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ENERGY EFFICIENCY IN MARINE TOURISM INDUSTRY: A CASE STUDY OF IC ÇEŞME MARINA

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I hereby declare that this master’s thesis titled as **“Energy Efficiency in Marine Tourism Industry: A Case Study of IC Çeşme Marina”** has been written by myself in accordance with the academic rules and ethical conduct. I also declare that all materials benefited in this thesis consist of the mentioned resources in the reference list. I verify all these with my honour.

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Ufuk Yakup ÇALIŞKAN

ÖZET

Yüksek Lisans Tezi

Deniz Turizmi Endüstrisinde Enerji Verimliliği:
IC Çeşme Marina Örneği

Ufuk Yakup ÇALIŞKAN

Dokuz Eylül Üniversitesi
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Enerji verimliliği terimi 70'li yıllarda yaşanan birçok petrol krizinden bu yana her yıl düzenli olarak önem kazanmaktadır. Türkiye gibi gelişmekte ve enerji bağımlılığı yüzünden enerji ihraç eden ülkeleri düşündüğümüzde, enerjinin verimli kullanımı en uygun ve anlaşılır önlem olabilir. Ekonomik katkı olarak deniz turizmi dizayn edildiğinde yüksek verimli ve sürüdürülebilir olabilir. Deniz turizmi yatçılık pazarı, su sporları pazarı ve kruvaziyer pazarını içine alan geniş bir endüstri kümesidir. Fakat enerji verimliliği olgusu literatürde kapsamlıca deniz turizmi uygulamaları ile bahsedilmemiştir. Bundan dolayı yazar yazında bir boşluk olduğunu düşünmüştür.

Bu yazının amacı deniz turizminde enerji verimliliği değişkenlerini elde etmek ve geleneksel uygulamalar ile bir deniz turizmi aktörünün uygulamaları arasında bir kıyaslama yapmaktır. Bu bağlamda bir marina seçilmiştir. Bu hedef doğrultusunda, ilk olarak deniz turizminde enerji verimliliği uygulamaları tartışılmış, sonrasında yarı yapılandırılmış görüşme formu, deniz turizmi uzmanlarından deniz turizminde enerji verimliliği değişkenleri hakkında bilgi almak için kullanılmıştır. Değişkenlerin elde edilmesi ve bu uygulamaların tipik tüketimlerinin belirlenmesinin üzerine IC Çeşme Marinanın uygulamaları bu temelde irdelenmiştir.

Anahtar Kelimeler: Deniz Turizmi, Enerji verimliliği, Marina, Sürdürülebilirlik.

ABSTRACT

Master Thesis

Energy Efficiency in Marine Tourism Industry:
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Energy efficiency term constantly has been gaining importance each year after several incidents of oil crisis happen around 70's. Thinking about energy dependence of energy in developing and at the same time energy importing countries such as Turkey, using energy efficiently would be the most coherent and appropriate execution. As a contributor to economy marine tourism could be high yielding and sustainable if it is designed to be. Marine tourism is a wide cluster of industries which include yachting market, water sports market and cruise market. However energy efficiency phenomena did not comprehensively mentioned with marine tourism applications in literature therefore author thought that there is a gap in the literature.

The main purposes of these papers are to obtain information on energy efficiency variables in marine tourism and conducting a comparison in between conventional applications and a marine tourism actor which in this case a marina. In accordance with this objective, first literature on energy efficiency applications in marine tourism are discussed latter semi structured interview used to get information on energy efficiency variables from marine tourism experts. Upon acquiring variables and determining typical consumptions of these applications IC Çeşme Marina's applications evaluated on that ground.

Keywords: Marine tourism, Energy efficiency, Marina, Sustainability.

ENERGY EFFICIENCY IN MARINE TOURISM INDUSTRY: A CASE STUDY OF IC ÇEŞME MARINA

CONTENTS

CHAPTER TWO;
ENERGY EFFICIENCY APPLICATIONS
IN MARINE TOURISM INDUSTRY

ABBREVIATIONS

AC: Alternating Current
ATES: Aquifer Thermal Energy Storage
BCE: Before Common Era
BTU: British Thermal Unit
CCHP: Combined Cooling, Heat and Power
CHP: Combined Heat and Power
CSI: Current Source Inverter
CRI: Color Rendering Index
DC: Direct Current
EIA: Energy Information Administration
EPPI: Efficiency Policy Progress Index
ERV: Energy Recovery Ventilators
HVAC: Heat, Ventilation and Air Conditioning
HP: Horse Power
HPHX: Heat Pipe Heat Exchangers
GDP: Gross Domestic Product
GHG: Greenhouse Gases
LED: Light Emitting Diode
MARPOL: Marine Pollution
MEPC: Marine Environment Protection Committee
MTOE: Metric Tons of Oil Equilavent
ICOMIA: International Council of Marine Industry Associations
IEA: International Energy Agency
IMO: International Maritime Organization
IOC: International Olympic Committee
OECD: Organization of Economic Cooperation and Development
OTEC: Ocean thermal energy conversion
PV: Photovoltaic
PCM: Phase Change Material
PWM: Pulse Width Modulation

TEU: Twenty Foot Equivalent Unit

TPES: Total Primary Energy Supply

US: United States

USA: United States of America

UNFCCC: United Nations Framework Conference on Climate Change

VFD: Variable Frequency Drivers

VSD: Variable Speed Drivers

VSI: Voltage Source Inverter

WEC: World Energy Council

UNWTO: United Nations World Tourism Organization

WWS: Wind Water Solar

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INTRODUCTION

Marine tourism is a service industry which its components are developing day by day on global and country basis in the tourism. Marine tourism covers the activities that people going from their living place to coastal areas and accommodating there. Activities of marine tourism have a base point of people chose coastal areas to make not only tourism but also many activities such as fishery, transportation, farming etc. As a result of these sea-centric activities people started to give importance and realize how beautiful is the natural aspects of seas, lakes and rivers. Consequently marine tourism flourished on this environment (Orams, 1999: 9).

Marine tourism has many components and many unique forms of businesses. In this research specifically, marine tourism have been investigated in three major topics which are yacht tourism industries, water sport tourism industries and cruise tourism industries. In this context yacht tourism includes marinas which are composed of many artificial and natural components that align a body of tourism activities. Services like mooring, towing, repairing and maintenance, supplements like fuel, electric and water supply and firefighting equipment facilities like bathrooms, showers, laundries, hospital, waste management facilities, market, shopping malls, and social recreational places such tennis court should be ensured by marina decision makers on a concept of modern marina (Dikeç, 2015: 1; Işık, 2010:1-5).

The last decade environmental performances and energy efficiency have been slightly arising as a problem in overall marine tourism environment because of the numerous reasons such as rise of fuel oil prices, emission legislations on greenhouse gases, efficiency of operations, efficiency of management and economic behaviors of firms. There were many researches concerning energy efficiency in buildings, various industrial plants, transportation, appliances, etc. however in marine tourism branch lack of researches have been eye-catching and did not attracted attention of researchers much since their operational consumption is comparatively low considering industrial practices. (Theotokatos et al., 2017).

As a result of above stated issue, overall applications of energy efficiency should be implied to marine tourism field as well. Following up this idea, with our thesis in first chapter energy efficiency is evaluated on the basics of thermodynamics and theoretical background. Overall improvement on policies of energy efficiency and energy employment in history, in future and at present and their energy and energy efficiency employment barriers are illustrated. In trends of energy efficiency; distribution of consumption, energy supply, overall progress on improvements on energy efficiency applications, investment on energy along with technologic jump points and finally academic trends with recent researches on energy efficiency are detailed. Then consumption is decomposed to their elements and forms of fuel. Overall statistics of shares of energy consumption and production discussed. Energy efficiency applications in general under lighting, heating, ventilation and air conditioning, motor systems and in smart homes have been set out.

In chapter two, author tried to enlarge the applications of energy efficiency to spread them in marine tourism components yacht tourism industries, water sports tourism industries and cruise tourism industries on three major application headings which are lighting, heating, ventilation and air conditioning and motor systems.

Author aimed to apply large amount of energy effectiveness topic to marine tourism branches, especially to marinas. In order to do this, broad literature review on applications has been conducted along with getting expert opinions in the sector. Findings are discussed with aim of the research, motives, quantitative and qualitative research methods are described then semi structured interviews with marine tourism experts and IC Çeşme Marina are illustrated. Data is evaluated in five categories which are lighting, heating, ventilation and air conditioning, motor systems, water management applications and office equipment.

Variables are generated after comprehensive literature review and face to face interviews with marine tourism experts. Results are collected to form an application list to generate a typical consumption list to compare with IC Çeşme Marina applications. After semi structured interview with them detailed analysis is shown at the end.

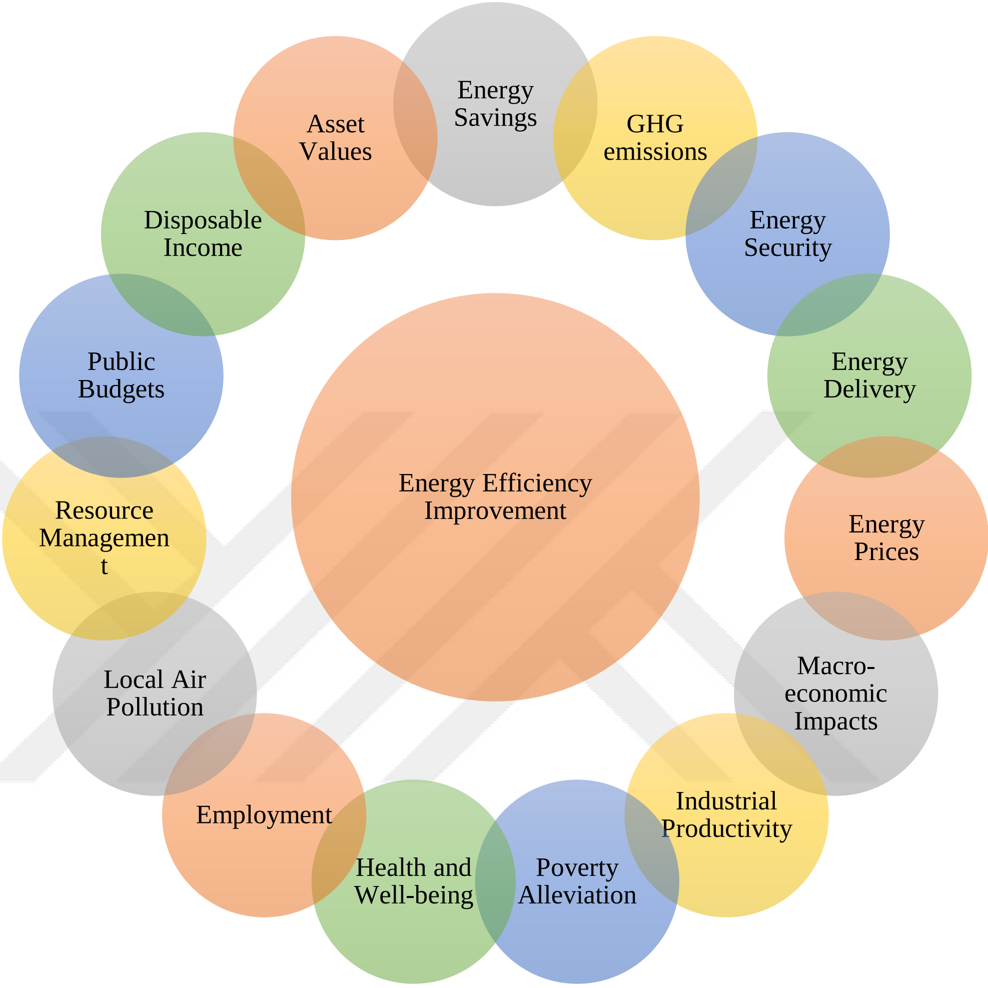
CHAPTER ONE;
ENERGY EFFICIENCY AS A CONCEPT

Energy efficiency levels have been significantly rising since the last 30 years. The mitigation on energy intensity was mainly because of the progress on energy efficiency on the main consuming means such as electrical household devices, industrial machines, transportation vehicles etc. World Energy Council (WEC) stated its opinion on energy efficiency by reckoning it as an energy resource and added up, rather than mentioning as a hidden energy resource, energy efficiency should be considered as “first fuel” in big economies. Also in 2016 WEC estimated energy efficiency as two fifth of primary energy consumption by labelling it as avoided consumption. In the same context oil alongside with coal and lignite did not surpass energy efficiency. In this calculation WEC used difference between current consumption at 1980 energy intensity levels and actual energy consumption (Öztürk, 2014: 4-5; WEC, 2013: 19-26; WEC, 2016a:8).

International Energy Agency (IEA) stated in *“Capturing the Multiple Benefits of Energy Efficiency”* that energy efficiency not only helps the energy demand reduction which what traditionally does but also creation of improved energy efficiency delivers as much as 2.5 times the value of the energy demand reduction. The biggest driver behind energy efficiency is capability of lessening energy demand and giving lower expenditure (IEA, 2014).

Being a tool that changes whole subject for numerous positive aspects such as lowering the industrial waste in terms of credit, time, pollution and Greenhouse gases emissions is what makes energy efficiency desirable and more needed by most of the world. And also stating what it does other than lowering the waste in any means it could be used as magic wand in many great-economies for giving availability to create more employment, to reshape company’s supply flow, to design the physicality of general work flow and making it more safe and also to make much more lasting asset value. As an appropriate outcome of this stimulation there will be a drop in energy prices, clearer skies, making products more affordable, spending more money to getting more efficient methods and more marketable economies. The table on the next page shows what energy efficiency directly can improve lower or stimulate in the scenario of constantly being implied (IEA, 2016).

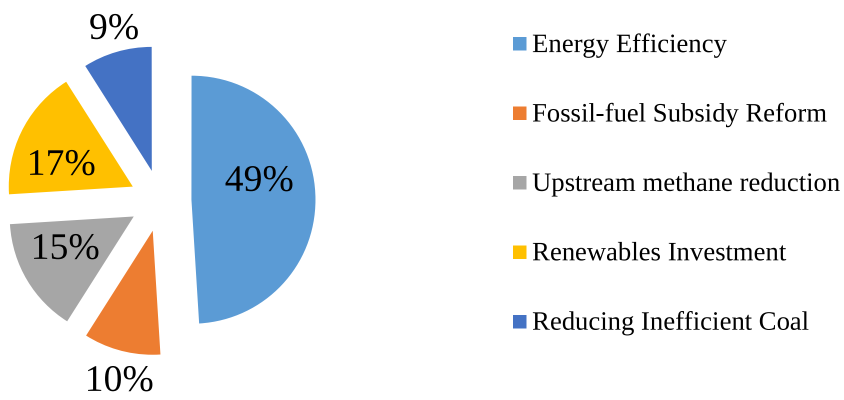
Figure 1: Multiple Benefits of Energy Efficiency



Source: IEA, 2014.

Projections of researchers show that, energy efficiency is going to be the number one effective method to fight with climate change and greenhouse gases emissions. The graph that is taken from the presentation of IEA in G20 clearly demonstrates the outcome if predicted scenario happens. In addition to that, in this case if planned statistics can be reached, the system does not damage the economic growth. They also claim that, there is a big untapped potential which accounts for two-third of economies such as; industry, transportation, power generation and buildings. Especially buildings and transportation are directly connected with maritime energy efficiency sectors (IEA, 2015: 2-10).

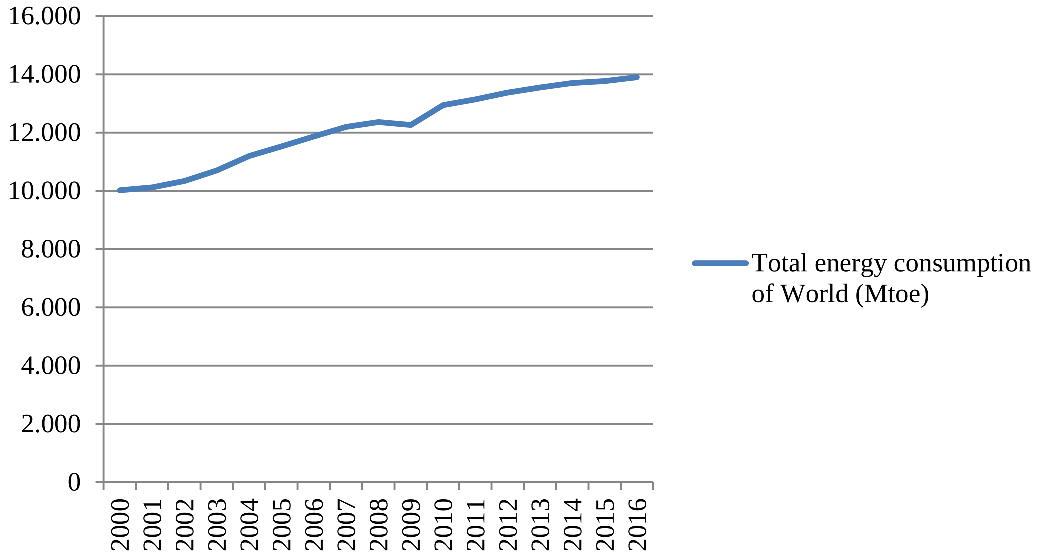
Table 1: Energy Savings by Measure Untill 2030



Source: IEA, G20 presentation, 2015.

Despite the fact that past 16 years there was a great jump for energy efficiency, in world energy that has been used in all kinds of production has been rising. Subtly this means as whole communation of human-beings we took what we earn from energy efficiency investments and put it on higher levels of energy service rather than shaving our consumption. In another form, effectiveness of the idea is changing direction with low levels of energy prices which leads much more use of energy and other resources.

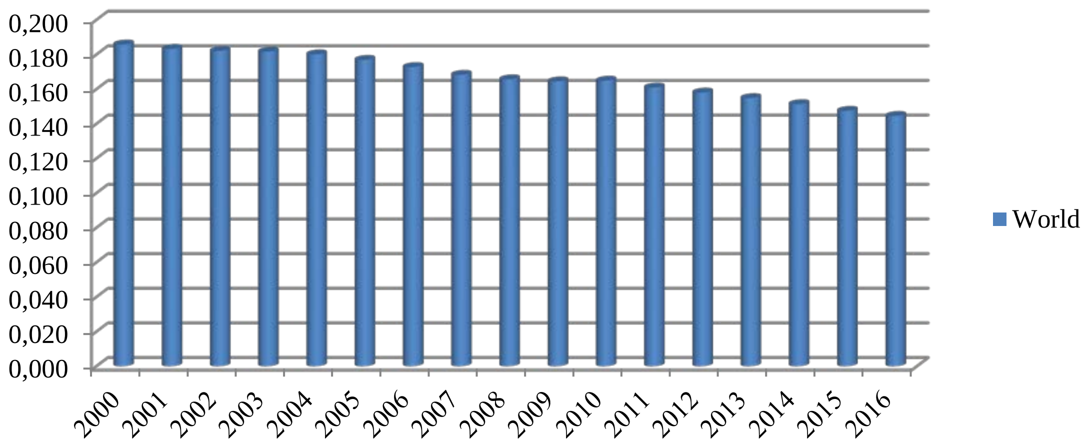
Table 2: Total Energy Consumption of World Between 2000 and 2016 Years in Line Graph



Source: Enerdata, 2017.

There has been a steady upward trend that indicates globallized world needs much more energy usage due to a couple of reasons such as increasing number of population, rising accumulated share of second world countries industralization from the pie chart of industrialization and growing reach span of electric usage and overall energy usage in rural and urban areas on world.

Table 3: Energy Intensity of GDP of World Between 2000 and 2016 Years in Bar Graph



Source: Enerdata, 2017.

According to biggest organizations that give insights on energy efficiency and global warming, energy efficiency helps environment via using resources wisely and not consuming in greater amounts. However there are opposite ideas such as Herring's 2006 dated article *"Energy Efficiency – a critical review"*. There are many theories and explanations that supporting energy efficiency implementations reduce global warming and many other ecological issues but Herring's theory claims that energy efficiency saves the inputs of processes however it will not lead to lowering national energy consumption starting from this point in global climate change war and it is "fatally flawed" (Herring, 2006, 10-19).

There are debates on the topic what they can do with the savings. At the end of the day above mentioned possibilities are just the outcome of the first action. In this approach cutting back over-use of resources and energy the firm earn the prizes of their investments then they had to decide what theyu can do with the outcome. Companies, sectors, countries and ordinary people are not obligated to spend their returns on energy efficiency or they do not need to hold themselves back from using more. Energy dilemma in here is users choice in between driving more or less after acquiring a fuel-efficient car (Gillingham and Palmer, 2014).

1.1. Evaluation of Energy Efficiency Terms

In the most brief explanation of energy efficiency it can be described as; a mean of managing and limiting energy consumption and its rise. Shortest way to illustrate energy efficiency is this approach; energy efficiency can be defined as spending same or less amount of energy resource to generate higher amount of services or more desirable output. To be more clear; If an action or work could produce either higher amount of output with same amount of input or same amount of output with less amount of input within the borders of not lowering quality and quantity of the outcome and not deforming the content or significance of product or service (either one unit or whole system); procurement process of service or good would be considered as energy efficient. The most simplified ratio to illustrate energy efficiency; last output of the process divided by energy input of the process (Economy and Foreign Policy Research Centre, 2015:3; Patterson, 1996:377).

$$\frac{useful\ output\ of\ process}{energy\ input\ into\ a\ process}$$

In the literature "useful" term created a controversy. Not only definition of useful can be different even in an objective research due to examining from different perspectives of efficiency (eventually this would lead us to a linguistic arguments) but also taking into account "useful work" it would open valuation and value judgement standards issues(considering a human subjective understanding is always a subjective judgement). Therefore, there should be indicators that give specific numbers to a concept to better find answers to these questions; "What does this concept stands for?", "What possibly should people adjust in order to reach their goal?" "How much is it successful?" and finally "How does this concept reshape their results afterwards?"

The term of "useful" in the equitation does not need to be necessarily energy output, it may be tonnes of product or materialistic equivalent of economic output that will be used for. To illustrate that insight; one of the most common method to measure energy efficiency in the field is energy / GDP (Gross Domestic Product) ratio. Latter, energy intensity is a measurement tool for energy efficiency which is calculated as units of energy divided by GDP. Although it is an energy efficiency measurement tool, energy intensity does not show everything about energy efficiency. For instance a country with lower energy intensity could be relatively small, service-based and has mild climate which would comparably has lower energy intensity in a comparison with a country that has higher energy intensity due to its industries however uses energy efficiency tools better than first country. Despite the fact that there are exceptions generally, higher energy intensity shows lack of energy efficiency in the economy and lower numbers illustrate the effectiveness in the economy. In addition to that, energy conservation is another term in the literature however has nothing to do with energy efficiency. Shallowly, this concept is satisfied when input of energy is decreased but the output did not change. Energy conservation points less or fewer energy use to get less or fewer economic output. Energy efficiency often confused with energy conservation issue (Economy and Foreign Policy Research Centre, 2015: 3; Patterson, 1996:377; Wilson et al., 1994; WEC, 2016c: 6).

Exergy is another important term that directly connects with energy efficiency under the concept of quality of the energy that goes under the system and its calculations. To quote a firm definition of the concept; *"The maximum useful work which can be extracted from a system as it reversibly comes into equilibrium with its environment."*. Depending on the ranking choosing the energy type is basically will produce more logical outcome and ability to control energy consumption in both ends supply and demand (Exergy Economics, 2018).

Rebound effect is the most basic problem that goes after energy efficient systems. Decision makers could make an energy efficiency investment to their system however afterwards it may lead to relatively low prices or more desirable outcome. As a consequence of this advantage, decision makers can or may want to use the resources heavily. Exploitation of the resource will lead us to another unwanted position which is defiling energy efficiency positive conception. Energy productivity ratio is the opposite version of energy/GDP ratio and in this term section. Basically it is calculated as gross domestic product divided by energy consumption of a nation. Therefore it represents the optimistic side of energy efficiency in broader sense. Total factor productivity (TFP) is another efficiency measurement tool that includes capital and labour factors in the calculation, therefore economists are more concerned with concept. Total factor productivity, as it name speaks, using all type of inputs in the weighing process eventually it may become the one of the best possible tool for sectorial researches or firms. Energy security or secure energy is another term that shows management of primary energy supply from a source, trustworthiness of infrastructure of energy supply and meeting with demand by any means. This term also includes not going in to a crisis when the supply is low. Lastly energy equity is used for accessibility of the energy. If energy equity is comparably high that shows it is more achievable to use in terms of tangible connections and affordability (Sorrell, 2007; WEC, 2017).

1.2. Energy Efficiency Indicators

Mostly researchers mentioned three major headlines when evaluating energy efficiency indicators; *thermodynamic*, *physical* and *economic* indicators and many combinations within them. In this terminology Thermodynamic indicators are calculated with given sole physical conditions such as temperature, pressure, concentration etc.). Due to this methodological approach this indicators are called science of energy efficiency. In other hand, physical indicators measures energy efficiency with direct output or end use services. For sake of clarification, tonnes of product have been produced or satisfactory level of people that goes into barber is what these indicators are concerned with. Lastly, economic indicators are more economy-wide indicators and these types of indicators put economic value on table first (Patterson, 1996; Sorrell, 2007; Ceylan, 2010; Economy and Foreign Policy Research Centre, 2015: 8).

Indicators of energy efficiency have been used by many organizations although there are few standard form of categorizations within indicators. Even though there are well-known energy efficiency indicators such as energy intensity (Gross Inland Energy Consumption (GIEC) / Gross Domestic Product (GDP)) mostly there is no acknowledged and adopted base format of rule or order for energy efficiency. There are combinations of indicators, to set an example, a researcher can measure a yacht shipyard’s energy efficiency by measuring the input in terms of effort of machines in used heat rate and measuring the output in terms of economic value of the yacht that has been launched or in context of how much work a machine could finish per hour or how many woods a chainsaw can cut to build that yacht. Patterson illustrated in his theory what we should state when we are talking about energy efficiency. There are numerous indicators which directly connected with energy efficiency such as how we define “useful input”. In this context, Patterson in his *“What is Energy Efficiency”* titled article, has proposed four critical main groups of indicators which are Thermodynamic (1), Physical-Thermodynamic (2), Economic-Thermodynamic (3) and Economic (4) indicators. Furthermore He discussed the flaws of every indicator group and basic methodological issues with how to reflect energy efficiency in its possible best state in sense of gaining recognition from every stakeholder of environment starting from supply and demand sides and varying up to basic consumer for the sake of not being misleading. However in these papers we will discuss energy efficiency in main three groups as stated in the beginning of this chapter (Patterson, 1996).

1.2.1. Thermodynamic Indicators

First-law energy efficiency indicator which also called as thermal efficiency and enthalpy efficiency represent caloric value and heat content-oriented side of thermodynamic indicators. Formula of this measurement is sum of useful output of the process divided by sum of all of the energy inputs of the process. First law of efficiency points out that a basic light bulb is used by 6% of the energy which makes remainder energy “waste”. If one adds waste output of the process to the useful output part it is going to be inputs and outputs of the processes are equal. As known as by science, energy does not lose any part of it when transforming but transforms into different forms. Since consumed part in the process referred as used or available or less available energy but not exactly fully “used up”. An electric heater for example only uses electricity power to convert heat which efficiency of this kind of machine is really high because of there is only limited loss of electricity to be gone. Problems within this indicator are energy quality issues. By using this method one counts one unit of electricity and one unit of solar energy will give same efficiency. Even though first-law energy efficiency indicator is one of the favourite instrument of people, considering availability of the inputs and outputs of the process, overlooking quality of the energy type that goes in to a system or goes out from the end, at best, would be imperfect. Ability to perform “useful work” or “availability” or in general “work potential” of inputs and outputs could lead us to misleading energy efficiency results. It is highlighted by this simplified logic by Sorrell; using high-pressure steam power as an energy source could accomplish more “useful work” than same amount of low-pressure steam power (Sorrell, 2007; Tsega. 2018: 3-8).

Second Law energy efficiency indicators are the substitution of first-law energy efficiency indicator when energy quality term is a must because of above mentioned exergy efficiency (energy quality indicator) issues. Eventually this understanding is surpassed by second law of efficiency, which demonstrably offered a greater potential for improvement. There is more than one approach in this indicator type. Briefly mentioning the exergy issue, it is basically comparing the energy quality of variation of energy within them. For example using low quality energy to generate higher quality energy shows the gap of exergy differences between them. Also exergy unlike energy can be destroyed in the process. According to this approach a space heater will show big percentage of energy efficiency because it only turns the heat content and consumes electricity by doing so however in this type of indicators the percentage of energy efficiency will immediately drop to the base level due to the fact that electricity which has high exergy ranking converted into space heat which has low exergy ranking in a comparison with electricity. Weighting by work potential heavily indicates and elaborately goes deep than taking only the heat content side of action (Patterson, 1996; Sorrell, 2007; Tsega, 2018: 3-8).

1.2.2. Physical Indicators

As mentioned earlier, physical indicators are related with “desired” end use services. Mostly it is calculated by this ratios; Desired Output (tonnes of product or given service)/ all energy input of the process. For instance, either there is a cargo ship; how much oil has spent divided by tonnes of product has been carried or delivered containers or there is a cruise ship; how many people has landed on land divided by how much energy has spent till that point is the basic formula of this type of indicators. Also these types of indicators could be commemorated with restriction due to the nature of end use services. If outcome is not coming from the same or similar process or system it would direct us to this fallacy; comparing oranges and apples would not be a necessity. Therefore the main problem within these types of energy efficiency indicators is restrictive nature of the measurement tool (Patterson, 1996; Sorrell, 2007).

1.2.3. Economic Indicators

Economic indicators of energy efficiency could be purely related with financial or going in hand with thermodynamic indicators. Calculating the value of the product or service with how much work accomplished and how much energy was spent is another way to represent energy efficiency of chosen system. If one only concentrates on sole market value of the product lack of technical energy efficiency problem arises. It may seem going off the trails of what has been wanted in the first place. There are numerous examples of economic indicators but most well-known among them is probably is Energy/GDP ratio. However the ratio and its counterparts in sectoral energy efficiency ratios are not exactly showing the technical issues that understood by everyone as core meaning of energy efficiency. Economic indicators are generally used for looking big pictures however missing the details drops the value of an artwork. There are hybrid methods such as calculating economic value of an output in context of market value and weighting inputs by thermodynamic measurement tools. Eventually for the sake of macro level energy policies using these methods are more useful however encountering separation of structural deficiencies and technical energy efficiency trends will be troublesome for this type of indicators (Patterson, 1996; Sorrell, 2007).

1.3. Barriers to Energy Efficiency

Energy efficiency praised as “the first fuel” because of numerous reasons such as its aspect drives innovation to the sectors such as electric bulbs and the lighting industry, itself becomes a new area. As they see energy efficiency as “fuel” they state the fact that the supply of the process cannot be disrupted. One of the good reason is it is home-grown energy. Furthermore, when the first establishment costs are provided, equipment pays itself in a long-term. On top of that, being environment friendly covers many things which start from moral issues to making a good impression of the entity on others eyes (IEA, 2014: 2-10).

Factors that shape energy since 1970 are listed like this; population and labor force growth (1), new technologies and productivity (2), environmental priorities (3) and international governance and geo-political relationships (4) by WEC’s report on energy scenarios. Even though all this concepts are related with energy policies, in this report they add another segment that called energy policies (WEC, 2016b: 33-42).

Knowing that there is a barrier in front of the path allows policy makers to foresee oncoming problems within them. If successfully dismantled this type of barriers via policies and other effective methods, barriers would be the jump point for many economies. Latter consequences of this approach enable us to reach uncovered parts of energy that is not under any regulations such as countries with has no mandatory policies implemented in their law.

There are some barriers to taken into account for energy efficiency in economies; problems with the first investment costs, rareness of highly informed investors, unfamiliarity to the energy efficient products, politic and regulatory problems, bureaucracy, cultural and behavioral problems. Constantly implying energy efficiency policies does not only helps to limit the cost of energy but also helps to mitigating greenhouse gases (GHG) emissions, cuts the need for investment in energy infrastructure, averts air pollution and decreases the reliance on imported fossil fuel (Ceylan, 2010: 1-5).

ODYSSEE MURE project’s november 2016 dated article on energy efficiency networks which is a concept to accelerate energy efficiency regulations and improvements in companies that designed in Switzerland in 80’s sets the barriers to energy efficiency like these; information and knowledge gap (1) fear of negative impact to the process (2) uncertainity on legal, economic and planning factors (3) low priority (4) lack of capital (5) high transaction cost of investment (6) (ODYSSEE MURE, 2016).

Rohdin and his friends went into the way of classification to these barriers as well. According to their classification on this issue: in economic perspective; hidden costs, access to capital, risk, heterogenity, imperfect information, principal-agent relationship, adverse selection and split incentives; in behavioral perspective; bounded rationality, inertia, credibility and trust, form of information and values; lastly on the organizational leg; culture and power (Rohdin et al., 2006).

In this concept heterogenity represent the problem within the investment is possibility of new technologies may not work in harmony with old one. Also split investments mean taking the not exact benefit of turning the system into efficient one. Bounded rationality is a basic human flaw that we can not know everything with full information. Credibilty is the encouragement of purchaser in the first steps to trust the product by the name on it. Power is the lack of management aspects to show interest in energy efficient applications to move firm one step further.

1.4. Energy Efficiency Policies

WEC in their 2016 report on energy perspectives mentioned two main questions about energy efficiency policies and their implementation; first the degree of commitment to energy efficiency of the policies and second presence of institutions that supports the implementation of the policies regionally or nationally. Generally adopting or accepting a law, provide a legal framework for adoption of targets or other regulations such as labelling, MEPS (i.e. Kenya, New Zealand, Singapore, etc.), enforcements for big economic actors (i.e. India) or even putting energy saving enforcements for utilities (i.e. France, China) or energy audits (i.e. Ireland). This may also provide a legal framework to create an energy efficiency fund (i.e. Thailand, Uruguay) (WEC, 2016c: 47-121).

After the last survey of WEC, there are additional 10 member countries which have implemented an energy efficiency law and four countries which have ongoing developments on a law with already enforcement. It sum up to a total number of 54. In the area of energy policy trends, adopting a law and implying with the help of an institution started to become a common approach by many countries worldwide. A law is expected to give more concrete status to an action, furthermore changing a law into a similar other law, may cause a confusion. Also it would be unusual if countries put a law and did not support it via an action plan. To a great extent countries did not demonstrate their law without a starting point and gradually implying. To finalize the fact that both organizations IEA and WEC distinguished having energy efficiency law with implementing and supporting the policies via facilities, institutions and concrete evidence of showing commitment to possess systematic approach and master plan to the issue. There is a statistic in appendices section that shows that Enerdata which is the research companies of many international and national energy agencies navigates in this issue by categorizing the countries that has shown a performance on this level of action (WEC, 2016c: 47-121; Enerdata, 2018).

1.4.1. Past and Future of Energy and Energy Employment on Policy Perspective

Energy efficient economies, sectors and companies have been more desirable within the last 30 years. It was mainly due to the world energy crisis in 1973. In addition to that, perception of global warming and climate change had been changing in that period as well. With the help of growth in the population, globalization and improvements in the technology and transportation, consumption has become the biggest reason lays behind that period of phenomenal understanding change. Consuming triggers the producing, as a consequence of this, energy become more popular topic. When big demand occurs, limited sources (such as oil in 1973) become more valuable which none of the producers regardless of their sector or branch would want. In order to prevent this issue, there are two precautions; using it wisely (energy efficiency) and using an alternative resource (renewable energy). These are the twin pillars of sustainable energy policy (Prindle et al., 2007).

Most of the time, crisis or a disaster generates prevention in human history, for instance Titanic incident led to public disclosures on issue of hypothermia. In 1973 and 1974 a similar case for producer countries has occurred. The Middle East War drove unprepared OECD countries to a challenge; a challenge of lack of information and organization. As a quick aftermath begun, OECD has established, Paris-based IEA with a big force on energy security and other questions of interoperability on energy policies. IEA defines their purposes in one sentence; “The Agency would become the focal point for energy co-operation on such issues as:

security of supply, long-term policy, information “transparency”, energy and the environment, research and development and international energy relations.” (https://www.iea.org/).

Another organization WEC which is “United Nation’s accredited global energy body” has more than 3000 member almost any type of energy related organizations in over 90 countries. In terms of relevancy WEC has reaching distance between the institutions like governmental and non-governmental organizations, private and state corporations and third parties such as academia and stakeholders that involved in energy associated issues such as public. Missions of WEC are genuinely informing and hosting meetings of those stakeholders in order to establish a platform that energy policies would get in negotiations. (https://www.worldenergy.org)

Today we are highly industrialized and living in big cities but we were not like this before. Since 2009 more than 50 per cent of population lives in cities. By 2070 it is foreseen that it will increase to 70 per cent. On the world there were only 3 mega cities that population of it can pass the limit of 10 million people however by 2025 we are expecting that it will be 27. In addition to that population of world will become 9.3 billion. In the economy there is stubborn fact that nobody can think of an industrialized enterprise without direct or indirect effect of policies or policy makers or the role of the state. Even their existence may bounded by policies of energy efficiency. For instance, on the surface electricity companies were state run in 70’s but in 90’s many countries converts themselves in real liberalization movements. But in oil industry private oil companies that has been dominating the market in 70’s are surpassed by state run oil companies. This huge impact showed details about how much importance that the community should give about energy policies. Private or state-run, every branches of economy are in need of energy efficiency if they do not want to waste more. Energy efficiency policies are investigated under the topic of energy policies. Eventually climate change, sustainability and many other topics come in a body. Between the years of 1990-2010, primary energy demand of world has been increased by 45 per cent. If nothing changes in the existing paradigm of energy, 87 per cent of global energy demand will belong to non-OECD countries by 2030. Also if the trend and ongoing rise of energy demand would continue it is expected that energy investments that will be needed is going to be 38 trillion United States (US) dollars. Predictions of energy investments show that these investments mostly will be required by non-OECD countries with the percentage of 65 an it will be approximately 25 trillion US dollars. At this point it would seem like that investments has to be hedged around or constrained by energy efficiency in order to limit or imprison the ongoing crisis of CO_2 and GHG emissions (Sevim, 2015: 1-3).

IEA foresee a future in 2040 that holds, 37% energy produced by renewables comparing with 23% today, 150 million electric vehicles compared with 1.5 million today, 50% growth in demand for natural gas, overtaking coal in the global energy mix, 0.5% average annual growth in energy sector carbon emissions and lastly 103.5 MB/D (millions of barrel per day) oil consumption compared with 92.5 MB/D in 2015. Even though, CO_2 emissions are not on track for a 2ºC scenario. After analysis they stated that, in order to achieve the 2ºC goal energy sector must be carbon-neutral by 2100 (IEA, World Energy Outlook, 2016).

In other hand, being the first to lead USA and European countries changed their agenda not in favor of climate change, energy efficiency and sustainability due to neglecting policy backing and co-operation. Although the meetings were held for reducing CO_2 emissions and emerging new technologies for energy efficiency via reserving 1.5 to 2 per cent global GDP of world most of the congress and other types of meetings were dismissed till Paris Agreement. Emerging and industrializing countries mostly displeased with this type of policy backing due to probability of life standard alteration risk. Copenhagen agreement on climate change ended in failure in 2009 because of these issues held them back. Eventually when countries are not concerned with energy efficiency they do not take part in energy efficiency policies too. The philosophy of energy efficiency indicates that eventually without a significant rebound effect policy to draw a line ideally would not be a problem. (http://www.eesi.org)

1.4.2. Today of Energy and Energy Employment on Policy Perspective

Nowadays, policies which are related with energy are formed around these factors; upward trend of demand of emerging countries, countries that trying to reshape their economy-wide energy investments, climate change issues, renewable energy technologies and perception, context of future dynamics of energy, energy security, energy poverty, affordable energy, oligopolistic market behaviors, environment, energy efficiency, consent of countries in agreements and technological improvements.

Energy efficiency policies are sub-topic of energy policies in general. Thinking about energy and not connecting it to energy efficiency nearly impossible in current paradigm. Also this connection exists in mirror. Depending on the issues such as climate change, energy saving, energy consumption, total factor productivity, GHG emissions, energy security or equity and any other energy related issue is interrelated with efficient energy management. As long as this connection between those terms with energy efficiency, striking problems when they are thrown to the face of world the first option of bat is energy efficiency. Above mentioned twin pillars of sustainability is well-known paradigm for today. As a result every energy policy or improvement will end upgrading energy efficiency tools. For instance, sector choice and big investments of a country will show a progress in efficiency because of newly emerged technologies will directly be used in those plants. A disaster will lead countries to unwillingness of abusing resources. Maybe just energy efficiency will be the number one topic in big reasons to have conducted agreement.

There were three recent reasons that shaped alteration of balance in energy. The first one was economically big countries such as USA and China have entered the markets of petroleum and natural gas. Even though they were implementing and promoting energy efficiency and investing on renewable energy systems (such as China's clean energy investments in 2015 have doubled EU numbers). Another reason that completely changed the perception is Fukushima disaster led EU countries to elaborately think about nuclear energy and set a fall back in energy production by using nuclear factory plants. Eventually this had to be the eye opening fact for EU and a chance to improvise technical efficiency in production and investments in other energy resources. The last reason was advance in energy efficiency and ongoing insist on policy conversion. Even though some ratification problems happen in many countries such as USA Paris agreement on climate change will dramatically improve energy efficiency on whole world. 167 out of 197 countries have ratified the agreement on a maximum base and it is going to rise probably (Sevim, 2017: 1-3; United Nations Climate Change, 2018).

2012 was the year that has the record for the biggest amount of CO_2 circulation on air since 800 thousand years. Also starting from world war two there has been steady upward going trend in many areas on climate change; global surface temperatures which had approximately minus 0.2ºC is now around 1ºC and global ocean heat content has arrived 24 heat content (10^{22} joules) from minus 8 from 60's both data show how much policy makers have to be intolerant with the issues of policy. According to above mentioned sustainability arrangements, as long as climate change is a policy maker's number one priority energy efficiency will come up with it. The idea of energy efficiency without rebound effect can and will reshape the world in many prosperous ways via lowering the resource abuse, changing investments, making economies more stable and improving, empowering us with technologies, giving us more secure, fast and affordable energy at both ends demand and supply and lastly creating better environment for future. At least this is the look of IEA and many other organizations around the world (https://climate.nasa.gov).

In November 2016, Paris agreement on climate change has entered into force. It was approved by 197 countries. In the webpage their opinion on the topic is claimed as this; countries acknowledged the fact that world needs to limit greenhouse gases emissions and focus efforts and investments toward a low-carbon, resilient and sustainable future. The goal is to limit the rise in global temperatures from above 2ºC to below 1,5ºC (https://www.iea.org)

According to the IEA's energy efficiency report; over 68 per cent of world energy need is not obligated to use in efficient way by policies that could been imposed. Lack of mandatory enforcement by policies are usually for pushing market in using minimum levels for performance and covering what company must do in most efficient way. Also this policies impose another term to enter any market which is if one tries to build or add a system or a device or a building in its assets it has to be energy efficient such as Turkey's new energy efficiency law on public buildings could be an example for this. Global energy efficiency coverage is increased by 1.4 percentage points in 2016 but it was mainly thanks to continuing energy efficiency policy improvements and replacement of non-efficient appliances and devices. This impact is not exactly the way as it seems when walking toward more efficient world. Only 1.5 per cent of the law that has been implemented changed the numbers which means without Asia this year was terrible for world (IEA,2017a; Official Gazette, 2008).

Overall pace of change in energy efficiency is understandable in the category of slow. Last year many countries hesitated to strenghtening and stricting their laws in order to accept heavy and light duty vehicles. 2016 policy changes was the lowest rate since 2009 which means new policies and other mandatory applications must be dictated in this dimension (IEA, 2017a).

G20 meeting in 2015 held in Antalya, Turkey. According to communiqué of G20 energy ministers, they adopted “G20 Energy Access Action Plan: Voluntary Collaboration on Energy Access”, specifically they accepted to co-operate, help and ratify the further actions on; improving efficiency of heavy duty vehicles which can be improved by 30% to 35% to be more efficient, networked products which are always on and needs to be taken an action plan against it, energy efficiency financing, cooling, heating and lighting systems of buildings, industrial energy management and electricity generation (G20 communiqué, 2015: 1-3; IEA, 2015).

Progress on the basis of energy efficiency by its probably the most marketable side with the aspects of being green energy, being jumped in front of many old technologies by nowadays and low costs and short term impact, “renewables”, could reduce electricity market at the price end.

2015 was the year that IEA mostly wanted an integration on policy focus. That year costs for renewables decreased however there was a need for radical change in the power systems to reserve a space for wind and solar power systems in industrialized operation by creating incentives oppotunuties and integration. In addition to that generators have been improvised however for flexibility issues and their cost reduction on market are needed shifts. IEA states its opinion on what wind and solar power market shares have to be as one out of four share of whole market. In order to achieve this type of accomplishment they stated that as long as the demand stays on table the status should not change even have to used as encouragement by policies and incentives for countries with intention of emerge or emerging countries. To set a barrier on decarbonization of power sector changes that helped along the way and newly developed precautions and incentives have to be implemented to ensure energy efficiency shows its aspect of reducing great demands in more modest levels (IEA, 2016).

According to Enerdata share of wind and solar power in 1990 was 0.35 per cent, in 2016 this percentage has risen to the 5.66. Also change between the years of 2015 and 2016 by the calculation of percentage divided by year on share of wind and solar power in electricity market totalled up to 14.3 per cent which is low in a comparison between 2000 and 2016 years which is 15.6 per cent (Enerdata, 2017).

Efficiency Policy Progress Index (EPPI) is the index that weights improvements and existence of policies and their enforcements and detailed scope since 2000. EPPI shows great distinction between China and other countries that trying to implemet their energy efficiency policies appropriately. To prove this by using EPPI, China only by itself has 10.9 score on EPPI whereas global EPPI score is 6.3 and last year it was improved by only 0.6 points which indicates the fact that progress converting countries in more energy efficient conditions even with policies takes time and effort however not using this method world would be on the tracks of over consumption as IEA states. Also China is well-known by the fact that giving importance on the energy topics. Another example to this, is China has been accounted for half of the implementation of mandatory efficiency policies in last sixteen years of EPPI. The reason lays behind it constant change in China's industry and energy productivity and consumption issues. "Most of the improvements were on energy efficiency are consist of freezers, refrigerators space heating and cooling whereas motor-driven systems, heavy duty vehicles and clothes dryers unitsdid not show the exact success in the chart." After mentioning this fact, we could also say that slowing down in progress which can be seem from EPPI with 0.75 average points of improvement was mainly due to "fewer new policies" and this trend resumed in the first half of 2017. Even though two newly developed obligations have entered into force utilities to deliver energy savings did not say too much in 2016. In overall trend programmes that has been used for limiting consumption in terms of saving and efficiency has rosen from 7.1 per cent in 2005 to 18.3 per cent in 2016 (IEA, 2017a; IEA, 2016).

Despite of great effort by many people (ie Paris Agreement) 2016 was not nutritious in the eyes of people that wants big steps in energy efficiency also 2017 is another year that will probably end in not exact satisfaction in the context of energy efficiency policies. IEA diagnosed the issue with this approach; it is less than what we expected and it is not normal that we are not in control or fully covered world energy demand supply by policies.

1.5. Energy Efficiency Trends

In 2017 WEC set the first priority or issue as commodity prices for energy. If commodity prices are volatile changes in the industry will be uncertain. As long as uncertainty is on the top of the firm like a cloud they will not see to install energy efficient system. A company if does not know how to react to the charts the question of how do they can install an energy efficient equipment to their system within this environment is a stalemate. Situation itself creates uncertainty about foreseen expectancy of the company. Another aspect or problem with this issue is resources and capacity used; at best it could be named as unbalanced. If a freight transport company which carries commodities on the load does not know how to react to the offer of the shipper and eventually these conditions creates two possible results gigantic profits or failure in terms of economic value of carriage. Most of the times in order to ensuring negotiation safety carrier stay on the good side of shipper and drop the freight in panic and find themselves in not profitable agreement. In this type of environment it is hard to encourage companies to invest in energy efficiency applications and convince them it would be better for them. Most of the time it can be seen that as soon as firms find capital to invest, rational choice of creating more profitable energy employment plan is made by companies. Logical use of energy resources is not expected from industries in ongoing unbalanced environment (WEC, 2017).

Energy intensity which is the measurement of primary energy demand to produce one unit of gross domestic product shows great signals via decreasing by 1.8 per cent in 2016. After 2010 energy intensity was going down like it did not before with 2.1 per cent. This number is carrying a great potential in a comparison with 1.3

per cent between 1970 and 2010. China is on the throne again like they did with policies from 2000 (EPPI), wind and solar energy investments and actively scaled up the improvements.

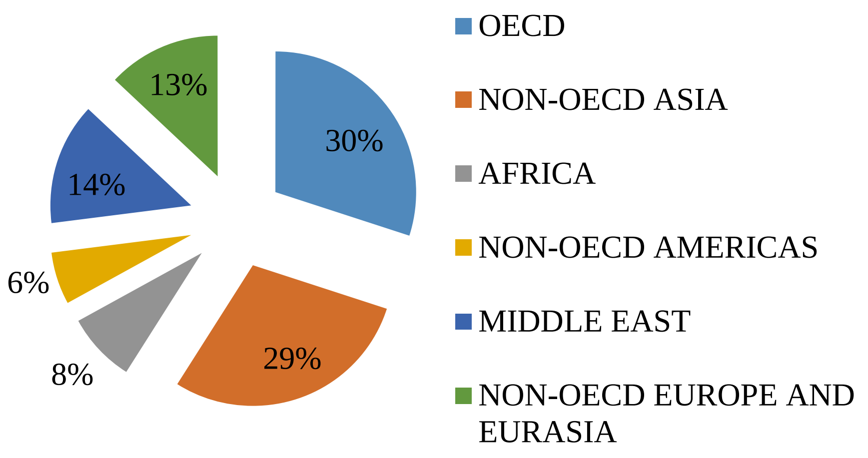
Even though improvements are genuinely exciting, along with slowing down in the new policies to reshape and cover more on world, pace of energy efficiency should not be stalled according to IEA.

2.2 trillion US dollars (twice the size of Australian economy); this is the economic impact of last year earnings of world from energy productivity. As long as energy intensity rates drop, producers will accomplish more GDP for each unit of energy consumed.

When comparing the years and overall trend of energy, as it stated as demand, by TPES (Total Primary Energy Supply) which is kind of negative because of always increasing demand of the energy, past is always better in the context of energy conservation however adding the issue of energy efficiency it may be different in the future. In 2014, by 0.3 per cent world was consuming less although without energy efficiency term it may seem like world has stopped and nobody show a sign of life which means balance has been not in favor of ongoing utilization of energy but with help of mandatory policies and major technology and understanding change future may will be different in terms of energy conservation. IEA gathered their results in the three main topics for energy efficiency; energy intensity levels, energy savings and multiple benefits of energy efficiency. In 2015, they gave a quite important part of their publication only for China and their developments on the many areas of energy efficiency. According to IEA available statistics, whole world's TPES 13.699.13 MTOE (Metric Tons of Oil Equilavent) whereas China's TPES 3051.5 MTOE. By looking at those statistics, China's revolutionary improvements mean a lot for world. Ecologically and economically speaking, if one of the biggest emerging country of world slides faster into energy efficiency than industrialized countries slide, the benefit will be shared by all the countries on world. Due to contrasting trends demand was stable non-OECD countries demanded 0.5 per cent more than last year and in OECD countries there was a fall by 0.3 per cent and this trend remained same in 2016 (IEA, 2017c; http://www.iea.org/statistics/statisticssearch/).

In TPES area top ten countries are listed as like these; China, USA, India, Russia, Japan, Germany, Brazil, Canada, Korea, and France. However in 1971 China's ranking was many steps behind and USA had the first position. In 40 years China's big step on the energy sector make them really strong in terms of production. Also China is one of the best countries for implementing energy efficiency in a blink of an eye to their system for to cut energy dependency by making more sustainable and efficient in all kinds of energy spectrum in economy.

Table 4: Total Production by Region in 2015



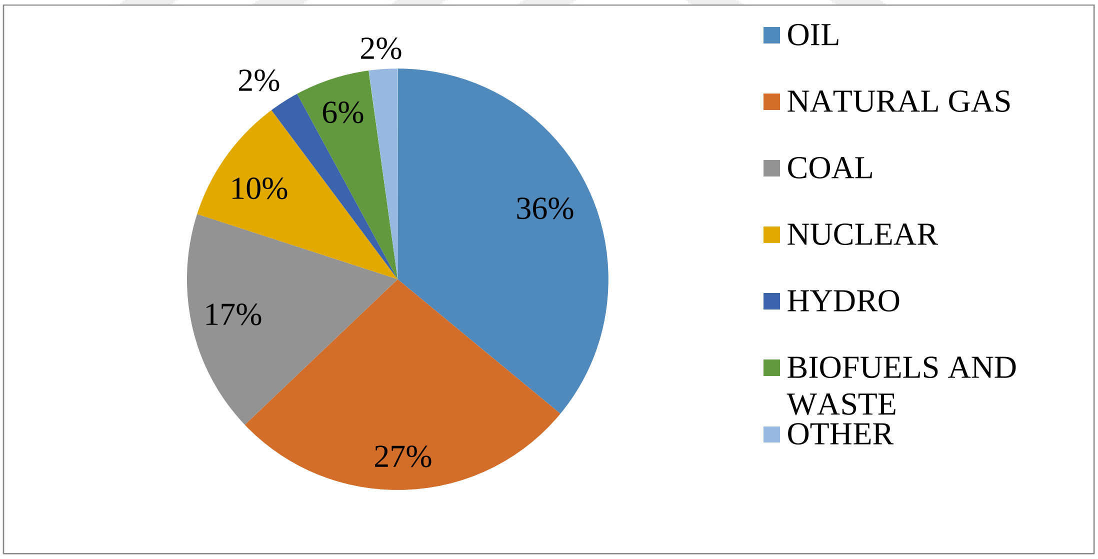
Source: IEA, 2017b: 9-10.

