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Preface

The International Conference on Sustainable Energy and Energy Calculations (ICSEEC) provides a forum for accessing to the up-to-date and authoritative knowledge from both engineering and science research areas related to energy science and technology.

The first ICSEEC was successfully taken place in Koycegiz, Mugla, Turkey during the period 12-14 April 2019. During the conference more than 40 paper-talks were delivered, which were under Energy Science and Technology, Enviromental Science and Engineering, Motivation, Electrical Engineering, Development and Utilization of Resources. The conference received a significant attention by the contributions from around the world.

We would also like to take this opportunity to thank many people. First and foremost we want to express our deep appreciation to the keynote speaker, the invited speakers, the session chairs and the reviewers for their efforts and kind help in this conferemce. Final thanks go to all authors and participants at ICSEEC2019 for helping to make it a productive and interactive meeting.

We acknowledge that the conference was succesfully completed as being hosted by Koycegiz Mugla Governorship and Municipality and also importantly as being financially supported by MEVASIS of Istanbul.

The Organizing Committee of ICSEEC2019.

Contents

Fabrication and Electronic Properties of a Diode Based On Organic Material

Bayram Gunduz

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Abstract

The anticipated advantages of organic materials rely on the possibility to fabricate organic opto-electronic devices. In here, a diode based on organic material (TDCV-TPA semiconductor) was fabricated. The current-voltage (I-V) measurements under dark were taken with a Keithley 2400 sourcemeter. The electronic parameters such as rectification ratio (r), reverse saturation current (I_o), ideality factor (n) and barrier height (ϕ_B) of the diode were obtained.

Introduction

Organic semiconductors (OSCs) have been studied since the early 1950s [1], dealing essentially with small molecules, e.g., condensed hydrocarbons and dyes [2]. The anticipated advantages of organic materials rely on the possibility to fabricate organic opto-electronic devices such as organic photovoltaics (OPVs), organic photovoltaic cells (OPVCs), organic field-effect transistors (OFETs), organic phototransistors, organic light emitting diodes (OLEDs), organic photodetectors and organic resonant tunneling diodes [3, 4, 5, 6].

Thienylenevinylenetriphenylamine functionalized with peripheral dicyanovinylene groups (TDCV-TPA) was designed as an isotropic material for solar cells [7]. TDCV-TPA displays an appreciable photoluminescence (PL) quantum efficiency [8].

The main aim of this study is to fabricate a n-Si/TDCV-TPA/Al diode and investigate its electronic properties by current–voltage measurements under dark.

Experimental

Active layer material

In here, tris[4-(5-dicyanomethylidenemethyl-2-thienyl)phenyl]amine (TDCV-TPA) small-molecule semiconducting dye was used as active layer. TDCV-TPA was purchased from Sigma–Aldrich Co.

The fabrication of the diode

To fabricate n-Si/TDCV-TPA/Al diode, n-type Si was purchased from the Sigma-Aldrich Co. Firstly, the smooth cut n-Si wafer was degreased with diamond cutter. Then, n-Si wafer was chemically cleaned with well-known RCA cleaning procedure [9]. Cleaned n-Si wafer was rinsed in deionized water (DIW) and was dried by high purity nitrogen [10]. Then, without wasting time a high purity aluminium (Al) metal was thermally deposited on the whole back surface of the n-Si using PVDHANDY/2S-TE thermal evaporation system. Then, TDCV-TPA active layer was thermally evaporated onto the whole bright surface of the n-Si-substrate. Finally, the Al metal was deposited on active layer. The rectifying contacts were formed in the form of circular dots of 1.930 mm diameter. The schematic structure of the n-Si/TDCV-TPA/Al diode is shown in Figure 1. The current-voltage (I-V) measurement was recorded under dark with a Keithley 2400 sourcemeter.

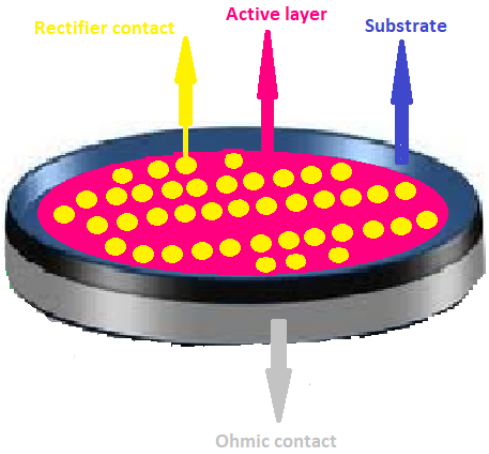

Figure 1: The schematic structure of the diode.

Results and discussion

Electronic properties of n-Si/TDCV-TPA/Al diode

The current-voltage (I-V) characteristics of n-Si/TDCV-TPA/Al diode for forward and reverse region were measured and were indicated in Figure 2(a,b) for non-logarithmic (I vs V) and semi-logarithmic (lnI v. V) currents vs V, respectively. The n-Si/TDCV-TPA/Al diode indicates a rectifying diode in forward-bias region.

The rectification ratio (r) is a significant parameter for a rectifying diode and is given by,

$$r = \frac{I_f}{I_r} \tag{1}$$

where I_f is forward current and I_r is reverse current. The rectification ratio of n-Si/TDCV-TPA/Al diode was found to be 76.71.

For a non-ideal diode, the standard equation of diode can be expressed by taking into account serial resistance can be written by:

$$I = I_0 \left[e^{-\frac{q(V-IR_s)}{nkT}} \right] \tag{2}$$

where q is the electronic charge, R_s is the series resistance, n is the ideality factor, k is the Boltzmann constant, T is the temperature and I_0 is the reverse saturation current.

The saturation current of the diode was obtained from the linear portion intercept of logI at V=0. Then, the ideality factor value of the diode under dark was found to be 2.774.

The barrier height of n-Si/TDCV-TPA/Al diode under dark was obtained as 0.929 eV.

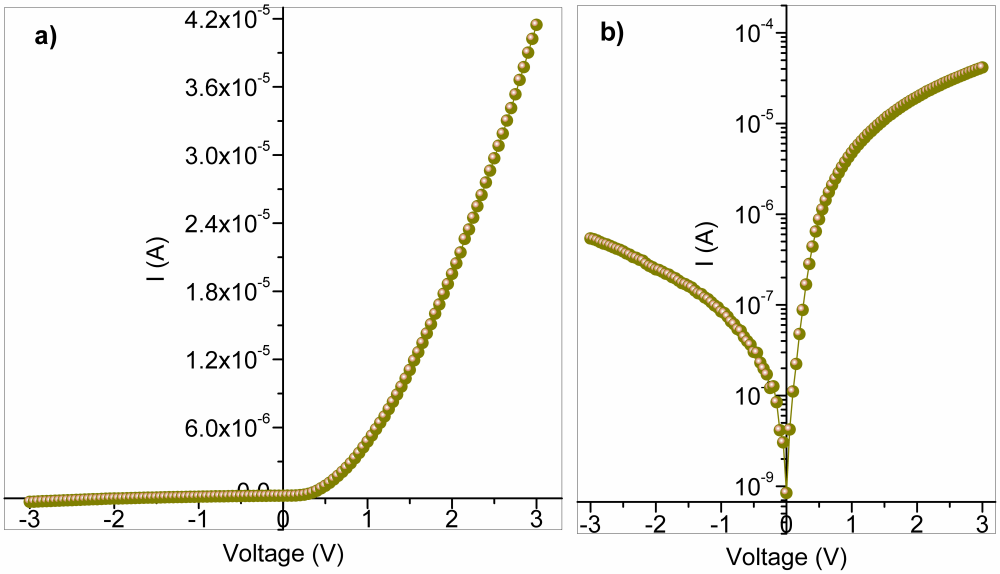

Figure 2: The plots of the a) I vs V and b) lnI vs V of the diode.

Conclusions

In here, the n-Si/TDCV-TPA/Al diode was fabricated using a soluble isotropic organic semiconductor. The current-voltage (I-V) characteristics under dark were investigated and its electronic parameters such as rectification ratio, reverse saturation current, ideality factor and barrier height were obtained. In further studies, I-V measurements of diode under different light intensities, even C-V measurements can be also taken. The effects of light on the diode can be examined. In other words, photoelectric properties can also be examined.

Acknowledgements

This study was supported by The Management Unit of Scientific Research Projects of Mus Alparslan University (MUSBAP) under Project BAP-17-EMF-4901-09.

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Optoelectronic Device Based On Gold Nanoparticle

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Abstract

Gold nanoparticles (GNPs) are versatile materials for a wide applications and have been used for centuries. More recently, these unique optoelectronic properties have been researched and utilized in high technology applications. In this study, a gold nanoparticle was used and electronic, photonic and optoelectronic characteristics of optoelectronic device based on GNP were investigated. Many interesting and useful results were obtained.

Introduction

Nanoparticles (NPs) obey the laws of quantum mechanics due to their small dimensions, so NPs have the ability to participate in quantum tunneling. Gold nanoparticles (GNPs) are versatile materials for a wide applications and have been used for centuries because of the vibrant colors produced by their interaction with visible light, easy modified surface chemistry and well-developed synthetic procedures [1, 2, 3]. In recent years, these unique optoelectronic properties have been investigated. The GNPs have been used in many high electronic, photonic and optoelectronic applications including electronic conductors, therapeutic agents, drug delivery in biological and medical applications, organic photovoltaics, catalysis and sensory probes [4, 5].

Electronic and optoelectronic devices, from computers and smart cell phones to solar cells, have become a part of our life [6]. Gold nanoparticles present distinct physical and optical properties and these properties vary depending on their shape, size, agglomeration state and surface structure. In here, the electronic, photonic and optoelectronic characteristics of optoelectronic device based on gold nanoparticle were investigated.

Experimental

Material

Gold nano-urchins were used in this study and purchased from Sigma-Aldrich Company. There are some synonyms such as gold nanoparticles and non-functionalized

Table 1: Product properties of gold nano-urchins.

Molecular weight (g/mol)	196.97
Average particle size (nm) (in 0.1 mM PBS)	50
Molar Concentration (M)	5.83×10^{-11}
Particles (/mL)	3.51×10^{10}
Surface area (nm2)	7.85×10^{3}
Particle Volume (nm3)	6.54×10^{4}

gold nanoparticles of this material. The product properties of the material is given in Table 1.

Figure 1 indicates the TEM of 100 nm gold nano urchins in the literature [**?**].

