Critical Approach to the Process of Energy Efficient Building Constructing

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ABSTRACT

Now days in all over the world; most of statehoods are applying energy efficiency regulations to the process of construction in their own countries beside regulate standards for historical and existing buildings in their borders. It seems necessary to use these codes to have a more sustainable life and help the future of our planet and posterity, to give them a chance for living in better condition. Regulating energy standards started in Scandinavian countries and developed through the technology in Germany and grew to all Europe and America. Faster and faster most countries started to regulate standards according to climatic changes and other factors in their own situation.

Due to technological advances and update the knowledge about ways of using energy and a different source of energy efficiency standards for the building construction process, codes and standards started to adapt to new information and situation. Every day the number of countries which they are starting to apply energy regulations in their countries are increasing, but in-between there are some countries that still do not have any codes for energy efficiency, such as the Turkish Republic of Northern Cyprus. This theorem puts the author on to think about the preparing basic information in this field with the hope of having prepared a suitable standard for Northern Cyprus in the future.

To reach this aim, many energy efficiency regulations in the building construction process have been studied, analyzed and compared. Similar standards have been found and studied in more detail; finding results of these analyzes are an attempt to find out the best energy method for TRNC. The aim of this research is to see what is the condition of Turkish Republic of Northern Cyprus currently, and what's missing as a background for applying any regulation in different parts of the construction process. This process has been divided into three parts as a design process, construction period and approval process. These divisions have bee done according to the different timing of building construction process to control the amount of energy used in the final product. To be energy efficient it is important to consider energy factors in design part, base of energy efficient design, building will be constructed and at the end level of energy efficiency success should be examined. For each section most suitable regulation is suggested to prepare needed information for regulators to have a clear view of the northern Cyprus case.

Keyword: Energy efficiency, building construction process, design regulations, constricting regulations, energy measuring and labeling, and standards development.

ÖZ

İçinde bulunduğumuz günlerde, tüm dünyada; birçok ülke kendi sınırları içerisinde tarihi ve var olan binaların inşası sırasında standart uygulamaların yanı sıra enerji verimliliğini koruyan kurallar uygulamaktadır. Bu kuralları uygulamak gezegenimizin ve gelecek nesillerin daha sürdürülebilir bir yaşam sürdürebilmeleri için gereklilik göstermekle birlikte, onlara daha iyi yaşam koşulları için bir şans sağlayacaktır. Enerji standartları uygulamaları, İskandinav ülkelerinde başlamış, Alman teknolojileri ile gelişmiş ve tüm Avrupa ve Amerika'ya büyüyerek yayılmıştır. Bir çok ülke de iklim değişiklikleri ve kendi durumlarındaki diğer faktörlerden dolayı giderek artarak bu standartları uygulamaya başlamıştır.

Bina yapım aşamasında yasa ve standartlar, enerji kullanımı ve farklı enerji verimliliği standartlarının teknolojik avantajlar ve güncel bilgiler sayesinde yenilenmesiyle bu bilgilere ışığında değişmeye başladı. Her gün yeni enerji yasalarını uygulayan ülkeler çoğalmaktadır fakat bununla birlikte halen enerji verimliliği yasalarını uygulamayan ülkeler bulunmaktadır. Kuzey Kıbrıs Türk Cumhuriyeti de bu ülkelerden biridir. Bu tez, yazarı bu konu üzerinde temel bilgileri hazırlamaya itmiş ve Kuzey Kıbrıs'ın geleceğinde kullanılabilir hazır bir standartlar kaynağı hazırlama isteği doğurmuştur.

Bu amaca ulaşabilmek için, inşaat aşamasında birçok enerji verimliliği yasası çalışılmış,incelenmiş ve kıyaslanmıştır. Birçok benzer standartlar bulunmuş ve detaylı olarak çalışılmıştır. Bu analizlerin sonuçları KKTC de uygulanabilecek en iyi enerji metodu için bir altyapı oluşturmuştur. Bu araştırmanın amacı, Kuzey Kıbrıs Türk Cumhuriyetinde şu anda içinde bulunulan durumu ortaya koymak ve inşaat aşamalarının farklı noktalarında bu yasaları uygulamak için eksik olan zeminleri saptamaktır. Bu süreç; tasarım aşaması, inşaat aşaması ve onay aşaması olarak üç aşamaya ayrılmıştır. Bu ayrımlar, tamamlanma aşamasına gelininceye kadar izlenen farklı yapım aşamalarındaki enerji kullanımını kontrol edebilmek amacıyla yapılmıştır. Enerji verimliliğini sağlayabilmek için, tasarım aşamasında sürdürülebilir enerji verimliliği göz önünde bulundurularak tasarım yapılması önemlidir. Bina inşasında ve son seviyede de enerji verimliliğinin başarısı incelenmelidir. Kuzey Kıbrıs konusunda net bir görüş ortaya koyabilmek için, her bölüm için en uygun yasalar önerilmiş ve yasalarla ilgili gerekli tüm bilgiler derlenmiştir.

Anahtar kelimeler: Enerji verimliliği, binalarda inşaat süreci, tasarım yasaları, kısıtlayıcı yasalar, enerji ölçümü ve sınıflandırma, standart gelişimi

I dedicate this thesis to my beloved family who have been always my support. It is their absolute love that motivates me to stand on my foot and set higher targets.

I hope that this achievement will although a small thank for my parents' effort all those years ago when they gave me the opportunity of the best education they could.

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Chapter 1

INTRODUCTION

Basic information about this study and explanation about how it is going to be concluded is a first step. The most important factor for each research is a necessity of doing any study to fill out the gaps in selected research areas. As a brief information, illustrating what is the problem to make the author interested in doing research to find the solution. The aim of the study will be cleared to show what the goal to reach is. The methodology of the thesis will be explained and limitation will be specified. Case study and reason of selecting it will be reviewed and steps of this study to reach the conclusion will be named.

1.1 Statement of Thesis Problem

Understanding the necessity of energy efficiency and how it is possible to implement standards around the world to have efficient buildings and save more energy is one of the most important criteria in sustainability. Discussion about energy efficiency regulations in buildings is coupled with construction and energy controlling. These sections could call design part, constructing part, controlling and labeling parts. In order to discover these sections it seems serious to explain the meaning of energy efficiency. As a straight definition “Percentage of total energy input to a machine or equipment that is consumed in useful work and not wasted as useless heat” (Business dictionary, 2013). Generally energy efficiency means have benefited as much as possible from any kinds of energy that has been used to having needs done. Energy efficiency contains different parts such as, Building, Industry, Vehicles, Alternative fuels and so on.

Buildings and lives there considers the most important portion of energy efficiency factors; insomuch providing a comfortable environment for people who lives or work there is costing lots of energy. It is important to use required energy efficiently. “Architecture and building offer the greatest potential for a sustainable shaping of the environment” (Hegger, Fuchs, Stark, & Zeumer, 2008). Energy efficiency in buildings includes different codes according to climate, constructing methods and way of measuring and building energy loss controlling; but this fact that the appropriate background in installing standards in different areas is inconspicuous.

Despite of globalization energy efficiency standards for all parts of building construction; still there are some countries that having been deprived of these standards; such as Cyprus Island. The problem with this study is the lack of knowledge about the necessity of regulation trough, energy efficiency, and the lack of background for installing any standard and shortage of update technology. The main question core the current study has been: what is ‘How we can generate energy efficiency process in Northern Cyprus’? Whether which factors are required and important for regulating energy efficiency regulations? What are the effects of regulating standards for future life?

1.2 Aim of Study

This study has three main aims:

1. Cumulating energy efficiency process in building around the world and finding how they are using these standards to make their building more efficient and checking how these processes are developed.
2. Checking different sections from design part, construction period and utilization in building and how supervisors in each part should follow and control everything through the energy efficiency regulations.
3. Provide basic information for regulating suitable energy efficiency for Turkish Republic of Northern Cyprus in future and further studies linked to this topic.

The aim is to find out the necessary factors that should be considered to regulate the energy efficiency standard for Northern Cyprus, check what have been done and which other kinds of infrastructures are needed to implement energy saving codes in this area. These codes will be separated and analyze through all sections of building construction (design, constructing period and controlling).

1.3 Methodology

Author used delve available information in order to find energy efficiency regulations around the world as the first method. The second method is compared and analyze related standards trough different factors. Third is to show the matter of having regulations in all part of building construction, from design till, the end requisiteness of controlling in all parts. The fourth is to deliberation the existing situation of saving energy within the case, at least explore the needed base and create primary information to regulate energy efficiency for Northern Cyprus.

As the finding the best way and find out the needed base for regulating energy efficiency standards for Northern Cyprus as this research aims; discussion about previous related activities and climate will be considered. Data collection of this research includes nine parts, the history of energy efficiency regulations in residential buildings, developing process and necessity factors, checking the methods and labeling, how to measure energy efficiency, and at last how to control it.

The data has been collected through books, articles and internet searching. In order to illustrate the meaning and importance of energy efficiency regulations now days and also the effect of implementation of these codes in the future of our planet; the objective is to consider the current situation beside the climate changing. The framework of this research methodology is to illustrate the result of comparing and analyzing different energy efficiency processes in buildings to find the most suitable way to Progress towards a green building.

At the beginning of the field work, essential information about: the history of energy efficiency, types of energy standards, important factors, the way of developing energy codes, differences between sections in order to controlling energy loss in the building, measuring methods, contradistinction that the building work efficiently or not. Therefore some of these issues will be evaluated with qualitative methods like methods used for regulations, and some of them will be evaluated quantitative measurement like the amount of heat loss. Consequently in energy efficiency context it is difficult to achieve a flawless conclusion. Furthermore, it looks quantitative measurement is the initial and the base for the qualitative method.

1.3.1 Case Study

This study case is located in the Mediterranean Sea, Cyprus Island. The case of this research is the northern part (Turkish part) of this Island which is known as the Turkish Republic of Northern Cyprus. The case carefully chosen based on certain criteria such as being without any process regulations through the energy efficiency factors and modification buildings in order to avoid waste of energy in residential buildings. On the other hand, having a database for regulation energy efficiency regulations in the future.

1.3.2 Thesis Limitation

Insomuch there is the limitation of time for this study and reach the goal of research, the author selected residential buildings as the focus. In the standings on the indicators, the main focus of this study will be on energy efficiency standards for triple stages of building construction process (design, construction, and controlling finished building). Historical buildings should regulate energy efficiency standards separate and buildings which are not in an acceptable situation for repairing are not considered in this research. The research is an intention to discover general information about energy efficiency in all building sections for Northern Cyprus, not to manufacture the exact standard for this area. This study is action for irradiate the beginning of the way for having clear and efficient regulation for TRNC.

1.4 The Research Design

The research will distribute into four basic sections:

1. Describing the aims of the research, define the main research questions and clear the focus.
2. Data context and information related to the topic.
3. Compare and analyze data and find out the result.

4. Discusses the works review within the case to achieve the conclusion.

This research explains the purposes, questions and previous related research according to the topic. The other step is studying Northern Cyprus as a case on the headquarters of basic information main criteria. Lastly, the author will try to summarize the main concepts of this thesis and answer to the research questions in the conclusion part.

The necessity of having energy efficiency regulation for countries which doesn't have their codes is clear. In the next chapter history of energy efficiency and different standards around the world will be discussed to prepare needed information for analysis and comparison to find the most suitable method for TRNC as a basic data for regulation codes to have energy efficient buildings.

Chapter 2

THEORETICAL BACKGROUND

In this chapter other researches related to this topic will be argued, then there will be exposure information about energy efficiency and how countries became more efficient or which kinds of method they used to reach this unavoidably target. Explanation will be given trough the energy efficiency regulations. Related regulations selected from a different part of construction in the world continents and countries to find out which kinds of method has been used and see how they are working. To understand better about different regulation around the planet earth, they have been divided trough continents In-between there will be a specific explanation about some standards, which seems more related to this research topic. Also, underneath of each part there will be a subdivision connected to all three parts of construction (the design part, construction period and approval).

2.1 History of Energy Efficiency

At the beginning, it is better to have brief information about energy and different kinds of it. Energy is a basic quantity in our world and energy cannot be created or destroyed, only converted. Simply ability to do work is call energy. “Only four forms of energy satisfy all our daily needs:

1. Biochemical (carbohydrates, proteins in food)
2. Heat (wood, natural gas) for hot water, buildings and industry
3. Electricity (light, appliances, refrigeration, heat)
4. Kinetic (transportation of people and goods)” (Ziagos & Wedel, 2007).

When human find out how to taping to the energy very deep in the earth and found fossil energy. By understanding the way of using this pure energy from the pocket of sun, human invented and built so many different things; without knowing the negative effects about this new source of energy, what will happen to the planet and what will be the outcomes. After a while effects of these fusil powers on the environment; made harmful damages to the planet earth that cannot be fixed. According to the result of using these kinds of energy that is the main reason of changing the face of the earth less than sixty years, humans started to think that they cannot use this power forever and it is not infinite (Arthus-Bertrabd, 2009). Another reason was the oil crisis in the world and fear of the un-sustainable price of fossil fuels. “The market value of U.S. corporations was nearly halved following the oil crisis of October 1973. Real energy prices more than doubled by the end of the decade, increasing energy costs and spurring innovation in energy-saving technologies by corporations” (Alpanda & Alva, 2008). Then the human started to use another source of energies along fossil energy and also tried to use energy efficiently.

The worst effect of this indiscriminate use is global warming. As a first step, scientists started to think about new sources of energy. “Unlike fossil fuels such as coal and oil, renewable energy will never run out. It is abundant in the environment, and can come from the sun, wind, running water, waves, and biomass; but the absolute value of all renewable energy sources is that we can use them, and then use them again. Another important advantage is that they don't emit greenhouse gases or atmospheric pollutants. So if we use more renewable energy, we can clean up our environment and help ourselves” (Electrical and Mechanical Services Department, 2013). That will be easier to obtain beside Can reduce the damage to nature. Human creative mid found out how to use renewable energy that was available everywhere and they were clean energies. Experts are mounting progressively critical alarm around climate change, regulators are casting about any ways to chap emissions, and the requisite for renewable energy is becoming very important (Mallon, 2006).

The second step was lead progress of technology around using more of renewable energy hand use all energy sources more efficiently. With daresay of developing clean technology may let both weather fiction and economic extension. The supposed access of upcoming technologies is a powerful driver of confirmation costs in utmost climate change samples (Brown & Chandler, 2008). Therefor way of using technology will have an important role to sustain being more efficient and being an influential factor for reducing the negative effects on nature.

As the third step in human thought about ‘how it is possible to have the most benefit from any kinds of energy that have been used?’ and the answers were collected under the energy efficiency title. Using energy efficiently became one of the most important subjects through all industrial areas. Faster and faster some standards appeared in each part of industry body for all scales. In-between architecture and direct relation to the peoples’ lives and comfort became very important. As Michael A. Weber says: “When you think of the global warming, what is the main contributing factor that comes to mind? If you are like most people, you probably thought of cars and transportation. But that is actually not correct. Energy use in buildings is in fact the worst offender when it comes to greenhouse gas emissions and contributing to climate change” (Weber, 2009). Lack of being efficient it was felt, therefor regulating energy efficiency via buildings has been started.

2.2 Literature Review

There are many researches' through the energy efficiency process regulations for all different parts of the construction process to find out gaps in these standards to fill them with the correct answers to have more efficient buildings and codes. Many researchers and institutes are working day and night on this subject to keep their knowledge up-to-date. In this field of study mostly calculation methods, which factors have been used and comparison between different regulations had studied.

As a calculation method, there are some programs and methods for understanding how much energy is needed for producing heat and electricity in any place. Also, it is possible to find out from which kind of energy source, we may have the maximum benefit. On the other hand, software will be helpful for calculating how much natural energy we are gaining (mostly from sun radiation and rain water). According to climatic information how much isolation is needed and using any method how much stop energy loose in our building. Simply by using computers and intelligent software and calculators there will be enough knowledge for understanding the best way to build our building anywhere on the planet earth. Also there are many suggestions for the clients with paying more money at the beginning and installing replacement in their building, there will be much more energy saving and their starting expenses will be covered very soon.

As an example Boon Edam Company that they focused on entrances. They say thermal insulation is necessary for building entrance to hold the indoor comfortable temperature. Mostly losing energy happens though building openings are between 20 to 50 percent. Boon Edam's software makes the possibility to provide measured knowledge according to comfortable temperatures and energy efficiency through the building's entrances. This software compares the usual door types with rolling model and as a data it works with the building model to show the amount of energy loss for each model and represent how much energy will be saved. Computing is based on the most absolute building criteria. For examination real climate information is used for the status of outdoor weather. Calculating kilowatt per hour per month is the method of showing the result beside the approximate time for payback if this method has been used (Boon Edam, 2013).

Or as another example, BuildDesk software has been designed for designers and energy appraisers. For calculating building energy efficiency in design part according to regulations and performance certificates this computer program will be helpful and disposal necessary data to whom is going to design the building for designing energy efficient building. Now it is possible to name some eventual that this software gives:

- Calculation of U-value professionally.
- Heat calculation for thermal mass and concentration analysis.
- Graphically designed for making this software easy to use to make a result building element analysis faster.
- Containing a wide database for material selection and constructions (BuildDesk, 2013).

Another model is an online construction R-Value calculator for a large number of common wall and roof, give a determined level of insulation. It makes having the benefit of the isothermal design method for thermal bridging (EERE, 2013). There are many other calculators like "energy stars group" that shared their methods online for getting results from different factors such as:

- “Commercial Kitchen Equipment Savings Calculator
- Appliance Savings Calculator
- Air Conditioning, Room – Savings Calculator
- Central Air Conditioning - Savings Calculator
- Dehumidifiers - Savings Calculator
- Air Source Heat Pump Savings Calculator
- Furnaces - Savings Calculator
- Compact Fluorescent Light Bulbs - Savings Calculator
- Exit Signs – Savings Calculator” (SBA, 2013).

To have maximum benefit from energy efficiency, it is important to know the role of each factor to prepare the energy and usage of it and the effect of factors to increase or decrease the speed of energy gain or lose. There are many factors like climate, energy sources, vernacular architecture in that area, construction technology, clients and peoples’ knowledge toward necessity and benefit from energy efficiency, for the usual design and built methods in specific places, rules and regulations to interest builders and owners to follow energy standards, and so on. It is possible to divide efficiency into two groups: high impact measures and capital measures. High impact measures are factors that have the most visible decrease in specified timing costs in the shortest period. Capital measures are typically taken much longer to generate a coming back on enterprises. Choices have to be prioritized according to what is best for the organizations instant budget.

Generally energy efficiency in the building is the best rise by attending to high impact measures first. The rate of money you save will fill over time. This reserve of excess income can be reinvested in wide measures that will gain fund by making the building itself able of conserving energy (Constellation, 2013).

One of the popular and useful methods to understand the weaknesses and to strengthen point in each field of study is a comparison. Due to this fact, many researches have been done with the help of this ideology to have a more clear result of analyzing energy efficiency regulations in different countries. Mostly in comparisons many factors of each standard will study and compare to another one like calculation methods, space heating requirements, climatic differences, the amount of renewable energy use, U-Value and R-Value method use, the effect of CO_2 emissions and etc. As a subset of these titles, the following options can be named that all together makes the possibility for the building to be more efficient in-order to energy usage:

- Building envelope
- Thermal bridges
- Openings and shadings
- Ventilation
- Internal loads
- Artificial lighting
- Heat distribution system
- Domestic hot water
- Energy supply system (Shearer & Anderson, 2008).

These comparisons might be in different parts of one country or between different countries' energy standards such as research has been done in Australia that shows how they have the result from 8 separated climatic condition it that area and after reach the average of these comparison results another comparison had studied between Australia energy efficiency result data with the similar possible situation in other countries to reach the conclusion. The aim of that research was to examine how their proposed 5-star energy codes and DTS prescriptions compare on a global level with related regulations, residential attributes, and provisions in similar climates. In pointing these targets, different Australian climate zones explained in the BCA have been matched to exteriority locations. In all locations, a specified standard house which encounter group country tantamount DTS provisions has been created and rated according to the final version of the AccuRate software of the find its heating and cooling charge provisions and get a comparable ‘star rating’ of efficiency. The results illustrated that, generally, the proposed 5-star Australian standard is not a difficult want, when compared commonly to housing proficiency rate being gained in comparative abroad places (Horne, et al., 2005).

Comparing for the cosmopolitan building performance evaluation order is they are continuing challenge. This assortment is intended to scoop the comprehension of how performance appraisal methodologies are built. Breaking the methodological specifications of many systems provide them to be compared. BPAS (Building performance assessment systems) in various countries are unique. Comparing building labels is sometimes possible, but it is feasible to compare their highlighted systems based on the order of giving basic ingredients. An analysis of these specifications proves that none of the studied evaluation methods are the same. Some clear tendency appears: calculated of total energy; heating, cooling, and hot water heating; measured grade seldom considers residential buildings. However, this assortment rating often thought to be equipollent and illustrate the variety of systems. Such as:

- Some calculated ratings consist process loads and some others do not;
- Many ratings recognize the main energy;
- Total performances have been used for calculating ratings;
- No consensus on how the area is measured, even similar rating types, is obvious.

Analysis out the single characteristics of each method gain transparency in energy performance evaluation. For the real estate craft, the cost of greener, more energy-efficient wealth is easier to verify with a comprehension of how these methods are quantified. While this assortment does not allow building-to-building comparisons, provide the actual estate association to peek behind the screen of energy performance, and make specification about what is significant to them. For regulators and researchers, the relative achievement of building energy efficiency standards appertains partly on how evaluation methods are designed. This framework assessment by making clear what obligation and aim underlie existing methods. It is uncertain how rating methodology structure, affects the achievement of building energy performance. Prevalent, exact, and code-accepted energy labels are absolute indicators; but a first step to energy standard comparison is expressing the same language, comparative evaluation, and develop a comprehension toward underlying obligation and precedence (Leipziger, 2013).

2.3 Energy Efficiency in Building

Buildings as an element that play the most important role in human life placed at the top of focus for energy efficiency and became more important that other usages of energy in people' daily life. To have efficient buildings even for a living (House), or working (office, factory and any other kind of indoor working areas) buildings it is important to calculating energy needs and use of energy from the very beginning. Thinking about energy and consider it as an important part of human life starts from designing part of building construction. It is a first step to design our building efficiently, but it is not enough to just rely for this section. It is more important to install energy thought on the design part of the real building construction. For following the correct way of having efficient architecture, it is important to have construction standards also. The accuracy of these codes is examined at different times of all constricting periods. To ensure for each proper product it is needed to approve the building according to energy loss after finishing construction. This will be the last step of dwelling energy checking and regulations.

Efficient efficiency (simply energy use) is the purpose of decreasing the need of energy value for output and providing services. As an instance, for using the minor amount of energy for heating or cooling indoor spaces (to sustain the comfortable temperature) building insulating will be a solution. The level of illumination (lighting) is another common energy usage factor in buildings. The way to solve this need starts in a design sector, if controlling of the amount of natural light consider at the beginning of design apart from the help of indoor illumination, also will be helpful for controlling temperature. Set fluorescent and LED lighting at night or time duration that we need more lighting instead of other kinds of illustrations will cause less energy and more convenience.

"Those involved in constructing and specifying buildings are today faced with the challenge of anticipating and designing for uncertain, perhaps rapidly changing, climatic conditions" (Chappells & Shove, 2007). As far as knowing the matter of being efficient trough the energy in the building scientist started to think about standardization building regulation. "The first real insulation requirements for U-values, R-values and specific insulation materials or multi-glazing, date back to the late 1950s and the early 1960s in Scandinavian countries. These national requirements were intended to improve energy efficiency and comfort in buildings" (Laustsen, 2008). Sweden was of the very first countries in the world that started to think about being sustainable before other countries and after a while Germany became a precursor in this field.

Then other countries started to regulate energy codes for their countries. Faster and faster most of developed countries had some standards related to building energy consumption; but something more was needed. These regulations were not complete and it was a feeling of lack of many factors. With the passage of time due to the circumstances of each region these standards started to change according many factors. However, lodging from the feck of the macrocosm's buildings, inherited skills, diverse surroundings, family structures, economies, technologies, and order of faith and symbolism, with many other factors, to chip in to the broad diversity of constructing shapes of different cultures (Oliver, 2006). Climate condition is the most important factor to consider, and according to climate changes with many other factors caused standards correction. Another important issue to think was the current and historical building that people live there or attract visitors. It is correct that existing buildings possess a huge value of energy (Giuliano, 2009). There should be a solution to put these buildings under energy efficiency title. This subject opened a new chapter with energy usage and loss in energy efficiency topic.

There are many simulations for re-claiming energy efficiency. If energy saving may cause extra costs; but there will be more benefit at the end like detracting energy use, costs and may outcome in a pecuniary cost saving. To more attentive and impartial review according to performance quality and measuring the successes of energy programs all over the world to give advices for improving the process, some agencies started to be formatted. The beginning of these gatherings was in America and then most of these agencies by increasing their activity outside the geographic boundaries started to become International. One of these agencies that has many followers and work powerful in this area is IEA. Ameliorated energy efficiency in buildings, industrial and transportation is the main aim of the IEA (International Energy Agency).

2.3.1 International Energy Agency

This agency (IEA) is an independent structure. Avouch trustworthy, clean and affordable energy is IEA duty. The IEA's primary duty was to help the nation attune a plural reactance relying in answer to the oil crisis. Main disorders in oil usage through the emancipation of emergence oil shares in the marketplace. At the center of global discussion is surrounded by energy, providing valid and disinterested study, the census, analysis and theory. Now on, the "IEA's focus is:

- Energy security: Promoting diversity, efficiency and flexibility within all energy sectors;
- Economic development: Ensuring the stable supply of energy to IEA member countries and promoting free markets to foster economic growth and eliminate energy poverty;
- Environmental awareness: Enhancing international knowledge of options for tackling climate change; and
- Engagement worldwide: Working closely with non-member countries, especially major producers and consumers, to find solutions to shared energy and environmental concerns" (IEA, 2013).

As a History of International Energy Agency; The IEA was based in answer to the April 1973 oil crisis to help states to co-ordinate through the escape of oil stocks.

IEA goals were:

- "To maintain and improve systems for coping with oil supply disruptions;
- To promote rational energy policies in a global context through co-operative relations with non-member countries, industry and international organizations;
- To operate a permanent information system on the international oil market;
- To improve the world's energy supply and demand structure by developing alternative energy sources and increasing the efficiency of energy use;
- To promote international collaboration on energy technology; and
- To assist in the integration of environmental and energy policies" (IEA, 2013).

Member Countries of International Energy Agency are wrought of 28 countries.

Each State before becoming a member, a volunteer country should illustrate:

- "As a net oil importer, reserves of crude oil and/or product equivalent to 90 days of the prior year's average net oil imports to which the government (even if it does not own those stocks directly) has immediate access should the Co-ordinated Emergency Response Measures (CERM) – which provide a rapid and flexible system of response to actual or imminent oil supply disruptions – be activated;
- A demand restraint programmer for reducing national oil consumption by up to 10%;
- Legislation and organization necessary to operate, on a national basis, the CERM; and

- Legislation and measures in place to ensure that all oil companies operating under its jurisdiction report information as is necessary” (IEA, 2013).

Whether or not the possibility member may verify the method. Each country should be a member of OECD before becoming a candidate for IEA membership. It is needed to be in the OECD, but it is not enough and there are other factors that make any country IEA member. There are some examples that countries such as Chile, Estonia, Iceland, Israel, Mexico and Slovenia are succeeded to be member countries of the OECD, but they couldn’t get exception to be IEA members (IEA, 2013). In the “Table 1” it lists IEA member countries.

Table 1: International energy agency member countries (http://www.iea.org/countries/membercountries)

AUSTRALIA	FRANCE	LUXEMBOURG	SLOVAK REPUBLIC
AUSTRIA	GERMANY	NETHERLAND	SPAIN
BELGIUM	GREECE	NEW ZEALAND	SWEDEN
CANADA	HUNGARY	NORWAY	SWITZERLAND
CZECH REPUBLIC	IRELAND	POLAND	TURKEY
DENMARK	ITALY	PORTUGAL	UNITED KINGDOM
FINLAND	JAPAN	REPUBLIC OF KOREA	UNITED STATE

2.3.2 Organization for Economic Co-operation and Development

The OECD (Organization for Economic Co-operation and Development) considers meliorate the financial and social well-being of human as their duty according to cultivate regulations. This organization acts as a forum for sharing a member's knowledge and upgraded skills and for finding solutions to solve common problems. This forum and its members are trying to set global codes on all related and common problems on the planet in a large wide field that includes from agriculture to the security of chemicals. Daily way of ordinary people' life is really important factor. They will get the most effect from any regulations, then it became OECD matters. For changing ordinary person's life better it seems it is needed and recommended to draw all issues based on reality and life experience. The OECD also works as the Trade Union Advisory Committee and have energetic relations with Ruther civil society organizations as well (OECD, 2013).

In the OECD countries there are some of them which they are organization countries and guiding this group. In "Table 2" it is possible to find a list of these countries and also when each of these countries joined the OECD. There is some rule and Attribute that create the possibility for each country to join this organization. OECD and way of being membership are another topic that it may find easily on the internet.

Table 2: OECD country members with the date of entering.
(http://www.iea.org/countries/membercountries)

Country	Date	Country	Date
AUSTRALIA	7 June 1971	JAPAN	28 April 1964
AUSTRIA	29 September 1961	KOREA	12 December 1996
BELGIUM	13 September 1961	LUXEMBOURG	7 December 1961
CANADA	10 April 1961	MEXICO	18 May 1994
CHILE	7 May 1961	NETHERLANDS	13 November 1961
CZECH REPUBLIC	21 December 2010	NEW ZEALAND	29 May 1973
DENMARK	30 May 1961	NORWAY	4 July 1961
ESTONIA	28 January 1969	POLAND	22 November 1996
FINLAND	7 August 1961	PORTUGAL	4 August 1961
FRANCE	27 September 1961	SLOVAK REPUBLIC	14 December 2000
GERMANY	27 September 1961	SLOVENIA	21 July 2010
GREECE	7 may 1969	SPAIN	3 August 1961
HUNGARY	5 June 1961	SWEDEN	28 September 1961
ICELAND	17 August 1961	SWITZERLAND	28 September 1961
ISRAEL	7 September 2010	TURKEY	2 August1961
ITALY	29 March 1962	UNITED KINGDOM	2 May 1961
		UNITED STATE	12 April 1961

2.3.3 Effective Factors for Energy Efficiency Regulation

A building's place and environment have the role as a key in regulating the temperature and illumination. As a specimen, vegetation, landscaping, and raises may cause shade and direct wind. In cold climates, in designing for the northern part of the earth building with the opposite side facing openings (south direction openings) and for the other part of the earth building with north facing openings gain the value of sunshine arrive to the building. Narrow home design containing windows, sealed doors, and installation heat insulation to different parts of the building like: walls, the basement, and foundations provide the chance between 25 to 50 percent to cut the loosing heat energy (EESI, 2006).

Light collared roof gain around 39 C° less than dark and black covered roofs that means darker one will be heated more and also, pass some of heat to the indoor area and have effect to thermal comfort of the indoor area in the building. US Studies researches gave analyzed selected building result that the dark colored roof covering in the building use 40 percent more energy for cooling compared with the light colored roofs. White roofs keep more energy in hot climates. Electronic cooling and heating systems may manage jut to improve the comfort of users inside (EESI, 2006).

Appropriate placement of openings and natural lights as well as using architectural ones that can decrease the requirement for artificial lighting (EESI, 2006). Fluorescent and LED lighting use 2/3 less power than light bulbs or usual lighting methods. Modern fluorescents output natural light, and in nearly all usages they cost impressive, contrary to their higher primary cost, by payback time low as few months (Green Energy Efficient Homes, 2013).

Technology growth also gives energy efficiency followers good opportunities to cut the use of energy in buildings. Most in public or companies' designers find out PIRs method (utilization of low charge Passive Infra Reds) will be a good solution for controlling lighting when places are tenants such as, toilets, corridors, or even office areas. Moreover, usage of daylight levels might be monitored and linked to the building's lighting program to turn on or off artificial lights inside or outside the building. Building Management Systems (BMS) is a program which has been designed to collect all information in one based computer and access have given to this intelligent computer.