In above mentioned chart China has been stated as non-OECD Asia country. Other than Producer China and big OECD producer countries Middle East region is worth to mention in context of which countries are elaborately interested in production of energy.

Among OECD countries Canada and USA have the biggest share in terms of production. Approximately their shares account for almost 60 per cent of OECD's all production. In addition to this, these countries are chased by Norway and Australia by big jumps in production in recent years. 6.2 per cent and 4.3 per cent production increase is tells whose economy is the production.

The connection in between who has been producing and what has been produced is the fact that worth to mention in order to speak of efficiency of something. After 2010 Australia, Canada and USA are dwelled on the issue of LNG market. As a result their capacity of production numbers got many digits to the overall number. After crisis of oil and fall of Middle East into a terrible situation of politics many fossil fuel producers had a drawback on production. Ukraine invasion by Russia led EU to make sanctions on Russia however Russia's power of energy production hold them a little bit back. At the other area meanwhile Middle East's fossil fuels decrease of price rates has been going on. China, a country that produces more than any other country has been directly affected. Due to this storyline, China keen on energy efficiency and renewable energy more than any other time in history. Plants have been designed, laws have been implemented and new systems have been emerged since then with a great pace. This energy crisis has two main opposite faces of medallion; first is new plants, new policies, new technologies and secure energy efficiency applications have been got on the stage, on the other hand second view is oligopoly of the trade of energy, terrible, or we can say disaster level politic issues, fluctuation on charts, ambiguous decisions by producers, over-dose level production, over use of resources, conflict of production interest flow and arguments and embargos between countries have been also dragged with the phenomena (IEA, 2017a; Zhao and Chen, 2018; http://oilprice.com;).

Table 5: OECD Total Primary Energy Supply by Fuel in 2016

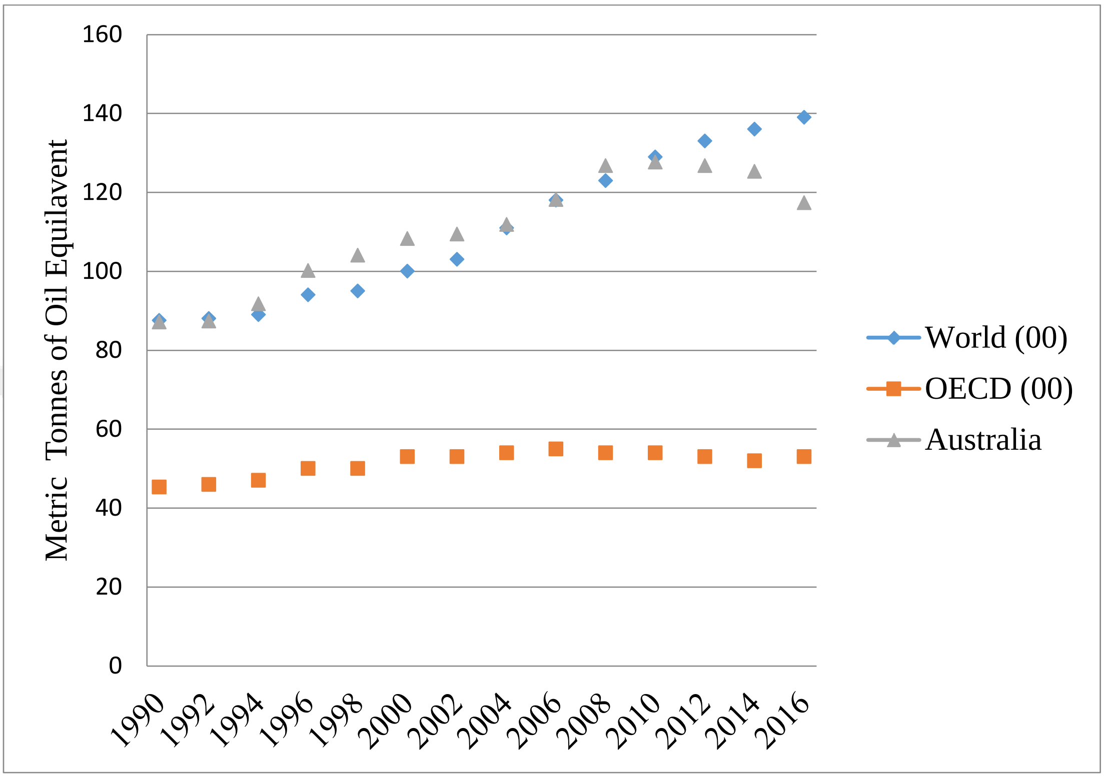


Source: IEA, 2017b: 7-8.

Notes: Excludes energy trade (1). In these graphs, peat and oil shale aggregated with coal (2). Includes geothermal, solar, wind, tide, wave, ocean, heat and other energy forms(3).

One of the concerns in trends is LNG. After the decisions and investments of USA, Canada and Australia world energy scale will probably change in not so long term. Causing oil producer countries to re-check their balance sheet and may be the positive impact to re-shape their consumption rates in order to stand still would be the best outcome for not abusing energy resources.

Table 6: Comparison in Between World, OECD and Australia Trends Between 1990 to 2016 Years Total Energy Consumption in MTOE



Source: Enerdata, 2017.

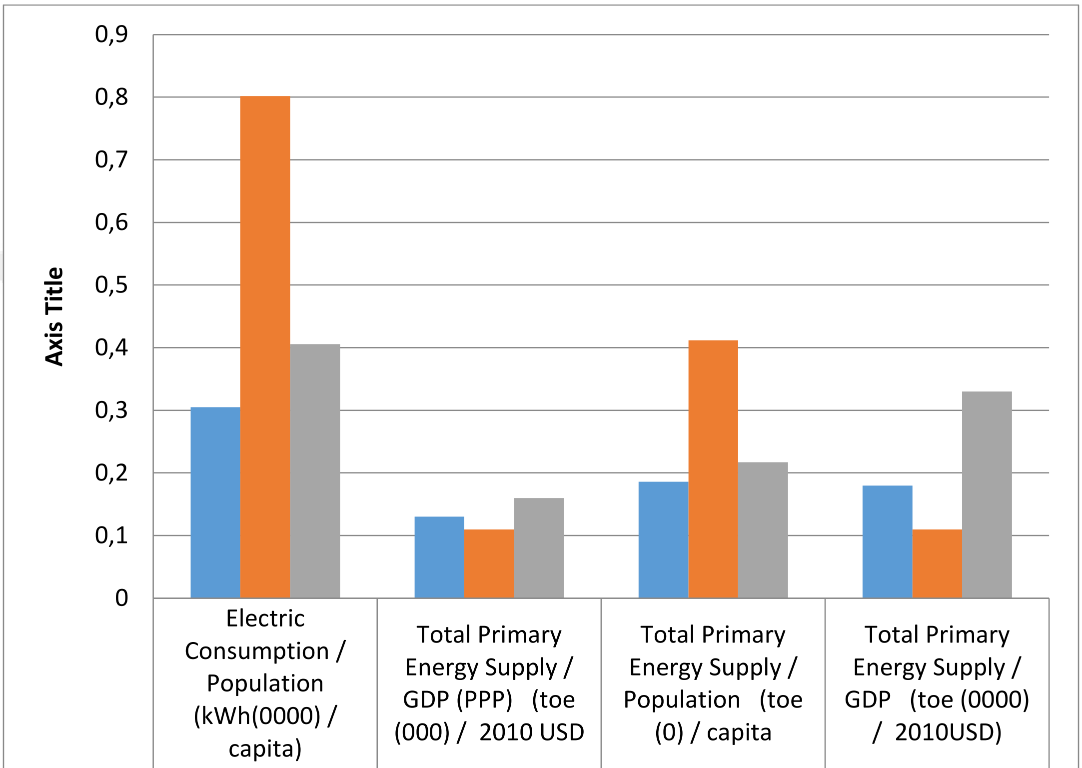
Note: Zeros indicates extraction of digits that put for clarification. Every zero indicates how many digit losses happened.

In this chart as stated above the transformation of general flow of consumption can be seen in multiple perspectives. One of the scenery is how an investor and producer country becomes more efficient while need for improvement has been occurred. Another view is how world's demand for energy has been rising when OECD's demand has been stable which broadening the topic that emerging countries or under construction countries, have been affecting resource consumption in a bad way. As long as this trend goes by this direction, there will be a must that twin pillars of energy sustainability (energy efficiency and renewable energy) should take more spotlights in order to achieve perks of efficiency which stated by IEA, not rebound effects of efficiency and moral abuse of improvements in technology.

China has been selected for their aspects of being high industrialized and population representation for a country is really high. Rather than comparing around

Turkey's 80 million people with OECD statistics, China's population gives better look to evaluate. Thus their improvements in sustainability on both of the legs renewable energy and energy efficiency shows that their decreasing consumption numbers and increasing clean production numbers which puts them in a spotlight for being a good example.

Table 7: Comparison of World, OECD and China in Selected Economic Energy Indicators



	Electric Consumption / Population (kWh(0000) / capita)	Total Primary Energy Supply / GDP (PPP) (toe (000) / 2010 USD	Total Primary Energy Supply / Population (toe (0) / capita	Total Primary Energy Supply / GDP (toe (0000) / 2010USD)
World	0,3052	0,13	0,186	0,18
OECD	0,8016	0,11	0,412	0,11
China	0,4057	0,16	0,217	0,33

Source: IEA, 2017b.

Notes: Gross production + imports – exports – losses (1). TPES for world includes international aviation and international marine bunkers as well as electricity and heat trade (2). Zeros which are in equations mean number of digits that extracted (3).

In this chart it can be seem that, beside that China is not becoming superpower they are superpower with production aspect, China has clearly prevented the consumption or abuse of energy resources whereas even OECD countries are not exactly at the same place. The path on ahead of China is shorter than world at least this can be said easily by looking at the demand of China with consumption rates. As a mass producer Also third and first sectors indicates that OECD countries are more available to produce however they are consuming at the same pace which shows that energy efficiency efforts are not at the same rate that expected and may be there is a rebound effect within the context of not lowering standards of their luxury. This could be destroyed by policies but as many as countries participation to the negotiation will be a long term issue such as Copenhagen. China is not well-known for its energy production but they are trying to be there via investments in energy efficiency, Researches and Developments and renewable energy plants such as wind and solar power in high numbers. China has been included because of all improvements in China represent the value that they give to issue on energy efficiency and sustainability in industries to households. This country leads the world in policies, energy intensity and investments and many other sectors as well. The main reason behind this is the dependency of China to resources. Shaving the consumption eventually will provide them better and sustainable production.

It is critical for energy efficiency to reach main sectors such as industry. In contrast to agree upon new policies, some of the emerging countries sharply reshaped the process of development and implementing new technologies without mandatory laws. This was mainly due to used technology in new factories and plants, capacity plans and lastly supply flow rearrangements of the firms. Application of EMS which is for tracking the flow of consumption as a result gives access to take opportunities of making sound and affordable consumption fluctuation and gaining incentives has an impact on the issue. Even though policies have been got into force and new technologies emerged but the process of applying to all industries all sectors and all firms and end-users will take time but point of arrow is not fully vertical.

1.5.1. Outstanding Energy and Energy Employment Applications Trends

IEA does not see energy efficiency in buildings area enough. By restricting the standards on the topics of heating and cooling and add envelope of buildings are not enough for creating chance or to concentrate. They insist on to take possible potential to gain 10 to 20 per cent improvement in appliances, equipment and lighting systems which are available for anyone. Compact fluorescent lamps and LEDs (Light Emitting Diode) are shows great success in their area. It is expected that indoor lighting in 2022 will meet by these two. WEC and IEA both stated the importance of motor vehicles issue and its major conversion. Thanks to policies; technologies and fuel prices are following them. Trucks which have a big share in oil consumption with 43 per cent are the new concern of policy makers. 16 per cent of fuel control has been accomplished but this number shows unwillingness of policy backing except Canada, China, Japan and USA (IEA, 2017b; IEA, 2017c; WEC, 2016b).

The progress since 2000 became more visible with 12 per cent less amount of energy used in 2016 compare with 2000 energy demand. That 12 per cent is approximately equivalent of another European Union. Also energy efficiency directly affects energy intensity as a consequence directly and indirectly reducing GHG emissions a little bit since 2014 is another big plus for energy efficiency. In the policies chapter it is detailed with renewables and renewable shares in electricity market. Improvements in energy efficiency pushing forward other inter-related topics as well (i.e. energy security). If energy efficiency would not exist in 2000 japan would import 20 per cent more oil and 23 per cent more gas. Another positive impact without thinking rebound effect Europe is using less gas by 30 per cent. By the changes in energy savings, United Kingdom and France saved 240 million cubic meters of daily gas supply during rush hours for demand. In another dimension, there is household side of energy efficiency. In 2016, Chinese houses would spend 25 per cent more energy and a German citizen gained nearly USD 580 per capita from energy efficiency. Energy Management Systems (EMS) dropped almost 20 per cent in last sixteen years starting from 2016. Certification of ISO 50001 which is the standard global certificate of energy management of International Organization for Standardization also grew in numbers in recent years. According to IEA energy efficiency 2017 report it is shown that companies with that certification gain 10 per cent more energy saving (IEA, 2017b; IEA, 2017c; WEC, 2016a).

1.5.2. Outstanding Energy and Energy Employments Investment Trends

Investments on energy on global basis in 2016 were around 1.7 trillion US dollars which was 12 per cent lower than previous year. That indicates the importance of prioritization of energy policies and agenda. Electricity sector became the most invested area in energy by passing fossil fuel supply for the first time ever. This trend especially indicates the new shape of energy demand. One can easily speculate that future is in electricity and other sources of renewables by giving a short look to the attest developments. By stating this fact it may open a new discussion in politics of energy shape. Mostly people's economic choices are affecting directly the policies but nowadays people's rationalized ideas affected policies at the end outcome is electricity which could be the substitution in future for energy efficiency and renewable resources. As much as it increases energy efficiency and other related topics with sustainability are bouncing higher from ground to expected goals (IEA, 2017c).

Investments in energy efficiency are increased by 9 per cent to 231 billion US dollars in 2016 but it was not a long run. Mostly the trend was steadily keep the upward trend on its way however IEA, WEC and other people that is interested in energy efficiency improvements are in anxious and nervous position. The main problem like it is mentioned above is lack of incoming policies and knowing this steady upward trend owes its positivity to mandatory policies and enforcements of state governance. In 2016, as one country China is on the throne again in investments with 24 per cent however Europe as a union is accounted for 30 per cent. In end-use sectors building investments such as appliances, envelopes and lighting single-handly over take 58 per cent of energy efficiency investments. In global energy service company segment in 2016, again China is the largest market among them 60 per cent of global revenues followed by USA by 20 per cent and Europe by 10 per cent. Also these companies are employing people and creating a new network of job. As long as energy efficiency stays on the board it will gain importance as commodity and will probably make up a dictatorship in many areas of energy market such as electricity by taking into account the projections of WEC (WEC, 2016b; IEA, 2017a).

In 2015 there were 65 billion US dollars that spent on energy research and development which was the clear new cut technologies. However there is a huge understanding change on energy efficiency and other issues in last four years numbers are not increasing. Europe and USA are the biggest undertakers with each one of them has one fourth of the market in terms of investments. As a share of GDP, after passing Japan in 2014 China did not gave the number one rank again. Public and private sources which are close to each other share research and development pie chart. Private researches are mostly focused on oil, gas and thermal power sector whereas public side of the researches are concerned with mostly energy efficiency, clean energy and other technologies which is related to clean energy. Technology will pull the policies on energy efficiency and other sustainability issues on a higher level. For instance, Carbon capture and storage project is also financed by large oil companies to reduce CO_2 on air but policies are not fully supportive on this issue mostly because of they did not catch up the pace (WEC, 2016b; IEA, 2017c).

Another plus for vehicles use of energy is progress on electrical vehicles. Instead of gasoline using electricity which can be obtained from sunlight, wind power or wave circulation is much reasonable in future due to steps of society. Another crucial aspect in efficiency is the role of digitalization which diminishes the difficulty in tracking, monitoring and interpreting the process on every step in order to handle energy that will be spent. 47 billion US dollars was channelized to infrastructures and software to make more digital the electricity sector also oil and gas side of the market tries to improve this management tool (IEA, 2017a).

Installation of smart technologies to accommodations and many other system devices are getting connected. As it is sound like most of them are energy efficiency control mechanism which can be monitored. For instance a newly built house which uses wind and solar power along with the oil in turn, when smart technologies take place in this process one could be the control mechanism of energy consumption. Such as smart meters that control energy use by tracking and displaying its movement in consumption. It is not futuristic anymore. “4 billion connected devices were in use by households worldwide and 1 billion may enter the calculation by 2017 and it may triple in 2020” says IEA report. Thinking about only the smart houses or smart cars are not necessary. There are big opportunities in industry too (IEA, 2017a).

1.5.3. Academic Trends

Some of the researches are mentioned in this segment with their authors, years, used technique to reach out energy efficiency evaluations, basic type and field they approached.

Table 8: Recent Researches on Energy Efficiency

Year	Author	Method	Technique	Type	Field
2018	Unakıtan and Aydın	Personal interview/ Non-participant direct observation/ Case study	Calculation of main input of energy in sunflower and wheat production plants	Field research	Agriculture, Forestry, and Fisheries
2018	Honus et al.	Personal interview/ Opinionnaire	In depth analysis of energy efficiency decision making process with experts and managers	Field research	Economics and businesses
2018	Ben and Steemers	Non-participant direct observation	Non-parametric correlation analysis is tried on between household appliances and their usage patterns	Field research	Civil engineering
2018	Cagno et al.	Personal interview/ Case Study	Comparison of 12 firms adaptation of energy efficiency measures	Field research	Economics and businesses
2018	Brogioli et al.	Laboratory research/ experimental	Energy efficiency of desalination processes are investigated through similar well known heat engine methods like carnot model	Laboratory research	Mechanical engineering
2018	Tillig et al.	Non-participant direct observation/ Participant observation/ Case study	Two reference ships are used to test out the consumption: a Ro-Ro and a tanker, in order to make clearer predictions on fuel consumption with uncertainty analysis of prediction model. Authors came up with 4 stages starting from early design to operation. Monte Carlo simulations for two environmental conditions and a simulation model have been applied to a real ship.	Field Research	Social and economic geography
2018	Capelo et al.	Non-participant direct observation/ Case study	Designing a tool that shows dynamics of energy service companies and markets of them in European Union has been applied to Portugal scale	Field research	Law
2018	Bertone et al.	Non-participant direct observation/ Case study	A coupled Bayesian Network – System Dynamics model was developed and retrofitting processes evaluated and showcased on a hospital	Field research	Civil engineering
2018	Thollander et al.	Non-participant direct observation/ Case study	Energy efficiency audit and evaluation model has been designed and applied 11 sawmills which have attended to Swedish Energy Audit program	Field research	Economics and businesses
2018	Sáez et al.	Participant observation/ Experimental/ Case study	Seven most common retrofitting processes have been conducted for construction and demolition waste experimental data has been obtained	Field research	Civil engineering
2018	Fei et al.	Non-participant direct observation/ Case Study	Using life cycle assessment, scenario analysis and other methods municipal solid waste efficiency in every aspect analyzed	Field research	Environmental engineering
2018	Goldbach et al.	Focused interview/ Case Study	Analysis of model of choosing digital efficiency criteria via analytic hierarchy process	Field research	Economics and businesses
2018	Gastli et al.	Group interview/ Opinionnarie	Using panels and survey to get perception of public on sustainable future and smart grids to inform policy makers	Field research	Civil engineering
2018	Fernández et al.	Participant observation/ Laboratory research	Data Envelopment Analysis is used to get efficiency of air separation units and Malmquist index analyzed in order to get temporal efficiency evolution scores	Laboratory research	Environmental engineering
2018	Algapani et al.	Laboratory research	Improving anaerobic digestion system for food wastes evaluated in terms of two-stage system energy efficiency	Laboratory research	Agricultural biotechnology

2018	Vieria er al.	Non-participant direct observation /Case study	A model has been structured for estimations of correlated saved emissions for Brazil industry sector and applied to three major programs	Field research	Environmental engineering
2018	Johansson and Thollander	Analysis of historical records	10 years of Swedish Industry of energy efficiency have been discussed	Library research	Economics and businesses
2018	Miller et al.	Laboratory research	Explaining the relation of a high power density Direct Formate Fuel Cell with potassium formate	Laboratory research	Chemical engineering
2018	Craig	Case study	Residential policy support for energy efficiency subsidies for investor-owned utility organizations in the southeast United States have been discussed with starting point of theory of planned behavior	Field research	Law
2018	Abbas et al.	Mass observation/ Case study	A cross-sectional data of 240 food grain farmers (corn and wheat growers) collected and analyzed in context of efficiency	Field research	Agriculture, Forestry, and Fisheries
2018	Charles et al.	Laboratory research	Extended the Vinyard-Zachary-Ananyev-Dismukes model compared the solar energy conversion efficiencies, determined genetically replaced the native PSII-D1 protein subunit from a higher plant with two cyanobacterial	Laboratory research	Chemical engineering
2018	Ryan and Dixon-O'Mara	Opinionnaire/ Personal interview/ Case study	Survey has been applied to small scale food retailers and consulted to external stakeholders	Field research	Economics and businesses
2018	Thyer et al.	Non-participant direct observation/ Analysis of historical records/ Case Study	Examining energy efficiency of a tourism recreational area's retrofit projections and calculating old gap with ground zero year and seventh year.	Field research	Civil engineering
2018	Darby	Analysis of documents	Visualizing from demand side and policy perspective electric storage heating examined in literature	Library research	Economics and businesses
2018	Kivimaa and Martiskainen	Analysis of historical records/ Analysis of documents	For 10 years period articles with case studies were magnified in European residential building sector alongside with analysis of drivers	Library research	Civil engineering
2018	Ahmadi-Karvigh et al.	Non-participant direct observation/ Case Study/ Experimental	Using inductive and deductive methods to get analysis of real time action (activity detection and recognition and waste estimation) of an house by using sensors and plug meters which evaluated on semantic reasoning with experimental study	Field research	Electrical engineering
2018	Pellegrini and Fernández	Mass observation	Analysis of crops, machinery, fuel and fertilizers efficiency through nations	Library research	Agriculture, Forestry, and Fisheries
2018	Seifhashemi et al.	Case study	Evaluation of efficiency in cool roof technology and its discussion and calculation of energy savings	Library research	Civil engineering
2018	Schimpe et al.	Participant observation/ Experimental/ Case study	Electro-thermal model of a stationary lithium-ion battery system is designed and evaluation of its energy efficiency is conducted model which offers a holistic approach	Field research	Mechanical engineering
2018	Han et al.	Non-participant observation/ Mass observation	Examining effects of trade integration and regional cooperation, on energy efficiency convergence, a concept that describes the catching up process of energy efficiency across countries sample of 89 countries was selected to analyze the process of energy efficiency from 2000 to 2014	Library research	Social and economic geography

2018	Derenski et al.	Analysis of historical records/ Non-participant observation/ Mass observation/ Case study	Historical records of consumption of gases and electricity of Los Angeles has been evaluated alongside with tracking monthly 100 schools in order to preserve characteristics of energy efficiency	Field research	Civil engineering
2018	Heidari et al.	Non-participant observation/ Case study	A dynamic model of lighting management has been assessed and analyses have been applied to sample area	Library research	Electrical engineering
2018	Makhsoos et al.	Analysis of Historical Documents/ Experimental/ Case Study	Optimal energy generation for a hybrid marine vehicle is proposed with sun trackers and photovoltaic array's size optimization and tested experimentally. "Morvarid", expected to do the bathymetry tasks autonomously.	Field Research/ Laboratory Research	Materials engineering
2018	Guerra-Santin et al.	Mass observation/ Case study	Occupants behavioral schema to zero energy efficiency in building performance have been asserted 2nd skin approach has been used to solve	Field research	Civil engineering
2018	Bye et al.	Analysis of documentation/ Mass observation	2030 policy goals for residential energy efficiency with multi-sector computable general equilibrium model of the Norwegian economy is used by CGE analysis in Norway	Field research	Law
2018	Wang et al.	Laboratory research	MinBalance algorithm has been presented in order to use in energy efficiency related big data tasks, four policy nodes are selected and nodes are balanced to minimize efficiency which lowered by waiting beforehand	Laboratory research	Computer and information sciences
2018	Hou et al.	Laboratory research	Two level approach of signal timing and vehicle speed in order to minimize consumption of energy in an intersection for this dynamic programming algorithm is designed	Laboratory research	Computer and information sciences
2018	Cormos	Laboratory research	Evaluating the copper-based Chemical Looping Air Separation system used in conjunction with two power generation technologies based on coal oxy-combustion and gasification processes	Laboratory research	Mechanical engineering
2018	Li and Lin	Non-participant observation/ Mass observation/ Experimental/ Case study	Malmqvust productivity index has been improved, growth accountancies model has been applied on Hicks-neutral and capital-embodied technological progress, dynamic panel data models are applied on these two types from 1997 to 2012.	Library research	Social and economic geography
2018	Gallego-Schmid et al.	Analysis of documentation/ Case study	Demonstrating life cycle assessment of microwaves and discussing Standby regulations, effects are shown in individual level and European Union level in order to evaluate de-carbonization	Library research	Law
2018	Liu and Hu	Experimental/ Laboratory research	Bi-level control framework is presented for a hybrid tracked vehicles, to predict energy demand based on Markov Chain fuzzy encoding predictor has been used, real-time recursive algorithm is applied and the Kullback-Leibler divergence rate is employed for alteration of control strategy	Laboratory research	Computer and information sciences
2018	Feta et al.	Participant observation/ Case study	Discussion of demand response potential of Dutch grid has been presented, linear optimization of allocation of works arising gases is evaluated in contexts of distribution network, on-site demand, storage capacities and ramp-up rate of power plant	Field research	Economics and businesses
2018	Zhou et al.	Analysis of documentation/ Non-participant direct observation	Environmental and water saving co-benefit of long-run energy efficiency improvement based on a recursive multi-sectorial dynamic CGE model is assessed	Library research	Social and economic geography

2018	Brambilla et al.	Participant observation/ Case study	Retrofitting case study was on renovation and re-use of the Atika building, Active House, a holistic vision for sustainable buildings labeling has been applied as method	Field research	Civil engineering
2018	Daaboul et al.	Participant observation/ Case study	Mixed-mode of ventilation has been proposed for Lebanon in HVAC systems and a control algorithm is set for windows and dynamic simulations are investigated in Beirut City	Field research	Civil engineering
2018	Cheng and Liu	Participant observation/Experimental/ Case study	Injection molding machines were under magnifying glass along with their apparatus and their energy efficiency factors, Cloud energy system, namely energy management network installed on two injection molding machines by variable frequency drives	Field research	Mechanical engineering
2018	Kneifel et al	Mass observation/ Case study	Measures of energy efficiency was examined in terms of cost-optimal and zero energy contexts using data from the Building Industry Reporting and design for Sustainability Low-Energy Residential Database	Field research	Civil engineering
2018	Munguia et al.	Participant observation/ Case study	Competitive advantages and efficient management of two Mexican manufacturing companies have been discussed in organizational context, UNEP's efficiency audit and methods have been applied	Field research	Economics and businesses
2018	Zhang et al.	Laboratory research	Proposed an energy efficiency index that describes single-phase flow and heat transfer of plate heat exchanger	Library research	Mechanical engineering
2018	Lin et al.	Laboratory research/ Experimental	Micro fabricated separation column for ultimate use in a wearable gas chromatographic micro-analytical system has been produced, lumped element model was used and published band trajectory model was used to estimate, four simple mixtures of volatile organic chemicals were used to evaluate the models	Laboratory research	Chemical engineering
2018	Kniescheski et al.	Analysis of historical records/ Case study	Number of models of range hoods were examined by independent and accredited testing institutes and explaining of energy efficiency labels and measurement has conducted	Library research	Mechanical engineering
2018	Jia and Lee	Analysis of historical records/ Mass observation/ Case study	Sixty six developments in office buildings were under magnifying glass in both new buildings and existing buildings in context of policy improvements and trending applications	Field research	Civil engineering
2018	Melvin	Analysis of historical records/ participant observation	Critically investigating underinvestment in buildings on energy efficiency with 2009 residential energy consumption data	Field research	Civil engineering
2018	Ge et al.	Experimental/ Case study	Setting up of photovoltaic facilities agricultural system in Guilinyang University, making in-depth study on the photovoltaic facility agricultural system	Laboratory research	Agriculture, Forestry, and Fisheries
2018	Zhang et al.	Analysis of historical records/ Mass observation/ Case study	Meta-frontier non-radial directional distance function based on the Data Envelopment Analysis window analysis in Clean Development Mechanism projects between 1990-2015 years investigated also study employs panel quantile regression	Field research	Mechanical engineering
2018	Minetto et al.	Analysis of historical records/ Non-participant direct observation	European Standards EN 14825 and EN 13215 is discussed, Sensitivity analysis of countries presented, Seasonal Energy Performance Ratio is discussed, a model has been presented	Library research	Mechanical engineering
2018	Triana et al.	Participant direct observation/ Mass observation/ Case study	Thermal and energy performance of social housing projects and other implications were on the focus, project of lower income sector housing was sampling objective in two major cities of Brazil	Field research	Social and economic geography

2018	Wang et al.	Analysis of historical records/ Laboratory research/ Experimental	Deep neural networks algorithm was improvements in efficiency issues have been investigated, an algorithm-hardware co-optimization framework is developed,	Laboratory research	Computer and information sciences
2018	Liu and Lin	Mass observation/ Case study	Comparison of provinces transportation energy efficiency, applying the new energy efficiency model that integrates output growth and energy conservation by using censored and truncated model	Field research	Social and economic geography
2018	Xiao et al.	Mass observation/ Experimental/ Case study	Calculating air pollution in terms of energy-environmental efficiency in sectors and slack-based measure model have been applied	Field research	Social and economic geography
2018	Chen et al.	Participant observation/ Experimental/ Case study	Slab thermal efficiency and slab region thermal efficiency models have been used on energy apportionment model of reheating furnace, bottleneck index of slab thermal efficiency with help of slab regional thermal efficiency proposed for a region, partial correlation analysis tested on the models	Field research/ Laboratory research	Mechanical engineering
2018	Shwom and Bruce	Personal interviews/ Analysis of historical records	Discussion of energy efficiency strategies with NGO leaders	Field research	Economics and businesses
2018	Pournazeri et al.	Participant observation/ Experimental/ Case study	A new variable valve actuation system has been proposed for energy efficiency along with its mathematical formula in order to raising energy efficiency model has been improved after the case study	Laboratory research	Mechanical engineering
2018	Bavaresco and Ghisi	Participant observation/ Case study	A behavioral questionnaire has been implied to get the data on interactions and data is tested on simulation programs on computers using DIVA for Rhino plug-in.	Field research	Computer and information sciences
2018	Kılıç and Altun	Analysis of historical records/ Non-participant direct observation/ Case study	Literature review on energy efficiency retrofits has been conducted and evaluating with criteria of convenience, efficiency and investor friendliness also a cement factory was under magnifying glass	Library research/ Field research	Civil engineering
2018	Azavedo et al.	Participant observation/ Case study	Production chain has been detailed in energy efficiency perspective, material and exergy have been discussed, to reduce emissions models were proposed.	Field research	Materials engineering
2018	Roman-Collado and Colinet	Analysis of historical records/ Non-participant direct observation/ Case study	Structural Decomposition Analysis has been used on Spanish input-output tables Logarithmic Mean Divisia Index (LMDI) analysis was the base for pre-work	Library research/ Field research	Social and economic geography
2018	Huang et al.	Experimental/ Case study	A hardware pipeline that accelerates three key fast multipole method steps has been proposed in order to improve efficiency of existing techniques.	Laboratory research	Computer and information sciences
2018	Kerimray et al.	Analysis of historical records/ Non-participant direct observation	Contains comprehensive review of energy consumption of selected country. Logarithmic Mean Divisia Index I method has been the tool.	Library research	Social and economic geography
2018	Foss	Analysis of historical records/ Participant observation/ Case study	Decomposing experience of 31 municipalities in the Dallas-Fort Worth region of Texas and interviews along with qualitative case study research.	Library research/ Field research	Social and economic geography
2018	Fichera and Avalle	Experimental/ Case study	In order to use the space in the cars offered HVAC model has been discussed. Adhesive joint of metal and plastic has been designed and used on the case.	Laboratory research	Mechanical engineering
2018	Abaunza et al.	Experimental/ Case study	Authors used prior scientific approach to new problem and tested EEUI by collecting three DCs data in laboratory	Laboratory research	Law

2018	Iftikhar et al.	Analysis of historical records/ Non-participant direct observation	Network Data Envelopment Analysis on SBM model with free link to the case to reach outputs. Direct network analyze has been conducted	Library research	Social and economic geography
2018	Du et al.	Experimental/ Case study	Newly developed circuit system with variable pressure controls has been proposed. Nonlinear dynamic optimization used on calculation. Comparison with conventional model has been offered.	Laboratory research	Electrical engineering
2018	Alberini	Analysis of historical records/ Participant observation/ Case study	Empirically bringing to attention household consumption demand. Surveying taxes and others in norms.	Library research/ Field research	Civil engineering
2018	Zhong and Hui	Experimental	Magnetic resonance for on-off on the wireless transfers method has been offered.	Laboratory research	Electrical engineering
2018	Papadakis et al.	Experimental/ Case study	Three existing methods of pre-heating compared with transient thermal modeling with the finite element method is performed for all the three methods. Last model has been applied to a case.	Laboratory research	Mechanical engineering
2018	Emek et al.	Analysis of historical records/ Experimental/ Case study	Contributing the literature on approximation algorithms with generic framework that allowing making estimations easier Roughgarden's smoothness toolbox has been the base.	Laboratory research	Computer and information sciences
2018	Zaim and Gazel	Analysis of historical records/ Experimental/ Case study	Illustrating how one can deal with energy intensity index with constructing new measures using directional technology distance functions. Numbers are stated by Fisher’s work and the overall study draws axiomatic properties of index. Applied to agricultural sector and existing studies.	Library research/ Field research	Environmental engineering
2018	Wang et al.	Analysis of historical records/ Case study	Empirical aspects in this paper studying the joint effects of clean power accessing to power grids on regional total-factor energy efficiency. Analyzing total-factor energy efficiencies of 29 provinces in China over the period 1991–2013, with DEA and static panel model considering panel fixed effect with instrument variable (FE-IV), dynamic panel model of system generalized method of moments (SYS-GMM) and panel smooth transition regression (PSTR) were the tools.	Library research/ Field research	Social and economic geography
2018	Cooper	Analysis of historical records/ Case study	Upon Vine et al.’s 2014 call for more randomized controlled trials (RCTs) in government-funded energy efficiency policy evaluation brought them to discuss epistemology. Set of researches has been examined and various number of advices for the green deal has been offered.	Library research	Law
2018	Boyd and Lee	Analysis of historical records/ Non-participant direct observation/ Experimental/ Case study	Study was on carbon price changes in reduced-form stochastic frontier energy demand analysis of plant level electricity and fuel data on chemical sectors, by dividing persistent (PE) and time-varying (TVE) components in order the discuss title.	Library research/ Field research	Economics and businesses
2018	Wohlfarth et al.	Analysis of historical records/ Case study	Discusses policies of energy efficiency on barrier level. 263 firms have been investigated on Learning Energy Efficiency Networks LEEN in Germany.	Library research/ Field research	Law

2018	Karvonen et al.	Participant observation/ Case study	50,000 tons of pyrolysis oil from wood for substitution for heavy fuel oil have been investigated to make biomass type more efficient. Combined heat and power plants evaluated on two methods: 1) life cycle assessment and 2) the Tool for Sustainability Impact Assessment.	Field research	Economics and businesses
2018	Zhong and Hui	Experimental/ Case study	Reconfigurable magnetic resonants have been discussed and a new version has been proposed. WPT systems have been controlled. Approach has been explained and practical measurements have been set forth.	Laboratory research/ Field research	Electrical engineering
2018	Soepardi et al.	Analysis of historical records/ Non-participant direct observation/ Case study	Upon six framework of energy efficiency improvement barriers are discussed in these papers. Steel producers in Indonesia have been the case study.	Library research/ Field research	Economics and businesses
2018	Young et al.	Participant observation/ Experimental/ Case study	In a holistic and systematic manner coal-fired plants efficiency on CO_2 capture processes. In Aspen Plus method a model has been proposed by simulation. Based on MEA a pilot scale process is scaled up to meet the market needs. Case study have been carried out with the help of simulation.	Laboratory research/ Field research	Mechanical engineering
2018	Ngo et al.	Experimental/ Case study	Power allocation scheme for Cell-free massive multiple-input multiple-output (MIMO) downlink and beam forming have been proposed.	Laboratory research	Computer and information sciences
2018	Büngeler et al.	Experimental/ Case study	Definitive work for lead-acid batteries has been set forth with partial state of charge.	Laboratory research	Electrical engineering
2018	Dotzler et al.	Analysis of historical records	Model and methods for measuring energy efficiency of complex public properties have been discussed. Uncertainty and sensitivity analysis were made via using Bayesian network model and systematic analysis. A ranking system has been proposed	Library research	Civil engineering
2018	Rentschler et al.	Non-participant direct observation/ Analysis of historical records	Classifying five categories of investment barriers by bringing evidence from sectors and proposing systematical overcoming schema.	Library research	Economics and businesses
2018	Alberini et al.	Non-participant direct observation/ Mail questionnaire/ Analysis of historical records	Preferences of Italy and Czech household materials have been investigated. Computer assisted web interviews were put on papers. Discrete choice experiments are conducted.	Library research/ Field research	Civil engineering
2018	Shi et al.	Experimental	Formulation of cross layer stochastic optimization approach has been conducted using fractional programming and Lyapunov optimization method.	Laboratory research	Computer and information sciences
2018	Hanmer et al.	Analysis of historical records/ Case study	337 house's heating dataset have been discussed via mixed method approach and combining quantitative analysis of data with interviews with householders. Thermal routines have been brought to attention.	Library research	Civil engineering
2018	Harrington et al.	Analysis of historical records/ Case study	Decomposition of 235houses in Australia was investigated.	Library research/ Field research	Civil engineering
2018	Ribeiro et al.	Experimental	Quantized hybrid transmitters equipped with a fully/partially-connected phase-shifting network composed of active/passive phase-shifters has been analyzed and put in a comparison with quantized digital pre-coders. Proposed quantized single-user MIMO system model based on an additive quantization noise approximation.	Laboratory research	Computer and information sciences

2018	Nurminen et al.	Experimental/ Case study	A new mechanism for energy efficiency in solar photovoltaic has been proposed. A prototype has demonstrated the allowance by computing the data.	Laboratory research	Electrical engineering
2018	Li et al.	Experimental/ Case study	Individually investigation of parameters were conducted and correlated to emulsion droplet sizes produced.	Laboratory research	Mechanical engineering
2018	Castel and Favre	Analysis of Documents	Development of expression were done. An analysis has been set forth. Discussion of modern Process Systems Engineering computations, including thermodynamic modeling and irreversible processes computations were in these papers. IPT based on diffusional mass transfer mechanism is shown.	Library research	Mechanical engineering
2018	Zhang et al.	Analysis of documents/ Analysis of historical records	Hedonic pricing model were proposed.	Library research/ Field research	Economics and businesses
2018	Kumar and Sukumar	Non-participant direct observation/ Analysis of historical records/ Experimental/ Case study	An algorithm has been set forth for better investigation of internet of things. After encryption research is going on because of new architectures of work. Elliptic curve cryptography (ECC) was the base.	Laboratory research/ Field research	Computer and information sciences
2018	Di Renzo et al.	Experimental/ Case study	Stochastic geometry tools were the base of downlink cellular networks. New closed-form analytical expression of the potential spectral efficiency has been set forth. Optimization has been studied.	Laboratory research	Computer and information sciences
2018	Deng et al.	Analysis of documents/ Experimental	PMV/Power model linked with ventilation was investigated. Energy savings are calculated. Mathematical model has been set forth.	Laboratory research	Civil engineering
2018	Ma et al.	Analysis of documents/ Experimental	Scaling law analysis three cavity systems were discussed. Graphene's Pauli-blocking modulation mechanism was discussed along with High-index tunability of grapheme. New method towards a 2D material printer has been set forth	Library research/ Laboratory research	Electrical engineering
2018	Martins et al.	Experimental/ Case study	Single stage amplifiers were designed and simulated for enhancement of energy efficiency	Laboratory research	Electrical engineering
2018	Johnson	Analysis of documents	Review of current literature has been set forth.	Library research	Environmental engineering
2018	Hashemi et al.	Experimental/ Case study	Proposing of an architecture that integrates the sub-6 GHz and mmWave technologies is included. Intense experiments have been conducted.	Laboratory research	Electrical engineering
2018	Lu et al.	Experimental	A large-scale distributed cluster algorithm has been shown. A parameter describing the spatial distribution of agents is assessed. A competition resolution mechanism is brought to attention.	Laboratory research	Computer and information sciences
2018	Chen and Yip	Experimental/ Case study	An innovative cascading osmotically mediated reverse osmosis (COMRO) technology has been proposed. New design of bilateral countercurrent reverse osmosis stages was the need.	Laboratory research	Chemical engineering
2018	Hajri and Assaaad	Experimental/ Case study	An alternative framework has been offered to modeling and user's profiles processes. Akaike information criterion and stochastic geometry used. Formulation of the system has been accomplished along with simulation.	Laboratory research	Computer and information sciences
2018	Zhang et al.	Analysis of documents	Dynamic cost learning effect discussed along with decision rights for energy efficiency	Library research	Economics and businesses

2018	Jung et al.	Experimental/ Case study	A variety of counter-based broadcast schemes were shown via count threshold value and a random access delay. New scheme proposed along with comparison.	Laboratory research/ Library research	Computer and information sciences
2018	Zhou et al.	Analysis of documents	A framework has been published along with the discussion of performance of related subject.	Library research	Computer and information sciences
2018	Shi et al.	Experimental/ Case study	Twenty MMO-type pigments with high stability were investigated. Introduction of 3D cup-shaped photothermal structure	Laboratory research	Mechanical engineering
2018	Vega et al.	Experimental/ Case study	New methodology for evaluation of action spectra using monochromatic LED sources has been proposed. Quantitative correlation between photonic efficiency and absorption spectrum were proven. Higher energy efficiency at 365 nm at for TiO2 and near visible for Fe-citrate were proven.	Laboratory research	Electrical engineering
2018	Sodhro et al.	Analysis of historical records/ Experimental/ Case study	Comparison is set. Energy efficiency comparison analysis of battery-driven or video transmission rate control algorithm and transmission power control–driven or power control algorithm has been shown Algorithms were analyzed.	Laboratory research/Library research	Computer and information sciences
2018	Marouani et al.	Experimental/ Case study	Improved power factor (PF) control scheme has been brought to attention.	Laboratory research	Electrical engineering
2018	Oskouei and Awuah-Offei	Analysis of historical records	Providing a framework to literature.	Library research	Environmental engineering
2018	Calore et al.	Participant observation	Lattice Boltzmann code has been used and assessed the energy usage.	Laboratory research	Computer and information sciences
2018	Giama and Papadopoulos	Participant observation/ Analysis of documents/ Mass observation	Carbon footprint analysis employed to investigate the processes along with benchmarking.	Field research/ Library research	Social and economic geography
2018	Wu et al.	Mass observation/ Analysis of historical records	Southampton cities have been investigated along with data analysis tools such as EPC.	Field research	Civil engineering
2018	Theotokatos et al.	Mass observation/ Analysis of documents	Analysis of bulk carrier fleet conducted in context of energy efficiency with new methodology for EEDI along with definitive work.	Field research/ Library research	Law/ Social and economic geography
2018	Hewitt	Mass observation/ Personal interviews/ Participant observation	Interviews and site visits were the main focus points along with energy data	Field research	Economics and businesses
2018	Wang et al.	Non-participant direct observation/ Experimental/Case study	Resources and data of energy consumption have been tracked in manufacturing processes on real-time management. A new model has been offered. Multilevel event model and complex event processing are used to get key performance indicators (e-KPIs). The non-dominant sorting genetic algorithm II is applied	Field research	Mechanical engineering
2018	Wang and Yuan	Non-participant direct observation/ Case study	37 subsector of China's industry were under magnifying glass in order to classify performance of air pollution prevention	Field research	Economics and businesses

2018	Schmidt and Ahlund	Analysis of documents	Review of literature has been set forth. Identified seven research guides. A survey of data in recent works has been capitalized.	Library research	Civil engineering
2018	Wei et al.	Experimental	Intensive mentioning of on small cell-networks have been brought to attention. New system for queue-aware scheduling has been proposed with experiments.	Laboratory research	Computer and information sciences
2018	Kizil et al.	Analysis of historical records/ Non-participant direct observation	Gross weight hauled per unit weight of payload used to determine energy efficiency	Field research	Social and economic geography
2018	Polverini and Tosoratti	Analysis of documents	A draft metric for the energy efficiency of computer servers has been proposed. A theoretical discussion was set forth.	Library research	Electrical engineering
2018	Miller et al.	Case study/ Non-participant direct observation	A decision-making equation was in use.	Field research/ Library research	Civil engineering
2018	Kialashaki	Non-participant direct observation/ Case study/ Analysis of documents	A model has been proposed for linear programming optimization model. Numerical study has been done in Tehran	Field research	Civil engineering
2018	Mostofavi et al.	Mass observation/ Non-participant direct observation	Three different data set of consumption analyzed along with proposing a model with Integrated Urban Metabolism Analysis Tool (IUMAT).	Field research	Environmental engineering
2018	Ye et al.	Experimental	New PtRuIr electro catalyst with selectively deposited Ir by pulse electro deposition system has been offered along with optimization.	Laboratory research	Chemical engineering
2018	Zeng et al.	Experimental	Plasma biogases reforming over K-, Ce- and Mg-promoted catalysts have been shown. Plasma-alone, catalysis-alone and plasma-catalysis modes were discussed.	Laboratory research	Chemical engineering
2018	Gonzales	Mass observation/ Non-participant direct observation	80 Eco-Management and Audit Schemes (EMAS) from 20 hospitals were under magnifying glass to see correlations.	Field research	Civil engineering
2018	Blum and Okwelum	Analysis of historical records/ Mass observation/ Non-participant direct observation	Data Envelopment Analysis (DEA) used. Lacking of DEA has been covered with calculation of DEA scale efficiency scores and applied the mass results.	Field research/ Library research	Economics and businesses
2018	Tejera et al.	Participant observation/ Case study	Case study of energy management applications for copper smelting has been investigated.	Field research	Materials engineering
2018	Zhou et al.	Mass observation/ Non-participant direct observation/ Case study	Heating differences have been investigated.	Field research	Civil engineering
2018	Pashchenko	Analysis of documents/ Experimental	Aspen HYSYS is used to perform thermodynamic analysis via Gibbs free energy minimization technique	Laboratory research/ Library research	Mechanical engineering
2018	Oprea et al.	Analysis of documents/ Analysis of historical records	Informatics solution has been proposed with three models and simulations with datasets.	Library research	Civil engineering
2018	Cabeza et al.	Analysis of historical records	Projections of past were bring head to head with current situation.	Library research	Environmental engineering

2018	Ali et al.	Analysis of historical records/ Participant observation/ Experimental/ Case study	A modified refrigerants SMR process was improved along with offer of metaheuristic VSO algorithm. Aspen Hysys software is used and algorithm coded in MATLAB.	Laboratory research/ Library research	Mechanical engineering
2018	Kittner et al.	Experimental/ Case study	Inductively coupled plasma mass spectrometry (ICP-MS) was the tool.	Laboratory research	Environmental engineering
2018	Yuan et al.	Analysis of historical records/ Case study	Projection of coal usage for almost everything has took place	Library research	Economics and businesses
2018	Terblanche et al.	Participant observation/ Case study	Feasibility analysis for ERS has been conducted. A simulation set forth	Field research	Social and economic geography
2018	Karpuz	Analysis of documents	Comprehensive literature review was conducted.	Library research	Environmental engineering
2018	He et al.	Experimental/ Case study	In this paper, N,P co-doped carbon microsphere (CMS-NP) have been the main topic. CMS-NP has been made ready.	Laboratory research	Chemical engineering
2018	Li et al.	Analysis of documents/ Analysis of historical records	Evaluation of Li-S batteries at a system level made.	Library research	Economics and businesses
2018	Darby	Analysis of documents	Discussion of smart technologies.	Library research	Civil engineering
2018	Geeroms et al.	Experimental/ Case study	Experiments of actuator have been set out.	Laboratory research	Electrical engineering
2018	Weber	Analysis of documents	Comprehensive literature review.	Library research	Economics and businesses
2018	Jha and Eyong	Experimental	Different variations of genetic algorithm (GA) method were proposed with energy models for data communication of WSNs	Laboratory research	Computer and information sciences
2018	Liu et al.	Analysis of documents/ Case study	Comparison biohythane with other bioenergy productions were discussed. A case study is used for demonstration.	Library research/ Field research	Environmental biotechnology
2018	Stanek et al.	Analysis of documents/ Case study	Renewable energy efficiency and policy backup in polish industries have been the main point of discussion. Moreover model for measurement and total life cycle assessments were discussed.	Library research	Law
2018	Pass et al.	Experimental/ Case study	Modeling of ambient, analysis of it and state-of-the-art in design for district systems have been published in these papers. Development of a diversity criterion for bidirectional system was also included.	Laboratory research	Mechanical engineering
2018	Lenarda et al.	Experimental/ Case study	Nano composite consisting of Vulcan, ceria and Pd nanoparticles was proposed. Catalyst have been tested along with the model.	Laboratory research	Materials engineering
2018	Dincer et al.	Experimental	System for compressed hydrogen and electrical power production nuclear generator has been shown. Rankine cycle method used as well as Aspen Plus.	Library research	Mechanical engineering
2018	Sivakumar and Sundaram	Analysis of documents/ Experimental/ Case study	Exergy and energy efficiency of selected topics have been evaluated via various thermal models such as Dunkle's model, Zheng Hongfei et al.'s model and Tsilingiris model. Compared and thermodynamic model tested on MATLAB code.	Library research	Computer and information sciences

2018	Nardini et al.	Analysis of historical records/ Experimental	Coordinated Scheduling for 5G technology is evaluated via realistic power, radiation and Signal-to-Interference-and-Noise-Ratio (SINR) models. Comparisons of 4G and 5G on both technologic simulations have been carried out.	Laboratory research	Computer and information sciences
2018	Castellani et al.	Analysis of documents/ Analysis of historical records/ Experimental	Integration of hydrate-based upgrading process has been accomplished. Environmental footprints have been discussed on three dimension.	Library research	Chemical engineering
2017	Hofman and Hughes	Analysis of documents/ Participant Observation/ Experimental/	Nature-based tourism documentaries and effectiveness with the help of questionnaires are discussed. A group of people's behavioral differences are tracked.	Field research	Psychology
2017	Mohamed et al.	Analysis of documents/ Analysis of historical records	Software models for cloud computing on smart buildings have been discussed.	Library research	Computer and information sciences
2017	Meera et al.	Experimental	Route discovery channel have been proposed. Genetic algorithm is used. .	Laboratory research	Computer and information sciences
2017	Moats	Analysis of documents/ Analysis of historical records	Discusses electrowinning and offering potential savings.	Library research	Environmental engineering
2017	Konya and Konya	Analysis of documents/ Analysis of historical records	Stemming practices and methods were brought to attention.	Library research	Mechanical engineering
2017	Bouchard et al.	Analysis of documents/ Case study	Case studies were illustration points for discussion of mineral processing.	Library research	Environmental engineering
2017	Sanchidriá n et al.	Participant observation/ Case study	Monitoring of various numbers of production zones	Field research	Social and economic geography
2017	Jacobs et al.	Experimental/ Case study	Conceptual model has been proposed and data for them have been provided. Various crops were investigated such as mustard, phacelia and sugar beet.	Laboratory research	Agriculture, forestry, and fisheries
2017	Khairullah et al.	Experimental	An algorithm has been designed. Before each super-frame computing is done. Discrete-time Markov chain (DTMC) process used and possibilities are calculated.	Laboratory research	Computer and information sciences
2017	Olsthoorn et al.	Non-participant direct observation/ Opinionnaire/ Case study	Putting up ex ante the effects of free riding on the cost-effectiveness of a rebate program, relying on contingent valuation choice experiments carried out with surveys in 8 European Member countries	Field research	Economics and businesses
2017	Ayan	Participant observation/ Case study	Changing lighting systems/ using smart sockets for determining energy usage to use in load management/ connecting smart HVAC efficiency applications	Field research	Social and economic geography
2017	Yasdıman	Analysis of documents	Calculating energy efficiency of innovative insulation materials. Literature review on new technologies in the field	Library research	Materials engineering
2017	Aydın	Opinionnaire/ Case Study	Evaluating the efficiency of municipal buildings and awareness in that regard	Field research	Civil engineering
2017	Çebi	Participant observation/ Case study	Examining energy efficiency of a residential are that consist of 10 blocks and evaluating the data with help of district concept adviser	Field research	Civil engineering
2017	Kobya	Non-participant direct observation/ Case Study	Comparing 4 buildings and their energy efficiency which applies the system in 4 climate zones of Turkey	Field research	Civil engineering
2017	Bükün	Participant observation/ Case study	Measuring how specific solar panel differentiation changes in sampled zones.	Field research	Environmental engineering

2017	Çeltek	Case study	Designing a building automation system.	Field research	Civil engineering
2017	Uz	Non-participant direct observation/ Case Study	Calculation and examining adaptability of phase change materials to energy efficiency systems	Field research	Materials engineering
2017	Bayata	Participant observation/ Case Study	Using 2 modules and 1 model for evaluating energy efficiency of a building, testing modules in 2k factor tests	Field research	Civil engineering
2017	Yıldırım	Participant observation/ Case Study	Calculating and comparison to get energy with resources of firm to use in heating and other means	Field research	Mechanical engineering
2017	Meral	Non-participant direct observation	Comparison of building performance in terms of energy efficiency on web based programs	Field research	Civil engineering
2017	Kılınç	Participant observation/ Case Study	Estimation and measuring of a water treatment facility	Field research	Environmental engineering
2017	Depe	Participant observation/ Case study	Differentiation phase change materials in two different climate zone and estimation of outcome	Field research	Materials engineering
2017	Dinçer	Participant observation/ Personal Interview/ Case study	Analyzing performance measures of indoor performance of energy efficiency, interviewing with users, evaluating with second or third resources	Field research	Civil engineering
2017	Baskın	Participant observation/ Case study	Comparison of two systematic evaluation of cold storage energy efficiency by measuring two location index and proportional and integral index	Field research	Mechanical engineering
2016	Schneider and Lechtenbö hmer	Analysis of historical records/ Case study	Decomposing combined micro-macro energy model for selected manufacturing industries along with technical scenario modeling for a nation to total site analysis (TSA), using ETS data and other sources. Under the optimization future scenarios have been evaluated. Preliminary scenario for relevancy also added for German steel production.	Library research	Civil engineering/ Social and economic geography
2015	Beşikçi	Participant observation/ Mass observation	Using fuzzy logic based multi-criteria decision-making model on handling of voyage decision	Field research	Social and economic geography
2015	Özkahram an	Analysis of documents	Extensive range of lifting efficiency literature review	Library research	Economics and business
2015	Ökke	Participant observation/ Case study	Estimations of heat losses/ Weighing electrical design of factory/ Offering opportunities of efficiency improvement	Field research	Physical sciences
2015	Alberini and Filippini	Non-participant direct observation/ Case study	Evaluation of a panel dataset between years of 1997 and 2009 with fitting stochastic frontier model	Field research	Civil Engineering
2013	Arkat	Participant observation/ Case study	Applying practice of model of an energy efficiency system to an airport	Field research	Civil engineering
2013	Timur	Participant observation/ Case study	Calculation of energy usage of a large hospital/ concluding an electric bill analysis/ large literature survey	Field research	Civil engineering
2013	Viola	Participant observation/ Case study	Comparison of selected shelter types in context of energy efficiency	Field research	Civil engineering
2010	Ceylan	Analysis of documents/ Mass observation	Economy- wide evaluation of energy efficiency levels and improvement methods/ comparison with 32 EU countries	Library research	Economics and business
2009	Tutak	Laboratory research/ Experimental	Evaluating luminance efficiency of LED technology	Laboratory research	Physics
2009	Yaman	Participant observation/ Case study	Making in depth analysis of energy efficiency effect on a building	Field research	Civil engineering

Note1: This distinction is based on Kothari's *"Research Methodology; Methods and Techniques"* book which discussed distinction in three groups by stating the fact that these are tools that researcher use in order to reach actual object of the research and reaching answer of asked question (library, field and laboratory researches). First group researchers are concerned collection of data where data are

available and insufficient to solving problem; second group consist of statistical techniques which are used for establishing relationships between data and unknowns; the third and the last group consist of methods that used for considering accuracy of the results obtained (Kothari, 2004).

