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Exploring Social Dimensions of Achieving Energy Efficiency in Urban Housing Design - A Case Study from Hanoi (Vietnam)

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Abstract: Achieving energy efficiency is widely regarded as the first bold step in paving the way for sustainable architecture to take shape. In Vietnam, energy efficiency has been mostly considered in technical aspects so far. Social dimensions, which are equally essential in the context of such a fast-developing country as Vietnam, have not yet been properly investigated. In fact, research projects only deal with affordability, amortisation and difficulties to overcome in view of state management and energy policy making. However, actually, social dimensions cover a much broader spectrum than what many people often imagine. Thus, by means of surveys, analyses of data and interviews, the author examines the following social issues of using energy at building level with 190 households in Hanoi: awareness of the importance of saving energy and using renewable energy at home, users' behaviour and application of (and readiness for) more energy-efficient solutions and obstacles on the way to achieve energy efficiency. The results and arguments will help planners, designers and engineers understand better the current situation before trying to take action in order to meet the public demand in urban housing design and management towards energy efficiency. In this regard, public awareness plays a key role, but having input data for a more efficient housing design and a better project management policy is also very important, requiring a more systematic and larger-scale study on household energy use. Without digitalisation as a new method of site surveying and data collecting, this aim might never be fulfilled.

Keywords: Energy efficiency, public awareness, users' behaviour, solutions, urban housing design and management, Hanoi, digitalisation

1. Introduction

1.1 Overview of Energy Efficiency in Vietnam

Vietnam officially started to go for green in 2007, shortly after Vietnam Green Building Council (VGBC) had been established. VGBC is responsible for the promotion and development of green buildings in the country and helps fulfil the development goals adopted by the Government with a special emphasis on sustainability in general, and on energy efficiency in particular. Energy efficiency forms part of all green building criteria and rating systems worldwide. For example, in LEED rating system as the world's most influential green building rating tool, energy efficiency in home design is given 37 points (out of a 110-point scorecard). In Vietnam, VGBC has developed its own criteria for residential buildings called LOTUS, in which energy efficiency makes up 24 points (out of an 84-point scorecard in the latest LOTUS Homes version coming out in 2019). In both rating systems, energy efficiency turns out to be the most outstanding factor drawn from a wide spectrum of criteria and sub-criteria in green building assessment, as demonstrated in the score weight

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(33.6% and 28.6%, respectively, of the overall score, considerably higher than the second and the third most important ones). The breakdown of each green building rating system is presented in Table 1 below:

Table 1 - Energy efficiency in LEED and LOTUS systems for home design – A comparative study

International (LEED system) (USGBC, 2019)		**National (LOTUS system) (VGBC, 2019)**	
Category	**Points**	**Points**	**Category (Equivalent)**
Integrative process	2	7	Community and Management
Location and transportation	15	16	Local environment
Sustainable sites	7		
Energy efficiency	37	24	Energy efficiency
Water efficiency	12	8	Water efficiency
Materials and resources	9	14	Materials and resources
Indoor environmental quality	18	11	Health and comfort
Additional score (innovation and priority)	10	4	Innovation credit
Total score	**110**	**84**	**Total score**

In terms of energy efficiency for housing design, VGBC has recently merged single-family and multi-family residential buildings divided in the period 2012 - 2019 into one category only under the name of LOTUS Homes:

Table 2 - Energy efficiency assessment in LOTUS Homes (VGBC, 2019)

Sub-categories of energy efficiency	**Points**
Passive design	5
Building envelope	4
Cooling	6
Artificial lighting	3
Water heating	2
Energy-efficient appliances	3
Energy monitoring	1
Total	**24**

Those indicators are obviously engineering-based and some critical social aspects related to energy use and energy efficiency have not yet been included in LOTUS rating and not properly considered either, although they play a key role in reality.

Energy efficiency has become a topical and also critical issue in Vietnam over the past ten years, as the Government, the Ministry of Construction, the Ministry of Industry and Commerce, the Ministry of Resources and Environment and many professional organisations, such as Vietnam Association of Architects and Vietnam Association of the Built Environment, have realised the importance of energy saving in buildings (on a small scale) and in cities as well as territories (on a large scale). The State Building Law promulgated in 2014, for example, addresses energy in view of ensuring indoor thermal comfort and reducing CO_2 emissions in Article 79 (National Assembly, 2014). Energy efficiency was later legalised with the National Building Norm for Energy Efficiency approved by the Ministry of Construction in 2013 and amended in 2017 with two national building norms QCVN 09:2013/BXD and QCVN 09:2017/BXD, respectively. In both versions, all buildings with over 2,500 m^2 gross floor area (GFA) in six types (office, hotel, hospital, school, supermarket and apartment) must comply with this norm. The requirements for buildings with GFA of less than 2,500 m^2 and other building types are still facultative but will become obligatory in the near future - until 2030 (Ministry of Construction, 2013 & 2017). In QCVN 09:2017/BXD, the importance of building envelopes and the optimisation of HVAC systems have been emphasised. Furthermore, installing energy-saving (or high-performance) equipment through energy labelling is more strongly encouraged (Ministry of Construction, 2017). In 2011, Decree No. 21/2011/ND-CP regarding energy saving by 8 - 10% in industry generally and in building industry particularly until 2030 was issued on the basis of the Law of Efficiency in Energy Use previously adopted by the National Assembly in 2010 (Government of Vietnam, 2011). However, energy efficiency has been mostly, comprehensively and intensively investigated in view of technology and policy making, not yet socially analysed, as far as users' awareness of and behaviour towards saving in energy consumption, acceptance and/or application of solutions available, readiness to change their lifestyles for a cleaner environment and a better quality of life, affordability and difficulties of achieving energy efficiency in everyday life approach and practice are concerned.