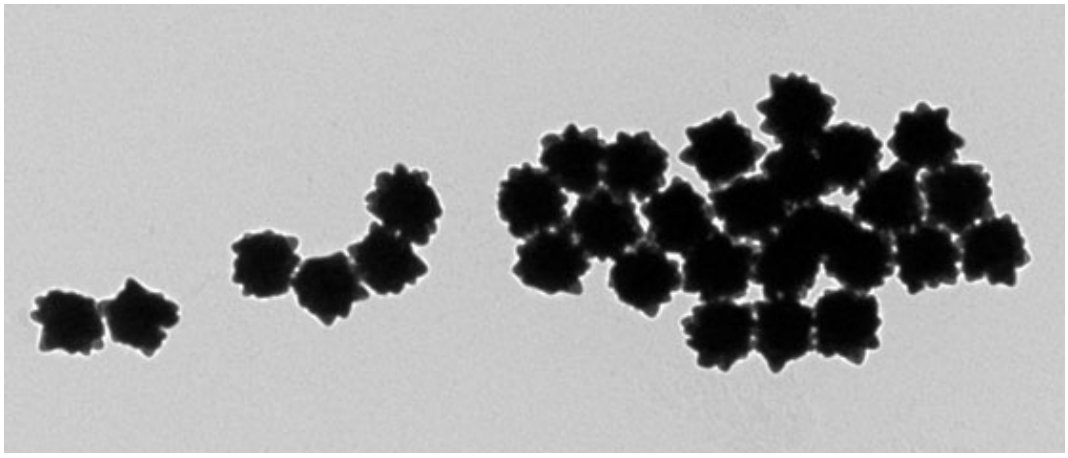

Figure 1: TEM of 100 nm gold nano urchins [**?**].

Measurements

The UV–Visible absorption spectra of the gold nano-urchins were performed with a Shimadzu model UV-1800 spectrophotometer. The current-voltage (I-V) measurements of the optoelectronic device were recorded with a Keithley 2400 sourcemeter.

Results and discussion

Gold nanoparticles (GNPs)

There are various sizes of gold nanoparticles (GNPs) and their sizes vary from 1 nm to 8 µm. Also, GNPs exhibit different shapes such as spherical, sub-octahedral, octahedral, decahedral, icosahedral multiple twined, multiple twined, irregular shape, tetrahedral, nanotriangles, nanoprisms, hexagonal platelets and nanorods as seen in Figure 2 [8].

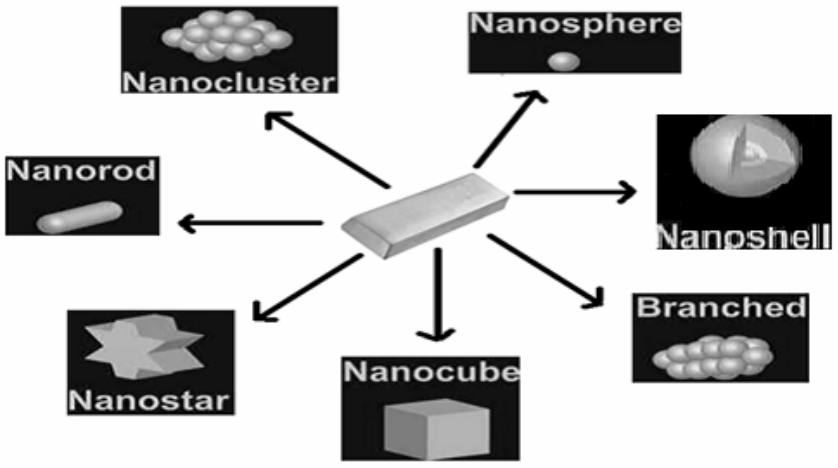

Figure 2: Various shapes of the GNPs [8].

UV–visible absorption spectra

The UV–visible absorption spectrum of the gold nano-urchins is shown in Figure 3. As seen in Figure 3, the maximum in the Au absorbance intensity is observed at 584.4 nm. The optical properties such as absorption maxima and absorption intensity are particle size dependent. An intense absorption peak at 584.4 nm is generally attributed to the surface plasmon excitation of gold nano-urchins.

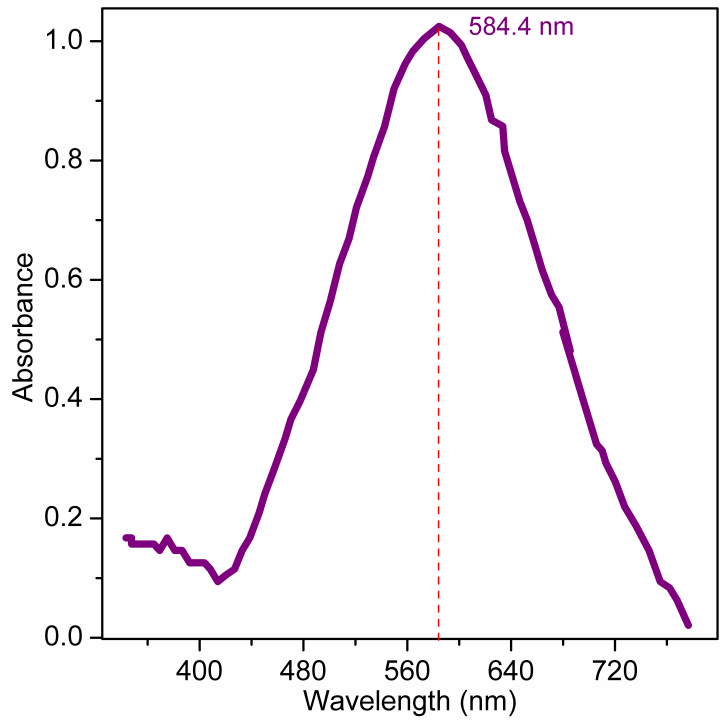

Figure 3: The UV–visible absorption spectrum of the gold nano-urchins.

Electronic properties

The current-voltage characteristic of the optoelectronic device is shown in Figure 4. In other words, the I-V curve shows a sensitivity of the current to voltage (ie electrical response). At the positive voltages, the current of the device increases almost linearly in the range of the milli ampere with the voltage as seen in Figure 4.

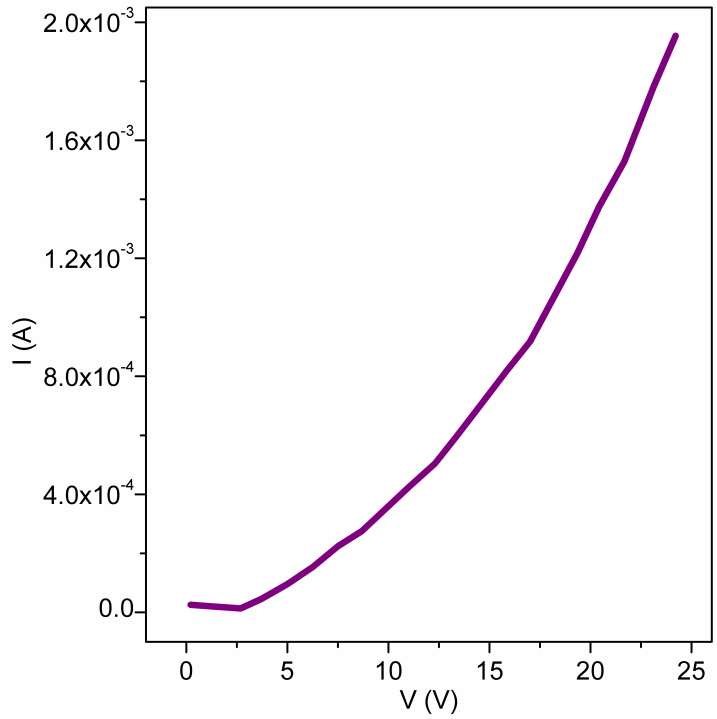

Figure 4: The current-voltage characteristic of the optoelectronic device.

Conclusions

The electronic, photonic and optoelectronic properties of gold nano-urchins were investigated. The maximum in the Au absorbance intensity is observed at 584.4 nm, which is generally attributed to the surface plasmon excitation of gold nano-urchins. The electrical response of the optoelectronic device was investigated by I-V characteristic. In future studies, optoelectronic devices can be produced under different conditions and their effects on optoelectronic properties can be examined.

Acknowledgements

This study was supported by The Management Unit of Scientific Research Projects of Mus Alparslan University (MUSBAP) under Project BAP-17-EMF-4901-09.

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Preparation and Characterization of Pristine and Al-doped Copper Oxide Thin Films for Solar Cell Applications

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Abstract

In this study, pristine and Al-doped CuO thin films were produced on soda-lime glass substrates by using the SILAR method. The influence of Al-doping concentration on the morphological, crystalline structure and optical properties of CuO materials were investigated by Scanning Electron Microscopy (SEM), X-ray diffraction (XRD) and UV-vis spectrophotometry measurements. From the SEM analysis, it was observed that Al addition increased the sizes of the particles. From the XRD analysis, it was obtained that Al addition tends to increase grain size. UV-vis. measurements exhibited that the optical band gap energy of the CuO films was increased with the increasing Al-doping percentage.

Keywords: CuO, SILAR, Al-doping, optical properties, solar cells.

Introduction

Semiconductors are the most interesting and most important class of solids and they have a wide range of applications in areas ranging from metals to insulators. The electrical conductivity of a semiconductor is directly dependent on the temperature and the most important feature of a semiconductor is the reduction of its resistivity when the temperature is increased [1, 2].

Metal oxide nanostructured materials are employed in the manufacture of various kinds of electronic devices, such as diodes, transistors, and biosensors. Metal oxide based devices have found large application due to their low cost, reliability and efficiency [3]. Metal oxide nanostructured materials represent an improving interest in different industries, especially with their proliferate physical and opto-electronic properties compared with their bulk counterparts [4, 3].

Among them, copper oxide (CuO) is one of the most discovered semiconductors due to their non-toxicity and great chemical stability. CuO is an important p-type

transition metal oxide with a narrow band gap of 1.2 eV range to 2.1 eV [4]. Main physical properties of CuO films depend on their structural, morphological, properties which are violently dependent on the arranging process. For nanostructured metal oxides, doping is a powerful way to organize their main physical and chemical properties. For this reason, different metal elements doped nanostructured thin film nanomaterials have become a focus for numerous researchers [8, 8]. The optical characteristics and thus the absorbance and transmittance of CuO can also be controlled by doping. Crystallite size and optical band gap and of CuO films can be adjusted by adding various dopants.

Many deposition techniques like molecular beam epitaxy [9], sputtering technique [10], pulsed laser deposition [6], sol-gel process [5], thermal evaporation method [13] and Successive Ionic Layer Adsorption and Reaction (SILAR) [4] have been utilized for the deposition of nanostructured metal oxide films. SILAR is a promising method because it is a simple, cheap, safe manufacturability and environmental friendly method [4, 14].

In the present paper, we produced pristine and Al-doped CuO thin films via using SILAR method. We focused on the structural, morphological and optical band gap energy properties of CuO films with the effect of Al concentrations in the growth solution.