Note2: Fields of sciences and technology classification based on "*Revised Field of Science and Technology (FOS) Classification in The Frascati Manual*" publication of OECD in 2007(OECD, 2007).

Note3: Lines with Aqua, Accent 5 highlights indicates the related papers are concerned with maritime, shipping, marine tourism, yachting, yacht tourism, marinas, cruise tourism, water sports tourism and other related genres that fall under the concerned issue of our work.

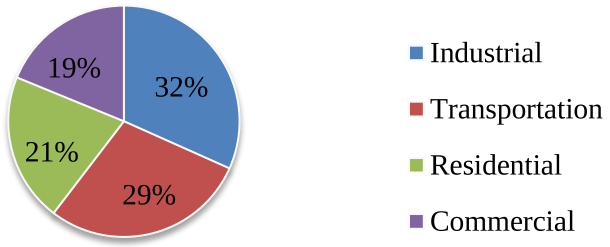
Source: https://tez.yok.gov.tr/, Date of access: 14.02.2018.

1.6. Energy Consumption

According to EIA (Energy Information Administration) petroleum, natural gases, renewable energy, nuclear electric energy and coal are primary energy sources and electricity is secondary energy source because of the reason that is generated through primary resources. Each energy source has their unique measurement: for liquid fuels barrels, gallons and liters, natural gases cubic meter or feet, coal in tons or pounds, electricity in watts however BTU (British Thermal Units) which is heat relevancy of energy measurement enables one to make comparison between fuel types. USA in the year of 2016 consumed 97.4 quadrillion BTU in total by product Petroleum 37 per cent, natural gases 29 per cent, coal 15 per cent, renewable energy 10 per cent, renewable energy 10 per cent. In the total renewable energy that is equal to 10.2 quadrillion BTU consumed types are listed like this: Hydroelectric 24 per cent, Biofuels 22 per cent, Wood 19 per cent, Wind 21 per cent, Biomass Waste 5 per cent, Geothermal 2 per cent and Solar 6 per cent. Biomass waste, wood and biofuels are gathered under the name of biomasses (EIA, 2018: 32-57).

In this section author will try to demonstrate the consumption of fuel types and their most generic usage areas in almost any dimension. By stating that, two countries and their various positioned situations are given as examples. In order to discuss in clearance energy efficiency one must has the data of how the consumption is shaped in different class of countries in terms of economic development. As a consequence of this effort of opening a ground for investigation, energy consumption is mentioned under end-use sectors, consumption by sectors, residential consumptions, commercial consumptions and fuel types. Below sectorial sharing of energy is shown with the case of USA with minor rounding that mentioned under the notes.

Table 9: Share of Total USA Energy Consumed by End Use Sector in 2016.



Source: US Energy Information Administration, *Monthly Energy Review*, Table 2.1, April 2018, preliminary data.

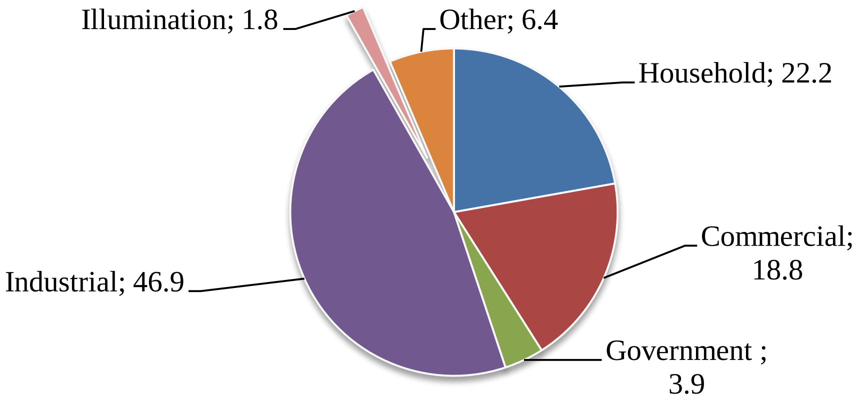
Note: Due to independent rounding sum of individual percentages may not equal to 100 (1).
97.4 Quadrillion BTU (2).

Biggest five energy consumer sectors according to EIA is ranked as these; 39 per cent electric power, 29 per cent transportation, 22 per cent industrial area, 6 per cent residential and 4 per cent commercial industries however electric power sector generates electricity whereas others consume (EIA, 2018).

Electricity is one of the upholder and touchstone of modern industrialized society. Common usage areas summarized as lighting, heating, cooling, refrigeration, machineries, operating devices, computer-based sophisticated appliances, public transportation and other uses. In 2016 retail sales of electricity went to 38 per cent residential, 37 per cent commercial, 25 per cent industrial and 0.2 per cent transportation sectors.

In a comparison with Turkey, USA's consumption is diffused more evenly and has more uniformed structure due to ingrained design of economy. Residential sector in USA addition of illumination to households with the exception of commercial and industrial lighting is really close to each other 24 per cent Turkey and 21 per cent USA residential energy consumption. Gap between two countries are indicated with 15 per cent more industrial consumption which illuminating the efficiency application gap between two countries. Turkey statistical data of net electricity consumed by sectors listed as below.

Table 10: Distribution of Net Electricity Consumption (Total of 231.204 GWh) by Sectors in Turkey, 2016.



Source: TEDC, Turkey Electricity Distribution and Consumption Statistics, Turkish Statistical Institute, 2018. https://www.tuik.gov.tr

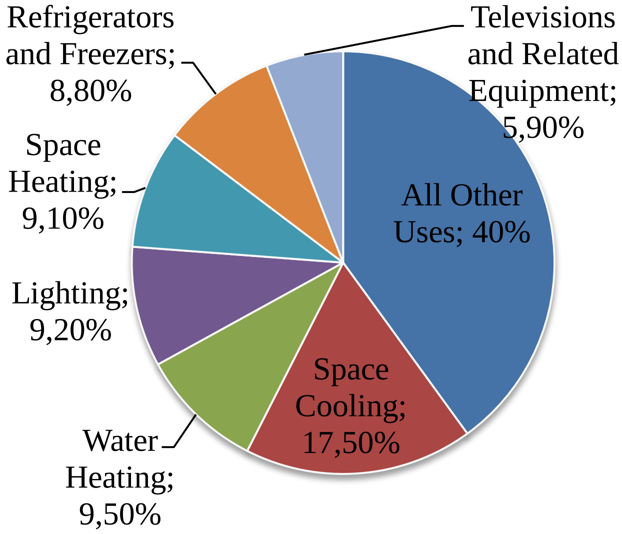
Notes: It includes consumption in agriculture, livestock, fishery sector and municipal water abstraction pumping facilities, and other public services etc. (1).

Figures in table may not add up to totals due to rounding (2).

Table below illustrates electricity consumption with the case of Turkey. Space cooling (air conditioning) was the main consumption chased up by water heating, lighting, space heating, refrigeration and televisions and related equipment in residential sector. Combination of usage of clothes washers, dryers, computers and related equipment, dishwashers, small appliances and other electrical equipment was two fifth of overall electrical use in residents.

In an effort to keeping the relevancy of the statistical value with title of these papers, an important discussion point is buildings. Buildings hold vital significance for marine tourism facilities. Also most of the critical value for tourist and their consumption is complex buildings that have facilities that can absorb energy efficiency to swallow in itself such as energy abuser spa centers. However to describe the phenomena energy efficiency points out the fact that limiting or decreasing energy consumption charts of existing applications. In all perspectives energy that used for luxury has to be subject of energy efficiency for sustainability on almost all ends under the segment of stakeholders starting from service providers till public that is affected by CO_2 emissions. Next table demonstrates depletion of electricity in buildings.

Table 11: U.S. Residential Sector Electricity Consumption by Major End Uses, 2016



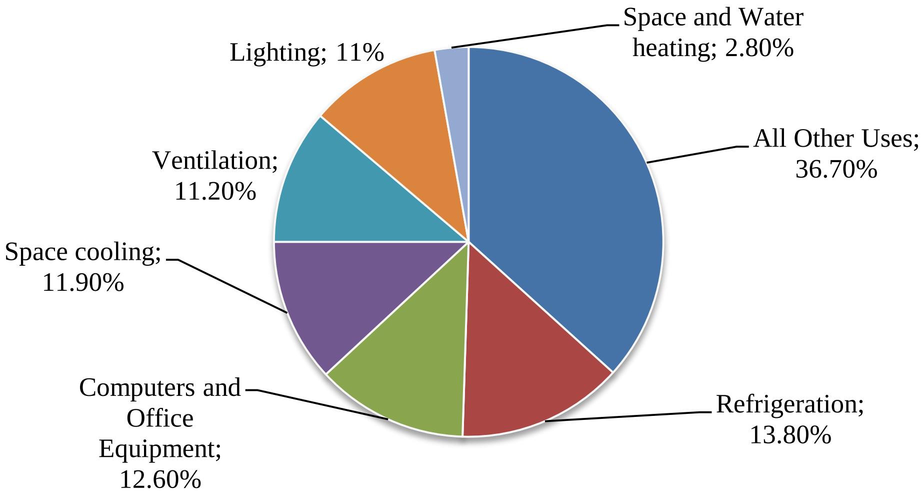
Source: US Energy Information Administration, Annual Energy Outlook 2017, Table 4, January 2017.

Notes: Includes consumption for heat and operating furnace fans and boiler pumps (1). Includes miscellanous appliance, clothes washers and dryers, computers and related equipment, stoves, dishwashers, heating elements and motors not included in the uses listed above (2).

Refrigeration took down lighting in largest annual use of electricity in commercial sector. This was mainly due to efficiency of lighting appliances had shown some positivity. Other major uses after these two can be mentioned as computers, office equipment, cooling, ventilation, space and water heating, powering, medical, security, fire suppression equipment, powering elevators, escalators, running, cooking and laundry. External electricity usage includes: water supply services, sewage treatment facilities, telecommunication equipment, outdoor and public lighting. In manufacturing machine drives single handedly dominates half of the consumption followed by process and boiler heating with 13 per cent and 7 per cent.

Below commercial consumption of electricity is stated in different end uses in order to specify which actions are prioritize to be subject of energy efficiency application discussions.

Table 12: U.S. Commercial Sector Electricity Consumption by Major End Uses, 2016



Source: US Energy Information Administration, Annual Energy Outlook 2017, Table 5, January 2017a.

EIA states that electricity demand has been rising steadily with the exception of 3 years in last almost 70 years. Although efficiency shows its aspects overall rebound effect cascaded afterwards (EIA, 2018).

Transportation sector is biggest consumer by three fourth of petroleum industry. In this industry crude oil, other liquids that are produced from fossil fuels and biofuels (mostly used as mixture version with gasoline and diesel) can be counted as major components. Industry of petroleum has a wide range of areas such as; vehicles, heating, chemical industry (as a raw material) and producing electricity. Among the products gasoline has number one spot.

Natural gas is mostly consumed for electrical power generation with 36 per cent and industrial use with 34 per cent followed by 16 per cent residential purpose, 11 per cent commercial and 3 per cent in transportation. Most of the natural gases goes to heat units of residents and generation plants of electricity. Three out of five sector uses natural gases for heating which are industrial, residential and commercial sectors. Half of the houses in USA use natural gases as a heating unit. Commercial business uses in both sides as heating and as cooling fuel (EIA, 2017b).

Table below describes how a country that produces and consumes petroleum products at the same time finding usage areas for energy from fossil fuels.

Table 13: United States Petroleum Products Consumption in 2016

Product	Annual Consumption (Million Barrels Per Day)	Product	Annual Consumption (Million Barrels Per Day)
Finished Motor Gasoline	9.317	Petrochemical Feed Stocks	0.323
Distillate Fuel Oil (Diesel Fuel and Heating Oil)	3.877	Lubricants	0.130
Hydrocarbon Gas Liquids (HGL)	2.536	Miscellaneous Products and Others	0.096
Kerosene-Type Jet Fuel	1.614	Special Napthas	0.049
Still Gas	0.697	Finished Aviation Gasoline	0.011
Asphalt and Road Oil	0.351	Kerosene	0.009
Petroleum Coke	0.345	Waxes	0.006
Residual Fuel Oil	0.326	**Total Petroleum Products**	**19.687**

Source: U.S. Energy Information Administration, Petroleum and Other Liquids—Product Supplied, as of September 13, 2017

Notes: Includes fuel ethanol in gasoline and biodiesel in distillate fuels (1). Others include other liquids not included in the table (2). Sum of individual products may not equal total due to independent rounding (3).

Diesel fuel used in many areas such as heavy construction equipment, trucks, buses, tractors, boats, trains, some automobiles, and electricity generators whereas heating oil also recognized by the name of fuel oil is the material for boilers, heating residents and industrial heating and electricity generation in power plants. Propane which one of the Hydrocarbon gas liquids is also used for heating space and water, cooking, clothes drying and combusting in transportation.

Perspective on heavy or light duty industrial consumption of machineries is vital in marine tourism industry due to the fact that to some extent firms depending on such means eventually to give services. As an example to this situation marinas wintering operation for yachts, handling of boats, cruise's main and auxiliary engines, electricity consumed by doing water sport activities can be stated. In a nutshell statement should be gathered around this approach, core actions of marine tourism has been carrying industrial consumption aspects to some extent that managers should not be overlooking the consumption in these areas.

1.7. Energy Efficiency Applications

The first red alert for the energy topic was in 70's. Energy efficiency applications due to the recent trends of consuming, producing and reproducing effects with economic tendencies of many commercially active countries keeping value for affordable products and service at the same level without being affected by inflations have been climbing in numbers after 90's. Sustainability above mentioned reasons became enormous topic for scientific researches. Snowball effect of improving one thing in technology triggered another field of science with another implementation of energy efficiency. Applications of energy efficiency are not a limited topic to discuss without stating a ground. Electricity is going to be the main discussion ground for energy efficiency because of the various reasons such as; future is seen in electricity, exergy points for electricity in a comparison with other fuel is high, convertibility of electricity, finding wider usage areas in storage technologies and applications, finding implementation area for almost any appliance and being appraised as substitution of fossil fuels. Jacobson et al. listed up to date implementations of energy efficiency in electrical technologies and measures, projected technologies that under construction for society to utilize and low utilized technologies, in almost any field including wind-water-solar (WWS) power generators. Almost all of them available technologies of energy efficiency and there is transition that undergoing for main transportation means such as air transportation, rail transportation and sea transportation. Energy efficiency applications concerning marine tourism could enter both areas operational and subsidiary operations such as residential energy efficiency. First part of operational energy efficiency such as cruise tourism's main component cruise ships should evaluate transportation, vehicle, electric vehicles and renewable energy (such as WWS (Wind, Water and Solar) main efficiency technologies (Jacobson, 2017).

Commercial wide use of WWS applications are going to be available at 100 per cent by 2050 according to Jacobson however in 2030 they foresee rapid transition to application by 80 per cent usage by 2030. In contrast super grids and smart grids should get in use immediately what he states. Large scale waterborne fright transport new ships and all new ships should catch up electrified and/ or electrolytic hydro technology alongside with all types of port operation and port retro electrification should be implemented to all ports as well. Small scale marine vehicles such as yachts may utilize electrification (Avdis et al., 2018).

Table 14: Electric Based Energy Efficiency Solutions

Electricity and Hydrogen Storage	Improved Geothermal production	Renewable WWS Electric Power Generators	Onshore/offshore wind turbines
	Improved Batteries		Wave devices
	Pumped hydroelectric storage		Tidal turbines
	Hydroelectric power plant reservoirs		Geothermal power plants for electricity
	Glass Bubbles for insulation to store hydrogen		Concentrated Solar Power (CSP) plants
	Electrolyzers to produce hydrogen from electricity		Solar photovoltaics (PV) for rooftops and power plants
	Tanks to store hydrogen for transportation primarily		Ocean Thermal Energy Conversion (OTEC)
	Electric compressors to compress hydrogen		In-stream hydroelectric turbines
	Concentrating Solar Power with storage (either molten salt or phase-change material)		Existing large hydroelectric reservoirs used more efficiently
Industrial Electric Usage	Dielectric heaters, , Electric arc furnaces Electric induction furnaces		Small hydroelectric reservoirs
	Utilities provide incentives for industry, companies, and individuals to shift their electricity use for certain uses and processes to non-peak times of day or night		Co-generation, tri-generation and multiple dimensional combo devices that produces electric with additional affects or get energy from multiple renewable resources

Source: Baltazar et al., 2009; Jacobson and Delucchi, 2011; Jacobson, 2017; and Pelc and Fujita; 2002.

Stating the fact that, future is electricity, almost all of the energy related organizations and field researchers promote and advocate for the electric and hybrid models of vehicles. In marine tourism industry two third of the industry depends on solely vehicle operations which are yachts and cruises operations. Exergy difference points has been shown in many water sport tourism facility via applications of electrical water ski equipment and all electric sport facilities (EIA; 2018; EIA, 2017a; Jacobson, 2017; WEC, 2018; http://www.samsunsukay.com/).

Building applications such as lighting efficiency applications (LED technology and advanced lighting controls) have been in commercial use as well because of the wide usage areas in residents. In addition to that almost all companies classed under three components of marine tourism (water sports, cruise and yacht) have to consider energy efficiency in residents as part of economic sustainability.

Not only core job but also secondary activities of a firm should be taken as targets of firm in order to be more efficient. As an explanation to this; water sport resorts company that operates main marine tourism activity with grey water re-use system, low rolling resistance tires, storing cold in winter, using passive solar design in activation area in summer and ensuring cooling with high efficient electric motors but did not apply any of the energy efficiency techniques to resort itself. Also appliances that goes under the name of efficiency where any motor or system that uses pumps or commercially retailed appliances such as refrigerators or washers if used, commercial activity of firm should be evaluated under efficiency fragment (Bertone et al., 2016).

In most of the time connection between technologies of electricity are easier than combustible energy types. Mentioning other connectable applications such as smart systems can consist of many applications of energy efficiency for instance smart televisions or smart houses. Accordance between main engines and auxiliary equipment, for the sake of clarification, electric ships which using electricity in all main propeller hull and overall propulsion engines can easily turn cooling systems with adding the circuits into together is opens the path of being more efficient in future. Adding more value to this process will eventually have to be the number one priority for the companies due to the reason that in future many researches forecast WWS applications and electrically advanced civilization (Yasdıman, 2017: 51-56).

Lighting, HVAC, water or motor or pump systemized or modeled energy efficiency applications and solutions are intricate into another generally. Especially in HVAC section these solutions are many due to dependency of the fossil fuels. Surpassing field of another genre of applications are possible such as cold storage and heat storage due to large buildings or operation areas needs bigger plants to cool down or heat up. Up to date services of motor systems and technologies of lighting enables to save more than any other era throughout recorded history with the luxury element. Geographical positioning and acting in accordance with need of the business place will always show pleasant face of saving such as irrigation of endemic plants, benefitting from sunlight, absorbing the winds of pool or water in summer time and taking advantage of near undersurface waters are some of the examples.

Table 15: Energy Efficient Resource Management Applications

Lighting	LED lighting	Heating, Cooling and Ventilation Systems	Cold Storage	Chilled water tanks
	Advanced lighting controls			Ice storage
	Smart Timer sockets		Heat Storage	Hot water tanks
	Improved electronic ballasts			Thermal walls
	Timers and Vacancy sensor (Image processing sensors and other improvements)			Rocks stored underground
	Reflective wall paints usage		Natural geothermal heating	
	Geographical positioning		Passive ventilation design	
Water efficiency	Efficient irrigation techniques for plants		Passive solar design	
	Refining and decontamination devices		Night ventilation cooling	
	Grey water re-use systems		Water-cooled heat exchanging	
	High efficiency irrigation systems		Programmable thermostats	
	High efficiency residential and commercial water fixtures		Geothermal heat pumps	
			Evaporative cooling systems	
Appliances	Adaptability and compability between devices		Heat recovery ventilation systems	
	Uniformity of appliances (cable chargers)		Energy efficient framing practices	
	High efficiency industrial pumps and motors		Heat pump air and water heaters	
	High-voltage direct current (HVDC) lines		Solar thermal collection devices for heat	
	Energy efficient residential appliances (refrigerators, vacuum cleaners, etc.)		High-efficiency double and triple-pane windows	
	High efficiency commercial appliances (refrigerators, washers, dryers)		Combined space and water heating air flow management	
	Long lasting, renewable appliances preferring appliances that enable rewrite over disposable/ single-use technologic appliances (DVD-rom)		Ductless heat pumps for heating and air conditioning	
			Variable refrigerant flow	
	Technology to enable remote start up and shut down of appliances and equipment that have flexible demand (i.e. water heaters, HVAC equipment, electric vehicles)		Building energy monitors to identify opportunities to reduce wasted energy	
			Sealing doors, windows, walls, outlets, and fireplaces to reduce heat / cold loss	
	Replacement for high energy users with electric users (lawnmowers, dryers, leaf blowers, water sprayers, fans, induction cooktop stoves)		Improved wall, floor, ceiling, and pipe insulation	

Source: Akaltan, 2016; Ayan, 2017; Bertone et al., 2016; Dubois and Blomsterberg, 2011; Jacobson, 2017; Lutron, 2014: 1-19; Thorn Lighting, 2010; UNECE, 2013; Van Heur and Verheijen 2008.

Correlatively subsidiary operational and operationally non-related activities of firms should be under conservation practices. Storage activities are always applicable for seasonal economic branches such as marine tourism. Using storage implications of energy will benefit more with payback ratio of investment always being small. Especially phase change materials (PCMs) and cold storage applications. Via using these methods less active firms that have find themselves under the categorization of marine tourism should aim more efficient and conservative facilities due to having to reduce all activities at big percentages in winter seasons. In addition to that, hydrogen and electricity storage applications almost connected to producing levels of energy too by doing so main segmentation need of the firm may be satisfied.

Table 16: Transportation Related Energy Efficiency Applications

Transport	**Vehicle Efficiency**	Low rolling resistance tires
Telecommuting rather than commute by car		Lightweight materials (i.e. carbon fiber, aluminum, fiberglass)
Improved public transportation		Regenerative braking systems
Improved carpooling and ride-sharing programs and technologies		High efficiency settings or dashboard fuel efficiency displays
Improved pedestrian infrastructure		**Electric Vehicles;** Light-, medium-, and heavy-duty on road automobiles, Short-distance trucks, Buses, Trains, Ships, Aircrafts, Non-road vehicles, Construction equipment, Agricultural equipment, Motorcycles, Forklifts
Improved biking infrastructure		
Transportation Demand Management programs that support adoption of low-carbon transportation practices		**Hydrogen Fuel Cell/Electric Hybrid Vehicles**; Long-distance trucks, Buses, Trains, Ships, Aircrafts, Construction equipment, Agricultural equipment
Urban land use practices to reduce transportation demand (i.e. mixed use development, increased residential densities)		**Charging applications;** home car chargers, chargers installed in parking garages, on streets and pedestals

Source: Jacobson, 2017 and UNECE, 2013.

In addition to this approach sub structural applications such as building electric vehicle charging installments to a marina will involve representation of the firm in the eye of environmental friendly customers that uses yachts that solely uses electricity.

In this section of the research applications are held in three major categories which are lighting systems, heat, ventilation and air conditioning systems (HVAC) and motor driven systems and various speed drives. Also in the context of this section technologic development on energy efficient devices and applications are described such as smart boilers, thermal insulation, soft starters, lighting control systems and in places that would be necessity technical explanations.

1.7.1. Lighting Systems

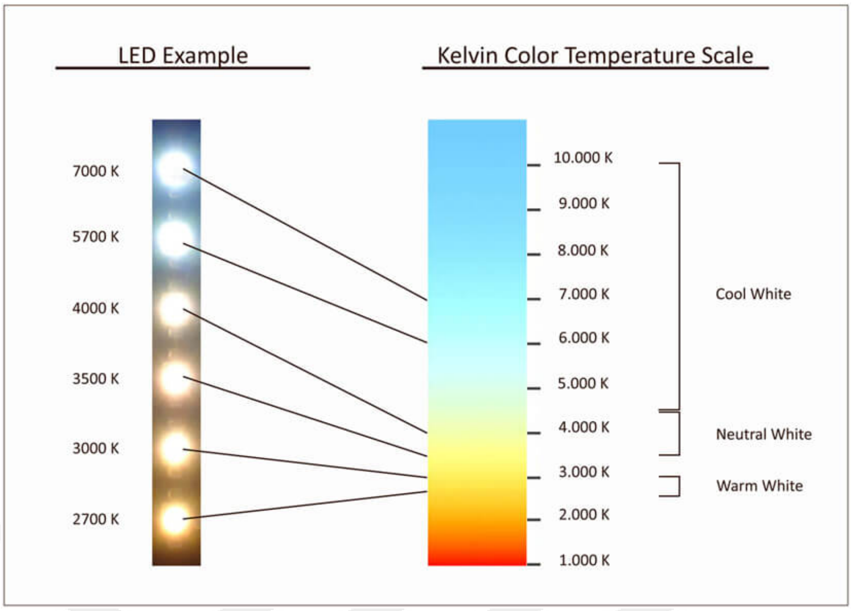
According to Ayan’s research in 2017 biggest percentage of a basic accommodation place’s electric consumption is first lighting with 22 percentage second is refrigerator with 17 percentage the third one is central heating boiler 14 with per cent (Ayan, 2017).

Lighting alongside with HVAC (most of the times it is only heating) are the biggest consumptions in accommodations. Core job, main accommodations, utility accommodations, recreational areas and almost everywhere needs some type of lighting to some degree. Lighting in energy efficiency applications is the probably best mean to start by being a cost-effective and easy to help to reduce total consumption in very short time. Evaluation of selected parts of the lamp is the key point in here. Systems of lighting mainly falls into four main components; lamp, fixture, ballast and control system. Each component has its relationship with energy use therefore each component is important for energy researchers. Equipment and selection of the material will determine the level of efficiency in any possible gap. However mostly users knowledge on lamp types and their characteristic generally is not so brilliant. Some of the selection basics for lamps are like these; one year working cost, how many watt uses and how many lumens releases in exchange, its lifetime, its working temperature, its harmfulness to the environment, how much effort must be spent in order to install it, color or colors it can flash, and its adaptability (Woodroof and Fetters, 2006: p: 352-372).

First of all, Luminous flux is the perception of light that received by a human and mostly have been used for power of light. Lumen is the unit of luminous flux which is the physical output of a source in a moment. Watt is the electrical value of each unit of power. Luminous efficacy is calculated as lumen divided into watt value. Lamps efficiencies are mostly mentioned with luminous efficacy term. Choosing one type of lamp in lighting systems depends on its luminous efficacy (Woodroof and Fetters, 2006: p: 352-360; Timur, 2013).

Below a figure of LED lighting methods in Kelvin color temperature scale is given for better understanding in lieu of above stated facts would have meet with meanings in real life.

Figure 2: Light Colors in Kelvin Chart



A color of the light source is another aspect of the system's component which is directly related with temperature (color temperature) and color rendering index. Temperatures of the lights physical aspects are expressed in kelvin. And color is shown as its temperature. It is also stated in textbooks that there is correlation between color temperature and appearance which relates to out topic lamp lights. Lamp colors can be divided into three main group lower than 3300 Kelvin which gives us warm type of white color, between 3300 Kelvin and 5300 Kelvin normal white color is the outcome if it is higher than 5300 Kelvin it is called as daylight type. In different sources numbers could be 300 Kelvin less and on the edges (Woodroof and Fetters, 2006: p: 352-355).

Smart sockets enable researchers to track the consumption of electrical usage in order to evaluate the energy efficiency. Therefore, estimation of basic places such as restaurants or rooms of a liner cruise ship can be tracked easily. According to the researches on energy efficiency in accommodations in Turkey most of the consumption of electric arises from two points; refrigerators and lighting devices. Instead of using generic type incandescent implementing LED technologies or compact fluorescent lamps to the lighting systems consumption rates would drop immediately but there is a gap in first establishment costs. However newly established system will remain longer therefore it will compensate the difference in no time. Just for main lighting job it is mainly considered as seasonal and starts from approximately 5 pm till 10 pm or even some full shift firms it will continue till 7 am. On 7/24 firms basis, compensation time will be in short due (Timur, 2013; Ayan, 2017)

If one can improvise their firm on one household level and can gain benefits from energy efficiency thinking about an industry or a region consumption or a country needs changing one bit means moving the mountains. In between 2011 and 2014 years it has been gradually prohibited to produce transact or export of 100, 75, 60 and 40 Watt incandescent lamps in order to combat with global warming and energy efficiency. Also the last non energy efficient lamp type is going to be restricted with the date of first of September 2018 Demand side management says for both energy efficiency and delaying the burden user's comfort is what should be the one of the priorities. Replacing any halogen lamps with LED (Light Emitting Diode) lamps on a same Lumen value and the same color of light with respect of same comfort level of user will change enormous level of energy efficiency on relatively big places. For instance, in Ayan's research it is calculated as 15 per cent drop after changing non efficient incandescent lamps with LED lamps within an accommodation (Ayan, 2017: p.65-67).

Basic the most common lamps characteristics in a comparison with others three lighting methods can be described as this

- Incandescent lamp**:** For 1100-1300 lumen illumination uses 75 to 100 Watt electric energy, sometimes sensible to humidity and heat, short life time, biggest consumer of energy, harmful to the environment, moves with moment, releases heat, cheap.

- Compact Fluorescence Lamps (CFL): For 1100-1300 lumen illumination uses 18 to 22 Watt electric energy, not durable, has toxic quicksilver material, harmful to the environment, less durable than incandescent, uses more energy than LED, release less heat than incandescent, average monetary burden.

- Light emitting Diode (LED): For 1100-1300 lumen illumination uses 9 to 13 Watt electric energy, the most durable, and not harmful to the environment, do not releases heat, least consumer of energy, expensive.

Table 17: Lamp Characteristics

	Wattages	Life Hour	Efficacy (Lumen / Watt)	Lumen Maintenance	Color rendition	Relight Time	Comparative Fixture Cost	Comparative Operating Cost
Incandescent	15 – 1500	750 – 12000	15 – 25	Fair to excellent	Excellent	Immediate	Low: Simple	High
Fluorescent	15 – 219	7500 – 24000	55 – 100	Fair to excellent	Good to excellent	Immediate	Moderate	Lower than incandescent
Compact Fluorescent	4 – 40	10000 – 20000	50 – 80	Fair	Good to excellent	Immediate – 3 seconds	Moderate	Lower than incandescent
Mercury Vapor	40 – 1000	15000 – 16000	50 – 60	Very good	Poor to excellent	3 – 10 min.	Higher than fluorescent	Lower than incandescent
Metal Halide	175 - 1000	1500 – 15000	80 - 100	Good	Very good	10 – 20 min.	Generally higher than mercury	Lower than mercury
High Pressure Sodium	70 – 1000	24000	75 – 140	Excellent	Fair	Less than one minute	High	Lowest of HID types
Low Pressure Sodium	35 - 180	18000	Up to 180	Excellent	Poor	Immediate	High	Low

Source: Capehart et al., 2008 p: 630

There are numerous determinant lays behind the issue of expensive usage of energy. Some of them are squandering energy, infertile or non-audited devices and equipment and misuse of devices.

Controversial ideas on LED technology such as Fassbinder’s, LED lamps are weak, cold light givers and energy efficiency of this technology is not on the required level due to these reasons LEDs are not suitable replacement candidate for fluorescent based lighting system. After this approach and many other feedbacks from consumers, LED technology proceeded in lighting and efficiency to produce better lighting to not distort comfort levels and carry efficiency to higher levels in order to draw away from incandescent lamp technology. Example to this perception is latest development on LED lighting still tries to develop in order to enrich lighting management can be Taulavuori et al. works on blue LED light enrichment of phytochemicals that passes on vegetables. (Fassbinder, 2013, p: 1-40; Taulavuori et al., 2017).

One of the applications of efficiency is being silent in peak hours. In many countries peak hours which are 17.00 to 22.00 in Turkey tariffed as double amount of night time. “Power” and “Energy” are different terms. Term of kW (kilowatt) equals to 1000 watts and means power transferred on a circuit whereas kWh (kilowatt per hour) is a different term for an appliance to use in one hour. For instance an iron that has 1 kW power uses 1 kWh in an hour. In second quarter of 2018 in Turkey for a place of business electric for 1 kWh (kilowatt/ hour) tariff is shaped as like this:

- Night time: 0.2883 TL (three period tariff)
- Day time: 0.4621 TL (three period tariff)
- Peak time: 0.7064 TL (three period tariff)
- Standard: 0.4642 TL (standard tariff)

Using some of the manageable and deployable usage of energy for instance if it is possible using vacuum cleaner before 17.00, using smart sockets on both washers or limiting the performance of central heating boiler in peak hours or etc. Even though it seems low level of change in terms of positive comeback because energy is already used and this will change comfort in non-suitable way. Eventually avoiding the peak hours will change efficiency however using smart sockets and managed consumption of energy is needed in all kinds of perspectives (Energy Market Regulatory Authority, 2018).

In Ayan’s research he also mentioned the fact that first investment cost in between non efficient and efficient lamps and their compensation time which is roughly could be defined as like this: LED 3 W capsulated lamp with 300 lm illumination power and 25000 hours in a comparison with lifetime non efficient halogen capsulated 20 W lamp which has 310 lm laminating power and 2000 hours lifetime on a 18 pieces basis in a basic house in Turkey will compensate the first investment cost in one year and two months however adding more pieces in this calculation will elongate the compensation time which shows the problem within the lighting issues (Ayan, 2017).

For recreational purposes light should be specialized as well. For instance red objects under warm lighting may attract more customers in marina shops because of object will show redder than normally. Color rendering index or CRI devote a lamp, capacity to colors of the objects of a lamp-lit. Maximum value in this index is 100 furthermore 70 CRI for a lamp counted as sufficient whereas 20 CRI considered poor. Incandescent lamps have generally 100 CRI, high pressure sodium has 40 CRI, low pressure sodium is about 85 CRI, warm-white fluorescent has 42 CRI and cool white has 67 CRI. High quality fluorescent lamps have around 90 CRI which is considered excellent which is similar to LED value (Timur, 2013).

Energy efficiency applications in lighting can be grouped into two such as efficient lighting: replacing conventional magnetic ballasts, dimming and new technology lamps (LEDs) and lighting management systems which are Daylight (photo) sensors, vacancy (occupancy) sensors and timers.

Electronic ballasts have some features to choose over electromagnetic ballasts such as higher efficacy, illumination quality, elongated lamp life and size advantage whereas electromagnetic ballasts are reliable, live longer, endure temporary voltage surges and hostile working environment and also recyclable in some parts. Technically and economically electronic ballasts indicates beneficiary aspects in contest of performance with high input power factor, low input current total harmonic distortion, low electromagnetic interference, good lamp current crest factor and low flickering (Chen and Chung, 2011: p: 588-601). Van Heur stated that magnetic ballasts tend to lose 15 to 20 per cent of energy consumption of the light sources whereas electronic one usually loses 1 or 2 per cent (Van Heur, 2008). Yan et al. research shows that even though electric ballasts are more efficient electromagnetic ballasts with dimmable technologies can be more efficient than dimmable electronic ballast systems. Hence recent trend of replacement of electromagnetic ballasts with electronic ballasts lead us to arisen problem of non-recyclable wastes taking into account that electromagnetic ballast can live up to 30 years or in some cases more. Due to usage of electrolytic in order to provide high DC voltage, electronic ballasts are not in the same level (Yan et al., 2009: p: 3069-3078).

Figure 3: 100 W Equilavent LED Light Bulb

Source: https://www.gelighting.com/

Finally, Zotos et al. offered a new smart outdoor lighting management system that remotely controllable and without disrupting process can save 37 per cent of consumption in one month which can be used in marinas (Zotos et al., 2012: p: 43-48). Lighting Systems could be mentioned in daylight (photo) sensors, vacancy sensors, timers and automated control systems. Nema states various strategies namely; scheduling, vacancy sensing, dimming and multi-level lighting, using daylight, trim and tuning, personal control, smart window shades, demand response, plug-load control (Nema, 2012). Daylight or photo sensors allow users to consume electricity when in time of need by detecting illumination level which are commonly used in outdoor lighting management systems and also can be applied to indoors system that uses daylight in adequate form such as cruise liners (Michigan, 2013). Time control is used to reduce mandatory illumination time with scheduling a program which can be quite sophisticated and simple at the same time such as pre-set timers to wake up devices or organizing many duties within multi-channel can be mentioned as time switches, special purpose cycle timers in a short repetitive duration could be very efficient with photo sensor tool in some industry work (Michigan, 2003).

Below one of the most simplistic methods of programmable timer socket is given with a figure. This lighting method can be used in many ways to reduce or limit the energy consumed by selected appliance in lighting or motor system selection. However in some cases it could be considered as primitive in a comparison with smart methods, remote control methods or systematic robotic designs.

Figure 4: Programmable Simple Timer Socket

Source: http://www.horozelektrik.com/tr/

Vacancy sensor is the one of the most common lighting management system that people see in almost every building. As it name describes it sense activity and turn itself on to the time there is no activity. General deficiencies and complains about the system are that cannot detect activity or duration time that it is on is so short that does not give allowance to user to finish its work. Some say these problems are related with not good programmed bootleg versions of vacancy sensors.

Also there is one distinction in vacancy sensors and occupancy sensors that occupancy sensor is fully automated whereas in vacancy sensor usage user should manually turned it on which makes luxury and comfort levels decrease and energy conservation levels increase. Another given example to distinction is vacancy sensors technology is similar to keycard lighting technology applications which enables user to utilize heating and lighting system when slot is full. Keycard technology is reducing errors of consumption and in this perspective can be mentioned with energy efficiency application. Door operated switches, audio controlled lighting systems and smart meters worth to mention by this approach (Ecoamica Technologies, 2018; Lutron, 2014).

Passive Infrared (PIR) technology is designed to sense changes in temperature, works well in small always occupant room and generally sensing major changes although considered as lowest technology in sensors. Ultrasonic technology is based on changes ultrasonic waves of motion such as bouncing ball in a room emits frequency alterations in sound, can sense typing. Dual-technology of sensors more sensitive and adaptive than both of the systems by using simultaneously both systems technology and choose one of the system detection and motion to stay on. Microwave and Continuous wave sensors which are radar based sensors that are being active by sending and receiving microwaves or CW radio signals like ultrasonic sensors. Basic difference between radar based sensors and ultrasonics are emitting electromagnetic waves rather than emitting sound and radar based sensors are less cost–efficient and energy-efficient. Image processing sensors uses segmented photographic process that understands activity by looking at motion. Best usage could be in supermarkets or parted areas that need illumination time to time. One of the shortcomings of this technology is its high initial cost that does not enable small users to choose. Estimated period of return for applications of sensor technology is considered approximately 3 years (Ecoamica Technologies, 2018; Dubois and Blomsterberg, 2011; Lutron, 2014; Thorn Lighting, 2014).

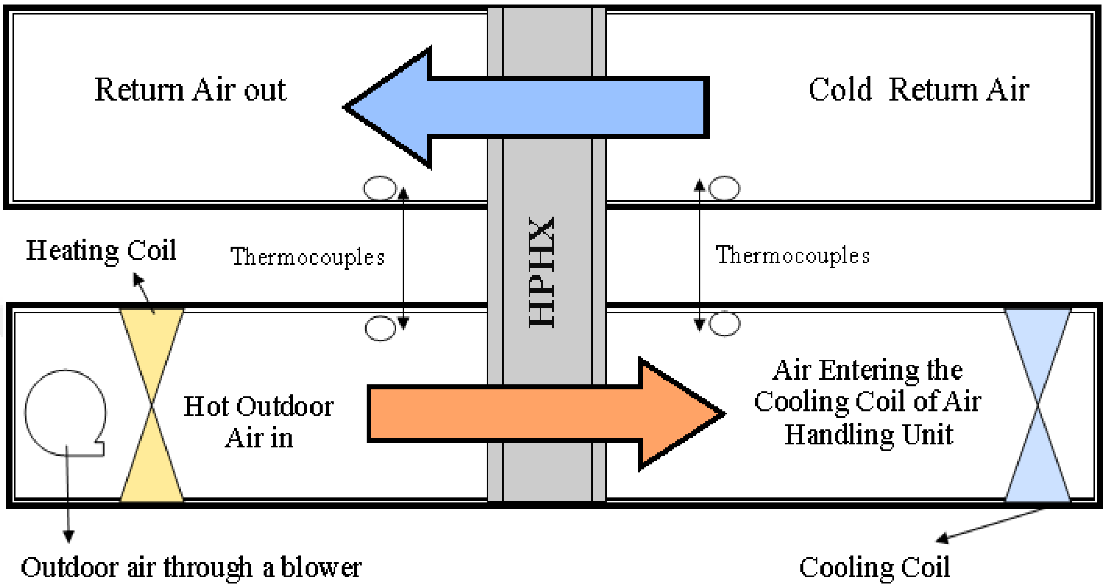
The most basic saying about energy efficiency it starts at designing stage such as Alzoubi et al. thesis, in research on natural daylight lighting in architectures reduces the need of additional expenditures of lighting contribution. Outcome is solar heat gain from interior design and positions of rooms which are aligned to utilize more from sunlight mitigate dependency of artificial lighting systems (Alzoubi and Al-zoubi, 2010). Another improvising efficiency method is of course maintenance and regular cleanup of devices. Outdoor connection of LED lighting is also improving (Photovoltaic array, battery, inverter, developments of photovoltaic cells and Power line communication inclusions) area that marine tourism can majorly utilize in perspective of tourism aspects such as in recreational areas of marinas, liner cruises ports or water sport resorts hotels (Amogpai, 2011; Jägerbrand, 2015; Shteynberg et al., 2010; Vethaak et al., 2017; Vildjiounaite et al., 2014).

1.7.2. Heat, Ventilation and Air Conditioning Systems

HVAC systems generated to provide conditioned air to users in almost everywhere. These applications contain practices of cooling, ventilation, thermal comfort, humidity control, heating and cross sectional applications. In many marine tourism activities generally heat that people need to feel free to walk around without a jacket is provided by nature. Because of this reason this thesis's general focused to cooling applications and mentions heating applications. One of the major consumption of energy in marine tourism is HVAC systems such as auxiliary cooling systems in cruise ships or marina buildings. Air conditioning represents separation of humidity from clean air. Hence HVAC system is a term that when a medium or larger residential place in our focus, for smaller buildings literature refers systems as direct expansions such as split systems. In addition to that some of the problems in commercial buildings can be mentioned as poor air exchange, low level of control on thermal conditions, technical problems (installation and maintenance), space design issues and inadequate technical support. Mostly in the literature desirable air conditions in residents considered somewhere between 20 to 24℃, 30 to 60 per cent humidity, 20 air change per hour (20 ACH) 50 to 150 colony forming units (CFU/ m^3). Some of generic precautions to poor conditions are regular maintenance, layout of the place should be evaluated in context of design for HVAC systems, segmentation of the place if decision makers can do it properly with technical support and space management should be a carried out topic (Balaras et al., 2007; Timur, 2013).

Heat pipe heat exchangers or in more commonly used name HPHXs are one of the most popular HVAC system applications in the field that mostly used in tropical or hot climates therefore it is suitable application to marine tourism. As a heat transfer device covered heat vaporization is utilized to send heat without losing or gaining temperature over long distance. When accomplishing the work device uses minimum energy eventually in context of energy efficiency it should be mentioned. In jadhav and Lele research, they stated the fact that possible highest efficiency levels with using 6 row HPHX can be reached in hot and dry climatic zones and in temperate climatic zone it did not show the same efficiency levels in cooling with coils (Kute et al., 2015; Jadhav and Lele, 2015).

Figure 5: Sensible Heat Recovery in Air Conditioning System Using HPHX



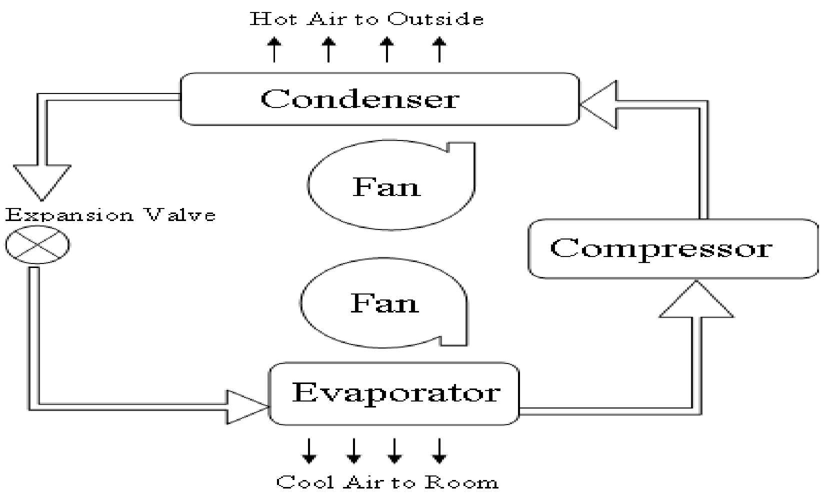
Source: Both, Kute et al., 2015 and Jadhav and Lele, 2015 diagrams are used to represent HPHX's working process.

A research that is conducted in Malaysian Hospital shows HPHXs energy efficiency in hot climate conditions could be very effective in terms of energy via saving 455 Mega Watt per Hour (mWh) in one year. In the same research calculations shows the system can pay itself in 1.6 years (Yau and Ahmadzadehtalatapeh, 2011).

Basics of cooling systems principle is cooled water in the cooling tower transferred to condenser by using condenser water pump to change steam with power or vapor to liquid in condenser. Compressor in the process pumps liquid to cooling system and compress gases refrigerant for system. Vapor in Evaporator sent by compressor and air handling unit conditions the air in this system where fan coiled unit is comparably small for the system. Evaporator, condenser, compressor and expansion valves compose one of the main components of cooling system which is chiller. Chiller generally the biggest consumer in the system with the duty of handling vapor compression and absorption by using condensers and evaporators Refrigerant liquid goes to evaporator for gas version of the liquid compressor manages cooling down but heat arises from this process which sent to condensers then condensers turn vapor into liquid and sent new hot water to cooling tower with pumps. With last step cooling cycle finalizes itself (Brandemuehl, 2004: 26-37).

Two types of condensers are most common; air cooled and water cooled. In extreme conditions such as lack of water resources or cold places that seasonally weather tends to go below 0ºC pretty usual air cooled condensers are preferable however temperate conditions in general makes water cooled systems more popular. In spite of that air cooled condensers are more active than water cooled in economy. Choosing efficient and appropriate condensers to system makes more efficient. Neglecting or not giving enough maintenance may reduce chiller efficiency by 10 to 35 per cent hence covered with dirt coil condensers (environment of air cooled condensers are generally covered in dust and dirt) are decreasing by 5 to 15 per cent, chemical cleaning in evaporator and condenser may save 5 to 10 per cent of energy. However water cooled systems are using chemicals and needs to maintenance in the tubes as well as air cooled systems. In addition to that water cooled systems are using water in context of consumption whereas air cooled systems are using two types of circulation interior and exterior air circulations. Blow down factor which after evaporation loss sediment that water cooled systems leaves hurts system, maintenance period and capital for replacement of water in broad distinction cooling systems (Energy Design Resources, 2010: 1-25; Osman et al., 2016: 1-10).

Figure 6: Operation Principle of the Chiller



Source: Brandemuehl, 2004: 28-34.

Phase change materials (PCM) are another application to cooling systems that serve the purpose of air conditioning. The applications are generally well-known for thermal isolation for cooling. Basics of the system can be mentioned as compositing material in order to achieve desired levels of temperature via adding nanoparticles and packaging in a container or capsule. Transport systems and residential system can utilize thanks to its aspect of contributing cooling energy savings with 40 per cent when applied. Clean room energy efficiency another methodology in the literature of cooling systems that focused attention on proper chilled piping pressure set point for the pumps. Differential pressure set point with VSDs could be determined and varying between 42 to 53 per cent energy efficiency can be gained after detection of proper point depending on existing set point and pipeline data. Benefit of new pumps can be in between 43 to 81 per cent with taking this process account (Hatamipour et al., 2007; Su and Yu, 2013; Zhai et al., 2013: 108-115).

Boilers are in the center of heating systems. Boilers which are pressure vessel class that is designed to produce steam and obtain hot water could be categorized according to their temperature, pressure, capacity burner types and other aspects. Hot water in a boiler is transferred with steam pipelines. Collectors are generated in the system in order to prevent losses of pressure and delivering with points of collectors. Combustion is the main activity that uses energy to climate air (Energystar, 2018).

Economizers with help of waste heats that flue gases heats boiler feed water in order to reduce energy that heating process losses to achieve by adding new water at low temperatures. Another terminology refers economizers as heat exchangers

Heat pumps are also gaining recognition in HVAC appliances in context of energy efficiency. System savings for heat pumps can be reached approximately 150.000 U.S. dollars in one year on large commercial building and payback period of time can be simulated as 1.8 years according to Shen et al. Although heat exchangers can be applicable in both systems heating and cooling at the same time, they are usually installed for heat recovery for heating systems mostly for transferring thermal energy in between two places that have differences in terms of temperature. External heating source are not seen as heat exchangers in decision makers eye. In addition to that decision makers generally choose exhaust, flue gases or hot liquid material that processed over external heating source. Depending on the material that will be used in the process could convert heating process into cooling process such as Freon gas for cooling and steam or hot water for heating. Energy recovery ventilators (ERVs) are devices which used for collecting exhausted air for outdoor ventilation air preconditioning. In a peak time they can reduce heating load with 75 per cent sensible and 60 per cent latent effectiveness and 18 per cent of cooling load. In this calculation also total annual heating energy usage will by 40 per cent and annual cooling energy usage by 8 per cent. Overall payback period with this savings enables installers to get back their money and make profit within 2 years. Insulation of steam systems with valve jackets is probably one of the highest ranked cost effective energy saving mean. The system base activity may state actually containing high steam in order to prevent losses and keeping environment safer by doing so (Goetzler, 2007; Shen et al., 2009; Aynur, 2010).