This software has allowed to control all electrical elements in the whole building to have more efficient building electricity usage (Bachelor Electrical, 2008). It is important to install space cooling and heating methods in houses to control energy usage and be more efficient. Even, it is more energy efficient to use earth source heat pumps. The result will be, electrical pumps usually use 4 times more electrical usage than heat pumps for hand over a tantamount amount of heat. Another ground source heat benefit, might be: it is possible to use reversed process in hot seasons by carry over heat from the indoor to the ground and run to cool the air inside. The only matter to make the building owners to have the benefit of this system is their cost at the beginning, but this will recover within five to ten years.

Smart meters are slowly being accepted by the commercial part for indoor monitoring targets. The use of PQA (Power Quality Analyzers) system for usage specification may be stated into an available building, harmonic falsification, head, relief and discontinuity between others to ultimately help having more energy efficiency in the building (Eco Wizard, 2010).

A successful example of the subset of Building data modelling is Green Building XML which is focused on green building design. Green Building XML, is used as input for energy imagery motors; but modern computers and recent technology give a chance to have many built tools related to energy efficiency available on the market. Yezioro, Dong and Leite succeed to manufacture an artificial approach for building performance simulation reorganization outcome. In these researchers thought, the best performance by using electricity in terms of heating and cooling is using detailed simulation tools (Yezioro, Dong, & Leite, 2008).

To achieve large energy savings it is important to do energy retrofit as a building analysis completely and also construction than formal retrofits. It is possible to have energy retrofits for all kinds of building as residential or non-residential. Applying results. Will have around 30-percent energy saving more (Fuerst & McAllister, 2009).

2.3.4 Energy Regulations around the World

There are some methods that they have been used to regulate energy policies and playing important roles in energy efficiency that some of the popular and important ones will be explained shortly in this part.

For indoor environment comfortable for humans, it is necessary to use technological instrument for heating, ventilation, and air conditioning that is named as HVAC method. Based on the ideology of HVAC method are:

- Thermodynamics
- Fluid mechanics
- Heat transfer.

These are main suborder of HVAC method but sometimes refrigeration is considered as a part of this method that change the summarization to HVAC&R or HVACR. HVAC in high-rise buildings, office buildings, industrial, and many other public functional buildings specially consider as a principal in the design to have fresh outdoor air along building temperature and humidity controlling man air conditioning systems.

The HVAC method invented trough factors such as:

- Industrial revolt
- Energy efficiency,
- System control.

Three heating, ventilating, and air-conditioning core subordinate are:

- Providing acceptable indoor air quality and thermal comfort.
- Maintenance costs.
- Operation (Zuha & Rock, 2002).

Administrative approximation for cooling and heating in the building pointing on indoor conditions and outdoor climate.

HVAC methods became an important factor in the modern construction process in modern building constructions. It is starting at the beginning in the design section. In this part designers and engineers decide to use one or more HVAC methods for the building depends on project scale. The second part starts after design finished, that means in construction period used method factors will be installed in the building. At the end after the project finished HVAC installations will be checked. For small projects or needed equipment's will be used, but in large dwelling all involved teams (architect, electric, and mechanic engineers) will consider, analyze, and design HVAC system and equipment for the project.

HVAC is applied in single buildings, the equipment captive is in some cases a deployment of a larger district heating or cooling network. In such cases, the maintenance features are simplified and measuring is important, and in several energy cases that is regurgitate to the larger system (Rezaie & Rosen, 2012).

In the large network HVAC basing on an economy that is impossible for individual dwelling, for renewable energy sources like solar radiation (Pauschinger, 2012), winter's cold, possibility for free cooling regard to cooling potentiaoneor some places buildings, ona more important chance to have thermal energy capacitor for all different seasons (Paksoy H., 2009).

The HVAC industry became global investment with a role in many buildings related factors such as:

- Operation and maintenance,
- System design and construction,
- Equipment manufacturing and sales,
- And in education and research.

HVAC industry and standards in international scale: ISO 16813:2006 is the type of the building standards (ISO, 2013), which establish environment design platform. ISO standard is regulated that designed to cover many energy and a standardization wide group of issues to be healthy with the perspective to protect many things such as:

- Provide a healthy indoor environment,
- Protect the environment for future generations,

- And promote collaboration.

All these factors working according to the various sector captive environmentally sustainable design. Also, “ISO16813 is applicable to new construction and the retrofit of existing buildings” (ISO, 2013).

The aims of tantalization of environment design are:

- Concerning sustainability in the design process from the very beginning stage.
- Controls factors such thermal comfort, HVAC system control, acoustical comfort, and indoor air quality at all stages of project;
- Evaluating of the design and discussion about the design process.

In USA countries: In the United States, generally engineers who following HVAC methods and working related are members of the American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE), Special to Chief Boilers License is an example of local engineer certified which has been issued by the state. ASHRAE is an international society for all organizations who consider HVAC as their interests. HVAC factors exchanges knowledge and having more benefit experiences is the Society result.

ASHRAE data is the most recognized HVAC design regulations. The most general ASHRAE Handbook is assets is heating and cooling calculations. Following ASHREA must council in professional design. Using UMC and IMC detailed code to reach HVAC standards for typical buildings is necessary requirements. However, SMACNA and ACCA codes are other useful materials references for project design.

International mechanical codes is the American design standards. In many places varies legislative process regulation might be adaptable. Publishing and updating codes are under International Association of Plumbing and Mechanical Officials (IAPMO) responsibility.

HVAC contractors and Air Duct companies in USA and Canada are members of NADCA (National Air Duct Cleaners Association). This organization has formed in 1989 as a non-profit association of HVAC companies. The aim of NADCA group is reaching first place in HVAC regulatory services.

To earn HVAC professionals' associates' degree you have opportunities to receive related training in the USA as a classroom courses and lectures or followed by an apprenticeship in a specific time period (HVAC Training, 2013). HVAC techs have certificates of training in different areas such as:

- "Air conditioning,
- Heat pumps,
- Gas heating,
- And commercial refrigeration" (NATE, 2013).

United Kingdom: in this land to allow the building to operate, insolation for building service engineers is needed. Which is cover the essential service. These insolation codes have been prepared in a chart for architectures and designers. Also in this chart some topics such as ventilating and air conditioning, heating, pumping industries, electro technical, and refrigeration are considered. Several guidance are carefully designed and publish according to HVAC methods for some countries like the United Kingdom, Australia, Ireland, Hong Kong, and New Zealand by CIBSE which include recommended standard prepared relative to UK building regulation. Some of the most important guides are:

- Energy Efficiency in Buildings
- Building Control Systems
- Heating, Ventilating, Air Conditioning and Refrigeration
- Transportation systems in Buildings
- Public Health Engineering
- Weather, Solar and IL luminance Data
- Sustainability
- Electricity in Buildings
- Maintenance Engineering and Management
- Reference Data
- Environmental Design
- Fire Safety Engineering

Some factors like electricity, heating, lighting, gas, and water supply are controlling in the construction section with maintenance and installation of services, designed by building service engineers which following their aim to making indoor spaces comfortable enough and healthy for whom is living or working there.

Asia: in Asia countries are following several methods or systems of HVAC. As an example the Philippine Society of Ventilating, Air Conditioning and Refrigerating Engineers (PSVARE) are using HVAC / MVAC standards in their country, or in India ISHRAE (Indian Society of Heating, Refrigerating and Air Conditioning Engineers) is promote HVAC in their own country that has been started in Delhi in 1981. These Indian codes have possibility to adapt to other Middle East countries as well.

Thermal resistance measuring is called R-value (Desjarlais, 2013) for building design and constructing industry usage. Thermal resistance per unit is The R-value discussion that has been used for any material for calculating the unit value. Following R-value will be helpful to say and calculating the division of thermal conductance according to the material thickness. Referring to McQuestion, Parker, and Spliter book which is published on 2005 example, “if you have the unit thermal resistance of a wall, divide it by the cross-sectional area of the depth of the wall to compute the thermal resistance. The unit thermal conductance of a material is denoted as C and is the reciprocal of the unit thermal resistance. This can also be called the unit surface conductance, commonly denoted” (McQuestion, Parker, & Spitler, 2005). To have a better insolation you have to reach higher numbers in calculation, also R-value is the reciprocal of U-value.

Internationally: mostly around the world these calculations are given in SI units in square-meter or Kelvins per Watt. For making simple to understand better how heat transfer from insulation to other space it may helpful to say it is somehow similar to electrical resistance. For calculating fixed insulation resistance it is needed to consider the temperature difference between two sides of the material which is depends on material thickness and type of material.

For different areas in the United States of America related to preparing comfortable indoor condition energy cost there is recommended R-values given by the department of energy according to the climatic situation of the place. Insulation types are divided into four for USA: rolls and batts, loose-fill, rigid foam, and foam-in-place (Energy.gov, 2013). Thermal resistance of insulation in the building is directly related to the thickness of insulation, which means to increase thermal resistance of insolation it is needed to increase the thickness of it.

For computer calculating heat loss for building walls, many factors are needed as a basic calculation data. Combining two different types of insulation in the wall may increase thermal bridge resistance of that specific wall but that does not mean R-Value will be doubled by this way. Another factor that is really important is considering openings in the buildings are not affected by R-Value calculation.

Insulation calculation through R-Value is measured by test condition related to ability of insulation type to reduce heat flow. Using calculated R-Value methods related to the specific area and using correct insulation will effect on all three kinds of heat transfers. Heat transfer modes are:

- Conduction,
- Convection,
- And radiation (Desjarlais, 2013).

Scientists found ways for reducing heat transfer in the building through windows such as using double or triple glazing windows or calculation glass thickness or size of windows in the building which phrase as U-Factor. Totally, U-Factor is the way to ratio of heat transfer for buildings elements heat conduction under standardization condition to provide comfortable indoor condition. Comfortable condition of the human body is being in a place without wind with fifty percent of humidity in twenty four siliceous heats (P2000, 2013).

In multiple insulation layer calculation it is needed to add all insulations layers R-Value:

- "R-value (outside air film) + R-value (brick) + R-value (sheathing) + R-value (insulation) + R-value (plasterboard) + R-value (inside air film) = R-value (total).
- To account for other components in a wall such as framing, an area-weighted average R-value of the whole wall may be calculated" (Desjarlais, 2013).

There is limitation for R-Value calculation to evaluate radiant barriers. Radiant barriers are reacting week in front of heat these barriers are working as radiant reflectors or emission of radiation reducer. After analyzing R-value systems as a conclusion it is clear to use this method calculation and software is very important for the building insulation, but just using R-value is not enough and there should be combination of R-value and some other systems.

It's very complex to calculate radiant barrier performance. Designing correct radiant barrier in a right place, almost all heat will flow by convection. Radiant barrier singly is not enough and heat flow will be affected by many other factors. Radiant barriers will effect on the electromagnetic spectra reflection include UV light, which have the advantage of their emissivity for infra-red range (Parker, Sherwin, & Anello, 2001).

Thin film of moisture barrier is a need for flammability of thermal insulation test over materials when the second material layer is foam. Thread, tape, and fasteners are parts of such details. This test is working when inflammation source pouting next to insulation material and observe the material will fire or not. After this part depends on the insulation reaction to the heat, test will continue, for example if it caught fire the combustion source will remove to understand the material will continue burning or not (United States. Federal Aviation Administration, 2005).

Building elements (wall, roof, or floor) heat loss measuring called U-Value. It might refer to ‘overall heat transfer co-efficient’ for measuring how different parts of designed building will transfer heat. This means U-Value and building envelope thermal performance has inversely relating. With rising numbers of U-Value calculation number in the building envelope, thermal performance will be worse. Energy standards and carbon reduction codes are formed from U-Value, because of that U-Value calculation became very important. All outdoor building surfaces and parts have to follow thermal regulations to express the highest level of U-Value. For avoiding costly re-working after project finishing, it is better to consider the U - value calculation at the beginning of the design process.

Having knowledge about buildup of each building element is needed for building U-Value calculations. Sequence positioned of all materials have to place properly and also it is important to know the thickness of each material. Conductivity of building materials obtain is another important issue to measure each material's heat passage ability, which referred to as a K-Value. It is possible to find necessary information some publications, books, or guidance like ‘the New Metric Handbook and the Architects’ Pocket Guide’. Being reciprocal in definition of The U-Value for all building element’s material resistance. U-Value is calculated from a formula which shows in a “Figure 1”.

Thermal resistances (R) are a combination of the different structural, surface and air space components which make up an element of construction. Typically:

$$U = \frac{1}{R_{so} + R_1 + R_2 + R_a + R_3 + R_4 \text{ etc} \dots + R_{si}(m^2K/W)}$$

Where: R_{so} = Outside or external surface resistance.
R_1, R_2, etc. = Thermal resistance of structural components.
R_a = Air space resistance, eg. wall cavity.
R_{si} = Internal surface resistance.

The thermal resistance of a structural component (R_1, R_2, etc.) is calculated by dividing its thickness (L) by its thermal conductivity (λ), i.e.

$$R(m^2K/W) = \frac{L(m)}{\lambda(W/mK)}$$

Figure 1: U-Value calculation formula (Chadely & Greeno, 2010, p.468)

Nearly all U-Value calculations are undertaken, formal software like 'BRE's', or BuildDesk company packages. For input data it is needed to know the exact material plus the thickness of each building element and know the location of it in the project. For U-Value calculation usually for glazing types, fixed values are considering, which given by reference books (RIBA, 2013).

Generally separation between indoor and outdoor spaces in the building called the building envelope or the building enclosure. The building envelope acts as maintaining help for outer building cover for creating a better environment inside. This factor is used by architectures and engineers to control the indoor climate. The building envelope is covering separated parts:

- Support the mechanical loads
- Control the flow energy of all types

- Finished the human desires on indoor and outdoor spaces (Straube & Burnett, 2005).

The building envelope is applied for the building different function spaces to have control of air, vapor, heat and rain. For the rain control there are many ways and systems to protect the building from rain to have a barrier between inside and outdoor spaces and also drained rain water and store it (Straube & Burnett, Rain Control and Design Strategies, 1999). Air control is the main fact next to heat provision of indoor spaces. The aim is ventilating air inside the building or guide fresh air from outside in a way not to lose indoor heated or cooled spaces. The building envelope physical factors are starting from the foundation and see the connection to all other parts of the building such as walls, openings, roof, ceiling and floors. Connection and interaction between the building different elements should consider in building's details and specified trough materials and fabrication process. To reach the aims of the building envelope design which are quality of indoor air, energy efficiency, climate comfort, and durability the building must barred from air, vapor and heat, it is also needed to have a solid structure and drainage plan. It is important to cover the building from moisture but in cold and hot-humid climate it became more important. Here it is better to note the heat barrier in the building envelope is not same as insulation. In some situation they may act instead of each other but generally there are differences between them.

2.4 Evaluation Process of Energy Efficient Building

Following energy efficient way to be more sustainable in building sector had different part, which standards should apply to all of them. These parts act to complete each other for the aim of energy efficiency. There are different energy regulation for each section of building construction or repairing all over the world. Most countries are following their own codes or their continent or decided to apply international standards in their countries. There are few governments that they are not installing energy efficiency codes for their building construction or existing ones. to understand energy efficiency in building sections better, they had listed below.

- Building design section regulation,
- Building construction section regulation,
- Building approval section regulation,
- And existing and historical building energy regulation.

Generally for each part there will be summarized explanation, then important related regulations around the world will be explained, and finally to see in different parts which standards are more successful and prepare data for case analyzing, there will be short conclusion according to the information which collected for that partition. The result of these codes will prepare opportunity to have general knowledge about energy efficiency codes in all building construction process to find the most suitable way for a thesis selected case.

2.4.1 Energy Efficient Building in Design Process

Forty percent of total energy usage in the world is according to building energy use, which is affected by many factors such as way of lighting, appliances and building equipment, climate control and etc. in the energy consumption field for sustainable world contribution from energy efficiency. Hence energy efficiency standards became as an important factor for the country's construction for considering necessary applies in the building sector to use energy in a most efficient way to reduce the amount of energy use.

In all over the world countries regulated their energy codes related to their climate and land situation. In-between there are some regulations which designed more flexible for all governments to give them opportunity to adapt these codes to their place. In following part some of the successful codes will be analyzed and see how they are working for their situation to find out strength points of them for understanding energy efficiency standard better. For regulating any standards for new place it seems necessary to use other countries in a similar situation experiences instead of try them again and waste money and time.

Some regulations designed flexible, then there is chance for regulators to study the situation in their own countries and try to calculate and find the best way of energy code for their own. In all regulations some important points have been considered. The first step in all these standards is to find out the current climate condition and check climate change in that place. As a base for any regulations is considered the HVAC method and see how it is possible to have it in building section. Then calculating R-Value which relates to the buildings separating elements like wall, ceiling and floors and U-Value for understanding building material thermal Coefficient of resistance. In HVAC topic is around how creates a comfortable situation in the buildings and talk about equipment installation kinds and source of energy for those. In R-Value designers will have information about building insulation about where they have to use them, how much will be the thicknesses and which material is giving the best result for building condition. For U-Value it is important to check it for everywhere but in hot climates it becomes more important for building energy efficiency.

ISO is a kind of global scale standards which covers many topics including energy efficiency. Most of the European countries are following this kind of regulation for their buildings according to energy efficiency. Most of the standards in Asia also considered ISO codes as a base for their energy standards like BCA (Building and Construction Authority) ISO 14000 Certification Scheme for Singapore. ISO is shown codes in a different labels like ISO/TC 163 (Thermal performance built environment), ISO/TC 205(Building environment design), ISO/TC 163/WG (Energy performance of buildings using the holistic approach) and so on. ISO standard is easy use codes and fast way for energy regulator. Because of that this standard has become popular in the world and also this method is covering many other topics as well. These issues made ISO codes well known in a global scale (ISO, 2013).

Another international energy efficiency code is IECC (International Energy Conservation Code). This energy code series is updating yearly and useful for energy regulators. That means for countries is a good chance to keep their knowledge update even if they are not using this method. This standard focuses on building envelope and how to design it efficiency in international scale. On the other hand argue about the energy efficiency installation in the building. There are issues about the mechanical lighting power system to control the amount of electricity usage in unnecessary space mostly in office buildings or in basements and corridors. Reduce amount of fossil energy usage in all possible ways is the aim of the IECC. This method is covering almost all kinds of building. Related codes for this study is a part in IECC which called low-rise residential buildings. This part is talking about residential buildings under three floors. All regulations are compatible with International Code Council (ICC) publishes, that means International codes (I-Codes) in different parts.

- “International Building Code,
- International Existing Building Code,

- International Fire Code,
- International Fuel Gas Code,
- International Green Construction Code,
- International Mechanical Code,
- ICC Performance Code,
- International Plumbing Code,
- International Private Sewage Disposal Code,
- International Property Maintenance Code,
- International Residential Code,
- International Swimming Pool and Spa Code,
- International Wild land-Urban Interface Code,
- And International Zoning Code" (IECC, 2012).

After 1998 United State of America started to change the MEC method to follow IECC. The reason of this changing was instead of having regulations for each part of the large scale continent, with one general standard with the possibility of adaptation to other climate zone will be more reasonable "Figure 2". Because of this flexibility this regulation has been followed also from out of America.

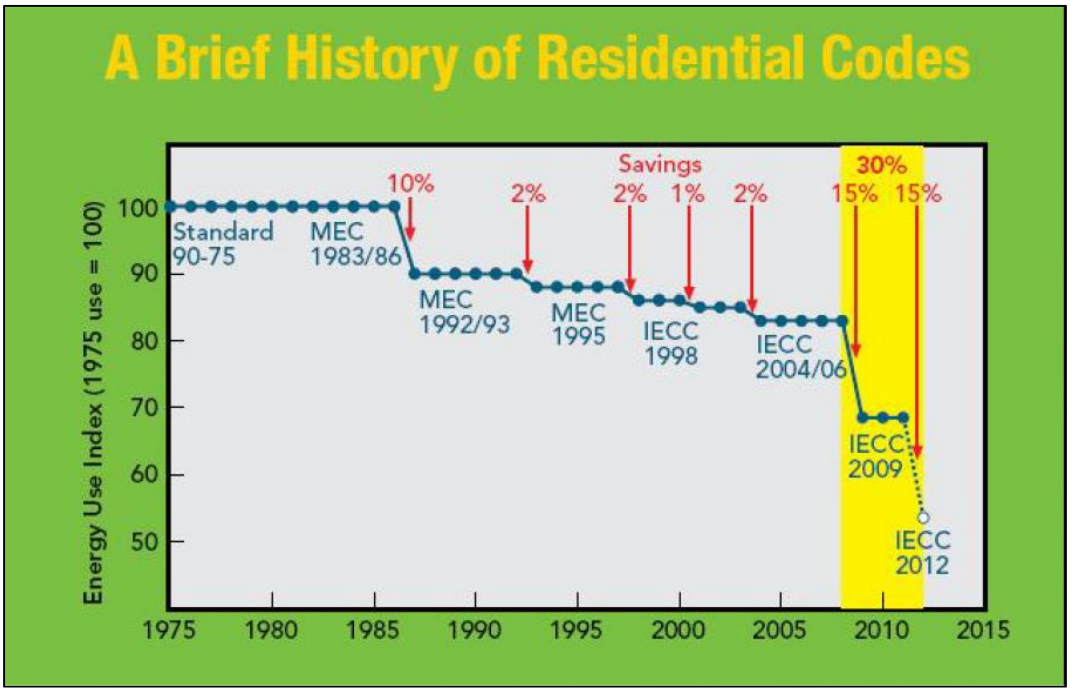

Figure 2: Brief history of residential codes in America.
(http://1.bp.blogspot.com/_1ihlem_-ym0/TVK2kwKp-oI/AAAAAAAAACM/O6mKquWzNtA/s1600/Jeremy%2527s-Blog2---DOE-History---Commercial-Building-Energy-Codes.gif)

In 2003 Australian energy efficiency standard has been regulated based on HIA (Housing Industry Association) till 2005 when government endorsed codes for 5-star residential buildings. In 2009, 6-star grading added to Australian standard. Soon energy codes in Australia (third country which started to have energy efficiency standards for their countries' buildings) became an important factor for house owners, buyers and renters. Reducing energy consumption and controlling amount of greenhouse gas in the atmosphere can be done by improving energy efficiency. Australia energy efficiency standards were named as Australian Building Codes Board (ABCB). Australia has been divided into different section according to climate conditions:

- “New south Wales,
- Australia capital territory,
- Victoria,

- Queensland,
- Western Australia,
- South Australia,
- Tasmania,
- And northern territory" (CCAA, 2011).

In each section of this country, base of energy efficiency regulation is same. Energy standard is evaluating building in six categories in all parts, but related to the climatic condition for each part, some factors are changed accordingly. National building regulation method of Australia has been provided by the building code of this country. Because of the size of this continent there are many countries in different climatic situations that they need their own energy efficiency regulations. Most of Asian countries started to walk in being efficient road later than European or American countries. In the following table there are some of countries in Asia and date of regulating their standards (Huang & Deringer, 2007). The most important regulation in Asia is China energy efficiency standard and Philippine. In China, areas are divided into three different climate zones and for each section they have published regulations. China has chosen the opposite way of America. Instead of regulating flexible regulation for the whole country, decided to have an exact standard due to each land section. In "Table 3" some Asian countries which have energy efficiency regulation has been shown.

Recently some other countries started to regulate energy efficiency for their own countries like Turkey, but they are at the beginning of being efficient road and just following ISO standard method and try to install it to their building which is not recommended. It is important to have regulation for exact condition in each country.

Table 3: Asian countries with energy efficiency regulation starting time. (Huang and Deringer, 2007)

China	Heating Zone in north China in 1986, and revised in 1995.
	Standard for tourist hotels in 1993.
	Hot-Summer Cold-Winter Region in central China in 2001.
	Hot-Summer Warm-Winter Region in south China in 2003.
	National energy efficient design standard for public buildings in 2007.
Hong Kong	Building energy standards started with the commissioning in 1990.
	Regulation was introduced in July 1995.
Taiwan	Energy standards for air-conditioned non-residential buildings in 1995.
	For residential buildings in 1997.
Japan	Energy Conservation Law was adopted in 1979.
	Last major revision in 1999.
Korea	Energy efficiency standard in 2004.
Malaysia	Start in the late 1980.
	First Version in 1986 and 1987.
	In 2001, the standard was revised.
	In 2006, the standard was revised.
Philippines	Sect oral Share of Energy Consumption in 1998.
	Sect oral Share of Carbon Emissions in 1998.
	Total energy consumption increased 6.9% from 2002 to 2003.
	Ten-year average increase of 4.7% from 2005 to 2014.
	Planning to reach 124.2 MMMT in 2014.
Singapore	Mandatory code in 1979.
	In 1989, a revision to the energy code was made.
	In 1999, three codes of practice for buildings were updated.
Thailand	First Version in the late 1980.
	First endorsed in 1995.
India	Integrated Energy Policy unveiled in 2006.

In Europe, Germany has a different energy regulation for itself which is called DENA. Energy efficiency in Germany focused on controlling the heat loss more than any other factors. Heat controlling is important in this country because about 85 percent of energy usage in private buildings is for heating spaces and water supply. Germany became harbinger in energy efficiency because of advanced technology and the way of usage of them. Using modern techniques in buildings refers to DENA standard may reduce the heat energy usage in the building about 20 percent. As the focused of Germany energy policy they are trying to cover all direct related and unrelated energy factors which will affect on building envelope and make the building more efficient. It is important to update information in this standard trough new technology development and should apply it to the market as well. Energy efficient building expect from building parts, there should be efficient energy use equipment which has been installed in the building to reduce energy consumption (DEAN, 2013). As a private non-profit organization registered in Germany as a DIN (German Institute for Standardization). DIN activity field covers are:

- “Industry,
- Associations,
- Public authorities,
- Commerce,
- Trades,
- And research organizations” (DIN, 2013).

Since 1917 this association is responsible of generating acknowledge for standards in Europe and also international scale. These information carried 90 percent of standards making base data.

As a conclusion for this par, energy efficiency regulation for each area is different than others. Even when there is somehow similar climate between two climates it is not enough to copy the regulation from one of them and apply it for the other contrary. Using flexible worldwide energy standards is helpful for the base information to regulate energy codes for any place but after compilation necessary primary data for energy policy it should be improved by other factors which are directly related to place climate condition, climate change and other building regulation in that area.

In cold and hot humid climate focused on moisture protection is more important that the other climate zones and generally in hot climates calculating U-Value factor is much serious that cold climate. At the beginning of the building design there should be chart of information about building material, orientation of the building and the building envelope. At the second step there should be insulated trough the sounded factors and the building site. Usage of different kinds of insulation is related to the space function and it is important to consider needed insulation in each space. For building openings, fixture of them and shading devises there are many systems which have to study for each building energy efficiency.

To be more efficient is not enough to just regulate codes in the building, rather there should be control on the market and have some standards thereto for the accessories energy consumption. Building regulation should be adaptable to the climate change and technology improvement. It not good to have fixed and straight energy standard because after a while regulator have to work on another regulation but with the flexible regulation according to the country situation with some changes or addition it is possible to follow on the energy efficiency road to reach sustainability easier.

Building energy efficiency standards are more useful when it is a method to the general building regulation in each country like structure, mechanical and electrical policies. That means energy standards should design after building regulation to cover all parts through energy factors. Simply by having energy efficiency regulation, it is not possible to reach sustainability goal or have maximum benefit from it.

For regulating update regulation DIN knowledge are used for most international and specified standards in the world. Following changes in researches made by this organization will be helpful to create better codes to be more sustainable.

2.4.2 Energy Efficient Building in Construction Process

After searching about energy efficiency regulation for the constructing section of the process, it became clear in most countries examine energy applies is combined with general constructing regulation like in Europe. Building standards for constructing new buildings and an extension to the existing buildings became worldwide since 1997. It means when building auditors go to the site for checking the progress of the project and accuracy of implementation detail in different timing, they have to check energy related factors also. They should check building envelope which covering wall thicknesses, insulation installation, foundation checking, roof isolation, building orientation, quality of opening fixture and so on.

Generally examining construction process divided into four different sections. At the beginning there is a complete information according to building information like where is the place of land, who is the owner, who is the designer, and which construction company is responsible to build it. As a second step drawing has to be checked to be sure they are prepared correctly according to the energy efficiency regulation in that country. For the third part during construction process, accuracy of constructing each part of the building should check in different timing of construction which starts from the foundation till finishing of roof top. At the end it is necessary to check finished building and also the addition parts of the building like HVAC systems, lightings or mechanical additions to prepare the basic information for approving the energy efficiency level of the building. In some policies all these parts are included but in some others one or two parts are checked. Mostly last part is examined, the reason is final product should be energy efficient which means all the other parts effect is clear in at the end but the gap in between is there is no possibility to check the thermal breaks and accuracy of insulation especially at the corners.

Few countries have specific parts in general regulation or separated standards for constructing process. In United Stade there are different approach according to the states. Florida is an example which has an exact checklist for construction part. In this regulation they have a template for auditor to control specifically energy efficiency factors during the building construction (the template example is attached to this research as an Appendix A). This information will prepare and check before construction starts and during the process, auditors will check according to the gathered information. Another regulation in United State called BEND in Oregon state which is covering all three parts of the construction process. This regulation start controlling everything from drawing cheching, continues to dwelling section and final controlling after building finished.

American Society for Testing and Materials (ASTM) is known as ASTM International around the world which have 150 countries followed with 12,000 standards that part of these standards are guidance for industry and governments (ASTM, 2013). This information is laboratory data which give the chance to construction standards regulators and examiners to have correct compared information to have the most useful building implementation during dwelling. Benefit of this method is knowledge about the way of testing the accuracy of constricting, but individually it is not a regulation for building makers.

As a conclusion for this part, most of energy efficiency parts of the buildings are checked during the general construction control around the world. Thus there are few exact regulation according to just energy efficiency in the construction section of the building process. Between construction regulation it seems in Germany pay more attention to check the energy efficiency factors in this section of building construction more than other parts of the world which somehow followed in European countries. Also following regulations about constructing section in a dwelling which is published in Florida will be useful. Having separate energy efficiency construction regulation as a check list divided by different constructing part will be more useful and recommended.

2.4.3 Energy Efficient Building in Approval Process

After the dwelling finished, the building should be test according to energy efficiency factors for getting approval and categorize building to different energy efficiency rating groups. These groups are known as labeling. Building label shows the information about building according to the amount of energy loss in the building and rate of building efficiency. Also, for labeling there are different methods which countries in the world are following them. Like an electrical appliance for electrical devices, building energy rating (BER) is an important issue for dwelling for each country who is following this method, which is labelled grade measuring is between A letter to G. In this label means highest rate of energy efficiency and on the other hand G is lowest grate. Ireland sustainable energy label evaluation covers energy use for:

- Space heating,
- Water heating,
- Ventilation,
- And lighting (SEAI, 2013).

BER calculation legislation might not to be same in all countries which using this system. This calculation is a flexible tool for helping to improve energy efficiency in buildings, but it is needs of the building owners for selling and also it is an important factor for buyers.

There are many countries which are using energy labeling for their buildings, and they are following different methods and label format which applies in their countries. In appendix “A” tables most of labeling methods around the planet is shown and grouped in different approval style with colors. Colors which group these labeling styles according to the calculation system and label style. Studying this table help reader to see which method is used more and make the comparison much clear. Firstly tables are divided according to the continents and then a sample of final label is placed under the country title. In some countries; especially in United State there are some certificates which are given to the buildings after special checking of energy usage for buildings which are in higher levels of energy efficiency than the general labeling standard.

The energy efficiency rating for housing in the United Kingdom is ‘National Home Energy Rating’ (NHER) method, which is working successfully for that land which is designed by National Energy Services (NES). Certifying scheme by using the NHER method for energy producing is listed in “Table 4”.

European Union countries are using the same labeling scheme to clear the product display for whom is going to buy or rent. In next “Figure 3” different parts of this method is shown and explaned.