Experiments

Pristine and Al-doped CuO films were obtained by the SILAR technique. The nonconductive microscope soda-lime glass slides were used in the experiments. Before the growth of thin film, the glass substrates were cleaned as reported elsewhere [15]. 0.1 M copper cloride solution was prepared via using Copper (II) Chloride Dihydrate. The pH value of the Copper (II) Chloride Dihydrate solution was regulated via adding NH3. Then, to obtain CuO films the glass substrates was first immersed in Copper (II) Chloride Dihydrate aqueous solution for 20 s to adsorb copper ions onto the glass slide. Then the substrate was rinsed for 20 s in DI water to remove weakly bound. So as to investigate the effect of Al-doping to the nanostructured CuO films different concentrations of AlCl3.2H2O salt were added to CuO solution bath. The aluminium doping level was varied from 0 to 2 at %.

All analyzes of the samples were performed at room temperature. X-ray diffractometer was used to analyze the crystal structure. SEM was used to analyze the surface morphological. The optical band gaps of the films were recorded using with un-polarized incident light perpendicular to the surface of the film.

Results and Discussion

The XRD patterns were used to determine the structural properties of pristine and Al-doped CuO films. Figure 1 presents the XRD patterns of CuO films deposited on the glass substrates via the SILAR technique. All the XRD patterns show a cubic crystal structure having a strong preferential orientation in the $(\bar{1}11)$ and (111)

direction. It is observed that a serious change in peak intensities with the change in aluminium concentration in the growth solution. This peak intensity change with the metal doping may be attributed to the change in crystalline quality of nanostructured thin films. The estimated crystallite size (D) of the samples was

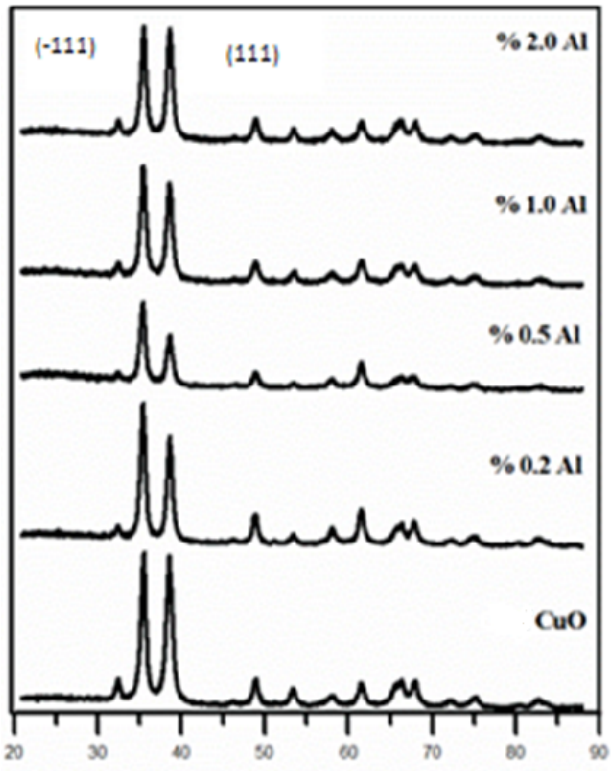

Figure 1: X-ray diffraction patterns of pristine and Al-doped CuO thin films.

estimated using the well-known Scherrer's formula:

$$D = \frac{k\lambda}{\beta \cos\theta}, \tag{1}$$

where β is the full width at half-maximum of diffraction, θ is the diffraction angle of the corresponding peak and λ is the wavelength of X-ray radiation. The calculated D values have been listed in Table 1. The estimated crystallite size has been found to vary between 21.82 and 20.07 nm with Al content, achieving the maximum in the case of 1.0 at %. This type of change in crystallite size as a consequence of doping process was reported in literature [16, 17]. For surface morphological examination of pristine and Al-doped CuO thin films, SEM was used.

Figure 2 presents the influence of aluminium concentration in the growth solution on surface morphology of the CuO samples. It can be seen that, there are plate-like CuO nanostructures which cover the whole surface of samples homogeneously. But with increased aluminium content, the shape and size of nanostructures start to change. The aluminium content in the growth solution stimulates an obvious change of particle size. The significant result is that the plate-like nanostructures are similar to our previous work [8]. In order to calculate the optical

Table 1: Estimated crystallite size values of pristine and Al-doped CuO thin films.

All concentration (%)	**Average Cristalite Size (nm)**
0	21.82
0.2	20.61
0.5	20.07
1.0	28.52
2.0	22.40

Table 2: Optical band gap energy values of CuO thin films.

All concentration (%)	**Band Gap(eV)**	
0	Eg_1=1.37 Eg_2=1.42 Eg_3=1.38	Eg=1.39
0.2	Eg_1=1.52 Eg_2=1.43 Eg_3=1.54	Eg=1.50
0.5	Eg_1=1.71 Eg_2=1.75 Eg_3=1.68	Eg=1.71
1.0	Eg_1=1.71 Eg_2=1.72 Eg_3=1.72	Eg=1.72
2.0	Eg_1=1.68 Eg_2=1.79 Eg_3=1.75	Eg=1.74

band gap energies of the samples, a THERMO 10S UV-vis. spectrophotometer was used in the room temperature. Estimated optical band gap energy values of all the CuO samples were given in Table 2. The variation of optical band gap energies of CuO samples as a function of Al-doping content was plotted in Figure 3.

These changes in optical band gap energy values due to Al-doping concentration were also reported in the literature [18]. It is seen that the optical band gap values of the samples were increased with increasing Al concentrations. This band gap widening may be due to the change of crystallite size of nanostructured thin film materials. Moreover, the change in the optical band gap in thin film materials can be clarified on the based on quantum size effect [19]. Obtained optical band gap results confirmed the Al concentration plays a vital role in tuning the band gap of the grown nanostructured materials.

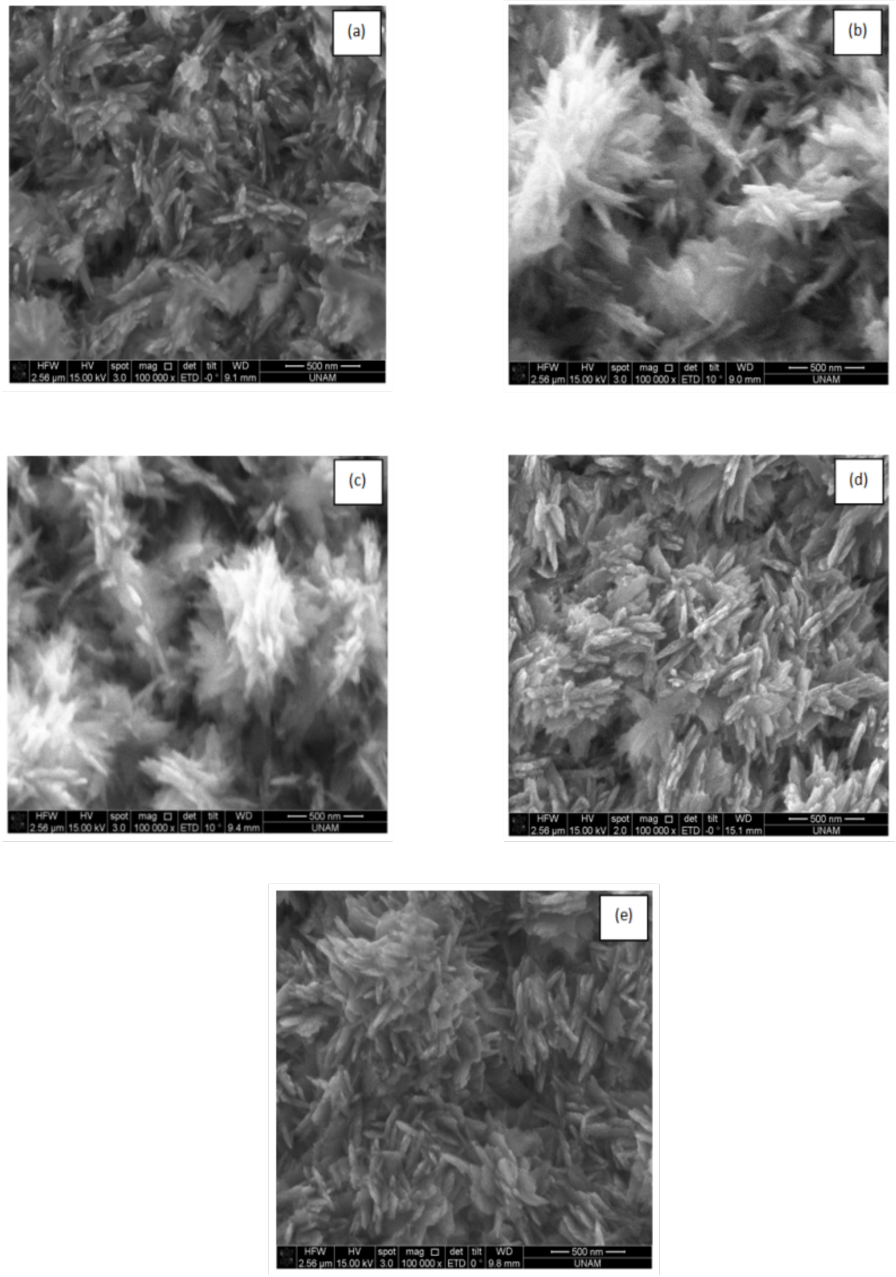

Figure 2: SEM images of pristine and Al-doped CuO films.

Conclusions

Pristine and Al doped CuO thin films were successfully deposited on soda-lime microscope glass substrate by SILAR method. The effect of Al-doping concentrations in the growth solution on crystal structure, morphology and optical band gap energy properties of CuO thin films was investigated. The main physical properties of the samples were affected considerably by Al content. Especially, UV–vis. measurements exhibited that the optical properties of CuO films adjusted as a consequence of Al-doping percentage. Hence, Al-doped CuO film is an encouraging material for sustainable energy materials such as solar cells.