VRV Systems (Variable refrigerant Volume) is multi-split air conditioning system that contains variable refrigerant flow or volume technology, composing of one outdoor and multiple indoor units VRV systems have the same mentality in terms of installation. Thanks to the variable speed compressors and electric expansion valves located in each indoor unit core job of VRV system is satisfied by altering refrigerant volume corresponding to heating or cooling need of zone which selected unit in control. There are two versions of the system: ducted and ductless. In ductless system heat is sent to or from the zone by circulating refrigerant to evaporators located near or within the conditioned space. In normal cases, opposite of this action take place. VRV system has high model of complexity and much more room for operation but can be considered as ductless multi-split system with extra ducted style fan coil units. Aspects of multiple compressors, many evaporators and complex oil-refrigerant management and control system add to complexity levels of this system however missing ventilation apparatus opens a need for the system. Advantages could be mentioned as: design flexibility, maintenance and commissioning, comfort, energy efficiency and installation advantages. In a comparison with ordinary compressors this technology could reduce consumption up to 40 per cent. The main reason lays behind that difference is the system utilize part-load efficiency and many other HVAC systems are using their 30 to 70 capacity in operating hours. Surpassing these hours via its inherent seasonal energy efficiency and high coefficient performance demonstrate the difference in other words. Another plus for the system is disposal of ductwork results in duct losses decrease which means mitigation of 10 to 20 per cent airflow errors. Installation cost for VRV systems is dependent on project however it is estimated by some sources 5 to 20 per cent higher than chilled water systems (Goetzler, 2007).

Cogeneration or CHP (Combined Heat and Power) can be explained with using one type of fuel to generate electrical and heat energy at the same time. The system is well-known for its high efficiency numbers. Cogeneration systems can be 25 per cent more efficient in a comparison with conventional models. Cogeneration model uses natural, liquid gas and biogas commonly and outputs are exhaust gases, high temperature liquid circuit (jacket water) and low temperature liquid circuit (after cooler or intercooler output). Exhaust gases which can reach to degree of 500ºC can be put the good use with a steam boiler, hot oil boiler or hot water boiler. Boiler type evaluation is the critical point in here. High temperature liquid circuit directly linked to a high temperature plate exchanger which transfers it for recycling. Operation principle for low temperature liquid circuit goes in the same process as jacket water. At the same time electricity in the process generated simultaneously in the generator segment of the process. Generators should be linked to gas engine. In shallow explanation, the system should be appropriate answer of energy efficiency issue where electricity is already a need and heating extras are needed too. Alexis et al. in their research calculated with energy cost reduction in their research for CHP system as 32.4 per cent however they accepted that it is dependent to conditions of implemented place. In some cases CHP systems are used in two different end of heat scale such as production of motor system can go heating and cooling systems separately. In addition to that, with the help of alternative internal combustion engine which consumes natural gas or proper fuel for absorption refrigeration system can use exhaust gases to provide cooling to replace electric chillers. This combined efficiency applications result in reduction of payback time to 5 years. One can increase the number of engines and get shorter payback period where consumption is high. Small scale of this model got the name of Micro-CHP. Combined cycle efficiency of Micro-CHP where electrical powers have been used averaged at 29 per cent in Griffin et al. research (Alexis and Liakos, 2013; Beretta et al., 2018; Chittum and Grace, 2018; Griffin, 2013; Silveira et al., 2012)

Fundamentals of Tri-generation Systems or CCHP (Combined Cooling, Heat and Power) are almost identical with cogeneration by using one fuel for generating heating, cooling and electricity simultaneously. Total efficiency may exceed 90 per cent level. CCHPs are using same inputs and the outputs with cogeneration systems. Segregation in here is structural design via adding absorption chillers and cooling tower system opens the way of being more efficient. This system is popular among chemistry industry, shopping malls, airports and hospitals. Absorption chiller system in CCHPs is the critic differentiation with conventional models. In absorption chillers pump takes place of compressor to absorb refrigerant from other liquid then pumps the liquid to high pressures and uses heat to transfer refrigerant from solution, at this stages does not use fluorocarbons of the system. Payback period for the system estimated as 15 months (Brandemuehl, 2004; Medrano et al., 2008; Moaleman et al., 2018: 191-195; Pagliarini et al., 2012).

Aquifer thermal energy storage (ATES) enables users to store natural energy such as thermal, solar and wind. Including recycling of consumed energy that comes from electricity or other fuels which has been used in heating or cooling ATES offers variety of energy efficiency methods and ecologic solutions. One of the overtures of ATES is keeping heat below of the surface and cold in winter. Using nearby air and water resources could improvise the system in favor of efficiency. Natural energy can be classified as solar energy in summer and aquifer when it gets cold. Not using ozone depleting Freon-12 gas, by using well system for pumping stored energy and saving fuels, combustibles and electricity ATES system can be the most environmental friendly among HVAC systems. Reduction of fuel oil by approximately 1000 m^3/year, decrease in CO_2 emission by 2100 tons/year, SOx by 7 tons/year, NOx by 8 tons/year indicates and approximately 0.7 tons/year of Freon-12 were Paksoy et al. research’s outcome. In a research in Antwerp groundwater mainly offered into service of cooling. 81 per cent of total cooling energy and 22 percent of total heating energy were provided by only using this system (Paksoy et al., 2000; Vanhoudt et al., 2011).

With rational usage of HVAC systems namely; smart thermostats, heat pumps if it is necessary, timing conditioners, effective air circulation, accommodation envelope and exergy choices, a system can save 10 to 12 per cent in heating and 15 per cent cooling without dropping the luxury element. Thermo regulators and central heat boilers are used for keeping the temperature intended levels for sake of job security or maybe just for comfort. Manuel thermo regulators are almost gone to be replaced with smart and programmable versions of it. Programmable types allow users to let thermo regulator to have control over place's heat and can detect the appropriate heat in order to narrow consumption and any other problems. It also allows users to design systems to make retrenchment via when occupied times it activates beforehand and when it will be luxury it limits itself. This topic could be evaluated in HVAC (Heat, Ventilation and Air Conditioning) systems by the reason that as much as it contributes to savings in electric consumption other fuels can directly be the counterparts of the issue. If it allows to seven day programs it can also shape users weekend and in week expense of energy. At the end, in the scenario of used wisely it can save 180 US dollars in a year and can drop consumption level of energy by 20 per cent within the borders of warming up and cooling down. Deficiencies of the system are first it may be too complicated for users which causes insensitivity and lack of network connection may push remote users and people who want remotely control or users who has no reach point to the system to choose smart heaters (Hudgins et al.,2018: 24-35).

In smart segment of the topic we should mention the fact that mobile technologies are getting more common in both marine industry and energy efficiency or in general on each level of our lives to the point that stakeholders of the intersections are directly concerned with it. With the help of the connection to internet, some of the HVAC systems may directly interfere the consumption according to incoming weather data. Above mentioned deficiencies are pluses in this segment latter via this convenient practices service businesses can differentiate places heat without a labor force which is another form of energy efficiency.

In smart technologies thermostats have become more popular. Crucial changes in smart thermostats are first they can be carried with your mobile phone if it is smart of course second it can be synced with other devices such as lights, sprinklers, security cams, switches and even doorbells, third with the help synchronization it can elevate place’s safety fourth learning model allows itself to reach non-effort areas which is also a big plus for efficiency. Adding that it can sense the movement in place when users are not at the place at that moment system can warn trespasser with lighting up the lights on turning the sprinklers, alarming the place and sending photos of the situation to users. Devices can share the knowledge within themselves such as Nest protect or Nest cam can pass the information that there is no user in absence therefore it can dim light bulbs. One of the newly developed thermostats is Nest which is founded by old Apple managers in 2011. Specific to Nest, if it is used correctly, system can save 10 to 12 per cent in heating and 15 per cent in cooling (https://nest.com/)

Ecobee is another company doing more or less doing same job with Nest. The company founded in 2007 in Toronto, Canada. Amazon Alexa and Apple are just the different actors who played the same role in this company. Additionally they differentiate themselves with room heat sensors in order to calculate distribution of heat is collected by each spot and spreads to environment equally. The last specification makes Ecobee company more desirable for large companies in terms of square meter. A conducted analysis in 2013 shows Ecobee can save averagely 23 per cent on heating and cooling contexts (https://www.ecobee.com/ecobee3-lite/).

Lastly Honeywell is another brand in smart thermostat technologies which according to their story go back 125 years of innovation. Its comparatively affordable price and geo-fence technology which does not sense with wireless connection but sense when user leaves the borders of the place makes it more optimal for many users. There are Wi-Fi connected models however those are incapable of learning and reacting by themselves (https://forwardthinking.honeywell.com/).

1.7.3. Electric Motor Systems and Various Speed Drives

In almost every industry electric motors play crucial roles ranging from water pumps in small marinas to auxiliary cooling system of gigantic marina hotels. In industrially developed nations electric motors hold big share of energy consumption in total national power consumption (Saidur, 2010a).

Electric motors are generally divided into two groups which are: AC motors and DC motors. In this approach, AC motors can be synchronous or asynchronous (induction) type. Asynchronous motors generally run on 1-phase or 3-phase power. More than 95% of all motors in various industries are AC induction motors. In Turkey, the most of electricity energy in industry sector is consumed by AC motors (Timur, 2013).

While stating that AC motors means “alternating current motors” that do not use brushes and commutators and systems that expected go longer and live longer more than “direct current motors” which called shortly as DC motors (example: batteries) while both of the motors do the same job of converting electrical energy to mechanical energy such as water pump motors (Carrow, 2001).

Even though from exergy point electric motors are advantageous in a comparison with oil-based motors, some of improvement methods could be mentioned as high-efficient motors, variable speed (frequency) drives (VSD) and capacitor banks (Saidur, 2010a). High-efficient motors can be detected by their nameplate via reading the efficiency class of motor. International Electro technical Commission offered unifying energy efficiency standards in the past and we have been using that since then by the name “IE” which stands for International Efficiency Class. According to that system, 3-phase motors with a power range from 0.75 kW to 375 kW can be classified on this terminology:

- IE1=Standard efficiency
- IE2=High efficiency
- IE3=Premium efficiency
- IE4=Super premium efficiency (Benhaddadi et al., 2010).

Efficient motor means the motor that does not give losses in the possible highest per cent. There are two kinds of motor losses. Normal motors designed to work between 83 to 92 per cent efficiency however value added or improved motors to be more efficient are significantly shows more numbers. Efficiency improvements on losses can reach 47 per cent of total losses. Losses in the stator area could prevented by adding more copper at design stage thereby reducing insulation thickness and opening more space to winding and wires can step up efficiency of the motor. Losses in the rotor section losses can be minimized via using larger conductor bars.

Core/iron losses can reduce by using thinner gauges at design stage. Windage and friction losses easily demolished by implying low loss fan design by making easier air to move. Stray load losses precautions only lessened by doing strict quality controls on devices and effective optimized design (Saidur, 2010b).

Table 18: Energy Saving Using High-Efficient Motors

Motor HP	Standard efficiency	High efficiency	Energy savings (kWh/Year)
1	76.8%	82.5%	111
5	83.9%	87.5%	301
20	88.3%	91%	1020
50	91.5%	93%	1604
100	91.9%	94.5%	7141
200	94%	95%	5213
500	94.1%	95.8%	25880

Source: Saidur, 2010b

Another important issue is inefficiency arising from selecting oversize motor that is not perfectly suitable power supply to work. This issue generally happens where decision maker has misconception of meeting with high load means big motors however low loads are generally wearing these type motors. Motors are designed to operate 75 per cent rated load and above if that number can not be reached due to fluctuation of working times optimum should be considered as between 60 to 90 per cent rated load. But ideal value is full capacity (Kaya et al., 2008; Saidur, 2010b).

When starting an AC induction motor user should know that these types of motors develops more torque than required torque at full speed which eventually stresses mechanical transmission system resulting in excessive wear and premature failure of chains, belts, gears, mechanical seals and drawing high unbalanced electricity from supply charges in a comparison with normal run. Soft starters provides reliable and economical solution by delivering a controlled release of power to the motor, consequently providing smooth, step less acceleration and deceleration. Motor’s life will be extended in this sense. VSDs are doing the same work with soft starters however by specialty of being a power converter that generates a multiphase, variable frequency output to drive a standard AC induction motor and to modulate and control the motor's speed, torque and mechanical power output. Parts of VSDs can be mentioned as rectifier, inverter and controller. Rectifier alters the alternate current to direct current and inverter changes DC power back to AC power. Reference signals are showing overall pulses to keep the correct voltage to frequency (V/Hz) ration in order to generate the rated torque (Miller et al., 2012).

Figure 7: A VSD Product

Source: http://www.unicous.com/

In Miller et al. work payback return that comes from energy efficient motors stated as 2 years for motor sizes greater than 40 kW (kilowatt) and less than 1 year for motors that use 90 kW. Mostly induction motors used in flow generating equipment like fans pumps and compressors. Without control flow would want to be 100 per cent speed however using VSD to control the flow can save up to 40 per cent of the energy. Thanks to design, VSDs aim to protect from over-heating by changing unbalanced fluctuation to constant required energy (Ristimaki, 2008).

Table 19: Potential Savings Using VSD

Average speed reduction (%)	**Potential energy savings (%)**
10	22
20	44
30	61
40	73
50	83
60	89

Source: Saidur et al., 2012.

According to affinity laws or cubic laws pump output or flow are proportional to the speed of pump which makes for 50 per cent flow pump should be at 50 per cent speed. After this forced energy pump does not need further more than 12.5 per cent of rated horse power. Also considering pressure is proportional to square of the speed and power consumed becomes proportional to cube of speed which indicates even minimum reduction in speed can show itself in consumed power (Abdelaziz, 2011; Ristimaki, 2008).

Energy efficiency of 3-phase induction motors

$$P = \sqrt{3} * V * I * \cos\phi * \eta$$

Note: P = motor rated power (W), V = motor rated voltage (V), , I = motor rated current (A), cosØ = power factor , η = efficiency of motor.

Not operating a motor within its voltage requirements causes inefficiency and premature failures that may be harmful to environment of work(such as noise), working process, refunding credit, safety of work and other unwanted issues. Turkel says various speed drivers are for regulating machine or devices working process in order to achieve the goal of elongating lifespan of the device or machine and stay healthy in terms of activity which perfectly matches with energy efficiency term (Turkel, 1999).

Difference between VFDs and VSDs is VSD is a bigger term that describes all motor systems whereas VFDs are only for AC type motors. May working process differs though all VFDs regulates AC motor in order to use in more efficient way. Along with new flux vector technology there are three basic variable frequency drivers (VFD) which are pulse width modulation (PWM), current source inverter (CSI), voltage source inverter (VSI) and recently popular flux vector PWM drives that considered as breed of combinations. Among them every one of them has their advantages and disadvantages.

I. PMW is the most common VFD because of these reasons; highly compatible nature, reliability, affordability and reflecting least amount of harmonics back into its power source. An example to its compatibility is this VFD type is working with motors that have ½ hp and 500 hp. Reliability comes from its duality that simultaneously regulates voltage and frequency. Mostly used units are rated either 230V or 460V, works in three phases and provides output frequencies ranging from 2 Hz to 400 Hz. Pulse width modulation term comes from each transition of the alternating voltage output is actually a series of short pulses of varying widths. By new technologies PWM designed to use higher frequencies with power cells by having more pulses in half cycles. With 92 per cent to 96 per cent this VFD type has the biggest efficiency and has the ability to ride through 3 to 5 Hz power loss. No motor cogging with six-step inverters, with fixed DC bus voltage there is excellent input power factor and low initial cost. Disadvantages are non-regenarative operations, motor heating and insulation breakdown due to high frequency switching of transistors in some applications and line-side power harmonics.

II. CSI working through this process; regulating incoming power and producing variable DC bus voltage. CSIs advantages are reliable via limiting current operation, has regenarative power capability and using the most simplistic circuits. Dsiadvantages could be mentioned as large power harmonic generation emitting to power source, cogging under 6 Hz, relies on big and costly inductor, inconvenience with multimotor applications and poor input power factor.

III. VSI design is not a current regulator like CSI however with aspects of working mentality looks pretty similiar to CSI. This design of VFD is considered a voltage regulator and uses transistors to compose adjustable frequency output to the motor. Simple design, apllicable to multimotor design, give access to operations without load dependant are the advantages whereas large power harmonic generation emitting to power source, poor input power sector, cogging below 6 Hz and non-regenarative operation makes this type disadvantageous (Carrow, 2001; Niku, 2011; Turkel, 1999).

Lastly flux vector PWM drives, is the part of PWM technology that still have capacity to improve even though it is considered new tool. PWM is being refined with power switching devices and smart 32-bit microprocessors. New PWM drive is not limited with normal torque and standard rpm (round per minute) applications that AC drives let the DC motors to have control over machines. This enables efficiency rates to go higher of a motor system that build around doing long lasting and exhausting works. Even though flux vector use similar DC drive system when controlling torque and has quick responses with wide speed control range, have the same power section with all PWM drives. Base differential point there is a closed loop control from the motor to the drive's microprocessor. Rotor position and speed of the drives can be visualized in real time by a resolver or digital encoder to have control over motor’s actual speed, torque, power and heat. Inverter section management gives user fundamental torque control which allows user to learn digitally or manually behaviour of motor. With diminshing impacts of load, speed and torque via commands, flux vectors ensures the excellent control over the system, can be full efficient in torque needs with 100 per cent at 0 speed, in a comparison with DC motors and drives there is a lower maintanence cost but has higher initial cost compared with other PWM drives, complex and lastly requires special motors in most cases (Carrow, 2001: p.45; Niku, 2011: p.280; Turkel, 1999).

Payback Period Calculation

$$Payback\ Time = \frac{Incremental\ cost\ of\ VSD}{Annual\ bill\ savings}$$

Source: Saidur et al., 2012.

1.7.4. Energy Efficiency Applications in Auxiliary Recreational Areas

Almost in every marine tourism branch accommodation play crucial role in energy efficiency. Recreational areas such as Water Sport Resorts in Water Sports Tourism, Liner ships in cruise tourism and marinas in yacht tourism represent this side of the energy efficiency in marine tourism.

In a research in Europe Union it is seen as buildings are consuming 40 per cent of energy and accounts for 36 per cent of CO_2 emissions. In same research it is emphasized that new buildings do not need as much as energy when comparing old ones. It could be stated this way; they need three to five liters of heating oil per square meter per year while old ones need 25 liters and some of them goes up to 60 liters in a year. Considering the fact that 35 per cent of EU’s buildings are over age of 50, EU planned to alter the conditions of energy efficiency by 5 to 6 per cent and 6 in CO_2 emissions in existing buildings (https://ec.europa.eu/energy/en/topics/energy-efficiency/buildings).

Figure 8: A Smart Thermostat

Source: https://www.ecobee.com/utilities/

Building energy rating or BER is probably the closest rating system to the energy labels for electrical devices which are used in accommodations in marine tourism such as refrigerators. BER could be defined as a various differences in energy efficiency on a basic home (Yasdıman, 2017).

Energy labels for household electrical appliances that most of the people see on their refrigerator and building energy rating (BER) are so close to each other in context of rating. Both labels have A-G scale whereas G is representing least efficient and A is the most efficient. According to Sustainable Energy Authority of Ireland BER is the rating system of accommodations and houses's energy efficiency rating system that based on the basics of standard occupancy, water and energy usage such as usage of heating fuels, space heating, lighting and ventilation. Each country according to the Kyoto Protocol which has been conducted in 1997 regulates these energy efficiency and saving methods in order to reduce emissions of pollutants and global climate change rates. Also these systems help to monitor and analyze the effectiveness of trials of new technologies or for instance how well insulation of the houses constructed (Yasdıman, 2017; https://www.seai.ie/).

Service users and providers in marine tourism industry generally prefer up to date services for sake of security, efficiency and safety. As a result of this approach smart and connected fully automated HVAC, lighting and motor driven systems such as Nest are going to be key structural material in design and improvement elements of marine tourism in future. Some of the present day technologies are given below:

- Synchronization is on the level of speaking with help of devices like Google Home or Amazon Alexa comfort level of user's falls to the area that mobile phones are may be the next surplus to shave.
- Nest Protector is a device that surpass the basic level of smoke detectors with these aspects; it speaks place and problem and sends your smart phone, it can sense both slow and fast burning situations, gives the chance to hushing alarm with smart phones, tests itself with batteries smoke detectors lights and alarm devices so there is no labor work for it, illuminates user path way when sensors works and humidity can be sensed by itself therefore wet places like marinas can be quite sure of distinction of smoke and steam.
- A lock also secure users safety level with knowledge and let users to share temporary passwords for places which could be used in business places hotels or marinas all-around type used areas and can be checked their entering and leaving time i.e. TP-Links's Yale .
- In addition to that technology the system allows you to control switches and electric consumption with smart LED lamps, smart plugs and smart sockets and switches. Detecting you with cam or sending a command to the HVAC system your estimated time of arrival will light up the lamps as you enter, commercial example to this: Kasa smart devices.
- Philips Hue is another smart LED light bulb that can trick trespassers into thinking that users are around with the help of security cams which is also can contribute to not fully used areas in businesses.
- LIFX wi-fi smart bulbs are versatile version for energy efficiency. Rush or peak hours are will be noticed by users via blink of light. It goes full brightness in case of carbon monoxide or smoke alarm is working if Nest protector is already built beforehand flashing red colour for alarm. Like above mentioned these bulbs will flashes when an intruder seems. It can dim the lights if there is not ongoing activity. When there is not action it simply puts itself in sleep mode. Being easy to install is another plus. Lastly there is a recreational chance to music visualizer and different colour options. It could be used for lobby in marinas.

- Nest Alarms play one of the key roles in smart homes with altering overall energy behavior according to user’s occupancy of the place. Motion based sensors allows to detection of opened window or doors. With benefits of cameras and animal detection it can sense the difference and will not go to alarm and also shows the pathway with LED illumination. And of course works in cooperation with cameras and sends user the scenes.
- Lutron Caséta is another lighting and HVAC energy efficient technology that can be used in recreational areas in accordance with other technologies via allowing users to control lighting and heat condition with remote control of windows, shutters, shades and dimmers. Learning users routine will allow system to work silently to get perfect lighting and energy efficiency. Lastly if there is a smoke or carbonmonoxide problem it will automatically draw the plan.
- MyQ Home Control device lets users to see if the garage is open which could be used in Marinas to be sure about garages however manually opened and closed garages will save money and energy. Eventually it can be counted as a tradeoff in between labor force and mobility.

Figure 9: MyQ Smart Garage Hub

Source: https://www.chamberlain.com/

- Nest hello doorbell is equipment in the system that allows users to detect people and talk with them in high quality connection.

- Nest cams are smart security cams with LED energy designed and more durable than other security cameras lastly bridges other equipment together. Also there is an option to install in both areas inside and outside.
- WeMo switches can detect with help of information that comes from Nest thermostat or other devices that collects information and can dim or shut the lights when users are not in absence. To save the energy it can shut the fans when there is no need.
- In larger fields such as Marinas field devices can be connected with Nest Connect devices.
- The last but not least Rachio smart sprinkler controller let users to arrange watering schedule and design to make as much as possible water and energy savings. When it is installed on inside it can also put down a fire if it detects any (https://nest.com/thermostats/; https://workswith.nest.com/).

CHAPTER TWO;
ENERGY EFFICIENCY APPLICATIONS IN MARINE TOURISM INDUSTRY

Academic literature on marine tourism goes back to 25 years. Although water is a crucial element for tourism, researches on the field got popularity simultaneously with sector popularity and recent years were opening of a close book which is an eye-catching deficiency. In the literature there were mainly articles. Marine tourism researches comprise general and specific issues to the point at the same time. Reports were second most common research type in terms of frequency. Symposiums and congresses that will take place in future will cover up the expected number of research hopefully. Although in reports mostly theatrically topics have been discussed in last years micro-scale topics were been investigated. Thesis segment is where the big problem according to Kozan et al., just a period of time national thesis has gained popularity on yacht tourism which is a component of marine tourism. Aside yacht tourism, before 2015 other all theses took up 14 per cent of academic literature on marine tourism which is mainly due to lack of marine tourism education programs. In books segment, to the date of last day of 2014, national production is 2 whereas international production is 14. Our country is clearly blessed in terms of tourism considering the fact of 8333 km of coastal band with addition of islands though these number of publishing evaluated as low. Reason of stimulation on the field got her root last half decade (Kozan et al., 2014; Turkish Naval Forces, 2018). Our main goal is to stitch the gap in this field with specific energy efficiency topic.

There is trend in meetings nationally and worldwide and it is destined to contribute to the field thank to this reason with chain effect it will pull attraction to the topic. In journals there was no evidence of specific marine tourism work. Mainly tourism and maritime are the topics that has been concentrated on. Also business, management, geographical issues themed maritime and tourism management works have been conducted. In the field there is only one program is giving courses in Turkey though there are two-year degree yacht tourism and marina businesses programs. International level is not so common as well in terms of number of programs. Consequently, works that have been conducted could be considered as low in terms of number. Lastly when mentioning the fact that academic researches can shape the face of an sector, economically sector will gain lots of things as long as contribution is on the way (Kozan et al., 2014; Ministry of National Education, 2018).

2.1. Marine Tourism As Rising Phenomena

Marine tourism is the combination of major two field of economy. Eventually the concept of commerce is defined in varieties of sentences. Orams in his book which is titled as “Marine Tourism: Developments, Impacts and Management” gave the illustration as terminology for marine tourism “marine tourism falls under the terminology of recreational activities which involve travelling away from one’s place of residence and which specialize on the marine environment as their host (where marine environment described as saline and tide-affected waters)” (Orams, 1999: 9). This definition excludes fresh waters and commercial marine activities which makes the concept shallow. Hall in 2001 stated his opinion on the topic by broadening the term with putting the term right next to coastal tourism however it includes ocean-based tourism such as deep-sea fishing and yacht cruising. In the concept of coastal tourism Hall mentions the fact that tourism in this spectrum includes leisure and recreationally oriented activities which takes place on both on the coastal zone and offshore coastal waters. Eventually this perception leads to involvement of shore-based tourism activities such as land-based whale watching, reef walking, cruise ship supply and yachting events (Hall, 2001). Bounded by dependency to its character, marine tourism can get together tourism activities and transportation and travelling activities at the same time (Işık, 2010).

It was considered as two main sub touristic activity; yacht tourism and cruise tourism (Miller and Auyong, 1991:75). Another definition is marine tourism comprises recreational activities like swimming, water polo, sailing, water skiing and diving with condition of being in touch with nature. In this perspective, Doğaner made research accordingly using above mentioned two categories (Doğaner, 2001: 1). Diakomihalis added to these terminologies by this mentioning coastal activities together; cruise tourism and yacht tourism with sea creatures-watching, walking on the beach, water skiing, wind surf, underwater fishing, swimming, visits of themed marine tourism amusement parks and lastly hosting activities of local resident (Diakomihalis, 2007: 242).

In next pages author will try to enlarge into a collage of energy efficiency main commercial applications with marine tourism aspects and unique applications.

2.2. Marine Tourism Terminology

Marine tourism sub-branches are service sectors that rapidly and constantly have been grown in recent years on both national and worldwide level. The reason that lies behind of marine tourism development is human-beings are water-centric creatures and established their civilization around water throughout history and eventually they preferably choose coastal zone to inhabit. People’s attention got in these places only after discovery of coastal zones has lot to offer in terms of activity and unique natural resources (Işık, 2010:1).

In this research Marine tourism components considered as; Water Sport Tourism, Cruise Tourism and Yacht Tourism. Tourism and recreation activities have become the sectors which affected by factors of economic and external social environment (Moscardo et al., 2001: 213). Especially coastal and marine tourism are the most improved branches since 20th century’s second half (Hall and Page, 2006: 360). On global level each year, popularity of marine tourism destinations and potential resources well-heard and their marketable value constantly improved (Jeong, 2014: 294).

Coastal tourism is a recreational based-tourism that takes place in coastal zones and distant areas of seas which includes superstructures like accommodation facilities, restaurants, catering industry and secondary facilities and infrastructures like marinas, retailers, suppliers of activities. In recent years this terminology spread by commemorated with boat tours, eco-tourism, cruise tourism, swimming with equipment or not, amateur fishing and diving. Although coastal tourism and marine tourism are close terms marine tourism comprises ocean related activities such as deep sea fishing and yacht tourism (Hall, 2001: 601-602).

Marine tourism has lots of in common with tourism sector. Scuba diving, wind surf, fishing, kayaking, interactions with marine creatures are part of marine tourism however commercial fishing, commercial exploration works and researches are not in the circle (Dikeç, 2015: 5-6).

In next pages author will try to investigate marine tourism categorization in order to make a clear statement for we are mentioning which type of characteristics in marine tourism industries.

2.3. Systematic Approach to Marine Tourism Industry

Marine tourism commerce is one of the most diversified segments of tourism in terms of scale, managerial scheme, economic conditions and business type. For example, Lück illustrated this issue by naming these branches: boat chartering, cruising, sea sports to all beach activities, marine wildlife observations or visits to fishing villages (Lück, 2007). In some cases one person can operate whole system like in chartered fishing-boat operators although this number of labor force is not applicable to the big scale cruise shipping companies (Orams, 1999). Speaking of how broad the topic is; marine tourism is directly related with some of the tourism activities for instance: “recreational boating, coast and marine-based ecotourism, cruises, swimming, recreational fishing, snorkeling and diving”. Latter indirectly related businesses with marine tourism could be mentioned as “boat maintenance shops, coastal resorts, windsurf rental agencies, restaurants, food industry, and activity suppliers” and so on (Orams, 1999; Hall, 2001; Paker, 2014). According to Turkish Chamber of Shipping (TCS) marine tourism is; tourism focused activities with the help of marine vehicles that takes place on marine and their professional extensions. In addition to that TCS made the segmentation in entities as marine vehicle oriented marine tourism and facility oriented marine tourism entities. Turkish Chamber of Shipping added to literature marine tourism categorization by this analysis of understanding (TCS, 2018).

Marine Tourism

- Marine Tourism Facilities and Businesses
  - Cruise Ship Ports (A and B type) and Businesses
  - Marinas (3, 4, 5 anchored) and Businesses
  - Other Businesses (Dock, Pier and Boat Yard) and Businesses
- Marine Tourism Vehicles and Businesses
  - Cruise Ships and Businesses
  - Yacht Investment and Businesses
    - Blue Cruise (Gulet) Businesses
    - Bareboat (Without Crew) Businesses
    - Daytrip Boats and Businesses
    - Floating Restaurants Businesses
  - Diving Tourism and Surface Activity Businesses
  - Other Means of Sea Transportation and Businesses (Dikeç, 2015).

Marine tourism vehicles should carry the purpose of tourism for example cruise ships, commercial yachts, floating restaurants and hotels, daily trip boats, recreation-oriented canal boats and have to have tourism certificates in this approach. On the other hand, facilities handled as places that give one or more services to one or more vehicles such as; cruise harbors, marinas, water sport resorts. Among these services, beside that supply in general such as provision/ water/ beverage/ electricity, accommodation, mooring, berthing to land, maintenance and entertainment should be mentioned (Official Gazette , 2009).

Marine tourism aspects can be categorized by their accessibilities and characteristic features. Orams mentioned also marine tourism can be analyzed in different groups, for instance; activity-based marine tourism, nature-based marine tourism, social and cultural attractions, and special events (Orams, 1999).

1) Activity-based marine tourism is built around as the name speaks for itself activities but due to the natural conditions and environment of point of service it is fluctuant however travellers and tourist usually made their choices trading off activity over location. Scuba diving, wind surfing, fishing, sailing can be mentioned as this branch.

2) Nature-based marine tourism is a nature resource oriented segment that relies on natural beauties such as biodiversity, coral reef or green sea turtles. Dilemma that as many as nature-based marine tourism destinations get high in number the pollution on these areas rising as well. Although high quality nature-based experiences become more available day by day, actual number of marine tourism eco-system is lowering. But another perspective is sometimes explorer tourists find new places underwater.

3) Social and cultural attractions include social interactions such as parties on cruise boats, picnics, bonfires on beaches. Cruise boats can be considered as also social attractions. Museums are like Viking Sip Museum Roskilde, Denmark and Bodrum underwater museum could be counted under this segment (Orams, 1999; Erkurt and Paker, 2014). Especially Turkey can create an opportunity to them via using cultural attractions with antique harbor cities such as Attaleia (Antalya), Coracesium (Alanya), Side, Ephesos (Efes) (Esmer and Erkurt, 2014). Underwater Archeoparks, interactive marine museums, imitation museums and war remnants are incredibly useful when touristic value is discussed. Antalya, Kaş hosts the oldest known ship’s replica (Uluburun) and İzmir, Mordoğan commercial and naval war ship replicas of B.C.E. 600 Aegean Sea and sunk in 18 meters deep in order to landscape underwater and also to seek attention C 47 which is a World War II transporter plane sunk alongside nearby. Project owner 360 Degree Historical Researches Foundation and Mordoğan municipality, Fishery Research Institute of Ankara and Ege Universities got together to accomplish this diving tourism project. Also above mentioned institute has projects like İzmir Historical Boats and Mordoğan Artificial Reef (Erkurt and Paker, 2014; http://www.360derece.info/).

4) Special Events like national yachting regattas, annual fishing competitions and offshore yachts races are audience-centric and interactive activities that brings attention to under and below the sea.

Marine tourism thanks to its genuine features, being an exclusive market and growth in it, impact on environment and hardship in managerial issues is separated among tourism branches. Mainly attraction point in marine tourism is internal motivation factors of travellers and tourists that could be named as curiosity, desire to escape the familiar and experience beauties or wilderness in order to get known in society for relaxation, excitement, solitude, peace, and proximity to nature (Orams, 1999).

Below stated distinction method for marine tourism opportunities on accessibility of the place of event could be mentioned as classification however today these accessibility of the opportunities have been diffusing into each other. Today there is nearly small chance of getting experience of pure solitude and remote islands are slightly started to use that opportunities in their advantage such as opening resorts. Also another critical point for distinction is surfing which was given as example has been brought to land and mostly interactions are really high on this opportunity.

Table 20: The Spectrum of Marine Recreation Opportunities

Charac-teristics	Class I Easily Accessible	Class II Accessible	Class III Less Accessible	Class IV Semi-Remote	Class V Remote
Experience	Much social interaction with others High degree of services and support Usually crowded	Often contact with others	Some Contact with others	Peace and quiet, close to nature Safety rescue available Occasional contact with others	Solitude Tranquility Closeness to nature Self-sufficiency
Environment	Many human influences and structures Lower quality natural environment	Human structures/ influences visible and close by	Few human structure, close by some visible	Evidence of some human activity e.g. lights on shore, mooring buoys	Isolated High quality Few human structures/ influences
Locations	Close to or in urban areas Beaches and intertidal area	Intertidal …> 100 meters offshore	100 meters…> 1 km offshore	Isolated coasts 1-50 km offshore	Uninhabited coastal areas > 50 km offshore
Examples of activities	Sunbathing People watching Swimming Playing games Eating Skim boarding Sightseeing	Swimming Snorkeling Fishing Jet-Skiing Non-powered boating Surfing Parasailing Windsurfing	Usually boat-based Sailing Fishing Snorkel/ Scuba diving	Some scuba diving Submarining Power boat(offshore equipped) Sailing –larger sailboats	Offshore sailing Live-aboard offshore fishing Remote coast sea-kayaking

Source: Orams, 1999, p.45.

Above mentioned table illustrates variety of marine tourism activities on accessibility perspective.

2.4. Energy Efficiency Applications in Marine Tourism Industry

Tourism is one of the biggest parts of the global economy that rely on movement of as many as possible travelers across the land and sea over large distances. Approximate contribution of tourism to the overall global climate change trend established at 5 per cent level of CO_2 emissions which indicates that sector cannot be singled out for consequences however national tourism economies are famous for being more carbon-intense. As long as carbon-intense services are carried out by this trend energy efficiency will be low in charts. Ongoing popular trend of sustainability pushes forward the question of how tourism's future going to be shaped. Course of state for tourism getting bigger every year and also its share of global greenhouse gas emissions whereas other sectors more or less, manage to accomplish some form of efficiency. Many researchers has conducted research on this issue such as; Gössling et al. discussed in their article the possible outcome of versus of course of tourism industry sustainability and +2ºC climate change policy targets of tourism goal. UNWTO mentioned some of the possible suspects, for instance opaqueness and discordant state of sector. Controversial condition is deforestation, rising sea levels, improvement of desert-like areas in number and loss of snowy and glacier areas in general generally indicates that tourism is both victim and contributor. Although global warming causes longer sunny days and overall longer summer season and eventually contributes to marine-based tourism to develop, UNWTO says negative effects of this phenomena outnumbers the positive effects. In long term predictions are deforestation and reduction in biodiversity will break the demand for tourism and opts in to chained catastrophic events for tourism such as rapid change in global temperatures will harm the ecosystem, ascent of sea levels will submerge small islands and shave some of the coastal region, lack of water and hot temperatures due to desertification will lead dissatisfaction of tourists and travellers, most of the ski resorts and mountain destinations will be forced to alter their position because of melting which needs big sources of credit, energy and time for service providers. (Gössling et al., 2013: 525-538; UNWTO, 2018).

Depending on estimations UNWTO illustrates the issue of how much contribution has given by tourism sector to climate change by CO_2, heating, air conditioning, construction, waste management, energy wastes, etc. even though they state the fact that giving exact figures is almost impossible due to broad nature and various components. Tourism accounts for 5 per cent of global CO_2 emissions and 4.6 per cent radiative forcing whereas transport sector accounts with all their proportions 75 per cent of all emissions. However it is stated in previous pages, on both topics policy perspective and ongoing trend, transport sector have been taking the precautions of possible disaster. In transportation contribution, air transportation has the highest rate with 54 to 75 per cent radiative forcing and on the total it has 40 per cent of tourism contribution to global climate change. Accommodation side of the sector stands for one fifth of the emissions which includes maintenance of crucial facilities such as restaurants, pools, bars, offices, electric systems etc., heating, air-conditioning, ventilation and waste of water. This understanding could be summarized by this approach water sport resorts and cruise ships generally have more energy consumption than fewer number of visitor capacity hotels in marinas and camping sites in water tourism. In that area also activities of tourism contributes approximately 3.5 per cent of emissions (UNWTO, 2018).

Marine tourism sector could reduce Greenhouse gas emissions and energy consumption via using alternative fuels (exergy) and hybrid motors (energy efficiency) with its high octane potential. Probably the most accessible in terms of reducing energy usage and activating more efficient way to service and produce is accommodation sector. Transportation sector such as air transport and sea transport is the main challenge for tourism however they search the ways to reduce carbon footprint and raise efficiency via incentives and taxes.

Three basic steps that should be taken in order to limit carbon footprint; first thing is representing other ways than air transportation would limit emissions which shows the path to marine tourism. Second by using carbon emission calculators through one of the offset organizations it can be easy to diminish waste energy by determining what is causing it. Third finding the means of compensate the carbon emissions such as renewable energies, efficiency of energy, conservation of energy, tree planting or education of environment.

Changing the operation patterns of entities that need specific climate conditions such as water sport tourism or winter tourism or health-wellness tourism could open the way of diversification to make easier shift to cut back dependency. Another possibility is adaptation of tourist destinations and implying new technologies which are hard due to involvement of changing mindset of everyone including tourists (UNWTO, 2018; UNEP and UNTWO, 2008).

In other cases, Muslu stated that marine tourism rises day by day in global tourism. Turkey has important marine tourism potential. Turkey's outstanding properties can be mentioned as coastal structure, climate, human resources, and fleet of wooden yachts which is the niche of this sector for country. Despite that Turkey has these features share of marine tourism in overall economy is compatibly lower than what it is expected to be. Other than yacht tourism, especially yacht marinas, economically marine tourism try to live another day as it stated in Muslu. Marine tourism sector pushes forward to development of supplementary sectors and clear choices of employment. Yacht construction is taking all responsibility to be the flag-bearer in this environment. Taking into account strategy of a country, marine tourism is indispensable in terms of economy. When right choices made by a country, it's a chance to get endless stream of economic help. Muslu believes that differentiation alongside with quality management in this sector could be the most efficient tool (Muslu, 2015).

Law no. 5627 or energy efficiency law in Turkey shapes energy efficiency policy and targets limiting consumption of energy via effectiveness, more utilization and releasing the cost of dependency on energy export. Then it is supported by other laws within context of audits, services, ESCOs and other agreement plans. In 2012 Turkey released "Energy Efficiency Strategy Paper" which was the temporary conclusion of energy efficiency active allocations. The paper was built on 7 main strategies which are; diminishing the losses of energy in the processes and loosing the burden of intensity in the industry and service sectors (1) decreasing consumption and carbon emissions of buildings, taking the benefits of renewable energy sources and improvising sustainable buildings (2) promoting energy efficiency equipment in the market (3) increasing the benefits of energy efficiency in terms of electricity by each side ending at distribution side (4) lessening the consumption rates of fossil fuel in motor vehicles and increasing with public transportation (5) taking one step ahead in public sector in energy efficiency (6) Last but not least developing organizational side of energy efficiency and sustainability issues, cooperation, information, public awareness, technological implementations and financial resource allocation. It is mainly calculated as 20 per cent loss with the help of this action preparing with in relation with 2011 energy intensity number within the country (Official Gazette, 2007).

2.4.1. Energy Efficiency Applications in Water Sports Tourism Market

Water sport tourism types comprise high number of activities that main common similarity is there should be water mass and only it is possible with an equipment or vehicle (Özbek, 2014).

Table 21: Water Sport Activities

Windsurf	Canoe	Skurfing	Kitesurf	Kitewing	Sailing	Parasailing
Wake-board	Wake-skate	Wake-surfing	Kneeboard	Wave-surf	Snuba	Flyboard
Sea-breachers	Skim-boarding	Pedalo	Waterbird	Water-blob	Seabob	Hovercraft
Scuba Diving	Shuttle Bike	Hiring Jet-ski	Hiring Speed Boats	Amphibian Quad Bike	Sup (Stand up Puddle)	Amphibian Car Driving
Hydro-philic Water Skiing	Deep-flight Super Falcon	Water skiing and Mono Water Skiing	Cable Water Skiing and Wake-board	Floatable Water Slides and Pools	Floatable Activities (Hamburger, Mable, Flyer,etc.)	Scenic Underwater Bubbles (SUB)

Source: Özbek, 2014.

Water sport tourism actively still enlarging area on world and also could be mentioned under active sport tourism as well like researchers did under the segment of outdoor sport tourism industry. Kouthouris categorized active sport tourism in three major category "a) sea water related activities organized around marines, such as sailing, yachting, scuba diving and sea kayaking, b) outdoor activities such as climbing, trekking, cross-country skiing, lake/river kayaking and rafting, and c) activities provided by resorts, clubs and spas, such as tennis, golf, and health fitness” (Kouthouris, 2005).

Table 22: Existing Energy Efficiency Applications in Water Sports Tourism

Water Sport Activities	Lighting Systems	HVAC Systems	Motor Systems	Renewable Systems
Windsurf	YES	N/A	N/A	N/A
Canoe	YES	N/A	N/A	N/A
Skurfing	YES	N/A	YES	N/A
Kitesurf	YES	N/A	N/A	N/A
Kitewing	YES	N/A	N/A	N/A
Sailing	YES	YES	YES	YES
Parasailing	YES	N/A	YES	YES
Wake-board	YES	N/A	YES	YES
Wake-skate	YES	N/A	YES	YES
Wake-surfing	YES	N/A	YES	YES
Kneeboard	YES	N/A	YES	YES
Wave-surf	YES	N/A	N/A	N/A
Snuba	YES	YES	YES	N/A
Flyboard	YES	N/A	YES	YES
Sea-breachers	N/A	N/A	YES	N/A
Skim-boarding	YES	N/A	N/A	N/A
Pedalo	YES	N/A	YES	YES
Waterbird	N/A	N/A	N/A	N/A
Water-blob	YES	YES	YES	N/A
Seabob	N/A	N/A	YES	YES
Hovercraft	YES	N/A	N/A	N/A
Scuba Diving	YES	N/A	N/A	N/A
Shuttle Bike	YES	N/A	N/A	N/A
Jet-ski	YES	N/A	YES	N/A
Speed Boats	YES	N/A	YES	N/A
Amphibian Quad Bike	YES	N/A	N/A	N/A
Sup (Stand up Puddle)	YES	N/A	N/A	N/A
Amphibian Car Driving	YES	N/A	YES	N/A
Hydrophilic Water Skiing	YES	N/A	YES	N/A
Deep-flight Series	N/A	N/A	YES	N/A
Water skiing and Mono Water Skiing	YES	N/A	YES	N/A
Cable Water Skiing and Wake-board	YES	N/A	YES	N/A
Floatable Water Slides and Pool	YES	YES	YES	N/A
Floatable Activities (Hamburger, Mable, Flyer,etc.)	YES	YES	YES	N/A
Scenic Underwater Bubbles (SUB)	N/A	YES	YES	N/A

Source: IKO, Version 5.0; Özbek, 2014.

Above stated table is chosen to be on the ground that extensions of activity are not counted as energy efficiency applications. Also even though it is not stated on the table some of the energy efficiency applications for boards to stay longer

Applying silicon spray to gears such as pulleys in every 10 to 15 times will make your equipment last longer in kite surf. Rinsing and drying out of equipment should be done after every session in order to protect equipment from harms of wear out effects of seawater and sand. Stick on patches for kites another maintenance way to treat well your equipment instead of replacing with new ones which enable users to spend less on equipment. Beeswax could be applied when lines starts wear and become furry. Furry lines will cause ruptures eventually. In most of the cases hiring equipment in order to test synergy between sportsman and equipment is highly recommended which will allow them to be more effective (http://kitesurfing-handbook.peterskiteboarding.com).

Picking right size and right material for place is highly crucial in water sports. For instance in kite sports, there are well known measures for picking up your board and kite matching with your place of activity. Variables like your height, your weight, your shoes size, board length, board material, board type, kite size, kite material, kite type and usual wind power and direction are important for sake of material. Overall compatibility in general water sport equipment will increase duration of materials (https://www.surfertoday.com).

Waterbirds are some kind of hydrofoil invention that has similar aspects with surf boards however efficiency for them never shown explicitly in the literature even applicable lighting and motor systems (http://www.aquaskipperuk.com/).

One of the components of marine tourism, water sport tourism activities will gain professionalism by policy backup of superstructure and infrastructure along with adaptation of water sport tourism with national regulation on policies, works in increase in number of qualified service staff and harmonization of superstructure operations. Undoubtedly, without plan and lack of management will give harm to; growth in sector, natural environment, tourism, group of people that are beneficiaries of marine tourism and even athletes (Göçmen and Doğan, 2014: 23-24).

2.4.1.1. Lighting Applications in Water Sport Tourism

Base efficiency for lighting equipment in water sport tourism is upgrading CFL usage with attachable LED products on boards or any place that has a surface area for attachable lights. LED lights and combo LED lights for diving sport are available technology. LED lanterns that work with solar energy are in the commercial use for almost any type of marine tourism facilities. Attachable LED lights with accumulator or wave regenerated or stimulated with batteries are in use of all board based water sport tourism aspects such as on boards, canoes, SUP boards, pedalos or places that 10 centimeters to 3 centimeters of space is available (http://www.martek.com.tr; https://actionglow.com/; http://guardianlights.com/water-sports).

Figure 10: Stand Up Paddle LED Lighting Kit

Source: https://nocqua.com/.

Above stated fact about lighting energy efficiency in water sport tourism covers almost every inch of the selected area because water sports are sportsmen-centric and vehicles are most of the time capable of having such appliances of LED technology. Although it can be seem efficient but there is no other open space for efficiency due to the fact that traditionally most of the water sports are positioned according to sun and lighting in this sense is meaningless, thankfully in environmental perspective.

Pedalos are one of the most common types of watersport vehicles with them being low investment and high yield. Solar panels can be used with small motor systems which make them highly efficient being sole man-powered and has WWS applications. Also LED lighting is applicable solution for night drives (http://www.gardasolar.com/).

2.4.1.2. HVAC Applications in Water Sport Tourism

Mostly heating, ventilation and air conditioning is done where there is a closed and protected area otherwise it could cost more than what has been planned. Also expenses and harm to environment would surpass any limit for even any luxurious activity and sportsmen or tourist.

Sea trek is the one of the versions of snuba that also known as helmet diving enables other systematic diving experiences in water sport tourism and creates more freedom for tourist. In this branch of water sport tourism all the air pump motor technology is served as energy efficiency options. An IE3 efficiency rated motor with 92 per cent success of efficiency would improve the business rather than using old technologic appliances when supplying air to tourists.

Floatable water slides and pools, floatable activities and water blobs has lots of similarity between each other like board based sport such as wave surf, wind surf, canoe, SUP, cabled water skiing, mono water skiing, wake-board, skim-boarding, kneeboard and skurfing. Carrying same motor efficiency for keeping inflation of plastics high is works as sea trek system and related with air pump motors that will have high efficiency.

Flyboards are slowly getting out of marine tourism sector with the element of air getting involved its design along with water jets. At the same time water variations for flyboards are becoming high in numbers. Thus flyboard is sole novel usage area of air circulation for HVAC systems and their high powered engines for lifting up to 200 kilograms of weight. Improvements on this marine tourism opportunity grow day by day in numbers. Also jet that is used for flying above the sea is being main attraction point for this system but allowance of such appliance is limited for energy efficiency. Commercially without being in touch with customers and being a military research and development project drastically lowers HVAC efficiency methods for now in order to ensure safety in first steps. In addition to that, being under construction enlarges the chance of getting multiple up to date efficient system in motor systems and sole power for air ventilation in the small pieces of multiple motors under the appliance (https://zapata.com).

Even though being an infusion of airplane, submarine and car seabreachers are going to gain popularity with gathering all these aspects however there are limited source of applied energy efficiency whereas tons of efficiency methods can be applicable on the vehicle such as lighting, HVAC and WWS systems (https://seabreacher.com/).

Figure 11: Laminated Windows Usage on A Sailing Boat

Source: Source: Photographed on coast of Sarıyer, İstanbul, 09/03/2018.

Laminated boats are getting popular day by day because they need lower maintenance comparing other types when not lowering the authentic look. Long life span, lower first investment, low and easy coating, disposable and easy replacement chance and double-sided glasses for HVAC applications are some of the aspects to make them number one option by gaining more common knowledge of yachters in future Laminated planking applications getting wider implication areas such as on board windows and doors in order to save from first investment, repairing expenses and low substitution costs also due to its antibacterial structure these coverage on boat will ensure clean environment for a low fee. Long lasting aspect is positivity for this type. Recently yachters and sail enthusiast are keening on this technologic application to see it alive (Muslu personal interview, 2018; Kurtluoğlu personal interview, 2018).

2.4.1.3. Motor Systems Applications in Water Sport Tourism

Most of the times motor systems are directly connected with renewable systems due to battery or electric applied systems to get enough energy to circulate a conduit. Water sports tourism do not rely on HVAC applications in general due to this only benefit point for renewable systems could be mentioned as motor systems and lighting systems.

As one of the main marine sport activities hovercrafts use approximately 200 horsepower in order to takeoff with one person and mass of machine. If assuming hovering job considered as zero mile per gallon and 40,25 kilometers per hour horizontally movement, inefficiency as “transportation” of hovercraft boils down to this; 200 horse powers equals 149200 watts which is around of 128000 kilocalorie per hour which is about 15,15 liters of gas per hour (Scientific Americans, 2012). Divided into its distance that it goes within that period for one person (usually they can take only one person); 40,25 kilometers per hour/ 15,15 liters per hour equals to 8,05 kilometers per 3,78 liters which shows recreational activities that based on the pleasure of tourist does not need to be involved in marginal utility of energy efficiency in this segment. In this perspective rational idea is not to waste gas on limited amount of flight time.

High-efficiency brushless DC drivetrain and underwater lithium-iron-phosphate battery pack, 40V system voltage and low electric signature makes deep-flight series dragon, super falcon and super falcon 3S efficient but due to the hardship of being designed to explore ocean: vehicles or tourism branch makes them not so well with energy (https://www.deepflight.com/).

Seabobs are vehicles that make swimming car riding with motor systems. E-jet power system which works with the principle of water displacement propels the vehicle with channeled high pressure of water. These facts evolve into environmentally friendly and low energy consumer electric-drive 3-phase sinus powered vehicle for a powerful machine with lithium-ion accumulators. Crafting material for this vehicle are carbon for body, ceramic for coating and metals that resistant to salty water. (http://seabob-ibiza.com/; http://seabob.com).

SUBs are vehicles that geared up with batteries and travels at about 2 knots and hovers between 610 and 726 centimeters. Controls are in held of tourist. In 45 minutes of diving all HVAC equipment are there for tourist to use all they need to do is pop up their head into their own personal submarine like vehicle and sit.

Skurfing refers to the tourism activity that one or more sportsmen on a board pulled by ropes on water surface. In the literature all the efficient motor for boats can be counted as efficiency on motor systems however other genres did not find quite application areas.

Not surfing but flying tourists with parachutes on water should be referred as parasailers. With the help of parachutes that tied up to a boat or pulling mechanism tourist can fly for this sport efficiency can be on all motor systems and renewable systems however HVAC systems can be offered for not for tourist but for service providers which can be excluded from our topics (http://www.para-sail.com/page10.html).