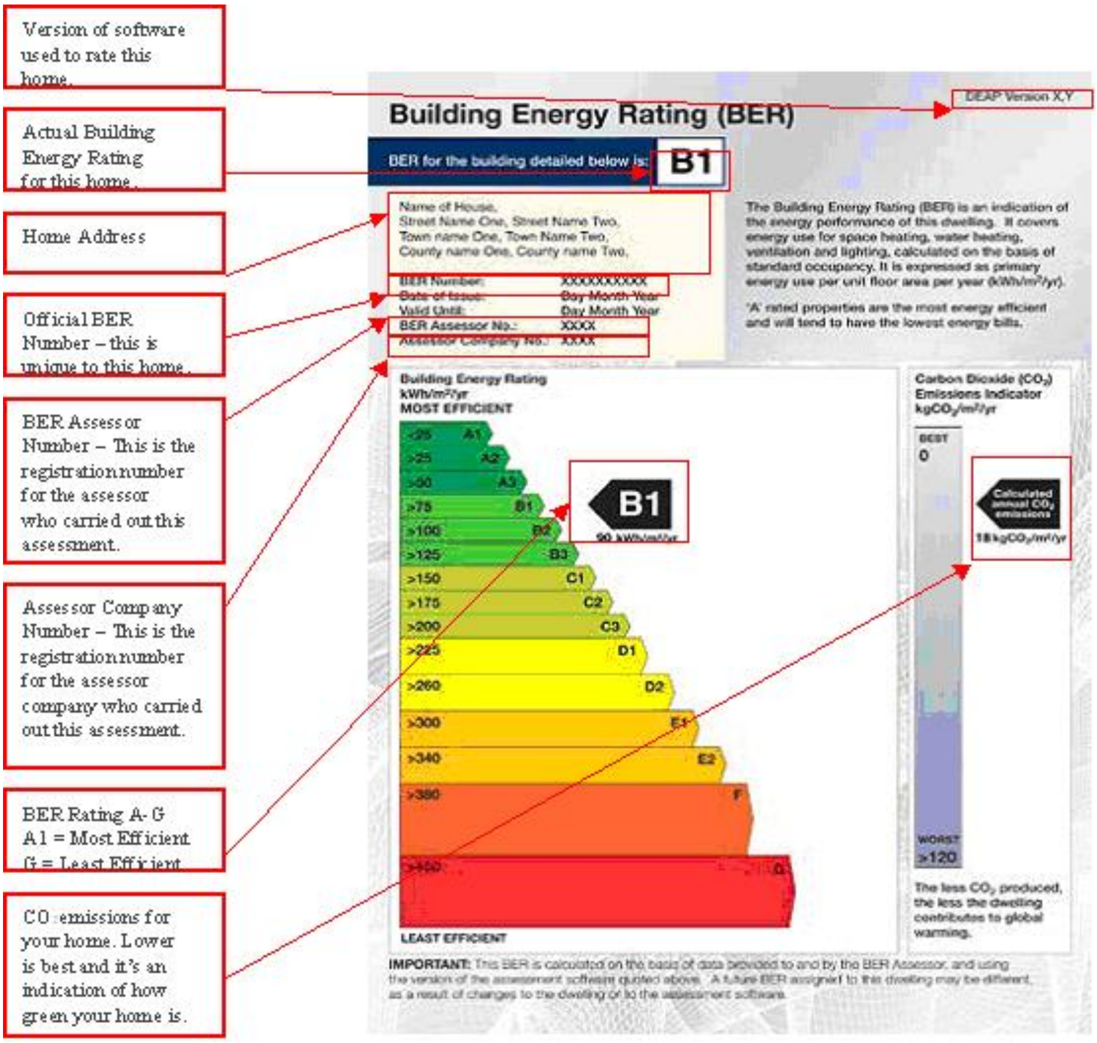

Figure 3: Building Energy Rating
(http://www.dublincity.ie/WaterWasteEnvironment/Sustainability/PublishingImages/ber.jpg)

Table 4: NHER certifying scheme.

Energy Performance Certificates for existing dwellings	using RDSAP
Reduced Data SAP. Survey system used to produce EPCs for existing homes (sphc, 2013).	
Energy Performance Certificates for new build dwellings	using SAP
SAP means; Standard Assessment Procedure to compare the energy and environmental performance of dwellings (standard-assessment-procedure, 2013).	
Energy Performance Certificates for non-domestic buildings dwellings	using SBEM
SBEM is a tool that supports the national calculation methodology for non-domestic buildings (bre, 2013).	
Display Energy Certificates for public buildings	using DECD
DCED is Pennsylvania Department of Community and Economic Development is a cabinet-level state agency in Pennsylvania.	

Measuring of dwelling energy efficiency is called Home Energy Rating (HER). It is possible to use this measuring for new dwelling and existing buildings. Having this label allow the owner of the building to have a report for energy efficiency upgrading needed for their own building Residential Energy Services Network (RESNET) in the US has a responsibility of publishing National Home Energy Rating regulations (RESNET, 2013).

Below there are necessary factors in the process of being certified:

- Training,
- Mentorship,
- And certification and professional Development.

Energy Efficiency of Natural Resources Canada (NRCan) is developed program in their own country which is called the EnerGuide. It is published to reduce greenhouse gas emissions in Canadian buildings in 2006. New house process steps for the EnerGuide are shown in the chart below.

Table 5: process steps for the Energuide.
(https://www.nrcan.gc.ca/energy/efficiency/industry/processes/systems-optimization/process-integration/approach/5505)

First	The EnerGuide for New Houses service starts with an analysis of the new house plans selected by the pending home owner by an EnerGuide for New Houses energy advisor.
Second	The advisor recommends energy-saving upgrades and works with the builder to develop a report that lists various cost-effective options.
Third	The builder then estimates the upgrade work and provides the client with a price.
Fourth	When construction is done, the EnerGuide advisor verifies the applied energy upgrades and performs a blower door test.
Fifth	After the data has been collected, the home receives its EnerGuide for New Houses rating.
Sixth	The home owner is provided an official label to display the rating on the home's furnace or electrical box.

The energy rating labels method is different in Australia and New Zealand for customers. This labeling allow customers to compare between similar buildings. This process started in New South Wales and Victoria in 1986 and after a while all Australia started to use the same method which is agreed by national labeling scheme in 1992. This agreement made Australia after Canada and US, third country who establish this kind of system (Harrington & Wilkenfeld, 1997).

At the beginning in Australian Building Codes (BCA) system all buildings were separated into 5 steps that shows with one star for each step. That means more stars are more energy efficient, but from 2002 another category was added to the Australian labeling method "Figure 4". 6-star building grade was given to buildings which consider efficient shower water, toilet flush water supply by collecting rainwater in a reserve tank, and using the solar heating system for hot water. Australian buildings mostly calculated by the House Energy Rating Software (HERS) such as NatHERS which have three different tools available for Australia energy evaluation for buildings.

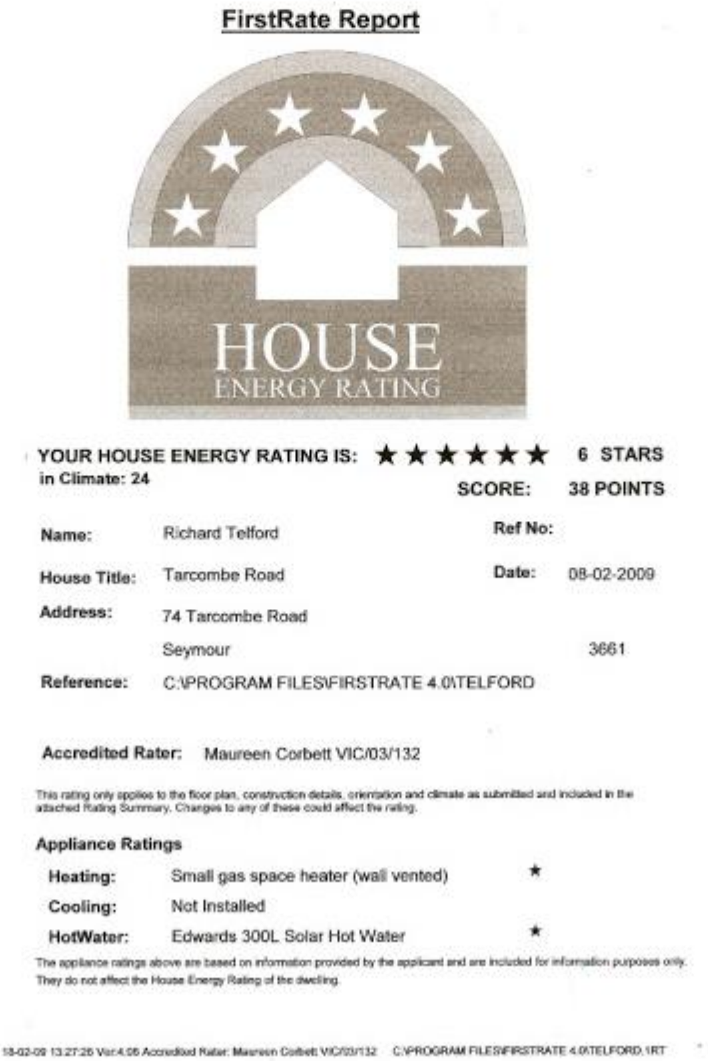

Figure 4: Australia 6-star energy label example (http://lh5.ggpht.com/_7VUbZQw-Pz4/SaiPS1CZ98I/AAAAAAAAAZc/70wrKms6Ckk/s576/House%20Energy%20Rating.jpg)

For evaluating energy efficiency after building construction there are many ways. In this research common forms of examining energy efficiency will be named and explained as a summary in following part. Generally for software calculation to give energy labels, design regulation will be considered. These design codes are acting as a basic data for program analyze according to the energy efficiency evaluation. There is a checklist for evaluators which help them to check all necessary factors in building to understand how efficient the building is.

Mostly for checking accuracy of building envelope installation after a construction period it is helpful to use infrared camera technology”Figure 5”. With this method it is possible to check heat insulation in-between the wall and also following how it continues to the corners, openings and connections between different parts of the building like wall and ceiling. The result of testing buildings with these kinds of cameras will be more acceptable in cold climate and give a chance to shoot the building and analyze heat loss. These cameras capturing heat from infrared light that is not visible to the human eye, which means intervals of infrared cameras is more than 450-750 nanometers which is the visible light range for normal cameras and human perception. Thermo graph cameras can detect till 14000 nanometer. Because of capturing heat in building infrared photos, in hot climate or after a very hot day the result might not be accurate. In thermal photography all heats above zero degree from all materials will be detected and convert heat factors to the thermo gram.

Figure 5: Infrared (thermo graphic) camera
(http://www.optimumstores.com/media/catalog/product/cache/39/image/700x700/17f82f742ffe127f42dca9de82fb58b1/images_new/flir/thermal_imagers/flir_t420bx/12102/flir-t420bx-building-thermal-imaging-ir-camera-320-x-240-resolution-60hz.jpg)

William Herschel was the one who discovered infrared as red light which had been used for measuring temperature (Herschel, 1800). At the beginning, usage of this new technology was for military issues and finding heat in the darkness. Infrared came to help wars and opened new ways of militate. In many new scientific developments, infrared has been used, but this time to keep people alive. In many parts of medical science and defense initiative, smart infrared sensors became helpful. After a while heat measuring cameras appeared and examiners found the way to use these cameras for measuring amount of unsold spaces for preparing a way to be more sustainable. With having the benefit of this technology it is possible to evaluate the building through energy efficiency result and find out missing or mistaken parts, and proceeding to solve problems. Using heat graph cameras gave chance to measuring existing or historical building which was impossible for energy scientists before as well. Heat photos "Figure 6"give basic information about heat insulation in the building but for having detailed information it is needed to use some other methods to finalize the analysis and give solutions to be more energy efficient.

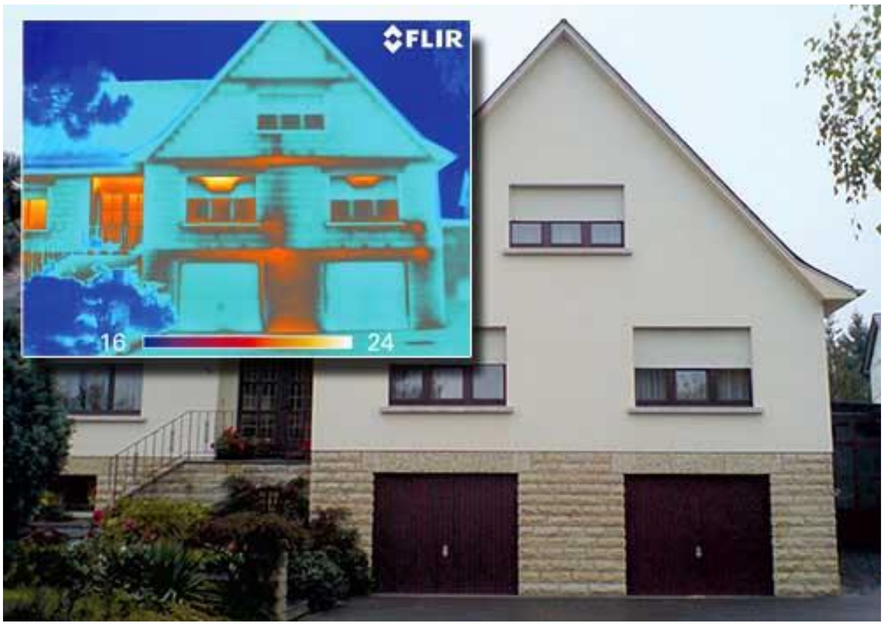

Figure 6: Thermo graph picture example (http://www.industrial-needs.com/technical-data/images/ir-camera-b-series-use-1.jpg)

For checking an older home, or the building which seems has a problem according to energy efficiency codes and understand the walls have correct insulation in them or not. Mostly heat loss happening through the wall bridges that makes walls insulations more important. After walls it is better to check other heat bridges in the building like a fixture of openings, floor and ceiling. To find out the type and thickness of insulation and also other material thickness and generally structure of the wall in the building, it should be checked by review of wall's layers and it happens when you reach different layers to test and measuring them. To have these information there are many ways that two most common ways and needed tolls will be explained in this part. Firs way is making holes in the wall to see the layers. For this method usually examiner uses drill to make the hole, to control the diameter of the hole nit to make it big to damage the building. After making the hole it is possible to check layers thicknesses and check the type of the insulation material. Another way to obtain needed information is trying to pull off some electrical switches and look into the gap there between junction and drywall. The problem with this method is related to the construction and covering inside the wall you may not see much often.

After finding wall layers, sample of insulation is needed that energy tester should pull off part of insulation to get the sample for tests. For doing this issue some tools like plastic made barbs are useful "Figure 7". Recently in an article written by Martin Holladay which is called 'Energy Upgrades for Beginners' shows different ways of doing this issue. In this article wooden barbs or chopstick is recommended because there might be electric wires passed through the selected part of the wall and this material will make your sample collecting safer.

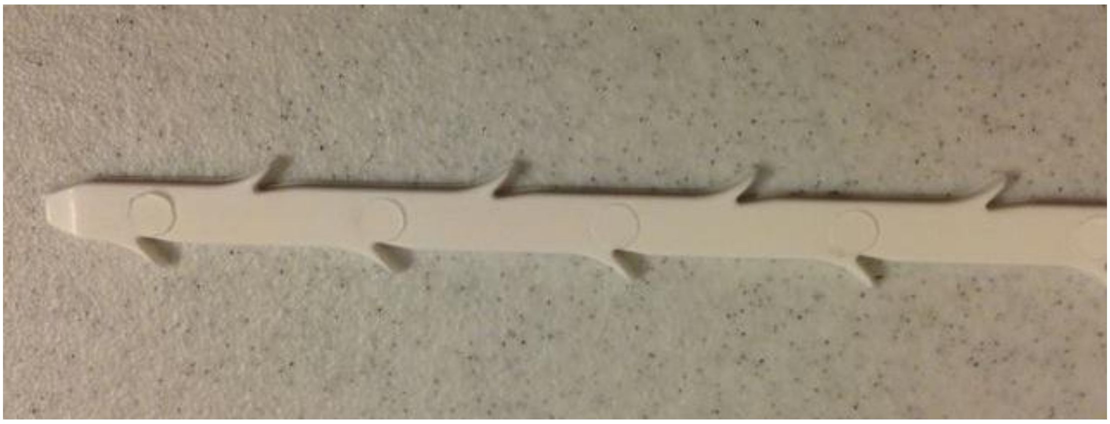

Figure 7: plastic barbs (http://www.energyvanguard.com/Portals/88935/images/insulation-inspection-wall-zip-it-tool-barbs.jpg)

The other tool which designed for unclogging drain basically is useful equipment for pull off the insulation for having sample is called the Zip-It “Figure 8”. This tool belongs to all energy professional functionary toolkit.

Figure 8: Zip it tool (http://www.energyvanguard.com/Portals/88935/images/insulation-wall-existing-home-inspection-zip-it-drain-cleaner-440.jpg)

The person who is going to approve the energy performance of the building should be qualifies, someone who is holding the energy certificate from official institutes like the Building Performance Institute (BPI) or RESNET. The building examiner should be families and test factors which are listed below.

- Combustion Safety
- Building Envelope
- HVAC
- Moisture Problems
- Detailed Report
- Extras

There are many levels of assessment, but in this research comprehensive energy audit selected as a focus.

Checking combustion appliances are really important to be examined in the building. Energy auditor should consider the building as a system. It is important to insulate interior spaces from carbon monoxide which may happen because of problem in back drafting. Spillage and content of the exhaust gases in furnaces and water heaters should be checked and generally ensure combustion appliance zone safety.

The other important factor for checking is Building Envelope which means testing insulation and air barrier surrounded building completely and touch each other correctly. For building envelope energy auditor have to check the integrity of the air barrier, adequacy of insulation levels, and alignment of insulation with air barrier.

The most energy usage in homes is used for cooling and heating indoor spaces to reach the comfortable interior spaces, thus it is vital to check the cooling and heating systems. It is necessary to for energy auditor to check related mechanical tools which have been set up in the building for air conditioning and also distribution systems. On the other hand, energy examiners have to measure the amount of duct leakage inside and outside the building envelope.

Moisture Problems are caused by building a connection in different ways to water such as, building pips, gutter connections, all outdoor faces which will touched by rain, basement and floor which protect building from moisture and condensation. Checking these elements needs to review all parts of dwelling and see how different parts have been built. In existing and historic buildings, energy auditors have benefited from some equipment like moisture meter which made the moisture measuring possible “Figure 9”. Benefit of this kind of equipment gives information to find the damaged or risky parts of the building to find the best solution for each of them.

Figure 9: Moisture meter
(http://www.tramexltd.com/User_Uploads/PD_22_ProfessionalMoistureMeter%28Digital%29.jpg)

Energy auditors have to prepared reports in a template which they have and in this report they have to explain all options which have been checked and if there is any missing issue or problems, will be mentioned in the report. Related to the report information selected building will get the energy efficiency grade which will be shown in the building label to show how efficient is that house for owners, buyers or who is going to live there. Through these information in most countries the tax of the building will be calculated.

Parts which explained above are base for the building evaluation in most countries, but there are some other options that might be needed and in some regulations they are must such as: checking the building heat loss with thermal imaging, water efficiency, building lighting energy usage, dryer vent, checking energy bill for existing buildings, and building acoustic.

Checking building acoustic in some countries and crowded cities is an important factor. Covering the building from outdoor disturbing sounds is the issue that mostly related to the design and landscape of the building like the distance from roads or highways or placing green areas and trees in between. The second step will be having some insulation if it is necessary. There are many kinds of acoustic measuring equipment in the market with different accuracy “Figure 10”. Mostly spaces which placed near main mechanical room should be insulated trough the unwanted sounds.

Figure 10: sound measuring equipment example
(http://www.dtu.dk/english/~/media/Institutter/Elektro/Elektro/Education/Master_programmes/Electrical_Engineering/SL1_acoustics/akustik_300x112.ashx)

After studying building approval it is clear that these grading is necessary through energy efficiency. Building labeling is acting like an ID for each building to show how efficient is the building and somehow became part of the building identity. Somehow for all labeling methods around the world, same basic information is needed. Changes are according to the countries which are adding or removing some parts related to the impotency of the factor for those areas. For controlling building energy efficiency, auditors have to consider details in a design part as a base to understand that energy efficiency regulations have been considered in the project or not. After finishing the design review, all collected data from construction period should be analyzed and see how energy efficiency factors installed in the building. At the end finished building must test to get the grade for energy efficiency. For measuring energy in building, the main factors like HVAC, insulation, moisture, and building envelope need to be checked to prepare building energy report for labeling.

In this process heat photos from infrared cameras are recommended for understanding the quality of the insulation and how they are working specially at the corners and opening ports. The best way of understanding the truth of thicknesses in different parts of the building (specially walls), measuring and examine all layers of the object is important which is possible with drilling or any other way. For the building construction near crowded places it is better to measure the indoor acoustic. All energy consumption equipment like water heater, heating and cooling systems, lightings and so on should be studied.

2.4.4 Energy Efficient Building in Existing Context

Energy efficiency in existing building improvement is as important as construct new energy efficient buildings. Most energy loss in countries which are starting to be sustainable is in existing and historic buildings. Non efficiency in these buildings happens because of not followed any factors of energy codes, then there will be heat-bridge in buildings and cost lots of energy to create a comfortable situation for human life there. Generally energy standards are different from normal existing constructed buildings and historical buildings. For historical ones because of the materials, thicknesses and also a way of building design and scale in the building constructed theme is different. On the other hand there are many limitations for these kinds of buildings because they are element of the place history and maintaining historical buildings is different to keep their historical time signs.

Usually historic buildings are under existing building title. In this research mostly energy efficiency regulation of ordinary existing buildings are studied. This study may cause energy standard for historical buildings energy standard in future after reach the regulated codes for existing building. "Building energy codes require new and existing buildings undergoing major renovations to meet minimum energy efficiency requirements. Well-designed, implemented, and enforced codes can help eliminate inefficient construction practices and technologies with little or no increase in total project costs" (EPA, 2006).

Making existing buildings efficient is not easy to do. There are extra steps and limitation according to the building condition in a comparison of new dwelling energy standards. Firstly there should be information for each current building situation to understand what need is and calculate energy factors for that building. There might be no access to the building blue print and detail. This building should be carefully analyzed to have basic and useful data about building situation for energy designers and engineers. There are many methods for finding these information which some of them are explained in section 2.2.3 in this chapter. Then, based on these data it is possible to calculate building energy needs and make the building efficient. Also for existing building will be labelled to show the performance of that according energy usage and loss. There have to be reason for building owners spend money to make their building efficient and it might happen by teaching people trough commercial and regulate related rules by the government for their own people. Making the building efficient has three steps.

Firs energy auditors should analyze the building and give the result for energy designers. Second building needs must design and apply for the building approval and at the end there should be maintaining method for keeping building in the correct situation. “The following can be considered as a part of your routine building maintenance and energy management best practices program:

- Collection energy data
- Analyzing energy data
- Taking action to target the best opportunities to save energy
- Tracking the energy saving progress” (OEE, 2013).

Nearly in all building energy efficiency regulations, there is a part related to the existing buildings which is calculated for their own countries. Same as new dwelling energy codes, for existing and historic buildings, standards should regulate according to climate issues and current condition of that area. European countries pay attention to this important factor in the road of sustainability more than other parts of the world. Mainly such countries like United Kingdome, Netherland, Germany, and Denmark are working sufficiently on this factor in Europe.

Existing building improvement percentage achievement is mainly depends on building owners himself to make their own building efficient. Using energy efficiency factors for existing buildings reduce 30 percent energy usage till 2011 in Europe. There is no force for applies individual existing building energy standards for building owners. Because of that the process of changing existing building conditions to the slightly situation is going slowly. Generally in UK and Holland most of the existing buildings adapt to this kind of codes and managed changes to their buildings according to climate changes. “Building regulation provides a crucial intervention point and one that is likely to become of increasing importance” (Bell, 2004). Approved document for existing building regulations are:

- “Extensions
- Material alternation
- Material change of use
- Provision or extension of a controlled service or fitting” (Bell, 2004).

Energy Efficiency for Existing Building (EEEB) is created in different areas like: technology introduction and transfer, Policy and standards, Industrial Corporation, demonstration project, knowledge management. This standard became very successful and the result was more acceptable compared to other energy efficiency codes for existing buildings (GIZ, 2013). Another successful energy standard for existing building energy efficiency is ICC which has specified chapter regard to built building condition and show how to upgrade the building according to energy efficiency standards. This regulation is more adaptable for climate condition in specified areas and easy to use for everywhere.

As a conclusion for this part existing building should be analyzed and measure to see the current building situation and find out problematical sections of it. For existing building regulation in hot and hot-humid climate it is better to follow exterior elements covering insulation such as va-Q-vip B “Figure 11” while for cold climate condition insulation from inside is recommended. Protecting building from moisture specially building connection to the ground is a must action in all climates. Changing accessories in the building marched to low energy usage with energy labeling is the first step and central mechanical facilities for commercial complexes is recommended. Check and change lighting inside and outside the building should adapt to level of needed illustration calculation and the result will be better if building owners use intelligent light controlling software and equipment.

Pipes and tabs should check to make sure of quality of heat transfer and safety of them, not to lose water in any case. Calculation and design shadings for the building openings according to sun radiation angle mostly in hot climates. Changing windows to double glazed or triple glazed to protect indoor weather and acoustic in all climate conditions will be helpful to make buildings more energy efficient. Nearly in all existing building regulation these factors are same with small changes to the area weather situation.

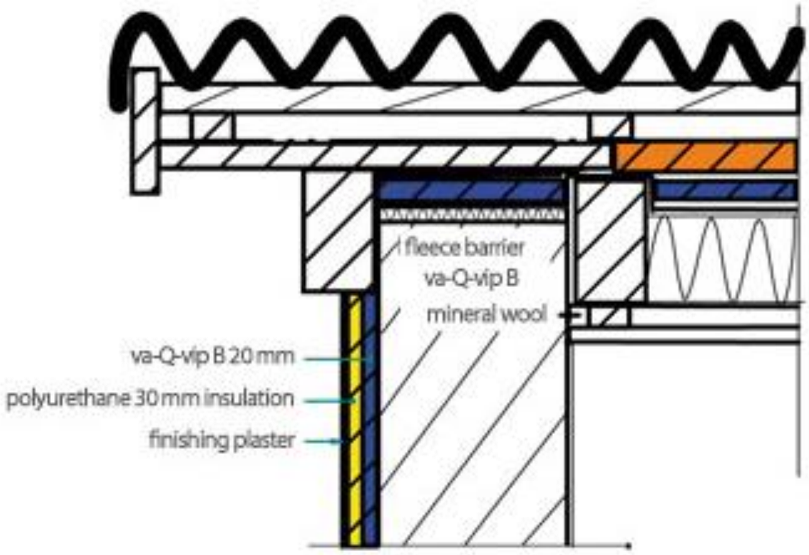

Figure 11: va-Q-vip B detail (http://www.va-q-tec.com/portal/pics/bau/aufbau_aussendaemmung-en.jpg)

2.5 Evolution of Energy Efficiency in Building Construction Process

Regulating energy efficiency codes and add it to usual building standards around the world started in Europe. At the beginning it was just additional of heat isolation to the building to reduce thermal bridge from inside of the building to the outside to make indoor spaces more comfortable for house users to reduce the usage of energy after the oil crisis. With the passage of time and growth of technology this option has been changed and developed as R-Value calculation. In R-Value besides considering the thermal insulation, calculation of needed thicknesses added to this process. Later R-Value calculation became an important option in the building energy efficiency factors.

Calculating and installing insulation changes according to climate instead of just keeping heat indoor after becoming under the sustainability title after creation. When this important topic proposed scientist started to argue about many factors which energy efficiency was one of the main subjects. Having the maximum benefit of the generated energy in any kind. Because the amount of energy use in the building section compared with other energy usage is higher countries started to think about the way of making buildings efficient. Then some international agencies appeared to control, compare and find gaps in energy efficiency around the world and being efficient in buildings became a worldwide factor. Due to climate change and global warming regulators started to change standards from fixed codes in their area to the flexible format to give the adapting chance to standards with climate issues.

It seems to need that having just heat insulation is not enough for being efficient and some other barriers appliers like moisture in buildings. Designing building envelope and material sample use became important at the beginning of the design process and U-Value calculation added to energy efficiency regulations in building construction process. Even for some functional buildings and in some mega cities acoustic insulation is part of calculation methods. Another important issue which added to this importance was HVAC to make indoor spaces more comfortable for users.

All these applies was necessary but not enough, thus regulators started to have the benefit of some renewable energy factors for buildings like rain water collecting tank and solar panels for heating water supply. In order to show the level of energy efficiency in each building, energy labeling for building has started. In this part buildings were grouped according to energy efficiency factors to show it to the house owners, renters and buyers. Governments also consider some point like taxes to make people more interested to build their home more efficient. Another important issue was ordinary peoples knowledge about the future of our planet and necessity of making these changes to have cheaper and more comfortable life.

As a matter of fact these additions forces construction regulations changed to consider these new parts as an important issue and the addition of energy efficiency factors to the regulated standards. Dwelling companies had to follow energy codes during the construction period. For understanding better in coming part, Germany energy efficiency evolution will give as an example “Figure 12”.

Germany health and safety regulations started in 1952 which faces energy crisis in 1973. After energy crisis, this regulation has been changed and published in 1977. Component U-Value factor was the main issue till 1984. Since 1984 till 1995, mean U-Value calculation was the main objective of health and safety regulation in Germany evolution. During 1995 to 2001 net energy demand for heating was added to mean U-Value calculation for Germany regulatory. The pic point of being efficient in Germany has started in 2001 with primary energy demand for heating and mean U-Value till EPBD regulation has been published in 2006. After 2006 primary energy demand for heating, cooling, ventilation and lighting (DHW) plus mean U-value under cover of EPBD were continued and edited by update knowledge from DIN researches (European Union, 2009).

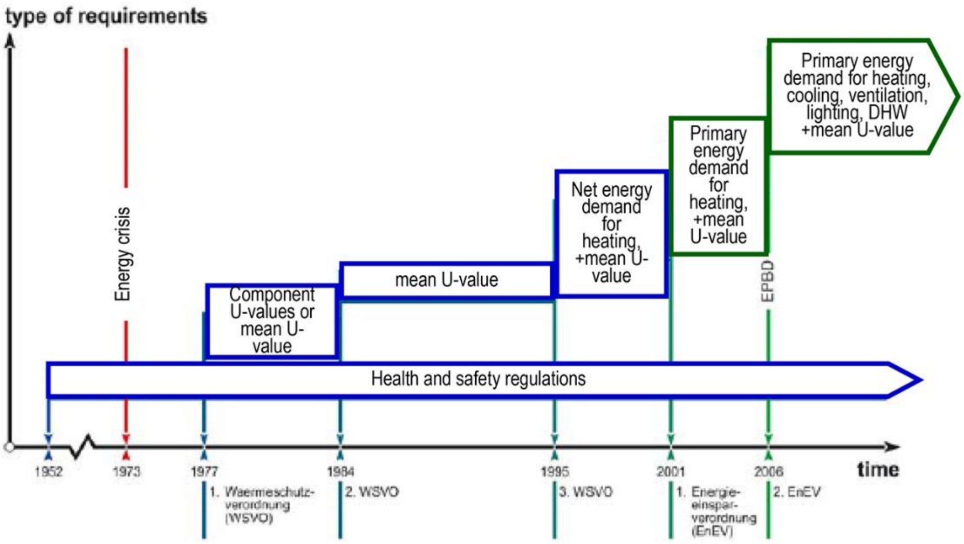

Figure 12: Germany health and safety regulation evolution. (European Union, 2009)

After collecting data from existing regulations and methods which are applied to the countries all around the world in “Chapter 2”; in next chapter these information will be analyzed and selected ones, according to the similar situation to Northern Cyprus, will be compared to find the most suitable energy efficiency standard in each section as a base for regulating Turkish Republic of Northern Cyprus energy code in building construction process.

Chapter 3

EVALUATION OF ENERGY EFFICIENT BUILDINGS IN THE CASE OF TURKISH REPUBLIC OF NORTHERN CYPRUS

In this chapter will be an explanation about the case of this study (the Turkish Republic of Northern Cyprus) about the location, division and climatic issues. After having knowledge about the Northern Cyprus climatic condition; common regulation in the similar climate zone will be compared and analyzed, and the result will be illustrated to have the most comfortable regulation in each part of the building construction process is recommended. To have a prepared base for regulating useful energy codes in this area more than energy efficiency regulation is needed. Author tried to explain the missing important base for having energy standards and apply these regulations to the TRNC residential construction. For each seperation comparison will shown and short conclusion will be done to have clear pass for final result of this study.