1.2 Overview of Household Energy Consumption and Data Digitalisation in Vietnam

Household energy consumption in major cities of Vietnam was reported to rise continually, from 798 kWh per capita in 2008 to 1,411 kWh per capita in 2014 (World Bank, 2015). European Chamber of Commerce in Vietnam also

conducted a review of energy consumption across Vietnam and a significant increase could be noted, from 998 kWh per capita in 2010 to 1,564 kWh per capita in 2015 (European Chamber of Commerce in Vietnam, 2017). Another survey in detail, more recently conducted within five years (2013 to 2017), shows a steady increase in the energy demand of a typical nuclear family living in central Hanoi: 44 kWh/m^{2}a (2013), 48 kWh/m^{2}a (2014), 50 kWh/m^{2}a (2015), 55 kWh/m^{2}a (2016) and 59 kWh/m^{2}a (2017) (Nguyen, 2018), because extreme weather conditions (too cold in winter and too hot in summer) have occurred more often and lasted longer in recent years than ever before. In the meantime, home energy use intensity in Hanoi, according to an investigation undertaken in 2016, varied between 23 kWh/m^{2}a and 73 kWh/m^{2}a, depending on orientation, design concept, type of housing, quality of living and daily life activity (Nguyen, 2018). Some other researchers and projects have chosen to deal with household energy consumption in major cities in Vietnam, but they focused on the amount of energy consumption with comparisons and explanations of different levels, and just mentioned users behaviour and awareness as a crucial factor without going further into detail with statistics to show more convincingly how essential practising energy saving really is or what may be drawn from the data in view of sociology. Therefore, it is necessary to focus more on social aspects of household energy consumption on a small scale first, before larger-scale studies can be carried out to achieve energy efficiency in both city planning and project management.

In Vietnam, the application of digitalisation to energy-related research has not yet been properly considered or investigated either. Actually, digitalisation or networking can be mostly found in state management, as the Government has since 2016 encouraged the implementation of e-authority and e-ministry concepts as an integral part of a nationwide administrative reform and paperwork simplification, especially in business registration, trade transaction, customs clearance and tax payment.

1.3 Research Objectives

The study aims to:

• better understand how city residents in different districts of the capital city of Hanoi living in different housing types and conditions think about energy issues in buildings, particularly energy efficiency, what they often do to save energy, how they are aware of the importance of energy sustainability and accept new energy-efficient housing concepts.

• provide project managers and even home designers with one insight into social aspects of achieving energy efficiency as the other side of the coin. The statistics and data analyses, though the survey was individually conducted on a small scale, are expected to be useful for decision makers when they intend to modify some current policies related to energy towards efficiency. The proposal of digitalisation concept applied to collecting input data suggests that a much more effective mechanism for energy-efficient housing architecture in Hanoi and other major cities should be established, in accordance with the 4.0 industry and technology.

1.4 Research Methods

The following research methods were used in this academic paper:

• Survey: Data on factual and social issues related to energy use and energy saving from 190 households living in 17 districts of Hanoi were collected;

• Data analyses: Data were categorised, analysed and compared with one another, where appropriate;

• Interview: Sixty households from three groups of respondents living in three housing types are intentionally chosen in Step Two for an interview to gather more in-formation used in analyses, such as the reasons for applying specific solutions and order of priority when choosing some products with regard to energy saving.

These three research methods should be consecutively/alternately taken to ensure the comprehensiveness of the data within an individual study. It requires a sufficient number of households. A city-wide distribution of households would be preferred to a same-district or even a same-settlement location. The diversity of data, such as housing types, family sizes, purposes of use, household electric apparatuses, applications of various solutions to the saving of electricity, etc. were taken into account. Additional information from interviews helped explain some facts in social aspects of a technical issue and support the key arguments.

2. Outcomes of Household Energy Consumption Survey in Hanoi

As part of an annual university scientific research project, a survey on household energy use and energy saving was carried out in 2019, with the participation of a total of 190 households living in 17 out of 30 districts (or equivalent administrative units) in Hanoi City. The distribution of respondents and the structure of housing types are shown in Fig. 1 and Table 3 below:

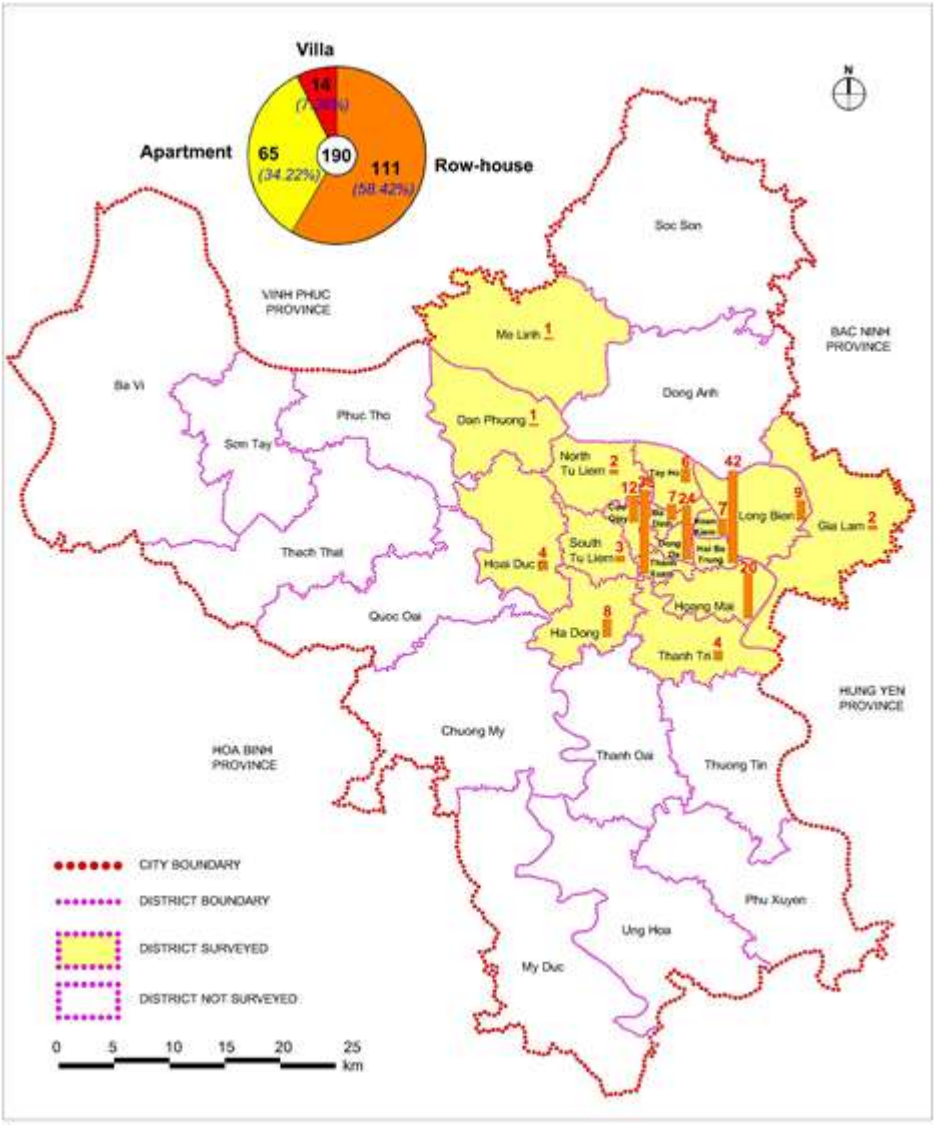

Fig. 1 - Distribution of households surveyed and housing type structures
(Background map from Hanoi People's Committee Portal - www.hanoi.gov.vn)

Table 3 - Distribution of households and housing types by district, from city centre to outskirts

No.	District	Number of households	Type 1: Villa or garden house	Type 2: Row house	Type 3: Apartment
01	Hoan Kiem	07	00	07	00
02	Ba Dinh	07	00	07	00
03	Dong Da	24	02	21	01
04	Hai Ba Trung	42	02	24	16
05	Thanh Xuan	38	03	13	22
06	Cau Giay	12	00	05	07
07	Tay Ho	06	00	06	00
08	Long Bien	09	00	08	01
09	Hoang Mai	20	02	05	13
10	Thanh Tri	04	00	04	00
11	Ha Dong	08	02	04	02
12	South Tu Liem	03	00	01	02
13	North Tu Liem	02	00	01	01
14	Hoai Duc	04	01	03	00
15	Dan Phuong	01	01	00	00

No.	District	Number of households	Type 1: Villa or garden house	Type 2: Row house	Type 3: Apartment
16	Me Linh	01	01	00	00
17	Gia Lam	02	00	02	00
	Total	**190**	**14**	**111**	**65**

Before analysing the importance of social aspects in energy efficiency, it is necessary to understand the current situation of applying energy-saving solutions in Hanoi. All the 190 households in the survey have already taken a number of measures over the past few years to minimise the unfavourable climate conditions and to reduce the energy consumption as well. In total, there are 18 solutions applied as listed from the most to the least popular in Fig. 2. A five-grade scale (38 households per grade) should be used to differentiate the levels of applicability: very low – low – medium – high – very high. Figure 2 shows that only seven out of 18 solutions are satisfactory (medium grade or above).

Surprisingly enough, the most popular solution (174 out of 190 cases, or 91.6%) is not technical - turning off electrical equipment when going out. Some respondents (62 out of 174) say that they understand quite well how important energy saving is, because they are university lecturers and researchers in architecture, urban planning and civil engineering, teaching energy-related subjects or building designers and project managers, working on green building projects frequently. The others (112 out of 174) have become aware of the issue and practised turning off electrical equipment if they no longer use it as a result of action programmes broadcast on various mass media channels, including the Earth Hour campaign in which Vietnam has joined with the world community since 2009.