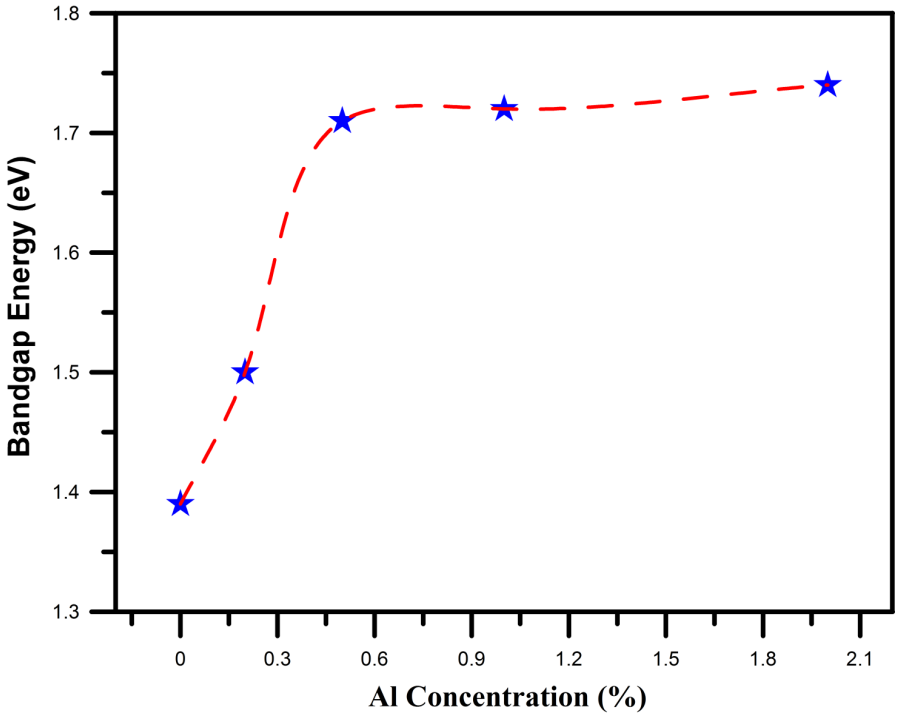

Figure 3: Optical band gap energy values of pristine and Al-doped CuO samples as a function of aluminium concentration.

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Microplastic Accumulation in Rainbow Trout (*Oncorhynchus Mykiss*)

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Abstract

The ubiquitous presence and persistency of microplastic contamination in aquatic ecosystems are considered a growing problem. Ingestion of microplastics has been reported in over 2000 aquatic organisms. The aim of this study was to investigate accumulation of polystyrene (PS) microplastics in gill and gastrointestinal tracts of rainbow trout (*Oncorhynchus Mykiss*). Virgin PS (30 or 300 μg/L) were exposed to fish for 14 days. Particles were analysed using micro-Raman spectroscopy. A total of 32 microplastics were found in both gill and gastrointestinal tract of fish. Under exposure to PS microplastics, however, accumulation of microplastics in the gill and gastrointestinal tract of fish increased with increasing microplastic concentrations. In both treatments, the concentration of PS microplastics was higher in gill compared to gastrointestinal tract. The results indicate the ingestion and accumulation of microplastics in tissues of fish should be considered in environmental risk assessment. This study also suggests that using *O. Mykiss* would be a promising indicator species for monitoring environmental contaminants such as microplastics.

Keywords: microplastics, accumulation, rainbow trout (*Oncorhynchus Mykiss*)

Introduction

Plastics are synthetic organic polymers, which are derived from the polymerisation of monomers extracted from oil or gas [1]. A recent comprehensive report on the total global production of plastics in the last fifty years showed the significant increase from 1.7 million tonnes in the 1950s to 335 million tonnes in 2016 [2]. The National Oceanic and Atmospheric Administration (NOAA) now defines the term microplastics as tiny ubiquitous plastic particles ¡5 mm in diameter [3]. Microplastics have been known as emerging marine pollutants of significant concern, due

to their persistence, ubiquity and toxic potential [4]. Primary microplastics come from synthetic polymer particles, which are usually contained in facial cleaners, cosmetic products, synthetic clothing, toothpaste, paints, coatings and air-blasting media. Secondary microplastics arise from the abiotic breakdown of larger plastic debris discarded in the environment due to abrasive wave action, UV radiation and abrasion with sand [5].

Recently microplastics have been globally detected in ocean waters, sediments, coastal areas and even in the freshwater systems [6,7]. Previous studies have reported that microplastics can be ingested by various aquatic organisms [5,8,9]. For example, a recent study showed that occurrence of microplastic ingestion in gastrointestinal tract of three commercial fish species: the sea bass (*Dicentrarchus labrax*), seabream (*Diplodus vulgaris*) and flounder (*Platichthys flesus*) from the Mondego estuary (Portugal). Results indicated a total of 157 particles were extracted from 38% of total fish, with 1.67 ± 0.27 (SD) microplastics per fish [10]. Another study reported the uptake and tissue accumulation of 23 polystyrene (PS) microplastics in zebrafish (*Danio rerio*) were detected. The results showed that after seven days of exposure, 5 μm diameter microplastics accumulated in fish gill, liver, and gut, while 20 μm diameter microplastics only accumulated in fish gill and gut [8].

An emerging area of concern related to microplastics is that they can also enter the human food chain through ingestion of seafood and terrestrial food products causing potential human health impacts [11]. Presence of microplastics in gut and tissues of aquatic species including some commercially important bivalves [12], fish [13], shrimps [14], and oysters [15] is well documented. Consumption of microplastics contaminated foods is a potential source of human microplastics intake. Toxic chemical additives in the plastic which are a palpable concern for human health include phthalates, bisphenol A (BPA), brominated flame retardants (BFR), triclosan, bisphenone, and organotins [16].

The aim of this study was to investigate the PS microplastic accumulation in gill and gastrointestinal tracts of rainbow trout (*Oncorhynchus Mykiss*). *O. Mykiss* were selected in this study because they are one of the most economically important fish species utilized for freshwater aquaculture [17].

Materials and methods

Experimental design

Healthy *O. Mykiss* (mean weight ± SD: 32.11 ± 8.10 g, mean total length: 13.21 ± 2.24 cm) were purchased from a trout farm in Karaj, Iran and transported to the faculty of Fisheries, Tehran University, Iran (see Figure 1). The *O. Mykiss* were maintained in 2000 L fiberglass tank in culture water (well-aerated water for two weeks before the experiment. Fish were fed ad libitum once a day with a commercial pellet diet (Kimiyagaran-e-Taghziyeh). During the acclimation, the culture water in the tank was refreshed every 48 h.

Acclimated *O. Mykiss* were randomly assigned into 200 L fiberglass aquaria,

each tank containing 5 fish. There were three experimental groups: control group (culture water alone); PS microplastic (30 μg/L), and PS microplastic (300 μg/L). Selected microplastic concentrations in this study are within or below concentrations employed by earlier studies on effects of microplastics on fish [5,18]. Test solutions for microplastics groups was prepared by adding microplastics stock solution to the culture water and the microplastics final concentration in the test solution were 30 μg/L and 300 μg/L. The exposure experiment lasted for 14 days. During the experiment, the test solution in each tank was refreshed every 24 h. All other conditions remained identical to those during acclimation. All tanks were continuously aerated by two airstones to maintain dispersion of particles in water. Feeding ceased 18 h before end of the exposure period. After a 14-day exposure, fish were euthanized with an overdose of clove oil. Then, gill and gastrointestinal tract were quickly removed and retained in aluminum foil.

Figure 1: Rainbow trout (*Oncorhynchus Mykiss*) used in this study.

Microplastic extraction

Microplastics in gill and gastrointestinal tracts of fish were isolated according to methods described by Karami (2017)[18]. Briefly, 200 mL (1:10 w/v) of KOH (10% w/v) was added to each bottle containing excised organs and gills and the bottles were incubated at 40 °C for 72 h. The digestates were then vacuum filtered through 149 μm filter membrane. To separate the potential microplastics from the digestion resistant materials, the 149 μm filter membranes were soaked in 10-15 mL NaI solution (4.4 M, 1.5 g/mL). Next, they were sonicated at 50 Hz for 5 min, agitated on an orbital shaker at 200 rpm for 5 min, and finally centrifuged at 500 $\times$ g for 2 min. The supernatant containing microplastics were then filtered through 8 μm filter membrane. The final stage was performed once more to ensure total extraction of microplastics.

Visual characterization

Visual inspection of the filter membranes was conducted using Motic SMZ-140 Stereomicroscope (Motic, China). Particles resembling microplastics were selected according to their morphology such as color, shape, and size. Raman spectra were from 50 to 3500 1/cm and the wavelength of incident laser was 532 nm was used to identified PS microplastics (Figure 2).

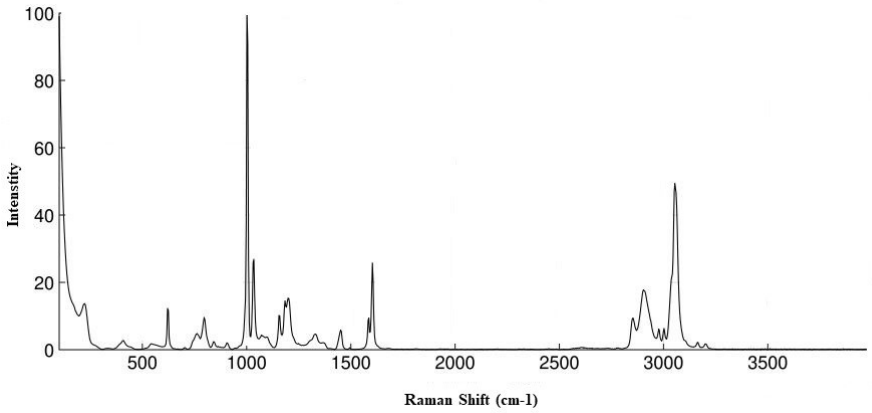

Figure 2: Raman spectra of polystyrene.

Statistical analysis

Prior to analysis, all data were checked for normality (Shapiro-Wilks test). Data were analysed by one-way ANOVA. If a one-way ANOVA detected significant differences ($p < 0.05$), a Tukey's post hoc test was performed to identify the differences among treatments.

Results

No mortalities occurred during exposure and fish in all treatments appeared healthy and actively feeding throughout the experiment. In general, 39 particles were found in both gill and gastrointestinal tract of fish which suspected to be microplastics based on their morphology (shape and color) under stereomicroscope. However, a total of 32 microplastics were found in both gill and gastrointestinal tract of fish according to Raman analysis. Figure 3 are some of the captured images of extracted PS microplastics particles. In both treatments, concentrations of PS microplastics was higher in gill compared to gastrointestinal tract. As such accumulation of microplastics in gill and gastrointestinal tracts of fish increased with increasing microplastic concentrations during exposure to PS microplastics (Figure 4).