3.1 Location of Cyprus Island

Cyprus island country is the third large island in the Eastern Mediterranean Sea “Figure 13”. The location of this Island is at the south of turkey and other country neighbors are Egypt at the south side, Syria and Lebanon at the east, Greece at the west and Israel at the southeast. It measures 240 kilometers long from end to end and 100 kilometers wide at its widest point. It lies between latitudes 34° and 36° N, and longitudes 32° and 35° E. Earliest living sign in this island is related around the 10th millennium BC. This island is located in a strategic place. Thus, many major powers of their time was occupied Cyprus Island like the Assyrians, Persians and Egypt warriors. The most effective empire which brought the constructing method to the island and still there are many buildings from their period in the island are in 1571 and British administration in 1878. Cyprus became independence in 1960 (Kypros, 2013).

Figure 13: Cyprus map (http://www.intercyprus.com/maps/map-of-cyprus.jpg)

In 1974 Cyprus has been divided into two parts:

- Northern part
- Southern part

The southern part or Greek part of the island is known as a Cyprus country and it is a member of the European Union. The northern part of the island is named Turkish Republic of Northern Cyprus, (TRNC) which is the objective of Turkey since 1995 ”Figure 14”. The population of the island was 50,000 Turkish Cypriot people and around 150,000 Greek Cypriot people, in 1995. In the Turkish Republic of Northen Cyprus after the war did not pay attention to the building construction quality till now.

Even there is not any related prepared regulation due to building construction. Because of missing building regulation generally most of the constructed buildings are at the low level of comfort or for having a comfortable condition they have to pay heavy electric bills. Also way of energy usage in Northern Cyprus is not following sustainability factors in the world, it may cause many problems for their people, the island and generally in global scale.

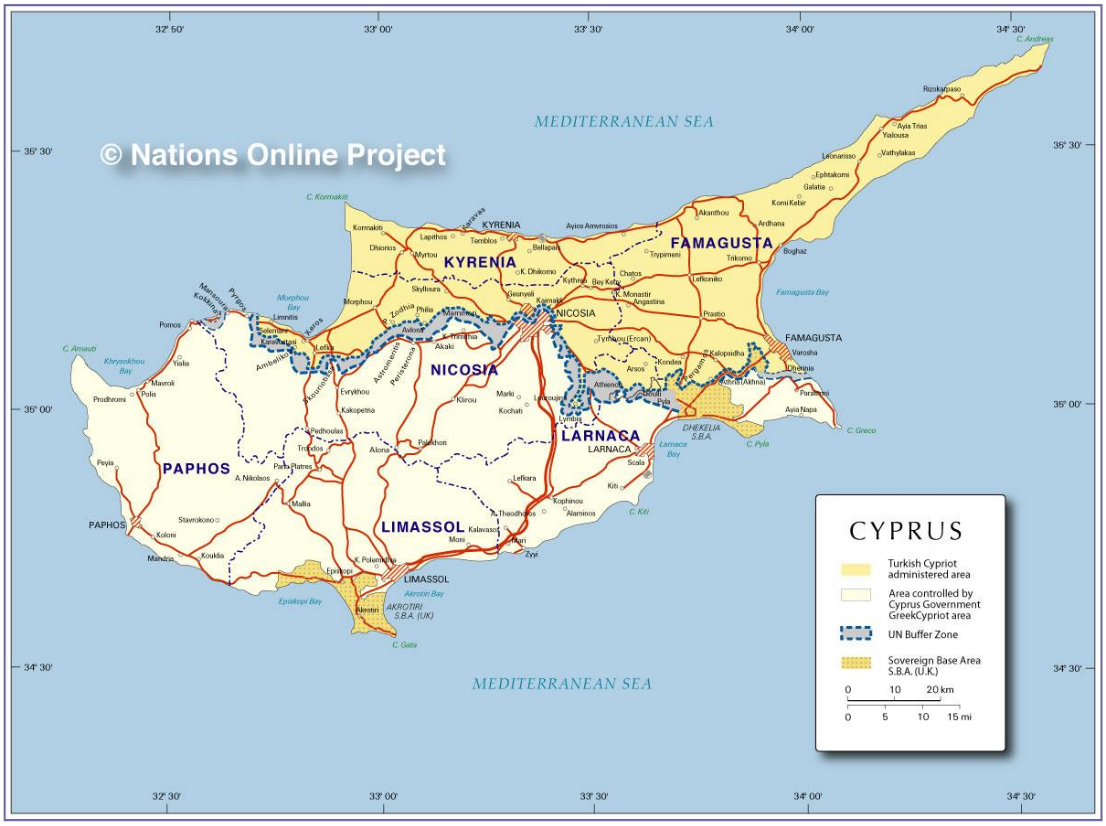

Figure 14: Cyprus division map (http://www.nationsonline.org/maps/cyprus_map.jpg)

3.2 Climatic Analysis of Cyprus

Cyprus Island takes place in hot-humid climate group which is located in the Mediterranean and the semi-arid zone with the Subtropical climate. There are some differences in Cyprus city's climate. Girne is in hot-humid climate with lower humidity toward the high mountain. Famagusta and Guzelyurt has transition between hot-humid and mixed climate. The humidity is higher at night and early morning, but it reduces during the noon tome and Lefkosa has hot-dry climate, and the reason is having distance from the sea (Hancer, 2005). Cyprus has mild winters and hot summers. The only possibility for snowing is on the top of the mountain at the center of the island. Rain has happened mainly in winter and having a dry summer beginning. In Cyprus warm climate the average of the day temperature is around 24 °C and at night duration is around 14 °. Generally there is a 8 month summer in this area which begins in April and ends in November. In the middle of the summer in the hottest month (July and August) temperature average is around 33 °C (MOA, 2013). The average of the annual sea temperature is around 21–22 °C. Average of sunshine on the island is between 3,300 hours to 3,500 hours, per year. The precipitation averages in the island mountain are around 1,000 millimeter rain, but this average is around 1,100 millimeter, at the top of the mountain. Generally rain average in Cyprus flat areas is between 300 to 450 millimeter. Earthquakes, usually not destructive, occur from time to time. Humidity averages in the island for the winter is around 60 to 80 percent and in summer is around 40 to 60 percent. Wind in Cyprus generally is not heavy and generally is coming from the west to the east “Figure 15, 16 and 17”. In a Famagusta city in Northern Cyprus, calculated body temperature is higher than air temperature in comparison, which is important for regulators to consider this issue as well and have the same calculation for other cities to find out similarity between TRNC different conditions (Ali Baba & Ozdeniz, 2011).

In appendix “B” and “C” there is climatic information about Northern Cyprus city's condition for showing more information to understand the TRNC climate more clear.

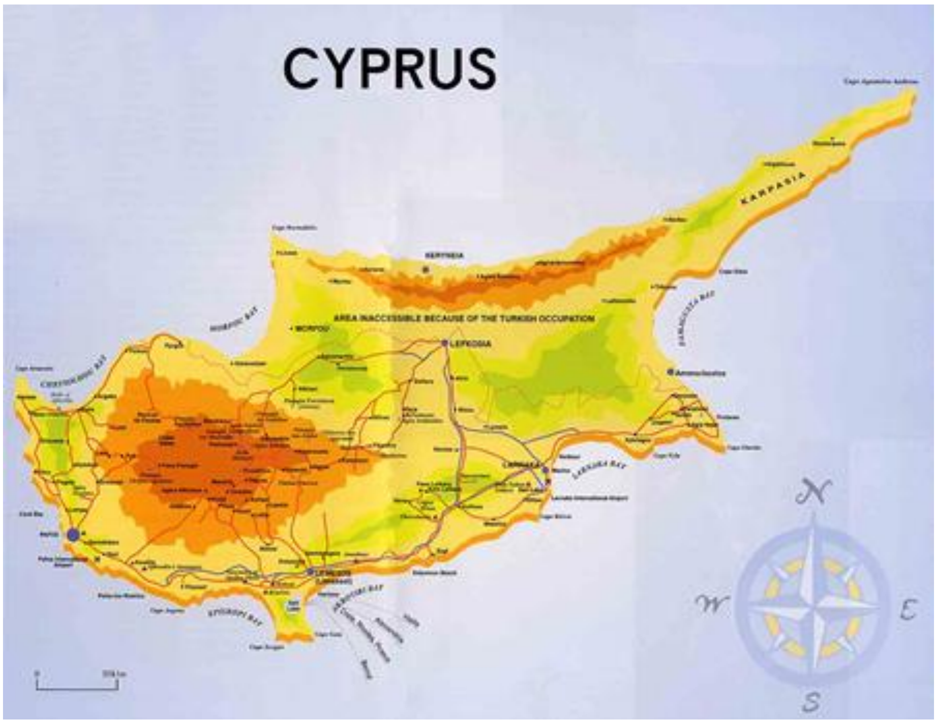

Figure 15: Cyprus climate information (http://faithandsurvival.com/wp-content/uploads/2013/03/cyprus-sm.jpg)

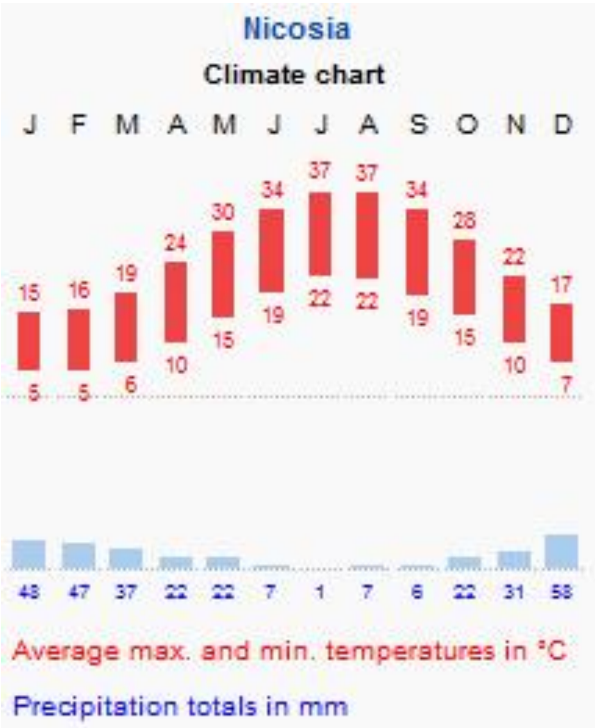

Figure 16: NicoMeteorologicalhart (World Metorological Organization)

Climate data for Nicosia, elevation: 162 m													
Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Average high °C (°F)	15.5 (59.9)	15.9 (60.6)	19.2 (66.6)	24.0 (75.2)	29.7 (85.5)	34.3 (93.7)	37.2 (99)	36.9 (98.4)	33.5 (92.3)	29.0 (84.2)	22.1 (71.8)	17.0 (62.6)	26.2 (79.2)
Daily mean °C (°F)	10.6 (51.1)	10.6 (51.1)	13.1 (55.6)	17.1 (62.8)	22.3 (72.1)	26.9 (80.4)	29.7 (85.5)	29.4 (84.9)	26.2 (79.2)	22.3 (72.1)	16.3 (61.3)	12.0 (53.6)	19.7 (67.5)
Average low °C (°F)	5.7 (42.3)	5.2 (41.4)	7.0 (44.6)	10.2 (50.4)	14.8 (58.6)	19.4 (66.9)	22.2 (72)	21.9 (71.4)	18.8 (65.8)	15.6 (60.1)	10.4 (50.7)	7.1 (44.8)	13.2 (55.8)
Precipitation mm (inches)	54.7 (2.154)	41.6 (1.638)	28.3 (1.114)	19.9 (0.783)	23.5 (0.925)	17.6 (0.693)	5.80 (0.2283)	1.30 (0.0512)	11.7 (0.461)	17.4 (0.685)	54.6 (2.15)	65.8 (2.591)	342.2 (13.472)
Avg. precipitation days (≥ 1 mm)	7.3	6.5	5.4	3.5	2.7	1.3	0.5	0.1	0.6	2.8	4.7	7.7	43.1
Mean monthly sunshine hours	182.9	200.1	238.7	267.0	331.7	369.0	387.5	365.8	312.0	275.9	213.0	170.5	3,314.1

Figure 17: Climate data for Nicosia (Exported from http://www.moa.gov.cy/moa/MS/MS.nsf/DMLclimet_reports_en/DMLclimet_reports_en?OpenDocument&Start=1&Count=1000&Expand=1 website)

3.3 Energy Efficiency Regulation in Northern Cyprus

There is no any energy efficiency regulation in Northern Cyprus, even in many parts of the building construction process there is a lack of basic regulation such as controlling the dwelling in the construction period. The only remarkable happening in Northern Cyprus related to sustainability is using heating water solar collector as an addition to the top of the building and insolation the roof to protect the building from rain water. Greek part of the island is paying attention to usage of renewable energy much more than Turkish part. They have got ninth World Renewable energy congress trophy which has been held in Florence in 2006. The main reason to find other energy sources for the Cyprus Island was because this place is far from electricity and gas network (Maxoulis & Kalogirou, 2008). Turkish part of Cyprus is left behind any sustainable process, thus it is important to find the way of using renewable energy like to build PV electricity network or sea wave for creating electricity and so on, and also regulate standards to have as much benefit as possible from any energy source in the building to stop the waste of energy and create more comfortable indoor area with the less energy usage amount.

3.4 Study Building Energy Efficiency Process Standards According to the Case

For finding most adaptable methods or combination of some, firs it is needed to find a similar situation about energy efficiency in the world countries to compare and analyze them to find out how they are working and which one gave better result according to the place which is using that method for building construction process. After illustrating the result, data should compare with the current situation in Turkish Cyprus to find the most comfortable energy efficient way as a base for regulating energy standards for TRNC. These information is prepared in three different parts of the building construction process and also studied for existing and functional historical buildings. In following parts energy advises is written for all four parts of this study:

- Design part,
- Construction part,
- Approval part,
- And existing buildings

3.4.1 Recommended Energy Efficient Building Method in Design

For HVAC method it is recommended to use American HVAC for calculating all factors. After studding different kinds of HVAC standards it became clear that heating, ventilating and air conditioning style in United State is more adaptable to all climate conditions and it will be suitable for this research case. It is important to highlight beside HVAC calculation and regulation mechanical machines and companies which are following energy efficiency standards in the world are needed. There should be possibility to have these systems in the market to give the opportunity to energy auditors to have an energy efficient design, without this happening it is not possible to have an efficient building according ho HVAC factors. To make it real it is obligated to the Cypriot government to create a way to import or produce needed HVAC system in the northern part of the island.

On the other hand for R-Value calculation it seems better to use Australian method. In this method thermal conductivity is dividing factor for thermal component calculation which is measured as ‘m2.K/W’. For total R-Value every building element thickness should be considered in a calculation. Surface resistance, air space, insulation material, and all used constructed material are part of the total calculation in this style. After installing this method to the different zones in Austrailia the result is shown that this system is working proparly. There are many extra calculations and modeling program for R-Value factor. It is recommended to use from these programs to have true imagination about the accuracy of the final product. The other benefit of using these programs is showing the exact result of imported data from the building as a final render and information which can be given to the construction team directly. It is not recommended to have exact program, due to the size of the building, the function of it and selected materials, programs might be different, each program has some advantages from the others. Having the R-Value calculated modem might be placed on the design process regulation but the chance of how to have the result might give to the designers and architectural companies.

According to the climate of Northern Cyprus, calculating U-Value is important for building design section. By having knowledge about all parts and material use early in the project helps designers to create a better architectural design for this island and have a better material selection to be more sustainable. Generally according to analyze U-Value calculation in different methods, result was there is not much difference between energy standards around the world. The only factor is for sure it is important to have U-Value calculation result of design, but the importance of it is different related to the weather of each zone. In the Mediterranean climate like the Turkish Republic of Northern Cyprus climate it is really important to consider U-Value information in design process.

In following tables summary of some energy efficiency regulation around the world will be shown to have more clear and understandable which one is more suitable for case of Northern Cyprus according to climate and factors which makes the standard more valuable. In this table code names and some details of energy efficiency regulation seperated by countrie name has been designed.

Table 6: Summary of energy efficiency detail in the design part of process, separated by countries. (http://www.sustainablebuildingscentre.org/pages/beep)

Australia

Mandatory	Chronology		Enforcement	
Building Code of Australia (Vol. 1 & 2 of the National Construction Code Series)	First version	2003	Fines	Not available
	Second version	2011	Demolition	Not available
	Current version	2012	Refusal of building permit	Not available
	Next revision	Not available	Imprisonment	Not available

Scope	Compliance Software	Floor area
All new detached and terrace houses, boarding houses < 300m2 (Vol.2) Multi-occupancy residential (Vol.1)	All software must comply with the Protocol for House Energy Rating Software 2006.1 (Vol.2) or Building Energy Analysis Software 2006.1 (Vol. 1)	Floor area in relation to a room, means the area of the room measured within the finished surfaces of the walls, incl. areas occupied by built in furniture, fixtures and fittings.

Climate Zones	Heating Degree Days	Average January maximum temperature	Average 3pm January Water Vapour Pressure
Climate zone 1	-	≥ 30°C	≥2.1kPa
Climate zone 2	-	<30°C	≥2.1kPa
Climate zone 3	-	≥ 30°C	≤2.1kPa
Climate zone 4	-	≥ 30°C	≤2.1kPa
Climate zone 5	<1000	<30°C	≤2.1kPa
Climate zone 6	1000-1999	<30°C	≤2.1kPa
Climate zone 7	2000 to Alpine	<30°C	≤2.1kPa
Climate zone 8	Alpine	Alpine	Alpine

Total energy consumption	End-uses considered	Thermal comfort: Temperature	Thermal comfort: Relative humidity
Not applicable.	Auxiliary devices, Cooling, Heating, Hot water, Lighting, and Ventilation.	20°C - 21°C for heating and 25°C - 28°C for cooling (Single occupancy houses) 18° Celsuis Dry Bulb - 26° Celsius Dry Bulb (Multi-occupancy buildings)	Not available

Insulation: Class 1: R-Values (m2.K/W)	Suspended floor	Walls	Class 2: R-Values (m2.K/W)	Floor	Suspended floor	Walls
Climate zone 1	1.5	2.8	Climate zone 1	0	1	3.3
Climate zone 2	1	2.8	Climate zone 2	0	1	3.3
Climate zone 3	1.5	2.8	Climate zone 3	0	0	3.3
Climate zone 4	2.25	2.8	Climate zone 4	0	0	2.8
Climate zone 5	1	2.8	Climate zone 5	0	1	2.8
Climate zone 6	2.25	2.8	Climate zone 6	0	1	2.8
Climate zone 7	2.75	2.8	Climate zone 7	1	1.5	2.8
Climate zone 8	3.25	3.8	Climate zone 8	2	2.5	3.8

HVAC	Hot water	Lighting	Skylights	Windows	Renewable energy
Single occupancy (class 1): Heating and cooling loads for model and reference buildings must be calculated by the specified method and criteria (Vol.2 V2.6.2.2) Multi-occupancy (class 2): Annual energy consumption for air conditioning mus be calculated with the specified method and criteria (Vol.1 Tables 2a-2g).	Greenhouse gas intensity of water heaters must be <100g CO2-e/MJ of the thermal energy load.	Multi-occupancy (class 2): Maximum illumination power density is prescribed by space type (Table J6.2a) with adjustments for control devices (Table J6.2b)	Total area < 5% of floor area, unless required by health and safety compliance requirements. SHGC and U factors are specified by ratio of shaft index to percentage of floor space. Listed in Table J1.4	The aggregate air-conditioning energy value attributable to the glazing must be calculated using the method and criteria specified in tables J2.4a &b	Heating for domestic services must obtained from an on-site renewable energy source, or reclaimed energy , or a source that has a greenhouse gas intensity <100g CO2]

Austria

Mandatory	Chronology		Enforcement	
OIB Guideline 6	First version	2007	Fines	Not available
			Demolition	Not available
	Current version	2011	Refusal of building permit	Not available
	Next revision	Not available	Imprisonment	Not available

Scope	Compliance Software	Floor area	Climate Zones	Total energy consumption	End-uses considered	Thermal comfort: Temperature	Thermal comfort: Relative humidity
Not available	Not available	Not available	Temperate; continental; cloudy; cold winters with frequent rain in lowlands and snow in mountains; cool summers with occasional showers	66 kWh/m2/year	Not available	Not available	Not available

Insulation: U-Values (W/m2.K)				
Walls	Roof	Floor	Door	Windows
0.35	0.2	0.4	1.4	1.4

HVAC	Hot water	Lighting	Skylights	Windows	Renewable energy
Not available	Not available	Not available	Not available	Not available	Not available

Belgium

Mandatory	Chronology		Enforcement	
PEB	First version	Not available	Fines	Not available
			Demolition	Not available
	Current version	2011	Refusal of building permit	Not available
	Next revision	Not available	Imprisonment	Not available

Scope	Compliance Software	Floor area	Climate Zones	Total energy consumption	End-uses considered	Thermal comfort: Temperature	Thermal comfort: Relative humidity	Insulation
All new buildings with a surface over 250m2 containing at least one dwelling.	Logiciel PEB v3.5	Not available	Temperate; mild winters, cool summers; rainy, humid, cloudy	Not available	Not available	Not available	Not available	Not available

HVAC	Hot water	Lighting	Skylights	Windows	Renewable energy
Not available	Not available	Not available	Not available	Not available	Cogeneration, biomass and SPV are considered in calculating E values

Canada

Mandatory	Chronology		Enforcement	
Alberta Building Code (based on National Energy Code of Canada for Buildings)	First version	1978	Fines	Not available
	Current version	2011	Demolition	Not available
			Refusal of building permit	Not available
	Next revision	2015	Imprisonment	Not available

Scope	Compliance Software	Floor area
All residential buildings except single family and small multiple family.	Not available	Not available

Climate Zones	Heating Degree Days
Climate zone 1 (Ontario Codes only)	<5000
Climate zone 2 (Ontario Codes only)	>5000
Climate zone 4	<3000
Climate zone 5	3000-3999
Climate zone 6	4000-4999
Climate zone 7 (Ontario Codes only)	HDD18 < 5000
Climate zone 7A	5000-5999
Climate zone 7B	6000-6999
Climate zone 8	≥7000

Total energy consumption	End-uses considered	Thermal comfort: Temperature	Thermal comfort: Relative humidity
Not included	Cooling, Heating	Not available	Not available

Insulation: Building assemblies in contact / below the ground	Floor	Roof	Walls	Building assemblies above ground	Floor	Roof	Walls	Windows
Climate zone 4	0.757	0.568	0.568	Climate zone 4	0.227	0.227	0.315	2.4
Climate zone 5	0.757	0.379	0.379	Climate zone 5	0.183	0.183	0.278	2.2
Climate zone 6	0.757	0.284	0.284	Climate zone 6	0.183	0.183	0.247	2.2
Climate zone 7A	0.757	0.284	0.284	Climate zone 7A	0.162	0.162	0.21	2.2
Climate zone 7B	0.757	0.284	0.284	Climate zone 7B	0.162	0.162	0.21	2.2
Climate zone 8	0.379	0.21	0.21	Climate zone 8	0.142	0.142	0.183	1.6
Windows	0.2 l/(s.m2) at 50 Pa			Doors	5 l/(s.m2) at 50 Pa			

HVAC	Hot water	Lighting	Skylights	Windows	Renewable energy
Not available	Not available	Not available	Not available	Total vertical fenestration and door area to gross wall area set for different climate conditions	Not available

Country	Mandatory	Chronology		Enforcement		Scope	Compliance Software	Floor area	Climate Zones	Total energy consumption	End-uses considered	Thermal comfort: Temperature	Thermal comfort: Relative humidity	Insulation	HVAC	Hot water	Lighting	Skylights	Windows	Renewable energy
China	Design Standard for Energy Efficiency in Residential Buildings in the Hot Summer and Cold Winter Zone	First version	Not available	Fines	Not available	Not available	Not available	Not available	Heating Degree Days Climate zone 1: ≥7000 Climate zone 2: 5500-7000 Climate zone 3: 4000-5499 Climate zone 4: <4000 Climate zone 5: <4000	Not available	Not available	Not available	Not available	Not available	Not available	Not available	Not available	Not available	Not available	Not available
				Demolition	Not available															
		Current version	2011	Refusal of building permit	Not available															
		Next revision	Not available	Imprisonment	Not available															
Czech Republic	Building code	First version	Not available	Fines	Not available	Not available	Not available	Not available	Temperate; cool summers; cold, cloudy, humid winters	120.0 - 142.0 kWh/m2/year	Not available	Not available	Not available	U-Values (W/m2.K) Walls: 0.3 Roof: 0.24 Floor: 0.45 Door: 1.7 Windows: 1.7	Not available	Not available	Not available	Not available	Not available	Not available
		Current version	Not available	Demolition	Not available															
				Refusal of building permit	Not available															
		Next revision	Not available	Imprisonment	Not available															
Denmark	Building Regulations	First version	1961	Fines	Not available	New residential buildings except holiday homes	SBi-Direction 213	The gross areas of all storeys, incl. basements and useable roof spaces, enclosed balconies etc, external and internal staircases, stairwells, access balconies and lift shafts in each storey	Temperate; humid and overcast; mild, windy winters and cool summers	Dwellings52.5 kWh/m2/year+ (1650 kWh/year divided by heated floor area) Low energy residential buildings (2015)30 kWh/m2/year+ (1000 kWh/year divided by heated floor area)	Cooling, Heating, Hot water, Ventilation	20°C	Specified in DS 474, Code for Indoor Thermal Climate	U-Values (W/m2.K) Walls: 0.3 Floor: 0.2 Roof: 0.2 Windows: 1.8	Ventilation installations must incorporate heat recovery with a dry temperature efficiency of no less than 70% (80% for single dwellings) Heat pumps for heat recovery must have a minimum coefficient of performance of 3.6 in heating mode.	Domestic water systems supplied by a domestic ventialtion heat pump must have a minimum COP (coefficient of performance) at the draw off point of 3.1.	No requirement	Energy gains through rooflights must not be less than - 10kWh/m2/year, in 2015 it should not be less than - 17kWh/m2/year	Solar energy gains 33 kWh/m2/year	Solar heating systems must be provided when the expected hot water consumption exceeds 2000l per day and able to meet 95% of demand
		Current version	2010	Demolition	Not available															
				Refusal of building permit	Not available															
		Next revision	2015	Imprisonment	Not available															
Finland	National Building Code of Finland	First version	Not available	Fines	Not available	All residential buildings >50m2 except holiday homes where no heating system is intended for all-year use	Ymparisto approved software	Not available	Cold temperate; potentially subarctic, but comparatively mild because of moderating influence of the North Atlantic Current, Baltic Sea, and more than 60,000 lakes	Not available	Not available	21°C	Not available	Building elements of semi-warm spaces Floor: 0.14 Windows: 1.4 Walls: 0.26 Building elements of warm and cooled cold spaces Floor: 0.09 Roof: 0.09 Walls: 0.17 Windows: 1	Not available	Not available	Not available	Not available	Total window area should not exceed 50% of total area of external walls	Not available
		Current version	2012	Demolition	Not available															
				Refusal of building permit	Not available															
		Next revision	2015	Imprisonment	Not available															
Greece	Regulation for Energy Performance of Buildings (REPB or "KENAK") and associated Technical Guidelines of the Technical Chamber of Greece (TGTCG)	First version	2010	Fines	No	All new residential buildings > 50 m2 all end uses. <50 m2 checked only for thermal insulation	KENAK (based on EN 13790)	Gross area	Temperate; mild, wet winters; hot, dry summers	Minimum requirement - Reference Building Class B (or higher)	Cooling, Heating, Hot water	In general 20°C for heating, 26°C for cooling, Table per building use is given in TGTCG No 1	In general 35-40 for heating, 45-50 for cooling, Table per building use is given in TGTCG No 1	Defined per building element in Tables of TGTC No 1	Min EER of 2.8 air-cooled, 3.8 water-cooled, with ESEER being introduced to be enforced at later stage (see TGTCG No 1)	Methodology and DHW needs defined in TGTCG No 1	Not a requirement for residential buildings	No requirement	Thermal characteristics of windows (incl. shading) and walls calculated for Reference Building (see TGTCG 1 & 3)	60% of domestic hot water from solar energy
		Current version	2010	Demolition	No															
				Refusal of building permit	Yes															
		Next revision	Not available	Imprisonment	No															

Country	Mandatory	Chronology		Enforcement	
France	RT 2012	First version	1955	Fines	Yes
		Current version	2012	Demolition	Yes
				Refusal of building permit	Yes
		Next revision	2017	Imprisonment	No
Germany	Energy Conservation Regulations (EnEV)	First version	1977	Fines	Yes
		Current version	2012	Demolition	No
				Refusal of building permit	Yes
		Next revision	Not available	Imprisonment	No
Hungary	Országos Településrendezési és Építési Követelmények' (OTÉK)	First version	Not available	Fines	Not available
		Current version	Not available	Demolition	Not available
				Refusal of building permit	Not available
		Next revision	Not available	Imprisonment	Not available
Ireland	Building Regulations: Part L Conservation of Fuel and Energy: Dwellings	First version	1991	Fines	Not available
		Current version	2011	Demolition	Not available
				Refusal of building permit	Not available
		Next revision	Not available	Imprisonment	Not available

Country	Scope	Compliance Software	Floor area	Climate Zones	Total energy consumption	End-uses considered	Thermal comfort: Temperature	Thermal comfort: Relative humidity
France	All new residential buildings	Clima-Win/Cypebat/DesignBuilder/Lesosai/Visual TTH/ArchiWisard/Pleiades/Comfie/U22WinRT 2012	The floor area of the building is equal to the sum of the surfaces of each floor level, calculated from the bare interior facades.	Climate zone H1a; Climate zone H1b; Climate zone H1c; Climate zone H2a; Climate zone H2b; Climate zone H2c; Climate zone H2d; Climate zone H3 Heating Degree Days / Cooling Degree Days: Not available	Requirement on comfort temperature in summer time National average primary energy consumption of 50 kWh/m2.yr for single-family house and 57.5 kWh/m2.yr for multi-family building Requirement on energy needs based on bioclimatic coefficient	Cooling, Heating, Hot water, Lighting, Ventilation	19 C in winter and 26 C in summer	Not available
Germany	All residential buildings which are heated or cooled using energy, incl. retirement and nursing homes, excl. those meant for use less than four months a year or temporary buildings	There is no compliance software specified	The outer boundary of an enclosed heated zone	Temperate and marine; cool, cloudy, wet winters and summers; occasional warm foehn wind	The energy performance requirement is based on an equivalent model building and measured as kWh/m2/year of primary energy	Cooling, Heating, Hot water, Ventilation	Not regulated	Not regulated
Hungary	Not available	Not available	Not available	Temperate; cold, cloudy, humid winters; warm summers	110.0 - 230.0 kWh/m2/year	Not available	Not available	Not available
Ireland	All new dwellings	Domestic Energy Assessment Procedure	Internal floor area, excludes unheated ancilliary areas, but includes conservatory-style sunspace as habitable area	Temperate maritime; modified by North Atlantic Current; mild winters, cool summers; consistently humid; overcast about half the time	Maximum elemental Uvalues are set, or permitted variations in combined area and average Uvalues	Cooling, Heating, Hot water, Lighting, Ventilation	Not available	Not available

Country	Insulation				
France	Average U value <=0.36 W/m2.K Ratio of global average linear thermal transmittance <=0.28 W/m2.K				
	U-Values (W/m2.K)				
	Walls	Roof	Floor	Door	Windows
Germany	0.28	0.2	0.35	1.8	1.3
Hungary	0.45	0.25	0.45	1.6	1.6
Ireland	0.6	0.3	0.6	3	3

Country	HVAC	Hot water	Lighting	Skylights	Windows	Renewable energy
France	Single occupancy (class 1): Heating and cooling To be connected to urban heating system supplied for more than 50% by renewable energy source or Boiler with efficiency of more than 90%	Solar hot water (2 m2 of solar panels) or Electric hot water (COP=2)	Total glazed area >= 1/6 of the total floor area	Not available	The Solar energy factor: 0.15 - 0.65	More than 5 kWh primary energy/m2.yr
Germany	SPF 4 maximum for air-conditioning systems with a cooling capacity >12kWh and 4 000m3/h vol. power of delivery air	Specified in part 4	Not applicable	1.40 W/(m2.K) Heat transfer coefficient. 0.60 glazing overall energy transmittance	Not available	If electricity from renewable energies is used it may be deducted from the delivered energy demand if generated in direct spatial relation to the building and used primarily in the building, not fed into the grid
Hungary	Not available	Not available	Not available	Not available	Not available	Not available
Ireland	Specific fan power: 0.8 W/L/s	All oil and gas fired boilers shall meet a minimum of 90% efficiency. CHP equivalent to 10 kWh/m2/annum thermal energy can be installed in place of RE requirement	Not available	Not available	Not available	10 kWh/m2/annum for thermal energy, or 4 kWh/m2/annum of electrical energy or a combination giving the same effect