The second and third most common solutions are quite simple but relatively effective in respondents' opinion: Using curtains, blinds and/or bamboo screens (159 out of 190 cases, or 83.7%) and painting roofs and external walls with a bright and light colour (125 out of 190 cases, or 65.8%). Both solutions are quite easy to apply in reality and these householders can make a decision quickly based on a large number of options or products available in the market. Out of 60 householders interviewed, 44 needed advice from close relatives, colleagues or friends when they did not know what kind of sun-shading systems or external wall paints to choose. As for these 44 respondents, they considered three key factors in the following order of importance: 1. Quality of products (21 choices), 2. Price of products (14 choices) and 3. Aesthetics of products (09 choices). With regard to the quality, 16 out of 21 householders choose to buy made-in-Vietnam products (in combination with price) while five prefer imported products from the EU or Japan (the products may be better designed).

The next common solution is based on design, when balconies and loggias are applied and able to help protect the houses or apartments from the solar heat and radiation through shading effect on the façade. Among 190 cases, 109 families (57.4%) regarded making use of loggias and/or balconies as "efficient", especially those living in houses or apartments facing West or Southwest (23 out of 60 interviewees).

The other solutions cover a wide range of application, from being simple (such as greening the façade by growing creeping plants and ornamental trees and closing/opening a double window structure in a flexible manner) to being complex and requiring some initial investments (for instance using double or triple glazing systems or applying a smart home concept). Some interesting facts and figures can be drawn from the statistics of solutions No. 6, No. 8, No. 14, No. 16, No. 17 and No. 18.

Solution No. 6 deals with planting shade trees near or around the house. Most of the households (65 out of 79 cases, or 82.3%) applying this solution live in villas (14 cases) or row-houses (51 out of 111 families) with a garden or a pavement in front of the house which is large or wide enough (over 6 m) to plant shade trees. For those living in apartments, particularly from the eighth floor upwards, they cannot make use of shading from shade trees, because of the limited height of shade trees and the requirement of the minimum distance from their homes to the shade trees planted.

Solution No. 8 emphasises energy efficiency by using energy-saving home electrical appliances, for example washing machines, dishwashers, light bulbs, particularly air-conditioners and fridges. The number of households saving energy marginally exceeds one third (66 out of 190, or 34.7%). The majority of them (43 out of 66, or 65.2%) have only LED or compact light bulbs while 23 households purchased further modern electronic equipment certified with three or more star energy-saving labels.

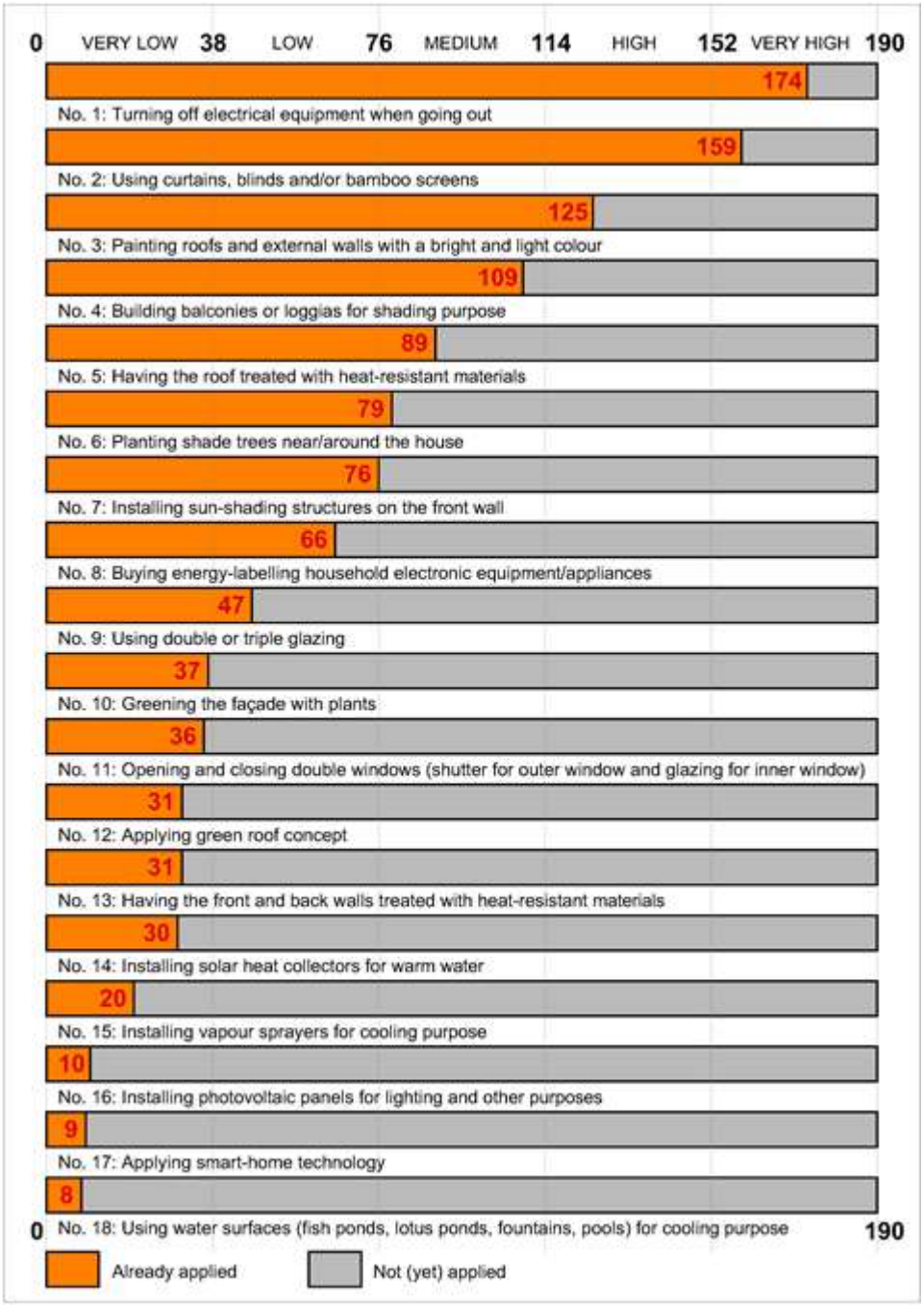

Fig. 2 - Application of energy-saving solutions among 190 households in 17 districts in Hanoi