Today there are 75 in Germany, 19 in France, 9 in Netherlands and Britain, 3 in Spain and 7 in Turkey(In order; Bursa Sukaypark, Antalya Hipnotcs Park 2 facility, Gold Cable Park, Kocaeli; İzmit Gölkay Park, Kartepe and Sapanca Park finally Samsun Sukay) overall in world 228 Wake-Parks existing. With the start in

2001 wake board recognized as a sport and has been arranging tournaments since then. Cable Water Skiing (wakeboard) even all basic principles are same with water skiing has the differentiation with water skiing on the point of motor system that pulls sportsmen. In water skiing, speedboats are used generally as mechanism whereas in the cabled version, electrical chairlift mechanism is used. Comparatively looking, there is low momentum in the beginning water skiing branch therefore it is difficult to get use to balanced point and learn whereas in cabled water skiing sportsmen pulled at the same pull force which makes easier to balance and improve themselves. It also shaves hours of training. Efficiency also show itself in capacity, a speedboat can pull 1 or 2 person at time, maximum whereas in electrical version up to 12 people can use the system. Economically cabled water skiing has many advantages. Another plus is cabled water skiing is environmentally friendly which can be described by this; thanks to the reason of usage electricity it does not release exhaust, oil and other pollutants, every skiing operation gains 9 tons of O^2 in a year for water, another aspect is because of speedboats need more momentum and place and cabled water skiing does not need that much space, it does not endangers further life of water areas. In our country because of pollution we can see the fact that in our many lakes biodiversity decreases and economically lose their feasibility. Considering about energy efficiency and sustainability and also economy, it is crucial to change sides on this subject (http://www.goldcablepark.com/tr/info.html; http://www.samsunsukay.com/).

According to Samsun Water Skiing Centre cabled water skiing can be taught in just 2 hours which enables tourists that completely new to this area can feel the satisfaction of success. Slalom, jumping from the ramp, barefoot sliding and wakeboard which gets popularity day by day are the opportunities of this sport branch to get endurance and skill. In addition to that, there is no limitation in this sport because of its full-safety nature. High pleasure and efficiency and low risk in terms of injury and pollution are main details of this water tourism segment (http://www.goldcablepark.com/tr/info.html; http://www.samsunsukay.com/).

Current drive motors which can be placed on SUPs with VSDs are available.

As an aftermath, the most possible availability of energy efficiency by looking at the table is sailing in water sport by coming all shapes and sizes and taking up more space on water and time of water sports enthusiasts. At the other side hydrofoil vehicle of water sports tourism waterbird has the lowest chance of getting or using less energy consumption. Although most of them are using zero or close to that level energy luxury element for all of them are minimized by these applications. If there would be more energy that is consumed more than zero it could be discussed.

2.4.2. Energy Efficiency Applications in Cruise Tourism Market

Since 2000 travellers look for novel alternatives to their holidays, there is an eye-catching growth that cruise tourism industry brought awareness with it. In second edition of Cruise Ship Tourism authors stated that this tourism branch attracted three generations X, Y and Z, thanks to this family oriented trips of liners becoming more affordable because of concentrated interest. As long as interest goes high on the charts, companies will improve their fleet by big ships and equip higher technologies to their ships and cruise harbors (Gigantic Cruise Ships: RCI's Oasis Class Ships; Oasis of the Seas (2009), Allure of the Seas (2010), Harmony of the Seas (2016) and Technologically Improved Cruise Ships: Quantum Class; Quantum of the Seas (2014), Anthem of the Seas (2015) and Ovation of the Seas (2016)). At the same time Cruise Lines eventually efficiency of the ships and harbors need to be discussed.

Chained with increasing number of passengers, technical developments, range of activities and services, cruise tourism has become economically one of the main parts of marine tourism. When these developments happen on world simultaneously Turkey had participation as well in the industry. According to Dikeç et al., Turkey needs to improvise the investments that not have been on the level of what we expected and should earn relative amount of portion. For instance, according to their work in cruise tourism they discovered the fact that, because of numerous reasons, in two ports of İzmir namely Çeşme and Didim, there weren't enough touristic income in the cruise terminal and recreational areas. Researchers point out that without further investments it will be hardship to protect competition with other regions (Dikeç et al., 2014).

Cruise Industry based on many components however the most eye-catching component of this marine tourism branch is the ship that offer travel to tourists. As a consequence, cruise ships regulations crosses roads with maritime industry and their regulations. In this sense, in the next pages described energy efficiency rules and regulations have to be applied to cruise ships that falls under the terminology of stated specifications.

2.4.2.1. Lighting Applications in Cruise Tourism

CRI for bathrooms, engine room, control room, pump room, workshop, storage room, freezer room, cargo room, passageway and open deck should be above 80 and it must be water resistant. Because of the reason that steam and water is a problem in such places IP of the device is essential for critical positions IP55 is needed but IP44 is mostly suitable recommendation for other areas. If there is a hospital, laundry, cuisine, galley or any type of room that could get wet IP level is also important thing in there as well. Dimming options for lighting systems is another beauty for energy efficiency in LED lighting systems for offices or other areas that will be occupied fewer hours in a comparison with other areas. Electromagnetic compatibility is crucial for places like engine room for luminaire system (https://glamox.com/).

Decorative berth lights, search lights, emergency lighting systems, floodlights, navigational flashlights, ballasts for new equipment, explosion proof lights, technical lights, architectural lighting methods, zone lights, downlights, table lamps, pole lights for hazardous places on board, flexible lights, helideck lighting methods, signaling lights are available in LED technologies in various methods of placing such as wall, recessed, surface, table and pole with options of corrosion proof, water proof, explosion proof and low heating.

Passenger corridors, passenger rooms and other places for lighting on a cruise ship can be lighted up by LED technologies instead of older methods of incandescent lighting methods. However there are few points to keen on such as vacancy sensors and dimmable options for when daylight is not enough are the exceptions for lighting systems for not working other than that it must be operated almost twenty four hours daily. Luminaires should be dimmed out when there are less than one person is using the place but keeping constantly working is needed in such places to ensure enlightening work and not to scare the tourists. Perfect suitability in luminaires section on corridors is enabled with long lasting equipment such as LED technology due to low chance of maintenance while on voyage and twenty hours of workload in a day. Thus corridors mostly are not open to daylight. Loose cables in a lighting fixture can create noise due to vibration on cruise which would not be the best thing for passenger marine approved products can silence that out. Also in cabins of passengers ceilings are not too high and fixtures of lighting should be recessed or mounted versions in order to gain some space for passenger. Above of working heat of 45 Celsius could be dangerous due to this fixture of luminaires should be operated under that heat along with being fire resistant. Dust and insect protection for efficiency is vital in almost any fixture electromagnetic compatibility of the system is highly needed. For emergency and escape routing on cruises centralized systems and decentralized version can be applied to enlightening work in order to ensure power back-up. Batteries in a each luminaire can be sufficient for escape signs however it would be costly to use that in all system. Guidance way in case of danger can be powered up with sound centralized system with uninterruptible power systems. Light signs for emergency case must be providing without failure. Quick plug and play connectors are easy to make maintenance for all lighting methods in order to not interrupt comfort of passengers (https://glamox.com/).

2.4.2.2. HVAC Applications in Cruise Tourism

According to Kanerva HVAC systems consumes up to one third of whole energy on the cruise ships. In most of the cases energy production separated two segments propulsion and hotel consumption. Need for maneuvering is satisfied from propulsion power which can be named as co or tri generation engine that produces electricity, heating, ventilation, fresh water and water heating and cooling while operates. Deliverance of such energy means are electricity production by steam, recovering waste heat from different sources air or water generation of supplying electricity. Usual consumption of the hotel side is around 4000 kW at harbor and sea (Kanerva, 2005; Korhonen 2016).

Even though cabin consumption which is consumption of passengers are small 1267 cabin consumption aggregates in major expense of energy. Approximate values of load are 2.2 kW for one cabin and 2787 kW for all hotel cabins whereas average values are around 350W for one independent cabin and 444 kW for all hotel cabins. Continuously taking up a space in energy portfolio cabin’s energy consumption limitation is a must. Shutting down when it is not occupied would end up in energy efficiency if it is possible. Average work of cabin ending up in 154-295 W daily totals at 195-374 kW this is 5 to 9 per cent of 4 MegaWatt consumption of ship (Nurmi, 2017; 14-22).

Ships energy performances and environmental comportment are gaining importance day by day due to fuel prices, modernity and emission legislations. Theotokatos et al. in 2017 made a research on ship cooling systems with using VSDs and calculating ships energy efficiency in the context of recent regulations. In their research they evaluated cooling system with application of VSD by two kinds of water fresh/ sea water. Stating that auxiliary systems of ships is not getting popular because of the reason that consumption of energy cannot be comparable with propulsion plants or hull/propeller consumption. Electrical energy of ship mostly goes to pumps, compressors and fans/blowers however these pumps are larger than usual due to proportion of ships are bigger and these ship pumps are normally utilized for her lifetime. These facts make ship cooling systems worth to evaluate in context of efficiency. Most of the time cooling systems in ships designed for worst case scenarios such as maximum workloads, maximum capacity loads and tropical weathers which results in unnecessary consumption of energy by having oversized pumps. Although at design stage for ships can be discussed for purpose-centric design, energy efficiency of ongoing ships can be altered by VSDs. Typical system includes pumps having steady speed of 60 Hz hence applying fluid flow control system with the help of branches and/or throttling valves. Three parts of ship cooling water systems can be mentioned as: sea water cooling system, low temperature fresh water cooling system and high temperature fresh water cooling systems (Theotokatos et al., 2017).

Sea water causes corrosion in machinery therefore push forward to design fresh water using cooling systems in ships. In addition to that, there should be one or more central coolers built on ship to cool hot fresh water that comes from machines and heat exchanger by using sea water. Seawater area has many pumps that align in parallels however one working one as a backup and one for operation at harbor are mandatory but three same main pumps can be used in order to ensure water flow rate for design point operation. Sea water flow rate is generally constant when pumps are working at steady speed. In some cases system valves settings component fouling corrosion issues can cause errors in the system. System operation conditions can alter the situation in central coolers with the result of fluctuating temperatures of sea water that exit (Det Norske Veritas, 2015; Det Norske Veritas, 2018).

Adjustable pump speed allows to users to maintain constant temperature levels on sea water flow and did not take up central cooler capacity. Mostly low temperature fresh water cooling system designed with 2 main pumps (can be three in some cases) to service main engine temperature of the system controlled by three way valve to always ensuring output temperature is as required. Three-way valve also mixes lower temperature flow of central cooler with relatively hotter by-pass flow where in need of balancing. If constant speed of pump is applied by-pass flow no more will be required thanks to matching systems. Hot temperature fresh water cooling systems uses 2 pumps one is operating and other one is back up in parallel for engine metallic parts and variable speed pumps are not required to design system to the intended levels due to existing system is already at the normal stage.

In the outcome of system enables to lowering pump speed eventually lowering fuel consumption. Rareness of maximum load also enables variable frequency drivers to be installed and eventually substantial reduction in consumption. In generic cases not mentioning tropical cases variable speed drives also applicable three parted cooling system (Theotokatos et al., 2017).

2.4.2.3. Motor Systems Applications in Cruise Tourism

A marine diesel combustion engine of a cruise ships produce energy for propulsion however adding up with electricity with 48 per cent, exhaust gases with

25.5 per cent, high temperature cooling water 15 per cent and low temperature cooling water with 11 per cent (Zou et al, 2013).

In novel methods of producing energy by at first step or secondary methods with co-generation and tri-generation methods, one must mention E-ferry with batteries around 1500 kW consumption, PV MS Tûranor Planet Solar, wind energy with 7000 kW E-Ship 1 by getting advantage of Magnus effect with renewable energy however Nurmi did not see the potential from renewable resources and energy efficient methods enough and mentioned the need for combustion engine (Nurmi, 2017; 14).

Frequency controllers on fans and pumps, waste heat recovery in cabins, engine room and air handling units with enthalpy recovery are common applications of energy efficiency in cruise industry to the point that could be sounds old technologies. Recent applications are focused on keeping constant operation speed in order to avoid consumption that arises when engine is overload with work. Air handling unit working process starts with enthalpy recovery wheel if it is not enough to stabilize condition heating coil starts to work. Circulated heat with steam only be used with re-heating that takes place in the same appliance. Energy supplies that heating coil feeds hot cooling water from the engines and steam to heat supply of air.

Due to limitations most of the times propulsion needs surpass the need for generating electricity moreover it is not efficient to produce electricity in a comparison with land facilities. Lastly in most of the engine room of cruise ships energy is not stored or storage of energy is not highly focused sudden demand in hotel side therefore becomes dangerous to meet.

Di Vaio and Medda has investigated 12 cruise terminals in Mediterranean basin on overall cruise terminals efficiency by evaluating the number of tourists visits, berth capacity and usage and main operational organization type (public/private). According to their managerial aspect focused efficiency thesis private sector shows significantly more efficiency with given ownership and terminal investments however competitive behaviors are keys to open the doors of energy efficient movements (Di Vaio and Medda, 2010).

International regulations and carbon output of ships should be stated for the sake of clarification. Because of the causes like rising levels of GHG emissions, appointment of United Nations Framework Conference on Climate Change Third Parties took place in Kyoto/Japan in 1997 and got into force in 2005 as “Kyoto Protocol” in order to diminish level of pollution or bring it to more reasonable levels (United Nations Framework Conference on Climate Change (UNFCCC, 1998)).

In the protocol, issue of pollution that originated from ships has been evaluated separately. Taking action job is channelized to the parties of protocol and International Maritime Organization (IMO). IMO created MARPOL (abbreviation of marine pollution) ANNEX VI in order to cope up with Sulphur Oxides and Nitrogen Oxides emissions. In 2008, IMO declared Baltic Sea, North Sea and English Channel as Sulphur Emissions Control Areas (SECAs) and all United States of America and Canada shores as Emission Control Areas (ECA) in order to fight with Nitrogen oxides emissions (IMO, 2005; IMO, 2016).

Even though UNFCCC aimed global reduction of CO_2 and GHG emissions there were not regulations on marine tourism sector. Oppositional ideas and large discussions led IMO’s Marine Environment Protection Committee (MEPC) to add an additional part (Chapter 4) to MARPOL ANNEX VI. Thus Energy Efficiency Design Index (EEDI) obligated to new ships which includes cruise passenger ships (having non-conventional propulsion) and Ship Energy Efficiency Management Plan (SEEMP) obligated to all ships (IMO, 2016). In addition to that, Europe with White Certificate applications in transportation aims 60 per cent loss on GHG emissions in 2011 (Fagerholt et al., 2015).

Briefly, EEDI is developed to theoretically measure CO_2 emission performance of ships that 400 gross tons and above. Mostly EEDI used in the ship designing and calculation of engine performance data. In this approach it is clear that IMO targeted induction via intersect the process of designing by modernist and technologically up to date information. Since first of January 2013, all the ships that sail internationally and have tonnage of 400 or above have calculation of Attained Energy Efficiency Design Index. This statistical data has to correspond to Required Energy Efficiency Design Index equally or below the number (IMO, 2016).

Calculation of EEDI

$$\frac{\left(\prod_{j=1}^{n} f_j\right)\left(\sum_{i=1}^{nME} P_{ME(i)}.C_{FME(i)}.SFOC_{ME(i)}\right)+\left(P_{AE}.C_{FAE}.SFOC_{AE*}\right)}{f_i.f_c.Capacity.f_w.V_{ref}} +$$

$$\frac{\left[\left(\prod_{j=1}^{n} f_j.\sum_{i=1}^{nPTI} P_{PTI(i)}-\sum_{i=1}^{neff} f_{eff(i)}-P_{AEeff(i)}\right)C_{FAE}.SFOC_{AE}\right]}{f_i.f_c.Capacity.f_w.V_{ref}} -$$

$$\frac{\left(\sum_{i=1}^{neff} f_{eff(i)}-P_{eff(i)}.C_{FME}.SFOC_{ME**}\right)}{f_i.f_c.Capacity.f_w.V_{ref}}$$

Source: IMO, *"Energy Efficient Ship Operation, Module 2 – Ship Energy Efficiency Regulations and Related Guidelines"*, 2016.

Primarily influencing parts of EEDI aspects could be mentioned as main engine and energy needed for propulsion which is shown in the first part in formula, auxiliary power requirements of the ship which is the second part which starts after first plus sign , innovative power generation devices on board such as solar power or electricity generation from various waste heat which are third term which can be seen after second plus sign, innovative technologies that compose mechanical power such as wind power in sails and kites which are the fourth part which indicated after minus sign and divided into ship capacity and its pace equals to the value of transport work (IMO, 2016).

SEEMP or Ship Energy Efficiency Management Plan is that is applicable for 400 gross tons or above ships which sail in international seas, which created by IMO in order to ensure energy efficiency is applied and paid attention in firms, in force since first of January 2013. Via optimizing performance of ships and track the efficiency rates of the ships in the fleet, SEEMP offers feasible options to improve efficiency of the firms (IMO, 2016). SEEMP has to be particularly designed for the ship. Mentioning the critical role for SEEMP, there are four steps that should be taken into consideration when specific SEEMP is drafted by managers; Planning (1), Implementation (2), Monitoring (3), Improvement (4) (Turkish Lloyd, 2012). Initial goal is carve out a plan to compose a mechanism which ship operations always progresses in terms of efficiency for the firm and/ or ship. The environment of the ship should be managed under these terms by this tool. Due to this reason, this plan should be prepared to minimize the burden of bureaucracy for welfare of routine operations (IMO, 2016).

In energy efficiency issues on this conversation, Turkish Chamber of Shipping stated that if EEDI is the technical version which enables to take necessary precautions, SEEMP is the operational side of the action plan and constitutes an opportunity to look forward to establish EEOI on ships to track the ship. In addition to that TCS, sees the process as design, construction, sea trial and operation when launching a ship. In this process EEDI and verification takes the initial position in design, then SEEMP take its place in between construction and sea trial to the end of ships life as planning and improvement purposes and lastly EEOI for monitoring starts in the trial process and ends where timeline end (TCS, 2016).

Energy efficiency of the ship preferably should be tracked by internationally standardized data. EEOI which is a tool that working fleet or ship could get desired numerical value of efficiency is one of the primary monitoring systems on world (Turkish Lloyd, 2012). Ship Energy Efficiency Operational Indicator or EEOI shortly, generated by IMO to be the guidelines for tracking of fuel performance and fuel performance in context of purpose of the ships, if carried cargo type of cargo, CO_2 emissions and pollutants and overall impact of the ship to global climate change. This discretionary guideline describes how a ship or firm should take actions by monitoring acts (IMO, 2009).

System gives outcome of mass of CO_2 generated in a voyage or voyages of a period in units such as tons of CO_2 divided into twenty foot equivalent unit (TEU) divided by nautical miles, tons of CO_2 divided into number of person carried divided by nautical miles. Mass of CO_2 value is calculated via multiplying factor value of fuel type with overall consumed fuel quantity and transport value is calculated via multiplying number of persons or number of cargo that has been carried with overall distance that traversed.

Calculation of EEOI

$$EEOI = \frac{\sum_J FC_j \,.\, CFj}{mCargo, i.\, Di}$$

- J: Fuel type
- i: Number of Voyages

- FCj: mass of j fuel that is consumed in i voyage;
- CFj: j amount of fuel CO_2 weight of fuel in mass converting factor;
- mcargo: mass of cargo that transported,
- Di: distant in nautical miles (IMO, 2018).

This indicator is affected by ship's operational variables. By time there is going to be difference between first designed operations and current operations, for instance a cargo carrier could be leased to cruise liner company which uses in different service, between that allocation EEDI and EEOI shows their differences. EEOI indicates performance result that has been appeared over a period of time. EEOI also enables benchmarking or comparison between sister ships and other ships in fleet. Another applicable efficiency that EEOI offers are lowering value of fuel consumption or quantity in a same route or increasing cargo capacity when ballast carrying by indicating performance values or reducing ship's waste time in ports (Erat, 2014; IMO, 2011; IMO, 2018).

IEEC or International Energy Efficiency Certificate is the certificate that ships that sail internationally and 400 gross tons or above that weight after the surveys, if suitability permits, has to get. According to IACS's (International Association of Classification Societies) unified interpretations, IECC get into force for both existing and under construction ships. In existing ships category after the closest survey of IAPP (International Air Pollution Prevention Certificate) and in under construction category after the ratification of SEEMP ships can be issued after first of January 2013. This certificate becomes invalid when changing the flag, changing an important part on ship or death of the ship (Erat, 2014; IMO, 2016; IMO, 2018).

Indicators for ships and boats for energy efficiency are not a standardized area for companies. However EEDI and EEOI can be the base level for Key Performance Indicators (KPI). As mentioned in the first chapter most basic definition for energy efficiency is ratio of outcomes and incomes. In this sense, fuel issue could be applicable even all cruise ships however changing the perspective to it is applicable to all ships make KYI not so specific for cruise ships. To be more clear container ships use this approach to be more efficient in the same way however marine tourism and maritime transportation besides being on water have not so many similarities. A liner company could achieve successful efficiency in terms of energy after determining indicators for the operation. Differentiation methods that cruise lines applied to their system by using sustainability can be illustrated by giving this examples; advanced voyage plans such as Seabourns's partnership with UNESCO (United Nations Educational, Scientific, and Cultural Organization) which leads them to sustainable tourism to the routes that historically listed as heritage and determining options to make optimization of speed and soundness of ship in terms of technology, modernity and innovative applications such as Royal Carribean's Quantum class (Erat, 2014; http://www.cruiseholidays.com/).

2.4.3. Energy Efficiency Applications in Yacht Tourism Market

Marine tourism has become indisputably one of the main sector in tourism with its pace in terms of development and economy. Recent years have been showing that Turkey has been performing quite well in order to achieve the goal that being a hub point in marine tourism in Europe and Mediterranean Sea. It is a well-known fact that with every development marina industry has been experienced, the service changing its managerial aspects and ensuring depth in the context of diversification in departments and eventually being more versatile every year. Although most of the marinas are not in fully charge of control on process-driven evaluation or did not adopt process-driven management style (ICOMIA, 2005: 6; Bezirgan, 2009: 4).

According to Transport, Maritime and Communication Ministry of Turkey yachts are the ships that built in the shape of yacht, has a cabin, a toilet, a sink and a kitchen, utilized for travel, sport and entertainment, mostly built out of wooden structures and manual dexterity, number of passenger is limited with 36, build with traditional or primitive methods, has its special design or being a replica or similar version of a ship. Differences of commercial ones are not being passenger or fishing vessel, capacity of passengers is 12 and in our water limited with 100 miles and with a legislation of not leaving more than 20 miles from closest land. Special yachts are considered longer boats more than 24 meters in this context. Also there are yachts that purposely given to sole order of state jobs. Wooden ship of primitive build term refers to same build and same dexterity and same capacity (Transport, Maritime and Communication Ministry of Turkey, 2018: 20).

In the literature “marina” definition is used in many forms. National Association of Engine Boat Manufacturers used as waterside facilities for trip or entertainment boats and added services like maintenance, fuel-oil supply, physical infrastructure (shower, toilet) provision services like food beverage services (Sarı, 2013). Heron and Juju states the fact that marinas are not just a mooring place and an entity should provide many services along with it for sake of diversification and facilities. In addition to that their statement of as being a temporary stop off point for cruise routes or homeport is marinas should give their holistic hospitality that attracts travellers and cruises and yacht owners in order to be more profitable rather than just being a stand-alone operational facility (Heron and Juju, 2012). Another almost same approach mentioned by Stone with giving specific importance to being a tourist destination (Stone, 2000). IMI (International Marina Institute) adds another aspect of being a place “accessible by land and by water, including berth places for visitors, accommodation, dining facilities, swimming pool and other entertainment and leisure facilities that provide a resort atmosphere” (Paker, 2014). According to regulations of tourism in official gazette of Turkey, marinas are coastal structures that act like merchant and needs to have licenses and are protected areas from impacts that comes from sea and wind with the aspects of providing safe mooring and walking connection for yachts and may offer technical and managerial help, social infrastructure, support, accommodation, maintenance and repair services to these yachts (Official Gazette, 2013). Services of marinas are wide range areas that are not in the solid state of matter; one can mention “office services (general, daily weather, currency exchange, assistance to custom procedure, etc.), port services (pilot boat, berths, etc.), technical services (paint, engine, electricity, etc.), health services (doctor, ambulance etc.), security (navigation, fire alarm etc.), social (yacht club, swimming pool, etc.), shopping and entertainment (bar, super market, restaurant etc.), environmental protection and general (electricity, telephone, WC, shower, etc.)” as their offerings (Paker, 2014).

Marinas can be put in a sentence like this; facilities that positioned on seaside, administrated by public or private entities with commercial purpose, give firstly on sea (mooring, pilotage, towing etc.) and secondarily on land (hauling, storage, translavation etc.) reservation and maintenance services to recreational boats in exchange for value and generally offer one or more service or product that related with boats such as electric-water, restroom-bathroom, maintenance and repair, waste management, combustibles and yacht markets (Anderson, 1993: 3; Atlay Işık, 2010: 15).

These groups of services determine the departments and conducted process in marinas in recreational boating industries. Depending on the aspects of marinas generally changes one marina to another however fundamentally core jobs have similarities in many firms (Koç and Karataş, 2017).

Efficiency in managerial side of yacht industry should be in organizational issue that involves rational allocation of works among workers and fixation of current situation. Due to not uniform nature of topic, there are many organizational scheme of firms depending on the aspects such as size and magnitude of firm, areas of activity, given services and products and capacities (Sarı, 2011: 50).

Most of the researches focused on pollution and other environmental focus areas related with marinas. Klein and Zviely restricted their work to the topics of erosion and loss of sand quantity on seafloor that comes from highly improvising marina industry relation. Webb and Kenough inspected impact level of pollution on the seafloor on selected organism in the zone that two marinas in the same geographical position. Atlay Işık made research that main focus was on holistic marketing approach in yacht industry and how perception of this approach is considered by supply and demand sides. Also, Sarı investigated service quality, levels of quality, satisfaction of yacht owners, variables of repeating the same choice and recommendation of yacht owners in marinas in the work. Rivero et al. open the discussion of interrelation between developing population on seaside with pollution that arises from recreational activity facilities like yachting, diving and fishing etc. Sevinç inspected competing strategies in the context of differentiation on the level of managerial side in marina companies in Turkey. Lastly Balcı examine effect of information system on marina operations and its contribution to consumer satisfaction (Atlay Işık, 2010: 315; Balcı, 2011: 5, Klein and Zviely, 2001:145; Rivero et al, 2013; Sarı, 2011: 3; Sevinç, 2014: 4; Webb and Keough, 2000: 345).

2.4.3.2. Energy Efficiency Applications in Yachting Market

Nowadays motor yachts are becoming more complex day by day to the point that even old small passenger ships are less detailed than yachts. According to BMT Nigel Gee firm auxiliary load of yacht can only equate to 22 per cent of propulsion consumption of the yacht by working all year non-stop. Typical operational profile for a yacht is 75 per cent at anchor or in port, 15 per cent on cruise speed, 7 per cent on maximum speed and 3 per cent maneuvering. The most critic evaluation point should be engine and hulls efficiency however most of the yachts spend their time at rest while load of auxiliary consumption is on scene. 110 meters motor yacht going speed at 17 knots with 80 passengers on board can contribute to CO_2 emissions 7 times more than car ride or short haul flight of an aircraft. In the case of same ship 2500 tons of fuel will result in 7.85 million tons of CO_2 emissions. Sticking to the topic, HVAC consumption is evaluated as 62 per cent, services 14 per cent, machinery systems 11 per cent, galley’s consumption 6 per cent, lighting 4 per cent, entertainment 2 per cent and navigation along with communication 1 per cent. These values are separated from actual consumption which is fuel consumption to move the vehicle. Waste heat recovery, intercooling and LED lights on the selected ship can payback itself in 3.5 years by cutting back in previous order 134500 US dollars for waste heat recovery, 108000 US dollars for intercooling system and 47500 US dollars for LED lights. These three methods can add up 16 per cent of auxiliary consumption efficiency. Various methods can be counted as additional yacht energy efficiency applications since energy is almost everywhere and every small or big job needs energy to be done. Some of the generic energy efficiency applicatiosn are turbocor compressors, using co-generation or where it is possible tri-generation systems for producing heat, cooling or electricity by taking advantage of working power of the engine and cabin management such as using less amount of energy when it is not in use and saving HVAC alternatives for sealing the door until it is needed to be open. Thermal insulation to vessel shell, energy efficient glasses, reducing direct lighting impacts and shaded exterior spaces and natural ventilation aspect via designing stage precautions are the main discussion points for reducing energy need of the yacht (BMT Nigel Gee, 2012: 2-4).

2.4.3.2.1. Lighting Applications in Yachting

By meeting large group of people, lighting solution providers tried to meet with their customer's needs by producing durable, reliable, efficient and appealing LED solutions. Usually first take-on about the context is to provide attractive, powerful lighting and not being abuser of energy on boat along with physically sound for damages of corrosion. Most of the above stated lighting solutions for cruise industry with IP44 or above protection can be very opportunistic for yacht industry. Purposely produced equipment for marine protection such as spotlights, light bars for underwater are convenient answer for energy problems on boats for low energy consumer or renewable energy producer boats (https://www.larsonelectronics.com/).

Figure 12: Marine Grade 150 Watt LED Flood Light (10-32 Volts DC, 14,790 Lumens, 12 Ampere)

Source: https://www.larsonelectronics.com/

Interior lighting for enthusiast of yachts can be applicable to walking areas which can be found on bigger luxury yachts. In deck light issues LED is also implemented technology for maneuvering and also it can be satisfying for lighting ambiance. Underwater LED lights for fishing and to decoratively appeal can increase grade of the boat.

Maintenance for such appliance is easier when it is designed for replacement and easily being mounted. By stating this author tried to point above stated ballast changing applications for lighting fixtures which can be very prosperous because of keeping vapor of the sea due to non-sound winding and non-proper placement and eventually keeping gaps on the fixture for air to pass into occurs frequently.

In order to reduce discomfort level that arises when LED lighting solutions is used without protection especially at nights where there is no or limited light source that comes outside installation processes must be evaluated for each case. It can reduce maneuvering effectiveness directly via being too illuminated to see outside for yacht enthusiasts. Converting to LED technology on board can result in payback of 2.5 years due to high initial cost but they are almost 30 per cent more efficient than Halogen light bulbs which are generally have wider share of usage. At the end, case scenario for consumption of electricity 22 meters yacht is held. Replacement for 74 Halogen lamps which consuming 20 Watts each one of them were 210 LED lamps which consumes 0.8 Watts for each one of them cumulatively 62 Amperes for 24 Volts versus 7 Amperes for 24 Volts. Also heat factor that LED technology reduces and cable size reduction makes this novel technology without rivalry. Also because of direct starting point for LED technology makes this technology elastic for in context of optic technology, lens and eye safety (http://www.hellamarine.com/).

Underwater lighting methods for yachts and colorful searchlights via LED methods are making easier to acquire high efficiency on board.

Grow lights which can be used for growing plants in less illuminated places with LED technology are highly efficient considering the fact that there will be self-powered vehicles of surface in future hence sometimes these lighting energy would considered as cheap and C vitamins are highly needed for yacht enthusiasts that goes for rides more than 3 months which can be prevented by eating red or green peppers, lemons, oranges and tomatoes.

Where there is stream of energy flow sensors can be applicable for larger yachts and yachts with many rooms however motion sensors or thermal sensors should be used at the same time with dual technology to reach optimum correctness to not to waste energy when trying to be more efficient.

2.4.3.2.2. HVAC Applications in Yachting

Main HVAC section and HVAC sections of water sport and cruise have been illustrated in detail however applications are similar due to limited area and a vehicle that goes on water. These applications carry the responsibility of work in collaboration with main energy driver of the vehicle and not being supplied by exterior source such as renewables. Also generation model directly impacts efficiency when there is high octane consumption. HVAC operations for Cruise vessels and other land solutions can be used on these types of luxury boats as well. Especially co and tri generation methods could save lots of HVAC consumption and consumption of water heating/cooling exercises. Other than above stated methods mostly protection and maintenance methods for yachts can be prosperous in its original methods. Protection of vehicles from nature harmful effects, examples high temperatures and corrosion, will lead to a condition that less consumption of electricity and fuels. Below specific cases for HVAC applications for yachting are discussed.

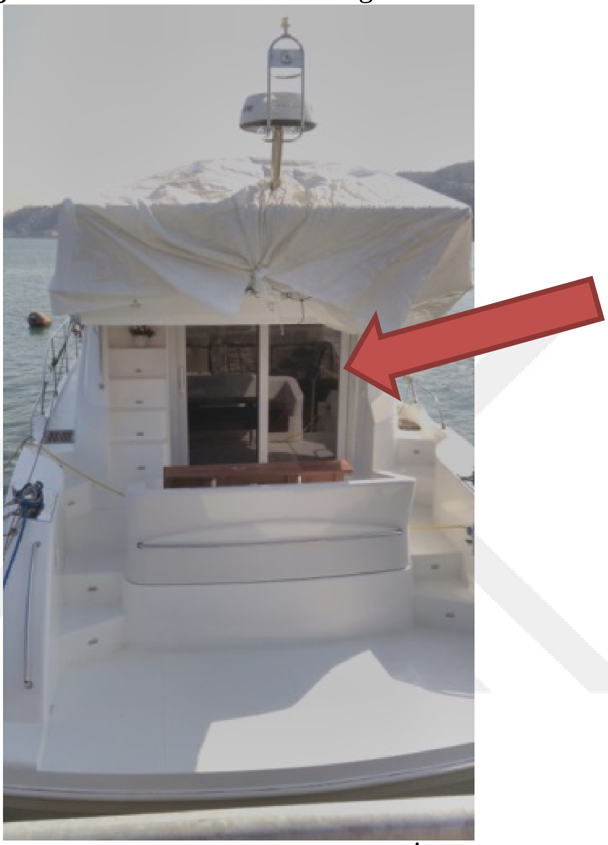
Figure 13: Protection of Boats with Membranes and Covers

Source: Photographed on coast of Sarıyer, İstanbul, 09/03/2018.

When actively using or at rest yachts need to be taken care for being under daylight almost any sunny day. Protecting from sunlight or water with a membrane or a cover will reduce consumption for HVAC activities when actively using the yacht without cruising on the sea. These easy to do applications like sliding rooftops and membrane and covers can be lifesaver at the energy end.

Windows are cruical which can be illustrated by stating double-glazing can save up to 3 per cent of all auxiliary expenses of yachts.

Figure 14: Filmed Windows Usage on Yachts



Source: Photographed on coast of Sarıyer, İstanbul, 09/03/2018.

Another efficiency application for long lasting is filming or using WWS advantage on glasses at design stage for yachters. Along with developments for flexi panels and solar energy systems generating energy for accumulators and storing in them, becoming more available for yachters. Rapid financial payback aspect and filmed usage with protecting inside of the boat and reducing view from the outside and climbing on privacy with lighting, HVAC, motor systems and renewable energy aspects solar windows with high technology can be the most prosperous, the most advance and the most efficient application in these papers and in the literature (https://solarwindow.com).

The most important issues for the HVAC section are mentioned as waste heat recovery systems, calorifiers, sophisticated fresh water cooling systems and water heating systems. 35 per cent of fuel energy consumed at the engines on high speed diesel generator sets has been passed into generators traditionally which means 65 per cent is lost to cooling waters, exhaust gases, radiated heat, fuel oil, electrical efficiencies etc. By using heat from engines to receive HVAC operations at 10 Celsius degree 48 per cent of vessel need for heating can be reduced which is roughly equals to 440 kW of electricity on selected board. Also taking the same waste heat recovery system advantage generators efficiency can go higher enough to see the 53 per cent of efficiency. Intercooling system has become typical for larger motor yachts. Intercooling should be operated at all times. However designing the system for adjusting pump duty on the fresh water and sea water side of the circuit to reflect consumer demand at optimal water temperatures which is 32 Celsius degree is possible furthermore with the help of VSDs extreme efficiency levels can be shown. (BMT Nigel Gee, 2012).

Ventilation helps reducing moisture and humidity below deck, prevents musty air from becoming an issue at same places, drier climates helps any type of fabrics and device to be in safer environment and to operate more efficiently. There are two versions of ventilators active and passive ones. Easy to describe, passive ones are like hatches, vents, louvers and grills type of ventilators that do not put effort on the work and just enables air to pass into and do its job. Active ones include air conditioners, fans and dehumidifiers. In some cases renewable energy take place with solar cell and batteries and allow fan operation with no electrical hookups and working on the two way in and out. Air conditioning system of 5000 BTU to 16000 BTU draws nearly 4 to 13 Amperes at the dock however in under way the system consumes most of the electricity. A sizeable inverter and a battery bank or a generator sets are highly needed for summer time in yachts. Hatch mounted portables, self-contained air conditioning units, split or remote air conditioning units, chilled water air conditioning and reverse cycle heating and cooling equipment are most common types for ventilation (https://www.westmarine.com/).

2.6.3.2.3. Motor Systems Applications in Yachting

Motor system as it is mentioned above the biggest abuser of energy in yachting taking into consideration that even though maritime transportation is the lowest energy consumer for carrying large amount of cargo it does not apply in same manner for yachtings due to effectiveness was not the main concern instead of comfort. However energy efficiency became more popular as popularity of the marine tourism type gets higher. Starting from the design, motor systems and its efficiency had found discussions grounds. Holtrop and Mennen way of reducing resistance or at least understanding what is on the way will eventually create a hydrodynamic gap for us to improve energy efficiency of such vehicles. Designing the ship hydrodynamic system for engines can be considered as wise when thinking about fuel prices. Their design for cruising on the water and meeting points of body of the ship and water held in context of efficiency (Holtrop and Mennen, 1982).

Figure 15: WWS Applications on a Boat

Source: Photographed on coast of Sarıyer, İstanbul, 09/03/2018.

Efficiency of the motors could be optimized by above stated applications and for further steps it can be synced with smart devices on auxillary systems such as heating, cooling and air conditioning. Although these applications seems and could be evaluated as futuristic, composing combined energy efficiency management is what digital era requires in order to be stay up to date.

Figure 16: Solar Panel Usage on Yachts

Source: Photographed on coast of Sarıyer, İstanbul, 09/03/2018.

Makshoos et al showcased remotely contolled unmanned surface vehicles which can be implemented itself and its features to yachting industry. Surface vehicle produces optimal of 5.8 kWh energy a day with 8 kWh capacity with lithium-ion batteries. Sun-tracked mobile energy producer is installed via experimental tests. PV arrays are designed for every month radiation on 8 square meters. “Morvarid” is hybrid consumer of energy for activating itself on sunny days. Morvarid can be expanded to yacht industry applications with bigger generation devices (Makhsoos et al., 2018).

One of the main criteria for yacht buyers is what it is using as propulsion mechanism. Most of the time sailing boats and motoryachts are getting head to head with an exception of using combined version motor yacht which can operate sail system in windy times. In sake of energy efficiency in marine tourism, not lowering the criterion of luxury motor yachts are essential due to various reasons such as operation availabilty in almost any time and sound system of prediction of estimated time of arrival and creating a proper scheduled vacancy. WWS applications for almost any place on boats such as bottom for wave energy, top deck for solar energy, glassed for solar energy, turbines for wind energy, aft propulsion and air circulation for re-use systems with the space of newly developed technologies can evolve a boat to zero consumption level of marine tourism or close to that approach like water sport tourism (Tüzer, 2018).

When a motorized yacht is in need of changing its motor that installed at aft, yacht owners should change it old motor with highly efficient four phased motor or highly efficient two phased motor with direct injection of fuel. The reason lays behind it is these motor genotypes consume fuel in a wise manner in order to minimize wasting fuel and limiting the release of harmful emissions (IC Çeşme Marina, 2018).

Cleaning of bottoms with high pressure water for removing shipworms will definitely one of the most important energy efficiency methods for yacht users because of the reasons that reducing fuel consumption, lowering the weight of boat, increasing maximum speeds and lowering the long term harms of nature of water (Akaltan, 2016: 68; EPA, 2012: 6; Muslu, private interview).

Jeong et al. discussed the criteria of selecting engine for marine tourism vehicles and their life cycle assessments in framework. Some of their inferences on the issue are new designs of boats body highly interconnected with energy efficiency in overall consumption. Hybrid vehicles are shown as superior to conventional methods by embarking high efficiency numbers. Smaller engines show more suitability in a comparison with larger engines for being handy and consuming less fuel. Rather than putting two medium sized engines on a tug assist boat winding many small engines solves the problem according to them (Jeong et al., 2018).

Figure 17: Highly Efficient Motors Usage on Yachts in İSTMARİN Tarabya Boat Park

Source:Photographed on coast of Tarabya, İstanbul, 09/03/2018.

Liu et al offered dual-mode propellers for renewable energy with novel vortex model for rotors. A 5-m propeller-turbine produces 20 kW at 2.1 m/s and with efficiency of 0.56. 0.5 meter rotor for yachts can produce 1.60 kW on 4 meter distance at second. This formulation is satisfactory for recharging the main engine's battery. The idea to use propeller as both propulsion and turbine devices for renewable energy and energy efficiency at the same time. Rotors are used on the same page to recieve and send energy for turning. Tidal or current turbines are in use for many years however gaining attraction on them seems relatively a new trend for low speed water vehicles such as yachts that anchored in a current or a regular sail boat for which propeller is used as towed turbine. Oceanvolt firm has been producing boats in same manner but hybrid vehicles with hydro generator. Although aspects of these boats being highly efficent after 10 knots of speed with 1 kW around 6-8 knots. (Liu et al., 2018; https://oceanvolt.com/)

Allwright made a research on how we can apply sailing efficiency or wind energy on shipping propulsions. It is a must to evaluate market barriers and its effectiveness for not disrupting comfort level. Improvements on the subjects of sail designs, rotors, kites and new hull designs will eventually lead us to use more wind power propulsions in different shapes and sizes. In order to move in the mentioned technologic developments with high grip will take time by looking at advance projects of wind solution to move the engine solely (Allwright, 2018).

Motors are becoming more efficient and renewable energy is taking up more space nowadays. Eventually these changes have to be reflected on the area of yachting and motor yachts. Change is going to be really fast due to efficiency of these applications are really significant and relevant. In next years zero consumption motor yachts with high luxury will be more common as storage systems for electricity and minimized versions of electricity generating WWS systems find commercial implementations.

2.4.3.3. Energy Efficiency Applications in Marina Market

One of the most important facilities of sustainability in marinas is energy efficiency and next station for it 0 carbon emissions and renewable energies. Liquid, gas and solid waste management has the most improvable aspects in marine tourism industry in context of sustainability. Boat repairing, painting, motor maintenance and fuel supply operations may cause pollution to the environment. Spills or emissions of chemical wastes, paints, oil and various poisonous gases can be impactful to human and water creatures (Heron ve Juju, 2012; Tuğdemir et al., 2016).

In their study Tuğdemir et al., set out sustainability variables in marinas after the literature review, outcome is this list:

- Energy Management
- Waste Management
- Safety of Work
- Noise, Land, Water and Air Pollutions Management
- Oil Pollutions
- Pollutions Raises From Maintenance
- Clarification of Boats
- Raising Public Awareness (Tuğdemir et al., 2016).

*Management of energy in marinas can be done through precise action plan of sustainability. Reducing credits that spared for energy and at the same time emissions will lead them to the aftermath of low operational cost and more environmentally friendly applications (Fedai ve Madran, 2015).

*Waste Management is highly needed because of the reason that most of the pollution that arises from marine tourism is released by boats and marinas wastes. Therefore wastes should be categorized as solid, liquid and gas wastes and analyze should be carried out (Fedai ve Madran, 2015). Even though solid wastes have no big impact to environment they do not look good for marina aesthetically. Collection and extermination should be carried out efficiently. Preventing boat pollutions, designing separation of wastes, re-use of materials and extermination of harmful materials are crucial processes (Görken, 2005).

*Safety of work in marinas can be evaluated under the terms of offered criteria by Occupational Health and Safety Assessment Series organization. Job security and work safety were under this protection of documents which will lead to reduce in accidents in work. Accessible equipment in case of danger could save lives of yachters, marina personal and others along with yachts and other vulnerable equipment. It is highly critical to get them in limited time in order to prevent or limit the damage of mentioned danger. It should be positioned on the most critical place. Efficiency of energy in this perspective is ensured on the saving valuables in short time or less amount of steps that person who wants to save items that have economic value (OHSAS 18001, 2015).

Figure 18: Seperation of Wastes in İSTMARİN Tarabya Boat Park

Source: Photographed on coast of Tarabya, İstanbul, 09/03/2018.

*Noise, Land, Water and Air Pollutions Management is highly needed for water pollution that arises from wastes, oil, fuel, machine lubricant, grey water, detergent, paint etc. in the water (NSW, 2018). Yacht septic tanks when dumped to sea can defile and contaminate in a way such domestic sewages do, if this case could not be under control it would lead to big dangers (Blue Flag Turkey, 2018).

*Oil pollutions is mainly can be understood as petrochemical hydrocarbon elements that floats on the surface or with airborne way diffuse to air or hang to the column of water or sink to deep seas and create danger on water creatures. Another danger is gasoline is flammable and can pose a danger of fire (Görken, 2005).

*Maintenance related pollution (painting of boats, removal of fouling organisms that sticks to bottom of boats, rasping, sand blasting, machine maintenance and repairings and mechanic works) can be grouped into these materials: raw materials containers, organic paint residues, heavy metals, bilge waters with oil (Küçükgül, 1998). Reducing the pollution and minimizing is only possible with separation of maintenance areas from other operational areas and using indoor facilities (Görken, 2005).

Figure 19: Accesible Maintenance and Safety Equipment in İSTMARİN Tarabya Boat Park

Source: Photographed on coast of Tarabya, İstanbul, 09/03/2018.

*Clarification of boats is for fouling organisms that sticks to the boat body and reduces boat speed and increases roughness of the boat surface and overall clearage of the boats. In most cases it is made in the water and chemicals to use on the surface will diffuse water as well. Choosing biodegradable and environmentally friendly appliances and materials will reduce the harmful actions of marina (Görken, 2005).

*Raising public awareness could be ensured by firstly giving trainings to marina workers and regularly scheduling trainings for marina to teach them about effect of pollutant materials to water, preventing pollution, reducing waste methods, properly extermination of wastes or separation, action plans. Secondly stakeholders of marina such as customers, in this case we can name them as yachters and seamen should be informed and programs for them must be implied, bulletins for environmental messages and bulletin boards should be placed in various points in marina and recycling and waste reduction should be encouraged (Görken, 2005).

2.4.3.3.1. Services in Marinas

Yacht harbors use anchors instead of using stars to show class of cluster of facility. And this classification process held by their special characteristics (Official Gazette, 2009). Turkey Marine Tourism Legislations present these labeling issues in 3 to 5 anchors and refers marinas as; yacht harbors, secondary yacht harbors, yacht berthing space and dry docks according to 08.06.1983 dated and 83/6708 numbered acts of related Board of Ministers (Güner, 2004; Paker, 2014). Depending on the location there could be a grouping system such as coastal and inland for example lake and river marinas. Because of the reason that marinas are amphibian places and their evaluation point is considered in coastal features and their wave characteristics and topographical elements get in the conversation. Also managerial scheme is important to decide movement styles like local government and private differences position of marina in terms of land-water conditions could be the main discussion and of course service aims along with it with involvement of maintenance, traditional, destination point and recreational area types of marina (Güner, 2004; Sarı, 2013).

Table 23: Marina Business Marine Operation Activities Processes

Main Process	Processes	Sub Processes
Marine Operations Activities Process	Reservation Activities Process	Season/ Year – Landing/ Launching
	Boat Mooring Activities Process	Daily – Season/ Year
	Boat Logging Activities Process	Daily – Season/ Year
	Landing/ Launching and Land Park Activities Process	Daily – Season/ Year
	Technician Entering Activities Process	
	Billing and Collecting Bills Activities Process	Main Services –Supportive and Facilitator Services – In Day and End of Day Activities
	Shift Control Activities Process	Mooring Team – Front Desk Team – Technical Team

*Source: Koç and Karataş *"Process Analysıs of "Marıne Operatıons Actıvıtıes" In Marınas: A Case Study"* 2017.

Arlı states that services of marina can be categorized by using this logic: there are two dimensions of services which are human being (yacht owners, captains) and vehicle dimensions. Describing from his perspective, marinas are tourism firms that gives accommodation place for private and commercial motor yachts or sail yachts and their possessors and captains (Arlı, 2012). Quality certifications are important documents that marina industry as well. Significantly well-known ones are Blue Flag, Golden Anchor, International Marine Certification Institute (IMCI) (Paker, 2014).

Table 24: Main operations in Marinas

Department / Team	Main duties
Management department	General coordination and ensuring orders - Weekly and monthly reports - Client interactions - Representation and advertising of marina - Participation to events
Front desk department	Reservation and keeping log - Tracking files for marine operations - Issuing and collecting bills of service - Interaction with marine radio channel - Main information
Business department	Client interaction - Charter parties – Tendering - (If there is) ensuring order in shops
Financial department	General accounting - Tax accounting - Issuing reports – Payments - Budgeting
Technical department	Maintenance of land facilities and marina equipment - Supply of electric and clean water to boats - Moving in accordance with fire and health safety plans - Clarification of marina land and facilities - Arranging environment - Cleaning environment (i.e. bilge drainage)
Mooring team	Mooring the boats - Pilotage with mooring boat - Ensuring order and control of port place - Interaction with marine radio channel - Tracking files of marine operations - Diving - Towing
Boatyard team	Technic maintenance - Ensuring order in boatyard place - Issuing documents related with operation - Watering with high pressure water back of boats - In a safe manner landing or launching the boats
Security team	7/24 - Watching security cameras for safety of the field - Control of fire safety plan

Source: Koç, Karataş *"Process Analysıs of "Marıne Operatıons Actıvıtıes" In Marınas: A Case Study"* 2017.

Given services in marinas could be listed as in three main categories which are; core services, supportive services and facilitator. Main services include activities these as well; mooring, landing or launching and land park. Facilitator services are mainly for giving access to customers to use core services with fuels, electric and water and maintenances services. Lastly supportive services are for altering given services from another marina in terms of improvisation or differentiations of marina from other marinas with café- restaurants and social facilities (Koç and Karataş, 2017).

As well as saving or making more efficient environment of businesses, creating an efficient core job with efficient motor systems can contribute in this era with the impact of nearly half of the consumption. Of course it would not be an equivalent of producer industries' efficiency alteration though service industries such as marina which uses quite effort in terms of giving services could re-shape their consumption and future planning according to energy efficiencies in motor systems. Adjusting working plans and maintenances of working equipment like water pumps, compressors, machine tools, handling vehicles and restoring devices in marinas would develop flawlessly efficient system that helps the marina in terms of equity and reliability. CO_2 emissions which are considered as close topic to energy efficiency suffered the most due to lack of action in industries. Saidur et al. stated in their article if a company adopts well-established energy-conserving systems it would result in a drop eleven to eighteen per cent on energy consumption which cannot be compensated with other tools rather than energy efficiency. Also in same article it is punctuated that if little or no cost energy efficiency applications could be implemented GHG emissions will lead its way to ten to thirty per cent loss (Saidur et al., 2011).

2.4.3.3.2. International Agreements, Regulations, Certifications Programs and Other Documents on Energy Efficiency in Marinas

Marinas are under obligation of abiding many laws by being responsible to many stakeholders of marine tourism. In next pages their responsibilities are discussed on the ground of sustainability and energy efficiency with the help of other academic works on the topic and author's effort (Dikeç and Töz, 2017).

Table 25: National and International Applications and Regulations of Energy Efficiency in Marinas

International Agreements	Paris Agreement on Climate Change 2016
	Kyoto Protocol 2005
IMO	MARPOL 73/ 78
	MARPOL ANNEX VI
	EEOI
	EEDI
	SEEMP
	MLC 2006
ISO	ISO 9000 Quality Management System
	ISO 9001 Quality Management System
	ISO 14001 Enviroment Management System
	ISO 14005 Enviroment Management System
	ISO 50001 Energy Management
National Regulations	Law no. 2878 Environment Law
	Law no.5216 Metropolitan Municipality Law
	Law no.5326 renewable Energy Production for Electricity Law
	Law no. 5627 on Energy Efficiency Law
	National Climate Change Strategy Papers 2010-2020
	Energy Efficiency Strategy Paper 2012
	Legislation no.25032 Advice on Noise Arising from Home Appliances
	Legislation no.27075 Energy Performance on Buildings
	Legislation no.27898 Marine Tourism
Certification Applications	Blue Flag
	Blue Star
	Blue Card
	Gold anchor
	Green Star

Source:Combination of Dikeç and Töz; Tuğdemir et al.,2016; IMO, ISO, Information System of Regulations, Gold Anchor, Blue Star, Blue Flag turkey, Ministry of Environment and Urbanization,Ministry of Energy, Ministry of tourism and Sports, Journal of Legislation.

ISO (International Organization for Standardization) offers variety of sustainability applications in terms of certification. ISO 9000, ISO 9001, ISO 14001, ISO 14005 and ISO 50001 are the most important ones (Heron, Juju, 2012).