	India	Italy	Japan
Mandatory	Energy Conservation Building Code	National Code	Rational use of energy within buildings
Chronology – First version	2007	2006	1980
Chronology – Current version	2009	2011	2009
Chronology – Next revision	Not available	Not available	Not available
Enforcement – Fines	Not available	Not available	Not available
Enforcement – Demolition	Not available	Not available	Not available
Enforcement – Refusal of building permit	Not available	Not available	Not available
Enforcement – Imprisonment	Not available	Not available	Not available
Scope	All kinds of new construction	All residential buildings	New residential buildings and major renovations on buildings >300m2
Compliance Software	Not available	CTI 2000	Not available
Floor area	Not available	Not available	Not available
Climate Zones	Climate zone Cold; Climate zone Composite; Climate zone Hot Dry; Climate zone Hot Humid; Climate zone Moderate	Climate zone A; Climate zone B; Climate zone C; Climate zone D; Climate zone E; Climate zone F	Varies from tropical in south to cool temperate in north
Climate Zones – Heating Degree Days / Cooling Degree Days	Not available	Not available	
Total energy consumption	Not available	Refer to Insulation section	120.0 - 142.0 kWh/m2/year
End-uses considered	Not available	Heating, Hot water	Not available
Thermal comfort	Not available / Not available	Temperature: 20°C for heating (+ 2°C), 26°C for cooling; Relative humidity: 50%	Not available / Not available
Insulation	See table below	See table below	Not available
HVAC	Not available	Not available	Not available
Hot water	Residential facilities with a centralised system shall have solar water heating for at least 1/5 o the design capacity. Service water heating equipment will require performance and minimum efficiency with respect to Indian Standards	Not available	Not available
Lighting	The mandatory requirements for lighting mostly relate to interior and exterior lighting control	Not available	Not available
Skylights	Not available	Not available	Not available
Windows	Refer to Insulation section	Not available	Not available
Renewable energy	Residential facilities with a centralised system shall have solar water heating for at least 1/5 o the design capacity. Service water heating equipment will require performance and minimum efficiency with respect to Indian Standards	Solar thermal energy or other renewable for water heating	Not available

India – Insulation

U-Values (W/m2.K)	Curtain walls	Roof	Walls	U-Values (W/m2.K)	Non-North windows	North windows
Climate zone Cold	20.48	24.67	13.85	Climate zone Cold	0.68	4.56
Climate zone Composite	22.06	25.98	15.01	Climate zone Composite	1.187	1.49
Climate zone Hot Dry	19.71	14.11	9.6	Climate zone Hot Dry	6.48	7.29
Climate zone Hot Humid	4.11	5.86	3.11	Climate zone Hot Humid	11.62	11.95
Climate zone Moderate	6.76	5.19		Climate zone Moderate	1.13	1.55

Italy – Insulation

U-Values (W/m2.K)	Floor	Roof	Walls	Windows	Energy performance requirements for heating, air-conditioning	Floor area to volume ratio < 0.2	Floor area to volume ratio > 0.9
Climate zone A	0.65	0.38	0.62	4.6	Climate zone A	8.5	36
Climate zone B	0.49	0.38	0.48	3	Climate zone B	12.8	48
Climate zone C	0.42	0.38	0.4	2.6	Climate zone C	21.3	68
Climate zone D	0.36	0.32	0.36	2.4	Climate zone D	34	88
Climate zone E	0.33	0.3	0.34	2.2	Climate zone E	46.8	116
Climate zone F	0.32	0.29	0.33	2	Climate zone F	46.8	116

Country	Mandatory	Chronology		Enforcement		Scope	Compliance Software	Floor area	Climate Zones	Total energy consumption	End-uses considered	Thermal comfort		Insulation	HVAC	Hot water	Lighting	Skylights	Windows	Renewable energy
Korea	Building Design Code for Energy Saving	First version	1986	Fines	Not available	Residential multifamily attached	Not available	Not available	Temperate, with rainfall heavier in summer than winter	Not available	Not available	Not available	Not available	U-Values (W/m2.K): see below	Not available	Not available	Not available	Not available	Not available	Not available
		Second version	2010	Demolition	Not available															
		Current version	2012	Refusal of building permit	Not available															
		Next revision	Not available	Imprisonment	Not available															
Luxembourg	Règlement grand-ducal modifié du 30 novembre 2007 concernant la performance énergétique des bâtiments d'habitatio	First version	1996	Fines	Not available	None	Not available	Not available	Modified continental with mild winters, cool summers	Requirements for primary energy demand are related to the ratio area / volume Multi-family residential: 80.0 - 160.0 kWh/m2/year Single-family residential: 90.0 - 160.0 kWh/m2/year	Auxiliary devices, Heating, Hot water, Ventilation	Not available	Not available	U-Values (W/m2.K): see below	Not available	Not available	Not available	Not available	Not available	Not available
		Second version	2008	Demolition	Not available															
		Current version	2012	Refusal of building permit	Not available					Requirements for heating energy demand are related to the ratio area / volume Multi-family residential: 40.0 - 95.0 kWh/m2/year Single-family residential: 55.0 - 95.0 kWh/m2/year										
		Next revision	Not available	Imprisonment	Not available															
Netherlands	Bouwbesluit 2012: Chapter 5	First version	Not available	Fines	Not available	Not available	Not available	Not available	Temperate; marine; cool summers and mild winters	Not available	Not available	Not available	Not available	Not available	Not available	Not available	Not available	Not available	Not available	No specific requirement, but renewables are included in the EPN classification
				Demolition	Not available															
		Current version	2012	Refusal of building permit	Not available															
		Next revision	Not available	Imprisonment	Not available															

Korea – Insulation: U-Values (W/m2.K)

Walls	Floor	Roof	Windows
0.36	0.3	0.2	2.1

Luxembourg – Insulation

U-Values (W/m2.K)	Walls	Roof	Floor	Door	Windows
Building elements exposed to outside air	0.32	0.25	0.32	2	1.5
Building elements adjacent to weakly heated rooms	0.5	0.35	2.5	0.5	2
Building elements adjacent to unheated rooms or soil	0.4	0.3	0.4	2.5	2

Country	Mandatory	Chronology		Enforcement		Scope	Compliance Software	Floor area	Climate Zones	Total energy consumption	End-uses considered	Thermal comfort: Temperature	Thermal comfort: Relative humidity	HVAC	Hot water	Lighting	Skylights	Windows	Renewable energy
New Zealand	H1 Energy Efficiency 3rd edition	First version	1992	Fines	Yes	Detached dwellings, multi-unit dwelling, group dwelling	Not available	In relation to a building, the floor area means (expressed in square metres) of all interior spaces used for activities normally associated with domestic living.	Climate zone 1; Climate zone 2; Climate zone 3 (Heating Degree Days: Not available; Cooling Degree Days: Not available)	Not requirement	Cooling, Heating, Hot water	20°C	Must comply with E3/AS1 for Internal Moisture	Not applicable	Minimum limits for gas storage and continuous flow water heaters. Electric storage water heaters must comply with NZ MEPS. Water systems over 700l capacity are not covered by the New Zealand Building Code	No requirements	1.2m2 Max. total area unless using the modelled compliance path	Depends on compliance method - typically windows are R0.26	No requirements
				Demolition	Yes														
		Current version	2011	Refusal of building permit	Yes														
		Next revision	Not available	Imprisonment	No														
Norway	The Planning and Building Act	First version	1985	Fines	Not available	All heated buildings except cottages < 50m2	Various software can be used if in line with national calculation methods	The gross areas of all storeys, incl. basements and useable Heated usable floor area	Temperate along coast, modified by North Atlantic Current; colder interior with increased precipitation and colder summers; rainy year-round on west coast	Small houses and leisure homes with more than 150 m2 of heated usable floor space: 120 kWh/m2/yea + (1600 kWh/year/ heated floor area); Block of flats: 115 kWh/m2/year + (1600 kWh/year/ heated floor area)	Appliances and equipment, Heating, Hot water, Lighting, Ventilation	22°C	Not available	Specific fan power: 2.5 kW/m3/s	Domestic water systems Buildings <500m2 must have at least 40% of space and water heating demand met by energy supplies other than direct acting electricity or fossil fuels	No specific requirements	Energy No specific requirments	The total sun factor for glass/windows (gt) shall be less than 0.15 on façades that catch the sun. Proportion of window and door areas ≤ 20% of heated usable floor space	Buildings <500m2 must have at least 60% of space and water heating demand met by energy supplies other than direct acting electricity or fossil fuels
		Current version	2010	Demolition	Not available														
				Refusal of building permit	Not available														
		Next revision	2015	Imprisonment	Not available														
Poland	Technical regulations: Energy Savings and Thermal insulation	First version	1994	Fines	Yes	All new residential	Not available	Net area	Temperate with cold, cloudy, moderately severe winters with frequent precipitation; mild summers with frequent showers and thundershowers	Not available	Heating, Ventilation	Not available	Not available	Not available	Not available	Not available	Not available	Maximum solar radiation coefficient gc < 0.5, but when > 50% of wall is transparent it becomes fG·gC < 0.25 where fG is the share of transparent parts in external wall.	No specific requirement, but renewables are included in the EPN classification
		Second version	2002	Demolition	Yes														
		Current version	2013	Refusal of building permit	Yes														
		Next revision	Not available	Imprisonment	Yes														

Insulation – New Zealand

U-Values (W/m2.K)	Walls	Roof	Floor	Skylights	Windows
Non-solid construction (with glazing <30% of total wall area)					
Climate zone 1	1.9	2.9	1.5	0.26	0.26
Climate zone 2	1.9	2.9	1.3	0.26	0.26
Climate zone 3	2	3.3	1.3	0.31	0.26
Solid timber construction (with glazing <30% of total wall area)					
Climate zone 1	0.8 - 1.3	3.5	1.3	0.26 - 0.31	0.26 - 0.31
Climate zone 2	0.9 - 1.4	3.5	1.3	0.26 - 0.31	0.26 - 0.31
Climate zone 3	1.1 - 1.6	3.5	1.3	0.31	0.26 - 0.31
Solid construction (excluding solid timber) (with glazing <30% of total wall area)					
Climate zone 1	0.8	3.5	1.3 - 1.5	0.26 - 0.31	0.26 - 0.31
Climate zone 2	0.9 - 1.0	3.5	1.3 - 1.5	0.31	0.26 - 0.31
Climate zone 3	1.0 - 1.2	3.5	1.3 - 1.5	0.31	0.26 - 0.31

Insulation – Norway: U-Values (W/m2.K)

Walls	Floor	Roof	Windows
0.22	0.18	0.18	1.6

Insulation – Poland

Not available

Country	Mandatory	Chronology		Enforcement		Scope	Compliance Software	Floor area	Total energy consumption	End-uses considered	Thermal comfort: Temperature	Thermal comfort: Relative humidity	HVAC	Hot water	Lighting	Skylights	Windows	Renewable energy
Portugal	Regulamento das Caracteristicas de Comportamento Térmico dos Edifícios (RCCTE)	First version	1991	Fines	Yes	All residential buildings licensed after enforcement of Decree-Law 80/2006, from 4 April	ITeCons CYPETERM RCCTE-STE	Represents the sum of the area of the internal compartments of a dwelling, excluding the area of internal walls	Primary energy consumption of 46 to 56 kWh/m2/year or 125 to 203 kWh/m2/year according to climate zone	Cooling, Heating, Hot water, Ventilation	Winter: 20ºC; Summer 25ºC - Used for nominal calculations	Not available	Not applicable	Not available	Not applicable	Not available	Not available	Included in total energy use
				Demolition	No													
		Current version	2012	Refusal of building permit	Yes													
		Next revision	2017	Imprisonment	No													
Russia	Thermal Performance of Buildings	First version	1979	Fines	Not available	Single family home and Multi-family homes	Not available	Not available	Not available	Not available	Not available	Not available	Single-family	Not available	Not available	Not available	Refer to Insulation section	Not available
		Second version	2003	Demolition	Not available													
		Current version	2012	Refusal of building permit	Not available													
		Next revision	Not available	Imprisonment	Not available													
Slovak Republic	Act No. 555-2005 Coll. on energy performance of buildings	First version	2006	Fines	Yes	Single-family and multi-family buildings > 50m2	None currently available	Not available	Depends on category	Auxiliary devices, Cooling, Heating, Hot water, Lighting, Ventilation	Not available	Not available	Not available	Not available	Not available	Not available	Not available	Included in energy calculation
				Demolition	No													
		Current version	2012	Refusal of building permit	No													
		Next revision	2017	Imprisonment	No													

Climate Zones

Country	Climate Zones	Heating Degree Days	Cooling Degree Days
Portugal	Climate zone W1	Not available	
	Climate zone W2		
	Climate zone W3		
Russia	Climate zone I	2000	Not available
	Climate zone II	4000	
	Climate zone III	6000	
	Climate zone III	6000	
	Climate zone IV	8000	
	Climate zoneV	10000	
	Climate zone VI	12000	
Slovak Republic	Temperate; cool summers; cold, cloudy, humid winters		

Insulation

Portugal: U-Values (W/m2.K)	Floor	Roof	Walls	Windows
Climate zone W1	0.5	0.5	0.7	4.3
Climate zone B	0.45	0.45	0.6	3.3
Climate zone C	0.4	0.4	0.5	3.3

Russia: R-Values (m2.K/W)	Door	Roof	Walls	Suspended floor
Climate zone I	0.3	2.8	2.1	3.2
Climate zone II	0.45	3.7	2.8	4.2
Climate zone III	0.6	4.6	3.5	5.2
Climate zone IV	0.7	5.5	4.2	6.2
Climate zoneV	0.75	6.4	4.9	7.2
Climate zone VI	0.8	7.3	5.6	8.2

Russia: Windows: R-Values (m2.K/W)	Multi-family	Single-family
Climate zone I	0.3	0.3
Climate zone II	0.45	0.45
Climate zone III	0.6	0.6
Climate zone IV	0.7	0.7
Climate zoneV	0.75	0.75
Climate zone VI	0.8	0.8

Slovak Republic: Insulation
Not available

South Africa

Mandatory	Chronology		Enforcement		Scope	Compliance Software	Floor area
National Building Regulation	First version	2011	Fines	Not available	All residential buildings	Not available	Not available
			Demolition	Not available			
	Current version	2011	Refusal of building permit	Not available			
	Next revision	Not available	Imprisonment	Not available			

Climate Zones	Heating Degree Days	Cooling Degree Days
Climate zone 1	Not available	
Climate zone 2		
Climate zone 3		
Climate zone 4		
Climate zone 5		
Climate zone 6		

Total energy consumption	End-uses considered	Thermal comfort	
200 kWh/m2/year	Cooling, Heating, Hot water, Lighting, Ventilation	Not available	Not available

Insulation: R-Values (m2.K/W)	Foor	Roof	Walls	Suspended floor
Climate zone 1	1	3.7	2.2	1.5
Climate zone 2	1	3.2	1.9	1.5
Climate zone 3	1	2.7	1.9	1
Climate zone 4	1	3.7	1.9	1
Climate zone 5		2.7	1.9	
Climate zone 6	1	3.5	2.2	1

HVAC	Hot water	Lighting	Skylights	Windows	Renewable energy
Not available	Not available	Not available	Not available	Not available	Not available

Spain

Mandatory	Chronology		Enforcement		Scope	Compliance Software	Floor area
Código Técnico de la Edificación	First version	1979	Fines	Yes	All new residential buildings	LIDER	The private closed interior surface, minus the non usable surface such as walls, partitions, columns, etc.. and plus fifty percent open areas. Definitions are adapted at local levels
	Second version	2006	Demolition	No			
	Current version	2012	Refusal of building permit	No			
	Next revision	Not available	Imprisonment	No			

Climate Zones	Winter climate severity index	Summer climate severity index
Climate zone A3	SCI ≤0.3	0.9< SCV ≤1.25
Climate zone A4	SCI ≤0.3	SCV >1.25
Climate zone B3	0.3 < SCI ≤ 0.6	0.9< SCV ≤1.25
Climate zone B4	0.3 < SCI ≤ 0.6	SCV >1.25
Climate zone C1	0.6 < SCI ≤ 0.95	SCV ≤0.6
Climate zone C2	0.6 < SCI ≤ 0.95	0.6 < SCV ≤ 0.9
Climate zone C3	0.6 < SCI ≤ 0.95	0.9< SCV ≤1.25
Climate zone C4	0.6 < SCI ≤ 0.95	SCV >1.25
Climate zone D1	0.95 < SCI ≤ 1.3	SCV ≤0.6
Climate zone D2	0.95 < SCI ≤ 1.3	0.6 < SCV ≤ 0.9
Climate zone D3	0.95 < SCI ≤ 1.3	0.9< SCV ≤1.25
Climate zone E1	SCI > 1.3	SCV ≤0.6

Total energy consumption	End-uses considered	Thermal comfort	
Reference buildings or U-Values	Cooling, Heating, Hot water	No requirement	No requirement

Insulation: U-Values (W/m2.K)	Foor	Roof	Walls
Climate zone A3	0.53	0.5	0.94
Climate zone A4	0.68	0.45	0.82
Climate zone B3	0.5	0.41	0.73
Climate zone B4	0.49	0.38	0.66
Climate zone C1	0.48	0.35	0.57

HVAC	Hot water	Lighting	Skylights	Windows	Renewable energy
Specifications depend on climate zone and construction, details listed in the legislation CTE DB HE1	No requirement	Specifications depend on climate zone and construction, details listed in the legislation CTE DB HE1	U values, solar factor and % of glazed area are given for all 12 climate zones in CTE DB HE1 Section 2, table 2.2	U values, solar factor and % of glazed area are given for all 12 climate zones in CTE DB HE1 Section 2, table 2.2	30% to 70% of domestic hot water to be covered by solar thermal energy

Sweden

Mandatory	Chronology		Enforcement		Scope	Compliance Software	Floor area
Building Regulations BBR10	First version	1946	Fines	Yes	Residential Buildings except buildings or parts of building used for short periods, or those which are not heated or cooled for most of the year	Not available	Indoor area intended to be heated to <10°C enclosed by the envelope
			Demolition	Yes			
	Current version	2012	Refusal of building permit	Yes			
	Next revision	Not available	Imprisonment	No			

Climate Zones	Heating Degree Days	Cooling Degree Days
Climate zone 1	Not available	
Climate zone 2		
Climate zone 3		

Total energy consumption	End-uses considered	Thermal comfort: Temperature	Thermal comfort: Relative humidity
Refer to Insulation section	Auxiliary devices, Cooling, Heating, Hot water	22°C	Not available

Insulation: U-Values (W/m2.K)	Roof	Walls	Floor	Windows	Door
Electrically heated	0.08	0.1	0.1	1.1	1.1
Other than electrical heating	0.13	0.18	0.15	1.3	1.3

Total energy consumption: kWh/m2/year	Electrically heated	Other than electrical heating
Climate zone 1	95	130
Climate zone 2	75	110
Climate zone 3	55	90

HVAC	Hot water	Lighting	Skylights	Windows	Renewable energy
Heating and cooling and air handling installations shall be provided with automatic regulation equipment	No requirement	No requirement	Not available	1.3 W/m2.K	Not available

	Mandatory	Chronology		Enforcement		Scope	Compliance Software	Floor area	Climate Zones	Total energy consumption	End-uses considered	Thermal comfort		Insulation					HVAC	Hot water	Lighting	Skylights	Windows	Renewable energy
Switzerland	MoPEC - MuKEn (Harmonised energy requirements for the Cantons)	First version	Not available	Fines	Not available	Not available	Not available	Not available	Temperate, but varies with altitude; cold, cloudy, rainy/snowy winters; cool to warm, cloudy, humid summers with occasional showers	42.0 - 54.0 kWh/m2/year	Not available	Not available	Not available	U-Values (W/m2.K)					Not available	Not available	Not available	Not available	Not available	Not available
				Demolition	Not available									Walls	Roof	Floor	Door	Windows						
		Current version	2009	Refusal of building permit	Not available									0.17 - 0.2	0.17 - 0.2	0.17 - 0.2	1.3	1.3						
		Next revision	Not available	Imprisonment	Not available																			
Tunisia	Thermal building regulation	First version	2004	Fines	Yes	All resindetial buildings with more than 500 m2	CLIP	Not available	Temperate in north with mild, rainy winters and hot, dry summers; desert in south	Not available	Cooling, Heating, Hot water, Lighting, Ventilation	Temperature	Relative humidity	Not available					Not available	Not available	Not available	Not available	Not available	Not available
				Demolition	Yes							19°C	Not available											
		Current version	2004	Refusal of building permit	Yes																			
		Next revision	Not available	Imprisonment	No																			
Turkey	Bep-TR (Regulation of energy performance of buildings)	First version	2008	Fines	No	All new buildings excluding industrial buildings for production, temporary buildings used <2 years, buildings with a total useful floor area <50m², greenhouses, workshops, and stand-alone buildings without heating and cooling needs	Under development by the ministry	Not available	Temperate; hot, dry summers with mild, wet winters; harsher in interior	Not available	Cooling, Heating, Hot water	Temperature	Relative humidity	TS 825 (similar to EN 13790)					Not available	EN 15316	EN 15251, EN 12464, EN 12665, EN 13032	Not available	TS 825	No requirement
		Second version	2010	Demolition	No							Changes with respect to building types (TS 825)	Changes with respect to building types (TS 825)											
		Current version	2013	Refusal of building permit	Yes																			
		Next revision	Not available	Imprisonment	No																			

<table>
<tr><th></th><th>Mandatory</th><th colspan="2">Chronology</th><th colspan="2">Enforcement</th><th>Scope</th><th>Compliance Software</th><th>Floor area</th><th colspan="3">Climate Zones</th><th>Total energy consumption</th><th>End-uses considered</th><th colspan="2">Thermal comfort</th><th colspan="4">Insulation</th><th>HVAC</th><th>Hot water</th><th>Lighting</th><th>Skylights</th><th>Windows</th><th>Renewable energy</th></tr>
<tr><td rowspan="4">United Kingdom</td><td rowspan="4">Building Regulations 2010</td><td>First version</td><td>1976</td><td>Fines</td><td>No</td><td rowspan="4">All dwellings and flats, excluding rooms for residential purposes like student and nursing residences, hostels</td><td rowspan="4">SAP (Standardised Assessment Procedure) 2009
Elmhurst Energy Systems
EPC online
Northgate Information Solutions</td><td rowspan="4">Enclosed spaces measured to the internal face of the external walls. Incl. areas of sloping surfaces such as staircases, excl. unenclosed areas such as open floors, covered ways and balconies</td><td colspan="3" rowspan="4">Temperate; moderated by prevailing southwest winds over the North Atlantic Current; more than one-half of the days are overcast</td><td rowspan="4">Building performance requirement (kgCO2/m2) based on equivalent model building</td><td rowspan="4">Cooling, Heating, Hot water, Lighting, Ventilation</td><td rowspan="4">Not available</td><td rowspan="4">Not available</td><td colspan="4">U-Values (W/m2.K)</td><td rowspan="4">Not available</td><td rowspan="4">Not available</td><td rowspan="4">Not available</td><td rowspan="4">Not available</td><td rowspan="4">Not available</td><td rowspan="4">Not available</td></tr>
<tr><td>Second version</td><td>2010</td><td>Demolition</td><td>No</td><td>Walls</td><td>Floor</td><td>Roof</td><td>Windows</td></tr>
<tr><td>Current version</td><td>2013</td><td>Refusal of building permit</td><td>No</td><td rowspan="2">0.3</td><td rowspan="2">0.25</td><td rowspan="2">0.2</td><td rowspan="2">2</td></tr>
<tr><td>Next revision</td><td>Not available</td><td>Imprisonment</td><td>No</td></tr>
<tr><td rowspan="9">United States</td><td rowspan="9">(2006 IEEC) Energy and Residential Energy Code for Alabama</td><td rowspan="4">First version</td><td rowspan="4">Not available</td><td rowspan="2">Fines</td><td rowspan="2">Not available</td><td rowspan="9">All residential buildings</td><td rowspan="9">Not available</td><td rowspan="9">Not available</td><td></td><td>Heating Degree Days</td><td>Cooling Degree Days</td><td rowspan="9">Not available</td><td rowspan="9">Not available</td><td rowspan="9">Not available</td><td rowspan="9">Not available</td><td colspan="4" rowspan="9">Not available</td><td rowspan="9">Not available</td><td rowspan="9">Not available</td><td rowspan="9">Not available</td><td rowspan="9">Not available</td><td rowspan="9">Not available</td><td rowspan="9">Not available</td></tr>
<tr><td>Climate zone 1</td><td colspan="2" rowspan="8">Not available</td></tr>
<tr><td rowspan="2">Demolition</td><td rowspan="2">Not available</td><td>Climate zone 2</td></tr>
<tr><td>Climate zone 3</td></tr>
<tr><td rowspan="3">Current version</td><td rowspan="3">2012</td><td rowspan="3">Refusal of building permit</td><td rowspan="3">Not available</td><td>Climate zone 4 (Except Marine)</td></tr>
<tr><td>Climate zone 4 Marine</td></tr>
<tr><td>Climate zone 5</td></tr>
<tr><td rowspan="2">Next revision</td><td rowspan="2">Not available</td><td rowspan="2">Imprisonment</td><td rowspan="2">Not available</td><td>Climate zone 6</td></tr>
<tr><td>Climate zone 7</td></tr>
</table>

Climate zone 8	

According to “Table 7” data it is clear energy efficiency standards depends on climate condition not geographical boundaries of the country. Countries which have more than one climate, regulated standards accordingly such as:

- Australia
- Canada
- China
- France
- India
- Italy
- New Zealand
- Portugal
- Russia
- South Africa
- Spain
- Sweden
- United State

For understanding these regulation better, according to each topic in “Table 7” successful country’s have been selected as a base of comparison. In following part all selected countries will be named and the result will be mentioned.

Chronology: in this part numbers of revisions for each regulation is important, it shows how these countries are developing their energy efficiency standards and which one is more updated and what is the plan for future climate change for those countries.

- Australia: in this country, there are 3 versions of standards and last version has been applied in 2012, but there is no new version on purpose for future till now.
- Canada: Canada energy efficiency regulation started in 1978, but the current version has been published in 2011. Next standard version is designed for 2015.
- Denmark: this country started applying energy codes before Canada in 1961 and current regulation published in 2010, but same as Canada next standard

- will be designed for 2015.
- France: current energy standard in France is more updated (2012) and the next version will be published in 2017.
- Korea, Loxamburg, Poland, and Russia: current version of energy codes in these countries are in the third step. Experience problems, according to climate condition and country situation makes changes in standards.
- Sweden: the earliest energy efficiency regulation has been designed in Sweden (1946), which makes this country above of others. The second official standard has been published in 2012, but during these 66 years there were correct for an energy standard in this country, but it is not possible to cut them as a new version.
- United Kingdom: this country started regulating energy codes on 1976, the second version has published in 2010 and current version applied on 2013. It is the most updated energy regulation in between and correcting energy standards is in command.

As a conclusion of this part it is possible to say at the beginning countries started to have just energy efficiency regulation, but after a few years, it became clear to match energy codes for building construction to the climate change and technology advances. Then energy efficiency regulation has been changed accordingly. Most of these countries updating energy efficiency standard between 5 to 7 years, but this time period is not fixed and it might change according to climate changes, speed of global warming and many other factors.

Enforcement: this factor consists of four heading: fines, demolition, refusal of building permit, and imprisonment. In most of countries, there is not confirmation of this issue, but in some countries like Greece, France, Germany, New Zealand, Poland, Portugal, Slovak Republic, Spain, Sweden, Tunisia, Turkey, and the United Kingdom there are specific orders for each factor. It is recommended to clarify these enforcement factors for new and developing regulations.

Scope: this factor is different in regulations, but generally regulations are applying for dwelling over 50m2, new construction and generally for single family home. It seems the most studied scope is belongs to Germany (All residential buildings which are heated or cooled using energy, incl. Retirement and nursing homes, excl. Those meant for use less than four months a year or temporary buildings) which is recommended.

Compliance Software: softwares are designed for each country regulation and method accordingly. Thus, it is not possible to evaluate these softwares without study them and see the result for comparison. It is important for regulators to analyze successful softwares to find out the best one and design their own program according to the successful software.

Floor area: this factor is a variation between countries. In some regulations floor area is not mentioned and in scope part this factor has been covered. It is possible to say this is adaptive calculation which is possible to have it in small countries like Northern Cyprus, but it's not applicable for large countries which have more that one climate zones.

Climate zones: in large countries, climate zones division have been done according to heating degree days, cooling degree days, maximum temperature, and water vapour pressure. This division have an effect on energy efficiency regulation in the design process to have the most comfortable, energy designed building according to climate condition. In case of Turkish Republic of Northern Cyprus there is no need to separate climate zones. This factor has been mentioned to find out similar climate conditions for studying regulation and have clear comparison.

Total energy consumption: calculating energy consumption is the average amount of energy usage per year in kWh/m2. Some countries are not effecting this factor to their regulation, but it is better to have knowledge about the amount of energy use to regulate more suitable energy efficiency standard for the building construction process.

Thermal comfort: for human being comfort it is necessary to consider temperature and relative humidity for indoor condition. Energy efficiency regulations should be designed accordingly. The most proper calculation belongs to Italy, but for the Turkish Republic of Northern Cyprus it seems enough to follow Turkey calculation method.

Insolation: for insolation calculation generally R-Value factor is considered as a base of computation, but for the hot climate condition mostly U-Value factor is more important. It is common between regulation to have calculated insolation for floor, roof, and wall; but it is possible to find suspended floor, windows, doors, and curtain wall in the calculation as well. It is recommended to have insolation calculation based on U-Value factor.

HVAC: there are many different confirmed information about HVAC systems and method. This issue is fixed according to the level of human comfort and the amount of mechanical usage for the thermal condition indoor. It is needed to regulate HVAC section of the standards as for market of the country. In this case Northen Cyprus market should develop and upgrade to give the chance to designers to follow future energy efficiency regulation.

Hot water: same as HVAC there is not fixed method for preparing hot water supply in all regulations and in many of them this calculation is not available. For the Turkish part of Cyprus island, it is common to have benefit of water heating solar panels and it is suitable for this area.

Lighting and windows: in most country lighting codes are not available, but there is regulated codes for turkey. As far as Northen Cyprus is considered part of Turkey country, it is recommended to use the same method with the correction for match it to the Northern Cyprus condition.

Renewable energy: in each country's regulation, according to climate condition and possibility of renewable energy in that area, there are codes to be followed. In the case of Northern Cyprus it is recommended to use solar PV panels and heating water collectors in beneficial. Also, it is possible to produce electricity from sea waves.

After analyzing energy efficiency regulation all around the world, the most successful factor in each standard became clear. Also, these codes in similar climatic condition to the Northern Cyprus have been selected and compared. Similar climate like China, International ISO standards, IECC codes, and hot climate zone in ABCB for Australia are most successful energy efficiency regulation which are helpful for regulating standards for Northern Cyprus. The result of the International Energy Conservation Code is more adaptable to the Northern Cyprus condition. The reason is IECC is the most flexible regulation with different calculation and variable ways to match these codes to new places.

Using IECC standard doesn't mean it is enough for regulating Turkish Republic of Northern Cyprus energy efficiency codes and it seems important to edit this regulation with some other methods which seems useful for this area and the result will be more acceptable. Also from China energy regulation, it is possible to work on traditional building energy design part for having possibility to design Cypriot building types. It is recommended to follow strong and successful factors from European countries which are mostly based on ISO standards. These factors are named above in the result part of "Table 7" comparison.

Before regulating standard for energy efficiency in Turkish Cyprus it is important to review general building regulation in this area and update it with new methods and technology in the world. There is lack of expert auditors and energy designers for this island which means it is necessary to add this field to the Northern Cyprus education programs and upbringing efficient workforce.