Solution No. 14 and Solution No. 16 highlight the advantage of exploiting solar energy in household daily life activities, including lighting, cooking, showering and washing with warm water, etc., hereby reducing the dependence on conventional energy supply and helping protect nature as well as living environment. Although using renewable energy, especially solar energy, is strongly encouraged, it is still challenging for a city-wide application, mostly because of the high price for the majority of the city residents. A complete set of solar equipment (14 m^2 photovoltaic panels consisting of six standard modules with a monitoring system, a distribution box, a grid-tie inverter, frame and some accessories) costs at least 2,000 USD in the market (Vu Phong Solar, 2019). That means, the pay-back time should be six or seven years on average. For this reason, only 10 households (out of 190 households surveyed, equal to 5.3%) have installed PV panels. In terms of using solar collectors for warm water, the number of families is three times higher (30 out of 190 households surveyed, or 15.8%) and they are mostly upper middle-class families or above. To understand more about the public awareness of renewable energy sources, 60 households were interviewed. All of them realise that making use of solar energy should be the right (or the best) solution for the future in Vietnam with regard to energy security and environmental protection, 43 respondents agree that wind energy will be the second option, 22 think that

geothermal heat could also be exploited, 15 know something about bio-mass and only nine have heard about tide and wave energy before. Out of the 43 respondents naming at least one more renewable energy source than solar energy, 32 are non-professionals.

Smart home technology (Solution No. 17) is much more expensive than Solution No. 14 and Solution No. 16 combined, actually costing from 5,000 USD (for mini-apartments) to 17,000 USD (for villas) offered by some of the leading domestic providers, such as BKAV, LUMI and ACIS (Smart Home Vietnam, 2020). That is why only a few families among the households surveyed (9 out of 190, or 4.7%) could afford the smart home full package price which helps them save a further amount of household energy consumption of up to 20% through the integration of all the power systems and the optimisation of the whole network.

Ranked as the very last in the list (Solution No. 18), using water surface for cooling the house through evaporation effect seems to be quite easy to apply, but in fact it is the least popular solution, found only in eight (out of 14) villas where the land plot is large enough, located in new districts or in the outskirts, to have a sufficient area (10 m^2 or more) for a fish pond, a lotus pond or a pool to ensure the efficiency of cooling the summer air. This water surface is planned either in the front of the house or on one side, normally in the prevailing wind direction. Using vapour sprayers can be an alternative of cooling for apartments or narrow row-houses. Such a system does not require a large space or cost so much, but only 20 households have it installed.

Asked about an opinion of energy saving in modern housing, 125 (out of 190 households investigated, equal to 65.8%) regarded it as "very important" and a further 62 respondents found it "important". That means, an overwhelming percentage of households (98.4%) agreed that energy saving plays a vital role in reality. But only 139 households (73.2%) would be longing for an offer of a complete energy-efficient home design concept. Not only 47 respondents (24.7%) hesitate to take more energy-efficient measures, but 105 out of 139 households (75.5%) also think that it will be difficult to achieve energy efficiency in housing design for various reasons (see Fig. 3).

Fig. 3 - Statistics on the awareness of the importance of energy saving in housing architecture and the acceptance of energy-efficient design concept

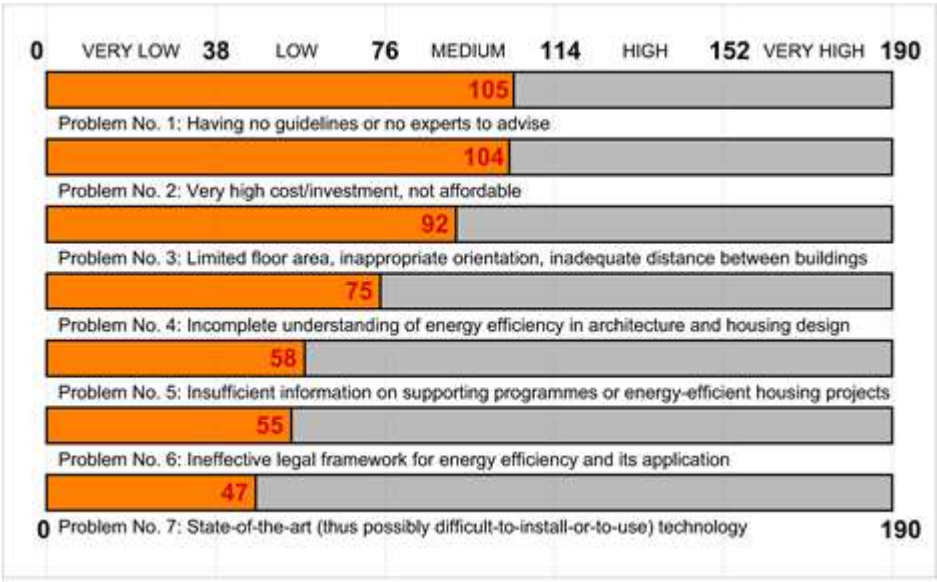

Fig. 4 - Problems on the way to achieve household energy efficiency from 190 cases in Hanoi

According to the survey, there are seven major obstacles on the way to achieve energy efficiency, arranged from the most to the least critical. These reasons are graphically presented in Fig. 4.