ISO 9000 Quality Management System is a quality standard system that aims to respond to customers in possible highest success rate in order to do that designs documentation, control and sustainability process within the firm (International Organization for Standardization, 2015). ISO 9001 Quality Management Systems Design/ Improvements, Production, Facility and Service Guarantee Model states the minimum requirements for effective quality management that can be applied without taking into consideration scale differences (International Organization for Standardization, 2015). ISO 14001 Environment Management System is designed for improving environment management schemas of the firms (Yüksel, 2003). ISO 14005 Environment Management System gives the guidance to firms that fall under the segmentation of small and medium sized firms even though it is applicable to all scales.

ISO 50001 Energy Management Systems is designed to be applicable to range of firms without mentioning being private or public, size, operational activity and geographical location. One freedom is given to the firms that baseline determination is up to user choice which means being efficient is encouraged at its peak. Unless it is implemented by regulation certification processes are just for their own internal and external stakeholder benefits. Standards of ISO 50001 will be updated in every 5 years to keep market requirements and standards relevancy on balance. Next update is going to be in 2019.

The ISO 50001 Energy Management Systems portfolio has been developing since 2011 when it was first born. List that is below are selected for the most suitable energy efficiency standards for marine tourism actors.

- ISO 50002 “Energy audits – Requirements with guidance for use”
- ISO 50004 “Energy management systems - Guidance for the implementation, maintenance and improvement of an energy management system”
- ISO 50006 “Energy management systems - Measuring energy performance using energy baselines (EnB) and energy performance indicators (EnPI)”
- ISO 50047 “Energy savings Determination of energy savings in organizations”
- ISO 17741 “General technical rules for measurement calculation and verification of energy savings of projects”

- ISO/IEC 13273-1 “Energy efficiency and renewable energy sources Common international terminology – Part 1 : Energy efficiency”
- ISO/IEC 13273-2 “Energy efficiency and renewable energy sources – Common international terminology – Part 2 : Renewable energy sources”

ISO took under development series of standards regarding this issue, the mots related to our topic is listesd as below;

- ISO 50007 “Activities relating to energy services – Guidelines for the assessment and improvement of the service to users”
- ISO 50008 “Commercial building energy data management for energy performance– Guidance for a systemic data exchange approach”
- ISO 50021, General guidelines for selecting energy savings evaluators”
- ISO 50044 “Energy savings evaluation – Economics and financial evaluation of energy saving projects”
- ISO 50046 ”General quantification methods for ex ante or expected energy savings” (International Organization for Standardization, 2016).

Law no. 2872 Environment Law states that marinas are under obligation of doing operations of collecting, storing, transporting and elimination and building structures for pollutions such as petroleum, oily solid wastes and bilge waters, dirty ballasts, sludges and slops, liquid wastes, domestic wastes that arises for their facilities and ships and other marine vehicles (Battal, 2011).

Gold Anchor is a global certification of meeting with requirements of marina standards and improving marina customers satisfactory levels in a marina. On the base of the system the star system of hotels and substructures of marina and quality evaluation process and standardization lay (The Yacht Harbour Association, 2018).

Headlines of evaluation can be named as; marina’s structural design and state, boat repairing and maintenance services, fuel supply services, land services, provision services, recreational services, customer satisfaction surveys, reservation procedures, customer feedbacks, marketing and advertisements.

There are 11 marina with 5 stars qualification these are; Ataköy Marina, Teos Marina, D-Marin Didim Marina, Palmarina Bodrum, D-Marin Turgutreis Marina, Milta Bodrum Marina, Marmaris Yacht Marina, D-Marin Gocek Marina, Ecesaray

Marina and Resort, Setur Antalya Marina and Kemer Turkiz Marina (The Yacht Harbour Association, 2018).

Blue Flag is an honor prize that has been given to the beaches, marinas and yachts that meets with determined criteria by Foundation for Environmental Education which is an international organization that operates in 44 countries. In Turkey Blue Flag Campaign is run by Ministry of Health and Tourism with start point of 1993 with establishment of Turkey Environmental Education Foundation (Blue Flag Turkey, 2018). Some of the requirements for marinas are environmental education and informing, environmental management, security and services and water quality (Blue Flag Turkey, 2018).

Blue Star is the system that indicates performance on quality with stars on all over the world. Regardless of their scale and geographical coverage (inland or shore) can be applicable to all marinas. There are up to 5 stars graduation scale which 5 is the highest rate. Criteria are like these; external resources, safety, health and hygiene, service quality, food and beverage services and social resources, management, environment protection, waste elimination and storing resources. There are 2 marinas which have this certificate in Turkey which are Teos Marina, Seferihisar and Palmarina, Bodrum (Blue Star Marina Program, 2018).

Blue Card System is developed for tracking wastes of marine vehicles digitally. On the base of the system allowing to legal entities to track down the waste type and quantity along with how much waste accumulated on the marine vehicle on waste collector ships, fishing ports, marinas and shore facilities with similar aspects can be visualized online. Thus diminishing of dumping bilge, contaminated water and wastes to the water from yachts and other boats was the purpose. Operation, enforcing law and auditing processes run by Ministry of Environment and Urbanization and points of purchase of the card are marinas, ports and fishing ports (Ministry of Environment and Urbanization, 2013).

Green Star Certificate; Protecting values like environmental, cultural, historical and communitic and improvements in marine tourism are possible elements that come together when only sustainable marketing approaches and demand and supply balance are ensured (Yıldız and Kılıç, 2016). Nowadays firms are concerned not only being profitable but also reaching environmental targets of the company and being active in social developments (Ceyhan and Ada, 2015). In the context of sustainable tourism, firms in marine tourism industry has been adopting approaches such; protecting environment, raising awareness on environment, green economy and projects like green star environmental awareness programme which is the phase for jumping the stage of green tourism for the sake of ensuring incentives to encourage the firms to be more contributable to the environment (Tutar, 2015).

Green star certification program aims to ensure that hotels to be more friendly towards environment starting from the designing stage, planning till ready to accept customers. In order to get this certificate hotels have to be more sensitive in terms of energy, water, environmentally harmful (poisonous gases etc.) material consumption, limiting the contamination, being more energy efficient, being more willing to use renewable energy use, designing accommodation operations more sustainable (Giritlioğlu ve Güzel, 2015). Ministry of tourism and sport issues this certificate under two circumstances, first ensuring meeting the conditions and second having tourism establishment certificate (Giritlioğlu ve Güzel, 2015). Conditions are;

- ✓ Having an action plan and environmental policy concerning environmental issues
- ✓ Having a dedicated personal to carry out that action plan or getting expert or expertise company help with an authorized personal that works in the firm
- ✓ Ensuring trainings for raising awareness by the firm for implying action plan
- ✓ Having environmentally friendly waste water management plan
- ✓ Keeping the logs of periodic maintenance of equipment, vehicles and hardware and software
- ✓ Keeping the records and tracking the data of water and electric consumption, energy losses that arises from HVAC operations and overall energy consumption
- ✓ Monitoring chemicals that firm use
- ✓ Monitoring wastes that firm produces and collection of data (Arısoy, 2014)

2.4.3.3.3. Lighting Applications in Marinas

Lighting applications that mentioned above are also applicable for marinas in the same manner where it needs. For the sake of clarification, vacancy sensors, occupancy sensors, LED technologies and maintenance issues are by the nature of the subject is same and precautions when implying such applications should be considered as similar. IP values for protection from water, high need of brightness and quality lighting along with appeal factor carry the same meaning in this topic as well. Dual technologies of sensors could be pushed out of the borders for less need of precise predictions of activity due to solid state of the ground and high amount of people are using bigger place in a comparison with boats or cruises. However there are some cases that emphasize the savings.

Exterior lighting could be crucial due to its need for high energy and high numbers of hours working. LED solutions along with software to reduce waste energy that arises when above stated daylight factors and similar factors take place are musts for evaluating refurbishment exterior lighting design. Recent Quantum leaps made possible improvement for LED technology to extend in marine environment with powerful luminaires. However LED lights have their shortcomings precise current regulations and voltage protections for reliability on a long term even though they have solid state nature and lacking of filaments to break. This is where VSD take the spotlights for such installation (http://www.hellamarine.com/).

A case study has been done to Abeking & Rasmussen Shipyard for mostly motor yachts in Germany by Thorn Lighting Company for lighting solutions which can be applicable for similar case of many marinas. All the effort resulted in 82 per cent of energy savings and 100 tons of CO_2 emissions per year. Case has been covered on the area of 6500 square meters with ship lifts and hoists, offices, halls, production areas and exterior lights. Low pressure sodium lamps, incandescent and halogen lamps have been on the use and 125W Mercury lamps for outside. System efficacy, maintenance scheduling, daylight factors and timed off scenarios are evaluated. In 2013 office lighting equipment changed with high photometric performance office mountable lighting solutions. In 2014 industrial areas was where changing started with powerful LED lighting materials with 93 lumen for each watt and staff could increase or decrease level of lighting in the working environment (http://www.thornlighting.com/).

Figure 20: Isaro LED for Exterior Lighting Solutions

Source: http://www.thornlighting.com/

Solar light collectors are available energy efficiency method in renewables. Optical fiber and a sunny place to is enough for this system however ships, cruises and yachts are not convenient places due to mobility, positioning and shade effects. Collector collects light in same manner after it reflects with fiber optic cable that passes sunlight with 100 or more mirrors to illuminate every dark place on anywhere that straw is placed. The main job is concentrating sunlight with fiber optics. One cable can reflect of the light power of 60W incandascent two cables can easily lit up the whole room (http://www.parans.com/index-en.cfm).

Lighting tunnels Solatube especially works in same manner to pass the sunlight with mirror effects to inside with the help of small tunnels. Possible usage way to built such application needs to be installed on nearsurface places that sunlight could not collected from windows or privacy is an issue such as cruise ships or guest houses of marinas (www.solatube.com).

Same case scenario at yachting efficiency for lighting can happen when using LED lighting methods on marina without using protections. Powerful lights are highly needed but using those lights without protection or from some cushion like material can cause reduction of effectiveness processes for mooring processes. This negative factor should be evaluated carefully (http://www.hellamarine.com/).

2.4.3.3.4. HVAC Applications in Marinas

Excluding water filtration and water treatment systems in HVAC operations, HVAC based applications carry the same identity card with HVAC applications in commercial buildings with low impact element of industrial plants applications.

Environmentally friendly paint removers open the saving way of reducing HVAC equipment that is needed for dusts and powders on the dry dock area. Nowadays above mentioned paint removers have become more popular due to their nature of being biodegradable. However the dust that arises from operation or paint that is removed by removers can be harmful to environment. Also in low temperature environments and two components epoxy paints creates a hardship for these types of paint removers (Hunt et al., 2007: 7).

Yacht maintenance and repairing operations should be only done on the dedicated places. Akaltan states that if 25 per cent of the surface of vehicle will go under repairing and maintenance activity is going to take place water or parking areas of marina are not suitable. Dedicated fields for emery, varnish, painting and coating applications along with applying poisonous gases will be so much convenient for marina personnel and other yacht users. Also because of protection from water harmful effects, other yachts, and health of workers ensured it can be seen more efficient (Matuk and Gordon, 2004: 39).

Vacuumed emery machines is another saving method for yacht users thanks to facility of locking down the dust and powder that arises from operations and lowering time and expenses for cleaning operations. Some marinas can lend the vacuumed emery machines to customers for 15 US dollars per hour. Along with vacuumed emery machines electrical appliances for cleaning operations should be more prevalent on related jobs (Akaltan, 2016: 69; Hunt et al., 2007: 8: Matuk and Gordon, 2004: 16).

Apart from these generic applications of energy efficiency on HVAC, some marinas need different treatment in order to protect boats from getting humidified. There are numerous ways of getting rid of such condition such as using dehumidifiers in selected areas or sealing down doors or constantly keeping ventilated the storage buildings. Even using roofs for ventilation or drying out the humidification effect can be seemed as solution.

Other HVAC applications that are used for cruise vessel, water sport facilities, water sports, cruise terminals and inside of yachts can be carried into this subject with an extension of building efficiency applications such as coating exercises or VRF cascade condensing boilers with heat pump extensions.

2.4.3.3.5. Motor Systems Applications in Marinas

In almost any device or any action of commercial benefit needs or depends on some structure of motors to some extent. Motor systems are everywhere in modern society though many aspects of them are using different sources of energy such electricity or fossil fuels. Electricity consumption for marinas should be evaluated independently for sake of better understanding and estimation due to efficiency of motor systems mostly reflected on motors with high torque or speed or power in general.

In marinas biggest consumer of fuel could be considered as travel lifts and boat hoists that uses hydraulic engines which fueled by diesel, gasoline and electricity. Most of these high powered motors works with the technology of hydraulic effectiveness which does not shown itself in economic effectiveness. Even though there are hybrid and fully electrical models they are not commercially active or accepted as mean of crucial element for this job.

AC or DC water pumps with VSD applications could play crucial role when washing bottoms of boats or pumping water for any kind of need.

Units of HVAC that works with motor systems is also another topic for marina energy efficiency.

As stated above all motor systems applications can be mentioned here as improvements in selected genre of energy efficiency. Specific applications for marinas are limited due to it is not focused on for fuel consumption. However all other methods should held as examples of energy efficiency in marinas because of their highly elastic nature for implementing any area.

2.4.3.3.6. Other Energy Efficiency Applications in Marinas

Sustainability in enterprises can be categorized as sustainable structure, design and building, sustainable furniture, equipment and fabric, water, energy, wastes, corporate social responsibility and sustainable provisions (food and drinks) (Sünnetçioğlu and Yılmaz, 2015). In management of sustainability marinas can be very prosperous by mentioning the facts of high water quality, clean and safe marinas, healthy fishes and shelled creatures, low maintenance expenses and high yields of income in marinas, rise in estimations of estates on shore side and rise in economic development of the area, sustainable enterprise and investment to sustainable future (EPA, 2003).

Enterprises in a marina can be described as interior marina businesses which mainly consist of restaurants, cafes, shopping malls, retailers etc. (Tuğdemir et al., 2016). Guests of marinas term stands for people that is non-owner of a yacht and without intention of commercial trade visiting marina for recreational activities. With the intention of keeping the attraction of tourism area or the popularity of the same area can be seen as related with improvements on sustainability in marine tourism. Mentioned improvements appears as a model that balances shares of market on international level and added-value in chained sectors with tourism and protection of environment. With the effort of maximum satisfying the next generations and current generations in most balanced and efficient method is the main goal rather than preserving everything for next generation (Gösling, 1999: 310, Tuğdemir et al., 2016).

Application topics are listed alphabetically below. These applications are mentioned here due to they did not find themselves in selected classification of efficiency.

-Cleaning Material Usage Applications

United States environmental Protection Agency stated the alternatives for harmful poisonous cleaning materials for every cleaning job with proportions. For all surface cleaners user can add 250 mililiters of vinegar to 10 liters of water and use.

Baking sodas are suitable answer for room perfumes when left open in a place. Replacement of ammonia based cleaners are mixture of vinegar, water and salt. Cleaning brass work can be done with paste of evenly mixtured vinegar, water and salt. Coppers can be cleaned with paste of mixture lemon water, salt and flour. Bleaches subsituted with baking soda and water. Chrome surfaces can be polished with baby oil and cleaned with cider vinegar. For all disinfectants one can use mixture of 125 mililiters of borax with 3,5 liters of water. Drain openers can be replaced with boiled water with quarter glass of baking soda and quarter glass of vinegar. Fiberglass stain removers replicable with baking soda paste. Floor cleaners are same with surface cleaners. On stainless steel areas for stains vinegar and for polishing baking soda paste are suitable. For toilets especially toilet bowls baking soda can be applied to brush. Wooden areas if it is lcoked down applying olive or almond oil would be satsfied the need. In order to clean glasses in almost any area two spoonful of vinegar with 1 liter of water is enough (United States Environmental Protection Agency, 2012: 5).

-Clean Water Applications

In almost all water tourism facilities clean water is an issue due to touristic activities brings people to the area and limited sources become more vulnerable furthermore it could endanger the environment of the area. Especially marinas with high seasonal difference of temperatures are under these pressures. Some of the pressures comes along with endangerment of clean water abuse in environment are erosion and desertation. Marinas are using green zones for recreation and the treatment of the zone becomes more non-affordable when countries like Turkey apply taxation for every liter of water for waste water price. Limiting the consumption can be summarized with these methods:

- Maintaining service boxes and checking periodically for spills of water.
- All hoses should be used with water gun.
- Green areas and other plants should be watered when there is a need. Timing of watering (early in the morning or at sunset) could reduce vaporization and save up to 50 per cent of waste.

- Green areas should be watered not frequently but rare but dense in order to water to reach under surface sources. Plants will grow more powerful roots to reach them and it will cut the expenses for a new plant.
- Fertilizers and other treatment methods should be limited and be used as few as possible.
- Gardens should consist of plants with similar dependency of water to be more efficient.
- Not to harm any bees, disinfection should be done after sunset.
- One should pick suitable plants for gardening and should care about geographical convenience of the plants in order to elimination of waste. Epidemic plants and geographical suitability can save tons of water and plants life.
- Big grass areas can be decorated with wild flowers, bushes and trees. This will enable the limiting watering sessions.
- Restoring rain waters can add up to gardening savings.
- Logging of water consumption can be crucial for detecting spills.
- Removing shower heads that are non efficient and replacing them with efficient ones will allow users to save more (Akaltan, 2016: 79-80, Rainforest Alliance; Conversation International; Education Ecotourism Association (ASEC), 2016: 51).

Ensavetec systems for heat recovery collects heat of used water in the shower. This efficiency upgrade consist of three parts a pump, a heat exchanger and a filter unit therefore easy to install. Work is done by collecting used water in the shower and send to heat exchanger for heating cold water and sending it back to the system which makes efficiency go higher with 40 per cent (http://ensavetec.com/en/).

Wasenco is a heat recovery device that holding grey waters at tanks and a heat exchanger with coils for heating and cooling along with heat transfer fluids are taking actions. Hot potable water is transferred in the same manner with ensavetec however the system needs big tank but do not use extra pımps instead uses hydroforic pumps. This makes some pressure lost but overall efficiency is around 30 to 70 per cent according to producers (http://wasenco.com/en/).

-Designing Stage Applications

At the design stage if all offices are built according to positioning of the sun, materials are picked for their aspects of reflecting or collecting the sunlight and insulations are precisely done a building can save up to 50 per cent. If swimming pool is going to be build it must be right in front of the offices in order to take the cooling winds in summer. Another designing advantage is painting walls in brighter palettes to get reflection advantage for lighting and heating which enables user firm to utilize sunlight as much as possible also cooling will need more energy more than lighting. LED lighting systems should be on each corner of the firm to gain advantage of saving up to 70 per cent. Re-chargeable batteries, up to date technologies such as using portable hard discs and universal serial buses (USBs) instead of compact discs, efficient home appliances, laptops instead of desktops, efficient showerheads, changing air conditioners filters at least once in a two year, systemming monitors or all computer system to shut down energy consumption when they are not on the use and finally if it is possible investing on WWS and wave energy sources are solutions that starts at the designing stage (Akaltan, 2016: 73; Lapinskienė et al., 2011: 57; Rainforest Alliance; Conversation International; Education Ecotourism Association (ASEC), 2016: 45-47).

Even though there are luxury and comfort level elements in marine tourism industry while taking into consideration efficiency on personal yachts, commercial yachts and commercial sailing boats should be held responsible for pollution and efficiency. To some extent, captains and seamens or whoever at the level of decision making on the marine tourism vehicles can retrofit and drydock according to the needs of profitability of the operations (Haslet Sever, semi structured interview,2018).

Floating docks are more prosperous however finds lower chance in the eye of marina designers. Some of the advantages are;

- Not affected by high or low wave situations and not finding themselves in submerged issue or full dry issue.
- Less harmful to environment by not creating sediment on the bottom
- Expandability is more comfortable and requires less investment cost

- Power pedestals are designed more carefuly due to this reason there is no electrical system flaw and black out
- Avaoiding all tax advantages if there is any
- Time advantage for instance some of them can be established and ready to go within 10 minutes
- Icing problems can be avoide by easy storing
- In stormy weathers switching the pipes can save lots of damage to the pipes on them.

Disadvantages are;

- Old docks are not easy to demolish and creates lots of procedures and inconveniency for disposal.
- Narrow floating docks have not the required stability and old stable docks are throwing low shadow comparing to them however wider floating docks do not need to concern about this problem (www.marinaappraisal.com).

-Fuel Station Applications

Aspects of fuel station and dispenser may vary however there are general precautions to not to waste any resource. For instance marina personnel can be educated on supplying procedures such as being careful and patient when pumping fuel or listening the vent pumps in order to hear last release of vent pipe or not filling gas tank after 95 per cent is filled due to dilatation of fuel on hot weathers.

Automatic shutoffs and seismic shutoff valves are in commercial use for fuel filling at marina park places. The explanation for the system is removal of pump handle that connected to dispenser starts the operation of dispenser or it could be started by switch of spring loaded activation or manual switching of lever, inserting nozzle into the gas tank is the second step, filling the gas tank and stopping is easy customer only needs to cutoff the stream of fuel by not pressing or switching the lever though gas tank can be unexpectedly filled or something pull high the pressure to the limit that gas stream can not enter anymore which can cause overflow. In most of the cases marinas are using automatic shutoff valves that stop automatically but in some cases filling operations are not run by this method which can cause inefficiency. Seismic shutoff valves are prevention of earthquake danger however automatic shutoff valves were the next stop for the technology (Bellavista, 2008).

Figure 21: Contoured Dispensers at Parking Area in İSTMARİN Tarabya Boat Park

Source: Photographed on coast of Tarabya, İstanbul, 09/03/2018.

Distant of dispenser nozzle and the fuel in the tank getting smaller when filling operation is on. Venturi pipe run alongside with gas nozzle. With the submersion of end of Venturi pipe it chokes with air pressure and hold downs the stream of gas. This shutdown can happen before wards of filling operation completion which makes customer frustrated and cause them squeezing handle again and inserting the risk of overflow however pausing is the solution which make allowance to the gas to continue to pouring.

Until few decades ago rotating wheels like dialing and entering number of gallons or prices was how one get the fuel from gas stations, in 1970s LCD screen panels for seven-segment to display digital look of alphabetic letters and numbers came in the business. This simple interface usage left its spot for computerized operations. These operation became complex with software to the point of inclusion of video playing, running advertisement, displaying amount of gas has been sold since the operation started, offer information and can interact with customer alongside with basic core job of displaying the amount and making a decision through screen.

Blend Valves are another type of valve that enables customer to choose from a variety of fuel types according to their octane ratings or another variable. In most of the gas stations dispenser can offer up to five types of fuel but for space management it is not possible to have five tanks underneath the surface. In many cases at those dispensers there are two tanks of the lowest and highest octane of fuel dispenser can produce with blending the octane of the lowest and highest octane material of fuels and giving the exact need of customer. But blending job is happening in the valves. This valve has inputs that can enable the gas entrance of two grades of gasoline. Movable barrier that called shoe is connected to nozzle of both and can be moved according to customer choice with the help of single motor-driven ratchet. The precise operation of blend valves proportioning allows mixing two grades of octanes for instance 90 per cent of highest octane and 10 per cent of the lowest octane with the help of ratchet by shifting the ratchet back and forth.

In the safety measures, there could be unexpected accidents that can be arising from human errors. Hot ashes of cigarettes or leaving engine on which can be creating sparks due to motor malfunctions that could light up a near gas leakage and static electricity could be dangerous as well as electric and hybrid cars engine's dynamic electricity. If one tries to pull away the vehicle from dispenser when nozzle is in the tank thanks to breakable design of nozzle which mostly designed to break into two pieces absent-minded action of customer could not pose a danger. Points of breakage are intended to be in precautious in such accident to not to release any leaks of oil or gas.

Bypassing or decreasing danger and loss with auto shutoffs on fuel lines and at the hose nozzles, designing drains that oil spills can accumulate, hydrocarbon filtering, testing out of petroleum tanks and pipelines, using fiber when fixing metal tanks, using polyethylene pipelines, providing watertight connecting pits, having spill containment equipment storage that is accessible and marked, avoiding overflows of operations, providing small petroleum absorbent pads and gloves and having hydrocarbon absorbent barriers, inspecting, control and maintenance of boats with fuel leaks and excess engine emissions, prohibiting bilge waste and usage of detergents and emulsifiers on fuel spills and for worst of the worst for an oil spill case creating an emergency plan and performing drills and training are some of the preventions and precautions that set out by ICOMIA (The International Council of Marine Industry Associations) (Bellavista, 2008; ICOMIA, 2012).

Storing and disposing areas for liquid materials should be located close to the maintenance areas that should be undercover protected from runoffs, fire hazard and be away from flood areas with berns and / or secondary containment. Providing clearly labeled separated containers for waste oils, fuels and other liquid wastes, ensuring periodic collections and transportation with authorized entity and lastly using product's health and safety instructions are mentioned under Best management practices for marinas in this approach (Bellavista 2008; ICOMIA, 2012).

-Rain Water Management Applications

According to United States Environmental Protection Agency or shortly EPA if rain water that fall to marina field is not filtered can cause contamination and create public health endangerment. There are some applications to use efficiently this natural resource such as; covering the field with green areas till the point of concrete should not there as long as it is a must this application is also will create beautiful image to marina users. Some of the flooring techniques with spacing between the blocks of stone allow the rain waters to meet with land and prevent harmful effects. Some of the filtering equipment also can improvise the energy efficiency of operations. Crenels can be placed to main points of collection of water in the operation area and these crenels must be cleaned at least two times in a year (Akaltan, 2016: 66; EPA, 2012: 7).

In some cases with the help of crenels rain water collection can evolve into rain water gardens with endemic plants and trees which creates a non-effort recreational area for a marina (The Manasquan Watershed Management Group, 2001: 20).

-Recycling and Waste Management Applications

Rather throwing away sometimes yacht owners can share what they have for their own boats such as paints, varnishes and other chemicals with other yachters. Marina can post a bulletin on the bulletin board for these trades. Yacht tourism industry can be educated on these issues and can get seminars on the issue. Storage batteries and cell batteries that headed for the last roundup should be collected some waste collection firms can make payments for them which will create an opportunity for marina (Akaltan, 2016: 72).

-Waste Water Applications

Orbital systems are shower versions with closed loop that claims using around 5 liters per shower of 10 minutes with dependancy of the dirtiness of the person who will take the shower. Depending on the installation 1.8 kW to 7.5 kW of electricity energy for a load can be mentioned. Saving around 90 per cent of water thanks to newly developed system will enable marinas to get the satisfaction of water savings (https://orbital-systems.com/).

Upfall showers are almost identical to orbital system but with two distinction points first water heating do not take place in upfall showers. Warm water is outsourced and as it gets colder new warm water should be supplied. Latter filtration of water is done with micro filter and disinfection process is exericsed with UV-lamps. Similar case and maintenance factors are carried in same context (http://www.upfallshower.com/).

Grey water re-use systems are available with all aspects in marinas. Since the environmental concerns has been praising by many stakeholders of marine tourism industry marinas are focusing on to water treatment and classification issues for the sake of efficiency and clear environment. IC Çeşme Marina made a classification on water that has been used in many processes of marina. Boats can produce three type of waste water bilge water, contaminated water and grey water. Bilge waters are can diffused into oils and fuels therefore putting a ped on the bottom of bilge could prevent release of poisonus gases and oil to the seas, maintanence of fuel pumps and fuel hoses can be a efficient solution as well, and lastly in case of emergency a filter can save a lot to not to contminate water. Contaminated water can not be dumped to the sea according to MARPOL ANNEX VI and 2878 numbered Environment Regulations of Turkey.

Mentioning the fact that with the help of using this blast of water again and again with collecting where it is possible is one of the biggest savings for a marina and energy efficiency applications for water management. Implying this application to marinas is already easy due to existing restrictions for collection of high pressure water after this washing (Akaltan; private interview).

Refining eqipment, maintaining regularly and using biodegredable chemicals are not harmful to environment in this segment. Oysters can be used as filtering equipment in a marina, an oyster with 6 cm height can filter 150 liters seawater by itself. If marina would have a chance of arranging an area for oyster cultivation it would create a diving opportunity and small pearl trade for the firm however these oyster are not going to be edible due to heavy metals and bacteria that marina produces. Building toilets close to pontoons and in adaquate numbers will make yachters daily operations easier. Marinas should provide backup absorption nozzles in order to not seeing a cut on the stream of services. Last but not least grey waters are considered harmful due to the reason of even biodegredable soaps and detergent can be harmful to seas (Akaltan, 2016; IC Çeşme Marina, 2018; Matuk and Gordon, 2004: 43; The Manasquan Watershed Management Group, 2001: 16).

CHAPTER THREE;
ENERGY EFFICIENCY APPLICATIONS OF IC ÇEŞME MARINA

In this research Marine tourism components considered as; Water Sport Tourism, Cruise Tourism and Yacht Tourism. Tourism and recreation activities have become the sectors which affected by factors of economic and external social environment. Especially coastal and marine tourism are the most improved branches since 20th century's second half. 2017 was selected as the International Year of Sustainable Tourism for Development by the United Nations. Sustainable tourism took the leading role to improve applications in tourism. In order to fight with global climate change and rising levels of emissions from tourism sector one of the twin pillars of sustainability; "energy efficiency" is a must for marine tourism applications. In the most brief explanation of energy efficiency it can be described as; a mean of managing and limiting energy consumption and its rise. In this chapter of this research evaluation of energy efficiency gained solid state with numbers (Patterson, 1996: 1-3).

3.1. Subject of the Research

Energy efficiency has become one of the main objectives of many industries for the sake of environment and profitability. The last decade environmental issues and economic effectiveness were one of the main concerning discussions among marine tourism industries. Mostly rise in fuel oil prices, legislation which focused on regulations for better environment, well established operations, managerial effectiveness, economic behaviors of the firms, exergy differential points, applied material or used goods or value-added services could be stated as evaluation points for energy efficiency (Theotokatos et al., 2017).

There are many applications of energy efficiency if one wants it to broaden the topic ranging from operational specific applications using electrical forklifts in handling of boats or keeping gray waters from bottom of the boat washing and using again to using efficient lighting appliances in managerial buildings of the firms. In this research we chose yacht industry of marine tourism branch and specifically a marina to make estimations of energy efficiency. For the qualitative part of the research literature review on general energy efficiency applications and expert opinions used to reach variables of energy efficiency in marine tourism. In addition to that core subject of the research is to set how much a marina can be energy efficient via all the methods that technology offers.

3.2. Aim of the Research

The sole purpose of the research is to consider approaches of marine tourism sector to energy efficiency phenomena and to get more up to date insights on effectiveness in operations and minimizing expenses in long term on marine equipment. In this research we aimed to apply wide energy effectiveness topic to marine tourism branches, especially to a marina. In order to do this, broad literature review on applications has been conducted along with getting expert opinions in the sector. 4th National Marine Tourism Seminar Symposium which was organized by Dokuz Eylül University Maritime Faculty, made it possible to reach the experts who have highest careers and experiences in the sector with broad knowledge from all corners of Turkey. We held the issue on mostly economic efficiency of applications. One of the objections was broadening our horizon by face to face semi structured interviews with experts. Face to face semi structured interviews gave the service of catching all expressions of experts on the topic and to get as many as possible information when conversation is going on. Their experiences, approaches, thoughts, intentions, comments, mental perceptions and reactions were targeted and in this direction shaping of research constructed.

Aim of the researcher was a contribution to energy efficient applications knowledge to the marine tourism environment and especially yachting industry and indicating the importance of how much difference can right practices and equipment can do solely. Also marine tourism branches includes variety of applications covering lighting systems applications, HVAC systems applications, motors system applications, energy generation applications, energy storage applications, renewable energy resource usage practices, environmental precautions and alternatives, irrigation and water conserving practices. These numbers of applications can cumulatively shape the face of a firm via representing them as green and sustainable company.

In order to accomplish core targeted objectives;

Via applying qualitative research methods;

- Stating Variables of Energy Efficiency in Marine Tourism via Literature Review on Energy Efficiency Applications on Appliances, Buildings, HVAC, Lighting and Motor Systems and Specific Applications to Each Branch of Marine Tourism
- Evaluating These Energy Efficiency Applications with Experts and Getting their Opinions on Listed Applications That Will Be Implied to Energy Efficiency Test

Via applying quantitative research methods;

- Listing Typical Consumptions of Applications, Machineries and Devices for a Marina
- Applying Energy Efficiency Comparison to IC Çeşme Marina with Semi Structured Interviews to indicate energy efficiency developments.

With these steps author tried to open up a discussion ground of energy efficiency in order to evaluate the firm on a clear facts of consumption in calorific values representations.

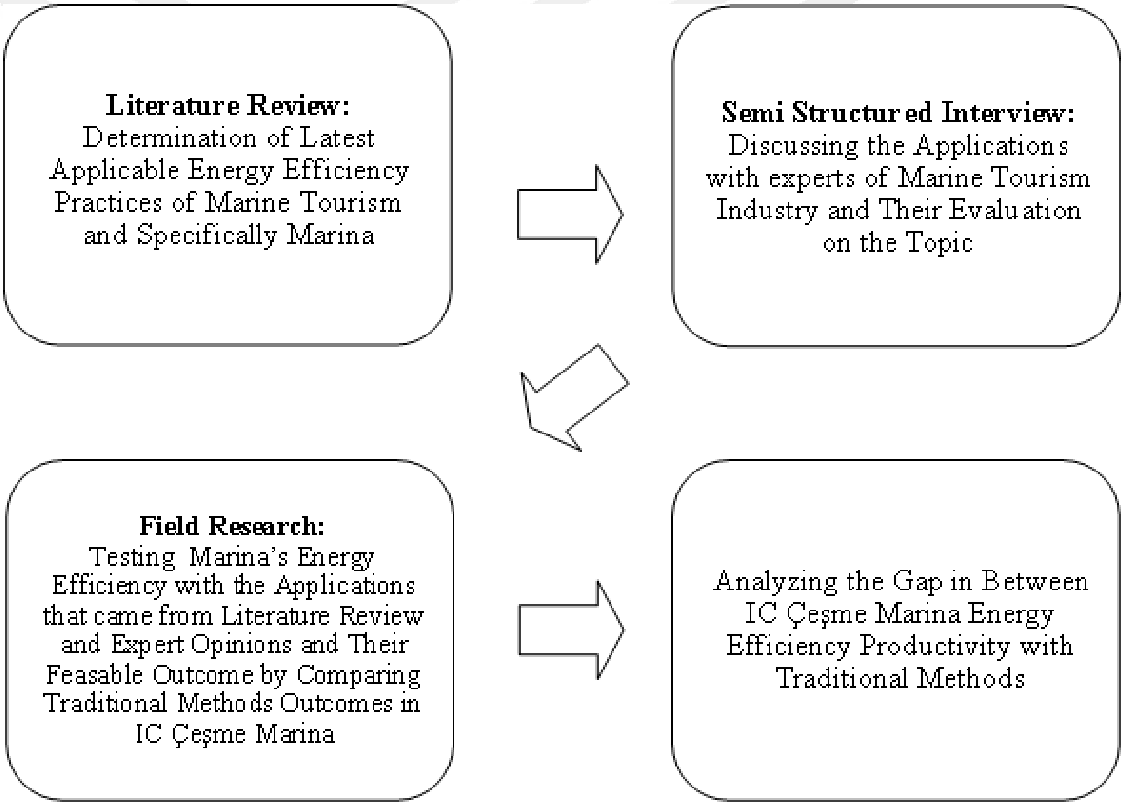
3.3. Importance of the Research

Even though there were sustainability researches in the field, lacking of energy efficiency headlined thesis were created a gap in between one of the most important marine tourism segment and energy. There were many researches concerning energy efficiency in buildings (for instance hospitals, municipal buildings, airports, schools etc.) , various industrial plants (for example mass production factories, food grain factories, steel factories, forest products production factories) , transportation (for instance in between cities, smart grids, vehicles etc.), appliances (for example phase change materials, house appliances, air conditioning appliances), etc. however in marine tourism branch lack of researches have been eye-catching and did not attracted attention of researchers much since their operational consumption is comparatively low considering industrial practices

3.4. Methodology of the Research

As stated aims and subject of the research modeling of the research is created in the figure below.

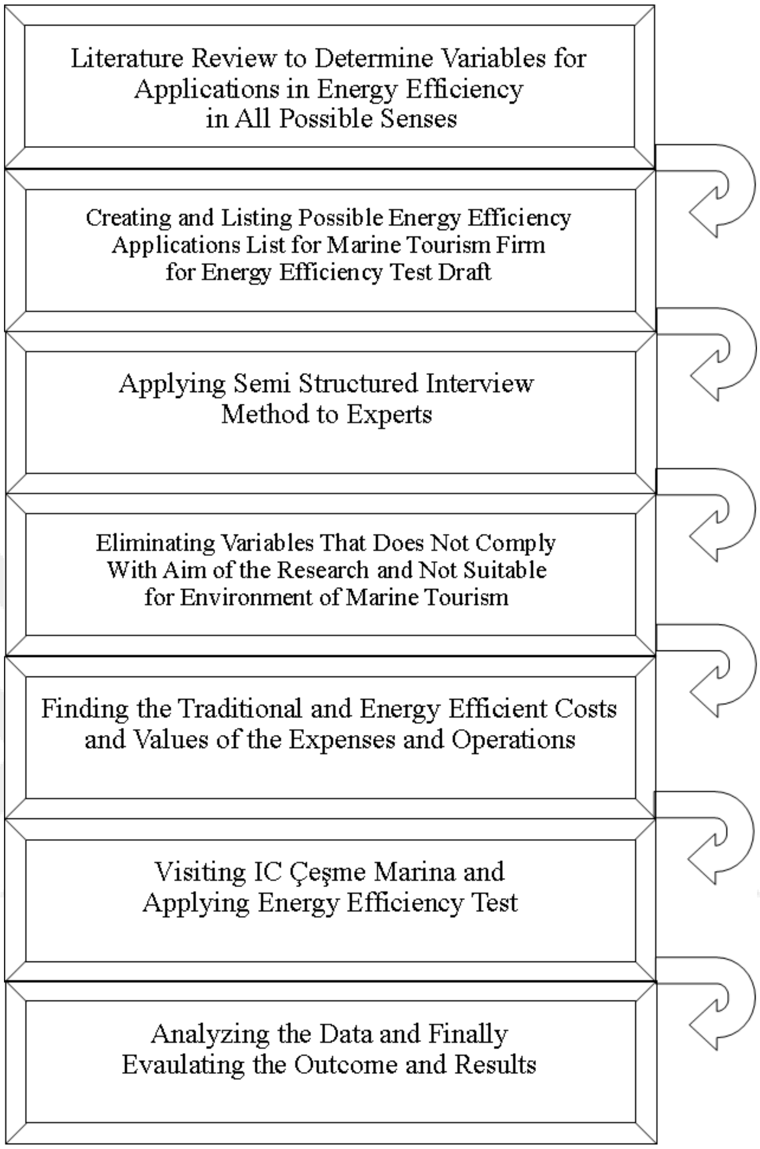
Figure 22: Schema of Flow of the Processes in Thesis



Variables that are collected after literature review brought to expertise opinions in order to re-check of their weight ratio for the sake of clarification. By this method researcher aimed to form the energy efficiency test that is suitable for marine tourism firm which in this case is a marina which belongs to termination of yachting industry.

Figure below describes the chronologic order of the steps that these papers include.

Figure 23: Flow Diagram of the Process of Research



All steps took place upon completion of previous step. Logical order has been created cumulatively in order to build up the schema of the papers.

3.4.1. Semi Structured Interview Method

In this section of research we brought applications of general energy efficiency methods to the knowledge of experts. Semi structured interview method has been applied which gave us to flexibility of asking questions in addition to designated questions. In this method also this flexibility ensured the setting contribution of experts to the optimal levels.

Data collection tool for this research is set as semi structured interviews which are one of the qualitative researches furthermore some of the questions were determined to ask participant experts. By taking into consideration the literature, questions were selected for marine tourism segments and the latest energy efficiency applications and their exergy differences. Evaluation of convenience, suitability and points of operations which open for improvements in energy efficiency applications are discussed with experts and their claims on approaches on the firms, customers and all other stakeholders on applications within the marine tourism environment are addressed.

3.4.1.2. Semi Structured Interview Method and Research Design

All the interviews held place in 23-24 February 2018. In Figure below all the dates and hours are given along with names of the experts and organizations they are working for in chronological order, within their consent.

Table 26: Information on Experts of Marine Tourism who helped Semi Structured Interview

Expert	Organization	Occupation	Date
Can Akaltan	IC Çeşme Marina	General Manager	23.02.2018 12:30
Yaşar Karabacak	Kuşadası Port	Harbor Master	23.02.2018 14:30
Özgür Altınkaya	Ulusoy Çeşme Port	Assistant Manager	23.02.2018 15:00
Enver Cem Hodoğlugil	Muğla Municipality Port Authority	Maritime Transportation and Certification Officer	23.02.2018 15:30
Haslet Sever	Professional Yachting Association	Head of the Association	23.02.2018 17:15
Murat Özbek	MARTEK	Sales Represantative	24.02.2018 08:30
Hasan Tunç Kurtluoğlu	Turkish Chamber of Shipping (İMEAK)	Bodrum Branch Office Board of Director Member	24.02.2018 12:30
Tuncay Kuleli	Muğla Sıtkı Koçman University	Research Professor	24.02.2018 13:00
Aziz Muslu	Ordu University	Assistant Professor	24.02.2018 13:30

Sampling processes for semi structured interviews held to make room for all marine tourism actors. Also experts who have participated to interviews are from different cities of Turkey such as Ordu, Muğla, Antalya, İzmir and İstanbul. All the interviews accomplished by face to face planned methods, thanks to the 4th national marine tourism symposium. Questions that are directed to experts were selected for getting as many as possible comment and knowledge on the energy efficiency in marine tourism industry. Example to that, interviews with Yaşar Karabacak, Özgür Altınkaya, and Enver Cem Hodoğlugil were mainly focused on cruise tourism energy efficiency applications on each actor in the industry whereas interviews with Can Akaltan, Haslet Sever and Hasan Tunç Kurtluoğlu were detailed on energy efficiency in yacht branch of marine tourism.

3.4.1.2. Results of Semi Structured Interviews

At the aftermath stage of semi structured interviews, in light of expert opinions variables that came from energy efficiency on HVAC, lighting, motor systems and appliances along with the specific industrial applications that experts shared their idea on, gave us a chance to evaluate these variables. A detailed contexts of interviews are at appendices section on the fifth and fourth appendices.

Table 27: Sources of Energy Efficiency Variables

Variables	Literature	Personal Interview
LIGHTING APPLICATIONS		
LED Lighting Methods (Lantern, Indoor, Outdoor, on Appliances etc.)	+	+
Corrosion Proof Sensors	+	+
WWS Energy Producer Glasses	+	+
Advanced lighting controls	+	+
Smart Timer sockets	+	+
Improved electronic ballasts	+	
Timers and Vacancy sensor (Image processing sensors and other technologic improvements)	+	+
Reflective wall paints usage	+	+
Geographical positioning	+	+
HVAC SYSTEMS APPLICATIONS		

Natural geothermal heating	+	+
Passive ventilation design	+	+
Passive solar design	+	+
Night ventilation cooling	+	+
Water-cooled heat exchanging	+	+
Programmable thermostats	+	+
Geothermal heat pumps	+	+
Evaporative cooling systems	+	+
Heat recovery ventilation systems	+	+
Energy efficient framing practices	+	+
Heat pump air and water heaters	+	+
Solar thermal collection devices for heat	+	+
High-efficiency double and triple-pane windows	+	+
Combined space and water heating air flow management	+	+
Sealing doors, windows, walls, outlets, and fireplaces to reduce heat / cold loss	+	+
Improved wall, floor, ceiling, and pipe insulation	+	+
Changing windows and caulking cracks	+	+
Wooden Designs (Laminate usage)	+	+
Deactivating Components of Air Conditioner	+	+
Chilled water tanks	+	
Ice storage	+	
Hot water tanks	+	
Thermal walls	+	
Rocks stored underground	+	
Dielectric heaters, , Electric arc furnaces Electric induction furnaces	+	
Ductless heat pumps for heating and air conditioning	+	
Variable refrigerant flow	+	
Building energy monitors to identify opportunities to reduce wasted energy	+	
Coating applications		+
MOTOR SYSTEMS APPLICATIONS		
High resistance and capacity cables	+	+
Corrosion Proof Equipment	+	+
Uniformity among appliances (cable chargers)	+	+
High efficiency industrial pumps and motors	+	+
High-voltage direct current (HVDC) lines	+	+
Energy efficient residential appliances (refrigerators, vacuum cleaners, etc.)	+	+
High efficiency commercial appliances (refrigerators, washers, dryers)	+	+

Long lasting, renewable appliances preferring appliances that enable rewrite over disposable/ single-use technologic appliances (DVD-rom)	+	+
Technology to enable remote start up and shut down of appliances and equipment that have flexible demand (i.e. water heaters, HVAC equipment, electric vehicles)	+	+
Replacement for high energy users with electric users (lawnmowers, dryers, leaf blowers, water sprayers, fans, induction cooktop stoves)	+	+
Electrical high horse power machineries that will be used in mooring towing landing launching	+	+
Electric Vehicles; Light-, medium-, and heavy-duty on road automobiles, Short-distance trucks, Buses, Trains, Ships, Aircrafts, Non-road vehicles, Construction equipment, Agricultural equipment, Motorcycles, Forklifts	+	+
Hydrogen Fuel Cell/Electric Hybrid Vehicles; Long-distance trucks, Buses, Trains, Ships, Aircrafts, Construction equipment, Agricultural equipment	+	+
Charging applications; home car chargers, chargers installed in parking garages, on streets and pedestals	+	+
Lightweight materials (i.e. carbon fiber, aluminum, fiberglass)	+	+
Improved public transportation	+	+
Improved carpooling and ride-sharing programs and technologies	+	+
Transportation Demand Management programs that support adoption of low-carbon transportation practices	+	+
Urban land use practices to reduce transportation demand (i.e. mixed use development, increased residential densities)	+	+
Effective Management Systems in Stowage	+	+
Telecommuting rather than commute by car	+	
Improved pedestrian infrastructure	+	
Improved biking infrastructure	+	
Regenerative braking systems	+	
Low rolling resistance tires	+	
Adaptability and compatibility between devices	+	
Shortening Boats		+
Using Low Capacity Appliances in order to minimize investments to 0 Consumption on Yachts		+
WATER APPLICATIONS		
Gray Water Re-use Systems	+	+
Operational Water Re-use Systems and Refining	+	+
Baking soda, flour, vinegar, apple vinegar, lemon water and salt usage for clarification	+	+
Landscaping	+	+
Efficient irrigation techniques for plants	+	+
Refining and decontamination devices	+	+
High efficiency irrigation systems	+	+
High efficiency residential and commercial water fixtures	+	+

ENERGY GENERATION AND STORAGE APPLICATIONS		
Flexi Panels	+	+
Onshore/offshore wind turbines	+	+
Wave devices	+	+
Tidal turbines	+	+
Using Sail Fabric On Board	+	+
Solar photovoltaic (PV) for rooftops and power plants	+	+
Ocean Thermal Energy Conversion (OTEC)	+	+
In-stream hydroelectric turbines	+	+
Electric compressors to compress hydrogen	+	+
Co-generation, tri-generation and multiple dimensional combo devices that produces electric with additional affects or get energy from multiple renewable resources	+	+
Improved Geothermal production	+	+
Improved Batteries	+	+
Pumped hydroelectric storage	+	
Hydroelectric power plant reservoirs	+	
Glass Bubbles for insulation to store hydrogen	+	
Electrolyzes to produce hydrogen from electricity	+	
Tanks to store hydrogen for transportation primarily	+	
Concentrating Solar Power with storage (either molten salt or phase-change material)	+	
Geothermal power plants for electricity	+	
Concentrated Solar Power (CSP) plants	+	
Existing large hydroelectric reservoirs used more efficiently	+	
Small hydroelectric reservoirs	+	
OTHER APPLICATIONS		
Smart Service Boxes	+	+
Contoured Service Boxes	+	+
Utilities provide incentives for industry, companies, and individuals to shift their electricity use for certain uses and processes to non-peak times of day or night	+	+
Waste Management on Board	+	+
Combination of Less Harmful Poison Protector And Paint	+	+
High efficiency settings or dashboard fuel efficiency displays	+	+
Efficient Manning	+	+
Efficient Worker Management	+	+
Effective Place Management on Boats		+

-Corrosion proof LED lighting methods have been in the commercial use in the industry eventually lighting management systems could be evaluated in two terms; first in the operational side and second in the auxilliary operational areas such as recreational accomodation places for instance hotels.

-Corrosion proof sensors on the dock area could create efficiencyon usage of electricity.

-Geographical positioning of the marina for commercial and operational sites of the area can be generous in terms of yielding by HVAC, erosion and wearing issues.

-Cogeneration and trigeneration equipment slowly enters to every place in business implying them to yachts, machines, HVAC systems, electric systems and operational activities would be the most efficient move by a marina.

-Material differences such as laminated or long lasting material usage on docks could be efficient solution at the design stage.

-Replacement of old cables with high capacity new ones would give the effect of less repairment costs.

-Smart and contoured service boxes could be the answer for losses and leakage problem of the firmin terms of electric and clear water.

-Applications and tools like automatic shutoff valves also will mostly erase the problem of fuel losses and leakages.

-WWS solutions such as Flexi panels in the marina can reduce HVAC and electric and oil dependency of the firm. However wind turbines does not allow the luxury feel of the marina because of the non suitable nature of the shadow effect and wave turbines are not exactly in the commercial usage or prices are not at the level of desired.

-Coatings and poisonous paints can be replaced with vinegar and biodegredable solutions which will lead to great savings in terms of credit and at the same time being more environmentally friendly.

-Opening fields of reinvestment by looking into future and choosing more convenient components for operational sides in terms of technology will allow to make space for new technologies in the firm.

-Effective place management will also give the space for workers and customers to use less energy in getting somewhere in the marina.

-Water consumption when washing bottom of boats is mostly high and saving for marina’s second or third usage is a clever choice.

-Grey water re-use systems can diminish the need for water and treatment for green areas of the marina along with refining solutions.

3.4.2. Field Research

Evaluation for energy efficiency in marine tourism environment is approached firstly by literature review and latter expert opinions on the issue are collected. In the last section of the research, field research which is an energy efficiency evaluation through a semi structured interview conducted with IC Çeşme Marina(Can Akaltan General Manager at IC Çeşme Marina and Tekin Yanmaz Technical Chief at IC Çeşme Marina) and a comparison convoyed to discuss performance of a marine tourism industry actor to get bigger information on marine tourism branch yacht industry. According to the actual purpose of the work, variables for energy efficiency in marine tourism applied along with expert opinions. Processes that have been taking places are listed as below;

1. Stage was the determining devices, machines or services that could consume energy.

2. Stage was the collecting information on conventional consumption of these variables that needs improvement.

These conventional consumption of variables are listed in the appendices section of the thesis

3. Stage was conducting semi structured interview with Can Akaltan and Tekin Yanmaz on these variables evaluation by their consumption, their working power, their working hours, other applications, overall consumption of marina and future applications.

3.5. Finding and Results

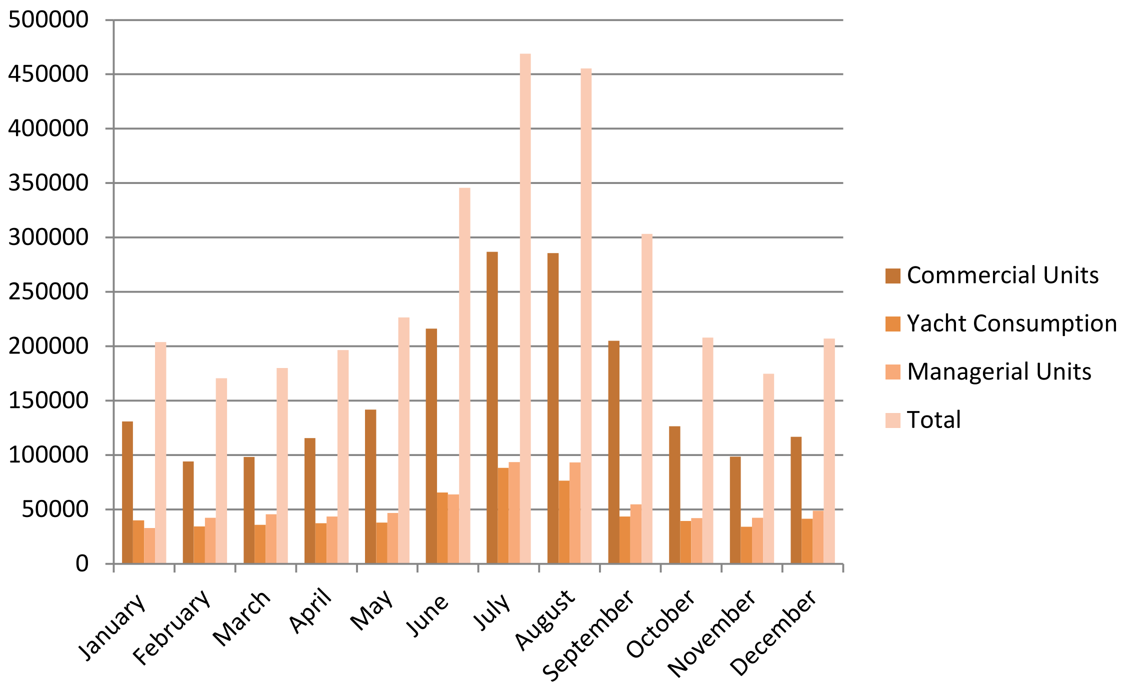
Applications were the main focus in this section, there will be analyzes of each topic that author had information on.