Another important issue is regulating energy efficiency codes is necessary, but it is not enough. Governments should consider the optional point of attracting employers, constructors and building owners to make their building as efficient as possible. This happens by improving related people with the knowledge of energy efficiency benefits which will cover primary expenses between 5 to 10 years. Another way is giving discounts and easy construction opportunity like to put Les taxes according to the level of efficiency in building or placing some rules for getting construction permission. Also it is recommended to give construction Leon with less interest in energy efficient designed buildings. Regulating energy codes should be equal to the material market and energy use equipment market. Simply that means TRNC market should change the way to follow sustainable marketing synchronous with worldwide marketing scale to be more adaptable to reach energy efficiency aim. Needed technology for different part of energy efficiency factors have to import to the island to be available for practitioners.

3.4.2 Recommended Energy Efficient Building Method in Construction

As far as there is no regulation for construction checking in Northern Cyprus, it is must for regulators to design the standard and publish it as soon as possible to improve the building condition quality in this area. It seems there will be enough to consider energy efficiency factors checking in a general regulation, but it is recommended to separate checklist according to collect information about energy efficiency options applies in the construction period. Then it will be clear for approval part to evaluate building through energy efficiency easier.

In following part according to the energy efficiency regulation in the construction process around the world three steps were classified. Generally there will be building information which consists of the exact place of building, designer or design team, type of the building, height of building and floor number, building owner, and construction company. In the first heading drawings have to be checked to see designer considered the energy efficiency regulation in design. In this section mostly building envelope will be checked. In next step there will be controlling construction in different time of construction to see the accuracy of energy efficiency factors installation. At the end of the construction period, the final product has to be checked and addition machines and lighting have to be examined. It is hardly recommended to have separated check list of energy efficiency in the construction process beside general construction checking regulation.

Table 7: Energy efficiency deviationsuction process devisions.

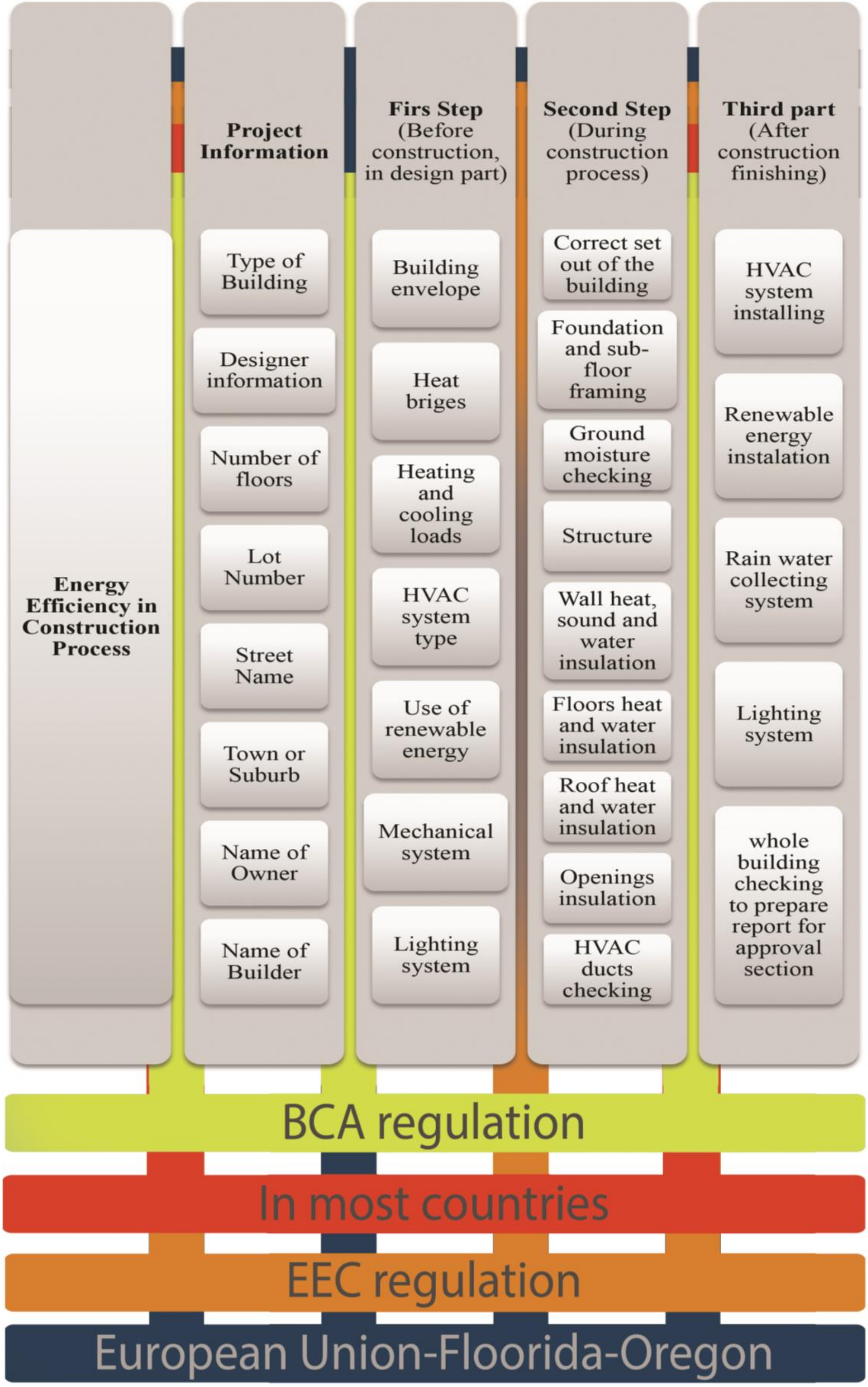

Table 8: Summary of energoffficiency regulation for construction process in some countries.

BCA	Australia	Zone 5	Compliance with 3.12.0		Compliance with Western Australia Additions for Water Use	Information checked before starting the construction	this check list is just applying in zone 5 in this ountry, but other zones do not follow
			Heating and cooling loads	Services	Water Use Efficiency		
			Building fabric thermal insulation				
			Thermal breaks		Swimming Pool Covers and Blankets		
			Compensation for loss of ceiling insulation				
			Floor edge insulation		Hot Water Use Efficiency		
			Building sealing				
EEC	International	Match with all climates	Sections Check	Factors which have to be checked during construction process	Heating & Cooling	Factors which have to be checked after construction process	
			Foundation		Fuel choice		
			Air sealing		Equipment size		
			Insulation		Equipment efficienc		
			Sheathing		Water Heating		
			HVAC combustion closet		Ventilation		
			Water heater		Ductwork		
Florida EE construction code	USA	Florida	Requirements for small additions, renovationto existing buildings andsite installation	Requirements for glass areas in additions	Minimum requirements for all packages	There is a first check list in this standard to analyze all building spaces acoording to energy efficiency	During construction process different factors should check and keep as a record sheet for the evaluation part
				Glass type, overhang and solar heat gain should check according to coefficient required for glass percentage	Exterior joints and cracks		
					Exterior windows and doors		
					Sole and top plates		
					Recessed lighting		
					Multi-story houses		
			Walls	20% / 30% / 40% / 50%	Exhaue fans		
			Ceilings		Combustion heating		
			Floors		Swimming pools and spas		
			Duct		Hot water pipes		
			Cooling		Shower heads		
			Space heating	Single	HVAC ducts		
			Hot water	Double	HVAC controls		
BEND	USA	Oregon	Envelope Enhancement Measure	Factors which have to be checked before and during construction process	Conservation Measure	Factors which have to be checked after construction process	
			High efficiency walls & windows		High efficiency HVAC system		
			High efficiency envelope		Solar photovoltaic		
			High efficiency ceiling, windows & duct sealing		Solar water heating		
			High efficiency thermal envelope UA		Ducted HVAC systems within conditioned space		
			Building tightness testing, ventilation & duct sealing		Ductless heat pump		
			Ducted HVAC systems within conditioned space		High efficiency water heating & lighting		
					Energy management device & duct sealing		
General European regulation	Europe	European Union countries	Design approval	Construction part	After construction	In Europe all energy efficiency checking placed in general construction regulation, but it will coer all sections of energy efficiency controlling parts during construction process.	
			Building envelope check	Foundation and sub-fl oor framing	Solar photovoltaic and hot water panels		
				Floors			
			Thermal insulation for walls, floors, and roof	Walls	HVAC machin		
				Roof	All mechanical equipments		
			Water insulation for walls and roof	Columns and beams	Building heat loss		
				Damp-proofi ng	Ventilation system		
			Lighting system	Roof and wall cladding	Openings insulation		
			HVAC system	Water proofi ng	Water pipes and ducts		
			Building energy usage type (use of renewable energy)	Openings	Water collecting system		
				Ducts and pipes insulation	Lighting efficiency		
In most countries examine energy applies is combined with general constructing regulation. Building standards for constructing new buildings and an extension to the existing buildings became worldwide from 1997							

Regulating for the construction part of the building process might be a milestone for the energy efficiency future of the Turkish Republic of Northern Cyprus. Thus after analyzing and comparing different methods of energy efficiency regulation for construction process around the world it is clear to follow the regulation of European countries. It is recommended to design separate regulation for energy efficiency from general construction regulation to have clear result for approval section. The gap in EU regulation is lack of specified codes of addition parts of the existing building which might cover by Florida construction regulation. Also for renewing or adding parts to the historical buildings has totally different regulations which are happening mostly in the United Kingdom and Netherland. In this research the focus is on regular existing buildings and new dwellings and this part will leave for further studies.

3.4.3 Recommended Energy Efficient Building Method in Approval

After studding approval methods and find out the weaknesses and strength of them, the most useful way will be explained in this part. There are some different methods around the world which are shown in chapter two and most popular ones have been explained. It seems better to follow the European labeling method which is more common in the world and seems easier and more useful for Northern Cyprus. This labelling is more familiar for ordinary people because they get used to read and understanding this kind of labeling in the case of Northern Cyprus. There is a usage of this labeling method for electrical accessories in the market and it is a clear product with higher levels of energy efficient usage in this label will give you more benefit according to energy usage. It is recommended to have a familiar style of buildings also. The other reason is the southern part of the Cyprus (Greek part) is part of the European Union and this study have the opportunity to apply for the other part of this island as well.

Approval process in this area is divided into two parts:

- New construction building approval
- Existing and historical building approval

Basic factors in the building energy grading is studied and also there will be recommended factors for the other possibilities considered. All information is collected, compared and analyzed through climatic condition in this part of the world. Building energy labeling for all new or existing buildings should became main factor for the building owners, renters, and constructing companies to reach the aim of sustainability for building construction process. This labeling have to be reasonable for the clients to accept for applying the regulation. At the beginning it seems important to give the basic knowledge about benefit of being efficient for the ordinary people which are the main users of buildings to teach them and let them understand about the help of these codes for a better life and also save more money. They need to know with the higher building energy label, they will pay less for energy bills and reach the comfortable situation for living in those buildings easier.

Energy efficiency regulation in the building construction process should consider as the aim of the government to motivate companies to apply energy policies correctly. The solution might be calculating the building tax according to the level of efficiency of it like nearly all countries in the world. Beside for the project which are considering energy efficiency standards will be bank loans with lower interest. At the end there should be prepared template for both new and existing buildings to make all steps clear for auditors to collect the data for building efficiency.

For Cyprus Island it seems no need to design and check for the acoustic factors to protect the building from outdoor noise, but inside the buildings it seems to need. It might easily done with the landscape and the effect of other considered insulation in the building, using double glazed windows or having cavity walls will be enough for Northern Cyprus condition according to the city's population and crowdedness. Also for inside sound protection between unit, it might be enough to just increase wall thicknesses and installing other insulation correctly. After applying these factors to the building effect of sound to the next unit will be reduced automatically and it will be enough for this condition.

On the other hand it is better to check building energy efficiency level after labeling to find out the heat loss due to time passing. It is important because of the humidity in the Island is in the high level, and also level of maintaining of the building owner is not acceptable. There is a lack of knowledge for building owners that the building needs mentioning in different parts which is not visible. There should be technicians to help people to understand necessary points and teach them how to protect their home according to any damage might happens due to time.

These checks will be easy with having benefit of the infrared cameras to examining the amount of heat loss in the building as a heat photo. After heat photography of the building and analyze, the result will be approved to the building users which the current situation is efficient enough or they need to have a more detailed energy check for the building and find the problems and offering the solution for fixing problems in any part of the building. According to owners effort the building might be checked after repairing or the grade of energy efficiency in that building will change according to the new level of energy usage there. Government's duty will be controlling these labeling and fix the tax payments for each change in energy level of the building.

For new constructed buildings it is better to examine the project after 30 years for the first time checking and then check it after each 10 years. For the existing buildings it is recommended to check the quality of the energy efficiency level of the building after 20 years for a first time and then test it again after each 10 years. This timing is proposed according to other countries' experiences, but it needs to be checked. The result in the long term will gives clue to regulators to fit the correct check-in time in the case of Turkish Repuclic of Northern Cyprus.

To reach the goal of approval there should be energy expert workers to understand different situations in the area and have the ability to examine the building according to energy efficiency factors. Collecting data should be done by these auditors, then this information has to be analyzed for grading building levels of efficiency. In Northern Cyprus there is a lack of knowledge about this issue. Thus it is needed to educate auditors and engineers for making the approval process possible. They have to be graduated according to examining building energy efficiency and have the opportunity to experience and get the degree for doing this importance. Also it is important for the Northern Cyprus market to synchronize itself to the new technology.

3.4.3.1 New Construction Approval

For new construction approval, it is important to check the process from the design step to see how energy codes calculated and applied to the building details. In studying design section, the building envelope has to be check accurate. There should be checking for the construction reports which have been reported in different timing during building construction. For approval process it is needed to regulate codes for the design process and construction firs and then the standard of approving energy efficiency in the building should be done accordingly.

Summary of labeling parts of building energy efficiency construction process is mentioned in “Table 9” according to the country which these codes are applying. It is clear to say amount of energy in each building will show the level of energy efficiency in that building. “Table 9” shows, in these standards stated in each regulation, how and when have been developed, what is the scope of the rating, the enforcement of applying energy labeling codes, which software has been used, what is the certification method for each one, and end use considered. This information will help regulators to have illustrated view of publishing the best standard for labeling evaluation in the building construction process for the Turkish Republic of Northern Cyprus.

Table 9: Summary of energy efficiency detail in labeling part of process, separated by countries. (http://www.sustainablebuildingscentre.org/pages/beep)

Country	Mandatory	Chronology		Enforcement	Compliance Softwares	Certification Methodology	Scope	Number of certified buildings	Database of certificates	End-uses Considered	Energy Rating	
Australia	NatHERS	First version	1993	Not available	AccuRate Sustainability Version 2.0.2.13x / BERS Professional (Version 4.2.110811) / FirstRate 5 v 5.1x	Calculated	All new residential buildings	Not available	Not available	Cooling, Heating, Ventilation	Star classification for MJ/m2 based on calculated energy demand	
		Current version	2007									
		Next revision	Not available									
Austria	EPBD Energy Performance Certificate	First version	2008	Not available	Not available	Not available	All new buildings	Not available	Not available	Cooling, Heating, Ventilation	Efficiency scale based on energy demand in KWh/m2.year	
											A	≤ 25 KWh/m2.year
		Current version	Not available								A+	≤ 15 KWh/m2.year
											A++	≤ 10 KWh/m2.year
											B	≤ 50 KWh/m2.year
											C	≤ 100 KWh/m2.year
		Next revision	Not available								D	≤ 150 KWh/m2.year
											E	≤ 200 KWh/m2.year
											F	≤ 250 KWh/m2.year
											G	> 250 KWh/m2.year
Belgium	Brussels Capital Region: PEB Energy Performance Certificate	First version	2008	Not available	Not available	Not available	All new buildings	Not available	Not available	Cooling, Heating, Ventilation	Scale based on primary energy consumption	
											A	16-30 kWh/m2.year
											A+	0-15 kWh/m2.year
											A++	Less than zero
											A-	31-45 kWh/m2.year
		Current version	2011								B	63-78 kWh/m2.year
											B+	46-62 kWh/m2.year
											B-	79-95 kWh/m2.year
											C	114-132 kWh/m2.year
											C+	96-113 kWh/m2.year
											C-	133-150 kWh/m2.year
											D	171-190 kWh/m2.year
		Next revision	Not available								D+	151-170 kWh/m2.year
											D-	191 - 210 kWh/m2.year
											E	233 -253 kWh/m2.year
											E+	211 - 232 kWh/m2.year
											E-	254-275 kWh/m2.year
											F	276-345 kWh/m2.year
											G	> 345 kWh/m2.year
Brazil	Qualiverde label	First version	2009	Not available	Not available	Level of energy efficiency measured through a points based system	Tax benefits to builders who meet at least 70% of items distributed on sustainability of sharers	Not available	Not available	Appliances and equipment, Auxiliary devices, Cooling, Heating, Hot water, Lighting, Vapour humidification, Ventilation		
		Current version	Not available									
		Next revision	Not available									
Canada	BOMA BESt (Building Environmental Standards)	First version	2005	Not available	Green Globes	Measured	Multi-Unit Residential Buildings	Not available	BOMA BESt certified buildings	Appliances and equipment, Cooling, Heating, Hot water, Lighting, Ventilation	Audit of a building's energy management and environmental impact	
		Current version	2012								BOMA BESt Level	< 70% on full assessment and meet all BOMA BESt practices
											BOMA BESt Level	70-79% on full assessment and meet all BOMA BESt practices
		Next revision	Not available								BOMA BESt Level	80-89% on full assessment and meet all BOMA BESt practices
											BOMA BESt Level	90-100% on full assessment and meet all BOMA BESt practices
Czech Republic	EPBD Energy Performance Certificate	First version	2007	Not available	National Calculation Tool (NKT)	Based on CEN standards	All new residential buildings >50m2 when rented or sold	Not available	Not available	Cooling, Heating, Hot water, Ventilation	Efficiency ratings based on delivered energy consumption incorporating climate zone and energy source data	
		Current version	Not available									
		Next revision	Not available									
Denmark	EBPD energy performance certificate	First version	1997	Not available	EK-Pro Energy08	Calculated	All new residential buildings	60231 in 2011 (new and existing incl summerhouses)	OIS	Cooling, Heating, Ventilation	Efficiency Scale (A= Heated floor area)	
											A1	<30.0 kWh/m2 year + 1000kWh/year/A
		Current version	2006								A2	< 52.5 kWh/m2 year + 1650kWh/year/A
											B	< 70.0kWh/m2 year + 2200kWh/year/A
											C	< 110 kWh/m2 year + 3200kWh/year/A
		Next revision	2011								D	< 150 kWh/m2 year + 4200kWh/year/A
											E	< 190kWh/m2 year + 5200kWh/year/A
											F	< 240 kWh/m2 year+ 6500 kWh/year/A
											G	> 240 kWh/m2 year + 6500kWh/year/A

	Mandatory	Chronology		Enforcement	Compliance Softwares	Certification Methodology	Scope	Number of certified buildings	Database of certificates	End-uses Considered	Energy Rating	
Finland	Energy Performance Certificate	First version	Not available	Not available	Not available	Calculated	All Residential	Not available	Not available	Cooling, Heating, Hot water	Net Final Energy Demand	
		Current version	2008								A	150 kWh/m2/year
											B	151-170 kWh/m2/year
											C	171-190 kWh/m2/year
											D	191-230 kWh/m2/year
		Next revision	2015								E	231-270 kWh/m2/year
											F	271-320 kWh/m2/year
											G	> 321 kWh/m2/year
France	Bâtiment Basse Consommation BBC	First version	2007	No labels awarded if energy requirements are not met.	Not available	Not available	All new buildings	39363 multi-family building & 19877 single-family building	Observatoire BBC	Cooling, Heating, Hot water, Lighting, Ventilation	Maximum primary energy consumption of 50kWh/m²/an for regulated loads	
		Current version	Not available									
		Next revision	Not available									
Germany	Zukunft Haus: Energy performance certificate	First version	2005	Penalties	There is no specific compliance software	Measured	All new residential buildings	Not available	Not available	Cooling, Heating, Hot water, Lighting, Ventilation	Energy consumption figure stated for both primary and final energy use marked on a scale from 0 - 400 kWh/m2/year	
		Current version	2009									
		Next revision	2012									
Greece	EPBD Energy Performance Certificate	First version	2010	Not available	Kenak	Audit	All Buildings > 50 m2	60,000 (by Apr 2012, new and existing)	Not available	Cooling, Heating, Hot water	Scale relative to modelled consumption values. E.A. is total primary energy consumption of existing building, K.A. is the reference building	
											A	0.33K.A < E.A. ≤ 0.50K.A.
											A+	E.A. ≤ 0.33K.A
		Current version	Not available								B	0.75K.A < E.A. ≤ 1.00K.A.
											B+	0.50K.A < E.A. ≤ 0.75K.A.
											E	1.82K.A < E.A. ≤ 2.27K.A.
		Next revision	Not available								H	2.73K.A.< E.A
											Γ	1.00K.A < E.A. ≤ 1.41K.A.
											Δ	1.41K.A < E.A. ≤ 1.82K.A.
											Z	2.27K.A < E.A. ≤ 2.73K.A.
Hungary	EPBD certification	First version	2006	Not available	Not available	Based on building regulations	All new buildings	Not available	Not available	Not available	Percentage efficiency scale based on primary consumption. 100% = 2006 requirements	
											A	56-76%
											A+	<55%
		Current version	2012								B	77-95%
											C	96-100%
											D	101-120%
											E	121-150%
		Next revision	Not available								F	151-190%
											G	191-250%
											H	251-340%
											I	>341%
India	IGBC Green Homes Rating System	First version	2009	Not available	Not available	Level of energy efficiency measured through a points based system	Housing projects, Apartments and Individual Homes	64	Not available	Appliances and equipment, Auxiliary devices, Cooling, Heating, Hot water, Lighting, Ventilation		
		Current version	2009									
		Next revision	Not available									
Ireland	EBPD Building Energy Rating	First version	2009	Not available	Not available	Calculated	All existing buildings when bought or rented	295,269	National BER register	Cooling, Heating, Hot water, Lighting, Ventilation	Scalar classification based on primary energy use	
											A1	≤ 25 kWh/m2.yr
											A2	>25 kWh/m2.yr
											A3	>50 kWh/m2.yr
											B1	>75 kWh/m2.yr
		Current version	Not available								B2	>100 kWh/m2.yr
											B3	>125 kWh/m2.yr
											C1	>150 kWh/m2.yr
											C3	>200 kWh/m2.yr
											D1	>225 kWh/m2.yr
		Next revision	Not available								D2	>260 kWh/m2.yr
											E1	>300 kWh/m2.yr
											E2	>340 kWh/m2.yr
											F	>380 kWh/m2.yr
											G	>450 kWh/m2.yr

	Mandatory	Chronology		Enforcement	Compliance Softwares	Certification Methodology	Scope	Number of certified buildings	Database of certificates	End-uses Considered	Energy Rating	
Italy	EPBD Energy Performance Certificate	First version	2007	Not available	Not available	Calculated monthly primary energy use	All new buildings	Not available	Not available	Heating, Hot water	An efficiency scale based on primary energy. Calculated for whole energy performance and single end uses. EPi = energy performance for heating only. L = region	
		Current version	2009								A	≤ 0.50 EPiL + 9 kWh/m2.year
		Next revision	Not available								A+	≤ 0.25 EPiL+ 9 kWh/m2.year
											B	≤ 0.75 EPiL + 12 kWh/m2.year
											C	≤ 1.00 EPiL + 18 kWh/m2.year
											D	≤ 1.25 EPiL + 21 kWh/m2.year
											E	≤ 1.75 EPiL + 24 kWh/m2.year
											F	≤ 2.50 EPiL + 30kWh/m2.year
											G	> 2.50 EPiL + 30 kWh/m2.year
Japan	Passive House	First version	1990	Not available	Passive House Planning Package PHPP Version 7 (2012) - EN	Calculated	New residential	2	Passive House projects	Appliances and equipment, Auxiliary devices, Cooling, Heating, Hot water, Lighting, Vapour humidification, Ventilation	Maximum cooling demand	15 kWh/m².year
		Current version	1990								Maximum space heating demand	15 kWh/m².year
		Next revision	Not available								Maximum total primary energy demand	120 kWh/m².year
Korea	Building Energy Efficiency Certification Programme	First version	2001	Not available	Not available	Not available	Multi-family residential buildings	699	Not available	Cooling, Heating, Hot water, Lighting, Ventilation		
		Current version	Not available								1	> 40%
		Next revision	Not available								2	30% - 40%
											3	20% - 30%
											4	10% - 20%
											5	< 10%
Luxembourg	EPBD Energy Performance Certificate	First version	2008	Not available	Not available	Calculated primary energy consumption	All new residential buildings	Not available	Not available	Auxiliary devices, Heating, Hot water, Ventilation	Single-family residential kWh/m2/year	
		Current version	2010								A	< 45
		Next revision	Not available								B	< 95
											C	< 125
											D	< 145
											E	< 210
											F	< 295
											G	< 395
											H	< 530
											I	> 530
Netherlands	EPBD Energy Performance Certificate	First version	1995	Not available	EP Check 3.0	Calculated	All buildings when bought or rented	Not available	Not available	Heating, Hot water, Lighting, Ventilation	Energy Index based on primary energy use, building type and energy savings measures taken	
		Current version	2011									
		Next revision	Not available									
New Zealand	Homestar	First version	2009	Not available	Not available	Not available	All residential buildings	Not available	Register of homes	Not available		
		Current version	2009									
		Next revision	Not available									
Norway	EPBD Energy Performance Certificate	First version	2010	Not available	Not available	Calculated primary energy to the building, and percentage of space and water heating possible by renewables	All new residential buildings	>40,000 by November 2010	Not available	Not available	Classification according to primary energy	
		Current version	Not available								A (Apartment blocks)	≤67 kWh/m2.yr
		Next revision	Not available								A (Small buildings)	≤79 kWh/m2.yr
											B (Apartment blocks)	≤100 kWh/m2.yr
											B (Small buildings	≤118 kWh/m2.yr
											C (Apartment blocks)	≤134 kWh/m2.yr
											C (Small buildings)	≤158 kWh/m2.yr
											D (Apartment blocks)	≤184 kWh/m2.yr
											D (Small buildings)	≤231 kWh/m2.yr
											E (Apartment blocks)	≤235 kWh/m2.yr
											E (Small buildings)	≤305 kWh/m2.yr
											F (Apartment blocks)	≤353 kWh/m2.yr
											F (Small buildings)	≤458 kWh/m2.yr
											G (Apartment blocks)	No limit
											G (Small buildings)	No limit
Poland	EPBD Energy Performance Certificate	First version	2009	Not available	Not available	Not available	New buildings and major renovations (different labels exist for Apartment buildings and Residential buildings)	Not available	Under development by the ministry	Cooling, Heating, Hot water	Linear scale of primary energy consumption with the building's energy performance marked, and compared to the modelled performance of a similar new building and a similar renovated building	
		Current version	2009									
		Next revision	2013									

	Mandatory	Chronology		Enforcement	Compliance Softwares	Certification Methodology	Scope	Number of certified buildings	Database of certificates	End-uses Considered	Energy Rating	
Portugal	Certificado de Desempenho Energético e da Qualidade do Ar Interior	First version	2007	Fine	Not available	Based on nominal conditions	All residential buildings	400,000	Not available	Cooling, Heating, Hot water, Ventilation	Primary Energy	
		Current version	2007								A	25-50%
		Next revision	Not available								A+	0-25%
											B	50-75%
											B-	75-100%
											C	100-150%
											D	150-200%
											E	200-250%
											F	250-300%
											G	> 300%
Russia	Energy Efficiency Class of Multifamily Building	First version	Not available	Not available	Not available	Not available	Not available	Not available	Not available	Not available		
		Current version	Not available									
		Next revision	Not available									
Slovak Republic	EPBD Energy performance certificate	First version	2008	No penalties issued for non-compliance	Not available	Calculated rating	All residential buildings except mobile homes	14730 (total by 2011)	Database of buildings managed by Building Testing and Research Institute	Cooling, Heating, Hot water, Lighting, Ventilation	Total delivered (final) energy	
		Current version	2008								A	< 54
		Next revision	Not available								B	55-110
											C	111-165
											D	166-220
											E	221-275
											F	276-330
											G	> 330
South Africa	Green Star South Africa – Multi Unit Residential v1	First version	2010	Not available	Not available	Not available	Multi Unit Residential	Not available	Not available	Cooling, Heating, Hot water, Lighting, Ventilation	Overall environmental rating includes Carbon emissions (kgCO2/m2/year)	
		Current version	2011									
		Next revision	Not available									
Spain	Certificado de Eficiencia Energética del Edificio	First version	2007	Set locally, information not collected	LIDER	Calculated	All residential buildings except mobile homes	2,000	Not available	Cooling, Heating, Hot water	Annual primary energy consumption and a classification based on CO2 emissions, where C1 is relative to a modelled building meeting regulations, and C2 is relative to existing building stock averages	
		Current version	2010								A	<0.15
		Next revision	Not available								B	0.15≤ C1 < 0.50
											C	0.50 ≤ C1 < 1.00
											D	1.00 ≤ C1 < 1.75
											E	C1 > 1.75 and 100 ≤ C2 < 1.00
											F	C1 > 1.75 and 1.00 ≤ C2 < 1.50
											G	C1 > 1.75 and 1.50 ≤ C2
Sweden	EPBD Energy Performance Certificate	First version	2005	Not available	Not available	Calculation based on measured values of energy used	All new buildings	Not available	Gripen / The griffon (not publically available)	Cooling, Heating, Hot water, Lighting, Ventilation	Classification according to final energy consumption	
		Current version	2010								1st smallest	< 50 kWh/m2
		Next revision	Not available								2nd smallest	50-100 kWh/m2
											3rd smallest	100-150 kWh/m2
											4th smallest	150-200 kWh/m2
											5th smallest	200-300 kWh/m2
											6th smallest	300-400 kWh/m2
Switzerland	Minergie	First version	Not available	Not available	Not available	Calculated	Not available	15 000 by 2009	Minergie List of Buildings	Heating, Hot water, Lighting, Ventilation	MINERGIE-P®-Standard	Maximum primary energy demand 120 kWh/m².year (passive house standards)
		Current version	Not available								MINERGIE®-	Energy demand <75% and fossil fuel < 50% of average buildings
		Next revision	Not available									
Turkey	Bep-TR	First version	2011	Local governments have to check certifications	Under development by the ministry	Comparison with reference building energy consumption	All new buildings excluding industrial buildings for production, temporary buildings used <2 years, buildings with a total useful floor area <50m², greenhouses, workshops, and stand-alone buildings without heating and cooling needs	Not available	Records held by the ministry	Not available	Classifications are under review	
		Current version	2011									
		Next revision	Not available									
United Kingdom	EPBD Energy Performance Certificate	First version	2008	£200	SAP2009	Calculated	All residential	7 161 844 (End of 2011)	EPC register	Cooling, Heating, Hot water, Lighting, Ventilation	An energy efficiency rating scale (100 = most efficient) and environmental rating scale (100=lowest CO2 emission)	
		Current version	2008								A	92 - 100
		Next revision	Not available								B	81 - 91
											C	69 - 80
											E	39 - 54
											F	21 - 38
											G	20-Jan
United States	Energy Performance Scheme (AL, MA, VA, WA)	First version	Not available	Not available	Not available	Calculated	Not available	Not available	Not available	Appliances and equipment, Cooling, Heating, Hot water, Ventilation		
		Current version	Not available									
		Next revision	Not available									

After construction finished, the building must check due to collecting needed data for building labeling. To make approval more clear it is better to design a check list for all parts of the building and check them to make the grading process simpler. With the combination of the European style of approval, in a combination of some parts of United Stade labeling system (giving different building certificates for the ones which are more sustainable than standard requirement) it is possible to have full filled and successful method, applicable for Northern Cyprus.

Building envelope specially thicknesses of different layers in the building have to measure with checking them in building sections and details. For collecting correct information drilling is recommended. With drilling method, auditors will see all layers of building section installation. Using infrared cameras is recommended even before drilling, to check the place of insulation to understand the situation of them at the corners and fixture of the openings and other parts of the building. Heat photography is the simplest way to see thermal bridges in the building. In any case which thermal usage is more than standard drilling method is highly recommended to see the quality and thickness of installed insolations. It is better to do a hot photo shoot during the night or in winter time. The result will be more clear to measuring the heat loss when the building is heated from inside, because of the Northern Cyprus climate it is not possible to do this measurement at daylight in the summer season.

