classification class and key features. Despite a wide agreement among politician and decision makers on need a RE support scheme, there is no general concrete framework of policies to support them for examining and choosing appropriate policy tools. Policies can be classified based on different criteria. For instance one classification includes price driven vs. capacity driven policies on one hand, and investment focused vs. generation based policies on the other hand. For example, FIT is more price-driven and generation based policy strategies, whereas, bidding is more capacity driven and investment focused policy strategies. The inventory list and categorization class provides a framework of policy tools based on their mechanisms and key features.

Accordingly, the following policy list is identified.

Table1. Generic categorization, policy inventory tools and their main key features

Category	Policy tool	Key features
Subsidies	Direct initial investment Low-interest loans Financial incentives for PV Conventional energy subsidies	Encourage micro-generation Simple implementation Lowering the installation costs Set up based on the technology and location
Incentive tariffs	FITs Net-metering TOD	Availability for all potential developers Guaranteed grid access Simple implementation Long-term contracts Most successful at developing renewable markets Stable stream of cash flow reduces the financing risk
Tax incentives	Tax credit RECs Investment tax credits	Encourage micro-generation Lowering the costs of renewables through market compensation Lower the level of risk involved and the costs of investing for renewables Boom-bust cycles due to time limitations
Pigovian tax	Eco-tax Fossil fuel tax Carbon tax	Encourage micro-generation Increasing conventional fuels prices Make renewables competitive in market
Obligation certificates or quota systems	RPS RES RO Mandatory green power option Mandatory market share (MMS)	Setting a target Stable political decisions Assigning the actors and setting the stage for market to function. Penalties should be adequately set and strictly enforced. No guaranteed price; which causes consistent pressure for cost reduction. Allow trading of RE using green certificates Administrative costs are low Complex to design, administrate fine tune, adjust and enforce.
Tendering systems	NFFO Centralized bidding or tendering Concession system	Setting the amount of renewable electricity capacity. Developing the infrastructure. Bids from project developers with the lowest cost of electricity. Creates competitiveness among the developers. Different targets for different renewable technologies. Helped in developing a strong service industry. Drop of prices to unrealistic levels

Category 1: Subsidies

Subsidies are measures that keep prices for consumers below market levels and for producers above market levels, or reduce costs for consumers and producers. The high upfront investment cost of renewables makes them unattractive choices for investors. Removing this barrier by reduction in the initial capital outlay is accomplished through direct subsidies. These subsidies are used to share the initial capital cost of the system, so that the consumer sees a lower price (Beck and Martinot 2004). Energy subsidies may be direct cash transfers to producers for lowering the installation costs of RETs, consumers, or related bodies, as well as indirect support mechanisms. The main mechanisms of this group include direct initial investment, incentive plans for specific technology or even conventional energy subsidies.

Category 2: Incentive Tariffs

Feed-in Tariffs (FITs), Time of day Metering (TOD) and Net-metering are the main mechanism in this category. FITs is a performance-based regulation incentive designed to accelerate investment in RETs. It achieved by offering long-term contracts to RE producers, typically based on the cost of generation of each technology. The term ''feed-in tariff'' derives from the German Stromeinspeisungsgesetz of 1990, which literally translated means ''electricity feeding-in law.'' Germany implemented FITs in order to create a market for renewable electricity by offering providers a fixed price for the recovery of generation costs (Sovacool 2008).

Net Metering is a RE policy which allows customers of small scale renewable energy systems to reduce their electric bills by offsetting their consumption with RE generation, independent of the timing of the generation relative to consumption (Darghouth et al. 2011). TOD also known as Time of Usage or Seasonal Time of Day metering involves dividing the day, month and year into tariff slots, with higher rates at peak load periods and low tariff rates at off-peak load periods (Komor 2004).

Category 3: Tax incentives

Tax Credit, Renewable Energy Credit (RECs) and Investment Tax Credits are the main mechanism in this category. Tax Credit is a sum that deducted from the total amount a taxpayer owes to the state. An energy tax credit is given to homeowners who make their homes more energy-efficient by installing energy-efficient improvements.

Investment Tax Credits is a means of lowering the costs of RETs through market compensation. The main types include investment, and production tax credits. They are largely used in Europe, USA, Japan, and India. Investment Tax Credits can cover the cost of the RE system itself, or even the total cost of the installation (Assmann et al. 2006).

Category 4: Pigovian Tax

A Pigovian tax is a tax applied to a market activity that is generating negative externalities. The tax is intended to correct inefficient market outcomes. Eco-tax, Carbon tax and Fossil Fuel Tax are the main mechanisms of this category. Eco-tax is an example of Pigovian taxes which attempts to make the private parties involved in the social burden of their actions. Eco-tax intended to promote ecologically sustainable activities via economic incentives.