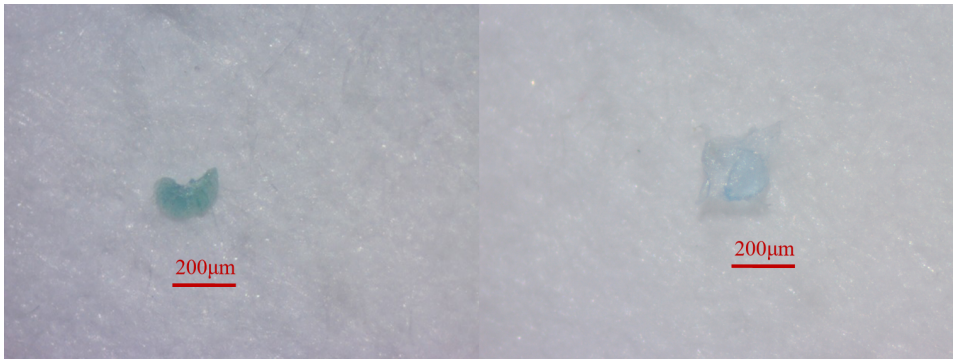

Figure 3: Microscopic images of isolated polystyrene particles from fish species.

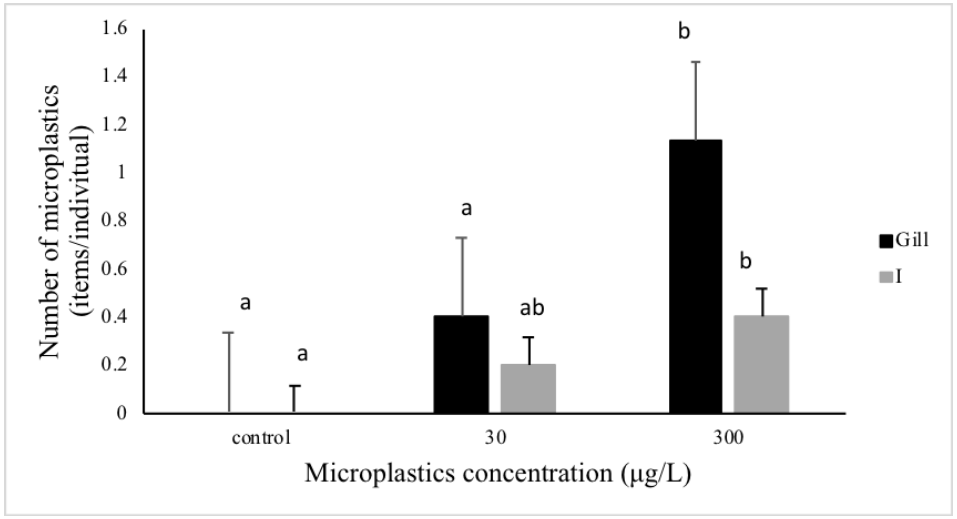

Figure 4: polystyrene microplastic accumulation in the gill (G) and intestine (I) of rainbow trout (*Oncorhynchus Mykiss*).

Discussion

Mismanagement of plastic products has led to the ubiquitous occurrence of microplastic particles in marine (0–1×10^4 items/m^3) [19] and aquatic environments (0–1×10^6 items/m^3) [20]. Microplastics have also been reported in a wide variety of species, particularly mussels and fish used for human consumption. It was evident from these studies that microplastics can be transmitted through aquatic food chains, which leads to its biological accumulation. For example, it was found that bivalves (*Mytilus edulis*) and (*Crassostrea gigas*) accumulated microplastics on average 0.36 ± 0.07 particles $g^{-}1$ (wet weight) and 0.47 ± 0.16 particles $g^{-}1$, respectively in contaminated environments [21].

Several studies have observed microplastics in some non-marine food products, such as canned sardine (1-3 plastic particles)[22] honey (40-660 items/kg honey)[23], sugars (32 ± 7 items/kg sugar)[24], fish meals (a total of 226 microplastics in four brands)[25] beer (12-109 items/L beer)[24] and table salt (7-681

items/kg salts)[26,27]. Microplastics were also detected in fish from the Persian Gulf, which a total of 828 microplastics were detected in the guts (gastrointestinal tracts), skin, muscle, gills and liver of demersal and pelagic fish (*Platycephalus indicus, Saurida tumbil, Sillago sihama, Cynoglossus abbreviatus*) from five sites [28]. Therefore, food products may represent an important route of entry for microplastics into humans, although systematic quantitative data of microplastics in human tissues have not been reported. In previous studies, uptake and accumulation of microplastics has already been described in aquatic organisms after exposure to microplastics in the laboratory [4,8,29] . The first site of particle uptake is on the gill surface, mediated by microvilli activity and endocytosis, and the microplastics are further uptaken into the stomach, intestine and digestive tubules via ciliae movement [29]. Another study suggested that adherence is a novel way for animals to accumulate microplastics beyond ingestion [4]. These show the dietary routes for human populations to be exposed to microplastics. Further studies are required to examine the effects of microplastics on different human tissues.

Concentrations of microplastic particles used in the present study are in keeping with reported levels in previous studies [5,18]. In this study, the accumulation of PS microplastics were observed in fish gills and gastrointestinal tract which significantly ($p < 0.05$) increased in the higher concentration (300 μg/L) of microplastics. These results indicate the considerable capacity of *O. Mykiss* to accumulate PS microplastics. Significant uptake and accumulation of microplastics were also reported in the gills, liver, and gut of *D. rerio* after 7 d of exposure to PS microplastics (5 μm) at 20 mg/L[30]. On the contrary, in exposed goldfish (*Carassius auratus*) to microplastics through food for 6 d with 50 microplastics particles per food pellet and found no evidence of accumulation of microplastics in the gastrointestinal tract or internal translocation to fish tissues post-exposure [31]. It may show inconsistent conclusions as possibly due to the different exposure designs among the studies. A recent study also used PS microplastics particles with two diameters (5 μm and 20 μm) to examine the tissue distribution, accumulation, and tissue-specific health risk of microplastics in mice, which the results showed that microplastics accumulated in liver, kidney and gut, with a tissue-accumulation kinetics and distribution pattern that was strongly depended on the microplastics particle size [32].

Conclusion

These results highlight the ingestion and accumulation of microplastics in gills and gastrointestinal tract of *O. Mykiss*, which could lead to perturbations in fish biological systems and should be considered in environmental risk assessment.

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Occupational Health and Safety Study in Coal Thermal Power Plant

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Abstract

The advancement of technology, the increase in population, the idea of dominating the world and the development of industry increase the speed of energy demand. Energy is an indispensable part of industrialization and daily life. The economic and social development of a country is the basic indicator of the need for energy. Energy, such as chemical, nuclear, mechanical (potential and kinetic), thermal, geothermal, hydraulic, solar, wind, and electrical energy, can be found in different ways at every stage of everyday life. In energy production in the world, non-renewable energy sources such as coal, natural gas and oil take the first place. This study focuses on the four year distribution of occupational accidents occurring in the coal thermal power plant. Thermal power plants are the largest industry in electricity production. In thermal power plants, accidents are caused by boiler, turbine, generator, operation and maintenance hazards. These data were collected by personnel interviews such as boiler section, turbine and generator section, coal and ash processing plant of workers working in different parts of thermal power plant. Analyzes were made on the basis of different variables. The distribution of accidents by age, educational status, according to the hours of the shift, days of the week, months and according to the injured regions of the body are shown. According to these results, accidents are seen as preventable accidents. In addition, these accidents, as in other sectors, appear to be caused by lack of training and neglect of employees.

Keywords: Electrical Energy, Electricity Production, Coal Thermal Power Plant, Occupational Health and Safety, Occupational Accident, Accident Distributions, Non-renewable Energy Sources, Questionnaires, Personal interview

Introduction

Industrialization in the world and Turkey, on the one hand while ensuring prosperity for mankind, but also brings dangers for humanity. Death and limb losses occur due to occupational accidents and occupational diseases. In terms of both employees and businesses, the concept of health and safety must first be adopted

and maintained [1]. As world states and international organizations are competing with each other in order to obtain energy resources, importance should be given to occupational health and safety issues in the energy sector.

The need for energy resources in the world is increasing day by day [2]. Energy is a mandatory production factor in production and is one of the key indicators of a country's economic and social development potential. There is a linear relationship between energy consumption and social development and it is seen that energy consumption increases with economic growth and prosperity [3].

The most fundamental element of the economic and social development of countries is energy, and those who manage the countries have to find and diversify the energy through uninterrupted, reliable, clean and cheap means [3, 4]. With the development of societies, there have been differences, changes and developments in the way in which the energy was obtained and the usage areas [5].

The resources obtained by different methods in economic terms are called energy sources and are classified in different ways. Energy resources are generally classified according to their use and convertibility. Energy sources are non-renewable or renewable according to their use; According to their convertibility, they are classified as primary and secondary energy sources (Figure 1). Non-renewable energy sources are energy resources that are classified in two different ways as short-term depleted, fossil-welded and core-welded. Renewable energy sources; refers to the resources that can remain in a very long period and which can renew itself [3]. The fact that the energy does not any conversion or change is called the primary energy source. Primary energy sources are petroleum, coal, natural gas, nuclear, hydraulic, biomass, wave-tide, sun and wind. The energy obtained as a result of the conversion of primary energy is known as secondary energy. Electricity, gasoline, diesel, diesel, coke, secondary coal, petroleum coke, air gas and liquefied petroleum gas (LPG) are among these types of energy sources [6]. Another type of classification, which is used frequently today, is the classification made by taking into account the characteristics of exhaustion or renewability at the end of the use of energy resources. According to this classification, non-decremental and inexhaustible energy sources are called renewable energy sources. Once used, energy sources that cannot renew themselves are known as non-renewable energy sources [6].

In this study, the importance of energy and energy sources are explained. What are the primary sources of energy in Turkey and what are the power generation percentages of primary energy sources (Table 1 and Figure 2 and 3). Finally, some concepts related to occupational health and safety are mentioned. The coal-fired thermal power plant was selected as the study area. Accidents that occurred between 2015 and 2018, the parts where they occurred, the reasons for realization and the days and months of the accident occurred are shown with graphs.