3.5.1. Overall Consumption of IC Çeşme Marina

"Power" and "Energy" are different terms. Term of kW (kilowatt) equals to 1000 watts and means power transferred on a circuit whereas kWh (kilowatt per hour) is a different term for an appliance to use in one hour. For instance an iron that has 1 kW power uses 1 kWh in an hour. As an accepted value for 1 cubic meter of natural gas equals to 10.64 kWh. According to Turkish Statistical Institute price of electricity in residential buildings for 1 kWh electric in last six months of 2017 average is 0.413 TL. In industries for the same amount and same period of time the price was 0.263 TL. IC Çeşme Marina calculated electric price for one kWh as 0.35 TL. In residential buildings for natural gas consumers paid 1.122 TL for 1 cubic meter of natural gas. At the same period and for a same amount industrial consumers paid 0.906 TL. Under water segment in İzmir, commercial places like a marina pays 5.80 TL for 1000 liters of water without sewerage payment (İzmir Water and Sewerage Administration, 2018; Turkish Statistical Institute, 2018).

IC Çeşme Marina consumption shares are divided as below.

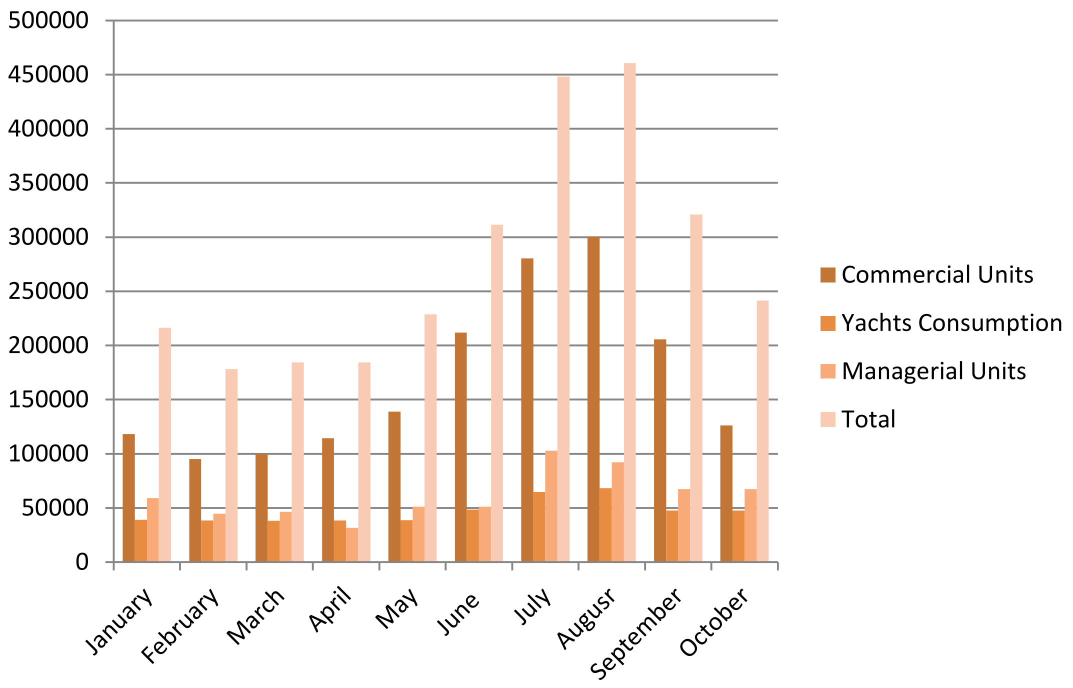
Table 28: Divisional Electricity Consumption of IC Çeşme Marina in 2016 in kWh



Marina's overall consumption (3141225 kWh) of electricity focused on distributing electricity to attraction points in the marina area. Runner up in this list with a close gap is managerial units which includes mostly buildings consumption and office equipment with HVAC activities. 2016 overall trend shows that main consumption arises on summer season with along with activity rise in yacht services. Only diminishable consumption in this chart belong managerial units by looking at marina's perspective.

Below part of the consumption data of IC Çeşme Marina in 2017 is shown with total amount of 2773960 kWh.

Table 29: Divisional Electricity Consumption of IC Çeşme Marina in 2017 in kWh



In a comparison with two years before 14650 kWh more electricity has been spent in last year in 10 months period. 2016 yacht consumption values are 30150 kWh more than 2017 year in the same period. 11029 kWh is the amount of commercial unit difference between 2016 and 2017 and 2017 seems more efficient by looking at this table. 55829 kWh of electricity difference in managerial units is probably due to the heat pump extension installation which means change of fuel types in HVAC systems. Apart from this improvement in energy efficiency overall consumption has been lowered however most of them do not passes into our subject directly such as decrease in yacht consumption values indicates yachts tend to need lower energy to move when one consider IC Çeşme Marina occupancy of mooring places percentage increased 95 per cent to 100 per cent last year but there should be more context in order to make that assumption. After opening of new malls in the marina commercial units showing a decrease in energy consumption which is another interesting fact to evaluate however author have limited knowledge on the issue.

2017 January to October - 2016 January to October Yacht Consumption	-30150
2017 January to October - 2016 January to October Commercial Units	-11029
2017 January to October - 2016 January to October Managerial Units	+55829
Total	14650

26212 kWh difference is just only in the January months of both years which can be held as proof of this consumption refers to heat pump consumption.

In July, August, September and October months one can see the effect of heat pump application working this time for cooling.

Hotel of marina is occupied on different percentages throughout a year.

Table 30: Hotel Occupancy Percentages

January	30
February	30
March	30
April	30
May	50
June	80
July	90
August	90
September	50
October	30
November	30
December	30

According to Energy Star all services consumption in a basic home in U.S. is divided as this: 29% heating, 21% electronics 13% cooling 13% water heating 12% lighting and 12% Appliances. Appliances include of refrigerator, dishwasher, dryer etc. and Electronics include telephone, TVs, small appliances, computers etc. (Energy Star, 2018).

Below IC Çeşme Marina's consumption answers are given in order to illustrate the subject these data will be essential. IC Çeşme Marina has been applying some of the energy efficiency applications to their marina. In next pages they will be held in their sub topic for sake of clarification on the issues. Applications and consumptions are given where there is a statistical data but some of the applications are immeasurable such as geographical positioning at design stage.

Table 31: Number of Appliances and Their Consumptions in IC Çeşme Marina

Variables	**Consumptions for per Unit**	**Number of Devices or Machines**
800 Lumen CFL 14W	3.4 kWh per month	60 pieces
800 Lumen LED 12W	2.9 kWh per month	120 pieces
1100 Lumen LED 14W	3.4 kWh per month	15 pieces
Refrigerator Freezer Bottom 52W Energy Star	37.9 kWh per month	1 piece
Computer and Monitor 100W	12 kWh per month	18 pieces
Laptop 21W	1.9 kWh per month	7 pieces
Modem 6W	1.1 kWh per month	2 pieces
Inkjet Printer standby and printing 71W	5.9 kWh per month Old: 0.03 kWh per hour of use New: 0.02 kWh per hour of use	4 pieces
Wireless Router 6W	1.1 kWh per month	1 piece
Computer with Flat Screen	Old: 0.8 kWh per hour of use Old: 97 kWh per year New: 0.7 kWh per hour of use	6 pieces
LCD TV	Old: 0.25 kWh per hour of use New: 0.09 kWh per hour of use	1 piece
Scanner	Old: 0.018 kWh per hour of use New: 0.01 kWh per hour of use	2 pieces
Copy Machine 1600W	1.6 kWh per hour of use	3 pieces
CCTV Security Cameras (system of 10 cameras and recorder with PC consumption)	100 kWh + 5 kWh + 12 kWh = 117 kWh per month	1 piece / new system IP CCTV
Combi Boiler	23.25 kWh 20.000 kcal %90 efficiency	5 pieces/ improvement with heat pump
Heat Pump Standard 10000W	750 kWh per month 10 kW for each unit operation power	5 pieces
Heat Pump (Electric) (7800 hours) (16 kW)	124.800 kWh	1 piece
Portable Heater Medium Settings 1000W	120 kWh per month	5 pieces
Water Filtration 440W	28.6 kWh per month	1 piece
Water Heater 30 to 50 Gallons High	385 kWh per month	3 pieces

Efficiency 4500W		
Travel Lift (Diesel) (2000 hours) (Capacity to uphold 80 Tons)	1680 euro diesel fuel 17304 kWh (based on calorific value conversion)	1 piece
Boat Mover (Diesel) (1800) (20 Tons)	378.4 euro diesel fuel 3897.52 kWh (based on calorific value conversion)	1 piece
Forklift (Diesel) (3400 hours per) (Capacity to uphold 3 Tons)	308.13 euro diesel fuel 3173.74 kWh (based on calorific value conversion)	1 piece
Mooring Boat (Outboard) (Gasoline) (18900 hours) (25/50/60 HP)	347.760 kWh for 25 HP/ 695.520 kWh for 50 HP/ 833.868 kWh for 60 HP 5068.96 euro diesel fuel for all boats	5 pieces
Bottom .Washing Machine(Electric) (9800 hours)	29.400 kWh	2 pieces
Water Booster (Electric) (208000 hours) (9/12 kW)	187.200 for 9 kW 249.600 for 12 kW	2 pieces
Drainage Pump (Electric)	0.4 kWh per hour of use	1 piece
Fire Pump(Diesel) (15 hours per year) (90 HP)	992.92 kWh per year	1 piece
Fire Pump (Electric) (45 hours per year) (75 kW)	3.375 kWh per year	2 pieces
Mobil Fire Pump (Gasoline) (35 hours per year) (3 HP)	77.22 kWh per year	6 pieces
Power Distribution Unit (Oil, Hermetic) (75000 hours)	800/1600 kVA 640/ 1280 kWh Output	2 pieces
Generator (Diesel) (85 hours)	400/630 kVA 320/504 kWh Output	2 pieces

Source: Energy Star, 2018; EPA, 2018; Işık, 2010; Mattison and Korn, 2012; McWhimney et al., 2004; Sanchez et al., 1998; Stein and Meier, 2000; Suzuki Marine, 2018; Timur, 2013; Water Sense, 2018;Yanmar, 2006; Yavuz et al., 2014; https://www.energy.gov.

Typical and actual consumption data of appliances, devices and machines are collected from various resources. Energy consumption rates are converted to kWh where there is a possibility of comparison with other means of consuming in that specific application. Consumptions of heat pumps, travel lift, boat mover, forklift, mooring boats, water boosters and mobile and stable fire pumps along with generation outputs of generator and power distribution unit are taken from IC Çeşme Marina statistics. Appliances' typical, energy efficient and improved consumptions are collected from different sources such as Kneifel et al, Energy Star website and publications, EPA's publications, Water Sense's publications and Sanchez et al.'s work. Evaluation of energy efficiency has been made for each section that all appliances and systems have been covered through detailed analysis in words or in numbers.

3.5.2. Lighting Systems Applications

For each sector of energy efficiency sub topics there will be evaluation on both ends consumption and applications if there is enough data. Evaluations are going to be given after specific information and historical background is given in logical order. For lighting section below listed facts are collected from semi structured interview as efficiency criterion.

- In light of above stated list, lighting systems are highly efficient thanks to LED technology and CFL consumption. In lighting working environment lighting system changed with LED lights.
- For floodlights and other powerful firm rather than using sodium lamps, metal halide or halogen preferred LED appliances.
- Existing practices of controlling lights with one programmable system allows them to cut back the energy abuse.
- Also security system lighting makes the lighting section efficiency go higher at nights or unoccupied sessions or periods with night vision, infrared technology and vacancy predictions.
- Deactivating of light sections in winter seasons when occupancy is relatively lower makes energy efficiency of the company go higher.
- Security section has been altered with IP CCTV system which consume less and works in infrared for better vision at nights as well. This system also has automation that non-occupant period is manually selected and general lighting is replaced with automation of security lighting systems.
- At the end of working hours all the equipment and devices are shut down for efficiency apart from essential systems such as controller and security systems.
- Lighting systems and HVAC systems namely coils and fan systems are controlled with programmable devices.

Below listed applications are listed as their consumption rates or impact of saving or relevancy in the each section. In this table annual consumption facts are taken as ordering criteria.

Apart from CFL usage lighting section efficiency was almost complete optimum applications and CFL is closest application to the optimum energy efficiency application. Author offers changing indoor lights with LED installation with electronic ballasts to use with vacancy sensors and where day light is reasonable for solar collectors at working hour's or lighting tunnels should be used to get free illumination.

Table 32: Evaluation of Energy Efficiency of Lighting Systems of IC Çeşme Marina

IC Çeşme Application	Efficiency Evaluation		Optimum Energy Efficient Application	Room For Improvement	Annual consumption
120 Pieces of 800 Lumen LED Lights (LED Lighting System Usage)	Efficient	Not efficient	LED Lighting System Usage (Indoor)	-Vacancy Sensors -Electronic Ballast -LED Technology -Solar Light Collectors -Lighting Tunnels	4176 kWh per year
60 Pieces of 800 Lumen CFL Lights (LED Lighting System Usage)	Efficient	Not efficient	LED Lighting System Usage (Indoor)	-Vacancy Sensors -Electronic Ballasts -Solar Light Collectors -Lighting Tunnels	2448 kWh per year – 2088 kWh per year (if LED lights installed)
15 Pieces of 1100 Lumen LED Lights (LED Lighting System Usage)	Efficient	Not efficient	LED Lighting System Usage (Outdoor)	-Vacancy Sensors -Electronic Ballasts -Solar Light Collectors -Lighting Tunnels	612 kWh per year

Efficiency rating process has been made through comparison of old systems typical consumption with existing system of IC Çeşme Marina. According to this information

* 800 Lumen LED Lights are more efficient against 800 Lumen Incandescent, Halogen, High Pressure Sodium, Metal Halide, Low Pressure Sodium, Mercury Vapor and CFL lamps.

* In 1100 Lumen LED Lights outdoor solutions LED technology is way much efficient above stated methods followed by CFL and High Pressure Sodium.

* 800 Lumen CFL Lights are second best efficient solution for indoor and outdoor illumination places.

All typical consumption rates of above stated methods are listed in appendix 3 in pages starting from appendix page 9 to appendix page 26.

It is not calculable but remote control program and device for lighting system is the closest application to timer sockets. The system of IC Çeşme Marina could save up to 20 per cent by reducing the time that devices are on. Automation system of security system is also crucial for working with infrared. Infrared enables to shut down every light that is not needed to be staying on for security systems that do not have this facility.

Table 33: Energy Efficiency Applications of IC Çeşme Marina in Lighting Systems

Energy Efficiency Application of IC Çeşme Marina	Possible Improvement Points
Lighting Automation with Remote Control	-Audible Sensors
Security System Lighting Automation	-Dual-Technology Sensors (for correction)
Security System Infrared	-Dual-Technology Sensors (for correction)
Energy Savings when unoccupied	-Lighting Tunnels -Solar Light Collectors

These systems on the security system and remote control of lighting automation are almost flawless technologies. With some minor improvements it could reach the point that current technologies allow us to tap energy efficiency capacity without using renewable energy.

3.5.3. HVAC Systems Applications

- Lighting systems and HVAC systems namely coils and fan systems are controlled with programmable devices.
- Existing technology for HVAC systems is still on the use with improvements like heat pump and heat recovery applications. Combi boilers that are used in IC Çeşme marina are not efficient considering cascade variations and condensing and hermetic technologies however new system of heat pump that supports the actual system lowers the energy consumption drastically.
- 5 units of mobile heaters with 1 kW power individually should be evaluated stabilized versions if there is no need for system and improvements

- ➢ Water heaters are considered fully efficient according to first law of efficiency but economic efficiency approach say that it depends. In IC Çeşme marina newly built system of water heaters with 3 pieces and novel technology of HVAC heat pumps with 5 units that consume 10 kWh of energy per hour and electricity that goes higher as it operates depending on the need. Water heaters in IC Çeşme marina are working with electricity which gains the fuel advantage but working consumption is high when there is no recovery of heat systems. Baseboards are alternatives for mobile heaters as their stabilized versions for outdoor and indoor.
- ➢ In order to reduce HVAC operations consumptions Heat Recovery systems built on Restrooms and Bathrooms in IC Çeşme Marina.
- ➢ For the same context all buildings have their insulation methods in order to reduce heat wastes.

Table 34: Evaluation of Energy Efficiency of HVAC Systems of IC Çeşme Marina

IC Çeşme Application	Efficiency Evaluation		Optimum Energy Efficient Application	Room For Improvement	Consumption
5 Combi Boilers with Heat Pump Extension	Efficient	Not efficient	VRF Cascade Condensing Boiler with Heat Pump Extension	-Co-generation and Tri-generation Systems -ATES -Smart Thermostats	23.25 kWh 20.000 kcal %90 efficiency - 2000 kWh %120 efficiency
5 Heat Pumps Standard 10000 W	Efficient	Not efficient	VRF Cascade Condensing Boiler with Heat Pump Extension	-Co-generation and Tri-generation systems -ATES -Smart Thermostats	13.195 kWh per year - 2000 kWh/ %120 efficiency
5 Portable Heaters Medium Settings 1000W	Efficient	Not efficient	-4’ Baseboard 1000W (Indoor) -Motion Based Heat Lamp with Propane Option	-VSD or VFD if they are connectible -Insulation of Air Circulation -If possible walls -Using Coverage if possible	450 kWh per month - 150 kWh per month – 200 kWh per month
3 Water Heaters 30 to 50 Gallons High Efficiency 4500W	Efficient	Not efficient	Heat Pump Water Heater 50 Gallons 600W	-Co-generation and Tri-generation Systems -ATES -Geographical Positioning	385 kWh per month – 144 kWh per month

Above listed applications are listed as their consumption rates or impact of saving or relevancy in the each section. In this table annual consumption facts are taken as ordering criteria.

* Combi boilers with heat pump extension were energy efficient to some degree in a comparison with other means of providing thermal energy for heating need. However heating stoves with wood, lignite, propane, fuel oil, diesel oil, room heaters, heating boiler, central heating boilers are slowly diminishing in numbers with improvements on the recent combi boilers. Condensing or hermetic versions are twenty and thirty per cent more efficient than conventional methods of heating with combi boilers. Heat pump extension was resolution of IC Çeşme Marina which made the system more energy efficient than the regular system of heating with combi boilers.

* Heat pumps are considered energy efficiency application by at least reducing number of devices that is dedicated to HVAC systems. Also energy efficiency comparison and study of the application made below.

* Mostly heating efficiency is different than other zones with electricity generally being least effective method. However accessibility and clean nature of this energy is what make it preferable. Mostly for outdoor heating method and various indoor methods of heating propane is considered highly efficient with ranging from 10000 BTUs to 60000 BTUs. Heat lamps for outdoor heating and baseboards for indoors are far more energy efficient systems instead of portable heaters.

* High efficiency water heaters even though they are not the best option are calculated as energy efficient thanks to their facility to consume approximately 20 kWh less in a month. Typical water heaters consume 404.8 kWh in a month IC Çeşme Marina uses a model that consumes 385 kWh per month.

Old types of combi boilers are not efficient and in HVAC system IC Çeşme Marina tries to cover up this gap with starting from heat pumps. Heat pumps serving as cooling and heating device and have the capacity built on water and air systems. IC Çeşme Marina used on the both systems on water system. Heat pump was one of them for replacement of combi boilers that consumes liquid petroleum gas. Estimated payback period for installation regardless of the fuel is used is 4 years.

Analysis of the heat pump installation was like this: it is estimated that 100 persons are going to be using hot water and one person is going to use 65 liters circulation heat losses calculated as 1.15 according to this daily hot water consumption is 7475 liters.

Table 35: Heat Pump Comparison with Other Means of Heating for 52.781 kWh or 45.391.938 kcal Annually

Heating Units	Heat Pump	LNG Combustible Heating	LPG Combustible Heating	Diesel Oil Combustible Heating
Annual Consumption in Turkish Liras	4.618	14.672	20.447	19.670
Four Year Consumption in Turkish Liras	18.473	58.689	81.787	78.679

In order that to heat incoming water at 15 Celsius degree up to 50 Celsius degree for 7475 liters daily 304 kWh should be consumed for 261.625 kcal. Hotel occupancy estimated as other than May and September which are 50 per cent, 80 per cent June and 90 per cent July and August is 30 per cent. Summed up annual consumption is 52.781 kWh with electricity consumption of heat pump 13.195 kWh. Electricity price for a kWh is 0.35 TL and annual consumption to heat up with heat pump 4618 TL. If company wanted to use LPG for same amount of kcal and time their expense would be 20447 TL.

Table 36: Energy Efficiency Applications of IC Çeşme Marina in HVAC Systems

Energy Efficiency Application of IC Çeşme Marina	Possible Improvement Points
HVAC Automation with Remote Control	-HPHXs –VSDs and VFDs -Smart Thermostats
Heat Recovery Systems on Bathrooms and Restrooms	-Co-generation and Tri-Generation by Steam
Thermal Insulations of Buildings	-PCM Applications
Geographical Positioning	-WWS Generation Applications

Renewable production and multiple generation methods are becoming more convenient day by day in all HVAC industry to the point that not using is a luxury.

Thermal Insulation helps to reduce 30 to 40 per cent of heating energy without landscaping.

Absence of co-generation and tri-generation systems could be considered as deficiency for such marine tourism company with high efficiency applications due to active usage of such system in other branches of marine tourism and overall maritime industry. Geographical positioning and effective landscaping are contributors to overall energy efficiency schema of the company.

3.5.4. Motor Systems Applications

- Technologies to improve efficiency of travel lifts are mostly mentioned in motor section. Travel lifts are hydraulic machines that mostly use diesel oil. The basic lift idea has two options mobile versions and non-mobile lifts such as elevators. In here we are talking about travel lift, boat mover and a forklift which all three uses diesel oil. If working hours of selected machine is high, hydraulic systems literally abuse fuels, in order to prevent this, a sleep mode or a similar practice can be applicable. Second-hand units of such machines are not preferable because of none of the first users will sell their machine unless operating costs or maintenance cost are gone out of control. Due to this such devices have to be first-hand. Exergy point for such machines are crucial; for lifts many fuels and different system can be mentioned starting using propane to electrical engines with batteries however as the unit that is going to be lifted gets heavier possibilities of different fuels and techniques are reduced because of power and exergy points related issues.
- Mostly hybrid systems for lifts are shaped as electric for drive systems and hydraulic diesel for operation system however in relatively small lifts such as 3 tons forklift with relatively small HP for other lifts can work with electricity and their work of 3400 hours are limited therefore there will be not a need for second battery. It would be so much efficient replacing such device with electrical ones thus changing 3 tons lifting capacity forklift with electric user one will diminish energy consumption to one fourth of existing consumption. Improved versions are designed hybrid to meet with counterweight when hydraulic drives are working and at the energy storage stages. Technologies like variable speed drives, frequency converters, Permanent Magnet motors

and Servo Motors, gearless drives and recuperation converters could be the main source of efficiency if it was designed. Optimization of counterweight would develop a system to lift 20 per cent rather than lifting 40 or 50 per cent of nominal loads according to average loads.

- Even though diesel or gasoline is the main source of fuel for generators, there are few options of renewable commercial generators. Mentioning this fact it is not widely accepted as a reliable source of back-up unit.
- One diesel unit of fire pump is working with high horse powers and others are working with electricity which gives them to exergy benefit of not wasting energy. Six fire pumps are working with gasoline however energy efficiency of such appliances could be evaluated as pointless due to their limited amount of working hours.
- Maintenance of devices and engines are periodically scheduled and done at time. In equipment and devices mostly rechargeable batteries are used such as radio communication devices, remotely controlled mouse and laptops.
- In dry dock area water filtration works for gray water that is used for bottom washing processes, recycling this water gives the opportunity to save at the end of water consumption. Both water filtration machine and cleaning machine is using electricity and new which makes them highly efficient. Also in last year staff of IC Çeşme Marina has been educated on water saving practices and all personnel are trained to protect environment and preserve efficiency. Sticking around water efficiency, using oysters gives fully natural of efficiency of not using any type of water filtration for appeal of the marina. There are debris collectors and water filters as non-efficient versions for natural ways however debris collectors for instance operating at a cost rate of 1.10 US dollars per day and water filtration machines are using electricity.
- Motor systems for boats are must be reliable and high power however for such low HP's electrical machines could be alternative if there is enough place. Commercially electrical machines in heavy duty area did not find enough room for themselves like they could not in emergency appliances.
- 318.74 liters of fuel consumption has been spend on machines to landscape.

In most of the cases technology for efficiency evaluation did not catch up the phase in commercial activities such as electric lift improvements, new motor designs, heavy duty vehicles and IE5 energy class motors.

Table 37: Evaluation of Energy Efficiency of Motor Systems of IC Çeşme Marina

IC Çeşme Application	Efficiency Evaluation		Energy Efficient Application	Room For Improvement	Consumption
Travel Lift (Diesel) (2000 hours) (Capacity to uphold 80 Tons)	Efficient	Not efficient	Hybrid drive and operation system with electricity	-Improvements on Servo and Permanent Magnetic Motors -VSDs and VFDs on next generation powerful electric lifts	1680 liters of euro diesel fuel 17304 kWh
Boat Mover (Diesel) (1800 hours) (20 Tons)	Efficient	Not efficient	Hybrid drive and operation system with electricity	-Improvements on Servo and Permanent Magnetic Motors -VSDs and VFDs on next generation powerful electric lifts	378.4 liters of euro diesel fuel 3897.52 kWh
5 Mooring Boats (Outboard) (Gasoline) (18900 hours) (25/50/60 HP)	Efficient	Not efficient	Fully Electric Boats with Electric Winches - Synchronous Reluctance Assisted Permanent Magnet Technology	-Improvements on Servo and Permanent Magnetic Motors -VSDs and VFDs on next generation powerful electric lifts -Hybrid drive and operation system with electricity -If possible wind, solar and wave energy generation from glasses, panels, co and tri generation systems, steams, currents and propellers and winds	347.760 kWh for 25 HP/ 695.520 kWh for 50 HP/ 833.868 kWh for 60 HP
Forklift (Diesel) (3400 hours per) (Capacity to uphold 3 Tons)	Efficient	Not efficient	Class 1 Electric Forklift with 3 Tons Capacity Single Battery - Hybrid drive and operation system with electricity	-Electric Forklifts without second – battery -Improvements on Servo and Permanent Magnetic Motors -VSDs and VFDs on next generation powerful electric lifts -Voltage Correction	308.13 liters of euro diesel fuel 3173.74 kWh – 793.44 kWh
Fire Pump(Diesel) (15 hours per year) (90 HP)	Efficient	Not efficient	Electric or Propane User Fire Pumps	-	1006.65 – 992.92 kWh per year
2 Fire Pumps (Electric) (45 hours per year) (75 kW)	Efficient	Not efficient	-	-	6750 kWh per year
6 Mobil Fire Pumps (Gasoline) (35 hours per year) (3 HP)	Efficient	Not efficient	Electric or Propane User Fire Pumps	-	470.4 kWh per year
2 Power Distribution Units (Oil, Hermetic) (75000 hours)	Efficient	Not efficient	-	-	800/1600 kVA 640/ 1280 kWh Output
2 Generators (Diesel) (85 hours)	Efficient	Not efficient	Renewable Generators	-	400/630 kVA 320/504 kWh Output

Above listed applications are listed as their consumption rates. In this table consumption statistics are taken as ordering criteria.

***** Travel lifts are driven with a hydraulic motor that works around 50 to 60 per cent efficiency however for such weight there are limited commercially applicable resolutions that met with high number of people. Therefore comparison should be in their specific engine type. Novelty of the machine along with high class and relatively low energy consumption of the lift makes the energy efficiency go higher. Old petrol engines such as 5 liters petrol V8 consumes eight to ten liter per lift which is enormously high for typical old models of petrol engines and do not need to mention it consumes gasoline.

* Boat movers carry the same characteristic on the low power. Even though there are higher opportunities of electrical winches in that segment it is also cannot be mentioned with commercially active applications which channels the discussions on specific motor consumptions. Chains and hydraulics are in need of constant maintenance in these type of motors which have been practiced throughout all these years for IC Çeşme Marina. For base point if Yanmar 4TNE106-SA industrial diesel engineis selected, fuel consumptions is going to be around three to four liters of diesel fuel.

* Heavy consumer mooring boats are using 1260 liters of fuel in a month whereas above the line of 900 liters per month could be mentioned as energy efficient.

* Electric forklifts are commercially active in contrast of recent analysis of hydraulic motors with high capacity. These forklifts also do the same work with diesel engine for a one fourth of the energy that diesel forklift needs. IC Çeşme Marina need for a forklift with 3 tons capacity of lifting can be satisfied with no extra battery and one electric forklift.

* Fire pumps are emergency machines are that have low number of alternatives and have limited time of working hours. The main system is powered with fossil fuels however backups for such system are electrical machines.

* For mobile fire pumps there are electrical options that did not meet with commercially activeness.

* For generators there are renewable and electrical options that did not meet with commercially activeness. Also these systems for blackouts and emergency issues reliability should be higher for such market acceptance.

Table 38: Energy Efficiency Applications of IC Çeşme Marina in Motor Systems

Energy Efficiency Application of IC Çeşme Marina	Possible Improvement Points
Periodically Scheduled Maintenance of Devices and Machines	Efficiency Monitoring System and Dashboards for the Calculations
Novel Machines and Devices	VSDs and VFDs applications along with Co and Tri Generation Systems, Renewables
Grey Water Applications	Closed Loop Filtration and Power Washer Systems
Oysters for Clarification of Marina Water	Debris Collectors Installation Around Marina
Environmentally Friendly Clarification Alternatives	Hot and Pressured Water Usage for Less Water Consumption
Matching Size of Energy Backup System	Renewable Energy Production Around Marina

Most of the motors life span is shortened due to incorrect voltages and voltage fluctuations. Even though all motors are new these efficiency applications will save the consumption and will diminish future error possibilities of the machines with electrical structure.

3.5.5. Water Management Applications

- Water boosters and drainage pumps consumption are using electricity. Eventually frequency drives and variable speed drives are essential for such devices. Also according to Turkey’s policy all new motors like IC Çeşme Marina’s are produced in the IE3 classification which makes them highly efficient however there is room for improvements.

Table 39: Evaluation of Energy Efficiency of Water Management of IC Çeşme Marina

2 Bottom Washing Machines (Electric) (9800 hours)	Efficient	Not efficient	IE4 Bottom .Washing Machines with hot water and high capacity and pressure	-VSDs and VFDs on next generation powerful electric machines -Voltage Correction	29.400 kWh
2 Water Boosters (Electric) (208000 hours) (9/12 kW)	Efficient	Not efficient	IE4 Water Boosters	-Variable Speed and Frequency Drives on next generation powerful electric machines	187.200 for 9 kW 249.600 for 12 kW
Water Filtration 440W	Efficient	Not efficient	Closed Loop System Water Filtration	-Improvements on Servo and Permanent Magnetic Motors -VSDs and VFDs -Voltage Correction	28.6 kWh per month
Drainage Pump (Electric)	Efficient	Not efficient	IE4 Drainage Pump	-VSDs and VFDs on next generation powerful electric machines -Voltage Correction	0.4 kWh per hour of use

* Electrical appliances efficiency are evaluated in the context of energy star evaluation on what are the typical consumption facts. For instance bottom washing machine which surpassed the cross of 20 kWh is considered as inefficient and has to be replaced.

* The motor systems of IC Çeşme Marina is relatively all new which are like in the most of the cases new induction motors are operating at 90 to 94 per cent of efficiency regularly. Normally water boosters with IE3 motor are considered when energy star and many resource draw the line of being energy efficient at IE1 motors. Also with the consumption of 416000 kWh per year which is 20 kWh per hour of

usage for high pressure hot water cleaning machine is can be alternative for such system, an inefficient one.

* Water filtration equipment is using 0.44 kWh however it works for grey waters that goes into the washing processes of boat’s bottoms. Also its efficiency in the specific appliance type is given as 474.700 kWh by EPA for 12 kW appliances and for 9 kW appliances it is 412.300 kWh annually.

* Consumption of drainage pump of IC Çeşme is low due to using new motors on the pumps. In a comparison with 1/3 HP sump pump drainage pumps are using half of the energy that is dedicated to pump out liquid material.

Water management practices in IC Çeşme Marina covers wide range of activities starting from training and education sessions to gray water applications below listed techniques just for water managements.

Table 40: Water Efficiency Applications of IC Çeşme Marina

Water Management and Conserving Education and Training Sessions with Staff
Grey Water Application
Water Re-use System on Bottom Washing Processes
Landscaping Techniques to Gain Water Efficiency
Plant Selection and Endemic Trees Growing
Sprinklers
Nozzles on Every Hose and Water Guns
Efficient Water Fixture
Irrigation Density and Scheduling

Grey water systems and re-use systems are showing their benefits at consumption end even though there is an effort for to save this water with electrical energy environmentally and as an economic value IC Çeşme Marina gaining multiple savings with this application. Sprinklers and their system use much more less water in a comparison with old methods of irrigation techniques.

Irrıgation density in IC Çeşme Marina is calculated with season effect where it is not needed watering is not going to take place also when there is real need irrigation is done heavily in order to make plants grow stronger. Reducing pot plants is needed due to water consumption in them is high.

87000 liters of water can be saved only by using landscaping methods. With plant selection addition to landscaping techniques approximately 130000 liters of water could be saved on a 100 m² land. More detailed version of this calculation is given in water system segment in appendix 3 table.

Olive trees especially do not need any type of irrigation. Other trees which do not give fruits are giving effect of ventilation and shading along with appeal factor.

3.5.6. Office Equipment Applications

- LED televisions instead of LCD televisions consume approximately one fourth of overall consumption per hours of usage however it could be considered as highly efficient in a comparison with old plasmas or old televisions with cathode rays or pretty old technologies of screens.
- Using laptops instead of desktop computers contribute to the overall efficiency however firm cannot supply personal computers to each worker thus working environment needs custom accessible and powerful computers to make various operations such as recording of security systems that is used with IP CCTV system. Apart from appeal factors old computer with cathode rays are consuming less but giving performance significantly considered low with low pixel rendering.
- Using Energy Star labeled products such as on inkjet printers, scanners, modems, computers, refrigerators, laptops, televisions and copy machines will allow them to save lots of energy efficiency.

In this segment consumption of every appliance is taken from energy star and comparison is made on their typical and energy efficient consumptions. In office equipment sections all of the machines and devices are efficient thanks to their consumption and low energy applications such as batteries on laptops or handling issues partially such as scanners.

* 18 Computers are put in a comparison with 0.1 kW unit computers and eventually some of the laptops in IC Çeşme Marina is so energy efficient that consumes 21W per hour when charging and uses this battery for at least 2 hours.

Table 41: Evaluation of Energy Efficiency of Office Equipment of IC Çeşme Marina

IC Çeşme Application	Efficiency Evaluation		Energy Efficient Application	Room For Improvement	Consumption
Refrigerator Freezer Bottom 52W Energy Star	Efficient	Not efficient	Energy Efficient Refrigerator Freezer Bottom	-Voltage Correction	454.8 kWh per year
18 Computers	Efficient	Not efficient	Energy Efficient Laptops	-	2592 kWh per year
7 Laptops 21W	Efficient	Not efficient	Energy Efficient Laptops	-	159.6 kWh per year
6 Computers with Flat Screen	Efficient	Not efficient	Energy Efficient Laptops	-	509.4 kWh per year
6 Desktop Computers	Efficient	Not efficient	Energy Efficient Laptops	-	0.1 kWh per hour of use
3 Laptop Computers	Efficient	Not efficient	Energy Efficient Laptops	-	0.05 kWh per hour of use
2 Modems 6W	Efficient	Not efficient	Energy Efficient Modems	-	16.4 kWh per year
4 pieces Inkjet Printer	Efficient	Not efficient	Inkjet printers	-	283.2 kWh per year
Wireless Router 6W	Efficient	Not efficient	Energy Efficient Wireless Router	-	13.2 kWh per year
LCD TV	Efficient	Not efficient	LED TV	-	0.09kWh per hour of use – 0.02 kWh per hour of use
2 Scanners	Efficient	Not efficient	Energy Efficient Scanners	-	1.04 kWh per year
3 Copy Machines 1600W	Efficient	Not efficient	Energy Efficient Copy Machines	-	1382.4 kWh per year

* In the office there are 6 desktop which uses 0.1 kWh and 6 desktop computers with flat screens which uses 0.7 kWh. All of them are considered energy efficient in a comparison with cathode monitors and cathode ray tube monitors.

* LCDs are more efficient than Plasmas whereas less efficient than LED televisions however televisions with cathode ray tubes are still have wide application areas.

* Modems, wireless router and two scanners are all new equipment that produced energy efficiently.

* There are Laser Printers that will top inkjet efficiency within 10 years however just for now inkjet printers are 4.5 kWh less consume electricity in a month.

* Three copy machines are energy efficient with their 1.6 kWh energy consumption in a hour according to energy star.

3.5. Conclusion & Discussion

In recent thirty years we have been witnessing great transformation of energy infrastructure change of all countries on world. Energy intensity lowering trend caught up mainly due to high need of energy, scarcity of these resources and ecological concerns. Marine tourism is on the other hand rarely met with energy efficiency phrase in the literature. In literature most of the energy efficiency related works are concentrated on engineering or various plants of industry. Marine tourism industry is mostly overlooked in this perspective. Few exceptions should be stated but they are focused on buildings such as aquariums or vehicles such as cruise ships. Regardless of the distinction marine tourism branches which are water sport tourism, cruise tourism and yachting tourism should be evaluated individually by their applications. Marine tourism has three branches which are water sport tourism, cruise tourism and yachting tourism. These sub topics have their own characteristics and own definitions. Each type conveys their activities on a complete different platform. Taking advantage of this research gap, author tried to illustrate energy efficiency applications for marine tourism industries by mentioning general energy efficiency applications, marine tourism and environment of its branches, lighting, HVAC and motor systems applications that specified to them and if there is a need to elaborate specific applications along with mentioning their specific applications that could be highlighted as niche.

Importance of energy efficiency studies is highly critical for developing countries like ours which depending on energy imports. In order to monitor energy consumption patterns and to discover the gaps between theoretical and practical differences in industry better following the applications closely shows great significance. While we live and do business we can contribute the energy efficiency and consume less and produce more at the same time. Contributions of this papers can be mentioned like this; detailed literature survey on overall lighting, HVAC, motor, residents and policy topics (1), detailed literature review on marine tourism energy efficiency applications under lighting, HVAC and motor systems (2), detailed literature review on yachting industry branch, marina, energy efficiency applications (3), setting out variables for marine tourism industries (4), bringing them to experts and gathering their opinion on the issues (5), according to those variables creating a consumption variables list with conventional and energy efficient methods (6), conducting a comparison with conventional methods with IC Çeşme Marina applications (7) setting out other points of improvement for each application on each system covering from core jobs to recreational points (8).

Energy efficiency variables for this research listed and with semi structured interviews expert opinions are gathered on the issue, with their contributions final energy efficiency variables for marine tourism industries has been set. Semi structured interviews are to get information from experts in detail and asking question to discuss variables in depth. It was also the most convenient method to reach as much as information is available. Conventional consumption of these variables levels determined in order to make a comparison on marine tourism company through semi structured interview.

Findings of this research show that there is a high efficiency graphic in IC Çeşme Marina. First of all lighting systems are covered with almost all optimum energy efficiency application with LEDs. Only exception is CFL usage which is the closest application to optimum application. Most important unmeasured applications are listed in that section according to that list no renewable energy applications took place in applications however automation and remote control systems saves lots of possible waste energy in the process.

In HVAC systems Marina uses old system combi boilers which can be replaced with hermetic or condensing versions, cascade system and VRV applications could be added to issue with heat pump extension. Heat pump installation is completed last year which is stated in detail in these papers. This changing makes stage of efficiency in HVAC section moderate however there are various alternatives to electric portable heaters. Same appliance work for HVAC section with remote controls waste heat recovery and insulation are well known methods that IC Çeşme Marina uses as well.

In motor systems it is clear that marina is using close to conventional methods but no more efficient than average good due to slow phase of technologic improvements meeting commercial demand. However in no more than one decade all the so-called efficient applications for today will be called highly inefficient. Lack of improvement devices and voltage correction practices will show its effect slowly by wearing out these machines and appliances by starting and turning off.

IC Çeşme Marina is highly efficient when it comes to water management systems most of the application points out the leading efficiency methods with high quality. There were so less points of improvements that only applications could be the guideline for many companies.

Office Equipment section could be mentioned with water management section for same scenario apart from minor downgrades such as using inkjet printers instead of laser printers and LCD screens instead of LED screens.

To conclude, in this research that is conducted in İzmir, author tried to evaluate energy efficiency in marine tourism industry with the help of marine tourism actors, a marina and marine tourism experts. Namely reaching that goal is accomplished by comparison of energy efficiency applications of IC Çeşme Marina with conventional and up to date applications by using many division of consumption. In author perspective as a country our policies on energy efficiency is going forward but hesitating more than it should do. For speaking marine tourism industry there should be a bigger focus on energy generation by using renewable energies. In order to go specific speaking for yachting industry there should be more electrical energy on engines. For marinas in this perspective there should be more electrical or hybrid models of heavy duty machines. For IC Çeşme Marina there should be more electrical appliances in all sections apart from HVAC.

Reliability of the electric appliances in critical positions for heavy duty vehicles and in industrial devices along with the emergency machines can be evaluated in marine tourism in future works at the same context. Software programs for energy efficiency designed for solely marine tourism industries can be investigated (1). Sole renewable energy propelled vehicles on the sea can be evaluated for marine tourism commercial activities with remote controls (2). Carrying tri-generation system on land facilities should be evaluated (3).

3.6. Limitations of Research

The research covers detailed literature review on energy efficiency applications and devices, a semi structured interview to get information on variables and evaluation with semi structured interview on a case study. Due to time and place restrictions every applications of energy efficiency are not included such as manning procedures or other uncountable or immeasurable practices. Energy efficiency is vast area that includes marina personal commuting style however author tried to include only measurable data that is collected from marina. The data concentrated on only one marina due to time and place restrictions. Some of the data are not specific for unified version such as consumption per hour of use and consumption per year this is mainly due to consumption hours of the application or machine or device was not recorded and author did not reach such information. Also even author had a chance to visit the marina and conduct semi structured interview, time restrictions for interview did not give an allowance to evaluate each machine when it is working. All information which is given verbally is accepted as honesty of IC Çeşme Marina personal. Another restriction for research as author tries to conclude papers there could be a development in such sectors or in general technology which cannot be determined and stated in these papers due to progressive work. This research is designed to cover all marinas in the literature review however some applications which can be heavily authentic could be exception for these papers. Findings of these papers are only focused on case study of IC Çeşme Marina and statistical data can be applied only to this situation. Accepted values of conventional consumptions could show differences on application to application or on device or machine differences.

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APPENDICES

APPENDIX 1

Existence of Implemented Energy Efficiency Law of Countries in Alphabetic Order

Country	Region	Energy efficiency law	Energy law with energy efficiency targets
Algeria	Africa	Y	Y
Argentina	Latin America	N	N
Austria	Europe	Y	Y
Benin	Africa	N	N
Bolivia	Latin America	Y	N
Botswana	Africa	N	N
Brazil	Latin America	Y	Y
Bulgaria	Europe	Y	N
Canada	North America	Y	N
Chile	Latin America	N	
China	Asia non-OECD	Y	
Colombia	Latin America	Y	Y
Croatia	Europe	Y	Y
Cyprus	Europe	Y	Y
Czech Republic	Europe	Y	N
Denmark	Europe	Y	N
Ecuador	Latin America	Y	Y
El Salvador	Latin America	N	N
Estonia	Europe	N	Y
Finland	Europe	Y	N
France	Europe	Y	Y
Germany	Europe	Y	Y
Ghana	Africa	N	N
Greece	Europe	Y	
Hong Kong	Asia non-OECD	Y	
Hungary	Europe	N	Y
India	Asia non-OECD	Y	
Indonesia	Asia non-OECD	Y	Y
Ireland	Europe	Y	Y
Israel	Middle-East	Y	
Italy	Europe	Y	Y
Japan	Asia OECD	Y	Y
Jordan	Middle-East	Y	N
Kazakhstan	CIS	Y	
Kenya	Africa	Y	N
Latvia	Europe	Y	N
Lebanon	Middle-East	Y	Y
Lithuania	Europe	N	Y
Malta	Europe	Y	Y

Mexico	Latin America	Y	N
Morocco	Africa	Y	y
New Zealand	Asia OECD	Y	Y
Nigeria	Africa	N	N
Pakistan	Asia non-OECD	N	N
Peru	Latin America	Y	Y
Poland	Europe	Y	Y
Portugal	Europe	Y	Y
Republic of Korea	Asia OECD	Y	
Romania	Europe	Y	Y
Russia	CIS	Y	Y
Senegal	Africa	N	
Serbia	Europe	Y	Y
Singapore	Asia non-OECD	Y	
Slovakia	Europe	Y	Y
Slovenia	Europe	N	Y
South Africa	Africa	Y	Y
Spain	Europe	Y	Y
Sri lanka	Asia non-OECD	Y	Y
Swaziland	Africa	N	N
Sweden	Europe	N	Y
Switzerland	Europe	Y	Y
Taiwan	Asia non-OECD	Y	N
Thailand	Asia non-OECD	Y	Y
Tunisia	Africa	Y	Y
Turkey	Europe	Y	N
Ukraine	CIS	Y	N
United Arab Emirates	Middle-East	N	N
United Kingdom	Europe		Y
United States	North America	Y	N
Uruguay	Latin America	Y	N
Vietnam	Asia non-OECD	Y	Y
Zimbabwe	Africa	N	N

Note: Gaps on the table are intentionally left blank due to sources put the note of will be updated in future.

Source: Combination of Enerdata and World Energy Council sources.

Source of website : (https://wec-policies.enerdata.net/) Date of Access: 10/10/2017.

APPENDIX 2

List of Implementations of Energy Efficiency in Electric Technologies

Energy Efficiency in Buildings	
Lighting	**Heating and cooling**
LED lighting	Programmable thermostats
Advanced lighting controls	Improved wall, floor, ceiling, and pipe insulation
Appliances	High-efficiency double and triple-pane windows
High efficiency industrial pumps and motors	Water-cooled heat exchanging
	Evaporative cooling systems
High efficiency commercial appliances (refrigerators, washers, dryers)	Ductless heat pumps for heating and air conditioning
Energy efficient residential appliances (refrigerators, vacuum cleaners, etc.)	Sealing doors, windows, walls, outlets, and fireplaces to reduce heat / cold loss
Variable refrigerant flow	Passive solar design
Water efficiency	Building energy monitors to identify opportunities to reduce wasted energy
High efficiency residential and commercial water fixtures	Energy efficient framing practices
	Heat recovery ventilation systems
High efficiency irrigation systems	Night ventilation cooling
	Passive ventilation design
Grey water re-use systems	Combined space and water heating air flow management

Transportation and Vehicle Efficiency Technologies	
Transportation	**Vehicle**
Telecommuting rather than commute by car	Low rolling resistance tires
Improved carpooling and ride-sharing programs and technologies	Lightweight materials (i.e. carbon fiber, aluminum, fiberglass)
Improved public transportation	Regenerative braking systems
Improved pedestrian infrastructure	High efficiency settings or dashboard fuel efficiency displays
Improved biking infrastructure	
Transportation Demand Management programs that support adoption of low-carbon transportation practices	Urban land use practices to reduce transportation demand (i.e. mixed use development, increased residential densities)

WWS Eleectric Power Generators and Low Temperature Heat Generators	
WWS Electric Power Generators	**Low- Temperature Heat Generators**
Onshore/offshore wind turbines	Geothermal heat pumps
Solar photovoltaics (PV) for rooftops and power plants	Natural geothermal heating
Concentrated Solar Power (CSP) plants	Solar thermal collection devices for heat
Geothermal power plants for electricity	In-stream hydroelectric turbines
Tidal turbines	Existing large hydroelectric reservoirs used more efficiently
Wave devices	Small hydroelectric reservoirs

Electricity, Heat, Cold and Hydrogen Storage	
Electricity Storage	**Cold Storage**
Geothermal	Chilled water tanks
Batteries	Ice storage
Pumped hydroelectric storage	**Heat Storage**
Hydroelectric power plant reservoirs	Hot water tanks
CSP with storage (either molten salt or phase-change material)	Rocks stored underground
	Thermal walls
Hydrogen Storage	Electrolyzes to produce hydrogen from electricity
Electric compressors to compress hydrogen	Tanks to store hydrogen for transportation primarily

Demand Response Technologies, Hydrogen Fuel Cell/Electric Hybrid Vehicles and Electric Vehicles	
Demand Response	**Hydrogen Fuel Cell/Electric Hybrid Vehicles**
Technology to enable remote start up and shut down of appliances and equipment that have flexible demand (i.e. water heaters, HVAC equipment, electric vehicles)	Long-distance trucks
	Buses
	Trains
	Ships
Utilities provide incentives for industry, companies, and individuals to shift their electricity use for certain uses and processes to non-peak times of day or	Aircraft
	Construction equipment

night	Agricultural equipment
Electric Vehicles	Non-road vehicles
Light-, medium-, and heavy-duty on road automobiles	Construction equipment
Short-distance trucks, buses trains, ships, aircraft	Agricultural equipment
Motorcycles	Forklifts

Source: Mark Z. Jacobson, *“List of Electric Technologies; Efficiency Measures to Replace 100% of Fossil Fuels Used for Energy Worldwide and Timelines for their Implementation”*, June 5, 2017.