Category 5: Obligation Certificates (Quota Systems)

Quota Systems guarantee the market share of RETs through government-mandated targets, such as; Renewable Portfolio Standards (RPS), Renewables Obligation (RO) and Mandatory Green Power Option (MGPO). RPS has been implemented in many regions of the world, and different terms have been used to define it. RPS, Mandatory Market Share (MMS) or Quotas are names given to a similar set of incentives for RE in various countries (Cherni and Kentish 2007). The main idea is the electricity portfolio of electric utilities must include a specific percentage of power generated from renewables. These mechanisms are essentially market based and they are designed to achieve a cost-efficient generation of RE (Komor 2004).

RO places an obligation on licensed electricity suppliers to source an increasing proportion of electricity from renewable sources. It was introduced in England, replacing the Non-Fossil Fuel Obligation which operated from 1990. MGPO requires electricity suppliers to provide an option for their customers to purchase green power either directly from their electric company or from an alternative provider (Menz 2005).

Category 6: Bidding, Tendering System

The Non-Fossil Fuel Obligation (NFFO) is one of the main mechanism of this category. It refers to a collection of orders requiring the electricity distribution network operators in England to purchase electricity from the nuclear power and renewable energy sectors. With NFFO the government specifies the share of capacity to be achieved from each resource (Connor 2003). Centralized Bidding or Tendering have been applied in the early stages of RE development in UK and are presently employed for wind power in China under the name of concession program (Han et al. 2009). As the name implies, the policy mechanism works by calling for bids from investors for RE projects.

4. Owners

Based on the PFC, property owners decide how to respond to the RE policies. In fact they are the key element in the adoption decisions making process. Owners may take on different measures to react to energy policies and improve energy efficiency of their properties. Energy saving measures and installation of renewables-based technologies in the built environment shall contribute to reaching renewable energy targets. However, this implies targeting different groups of property owners that are differ in terms of socioeconomic characteristics, financial status, and spatial considerations. In this section, we investigate how different groups of owners make a decision in favor of ET adoption and this is done by answering the following questions: what are the main categories of property owners? What are the main influential attributes and determinants for adoption decision making of owners? And finally how is this adoption process modeled based on these determinant attributes?

In this study we presume that owners react to the policies when a policy is developed and issued. The study will focus on the three distinct types of properties and accordingly three distinct groups of owners which are categorized as follows:

- House Owner
- Housing Corporation
- Real Estate Investors

House owners and Housing corporations own residential properties whereas real estate investors own offices and industrial properties. Each category has its own attributes and characteristics that determine the adoption decision making process. Different categorizations of property owners are identified in literature, but there was no general agreement about them. Most of owner categorizations had been done based on the research context and approach. Accordingly in this study the owner categorization is also strongly related to the context of the research, which is developing a model for simulating the effects of RE policies on urban built environment. In this context House Owner is an individual in possession of title for building or land. The owner may be responsible for paying taxes for the property (or properties) and has the authority to make a decision for implementing required changes on it. It can be single or multifamily property and house or apartment. Housing Corporation is a private organization or firm that meets certain legal requirements to be recognized as having legal existence as an entity and owned by their stockholders. It provides and purchases wide range of housing or apartments to rent to tenants. Real estate investor is someone who invests in real estate. An investor may purchases a property, make repairs and/or improvements to the properties. Real estate investors can develop or purchase industrial or commercial properties (or a combination of both) based on their investment objectives.

Each owner groups make decision for implementing required changes on properties to react to the energy policies. Different factors influence the decision making of owners, such as socio-demographic characteristics, property attributes and spatial considerations. These attributes and detailed knowledge of the underlying determinants behind the owner decision making can contribute to the better design of policy instruments that targeting promotion of RETs in urban area.

Table 2 gives an overview of the most frequently used explanatory variables for modeling the decision making process of owners based on the reviewed studies. The explanatory variables based on the owners, their properties and energy technologies (ETs) are classified into (1) socio demographic characteristics, (2) property characteristics, (3) energy technology characteristics and (4) spatial characteristics.

Table2. Overview of the most frequently used explanatory variables and key determinants for modeling the decision making process of owners.