All applied mechanical equipment has to be checked through the energy usage base. For having this happening other non-related energy regulation to the market is needed to be reviewed or change for Northern Cyprus electrical and fuel motors systems. To reach more efficient building it is important to use the higher energy grade equipment in the importation or building new companies to produce necessary products based on energy factores. It's highly recommended to give higher energy level to buildings which are using renewable energy for their homes like solar heating water supply, collecting rain water tank and earth heat pumping.

Approval for new building construction is a long term process. First it is needed to regulate standards for design and construction sections. After applying those codes it is possible to check the building through energy efficiency. As a governmental part, it is possible to start regulating and makes some changes to the current way of tax calculating to prepare the base for applying coming standards and code.

3.4.3.2 Existing Building Approval

As a starting point for energy efficiency approval process for existing building it is suggested to check the existing building with the thermal cameras to understand the level of heat loss and find out the critical parts of the building in terms of heat loss. It will be common for all buildings on this Island. The reason is it is not possible to find any energy efficiency standards for building in Northern Cyprus case till now, then nearly all buildings will have the lots of heat energy loss, and moisture effected parts especially in the connected parts to the ground. With the primary data on the building energy loss, auditors can examine all parts of the building to have more accurate information for the designers and building energy engineers to find the best solution to achieve the highest energy efficiency result.

The most important factor for checking in existing buildings is moisture measurement according to the climatic condition. It seems there is no need of using drilling method for existing building because of the lack of heat and water insulation in Northern Cyprus buildings. The only common energy related activities in TRNC buildings is having benefit of water heating solar collectors as an addition to the top of the building's roof, not as a part of the architectural design which have negative effect on city image.

The approval process for existing building is a mid term process to achieve energy labeling for building as soon as possible. Examining existing building energy use might start earlier to give them to the building owners to fix their building problems to have higher levels of energy efficiency. After fixing problems in the building, auditors will examine the building again to see the building condition through energy efficiency after repairmen to illustrate the building energy efficiency label level. The governments will do the tax calculation changes for each building after collecting information about the level of energy efficiency in each building and apply it from that time.

3.4.4 Recommended Energy Efficiency Building Method for Existing and Historical Buildings

By analyzing Northern Cyprus existing building conditions, it is possible to group them in three categories:

- Historical buildings
- Buildings cannot be repaired
- Building possible to repair

This research is focused on the third part. Historical buildings should regulate energy efficiency standards separate and buildings which are not in an acceptable situation for repairing are not considered in this analysis. Firstly basic information for understanding the building current condition is needed. Then it is possible to study the building and find a suitable solution for it. According to Turkish Cyprus climate it is recommended to have the benefit of exterior heat insulation and base moisture covering for the basement or ground touched areas. After comparing regulation sections about existing building energy efficiency, it seems ICC method is more adaptable for Turkish Republic of Northern Cyprus condition. The main problem with TRNC situation is there is no insulation in most existing buildings that means there is a huge thermal bridge in most buildings.

It is important to calculate and apply shadings for openings which is possible with many available software and sun radiation angle in this area. There is no need for acoustic insulation in this country, but for controlling heat transfer between indoor and outdoor it is better to use double glazed windows. Even for possible situation it is recommended to cover the building with another façade which is called double façade buildings. Transparent areas should measure and analyze, if it is needed it is better to eliminate some glass made parts of the building. This countries' existing buildings have a serious problem with piping and they are not accessible. Most of these pipes are acting like a thermal bridge for water and transfer heat from water to the surrounded atmosphere.

Chapter 4

CONCLUSION

This part contains recommendations and suggestions for each analyzed section of energy efficiency in building construction process. Given information has been gathered according to other countries' experiences and similar condition around the world has been divided for finding the result which is finding the most suitable regulation for case of Northern Cyprus. All three defended parts of the construction process (design process, dwelling process and approval process) will be concluded separately to have a basic information and find out the needs for regulating Turkish Republic of Northern Cyprus energy efficiency standards in building. For more information HVAC system will be suggested which have a great effect of being efficient. At the end further studies will mentioned to have continuity in this road to reach the sufficient energy efficient standard for Turkish Republic of Northern Cyprus, and as a next step for the whole Cyprus Island.

There are many methods for HVAC in different countries. it is important to mention that HVAC system mostlly related to mechanical system which attached to the buildings. These systems are produces by many companies and are selling in the market, but that doesnt mean it is not necessary to follow standards to have suitable HVAC system for each country. In a comparison of heating, ventilating and air conditioning it became clear that the style which is used in United State is more adaptable to most climate conditions and it will be suitable for Turkish part of Cyprus area. Beside for creating energy efficiency regulations it is clear to design building envelope properly. The most important factors for building envelope design is calculating R-Value and U-value. Australian R-Value calculation is suggested which is applied successfully in hot-humid zone in this country. In this method thermal conductivity is dividing factor for thermal component calculation which is measured as ‘m2.K/W’. Another important factor in the building envelope is U-Value. U-Value is covering many calculations in different parts of the building which is directly effected on architectural design and construction. In a comparison in countries U-Value calculation there is not much differentiation in-between and mostly their result is becoming similar. In Northern Cyprus it is important to have an accurate calculation for this factor in the building envelope. It is recommended to follow the ISO standard calculation to be same as southern part of Cyprus which tries to apply European Union standards to their area. There has to be bigger market on the island to give more opportunity to designers to be more free in their design. Specially there is lack of materials in high quality in energy saving in the Turkish Republic of Northern Cyprus market.

It is obvious only regulating standards for any place is not enough. For making possible applying any regulation for the Turkish Republic of Northern Cyprus, some necessary factors are missing. There are some codes in current design part of a building in TRNC, but it is not enough and it needs to be upgraded. There is lack of expert and educated energy auditors here, on the other hand ordinary peoples knowledge about the benefits of being efficient should be higher. First solution adds energy efficiency field in Northern Cyprus universities and motivate students to study in this field of study like job opportunities or having scholarship for it. Also with television and radio advertising, improve residence knowledge with different programs to let them know about how important is this issue. With holding gatherings and conferences about this topic basic information will transfer to academics and ordinary people in TRNC. Governments should consider the optional point of attracting employers, constructors and building owners to make their building as efficient as possible.Beside there is no prepared and strong regulation for constructing process. At least it is needed common regulation for this section and then energy checking has to be done accordingly. There is no evaluation for buildings according to energy usage of the final product. Which give the regulator the chance of design accurate codes for this part.

To reach energy efficiency in Turkish Republic of Northern Cyprus, four steps is recommended as a solution:

- Preparing needed base for applying energy efficiency regulation for building construction process (5 year process).
- The short term solution will be starting examining and finding solution for existing buildings and regulating standard for it. Beside starting energy efficiency evaluation and labeling of buildings (10 year process).
- The mid term solution is regulating energy efficiency regulation for new construction projects in diverse sections of the process (30 year process).
- Long term solution will be correcting any mistakes and review all regulations after experiencing and examine regulated codes in the area, and also finalized the standard with regulating codes for building additions and historical ones (50 year process).

It is clear that timing is declared, and it has been conjectured. For the specific timing more study is needed.

For the first step it is obvious to follow an international energy conservation code which is applied in Unied state in the design part of building construction process. The reason for recommending this standard is ability of adaptation to different climate condition with variable factors which are designed in this regulation. It is important to study the Germany chronology in more detail as a successful developmental code according to situation changes. Duration for preparing and updating any energy efficiency regulation is between 5-7 years, which should be considered by regulators. It is recommended to clarify enforcement factors and applying Germany calculated scope for the Turkish Republic of Northern Cyprus.

It is possible to have calculated the adaptive floor area which is applicable to small country like Northern Cyprus, on the other hand, there is not specific software and it should be designed according to each regulation. Thus, this factor is going to place right after regulating energy standard, and for understanding these softwares better it has to be designed after studying successful programs in other regulation. It is recommended to have knowledge about the amount of energy usage for regulating energy efficiency standard for Turkish part of Cyprus island. For thermal comfort factor, lighting and windows calculation, it seems enough to follow Turkey codes. It is better to use U-Value as a calculation base for regulators in insolation for the Northern Cyprus climate condition. It is beneficial to use solar panels for producing electricity and hot water supply in this case and there is a possibility to convert sea waves to the electricity as well.

As a second step of building energy efficiency process there has to be a controlling of accuracy of energy installation in the construction process. In countries around the planet, there are few specified check lists for this section. Most countries are using common construction regulation which is covering energy efficiency factors in it. After comparison and according to Northern Cyprus situations; following the regulation of European countries is recommended. As a result of this study, having a separate checklist for construction prosecc limited to the energy factors in different time of constructing is suggested. Having this knowledge at the end of a project will be helpful in the approval process. It is recommended to design separated regulation as a check list of energy efficiency from general construction regulation to have clear result for approval section. The gap in European Union country regulation is the lack of standards for addition designed parts to the existing buildings. There is possibility to full fill this gap by combining EU codes with the regulation which is applied in Florida construction energy check list.

At the end of building construction process; everything has to be checked according to energy use and loss to find out the how efficient product we have. Comparing energy approval methods are not complicated. As it has been mentioned in the chapter three Europe at approval style is more common around the world. On the other hand this system has been recommended according to Northern Cyprus geographical place. As far as southern part of Cyprus is part of the EU it is logical to follow the methods in Europe to create a possible situation of getting upgrades and go to the highest level of efficiency table in this area. Also the other part of Cyprus island is applying the same method to their section. This labeling will help building owners, buyers and renters decide which kind of building will be beneficial for them and how much. The solution might be calculating the building tax according to the level of building efficiency. There will be a different process for examining energy efficiency in new construction projects and existing buildings. It is recommended to check the building energy loss by infrared cameras in a life duration of building to have confidence about building energy efficiency level due to time passing. It is necessary to check the building each several years because of climatic condition in the case of TRNC, specially humidity on this island will have damage in many parts of the building and this is the owner duty to maintain the building against any damage. Checking time is suggested as 30 years after finishing construction as a firs check and then each 10 years for new dwellings and for existing buildings it will be 20 years after getting approval and then each 10 years.

There is some regulation for specified situation which is not taking place in research limitation like addition and renovation of historical buildings design, construction and approval process regulation. In a case of Northern Cyprus it feel needed to think and create such standards which is highly recommended as a further study based on this research information. This study had tried to survey on the energy efficiency process regulation and finding the best way of energy standard regulating for the Turkish Republic of Northern Cyprus. Further study could be considered in regulating exact codes and calculations throughout Northern Cyprus for all parts of the building construction process under the heading of efficiency improvement in buildings within this part of the Cyprus Island. This study may act as a background information to finding most beneficial method for this area and give necessary information to whom that going to regulate this important standard for Northern Cyprus case. This research also will be useful for whole Cyprus (Turkish and Greek parts) and give this opportunity for finding a suitable way of being efficient for the southern part of the island as well. For regulating energy efficiency regulation for Northern Cyprus it is strongly recommended to check the other side of Cyprus codes. This process has been started for a while in the south part of the island and give this opportunity to have the benefit of their experiences in these past years. In the hope that Turkish Republic of

Northern Cyprus energy standard will regulate soon and comfortable enough for the Island climate and condition.

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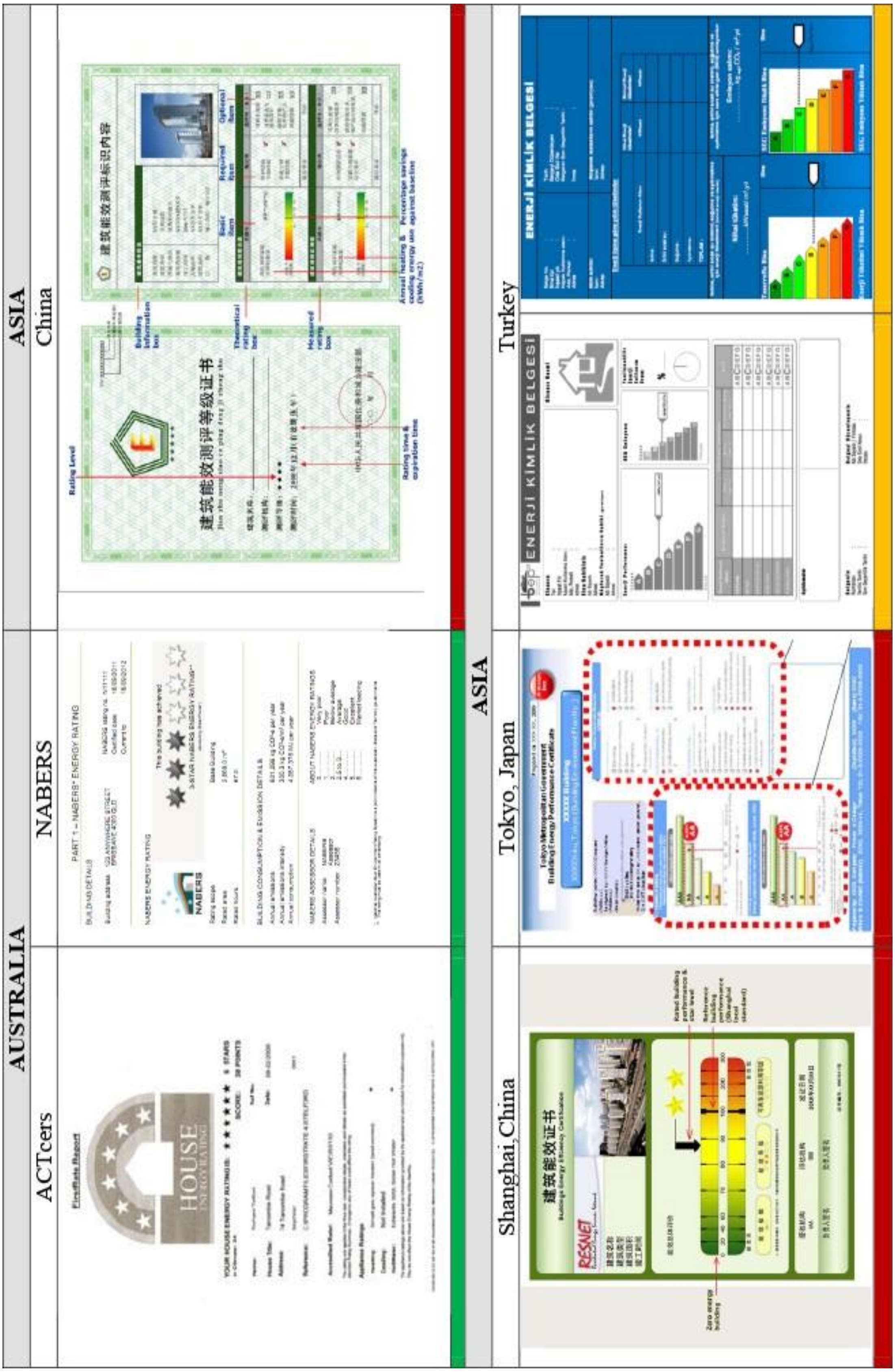
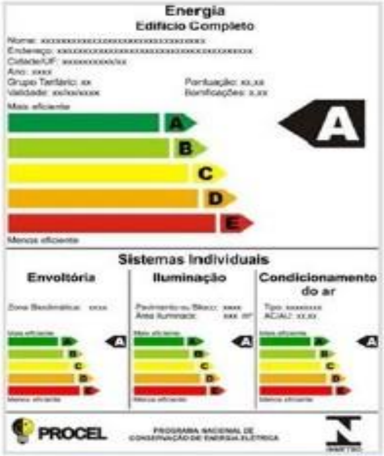
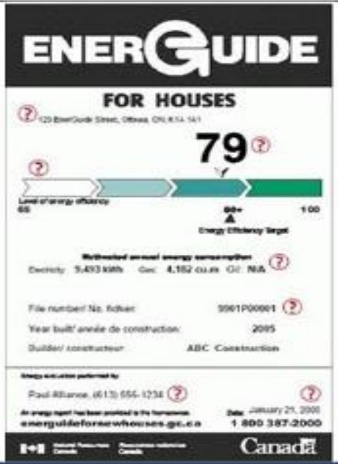
APPENDICES

Appendix A: Energy Labeling Samples Around the World.

(http://www.buildingrating.org/content/energy-label-gallery)



BRAZIL	CANADA	
Procel-Edifica	EnterGuide	E-Scale
		

EUROPEAN UNION		
Austria	Belgium	
		 

EUROPEAN UNION

Bulgaria

Croatia

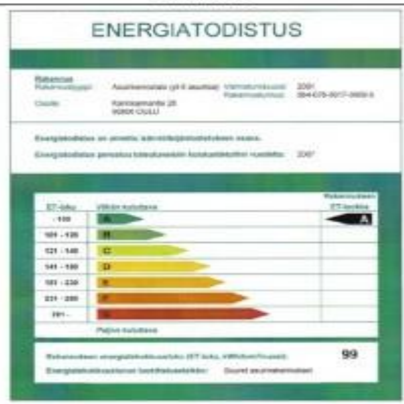
Cyprus

Czezh republic

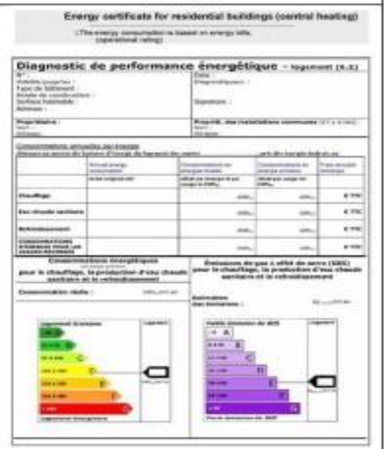
Denmark

Estonia

Finland

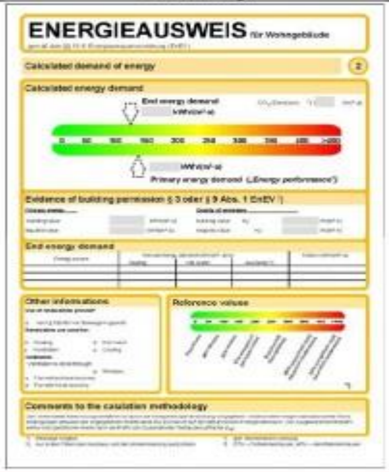


France



EUROPEAN UNION

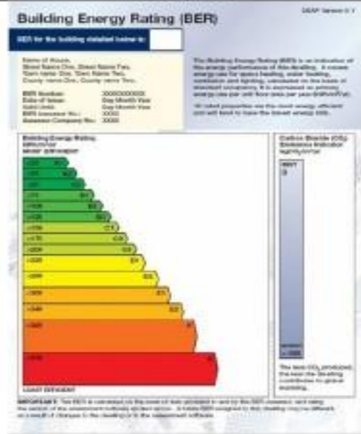
Germany



Greese

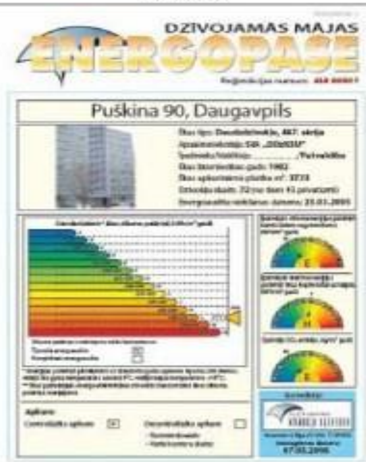
Hungary

Ireland



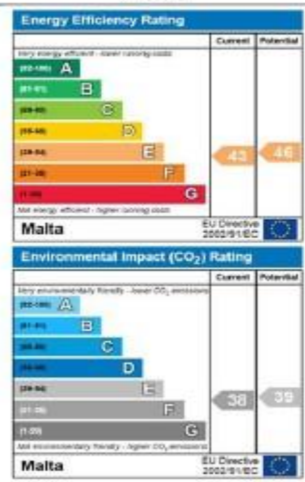
Italy

Latvia



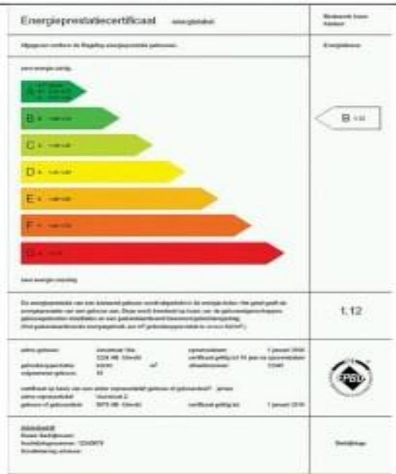
Lithuania

Malta

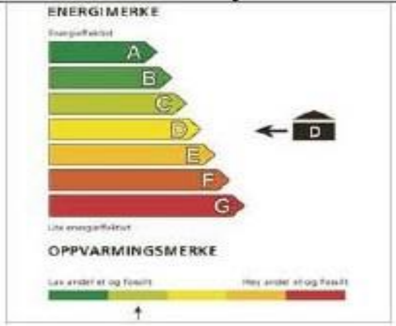


EUROPEAN UNION

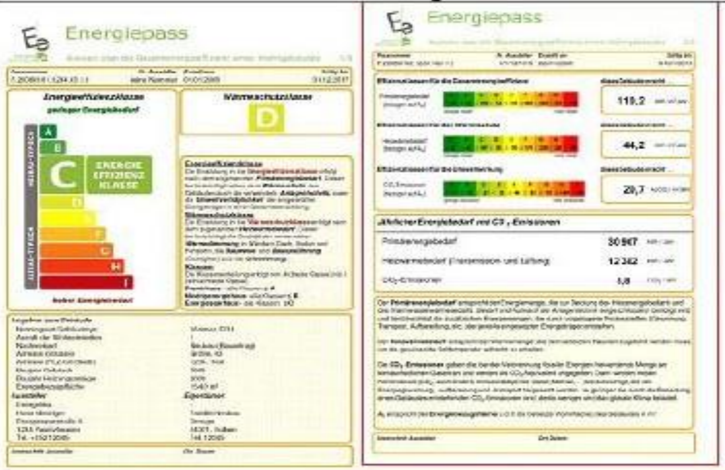
Netherlands



Norway



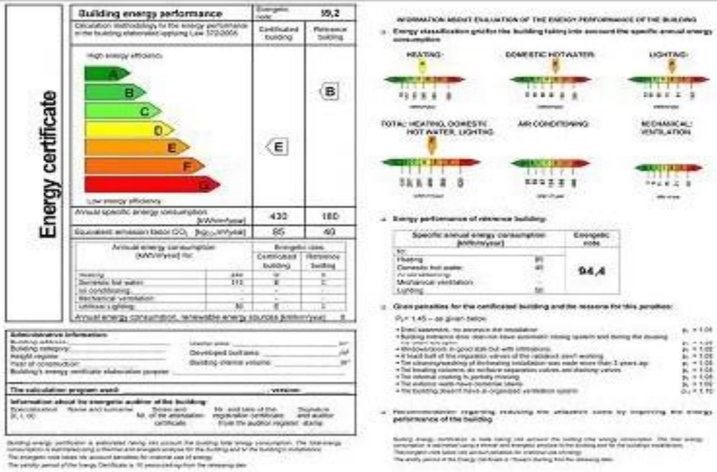
Luxembourg

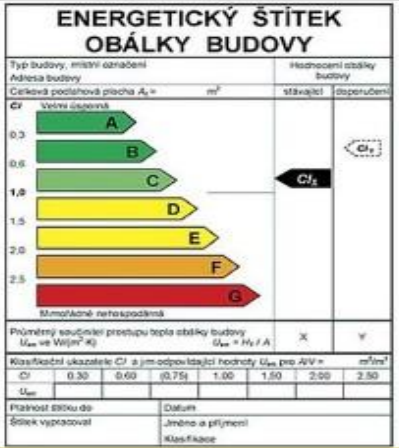
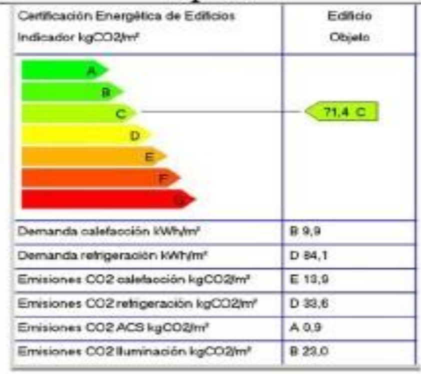


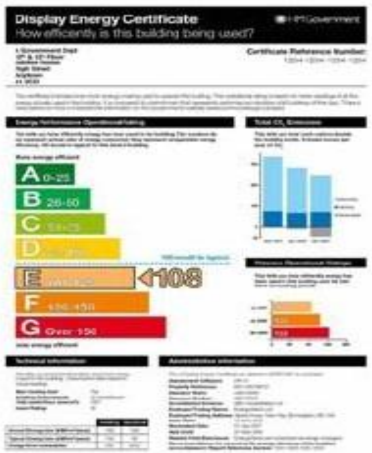
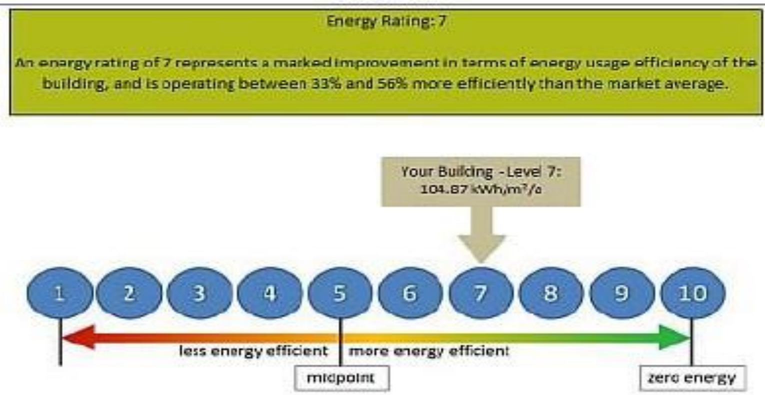
Poland

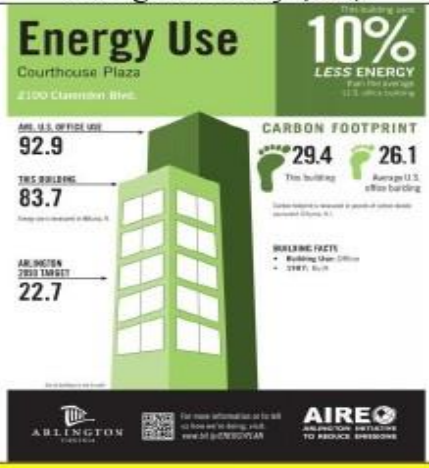
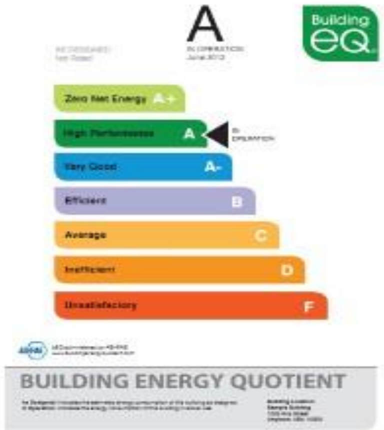
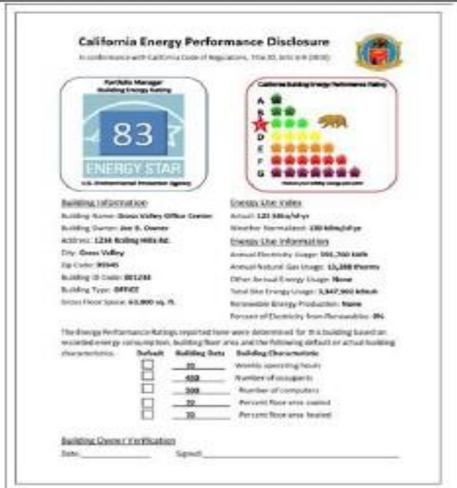
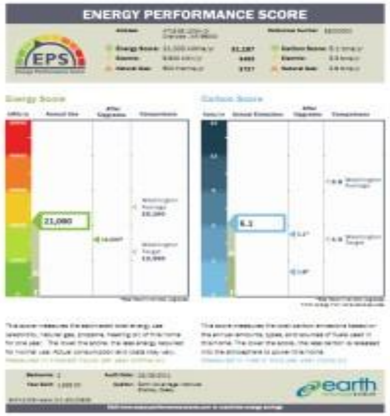
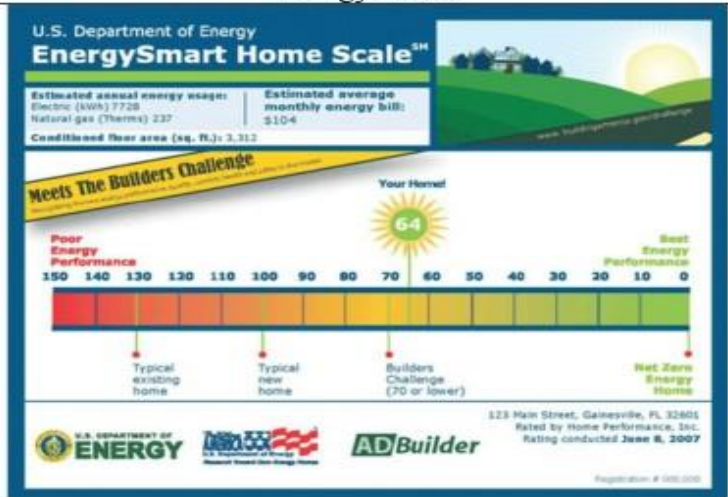
Portugal

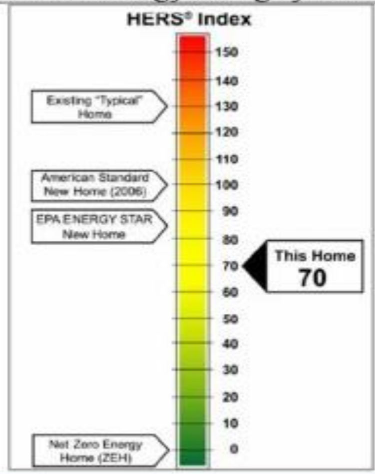
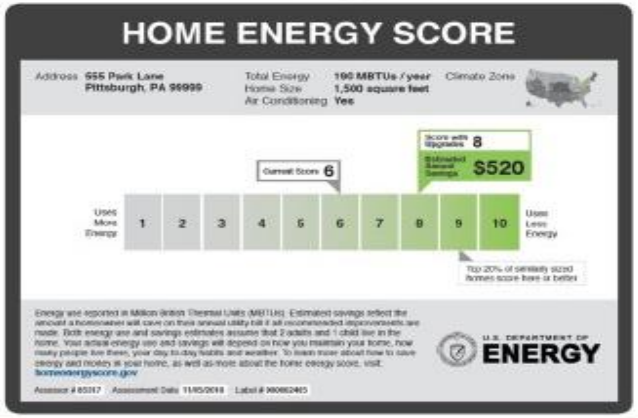
Romania



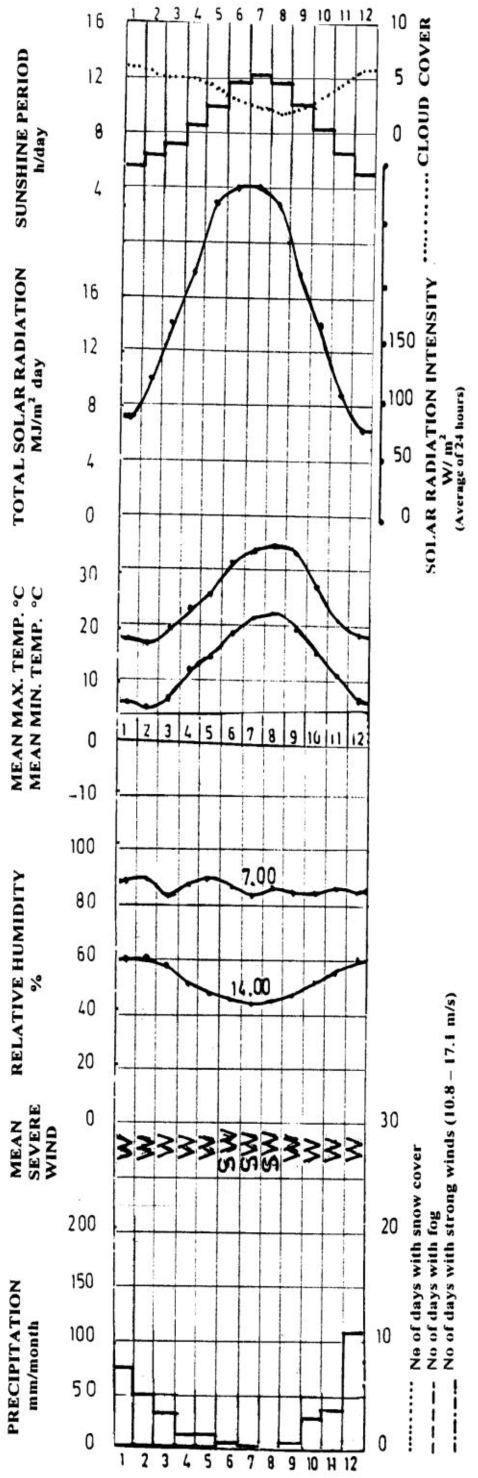
EUROPEAN UNION			
Slovak republic	Slovenia	Spain	Sweden
			