Primary Energy Situation in Turkey

According to the latest data in February 2019, 40% of our electricity production was made of coal, 16% of natural gas, 31% of hydraulic energy, 8% of wind energy,

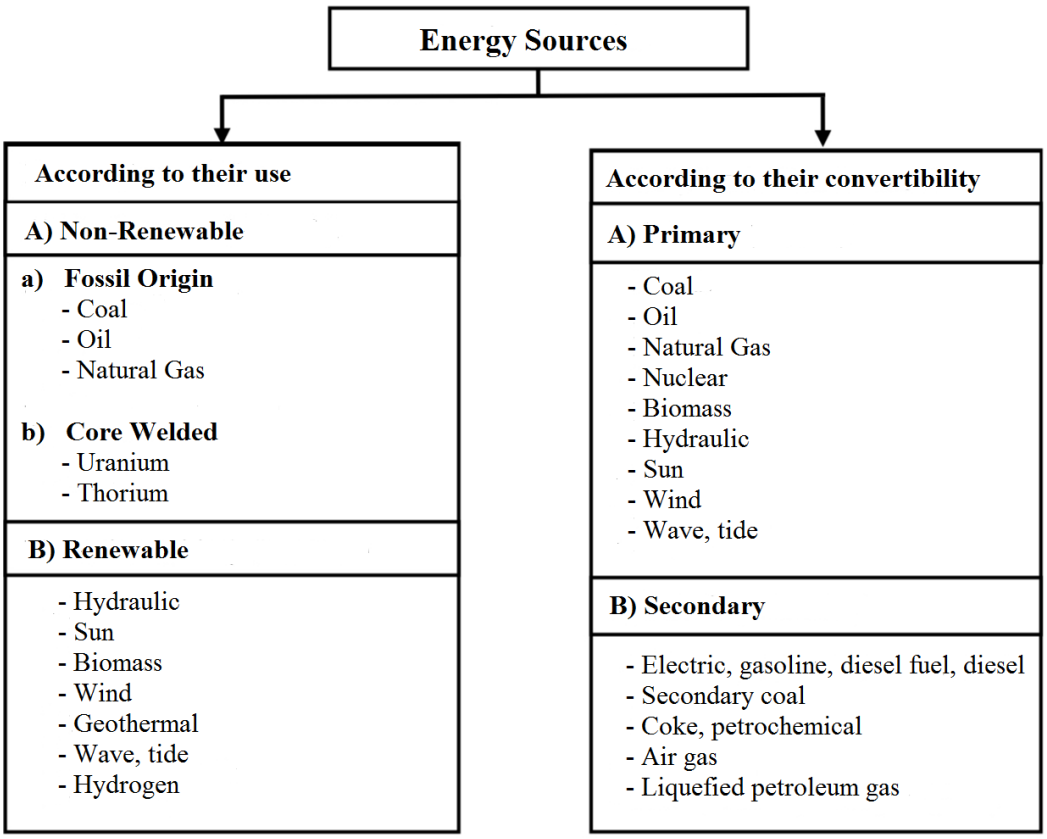

Figure 1: Classification of energy sources.

1% of solar energy, 3% of geothermal energy and 1% was obtained from other sources.

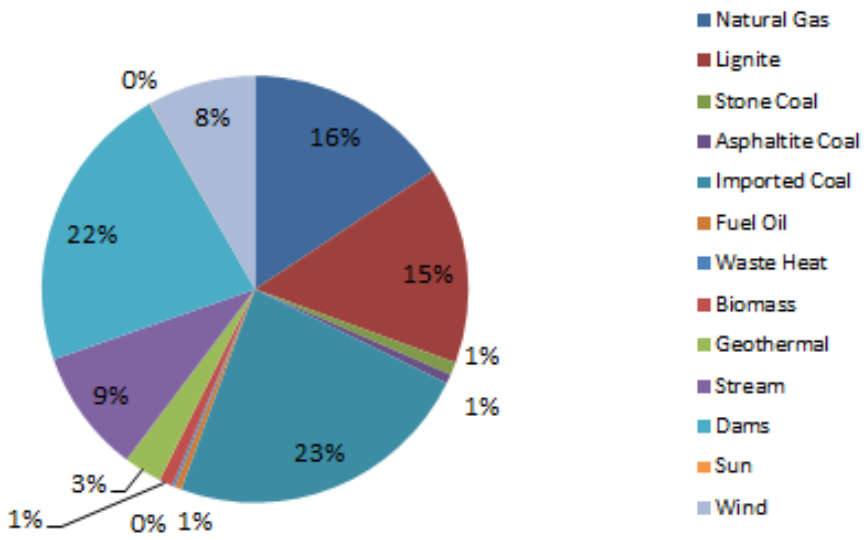

Figure 2: Energy production resources percentages (28 February 2019 Data).

Table 1: Primary energy resources consumed in Turkey (Source: The Chamber of Electrical Engineers of UCTEA [7]).

DISTRIBUTION OF ENERGY PRODUCTION BY SOURCES	
	28 February 2019 Data
Natural Gas	3,564,381.58
LNG	0
Lignite	3,403,311.15
Stone coal	220,416
Asphaltite coal	159,951.98
Imported coal	5,325,844.49
Fuel oil	116,343.3
Diesel	0
Naphta	0
LPG	0
Waste heat	50,452.18
Biomass	232,037.45
Geothermal	659,529.49
Stream	3,125,045.16
Dams	5,020,812.94
Sun	9,807.58
Wind	1,868,266.63
TOTAL (MWh)	22,776,199.93

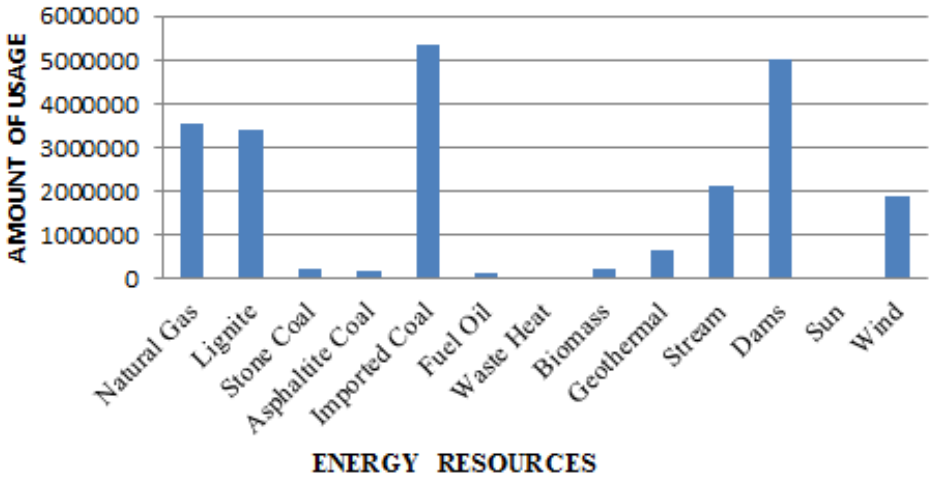

Figure 3: Turkey's primary energy resources production rates (28 February 2019 Data).

From this point of view, the distribution of primary energy consumption according to sources seems to be the most highly renewable energy sources with natural gas(16%) and coal (40%). The rest seems to be in the form of hydraulic (31%) and other renewable energy (12%). Here, wind energy, solar energy, biomass energy and geothermal energy are considered as renewable energy sources.

Occupational Health and Safety Concepts and Definitions

Occupational Health and Safety

The concept of occupational health and safety is one of the most important issues in recent years. The core of the concept of occupational health and safety is the protection of employees against the risks they face from work and the work environment. There are two definitions about occupational health and safety [8].

Occupational Health: It is a branch of medicine established to keep the health of employees in the workplace at physical, mental and social levels, to keep working conditions and production equipment in term of health, to protect employees from harmful effects and to ensure harmony of work and employee. *Occupational Safety:* It is called a whole set of measures that must be taken to create a reliable working environment to prevent occupational accidents [1].

Accident: A sudden event that result in an undesired outcome such as property damage, bodily injury or death.

Occupational Accident: An incident that occurs during work or during the execution of the work, which causes death or makes the body integrity spiritually or physically disabled [9].

Injury: Physical damage to body tissues caused by an accident or by exposure to environmental stressors. This injury may lead to death and is then called a "fatal accident" or may cause partial disability or lead to sick leave for a period of time.

Unsafe Conditions: Factors that disrupt work safety and make the work environment dangerous are environment, machinery and materials. Factors such as failure to use machinery suitable for the work, unselected production system suitable for the work, insufficient equipment, design flaws are unsafe conditions.

Insecure Behaviours: It is the situation that the worker endangers the job security due to some erroneous behaviours and attitudes. The level of education, level of experience and psychological status of the workers have an important role in making non-safety movements. Intensive working hours, not knowing and not implementing safety rules, not using proper protective equipment are known as unsafe behaviours. The use of low material safety equipment, maintenance work when machinery and equipment is in operation, unnecessary jokes, behaviours distracting the employee are considered unsafe movements.

Occupational Disease: Occupational disease can be defined as an disease, disability or psychological breakdown situations that can be temporary or permanent due to the equipment, materials and environmental impacts of the employees [10].

Coal Thermal Power Plant

Thermal power plants are stream- powered structures. Thermal power plants are also known as Energy Recycling Plants. Thermal power plants are the structures that convert heat energy into electrical energy. In the plants, steam is generated by heating the water. The power of this steam is turned turbines and converted into electrical energy.

The number of thermal power plants installed and registered in Turkey is 42. These thermal plants use imported coal, lignite, asphaltite, coal and stone coal. Selected this thermal power plant is one of Turkey's largest thermal power plants with high power MWe. With the electrical energy it produces, it can meet all electrical energy needs such as housing, industry, metro transportation, official apartment, environmental lighting needed in the daily life of hundreds of thousands of people.

Occupational Accidents and Causes in Coal-Fired Thermal Power Plants

The distribution of work accidents according to various parameters is as follows (Table 2-9 and Figure 5-11).

When the accidents occurred according to age groups are examined; 38 accidents occurred in employees aged 41 and over. This ratio is 42%. Research shows that individuals are exposed to loss of physical and cognitive abilities along with

Table 2: Distribution of occupational accident by age.

AGE GROUPS	2015-2018	
	TOTAL	
		%
18 - 25	8	9%
26 - 30	17	19%
31 - 35	11	12%
36 - 40	17	19%
41 - OLDER	38	42%
TOTAL	91	100

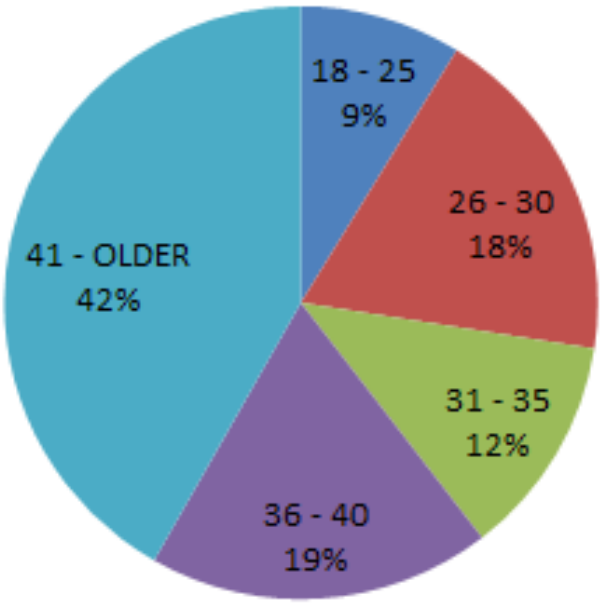

Figure 4: Distribution of occupational accident by age (2015-2018).

ageing. There is a non-negligible relationship between employees' age and performance, working power, comprehension and mobility, reflexes. The muscle strength of the people reaches the highest level in the 20-30 age period and gradually decreases after this age period. With age, the ability of the employees to think, perceive, react, learn, solve the problems in functional terms is decreasing. These talent regressions may adversely affect employee productivity and safe behaviour.