Socio demographic characteristics	Property characteristics	Energy technology characteristics	Spatial characteristics
Age	Age of property	Purchase and installation costs	Spatial understanding
Income	Floor-size	Maintenance costs	Climate zone
Education	Household-type	Environmental protection	Location
Gender	Building type	Independence from fossil fuels	
Environmental awareness	Energy-label	Energy supply	
Family type	Ownership		
Number of children	Annual energy-cost		
	Property renovation		
	Previous investments		

Most previous studies in this area consider the first two categories: socio demographic and property characteristics. Researches that explicitly consider preferences about energy technology characteristics are typically based on the choice experiments i.e. stated preferences data. Spatial characteristics are totally missing in this research area.

The variables from four different categories will be employed for modeling the adoption decision making process of owners. The first category is socio-demographic characteristics of owners. Income is an important variable that determines the financial possibilities of owners. The influence of income on the adoption decision making varies across studies. Some studies showed that owner's income influences on investment behavior (Black et al. 1985; Costanzo et al. 1986; Dillman et al. 1983; Herring et al. 2007), while others indicate no or a low correlation between income and investment behavior (Barr et al. 2005; Ruderman et al. 1987; Ürge-Vorsatz and Hauff 2001). Age of owners reflects e.g. experience, risk aversion or desired payback period and influences their adoption decision making. Older owners are less likely to adopt RETs (Carlsson-Kanyama et al. 2005; Mahapatra and Gustavsson 2008).This may be linked to their perceived uncertainty of whether the investment will be paid back during their occupancy in the house, less concern about the energy situation (Black et al. 1985) and lesser awareness about energy efficiency measures(Lindén et al. 2006). Studies show that level of education influences the acceptance of energy efficiency measures (Held 1983; Olsen 1983; Ürge-Vorsatz and Hauff 2001). Owners with higher educational qualification are more likely to accept measures compared to those with lower educational level (Poortinga et al. 2003). Owners' awareness of sustainable energy measures may influence the adoption of such measures (Rogers 2003). We argue that education can be a proxy for environmental awareness. Thus, owners with university education are expected to decide about RETs with a relatively low effort. Gender attribute demonstrate gender effects. Gender may influence environmental behavior. A review by Zelezny of 13 studies showed that in approximately 70% of the studies, women were reported to show more pro-environmental behavior than men (Zelezny et al. 2000).

Property Characteristics as a second category also has an impact on the adoption decision making process. The attribute size relates to the floor space and captures effects from a higher energy demand. The age of property serves as a proxy for the energy and technical standard of properties and influences the adoption of energy efficiency measures. Owners of older properties are more inclined to adopt such measures as their properties are in physically or aesthetically poor condition and typically have low energy efficiency standards (Gustavsson and Joelsson 2007). The Type attribute describes the type of properties (row house, Apartment, Duplex, Semi-Detached, Detached) and can be an indicator for energy demand patterns. The Energy Label may serve as an indicator for the building's energy requirements. Ownership, i.e., the rental or ownership of a property, influences the adoption of energy efficiency measures (Black et al. 1985; Costanzo et al. 1986). Previous investment in energy efficiency improvements in the house might increase homeowners' confidence in further adopting energy efficient measures (Costanzo et al. 1986). The need for more energy may encourage the adoption of energy efficiency measures. Buildings energy cost could stimulate owners' choice of energy efficiency measures (Black et al. 1985). Owners who perceive the energy cost to be high may adopt energy efficiency measures if they believe these measures would enough reduce the energy cost.

The energy technologies (ETs) characteristics are third category. From the potential technologies perspective, several technological developments and transitions are taken into account. Five most relevant RETs include: micro-wind turbines, solar heating and photovoltaic panels, geothermal heating system, biomass plants, and residual heating are considered. As mentioned prior researches in this area more considered the first two attribute groups namely: socio demographic and property characteristics. The effects of the ETs attributes on the decision making process has received less attention such as: the cost and energy production of ETs. Additionally we take into account three variables that capture the owner's preferences relate to the cost effects of ETs namely: purchase, installation and maintenance cost. These variables along with energy supply and environmental protection also somehow represent the willingness to pay (WTP) of owners to adopt ETs. Literature shows that the heterogeneity of these attributes influence on the owner's adoption decision making.