It is obvious to notice that the biggest problem to solve is the lack of a so-called guideline for energy-efficient home design officially published by a competent state organisation, such as the Ministry of Construction or Vietnam Green Building Council. Similarly, apart from a guidebook, people need experts, either architects or engineers, in energy-efficient building to advise them on appropriate solutions in specific conditions of construction sites, but it is not always easy to find such qualified consultants. Over half of the respondents (105 out of 190 households, or 55.3%) did not feel satisfied with that situation.

Once again, financing is placed among the greatest difficulties in achieving energy efficiency, with 104 respondents (54.7%) saying that they cannot afford an energy-efficient house or apartment in five to ten years' time unless the State makes a new supporting policy in line with a more generous bank loan programme (longer payback term and lower rate of interest). Currently they are categorised as "middle-class" or "low-income" households. A funding balance of 50% - 50% for the total cost of an energy-efficient house or apartment shall be applicable to a middle-class family while the share of 75% (state aid) - 25% (household contribution) can be accepted for those with less spending power.

Another case to consider in reality is that a house or an apartment faces West or Southwest as an unfavourable orientation. Furthermore, the distance between that house or that apartment and the opposite block fails to meet the minimum distance requirement. Consequently, that house or that apartment will not be properly ventilated and/or well-lit with daylight, thus unhealthy to live in. Should the floor area be limited (less than 40 m^2) and the house constructed in a high-density quarter where people are easily and immensely affected by the urban heat island effect, it will also be difficult to ensure a good quality of building and living. This problem ranks third in the list with 92 votes.

Seventy five households, mostly non-professionals (65 out of 75, or equal to 86.7%), admit that they do not understand well what energy efficiency actually re-quires, even some professionals with over five years of work experience. They imagine green or energy-efficient architecture in a very simple way: Planting as many trees as possible inside and/or outside a house or an apartment and installing a warm water collector or a photovoltaic panel on the roof would be sufficient. Of course such an understanding is incomplete and it is suggested that more education programmes as well as promotion campaigns should be launched in order to raise the public aware-ness of energy efficiency in both housing design and project management.

A considerable number of people found shortcomings in the information system and legal framework (58 and 55 interviewees, respectively). They complained that they did not receive any information on the state's supporting policies or the city's energy-efficient housing projects, or they did but it came very late, thus they could not stand a chance to buy a house or an apartment that they wished, even when they have enough money to do so. Many of them also thought that the current building law and the sub-law documents would not pave the way for energy efficiency to take root, because of cumbersome procedures in building project approval and certification, as well as in assistance and implementation. Therefore, the current building law needs to be modified as soon as possible.

Last but not least, energy-efficient architecture requires state-of-the-art technology, especially in super energy-saving buildings like passive houses or zero-energy houses. In addition to a much higher building cost, the operation or the monitoring of a complex household energy system can be a barrier to elderly people, as demonstrated in the fact that 38 out of 47 home owners who hesitate to apply innovative energy technology for greater energy efficiency are over 60 years old. They tend to prefer something simple and easy to use.

3. Discussion of Initial Research Findings

The social dimensions of achieving energy efficiency in urban housing design in Hanoi and other Vietnamese major cities have been partially (but somehow clearly) reflected in the following five aspects and demonstrated with relevant statistics: 1. Awareness of the importance of saving energy and using renewable energy at home, 2. Users' behaviour towards and their practice of energy-saving solutions at home, 3. Readiness to change for a higher level of energy-efficiency when purchasing new houses/apartments or deciding to renovate old houses/apartments, 4. Affordability and 5. Greatest obstacles for achieving household energy efficiency.

The on-going public awareness raising programmes are very successful, as most people have realised how important energy efficiency can be while confronting an energy crisis and facing an increasing electricity price. A good understanding will result in right behaviour, such as switching off lights, electric fans, TVs, CD players and other home apparatuses before going out, even for a few minutes. In this regard, the public feedback is absolutely positive. Many of them also become well conscious of the fact that energy saving is the first bold step towards energy efficiency.

Among 18 energy-saving solutions, only two are directly related to user behaviour. Apart from turning off electricity-consuming appliances if not necessary, it is highly recommended to purchase energy-labelled equipment, not just LED lamps, but also more energy-intensive appliances, especially air-conditioners, fridges, dish-washers and washing machines. An air-conditioner manufactured in Vietnam with technology transferred by Mitsubishi as one of the most favourite Japanese trademarks in Vietnam, for example, can save up to 30% - 50% - 70% of electricity (three - four - five star labelling, respectively). In order to encourage more and more people to use such environment-friendlier building products and electricity equipment, the state should promulgate an incentive policy targeted at both manufacturers and

customers, first of all at the low-income group. For manufacturers, they can be allowed to gain so much from reducing enterprise taxes and probably other benefits from the government and/or the local authority.