51,56% of those who had work accidents were in the form of primary school, 17,19% in middle school, 9% in high school or higher education. The occupational accident rate is low due to the fact that the industrial vocational high school grad-

Table 3: Distribution of occupational accident according to educational status.

EDUCATIONAL STATUS	2015-2018	
	TOTAL	
	NUMBER OF ACCIDENTS	ACCIDENT %
Primary Education	51	56%
Secondary Education	17	19%
High School	8	9%
Ind. Vocational School	2	2%
Associate's Degree	6	7%
Bachelor's Degree	7	8%
TOTAL	91	100%

uates are qualified personnel trained in the sector. Professional technical training given at work place, occupational health and safety trainings provided in the work place, enable the worker to improve himself or herself and become professional.

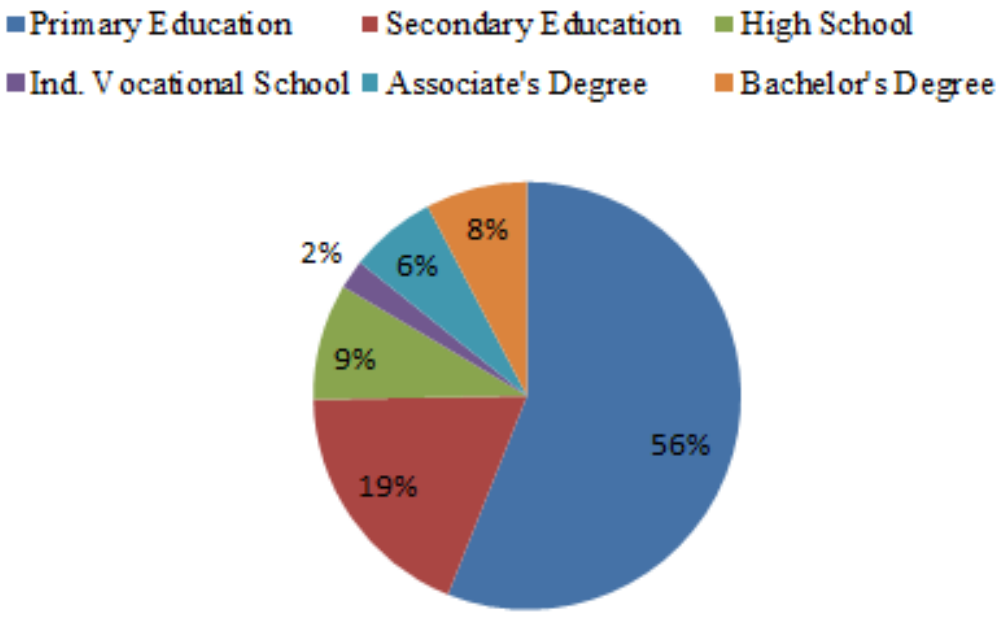

Figure 5: Distribution of occupational accident according to educational status (2015-2018)

Professionalization will reduce the risk of accidents and will contribute to the product and service to be produced, to save time and waste and to contribute to both the work place and the country's economy and to the individual development.

Table 4: Distribution of occupational accident By days Of the week (2015-2018).

DAYS OF WEEK	2015-2018	
	TOTAL	
	Number of Accidents	Accident%
Monday	9	10%
Tuesday	20	22%
Wednesday	14	15%
Thursday	11	12%
Friday	18	20%
Saturday	10	11%
Sunday	9	10%
TOTAL	91	100%

After evaluating the data at Figure 6, it can be seen that most of the accidents took place on Tuesday. Figure 7 shows the distribution of accidents occurring in the enterprise by shifts. A total of 91 accidents occurred between 2015 and 2018. According to the data, employees had a work accident during the first three hours of their work. A total of 32 occupational accidents occurred. The data published in the social security institution showed that employees had an accident in the first three hours. When the causes of the accident distribution were investigated, it was concluded that the work intensity was higher in the 1st and 2nd shifts and all maintenance and repair works could be performed in these shifts.

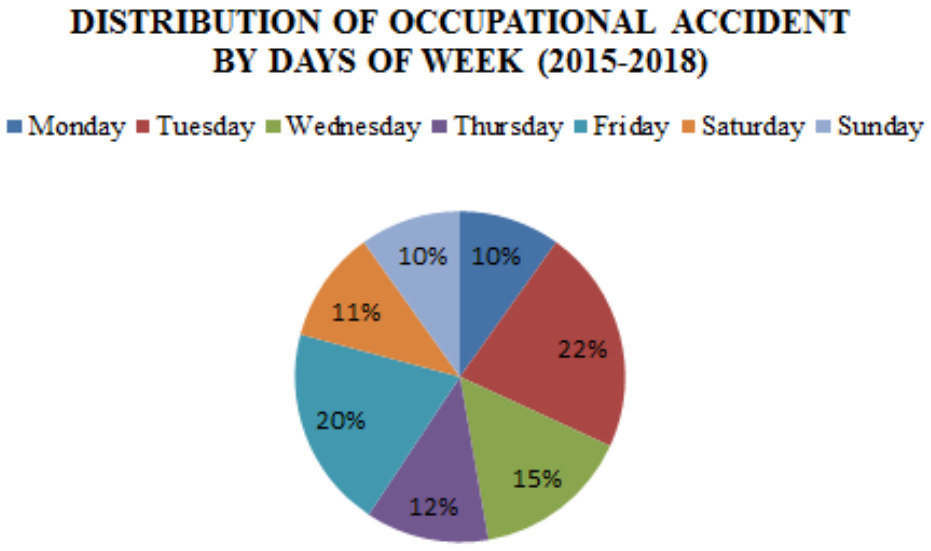

Figure 6: Distribution of occupational accidents by days of week (2015-2018).

Table 5: Distribution of occupational accidents by working hours (2015-2018).

WORKING HOURS	2015-2018	
	TOTAL	
	Number of Accidents	
1. -2. hours	32	35%
3. - 4. hours	18	20%
5. - 6. hours	27	30%
7. - 8. hours	14	15%
TOTAL	91	100

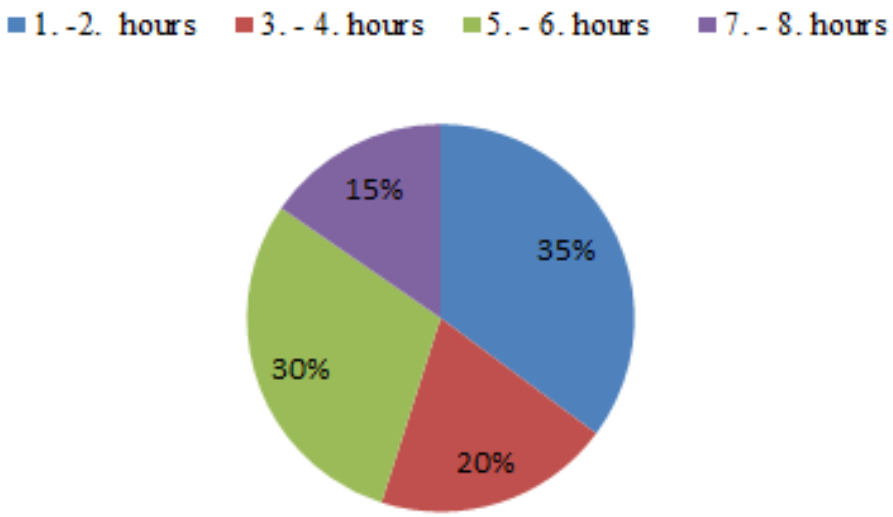

Figure 7: Distribution of occupational accidents by working hours (2015-2018).

Between the years of 2015 and 2018, the distribution of occupational accidents varies between 3 and 12 employees. There is no significant difference in the number of occupational accidents except for the decrease in December. As seen in Figure 8, occupational accidents occurred mostly in March.

According to figure 9, occupational accidents occurred mostly in the mechanical maintenance department of external facilities. In the second row, there were 10 and 9 accidents between 2015 and 2018 in the boiler operation and boiler operation department.

Total of 87 accidents have been occurred in these period. Only 1 accidental injury has occurred in the internal organs. As a result of work accidents, the injured limbs are as shown in Figure 10. As physical force is used, most injuries often occur on the feet, ankles, hands, hands fingers and wrists. The causes of occupational accidents can be divided into various classes. When the accidents between 2015 and 2018 are examined, 35 accidents occurred from the personal

Table 6: Distribution of occupational accidents by months (2015-2018)

MONTHS	2015-2018	
	TOTAL	
	Number of Accident	Accident %
January	8	9%
February	4	4%
March	12	13%
April	10	11%
May	6	7%
June	11	12%
July	8	9%
August	11	12%
September	5	5%
October	9	10%
November	4	4%
December	3	3%
TOTAL	91	100%

Table 7: Distribution of occupational accidents by units (2015-2018).

UNITS	2015-2018	
	TOTAL	
	Number of Accidents	Accident %
Ash- slag	8	10%
Coal Preparation	6	8%
DTMB	13	17%
Boiler Operation	10	13%
Mill Maintenance	5	6%
Turbine Maintenance	3	4%
Measure Check	1	1%
Flue Gas Maintenance	7	9%
Mech. Main. Workplace	3	4%
Boiler Main. Workplace	9	12%
Electrical Maintenance	4	5%
Hydrogen Production	1	1%
Turbine Operation	1	1%
Electrical Operation	3	4%
Laboratory	3	4%
TOTAL	77	100%

Table 8: Distribution of occupational accidents according to the injured areas of the body (2015-2018).

INJURED AREAS OF THE BODY	2015-2018	
	TOTAL	
	Number of Accident	Accident %
Ankles and Feet	21	23%
Toes	1	1%
Legs	6	7%
Head	7	8%
Body (Back, Chest, Belly)	3	3%
Neck	-	0%
Wrist, Hands	16	18%
Dita	18	21%
Eyes	5	5%
İnternal Organs	1	1%
Backbone	1	1%
Shoulder, Arms	8	9%
Face	3	3%
TOTAL	90	100%

Table 9: Distribution of occupational accidents by reason of accidents (2015-2018).