Spatial characteristics are the last category for modeling the decision making process of owners. This category reflects variables that are connected to the geographical implications and spatial scale of properties that cannot be attributed in the micro level i.e. level of individual owners and properties. This study considers different properties such as residential, office and industrial buildings that are quite heterogeneous in terms of geographical location, function, technical characteristics and spatial scales. Accordingly the decision making process of owners are also affected by these spatial heterogeneity. Individual owner decision making may be less affected by spatial implications than housing cooperation owners or real estate investors that normally own variety of properties in large scale. As a result, these differences in spatial aspects and their effects on decision making process are addressed through the owner's type. The location attribute may reflect distinctions between properties location in urban areas. It captures the geographical and geological aspects such as availability of RE resources such as biomass, solar irradiation, wind or geothermal energy. For example in urban areas, properties that are closer to agricultural area can use cheap biomass energy or in industrial districts residual heating of industrial processes is cheaply accessible to use for property owners. Spatial awareness of owners is one of the main characteristics of owners. It is the state or ability to perceive, to feel, or to be conscious of environment. More broadly, it is the state or quality of being aware of something. In this research context, awareness means to what extent owners are aware of their surrounding environment, in terms of parcels, neighbourhoods, district or city scales**.** It addresses the spatial scales that owners can consider in their decision making process. For instance spatial awareness of individual house owner is often limited to his/her neighbours whereas real estate investor or housing cooperation owner should be aware of the whole city or region to come to the right decision regarding ETs adoption.

5. Decision Making

As mentioned the aim of this study is analysing the adoption decision making process of property owners at micro-level in response to the energy policies in city scale by accounting the heterogeneity of owners. Accordingly, it is of high relevance to gain a deeper understanding of the owner decision making process. In general decision making can be regarded as the mental continuous process, integrated in the interaction with environment, resulting in the choice of a course of action among several alternative scenarios. The process is usually terminated when a satisfactory solution is reached. Every decision making process produces a final choice that should be examined in the context of a set of needs, preferences and individual characteristics. Decision making can be either reasoning process or emotional process which is often interpreted as a rational or non-rational decision making process respectively. In literature based on the rationality in decision making, there are two cognitive styles in decision making; maximizers and satisfiers. Maximizers try to make an optimal decision without any limitation in available information, time and processing ability of mind whereas satisfiers try to find a solution that is good enough based on the limited human ability and resources. Based on this concept two different approaches are employed for analyzing the energy technology adoption decision making of owners; rational analysis and non-rational analysis. The basic idea of rational (or purely rational) decision making implies patterns of behavior and decisions that made only based on the maximizing benefits and minimizing costs. In other words, owners take decisions about how they react to the energy policies just based on the comparing the costs and benefits of energy technologies. This implies economic (cost and benefit) and energetic (energy supply and demand) factors are the main determinants for modeling the adoption decision making of owners.

The rational choice analysis is commonly used in economic theory since customers want to have the most useful products at the lowest price. From a computational view, mathematical techniques can be used for modeling the decision making process. The main strength of this approach is that the simulation of decision-making process can be done entirely computationally. Cost benefit analysis (CBA) as a systematic process for calculating and comparing benefits and costs of decisions, is one of the most widely used techniques in this area.

Non-rational decision making approach (also known as a bounded rationality) implies that the rationality of owners in decision making is limited by factors such as the amount of information they have, the cognitive limitations of their minds, their backgrounds and cultures and the limited time that they have to make decisions. As a result the decision making process of each owner will be different and heterogeneous. Also in addition to the financial and energetic variables, other variables such as socio-economic, cultural and environmental variables are involved in the decision making process. This concept was developed due to the fact that purely rational decisions are often not feasible in practice. From a computational view, in this approach decisions are modeled in terms of algorithms and heuristics. They are proposed as an alternative basis for the mathematical modeling as used in economics and related disciplines.

6. Conclusions

The main aim of this study is examining the effects of applying RE policies in urban areas and analyzing the adoption decision making process of owners at micro-level in response to policies in city scale based on the PFC. The policy flow cycle as a heuristic, iterative and normative framework is proposed to show how energy policies is developed, analyzed and evaluated in urban areas, including; Agenda Setting, Policy Analysis, Policy Formulation, Launching, Adoption, Implementation and Assessment. Based on the extensive literature review and surveys an inventory list of existing RE policies is provided and categorized based on their application mechanisms and key features. Property owners as a core of PFC and their main categorizations are presented. Explanatory variables and key determinant for modeling the decision making process of owners, including (1) socio demographic characteristics, (2) property characteristics, (3) energy technology characteristics and (4) spatial characteristics are identified and elaborated. Adoption decision making of owners is discussed based on the two main reasoning approaches: pure-rational and non-rational.

As mentioned the research approach of this paper is descriptive. In future research a simulation model based on the agent based modeling (ABM) approach will be developed. In this model property owners as an agent with specific characteristics decide which energy technologies they choose as a reaction to the policies. The simulation also will be done based on the two reasoning approaches; pure rational and non-rational. Comparison of results provides insight into the effectiveness of energy policies that can be anticipated.

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