APPENDIX 3

List For Energy Efficiency Evaluation of IC Çeşme Marina

Variables	**Conventional methods**	**IC ÇEŞME Applications**
LIGHTING SYSTEMS		
800 Lumen Incandescent 60W	14 kWh per month	
800 Lumen Halogen 43W	10.3 kWh per month	
800 Lumen CFL 14W	3.4 kWh per month	
800 Lumen LED 12W	2.9 kWh per month	
800 Lumen Metal Halide 10W	2.5 kWh per month	
800 Lumen High Pressure Sodium (Outdoor) 9W	0.009 kWh per hour of use	
800 Lumen Low Pressure Sodium 6W	0.006 kWh per hour of use	
800 Lumen Mercury Vapor 30W	0.03 kWh per hour of use	
1100 Lumen Incandescent 75W	18 kWh per month	
1100 Lumen Halogen 53W	12.7 kWh per month	
1100 Lumen LED 14W	3.4 kWh per month	
1600 Lumen Incandescent 100W	24 kWh per month	
1600 Lumen Halogen 72W	17.3 kWh per month	
1600 Lumen CFL 23W	5.5 kWh per month	
1600 Lumen LED 18W	4.3 kWh per month	
2600 Lumen Incandescent 150W	36 kWh per month	
2600 Lumen Halogen 105W	25.2 kWh per month	
2600 Lumen CFL 36W	8.6 kWh per month	
4’ Fluorescent 2 Bulb Fixture 100W	24 kWh per month	
High Pressure Sodium Bulb 75W	22.5 kWh per month	
Mercury Vapor 150W	45 kWh per month	
Incandescent: 750 to 1000 hours / Halogen: 1000 to 3000 hours / CFL: 8000 to 12000 hours / LED: 18000 to 22000 hours		
250 W Metal Halide versus	MH: 8484 kWh per year	

130 W LED (7 Units) (Outdoor)	LED: 4053 kWh per year	
Lighting with Passive Infrared Sensors(Rarely Occupied Areas)	Old: 14 kWh per month New: 9.8 kWh per month	
Lighting with Ultrasonic Sensors (Usually Occupied Areas)	Old: 14 kWh per month New: 10.5 kWh per month	
Lighting with Audible Sensors (Industrial Areas)	Old: 14 kWh per month New: 12.6 kWh per month	
Lighting with Ultrasonic Sensors	Old: 14 kWh per month New: 11.2 kWh per month	
Lighting with Dual-technology Sensors (Passive Infrared and Ultrasonic)	Old: 14 kWh per month New: 8.4 kWh per month	
Solar Daylight Lamps (Night Illumination)	Old: 14 kWh per month New: 1 kWh per month	
Installing Efficient Electronic Ballast	W/o EB: 45 kWh per month W EB: 26.25 kWh per month	
Installing Timer Sockets	W/o TS: 14 kWh per month W TS: 12.6 kWh per month	
HVAC SYSTEMS		
COOLING and VENTILATION		
Portable A.C. 5000BTU 500W	75 kWh per month	
Window A.C. 10000BTU 1000W	150 kWh per month	
Fan Ceiling 100W	36 kWh per month	
Fan Exhaust Midi 150W	9 kWh per month	
Fan Portable Box Fan 20” 100W	18 kWh per month	
Fan oscillating 125W	22.5 kWh per month	
Fan Whole House 400W	72 kWh per month	
Fan Dual Unit 200W	36 kWh per month	

<table>
<tr><td>Furnace Fan 350W</td><td colspan="2">105 kWh per month</td><td></td></tr>
<tr><td>Portable Industrial Dehumidifiers</td><td colspan="2">1 kWh per hour of use</td><td></td></tr>
<tr><td>Humidifier 75W</td><td colspan="2">4.5 kWh per month</td><td></td></tr>
<tr><td>Vaporizer 750W</td><td colspan="2">1080 kWh per year</td><td></td></tr>
<tr><td>Dehumidifiers</td><td>4.2 kWh per day of use
1000 kWh per year</td><td>0.22 kWh per hour of use
2.1 kWh per day of use
500 kWh per year</td><td></td></tr>
<tr><td>Table Fan</td><td colspan="2">Old: 0.025 kWh per hour of use
New: 0.01 kWh per hour of use</td><td></td></tr>
<tr><td>Dehumidifier 65 pint 790W</td><td colspan="2">71.1 kWh per month</td><td></td></tr>
<tr><td>Dehumidifier Whole Houser 111W Energy Star</td><td colspan="2">79.9 kWh per month</td><td></td></tr>
<tr><td>Ceiling Fan</td><td colspan="2">Old: 0.75 kWh per hour of use
New: 0.25 kWh per hour of use</td><td></td></tr>
<tr><td>Room Air Purifier</td><td colspan="2">Old: 550 kWh per year
New: 225 kWh per year</td><td></td></tr>
<tr><td>Air Purifier 100W</td><td colspan="2">48.9 kWh per month</td><td></td></tr>
<tr><td>Air Purifier (EnergyStar) 30W</td><td colspan="2">16.3 kWh per month</td><td></td></tr>
<tr><td>Home type Air Conditioner</td><td>4 kWh per hour of use
8000 kWh per year</td><td>1 kWh per hour of use
2000 kWh per year</td><td></td></tr>
<tr><td>Home type Inverter Air Conditioner</td><td colspan="2">Old: 1.8 kWh per hour of use
New: 1.3 kWh per hour of use</td><td></td></tr>
</table>

Range Hood Light and Fan 185W	5.6 kWh per month	
Cooling towers, heating pumps and boiler fans motors combined with and without VSD (for industrial building)	W/o VSD: 1946407 kWh per year W VSD: 1362485 kWh per year	
HEATING		
Heating Stove (wood)	2.9 kWh 2500 kcal 65% efficiency	
Heating Stove (lignite)	3.50 kWh 3000 65% efficiency	
Heating Stove (propane) (kilogram)	12.87 kWh 65%efficiency	
Heating Stove (fuel oil)	10.69 kWh %80 efficiency	
Room Heater	100000 kcal %80 efficiency	
Heating Boiler	407.05 350000 kcal %80 efficiency	
Combi Boiler	23.25 kWh 20.000 kcal %90 efficiency	
Condensing Combi Boiler	23.25 kWh 21078 kcal %110efficiency	
Hermetic Combi Boiler	23.25 kWh 20640 kcal %110 efficiency	
VRF Cascade Condensing Boiler (one unit) (for complex buildings)	3 kWh per 9hour of use %120 efficiency	
VRF Cascade condensing	2000 kWh	

Boiler with Heat Pump extension	%120 efficiency	
4’ Baseboard 1000W	150 kWh per month	
6’ Baseboard 1500W	360 kWh per month	
8’ Baseboard 2000W	480 kWh per month	
Heat Pump Ductless 3600W	648 kWh per month	
Heat Pump Standard 5000W	750 kWh per month	
Portable Heater Low Settings 750W	90 kWh per month	
Portable Heater Medium Settings 1000W	120 kWh per month	
Portable Heater High Settings 1500W	180 kWh per month	
Space Heater 1800W	1.8 kWh per hour of use	
Electric Driven Air Furnace 15000W	2250 kWh per month	
Electric Driven Air Furnace 10000W	1500 kWh per month	
Electric Wall Heater 1500W	225 kWh per month	
Electric Blanket	0,2 kWh per hour of use	
Electric Heater Fan	Old: 3 kWh per hour of use New: 2 kWh per hour of use	
Electric Blanket 100W	6 kWh per month	
Heat Lamp 250W	5 kWh per month	
Heating Pad 75W	1.5 kWh per month	
Back-up heating appliance 2000W	240 kWh per year	
Hot Water Immersion Heater	3 kWh per hour of use	
MOTOR SYSTEMS		
Submersible Water Pump	0.4 kWh per hour of use	
Vacuum Cleaner	Old: 0.7 kWh per hour of use New: 0.2 kWh per hour of	

	use	
Strimmer	Old: 0.5 kWh per hour of use New: 0.3 kWh per hour of use	
Lawnmower	Old: 1.4 kWh per hour of use New: 1 kWh per hour of use	
Electric Mower	1.5 kWh per hour of use	
Cordless Drill Charger	Old: 0.15 kWh per hour of use New: 0.7 kWh per hour of use	
9" disc sander	1.2 kWh per hour of use	
3" belt sander	1 kWh per hour of use	
Sump Pump 1/3 HP 800W	0.8 kWh per hour of use	
Compressor 600W (1HP)	144 kWh per year	
Bug Zapper 40W	144 kWh per year	
3/8” Drill 400W	48 kWh per year	
Bench Grinder 600W	14.4 kWh per year	
Cordless Tool 34W	37.2 kWh per year	
Lawn Mower 1500W	90 kWh per year	
Motor 600W (1HP)	144 kWh per year	
Sander Belt 300W	18 kWh per year	
Sander Orbital 500W	30 kWh per year	
Circular Saw 1000W	60 kWh per year	
12” Chain Saw 440W	42 kWh per year	
Reciprocator Saw 750W	45.6 kWh per year	
Saber Saw 400W	24 kWh per year	
10” Table Saw 1800W	108 kWh per year	
Soldering Gun 600W	72 kWh per year	
Treadmill 1500W (2HP)	270 kWh per year	
Power Shower	Old: 10.5 kWh per hour of	

	use New: 7.5 kWh per hour of use		
Garage Door Opener 350W	0.35 kWh per hour of use		
Waterpik 100W	0.1 kWh per hour of use		
¼” Drill 250W	0.25 kWh per hour of use		
½” Drill 750W	0.75 kWh per hour of use		
1” Drill 1000W	1 kWh per hour of use		
14” Band Saw 1100W	1.1 kWh per hour of use		
3-phase motor (20.76 kW) (160 hours of work in a month)	3771.7 kWh per month		
336 kW fixed speed booster pump, water supplier (medium voltage drives)	92848.3 kWh per month 1114180 kWh per year	80715 kWh per month 968580 kWh per year	
Old Standard Motor EFF3 with efficiency of 90.4% versus High efficiency EFF1 with 94.8% efficiency (3000 rpm) (75% load) (75 kW)	EFF3: 600000 kWh per year EFF1: 584779 kWh per year		
Old Standard Motor EFF3 with efficiency of 90.4% versus High efficiency EFF1 with 94.8% efficiency (3000 rpm) (75% load)	90 kWh per hour of use 720000 kWh per year	75 kWh per hour of use 636313 kWh per year	
100 HP Industrial Motor System Correction on Voltage from 2.5% to 1% (8000 hours per year)	596560 kWh per year	587060 kWh per year	
100 HP Diesel Engine for a Yacht with 8 to 9 meters	120 liters per hour on displacement speed		
WATER SYSTEMS			

Aquarium Pump 10 Gallon 80W	57.6 kWh per month	
Aquarium 50 Gallon 250W	180 kWh per month	
Bathtub with Jets 75W	6.8 kWh per month	
Hot Tub Heater 5000W	900 kWh per month	
Hot Tub Pump 1000W	30 kWh per month	
Heat Pump Water Heater 50 Gallons 600W	144 kWh per month	
Heat Pump Water Heater 80 Gallons 655W	157 kWh per month	
Irrigation Pump 150W	1314 kWh per year	
Pool Heater 275W	201 kWh per year	
Pool Pump 2250W	1643 kWh per year	
Sewage Pump 1/3 HP 25W	9 kWh per year	
Spa (electricity)	1144 kWh per year	
Spa (gas)	31200000 BTU per year	
Tankless Water Heater: 2 Users 14000W	315 kWh per month	
Tankless Water Heater: 4 Users 28000W	952 kWh per month	
Water Cooler with Hot Water400W	72 kWh per month	
Water Dispenser	0.1 kWh per hour of use	
Water Feature	0.035 kWh per hour of use	
Water Fılter and Cooler	Old: 0.1 kWh per hour of use New: 0.070 kWh per hour of use	
Water Filtration 440W	28.6 kWh per month	
Water Heater 30 to 50 Gallons 4500W	404.8 kWh per month	
Water Heater 30 to 50 Gallons High Efficiency 4500W	385 kWh per month	
Water Heater 80 Gallons	423 kWh per month	

4500W			
Water Heater 80 Gallons High Efficiency 5500W	385.2 kWh per month		
Well Pump 660W	39.6 kWh per month		
Watering (Water) (100 m’) (with season effect 5 moths of irrigation of plants) (per year)	870645 liters per year		
Using Spray Nozzles and Water Guns(Water) (100 m’) (with season effect 5 moths of irrigation) (per year)	8265612.75 liters per year		
Using Spray Nozzles and Water Guns(Water) (100 m’)	19837470.6 liters per year		
Landscaped area consumption(Water) (100 m’) (with season effect 5 moths of irrigation) (per year)	783581.5 liters per year		
Landscaped area and plant selection (Water) (100 m’) (with season effect 5 moths of irrigation) (per year)	740048.25 liters per year		
Landscaped area, plant selection, using water guns and spray nozzles (Water) (100 m’) (with season effect 5 moths of irrigation) (per year)	6.92038.6 liters per year		
Weather-based Irrıgation Controllers, Landscaped area, plant selection, using water guns and spray nozzles (Water) (100 m’) (with season effect 5 moths of irrigation) (per year)	444028.95 liters per year		
Rain Controller, Freeze Sensor and Weather-based	2604167 per month	1562500 per month	

Irrıgation Controller (372000 square feet) (Water)	31250000 liters per year	18750000 per year	
Older Toilets versus New Toilets (water) (5 flushes)	48358.6355 liters per year 26.5 liters per flash	8842.7219 liters per year 4.85 liters per flash	
Two 160 bar high pressure cleaning machine one operating at 1200 liters per hour and other 700 liters per hour	72 minutes (700 liters per hour)	26 minutes(1200 liters per hour)	
Hot Water usage on cleaning with high pressure cleaners versus Cold Water	100 minutes (Cold Water)	60 minutes(Hot Water)	
High Pressure Hot Water Cleaning Machine	20 kWh per hour of usage		
KITCHEN			
Blender 300W	7.2 kWh per year		
Bread Maker 500W	42 kWh per year		
Can Opener 100W	1.2 kWh per year		
Coffee Maker 1000W	180 kWh per year		
Espresso Maker 360W	32.4 kWh per year		
Deep Fat Fryer 1500W	48 kWh per year		
Electric Fry Pan 1500W	180 kWh per year		
Electric Grill Counter Top 1425W	132 kWh per year		
Electric Kettle 1200W	144 kWh per year		
Food Processor 360W	1.8 kWh per month		
Microwave 0.75 cubic feet 600W	15 kWh per month		
Microwave 1.25 cubic feet 1500W	15 kWh per month		

Mixer Stand 100W	0.3 kWh per month	
Popcorn Maker 1400W	1.4 kWh per month	
Rice Cooker 500W	2 kWh per month	
Toaster 1000W	18 kWh per month	
Toaster Oven 1500W	18 kWh per month	
Waffle Iron 1200W	4.8 kWh per month	
Electric Oven with 6” Range1400W	21 kWh per month	
Electric Oven with 8” Range 2000W	30 kWh per month	
Oven: Broiler 3200W	48 kWh per month	
Upright Freezer 66W Energy Star	47.5 kWh per month	
Chest Freezer 41W Energy Star	28.5 kWh per month	
Refrigerator Freezer Bottom 67W	48.2 kWh per month	
Refrigerator Freezer Bottom 52W Energy Star	37.9 kWh per month	
Refrigerator Freezer Bottom and Door Ice77W	55.4 kWh per month	
Refrigerator Freezer Bottom and Door Ice 60W Energy Star	43.2 kWh per month	
Refrigerator Side-x-Side 73W	52.6 kWh per month	
Refrigerator Side-x-Side 57W Energy star	41 kWh per month	
Refrigerator Door Ice 78W	56.2 kWh per month	
Refrigerator Door Ice 61W Energy Star	43.9 kWh per month	
Rice Cooker	Old: 0.25 kWh per hour of use New: 0.2 kWh per hour of use	

Oven	2.15 kWh per hour of use	
Microwave	Old: 1.7 kWh per hour of use New: 0.6 kWh per hour of use	
Coffee Maker	Old: 1.4 kWh per hour of use New: 0.8 kWh per hour of use	
Electric Kettle	Old: 3 kWh per hour of use New: 1.2 kWh per hour of use	
Food Blender	Old: 0.4 kWh per hour of use New: 0.3 kWh per hour of use	
Toaster	Old: 1.8 kWh per hour of use New: 0.8 kWh per hour of use	
Cooker Hood	Old: 0.15 kWh per hour of use New: 0.07 kWh per hour of use	
Conventional Electric Oven	Old: 2.5 kWh per hour of use New: 2 kWh per hour of use	
Dishwasher	Old: 1.5 kWh per hour of use New: 1.2 kWh per hour of use	
Combination of Refrigerator and Freezer	Old: 0.4 kWh per hour of use New: 0.15 kWh per hour of	

	use		
BATHROOM			
Front-load Washer 100W	3.6 kWh per month		
Front-load Washer 150W Energy Star	5.4 kWh per month		
Top-load Washer 477W	12.9 kWh per month		
Top-load Washer 322W Energy Star	11.6 kWh per month		
Clothes Washers (energy) (300 loads)	375 kWh per year	280 kWh per year	
Clothes Washers (water) (300 loads)	26100 liters per year 87 liters per use	15000 liters per year 50 liters per use	
Commercial Clothes Washers (water) (per load)	127 liters per load	49 liters per load	
Commercial Clothes Washers (energy) (per load)	2018 kWh per month 24216 kWh per year	1682 kWh per month 20180 kWh per year	
Clothes Dryer	1 kWh per hour of use 500 kWh per year		
Clothes Dryer 3400W	31.8 kWh per month		
Iron	Old: 2.4 kWh per hour of use New: 1 kWh per hour of use		
Hair Dryer 1500W	6.75 kWh per month		
Hair Blow Dryer	Old: 2.5 kWh per hour of use New: 1.8 kWh per hour of use		
Electric Shaver	Old: 0.015 kWh per hour of use		

	New: 0.02 kWh per hour of use	
OFFICE EQUIPMENT		
Computer and Monitor 100W	12 kWh per month	
Laptop 21W	1.9 kWh per month	
Modem 6W	1.1 kWh per month	
Inkjet Printer standby and printing 71W	5.9 kWh per month	
Laser Printer printing and standby149 W	15.4 kWh per month	
Wireless Router 6W	1.1 kWh per month	
TV with Cathode Ray Tube	0.15 kWh per hour of use 180 kWh per year	
Mobile Phone Charger	0.005 kWh per hour of use 1.85 kWh per year	
Computer with Cathode Monitor	Old: 0.2 kWh per hour of use Old: 506 kWh per year New: 0.1 kWh per hour of use	
Computer with Flat Screen	Old: 0.8 kWh per hour of use Old: 97 kWh per year New: 0.7 kWh per hour of use	
LED TV	Old: 0.06 kWh per hour of use New: 0.02 kWh per hour of use	
LCD TV	Old: 0.25 kWh per hour of use New: 0.09 kWh per hour of use	
Old Plasma TV	Old: 0.344 kWh per hour of	

	use New: 0.261 kWh per hour of use	
Tablet Computer	Old: 0.01 kWh per hour of use New: 0.005 kWh per hour of use	
Tablet Charger	Old: 0.015 kWh per hour of use New: 0.01 kWh per hour of use	
Smart Phone Charger	Old: 0.007 kWh per hour of use New: 0.004 kWh per hour of use	
Home Type Internet Router	Old: 0.015 kWh per hour of use New: 0.005 kWh per hour of use	
Inkjet Printer	Old: 0.03 kWh per hour of use New: 0.02 kWh per hour of use	
Scanner	Old: 0.018 kWh per hour of use New: 0.01 kWh per hour of use	
Laptop Computer	Old: 0.1 kWh per hour of use New: 0.05 kWh per hour of use	
Desktop Computer	Old: 0.45 kWh per hour of use New: 0.1 kWh per hour of use	

Radio Clock	Old: 0.002 kWh per hour of use New: 0.001 kWh per hour of use	
25" Color TV	0.15 kWh per hour of use	
Fax Machine 65w	0.065 kWh per hour of use	
Copy Machine 1600W	1.6 kWh per hour of use	
DVD Player 12W	2.8 kWh per month	
DVD Player Energy Star 6W	1.3 kWh per month	
HD DVR Set-Top Box 32W	22.9 kWh per month	
HD Receiver Set Top Box 20W	14.3 kWh per month	
Satellite Dish 15W	1.8 kWh per month	
Surround-sound System 6W	0.5 kWh per month	
35” LCD TV 65W	10.1 kWh per month	
35” LED TV 100W	15 kWh per month	
45” LCD TV 110W	17 kWh per month	
45” LED TV127W	19.1 kWh per month	
46” Plasma TV 225W	33.8 kWh per month	
55” LCD TV 155W	23.3 kWh per month	
55” LED TV 165W	25.3 kWh per month	
54” Plasma TV 325W	48.8 kWh per month	
CCTV Security Cameras (per unit of camera)	Old: 10 kWh per hour New: 6 kWh per hour	
CCTV Security Cameras (system of 10 cameras and recorder with PC consumption)	100 kWh + 5 kWh + 12 kWh = 117 kWh per hour	
MISCELLANOUS		
Adjustable Bed 85W	10.2 kWh per month	
Baby Monitor 1W	0.7 kWh per month	
Dialysis Machine 1450W	94.2 kWh per month	
Nebulizer 1035W	47 kWh per month	
O’ Concentrator 460W	3972 kWh per year	

Game Console	Old: 0.2 kWh per hour of use New: 0.12 kWh per hour of use	
2013 Microsoft Xbox One 110W	20 kWh per month	
2010 Nintendo Wii 14W	2.4 kWh per month	
2013 Playstation 4 137W	24.2 kWh per month	

Source: Energy Star, 2018; EPA, 2018; Işık, 2010; Mattison and Korn, 2012; McWhimney et al., 2004; Sanchez et al., 1998; Stein and Meier, 2000; Suzuki Marine, 2018; Timur, 2013; Water Sense, 2018;Yanmar, 2006; Yavuz et al., 2014; https://www.energy.gov.

APPENDIX 4

List of Energy Efficiency Applications Ground Zero Point in Turkish To Inform Marine Tourism Experts

Işıklandırma			**Aletler**		
LED ampüller			Yüksek verimli endüstriyel motor ve ya pompalar		
Zaman ayarlı prizler					
İleri ışıklandırma kontrolü			Yüksek verimli buzdolabı, çamaşır makinesi, süpürge gibi ev aletleri		
Gelişmiş elektronik balast					
Akıllı ışıklandırma			Yüksek verimli buzdolabı, çamaşır makinesi, kurutucu gibi iş aletleri		
Sensörler					
Isıtma ve Soğutma			Değişken debili soğutucu akışı (klima)		
Programlanabilir termostat			**Su verimliliği**		
Duvar, zemin, tavan ya da boru yalıtımı			Yüksek verimli ev ve iş yeri su demirbaşı (ayarlanabilir başlıklı musluklar gibi)		
Pimapen			Verimli sulama sistemleri		
Binanın pasif olarak güneş ışığından yararlanması			Gri su tekrar kullanım sistemi		
			Araçlar		
Kapı, cam gibi ısı kaybının olacağı yerlerin yalıtımı			Yuvarlanma direnci düşük tekerlekler		
Gece havalandırarak soğutma sistemi			Hafif materyaller (karbonfiber, aluminyum, fiberglas gibi)		
Buharlaşmalı soğutma			Rejeneratif fren sistemi		
Enerji verimli çerçeveleme yalıtımı			Yüksek verimli yakıt tüketimi ayarları ve ya göstergeleri		
Borusuz ısı pompası			**Elektrikli araçlar**		
Isı geri kazanım sistemi			Forklift-motorbisiklet-hafif/orta ve ya ağır iş yol araçları-inşaat ve ya operasyon aracı-ekipman-tarım aracı-kısa mesafe otobüs, tren, tır ve ya hava aracı		
Su soğutmalı ısı değiştiricisi					
Pasif havalandırma sistemi					
Alan ve su ve hava ısıtma yönetimi			Yol aracı olmayan her türlü araç		
Isı depolama			**Soğuk depolama**		
Sıcak su tankları			Soğutulmuş su tankı		
Termal duvarlar			Buz depolama		
Yeraltına ısıtmak amaçlı taş depolama			**Hidrojen depolama**		
Hibrit araçlar (Hidrojen ve ya Elektrik yakıt pilli)			Elektrik kompressörlerinde hidrojen kullanma amaçlı		
Uzun mesafe tırları-otobüs-tren-gemi-hava aracı-inşaat veya operasyon aracı-ekipman-tarım aracı			Elektrolizör elektrikten hidrojen kullanma amaçlı		
			Ulaşım amaçlı tanklarda depolama		
Talep cevabı			**Elektrik depolama**		
			Bataryalar yoluyla saklama		

Uzaktan kontrol (akıllı termostatlar gibi önceden ısıtma,su ısıtması gibi görevleri yapabilecek teknoloji)			Jeotermal/ hidroelektrik santral tankları ve ya pompalanışı/ erimiş tuz ve ya faz değişim malzemesi ile üretilen enerjiyi saklama		
Elektrik harcamalarını yük zamanında yapıp puantiye farkından zarar görmemek için kullanılan kaynaklar			**Düşük sıcaklıklı ısı jeneratörleri**		
			Isıtma için günışığı termal depolama aletleri		
Rüzgar-Su-Güneş güç jeneratörleri			Jeotermal ısı pompaları		
			Doğal jeotermal ısıtma		
Rüzgar türbinü (kıyıda ya da denizde)			**Ulaşım**		
Yek odaklı güneş enerji santrali			Evden çalışma		
Jeotermal enerji santrali			Araç ve yolculuk ortak kullanım program ve teknolijeleri		
Güneş enerjisi çatıda ve ya güç kaynağında			İleri toplu taşıma		
Med cezir türbini			İleri yaya altyapısı		
Dalga aletleri			İleri bisiklet altyapısı		
Buhar güçlü hidroelektrik türbinü			Düşük karbon tüketimi için ulaşım talep yönetimi		
Küçük hidroelektrik deposu					
Büyük hidroelektrik deposunun verimli kullanımı			Ulaşım için halk arazi kullanımı uygulamaları (bina yoğunluğu gibi)		
Elektrikli araç şarj altyapısı			**Fosil yakıt tüketiminin azaltılması için elektrikli aletler**		
Ev araç şarjları			Hava ve su ısıtmak için ısı pompaları		
Park noktalarında şarj istasyonları			Elektrkli ocaküstü setleri / çim biçme makinesi/ vantilatörler/ kurutucu/ fıskiyeler		
Yüksek ısılı endüstriyel ekipmanlar					
Elektrik arklı fırınlar			Elektrikli çim biçme makinesi		
Yalıtkan Isıtıcılar			**Uzun mesafe İletişimleri**		
Elektrik emisyonlu fırınlar			Yüksek voltajlı doğru akım hatları		

Source: Mark Z. Jacobson, *“List of Electric Technologies; Efficiency Measures to Replace 100% of Fossil Fuels Used for Energy Worldwide and Timelines for their Implementation”*, United States of America June 5, 2017 and United Nations Economic Commissions For Europe, *Study on the application of energy efficiency and renewable energy advanced technologies in Central Asian Countries*, Kraainem, Belgium, 2013.

APPENDIX 5

Context of Semi Structured Interviews with Marine Tourism Experts

Questions in panels

Question directed to Aziz Güngör at 01:48:00 of the Panel

Question: What are the applications of renewable energy in cruise tourism other energy efficiency applications? Would not be prosperous for ports and ship at the same time?

Answer; "Teşekkür ediyorum sorunuz için. Tabi dünyada ki bütün küresel eğilimleri baktığımız zaman, hepsini dile getirmek mümkün değil ama, çok önemli bir konu bahsettiğiniz konu. Yeni inşa edilen gemilerin bir çoğunda özellikle temiz yakıt konusu çok ciddi şekilde ele alınmakta. Bir çok yeni firmanın hibrit motorlarla özellikle sıkıştırılmış gaz LNG dediğimiz doğal gaz ve CNG dediğimiz (Compress Natural Gas) makinalarıyla inşa ettiğini görüyüroruz bu çok önemli. Bunda tabi akdeniz pazarında ki avrupa birliği uygulamaları çok önemli sulphur'un kısıtlanması yakıt için bir çok firmayı aslında buna sevk etti. Bu işin gemi endüstrisi tarafında bir de limanların ve destinasyonların sürekliliği bakımından çevreye duyarlı tesisler olarak faaliyet göstermeleri çok önemli. Bu anlamda türkiye çok ilerledi özellikle; denizcilik ulaştırma ve haberleşme bakanlığı yeşil liman uygulamalarını faaileyete geçirdi ve 14 limanımımız sertifika aldı: kuşadası bodrum marmara limanlarımızda çevreye zarar veren unsurlar üretmiyoruz tabi bunları salt kruvaziyer liman işletmeciliği yapan limanlar için söylüyorum; türkiyede kombine limanlar var hem kruvaziyer turizmi hem ticari limancılığın yapıldığı limanlar var burada dökme yük elleçlemesi olabiliyor hava kalitesini etkileyen bir takım yüklerin elleçlemesi olabiliyor. Bunlar açısından bu çok önemli dünyada da ciddi bir hassasiyet var. 3. Ayakta limanları konuştuk taşımacıları konuştuk tüketici ayağına baktığımızda kruvaziyer turizmi yolcularının özellikle firma ve destinasyon tercih ederken çevreye saygılı limanları, çevreye saygılı destinasyonları ve firmaları da karar mekanizmalarına dahil ettiklerini görüyoruz. Bunlar bahsetmesekte bu çok kapsamlı ayrıntılı ve bambaşka bir konu teşekkür ederim.

English Translation:

“When you look at the global dispositions, naming all of them is impossible but, it is really important. In new building sector clean fuel issues are taken seriously. Lots of new ships have been built with LNG and CNG machines. In this context applications of EU in Mediterranean market on legislation on sulphur have directed many firms to do that. In industry of ship in the sector, it is important that sustainability of destinations and ports act susceptible. In this are Turkey has been progressing especially with ministry of transportation, maritime and communication applied green port application and 14 ports have this certificate such as Kuşadası, Bodrum, Marmaris ports are the facilities. We do not produce factors that put dangers on environment in our ports but I am mentioning solely cruise ports. There are ports in Turkey that makes combined actions of both cruise and trade activities at the same time, in those places unfortunately handling of bulk cargoes that can produce air pollution. In this perception world is highly sensitive on this issue. When we look at last stage which is consumer, we can see that tourist add sustainability of ports and destinations to their decision making process.”

Question directed to Can Akaltan at 01:52:00 of the Panel

Question: IC Çeşme Marina have been applying energy efficiency applications such as; gray water re-cycling and auto shutoff valves what are you planning to imply in near future?

Answer: <u>Öncelikle çok teşekkürler bu çok güzel bir soru. Biz IC çeşme marina üretimi olarak yenilenebilir enerjiye çok büyük önem veriyoruz.bu konularda çok heyecanlanıyorum ve sürdürülebilir ve yenilenebilir enerji ile ilgili çalışmaları yakından takip ediyorum. Bununla ilgili çok çalışmamız var Çeşme de ki ilk elektrikli araba şarj istasyonunu getiriyoruz ilk ve tek olacak hem ticari hem yatçılar için iki tane şarj istasyonumuz olacak. Bunlardan bir tanesi super şarj edilebilir bir saatte arabayı şarj edebilen diğeri de *öksürük nedeniyle duyulamıyor* saatte şarj edebilen bir cihaz olacak. Onun dışında ben çok uğraştım esasen marinanın bütün enerjisini sürüdürülebilir kaynaklardan elde etmek için çevre hedefimiz gereği bizim asıl hedefimiz marınanın karbon ayak izini 0’a indirebilmek ama açıkçası çok kolay</u>

olmadı çünkü deniz kıyısında olduğumuz için solar panelleri mendireğinize koymak çok uygun olmuyor maalesef çok fazla bakım onarım gideriniz oluyor o yüzden kazandığınız enerjiye değmiyor yani bir yatırım yaparken o yatırımın mutlaka “feasible”olması lazım. Çatıları düşündük ama bizim dizaynımız ödüllü bir dizayn bunu kolay kolay yapamıyoruz ama bunu yapan ve ya yapacak olan marinalar var türkiye içerisinde onu da biliyorum yine vazgeçmedim enerji kooperatifi kurmak istedim ben; türkiyede çok ilginç bir mevzuat var enerji kooperatifi kurduğunuz zaman marina dışında bir yer satın alıp onun içine bir güneş enerjisi ya da rüzgar enerjisi santrali kurup o elektriği kullanabiliyorsunuz bununla ilgili temiz enerji sertifikası alabiliyorsunuz. Ama bununla ilgili pek çok sorunla karşılaştım şu an için olurunda değilim ama yine de araştırmaya devam ediyoruz şu son geçiş dediğim gibi 15 sene de turizm sektörünün gelişim hızına baktığınız zaman inanılmaz bir hıza gelişiyor her geçen sene bu hızlanıyor. O yüzden sanıyorum 5 sene içerisinde bu feasible türüne ulaşmış olacağız. Marinanın karbon izini tamamen yok etmesi de bir 10 sene içerisinde olacaktırdiye düşünüyorum.”

English Translation:

“We, as IC Çeşme Marina service providers, are leaned on renewable energy applications. Personally I am feeling excitement and closely following the news on sustainable and renewable energies practices. There is an undergoing work, we have. We will bring the first and only electric charge station in Çeşme. There will be two charge station one for commercial and one for yachters. One of them going to be super chargeable model that takes 1 hour to charge a car and other one takes *ineligible due to coughing * hour to charge a car. Other than that, I particularly concentrated on to meet all energy demands of the marina with renewable energies. One of the reasons was our environmental goal that is to reduce carbon footprint of marina to 0 level. Strictly speaking, it is not quite easy. When you are at shore installing solar panels to your jetty unfortunately not quite clever choice for feasibility in addition to that feasibility show itself in maintenance factor, the energy you spent should be lower than you get. In order to not mess with our award-winning design we could not put solar panels to our rooftops however I know some of the marinas are doing this. I did not gave up on this issue. I wanted to establish an energy cooperative, there is an interesting legislation that you can built an energy center that include solar or wind energy for instance you can use that energy in your work place and get certificated by doing so, however there were many difficulties and cool down process for now but we will continue to our research in this way. The last 15 years were in terms progressive development marine tourism has been performing and improving day by day. I believe in 5 years we can able to imply feasible type of applications and in 10 years marinas could remove their carbon footprint."

Private Interviews

Question: Q
Answer: A

Private interview with Can Akaltan (General Manager at IC Çesme Marina)

Q: Which energy efficiency applications are available in marina?

A: LED lighting, controllable systems and sensors almost all of the lighting devices are in use. Our hotel made out of wooden therefore it is hard to use walls as storage actor. Other than that, where applications create a contrast with design we are not trying push to imply. For instance evaporative cooling systems and thermal insulation methods were implied. In summers, north winds are effective in our place; vaporization of the sea directly affects cooling which thought at design stage and positioning. Last year we installed heat pumps to all restrooms we invested to that and heat exchangers. In heat exchangers our system works in this flow; water to air. Grey water reuse systems and high efficiency of irrigation systems are in use. In the operation aspects washing of bottoms of yachts are really effective thanks to collecting water again and again by filtering. Forklifts and Yachts that use solely electric power are not available technologies to mass use but the most important one in this technology is electrical lift but 80 tons is heavy to use electrical power however I believe those are going to be ready in near future. I see as the last step to cut back all carbon footprints in marinas. Hybrids are in use. Geothermal energy is not close. Electric charge station and integration of all clean energy aspects such as Tesla and Nissan lifts are already in our system and hybrid fuel systems going to be available too. Wind energy in WWS systems is considered loud for recreational area. In addition to that shadow effect of the turbines can distort customer's satisfaction and comfort levels. Efficiency of wave energy is low although there are implications in England and Ireland they did not use it efficiently. I know that the biggest potential in energy area is wave energy however there is still a capacity to improve. It will be like solar energy in 10 years for us. Quiet, it is under the water and you do not see working it and act as calmer of the water.

Q: Is there any possibility of being more effective in energy area in winter such as producing and storing?

A: Like I said before due to our design Tesla's rooftops and other aspects that distort visual aspects are not my favorite or cannot apply to marina due to color and design issues. Blue design of marina is not getting along in color scale with black roof tiles. Design factor and leisure factor are where we concentrated though you are right technically.

Q: What are the possible implications of energy efficiency in marina industry?

A: I genuinely believe electric motors and solar energy are going to be crucial for energy. You cannot get wind or wave 100 per cent at every time. For instance I in my spared attend wind sailing races. In 5 minutes you can race at full blown wind however when it is cut you have to wait till next wind but solar energy is not like that always there for you, power factor does not fluctuate. Only problem within solar energy is when it is cloudy your expenses in energy rises however we are luckier than the most by getting 300 days in a year it is sunny in our area.

Private interview with Yaşar Karabacak (Kuşadası Harbor Master)

Q: Are there any energy efficiency application in port of Kuşadası? What are the cruise implications of energy efficiency to the sector?

A: Port uses mains voltage for supply in terms of electricity and there are generators other than that. These generators are for lighting, heating, cooling and for security. Port did not use any sort of energy efficiency additionally in operational section.

Q: Do port make periodic maintenances and repairing of these generators and what are the time window for them?

A: I am not in charge of those devices eventually electric engineers are responsible for them. By looking at flawless work I can say they do this periodic maintenance and repairing.

Q: Did port apply any energy efficiency applications in secondary operational areas such as building?

A: Our building is built in 1982 therefore we are at the stage of rebuilding. We eventually have to obey the energy efficiency standards in public buildings. Smart building or green building or green port approaches are not in use in our envisioned standards. Needs of procedure has been satisfied and hardware are at satisfying levels. However in new building standards those are undertaken facts. Before energy efficiency we are more concerned with safety at this point. The buildings most important tests such as earthquake test are conducted.

Private interview with Özgür Altınkaya (Ulusoy Çeşme Port Assistant Manager)

Q: Are there any energy efficiency applications in port?

A: We are using smart conduit boxes in order to minimize the losses of electricity. We use mains electricity supply. Flow of electricity is observed with smart meters. In manual version of these meters it is hard to detect which boats consumes how much energy due to this reasons losses and leakage reaches higher in ports that do not use this system. Also there are contoured version of electrical panels that enables customer use electrical supply with down payment method and when you do not have contour you are not utilize the system this one also reduces losses and enables us to reduce. In lighting some of the places use solar energy systems such as roofs of conduit boxes however in Turkey when we look at overall trend renewable energy is in the stage of crawling. Most of the lighting systems are applied such as LED systems.

Q: Did port apply any energy efficiency applications in secondary operational areas such as building?

A: Of course we use high efficient appliance, PVC windows and other small saving methods. Those are factors that have been paid attention by us however actual energy consumption in marina is yachters. Even when nobody is on board of yacht, yacht has needs like charging batteries. Equipment and devices which are on board play crucial role in energy efficiency. There are lots of applications such as LED management, passive/active systems, smart camera devices and etc. In marina efficiency related with these aspects and we are mostly providers to some extent.

Q: What are the operational activities that can be more energy efficient or did you apply any efficiency factors?

A: The most basic operations of marina are mooring, towing, landing/ launching and pilotage. Fuel consumption in boats is limited and lifts have the same conditions. Lighting could be where you can be efficient.

Q: Do port make periodic maintenances and repairing and what are the time window for them?
A: Depending on the aspects of boat it changes. Some boats are wooden sand papering, placing of the boat should be evaluated and landing and launching should

be done in careful manner and within the plans and programs. Effectively using land area is directly connected with responsibilities of land operation managers.

Q: In which level of managerial choice of energy utilization of a marine tourism firm should be evaluated? Should it be on personal level or organizational level?

A: Saving or efficiency of the firms is interrelated with investments. The first thing a firm should do is investment in order to gain efficiency. 4 years in the past, expense that arises from switching old conduit boxes was around 350.000 Turkish Liras. Probably this expense got too much higher. Without making this investment sufficient efficiency would not be satisfied moreover. Moreover regulations and legislations of energy efficiency could be evaluated on governmental level by stating the standards. Government wants CE certificated cabling in ports which arises from ISPS rules. This is a standard that needs to be met. In marinas or in overall marine tourism sector lack of standardization show itself. On personal level it would not be at desired stage in my opinion it should be on governmental stage.

<u>Private interview with Haslet Sever (Head of Professional Yachting Association)</u>

Q: Which energy efficiency methods and applications should be considered by yachters? What are the possible improvable consumption reductions?

A: The biggest problem in industry sailing with boats slowly changes their vehicle from sailboats to motorized yachts and even catamaran which uses topsails and wind energy in our minds as an image, slowly started to use motors and changes into motorized catamarans. However new developments are on the horizon such as electric and hybrid motors by filling batteries via solar energy. There are hybrid improvements also however in the industry it is not applied and mass did not use these applications at this point. In my opinion biggest consumption is fuels moreover technically speaking, personal efficiency is another abuse of energy in context of efficiency. Due to lack of management in manning on yachts, we observed that a captain on a yacht could be forced perform duties of stewards and cabin boys. This is the problem in the process of teaching and shaping the way of thinking in our seamen. Also super yachts, especially longer boats than 24 meters are complete energy monsters that exploiting energy resources. This is because of the equality of these luxury yachts owners are really high earners community such as petrol company owners in Middle East region or Russian holdings owners. In relatively smaller boat section energy applications that we see are solar and wind energy formulas that charge the battery in order to cut back to the desired level of energy consumption. In new technologies there are generators that when working produce energy to refill battery and when your system is back on again that consumed energy enters the system via inverters and redressor however it is a plus of an already existing system that belong two phase and three phase systems. Efficiency is not in the level that we wanted. Reducing energy needs of appliances via using new generation appliances that consumes less energy and wattage enabling of batteries are what happening in yachting industry by replacing small appliances in engine rooms took place, some of the cooling systems such as evaporative systems works in 12 watt and 24 watt took place, refining and lighting systems designed in this way and even air conditioning system designed in this way. The problem of energy efficient applications is first investment cost is not on the same level with old technology appliances.

Q: What are the applications of renewable energy in yacht tourism and do you believe that it is effectively used by industry? Or will be used?

A: One of the Cousteau's works was related with renewable energy that waves which pops to boats shaft moves the main energy turbines and produces energy. I thought that work was never practically introduced. If I remember correct I saw in a documentary that and may be wind energy that taken by boats upper structure can send this energy to bottom structures. Solar energy is already an application that has been used on yachts non-operational places and roofs of ships after reduction in first investment costs and improving design quality of the primitive technologic design of solar panels. In some cases glasses that produces electricity has been applied on yachts which uses full glass on upper structure. Also de-activating some of the components of climate conditioners which have more than one compressor can satisfy both at the same time air conditioning in the place and energy consumption in the process. Only disadvantage in this application is heating of climate conditioner. Also in our ship we also use waste management applications for sustainability however this applications are for big yachts that manning and business of the yacht are more complex than smaller boats. This application is more appropriate to aesthetic of yacht. Although there are extreme systems they did not meet with masses in the market unfortunately. At this stage more of the focus on storage of electricity on boats in order to re-use afterward. In actual conditions yachting industry is not limited on energy consumption issue moreover luxury is not rational in real life consumptions due to nature of joy in richness.

Q: In which level of managerial choice of energy utilization of a marine tourism firm should be evaluated? Should it be on personal level or organizational level?

A: Like I stated before energy efficiency is a broad topic that managing personnel and managing operation are being core. Even waste management is a branch of this broad topic. Lowering tempo by reducing compressors are not systematic movements in energy efficiency. I believe it is on the personal level not on systematic level that comprises technologic, managerial and design processes.

*Note: Quote of Sever Captain's on Cousteau's work is applied in a narrowed manner with OTEC (Ocean Thermal Energy Conversion) systems and one of the biggest promoters of this system is grandson of the famous scuba-diving inverter, Fabian Cousteau (OTEC symposium, 2016).

<u>Private interview with Murat Özbek (MARTEK Sales Represantative)</u>

Q: Which energy efficiency methods and applications should be considered by water sport enthusiasts and firms? What are the possible improvable consumption reductions?

A: In my main specialty area in water sport, which is sailboats, do not need any type of energy consumption. In motorized water sports energy efficiency methods are limited. Yes, there are fuel differences such as using electricity to some degree however trust point in water sports is the main cause of continuous usage of fossil fuels for instance when driving a car in roadways when you are running out of gas you could go to a station but you are not in the same situation on sea. My interest areas are yachts, sailboats and surf which cards are same and will be same. I do not foresee a future that applications will change drastically.

Q: What are the applications of renewable energy in yacht tourism and do you believe that it is effectively used by industry? Or will be used?

A: Like I stated before we always use wind in sailboats. Although it is already existing renewable energy water sport tourism utilize energy efficiency. There are some WWS applications such as using wind energy to convert electricity and boat can utilize pushing factor of the sea when she goes however those systems are at the age of crawling. Those systems are not ready for market entrance but there are some applications no one can deny. When you go to a marina one can see metal turbines. In addition to that solar panels on the sailing boats could be mentioned but frame is not so big. Eventually water sport tourism is a wide range scale which contains even swimming narrowing that to the point using a vehicle and doing on the sea reduces many topics from conversation. Cable water skiing and cable wakeboard and other motorized water sport tourism market mostly uses electric energy which is considered as clean however I do not believe that they produce full time what they consumed.

Q: Do water sport resorts and other marine tourism components apply any energy efficiency applications in secondary operational areas such as building?

A: I believe that most of the work in this context should be done by engineers rather than managers of water sport companies. Context should be enlarged with water sport tourism to the point that every action with vehicle on the sea should be considered in marine tourism activity. Most of the researches fall into futuristic progress area that related with sail boats and WWS energy factors such as wind. The main reason lays behind the issue that do not find enough place to improve in context of energy is already using WWS, exergic differentiation points and energy efficiency applications. One of the futuristic methods that are related with water sport tourism is using sail fabric to get wind energy pushback factor of the sea in wave energy, solar energy by solar panels and heat differences in electricity energy and cooling and heating facilities and flow of the sea that bumps into shaft to electricity via turbines. Exiting the water sport tourism area, we can build sails on top of the cruise ships but it is too not designable and application of it could distortion factor of luxury however it can add points in cell of differentiation. Lastly I do not believe that there is much space for energy efficiency in the topic of water sport marine tourism.

Private interview with Hasan Tunç Kurtluoğlu (İMEAK Chamber of Shipping Bodrum Branch Office Board of Director Member)

Q: Which energy efficiency methods and applications should be considered in marine tourism? What are the possible improvable consumption reductions?

A: Actually it is really important issue that concerned with using less energy to get same level of work done. Renewable energy is the final point of discussion such as wind water and sunlight. And water pushback force levels are not used in the market. Arguments and applications are not on the desired level. Electric producing and filling battery technologies are not on the desired level as well. Heating of machines on the time using for another job can be utilized but not in the market as well. Energy conservation on boats with these implications could rise to 70 per cent. Eliminating of diesel motors in order to replace with electric motors on the way along with solar energy improvements which we do not utilize however 8 months in a year produces continuous energy. In my perspective we are only using solar energy in some cases and in some boats only for filling batteries but we should utilize it when first investment costs are on the level that we all want. Lastly bays of our nation should be protected for sake of land efficiency there would not be any marine tourism activity.

Q: What are the operational activities that can be more energy efficient in yacht industry or did you apply any efficiency factors?

A: We are using electric appliances that vary between 24 to 220 wattages in yachts. Heating and cooling applications are available with exhaust system in circulation of water. By pass systems are also applicable to yachts. Solar panels and flexi panels are on the corner. Using flexi panels instead of sunshades on yachts can be the main application in order to fight with carbon emissions.

Q: Do marine tourism components apply any energy efficiency applications in secondary operational areas such as building?

A: I believe that marinas are selling electricity on really high prices and some of them produce electricity with renewable energies but mostly it is on the symbolic rates. Even some of the marinas are on the shore of continuous flow of water such as rivers but they do not utilize that flow to produce energy.

Q: In which level of managerial choice of energy utilization of a marine tourism firm should be evaluated? Should it be on personal level or organizational level? Do they need certification in order to show more energy prosperity?

A: On the yacht, building a yacht or marina side of the yacht industry do not use these approaches on organizational levels mostly it is on personal level. The development in this sector bound to creativity of the yacht builders sector. I personally believe that person on the boat knows better than others however I also believe there should be legislation and regulations in order to replace diesel engines with electric engines. Although there is a need for incentives there is no visible regulation change in the process. Government should be active in this type of incentives. Chances are go in danger because the incentives are needed in that place.

Q: Does yachting industry make periodic maintenances and repairing and are the time window for them appropriate?

A: That is not appropriate for instance battery systems which have life span of 5 years are mostly thrown in basket in 2 years. Redressors and entrance of mains supply electrics in the battery systems should be more developed.

*Note: In contrast of what Kurtluoğlu stated on regulations on electric motors it will make electric motors more expensive in near future in Turkey by taxes updates. Its expenses are climbing from 0 per cent to 25 per cent instantly (Ministry of Finance, 2018).

Private intervie with Tuncay Kuleli (Professor in marine tourism)

Q: Which energy efficiency methods and applications should be considered in marine tourism? What are the possible improvable consumption reductions?

A: In my opinion we should consider first yacht industry sector then second cruise industry. Renewable energy, biodiesel and biodiesel fuels and solar energy are where the focus must be on. In terms of vehicles yacht are one step ahead and it will show their difference in overall consumption.

Q: Do marine tourism components apply any energy efficiency applications in secondary operational areas such as building?

A: There are legislations on new buildings it is going to be mandatory for every commercial activity. Smart buildings are going to be necessity. Gray water re use systems should be applied. Firms should not have to wait any incentives because standards are in use regulations are in use therefore it should change immediately. Developments in this area certainly will give benefit to firms.

Q: What are the operational activities that can be more energy efficient in marine tourism industry? What are the competition advantages of energy efficiency in the market?

A: I gave a presentation on green destinations implications yesterday, some of the critical aspects of green destinations and sustainability in marine tourism are having an action plan against climate change and how much a firm applies renewable energy in consumed fuel management. On a competition standpoint in the market it of course being more energy efficient and being more environmentally friendly will ensure benefits for a firm. Also marketing of the destination when a firm in marine tourism such as marina is environmentally friendly should be easier. It is a precondition of getting a big plus as a destination. How much a firm applies energy efficiency in supply chain or in main operation has become an important determinant that does not concerned with you having marina, sea taxi or floating hotel. Case scenario of using main operation side conventional methods but using highest energy efficiency in hotels is not adequate anymore for a destination. All factors should be on the same level of energy efficiency. However ideology for yacht industry works in the same manner for cruise tourism as well. Beside that I know cruise ships tend to have higher emission rates. Diminishing exhaust gases would be appropriate for them. Solar energy and wind energy at voyage stage could be a beneficiary factor for them. At this point it is dependent on engineering and firm’s mentality change.

Q: In which level of managerial choice of energy utilization of a marine tourism firm should be evaluated? Should it be on personal level or organizational level? Do they need certification in order to show more energy prosperity?

A: Evaluating efforts in energy efficiency in adequate or not perspective would be harsh because people are actually putting some effort to these topics. I believe that when it is on parallel lines that simultaneously enable managerial stage to take actions and individuals are going to be actor of this process. Like I stated before it would be unfortunate to consider these efforts as non-adequate. World is changing really fast in accordance with that how we produce or consume energy is also changing really fast. We have to be prepared not only at government level but also local destinations level.

Private interview with Aziz Muslu (Assistant Professor in Maritime Management/ Marin Tourism Expert/ Captain)

Q: Which energy efficiency methods and applications should be considered in marine tourism? What are the possible improvable consumption reductions?

A: I do believe that energy efficiency mentality is partially being implied. Generators and solar panels are being applied. LED lighting methods are in use. Timer sockets and other programmable lighting efficiency techniques have been implied to marina and blue voyage sectors. Even if electronic ballast, smart lighting and sensor technology and other lighting methods has been implied diesel fuel consumption is continuously progressing in the sector via generators and other appliances. Some of the technologies on land are not directly applicable to marine tourism sector for instance sensor technology due to corrosion on sea vehicles did not find their places on board, there is a definite need to innovate them. Innovating equipment in terms of corrosion and other sea factor will enable marine tourism actor to use more efficient equipment on vehicles and on land operational apparatus. Even there are trials of hybrid vehicles and electric vehicles they did not meet with exact requirements because of investment costs. I believe they are not in adequate position for being applied. Due to shortening and minimizing boats and its areas marine tourism actors are avoiding to fill their precious place with high cost solar panels. Water heaters and regaining heat losses into the system with exhaust systems has been in actual use which makes there is some improvement in energy efficiency applications roughly. Incentives for hybrid and electric vehicles are needed and most importantly investment costs for applications and equipment should be reduced.

Q: Do marine tourism actors make periodic maintenances and repairing and do you find it satisfying?

A: New building sector focused on laminated boats which eliminates the need for maintenance and caulking need along with it. There were big costs especially caulking, applying pastes and painting, generator, electric, effort of workers etc. these were adding up to total expenses. In laminated boats handling it is much easier and eventually there should be implications of innovative technologies like materials that long last and effectively sail. In this context materials should be more environmentally friendly. Waste management what we can additionally mention in this perspective. However we improved a lot using second hand motors that come from truck on boats to the level of discussing efficient motors moreover it is a must for sector that motors should be evaluated. In construction of new yachts we can say efficiency of the machine and boat mostly interdependent on how new is the technology for example to that losses of oil is totally diminished in new motor technologies or contamination of bilge water is going to be less probability which makes yachters more environmentally friendly and consuming less energy.

Q: Do marine tourism components apply any energy efficiency applications in secondary operational areas such as building?

A: In launching and landing operations of marinas using efficient lifts can be one of the applications. Annual maintenance factors like sand papering, applying paste then again sand papering, polishing, altering sea water into clean water to wash boat, in order to do that working separators to get clean water, painting of boats make these processes insufficient in terms of efficiency. In motor yachts you have to wash boat periodically which means consumption. Even though there are too many consumption factors to firms and harmful activities of the firm to the environment as an additional negative impact, in marine tourism, economic activity relies on luxury and you as a marine tourism actor have to shine that boat. These consumption still compound marina expenses. I believe that long lasting materials are going to be crucial for yacht industry. In cruise sector, there is not much we can say about, the main operational component is prepared to voyage by dry-docking. It is a clear dilemma that how sector will grow. Another factor is bigger boats especially wooden gullets which enters the market causes bigger expenses and bigger investments. In my perspective economically we have to courage more sustainable boats and yachters in using hybrid systems and at final we have to make it a trend or fashion to use sustainability in order channelize people into thinking that is going to be more useful for instance saying instead of I have this much long boat which uses this much energy saying I have a environmentally friendly eco-boat will enable prestige motive in yacht industry. At the end of the day having a boat is a cause of prestige.

Q: In which level of managerial choice of energy utilization of a marine tourism firm should be evaluated? Should it be on personal level or organizational level? Do they need certification in order to show more energy prosperity?

A: In mandatory military service everyone picks up cigarette ends from ground though everyone still throws their cigarette ends to the ground. It is hard to create awareness by totalitarian governmental interventions. There should be principles of voluntary actions in order to create awareness. Other terms are not appropriate for probability of marine tourism actors to get in action. When you pass the awareness of when you use too much water, fuel or even electricity you deforming nature, you adding up one more bit to global climate change and you harm, individual motivations will be stimulated and consumers will not only look from the binoculars of expenses and consumption they are going to think about sustainability factor of tourism as well. I had one customer that cried over GHG emissions of the plane that carries his product and rejected in China and had to bring back the product. That person is on that level of awareness.

Q: What do you want to add on meeting point of energy efficiency and marine tourism?

A: Gullets lengths are getting higher and they are genuinely feeling the problem of finding bays to enter due to size and draft issues. In my opinion we should rather than maximizing boats in order to utilize every bay or trying to meet with bay and the gullet we have to make trend of designed modern boats that efficiently utilize applications of energy efficiency and also there should be given attention to environmental factors at designing stage. Even we can establish a brand to apply this system to marine tourism sector. Other than that equipment segment is slowly changing their head to that conversation. Expenses in that area could be diminished with incentives, lowering taxes and import and export of this equipment should be more easier. Research points in energy efficiency in marine tourism should be related with coatings, spray paints, poison protectors or comparison of boats that equipped with old and new machine and their maintenance expenses differences. Especially comparison of expenses can be the good point for pushing yachters and other marine tourism actors to be more efficient in terms of consumption. Also comparison of commercial yachts and gullets could be another topic. Diminishing poisonous gases, poison protectors and paints that deforms nature could be evaluation point too.

Private interview with Captain Enver Cem Hodoğlugil (Muğla Municipality Port Authorized Officer/ Maritime Transportation and Certification Officer)

Q: Which energy efficiency applications are available in ports? Did ports apply any energy efficiency applications in secondary operational areas such as building?

A: One of our technical personal made his research on paying energy demand of Bodrum port hall of passengers by solar energy. We do care about energy efficiency in Muğla ports with projects like these and implying all of the projects to ports. We are at the stage of finding funds to finance the projects. We did not make any allocation of land usage in terms of energy efficiency. In addition to that we do not use cooling or heating techniques to the port. Due to direct connection of mains supply electricity we did not created a fund for energy efficient vehicles, tools, equipment or appliances. In most of the cases government is concerned with those issues. Conduit boxes and electrical charge station are going to be available in all city ports. Due to we do not handle and focused to carry passengers we are not utilizing electric or hybrid vehicles. However electric appliances will be more reachable in next years.