EUROPEAN UNION		SOUTH AFRICA
United Kingdom (DEC)	United Kingdom (EPC)	GBCSA
		

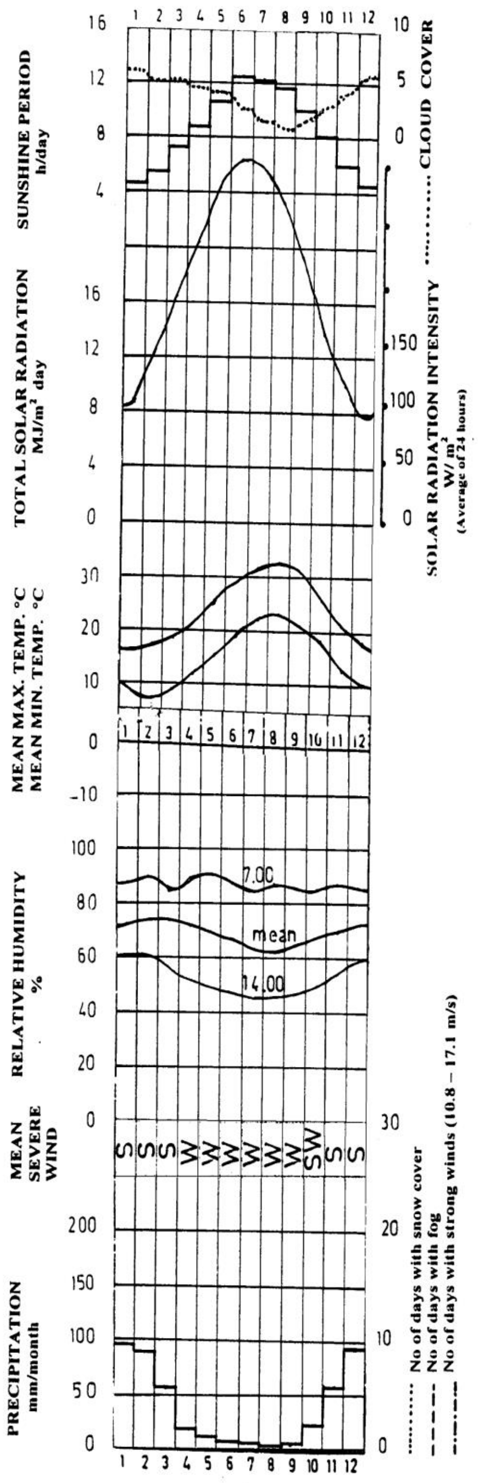
UNITED STATES		
Arlington county (VA)	Building energy quotient	California home energy rating certificate
		
California energy performance disclosure	Energy performance score	Energy smart
		

UNITED STATES		
Energy performance score (Oregon)	Home energy rating system	Energy star statement of energy performance
		
Home energy rating certificate		Home energy score
		

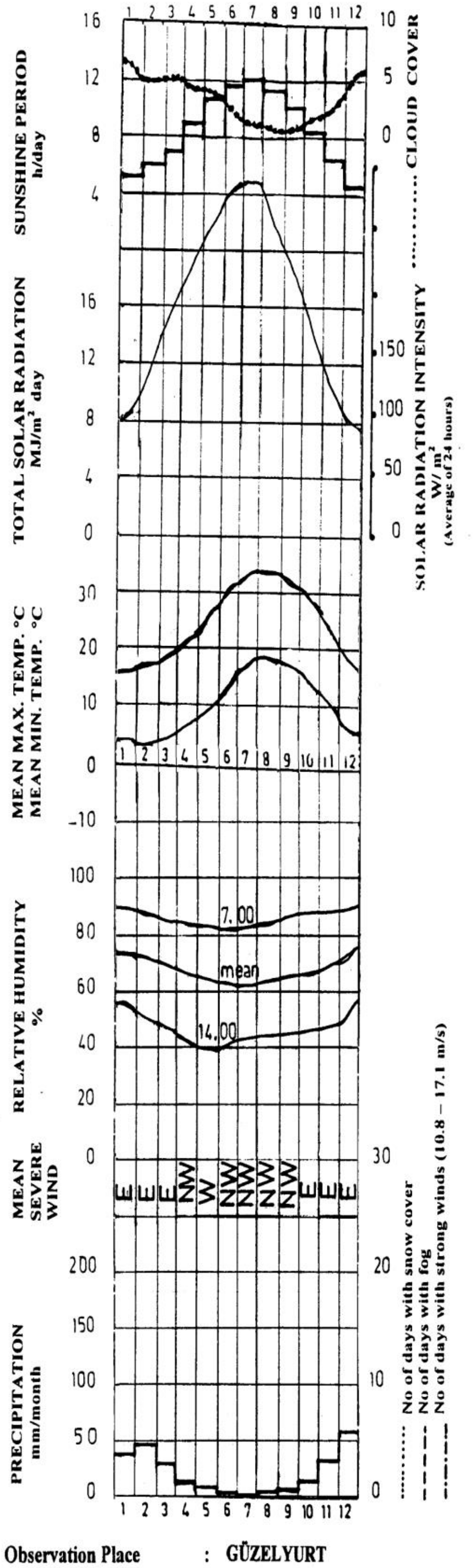
Appendix B: Meteorological Charts of Turkish Republic of Northern Cyprus Cities. (Ali baba, 2004)



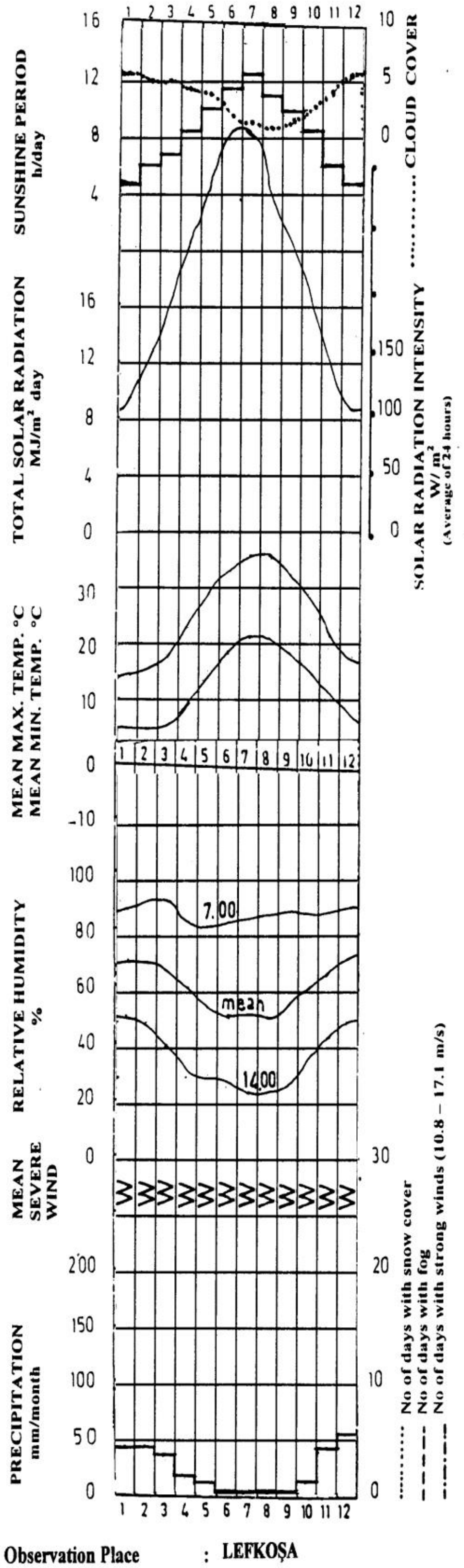
Observation Place : GAZIMAGUSA
Location : 35 ° N Latitude 34 ° E Longitude
Elevation Above Sea Level : 7 m.



Observation Place : GİRNE
Location : 35.5 ° N Latitude 33.5 ° E Longitud
Elevation Above Sea Level :

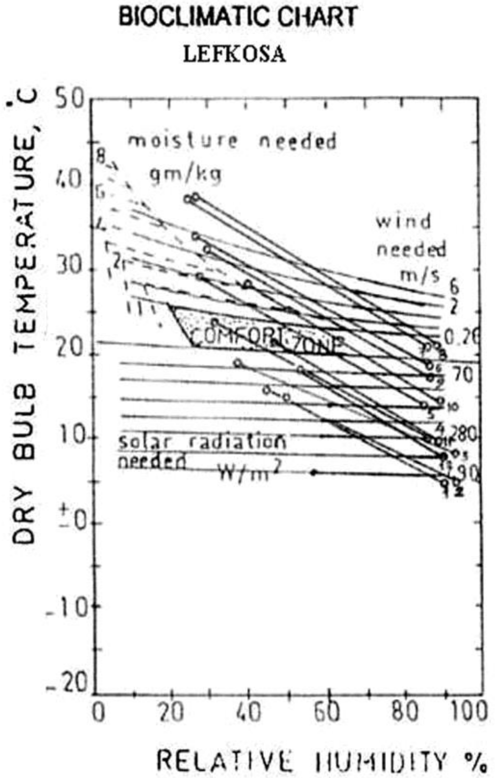


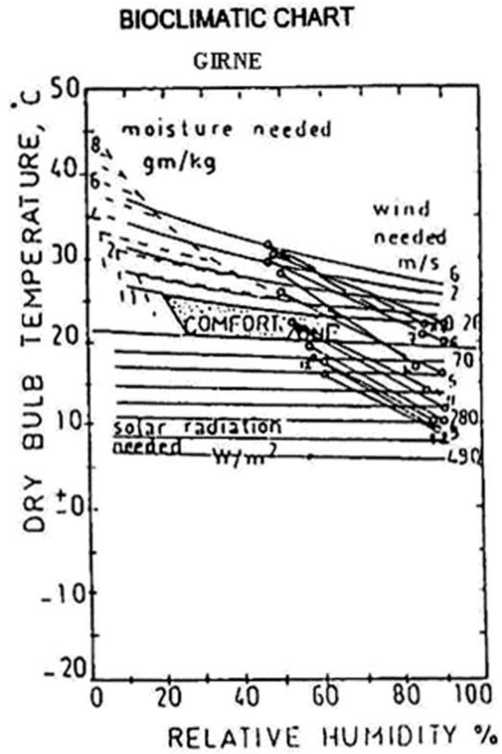
Observation Place : GÜZELYURT
Location : 35.3 ° N Latitude 33 ° E Longitude
Elevation Above Sea Level :

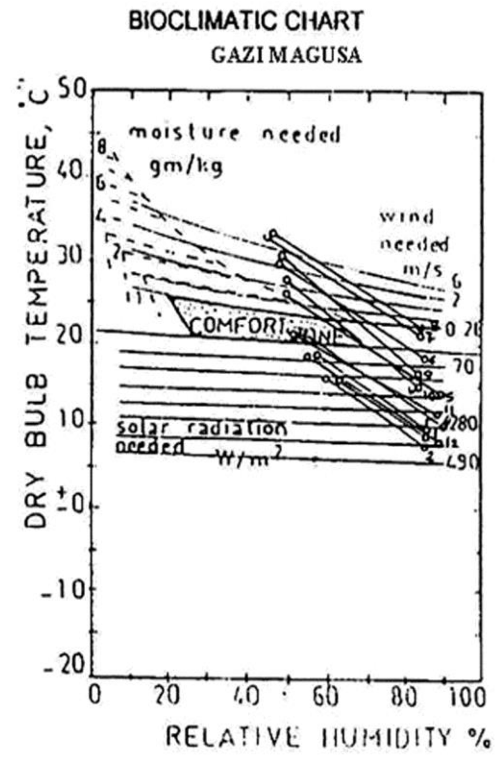


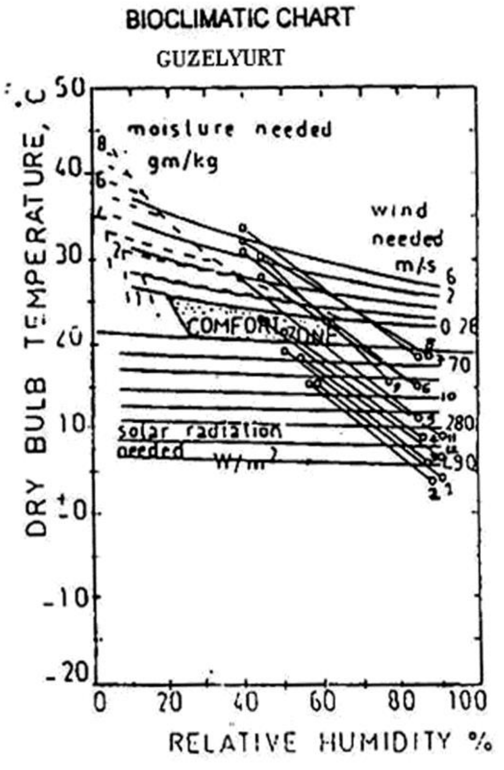
Observation Place : LEFKOŞA
Location : 35.2 ° N Latitude 33.5 ° E Longitude
Elevation Above Sea Level :

Appendix C: Climatic Data Plotted New Bioclimatic Charts of Lefkosa, Girne, Gazimagusa (Famagusta), and Guzelyurt. *(Hancer, 2005)*









Appendix D: Florida Energy Efficiency Code for Building Construction Checklist.

FLORIDA ENERGY EFFICIENCY CODE FOR BUILDING CONSTRUCTION

FORM 600C-01 **Residential Limited Applications Prescriptive Method C** **CENTRAL 4 5 6**

Small Additions, Renovations & Building Systems

Compliance with Method C of Chapter 6 of the Florida Energy Efficiency Code may be demonstrated by the use of Form 600C-01 for additions of 600 square feet or less, site- installed components of manufactured homes, and renovations to single and multifamily residences. Alternative methods are provided for additions by use of Form 600B-01 or 600A-01.

PROJECT NAME: AND ADDRESS:		BUILDER:	
		PERMITTING OFFICE:	CLIMATE ZONE: 4 ☐ 5 ☐ 6 ☐
OWNER:		PERMIT NO.:	JURISDICTION NO.:

SMALL ADDITIONS TO EXISTING RESIDENCES (600 Square feet or less of conditioned area). Prescriptive requirements in Tables 6C-1, 6C-2 and 6C-3 apply only to the components of the addition, not to the existing building. Space heating, cooling, and water heating equipment efficiency levels must be met only when equipment is installed specifically to serve the addition or is being installed in conjunction with the addition construction. Components separating unconditioned spaces from conditioned spaces must meet the prescribed minimum insulation levels. RENOVATIONS (Residential buildings undergoing renovations costing more than 30% of the assessed value of the building). Prescriptive requirements in Tables 6C-1 and 6C-2 apply only to the components and equipment being renovated or replaced. MANUFACTURED HOMES AND BUILDINGS. Only site-installed components and features are covered by this form. BUILDING SYSTEMS Comply when complete new system is installed.

	Please Print	CK
1. Renovation, Addition, New System or Manufactured Home	1. ______	____
2. Single family detached or Multifamily attached	2. ______	____
3. If Multifamily—No. of units covered by this submission	3. ______	____
4. Conditioned floor area (sq. ft.)	4. ______	____
5. Predominant eave overhang (ft.)	5. ______	____
6. Glass area and type:	Single Pane / Double Pane	
a. Clear glass	6a. ______ sq. ft. ______ sq. ft.	____
b. Tint, film or solar screen	6b. ______ sq. ft. ______ sq. ft.	____
7. Percentage of glass to floor area	7. ______ %	____
8. Floor type and insulation:		
a. Slab-on-grade (R-value)	8a. R= ____ ______ lin. ft.	____
b. Wood, raised (R-value)	8b. R= ____ ______ sq. ft.	____
c. Wood, common (R-value)	8c. R= ____ ______ sq. ft.	____
d. Concrete, raised (R-value)	8d. R= ____ ______ sq. ft.	____
e. Concrete, common (R-value)	8e. R= ____ ______ sq. ft.	____
9. Wall type and insulation:		
a. Exterior:		
1. Masonry (Insulation R-value)	9a-1 R= ____ ______ sq. ft.	____
2. Wood frame (Insulation R-value)	9a-2 R= ____ ______ sq. ft.	____
b. Adjacent:		
1. Masonry (Insulation R-value)	9b-1 R= ____ ______ sq. ft.	____
2. Wood frame (Insulation R-value)	9b-2 R= ____ ______ sq. ft.	____
c. Marriage Walls of Multiple Units* (Yes/No)	9c ______ ______	
10. Ceiling type and insulation:		
a. Under attic (Insulation R-value)	10a. R= ____ ______ sq. ft.	____
b. Single assembly (Insulation R-value)	10b. R= ____ ______ sq. ft.	____
11. Cooling system* (Types: central, room unit, package terminal A.C., gas, existing, none)	11. Type: ______	____
	SEER/EER: ______	____
12. Heating system*: (Types: heat pump, elec. strip, natural gas, L.P. gas, gas h.p., room or PTAC, existing, none)	12. Type: ______	____
	HSPF/COP/AFUE: ______	____
13. Air Distribution System*:		
a. Backflow damper or single package systems* (Yes/No)	13a. ______	____
b. Ducts on marriage walls adequately sealed* (Yes/No)	13b. ______	____
14. Hot water system: (Types: elec., natural gas, other, existing, none)	14. Type: ______	____
	EF: ______	____

* Pertains to manufactured homes with site installed components.

I hereby certify that the plans and specifications covered by the calculation are in compliance with the Florida Energy Code. PREPARED BY: ______ DATE: ______ I hereby certify that this building is in compliance with the Florida Energy Code. OWNER AGENT: ______ DATE: ______	Review of plans and specifications covered by this calculation indicates compliance with the Florida Energy Code. Before construction is completed, this building will be inspected for compliance in accordance with Section 553.908, F.S. BUILDING OFFICIAL: ______ DATE: ______

– 1 –

TABLE 6C-1 : PRESCRIPTIVE REQUIREMENTS FOR SMALL ADDITIONS (600 Sq. Ft. and Less), RENOVATIONS TO EXISTING BUILDINGS AND SITE-INSTALLED COMPONENTS OF MANUFACTURED HOMES.

	COMPONENT	MINIMUM INSULATION	INSULATION INSTALLED
WALLS	Concrete Block	R-5	____
	Frame, 2´ x 4´	R-11	____
	Frame, 2´ x 6´	R-19	____
	Common, Frame	R-11	____
	Common, Masonry	R-3	____
CEILINGS	Under Attic	R-30	____
	Single Assembly; Enclosed		
	Frame	R-19	____
	Metal Pans	R-13	____
	Single Assembly; Open	R-10	____
	Common, Frame	R-11	____
FLOORS	Slab-on-grade	No Minimum	____
	Raised Wood	R-11	____
	Raised Concrete	R-5	____
	Common, Frame	R-11	____
DUCT	In unconditioned space	R-6	____
	In conditioned space	No minimum	____

	EQUIPMENT	MINIMUM EFFICIENCY	INSTALLED EFFICIENCY
COOLING	Central A/C - Split	SEER = 10.0	SEER = ____
	-Single Pkg.	SEER = 9.7	SEER = ____
	Room unit or PTAC	EER = 8.5*	EER = ____
SPACE HEATING	Electric Resistance	ANY	
	Heat pump - Split	HSPF = 6.8	HSPF = ____
	- Single Pkg.	HSPF = 6.6	HSPF = ____
	Room unit or PTHP	COP = 2.7*	HSPF/ COP = ____
	Gas, natural or propane	AFUE = .78	AFUE = ____
	Fuel Oil	AFUE = .78	AFUE = ____
HOT WATER	Electric Resistance	EF = .88	EF = ____
	Gas; Natural or L.P.	EF = .54	EF = ____
	Fuel Oil	EF = .54	EF = ____

* See Table 6-3, 6-7

TABLE 6C-2: PRESCRIPTIVE REQUIREMENTS FOR GLASS AREAS IN ADDITIONS ONLY

Maximum percentage glass to floor area allowed is selected by type, overhang length, and solar heat gain coefficient. Maximum% = ____ Installed % = ____

GLASS TYPE, OVERHANG, AND SOLAR HEAT GAIN COEFFICIENT REQUIRED FOR GLASS PERCENTAGE ALLOWED

UP TO 20%		UP TO 30%		UP TO 40%		UP TO 50%	
Single	Double	Single	Double	Single	Double	Single	Double
OH - SHGC	OH - SHGC	OH - SHGC	OH - SHGC	OH - SHGC	OH - SHGC	OH - SHGC	OH - SHGC
1´- .87 0´- .75	0´- .78	2´- .87 1´- .75 0´- .57	1´- .78 0´- .61	3' - .87 2' - .75 1' - .57 0' - .39	2´- .78 1´- .61 0´- .44	4' - .87 3' - .75 2' - .57 1' - .39 0' - .30	3´- .78 2´- .61 1´- .44 0´- .35

Get certified SHGC from the manufacturer or use defaults: Single clear SHGC = .87, double clear SHGC = .78, and single tint SHGC = .75.

TABLE 6C-3 MINIMUM REQUIREMENTS FOR ALL PACKAGES

COMPONENTS	SECTION	REQUIREMENTS	CHECK
Exterior Joints & Cracks	606.1	To be caulked, gasketed, weather-stripped or otherwise sealed.	
Exterior Windows & Doors	606.1	Max. 0.3 cfm/sq.ft. window area; .5 cfm/sq.ft. door area.	
Sole & Top Plates	606.1	Sole plates and penetrations through top plates of exterior walls must be sealed.	
Recessed Lighting	606.1	Type IC rated with no penetrations (two alternatives allowed).	
Multi-story Houses	606.1	Air barrier on perimeter of floor cavity between floors.	
Exhaust Fans	606.1	Exhaust fans vented to unconditioned space shall have dampers, except for combustion devices with integral exhaust ductwork.	
Combustion Heating	606.1	Combustion space and water heating systems must be provided with outside combustion air, except for direct vent appliances.	
Water Heaters	612.1	Comply with efficiency requirements in Table 6-12. Switch or clearly marked circuit breaker (electric) or cutoff (gas) must be provided. External or built-in heat trap required for vertical pipe risers.	
Swimming Pools & Spas	612.1	Spas & heated pools must have covers (except solar heated). Non-commercial pools must have a pump timer. Gas spa & pool heaters must have minimum thermal efficiency of 78%.	
Hot Water Pipes	612.1	Insulation is required for hot water circulating systems (including heat recovery units).	
Shower Heads	612.1	Water flow must be restricted to no more than 2.5 gallons per minute at 80 PSIG.	
HVAC Duct Construction, Insulation & Installation	610.1	All ducts, fittings, mechanical equipment and plenum chambers shall be mechanically attached, sealed, insulated and installed in accordance with the criteria of Section 610.1. Ducts in attics must be insulated to a minimum of R-6.	
HVAC Controls	607.1	Separate readily accessible manual or automatic thermostat for each system.	

GENERAL DIRECTIONS:

1. On Table 6C-1 indicate the R-value of the insulation being added to each component and the efficiency levels of the equipment being installed. All R-values and efficiencies installed must meet or exceed the minimum values listed. Components and equipment neither being added nor renovated may be left blank.
2. ADDITIONS ONLY. Determine the percentage of new glass to conditioned floor area in the addition as follows. Total the areas of all glass windows, sliding glass doors and glass door panels. Double the area of all non-vertical roof glass and add it to the previous total. When glass in existing exterior walls is being removed or enclosed by the addition, an amount equal to the total area of this glass may be subtracted from the total glass area. Divide the adjusted glass area total by the conditioned floor area of the addition. Multiply by 100 to get the percent. Find the largest glass percentage under which your calculated percentage falls on Table 6C-2. Prescriptives are given by the type of glass (Single or Double pane) and the overhang (OH) paired with a solar hear gain coefficient (SHGC). For a given glass type and overhang, the minimum solar heat gain coefficient allowed is specified. Actual glass windows and doors previously in the exterior walls of the house and being reinstalled in the addition do not have to comply with the overhang and solar heat gain coefficient requirements on Table 6C-2. All new glass in the addition must meet the requirement for one of the options in the glass percentage category you indicated. The overhang (OH) distance is measured perpendicularly from the face of the glass to a point directly under the outermost edge of the overhang.
3. RENOVATIONS ONLY. Replacement glass needs to meet the following requirements. Any glass type and solar heat gain coefficient may be used for glass areas which are under at least a two foot overhang and whose lowest edge does not extend further than 8 feet from the overhang. Glass areas being renovated that do not meet this criteria must be either single-pane tinted, double-pane clear or double-pane tinted.
4. BUILDING SYSTEMS. Comply when new system is installed for system installed.
5. Complete the information requested on the top half of page 1.
6. Read "Minimum Requirements for Small Additions and Renovations", Table 6C-3, and check all applicable items.
7. Read, sign and date the "Owner/Agent" certification statement on page 1.

Appendix E: BCA Energy and Water Efficiency Verification Checklist.

Government of **Western Australia**
Department of **Commerce**

CLIMATE ZONE 5

BCA Energy and Water Efficiency Verification
OPTION 1 - ENERGY RATING

Deemed-to-Satisfy Solutions for Class 1 and 10 Buildings and Structures

Building Details

Type of Building			
Lot Number		Street Number	
Street Name			
Town or Suburb		Postcode	
Name of Owner			
Name of Builder			

NOTE: **This verification sheet is designed to be used in conjunction with the Deemed-to-Satisfy (DTS) Provisions of the Building Code of Australia 2012 Part 3.12 and Western Australia Additions. It should not replace the BCA.**

The relevant building surveyor must ensure that plans and specifications comply with the Building Code of Australia and any other relevant legislation before issuing a certificate of design compliance.

The information contained in this verification sheet is intended for general guidance only and must not be relied upon in any particular set of circumstances.

If you require assistance in filling out this sheet, please contact a suitably qualified person such as a building surveyor or energy assessor.

Compliance with 3.12.0(a)(i)	N/A	Yes
(A) Heating and cooling loads		
3.12.0.1 - Software that is accredited under the Nationwide House Energy Rating Scheme (NatHERS) for House Energy Rating Software has been used to demonstrate an energy rating of at least 6 stars is achieved for the proposed works. A copy of the certificate or report is attached.		☐
(B) Building fabric thermal insulation		
All required insulation will be installed in accordance with **3.12.1.1**, the Manufacturer's Specifications, and AS/NZS 4859.1		☐
(C) Thermal breaks		
This building has a metal roof fixed to metal purlins, rafters or battens and either does not have a ceiling lining or the ceiling lining is attached to the same metal purlins, rafters or battens. Thermal breaks not less than R0.2 will be installed in accordance with **3.12.1.2(c)**.	☐	☐
This building has lightweight external cladding such as weatherboards, fibre cement or metal sheeting fixed to a metal frame that does not have a wall lining or has a wall lining attached to the same metal frame. Thermal breaks of R0.2 will be installed in accordance with **3.12.1.4(b)**.	☐	☐

BCA 2012 Energy Efficiency Option 1 - Energy Rating   Page 1 of 3

Compliance with 3.12.0(a)(i) Continued	N/A	Yes
(D) Compensation for loss of ceiling insulation		
This building will have exhaust fans, flues or recessed downlights which results in a reduction of 0.5% or more of the ceiling insulation. In accordance with **3.12.1.2(e)**, the R-Value of the remaining ceiling insulation will be increased in accordance with **Table 3.12.1.1b** – documentary evidence is attached.	☐	☐
(E) Floor edge insulation		
This building has a concrete slab on ground with in-slab heating or cooling system. Water resistant insulation will be installed in accordance with **3.12.1.5(c)** and **(d)**. **R1.0** vertical edge perimeter	☐	☐
(F) Building sealing *Not applicable to ventilation openings required for the safe operation of gas appliances, buildings that are conditioned only by an evaporative cooler, or buildings used for the accommodation of vehicles.*		
The only means of air-conditioning is by evaporative cooling therefore the building is not required to be sealed.	☐	☐
All chimneys, flues and exhaust fans are fitted with dampers or flaps in accordance with **3.12.3.1**	☐	☐
All roof lights serving habitable rooms or conditioned spaces will be sealed in accordance with **3.12.3.2**	☐	☐
External windows and doors serving habitable rooms or conditioned spaces will be fitted with air infiltration seals in accordance with **3.12.3.3**	☐	☐
Exhaust fans serving habitable rooms or conditioned spaces will be sealed in accordance with **3.12.3.4**	☐	☐
Roofs, walls and floors that form part of the external fabric of habitable rooms or conditioned spaces will be constructed to minimise air leakage in accordance with **3.12.3.5**	☐	☐
Evaporative coolers serving habitable rooms or heated spaces will be fitted with dampers in accordance with **3.12.3.6**	☐	☐

Compliance with 3.12.0(b)	N/A	Yes
Part 3.12.5 Services		
3.12.5.0 - Hot water supply system(s) will be designed and installed in accordance with section 8 of AS/NZS 3500.4 or clause 3.38 of AS/NZS 3500.5	☐	☐
Thermal insulation for central heating water piping and heating and cooling ductwork will be protected from weather and able to withstand temperature within piping or ductwork, in accordance with **3.12.5.1**	☐	☐
Central heating water piping that is not within a conditioned space will be insulated to achieve the minimum total R-values in accordance with **Table 3.12.5.1**	☐	☐
Heating and cooling ductwork is designed and will be installed and insulated in accordance with **3.12.5.3**	☐	☐
Electrical resistance space heating is designed and will be installed in accordance with **3.12.5.4**	☐	☐
Artificial lighting is designed and will be installed in accordance with **3.12.5.5** - documentary evidence is attached.	☐	☐
The water heater in the hot water supply system will comply with **3.12.5.6**	☐	☐
Heating for a swimming pool (other than a spa pool) will be by a solar heater not boosted by electric resistance heating and circulation pump in accordance with **3.12.5.7**	☐	☐
Heating for a spa pool that shares a water recirculation system with a swimming pool and circulation pump will be in accordance with **3.12.5.7**	☐	☐

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Compliance with Western Australia Additions for Water Use *Only applies to houses using potable water supplied by a licensed operator*	N/A	Yes
WA 2.3.1 Water Use Efficiency		
All tap fittings (other than bath outlets and garden taps) will be a minimum 4-star WELS rated.	☐	☐
All showerheads will be a minimum 3-star WELS rated.	☐	☐
All sanitary flushing systems will be a minimum dual-flush, 4-stars WELS rated.	☐	☐
WA 2.3.2 Swimming Pool Covers and Blankets		
Any new outdoor swimming pool or spa will be supplied with a cover that reduces water evaporation and is accredited under the Smart Approved Watermark Scheme.	☐	☐
WA 2.3.3 Hot Water Use Efficiency		
All internal hot water outlets will be connected to a hot water system or a re-circulating hot water system with pipes installed and insulated in accordance with AS/NZS 3500: Plumbing and Drainage, Part 4 Heated Water Services.	☐	☐
The pipe from the hot water system or re-circulating hot water system to the furthest hot water outlet will be less than either 20 m in length or 2 litres of internal volume.	☐	☐

BCA Energy and Water Efficiency Verification Declaration

I declare that the details provided on these verification sheets (and any supporting documentation accompanying them), are true and correctly reflect the plans and specifications of the proposed building that have been submitted for a building permit.

Name			
Company Name			
Address			
Phone Number		**Fax**	
Email Address			
Signature		**Date**	