From the outcomes of the survey, it does not seem at present that many people get ready to change for a higher level of energy efficiency, even if they are going to buy new houses/apartments or about to renovate their current homes for a higher level of comfort. Several key solutions are simple but really efficient and very easy to apply. Nevertheless, they are ranked in the bottom half of the list, for instance, green roof and façade, heat-resistant wall, cooling through evaporation effect (all of these measures go with less than 20% of the total number of households saying yes). Most of the interviewees (53 out of 60 are convinced of the advantages of energy-efficient architecture, but they are also reluctant about the higher cost. Among these 53 cases, only nine households can afford the price (those living in villas), 24 respondents say that they can borrow money, either from family members or from the banks with concessional loans (those living mostly in row-houses) to purchase a standard energy-saving house or apartment and 20 families have no financial means (those mostly living in apartments). Once again, affordability matters in providing energy-efficient architecture for the public.

In exploiting solar energy as a potential substitute for conventional energy sources, affordability is often the last hurdle to overcome before putting the design concept into practice. The percentage in each case (using solar heat collectors and installing solar cells) is astonishingly low, although almost all of the householders agree that using regenerative energy would be an imperative need for today. The main reason for this hesitation, as previously mentioned, is an initial investment in innovative building technologies and efficient energy systems which most of them could not afford. Energy-efficient architecture means, in their opinion, high-tech design and will only aim at high-end users, while the majority of city residents still belong to middle and low-income groups. In the same way, smart home design has been and continues to be chosen mostly by high or very high-income residents only.

This public opinion survey also pointed out some gaps to fill while striving for energy efficiency: The lack of consultancy from professional organisations, the lack of financial support from the state and state agencies, the lack of pre-requisite site conditions for planning and building towards energy efficiency, the lack of knowledge from the public, the lack of information from the state departments and authorities, and the lack of legal bases for implementation from legislative bodies. In case these problems co-exist, the goal of achieving energy efficiency will certainly be more difficult to reach. The feedback from the public, if frequently collected, will always be useful, helping decision makers adopt a new housing policy facilitating energy efficiency or adjust the current one in time so as to meet the requirements of the reality as well as the demand of the community. The success of any urban development or redevelopment project in general (and the one in energy efficiency improvement in particular) can be measured with the level of satisfaction of the public as another social dimension which still remains unexplored somehow. Similarly, through a city-wide data-collecting network, housing planners and architects can be informed of the problems in housing design and improve both the design and construction quality. Applying some high-tech energy-saving solutions is recommended in addition to (or in combination with) simple-but-efficient ones.

4. Digitalisation as a New Tool in Energy Studies

4.1 Why Digitalisation?

In order to achieve energy efficiency in both planning and architecture, it is vital to understand how people use energy as the first step, before going further with a number of practical solutions, architecturally, technically and socially considered. In this first step, data collection plays an extremely important role, helping researchers find out a wide range of important information, such as housing patterns, house or apartment orientation, number of family members, floor areas, number of household electric appliances and their electric power/consumption levels, especially air-conditioners, fridges and washing machines as the most intensive electricity consumers, measures currently taken to ensure indoor comfort as well as to save energy, monthly and annual electricity bills, possibilities to use regenerative energy sources and awareness of the importance of using clean energy as well as the role of green building. It is obvious that the data are quite diverse and that the more data are collected, the better the results can be.

The ground of this individual study would have been better founded, if it had been undertaken on a much larger scale with more respondents - 40 or 50 households per central districts and 20 to 30 participants in the outlying districts. That is to say, the participation of 1,500 to 2,000 households would be needed for a much stronger database. Obviously, a conventional survey by means of hand-out questionnaires, no matter how well it might be technically or financially supported, will no longer meet this demand. As far as the update and accuracy of data is taken into account, the entire process cannot go without digitalisation. In other words, the application of information technology and the establishment of a city-wide data collecting network are pre-requisite conditions.

4.2 How Digitalisation?

Digitalisation in terms of collecting energy input data will take the form of an e-survey, providing information on a regular basis (monthly, quarterly and yearly) and most significantly being conducted on a large scale (district-wide and city-wide). It will save so much time and ensure the accuracy as well as update of information.

Digitalisation, in this case, will be in accordance with the mainstream of e-government and e-authority in the reform of administrative system initiated by the Prime Minister and supported by the Ministry of Science and Technology. The digitalisation concept will be developed on a strong IT foundation and a city-wide net-work connected to every household. Each household in each ward (neighbourhood) is provided with a personal account to log in and an email address, for example: name_of_householder@name_of_ward.name_of_district.hn.vn to receive a notification with a link to an e-survey formulated by a professional organisation or a group of research institutes involved in an energy data survey. In order to avoid repetition, if many people living in the same ward share one name, special characters may be added to the e-mail address and the account as well. This system will be co-managed by the city and district authorities, with cooperation of some professional organisations which investigate energy consumption and energy efficiency. The experts from these professional organisations can either work individually or in groups to establish one survey and a survey form with instructions and requirements will be sent to all the households in any specific areas of the city. The recipients should be given enough time to complete the form and return it to the central manager. The data will then be digitally analysed and published in form of statistics for those who are interested. The entire system can be illustrated in Fig. 5 below:

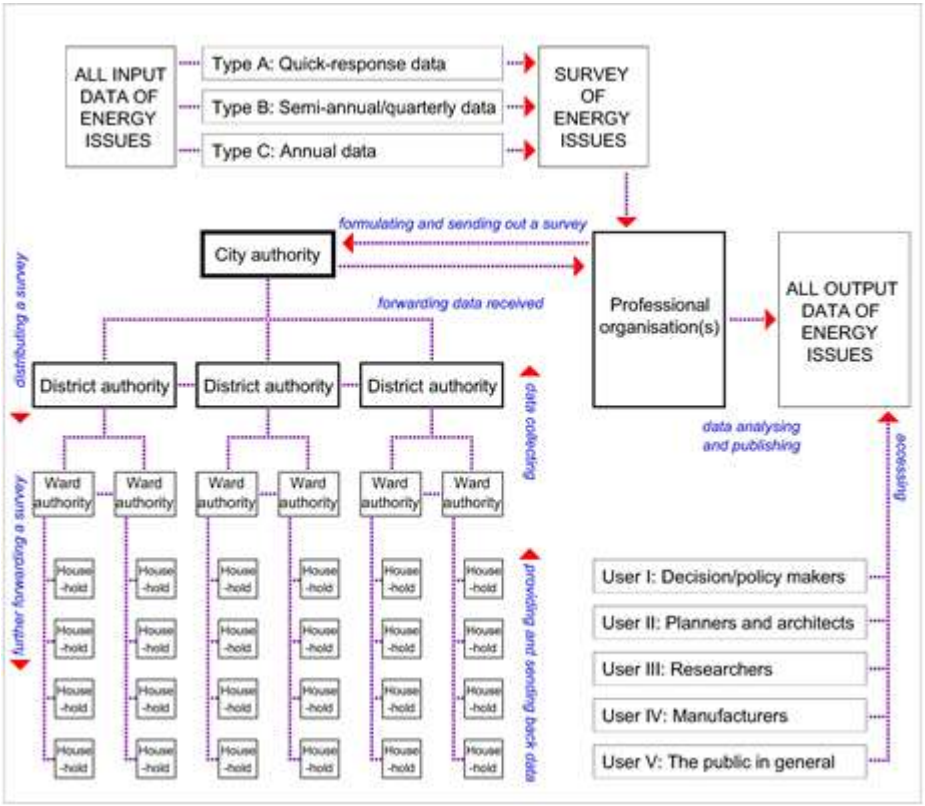

Fig. 5 - Digitalisation concept proposed for collecting energy data to help achieve energy efficiency in urban planning and design

The input data can be divided into three categories: 1. Quick-response data (for instance the public opinions of a law related to energy or an official document to be adopted and votes for a multi-optional decision to be made), 2. Semi-annual or quarterly data (for example purchase of new electric household equipment and application of energy-saving solutions) and 3. Annual data (such as full-year energy consumption, GFA and family size). Depending on the requirements, the questions in a household energy survey form can be properly designed.

The output data are digitalised and targeted at different groups of users: General data are useful for the public while researchers need all kinds of data. Planners and architects are interested in data relevant to design. In the meantime, manufacturers pay special attention to technical specifications of household electrical equipment and managers should know how and why people are satisfied or unsatisfied with the current policy. Some data are open while the access to the others may be restricted.

5. Conclusion

It is still a long way for Vietnam in general, and for Hanoi in particular, to go towards energy efficiency. In fact, many simple solutions such as greening roofs and/or façades, opening/closing double-glazed windows subject to weather conditions and spraying vapour for cooling are not very common as shown in the household energy consumption survey. Most of the energy-saving solutions (15 out of 18) are not so widely applied as expected. Some of them are very important and indispensable in the modern time, for example using smart-home technology, installing solar panels and purchasing energy-labelled products. However, the public awareness of energy efficiency and environmental protection has significantly increased in recent years and it can be regarded as a dynamo for a major change in the city development.

Energy efficiency should not be only technically considered. Its social dimensions are interesting enough to explore. Actually, they play a key role and encompass a wide range of issues. Understanding well the difficulties and barriers on the way to achieve energy efficiency will help enhance the level of sustainability step by step, in accordance with the strict requirements of green buildings. Innovative energy solutions and technologies should be strongly encouraged in housing design and building operation.

Digitalisation will be regarded as a fulcrum and highly useful tool for studies on energy use as well as energy efficiency in urban housing, especially in major cities, in the 4.0 era. Digitalisation can be interpreted into a city-wide network of data providers and researchers as well as managers, so that all the data as input for studies will be collected quickly and frequently on a much larger scale. In fact, digitalisation will be a revolution at both pre-design stage and post-design stage (management).

In this circumstance, public opinion surveys related to energy efficiency and sustainability must be undertaken on a much larger scale and as frequently as possible with the support of information technology. The data obtained from an e-survey will surely be useful for all the parties involved in this process, including building occupants, building consultants, building scientists and energy experts, policy makers, funding providers, project developers and managers, and equipment manufacturers as well. They will form a multi-lateral mechanism and have to make it work smoothly by taking their full responsibilities and cooperating closely with one another.

As a new concept, digitalisation and networking of energy data should be put into practice first in Hanoi with some pilot case studies at district level. If successfully implemented, it can be further applied to other districts of the capital city, and later to the whole country.

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Note

All the data, including charts and tables, given in the academic paper without citations are the outcomes of a household energy consumption survey and an interview conducted by the author and collaborators. These data have not yet been published in any journals or conference proceedings.

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