REASON OF ACCIDENTS	2015-2018	
	TOTAL	
	Number of Accident	Accident %
Personal Errors (Carelessness)	35	56%
No Personal Protective Equipment	8	13%
Use of defective, unsuitable equipment	1	2%
Unsuitable Working Environment	4	6%
Unsuitable walking paths, passageways	3	5%
Insufficient protection in high places	2	3%
Wrong method of doing business	9	15%
TOTAL	62	100%

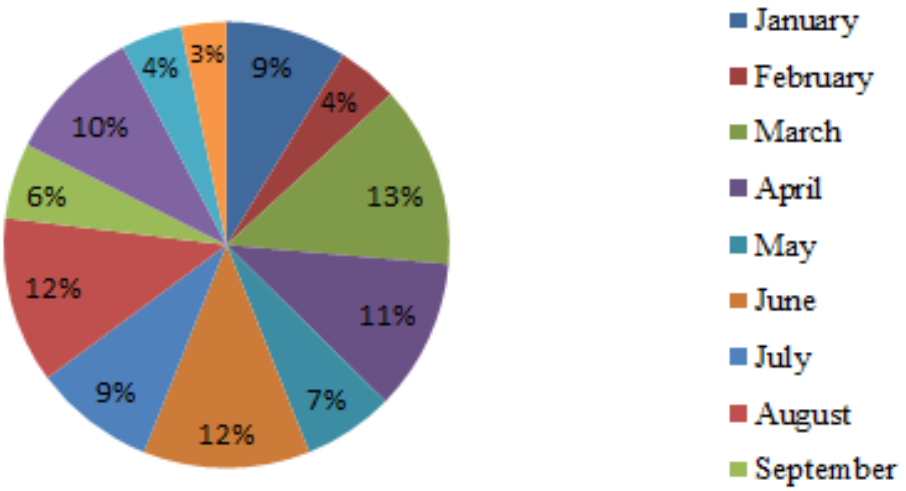

Figure 8: Distribution of occupational accidents by months (2015- 2018).

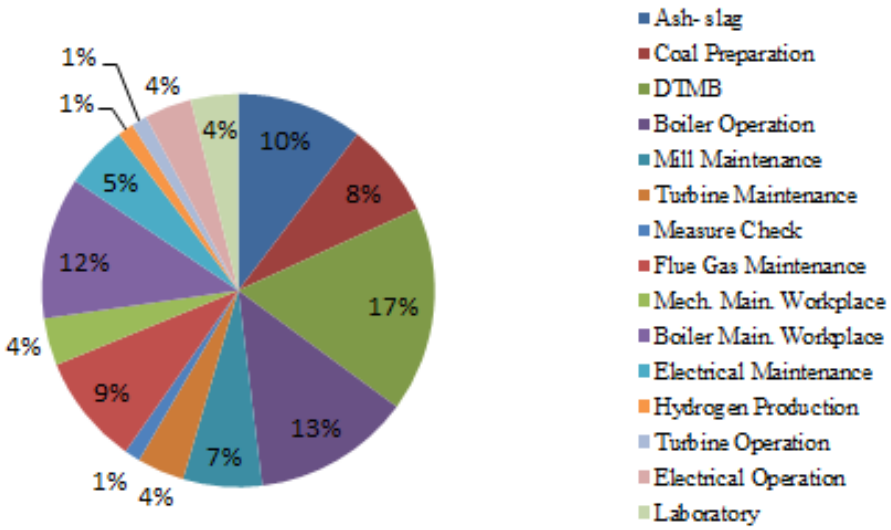

Figure 9: Distribution of occupational accidents by units (2015-2018).

errors of the employees. A high percentage of the remaining accidents were due to the selection and implementation of the wrong method for the conduct of the work.

Discussion and Conclusions

In this study, the occupational accidents occurred between the years of 2015 and 2018 in the coal thermal power plant were investigated. These accidents are preventable accidents. As in other sectors, it is due to lack of training and neglect of employees. Most accidents can be considered as personal errors and the oc-

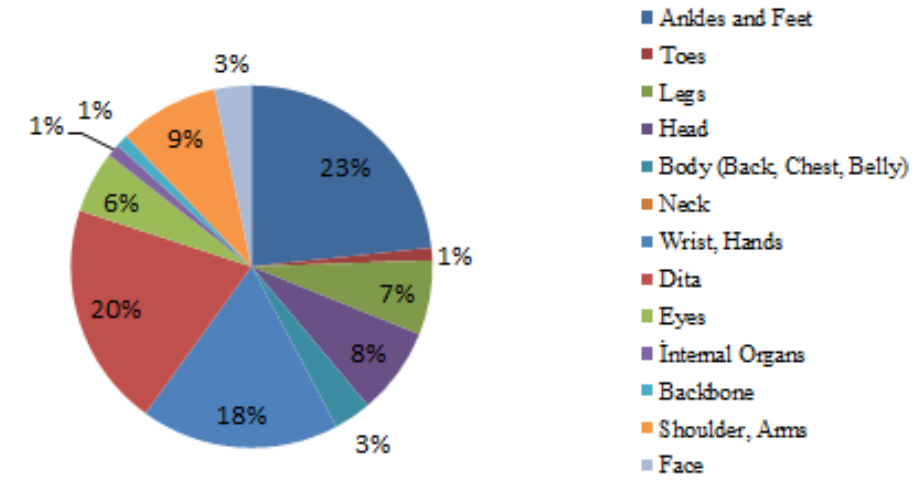

Figure 10: Occupational accidents according to injures areas of the body (2015-2018).

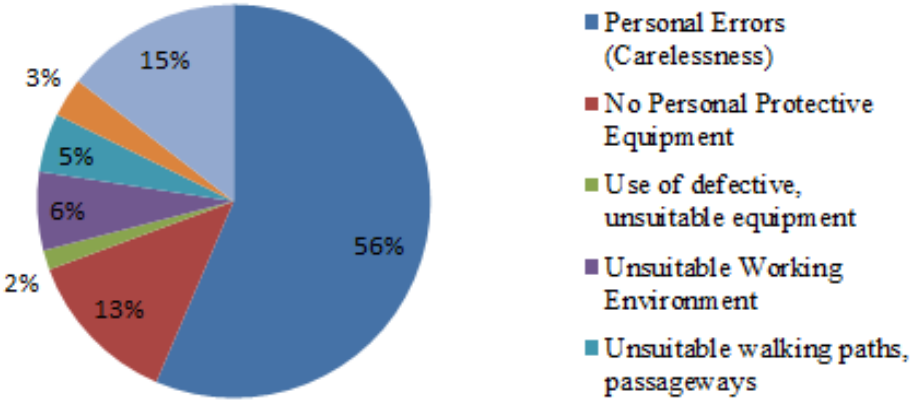

Figure 11: Distribution of occupational accidents by reason of accidents (2015-2018).

cupational health and safety deficiencies of company have a very small share in accidents. When workers gain experience over time, occupational accidents are greatly reduced if personal protective equipment is used regularly and properly, and job safety awareness is increased. The enterprise thinks that accidents can be solved by education. Therefore, in order to raise the level of awareness of its employees, it organizes occupational safety training and vocational training. The company tries to create a culture of occupational safety.

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Human Awareness and Ecological Footprint

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Abstract

In the presented research, we will point out a view of young students on the current environmental situation. We have participated in Erasmus+ project Green Energy Skills for Youth (Green4U), where we met many young people from different countries. We will share our experiences and the insights gained through our participation in the project.

The first Academy was held in Slovenia, in the city of Maribor, where we hosted youth from Turkey. The next Academy took place in Germany, in Potsdam, where young people from Slovenia, Germany and Turkey took part. The last Academy was held in the Turkish town of Köyceğiz. The main aim of Academy was to raise awareness among young people about climate change, environmental protection and green energy.

Young people initially perceived the participation in the project as fun only, but they quickly realized that there are many environmental problems for which we (humans in general) are truly responsible. We learned that we - young people - can greatly contribute to this change. In the article, we present in greater detail the experience and findings formed by participants in the project during their engagement in activities, presentations and seminars.

Introduction

The use of contemporary learning strategies, such as research- and problem-based learning connected to collaborative teaching/learning, and brain-based techniques based on information-communication technologies, have provided scholars from diverse disciplines, for our research problem of ecological footprint, most notably from the fields of chemistry, biology, physics, philosophy, engineering, and technology, with an unusual opportunity to observe possible flaws in their own thinking and awareness [1].

In the process of education, which mostly points out the importance of acquiring knowledge and developing cognitive competences, the question arises of what happens with the students' social skills and their social competences, and whether

we can increase social competences gradually, step by step? Human beings are social beings. From our own research, as well as from the research conducted by many other researchers [2, 3, 4] it is obvious that with intensive individualization and differentiation of the teaching/learning process (one-on-one tutoring), there is a drastic decrease in social skills and social awareness, which is crucial in the area of ecology.

What can/must we do? As we have already mentioned, the recurrent theme of this research will be the "ecological footprint"; and proprioception plays an important role in this story. What does proprioception really mean? Proprioception could also be named self-perception of thought, or self-awareness of thought, i.e. thought, which is able to perceive its own movement, be aware of its own movement. With proprioception, in specific activities as part of a particular lesson (for example, a lesson about ecological footprint), the emotional intelligence of a person (Figure 1) also develops, which will change, step by step, the human historical memory, and add new elements to this historical memory on the level of intuitive thinking. We must therefore develop this awareness in every individual; we must "change" or establish the specific way of thinking (creative, critical, and conscious thinking); and it is very important to begin this process with students of the youngest possible age. In the case of the ecological footprint problem, competences must be developed step by step, which enable us to deal with the day-to-day needs of others, and which help raise the awareness that we have only one earth — a complex puzzle, for which everyone is responsible, and to which everyone can contribute their small (but important) piece. And all of this has been the main goal of the project Green4U [5].

In Figure 1, Self-Awareness refers to knowing one's internal states, perception, resources, and intuition; Self-Management refers to managing one's internal states, impulses, and resources; Social Awareness refers to how people handle relationships, and to the awareness of others' feelings, needs, and concerns; while Relationship Management is concerned with the skill or adeptness at inducing desirable responses in others.

Self-awareness and sustainability

"The Sustainable Development Goals are the blueprint to achieve a better and more sustainable future for all. They address the global challenges we face, including those related to poverty, inequality, climate, environmental degradation, prosperity, and peace and justice. The Goals interconnect and in order to leave no one behind, it is important that we achieve each Goal and target by 2030. We will point out only the area of environmental degradation connected with energetic policy" [6].

The principle of sustainable forms of energy is to meet the energy needs of the present time and at the same time not jeopardize the energy needs of the future generations. There are two basic principles of sustainable energy: cleaner methods of energy generation and energy saving in all areas.

Sustainable energy includes both energy production and heating, cooling and powering systems and machines. In the field of energy production, the terms

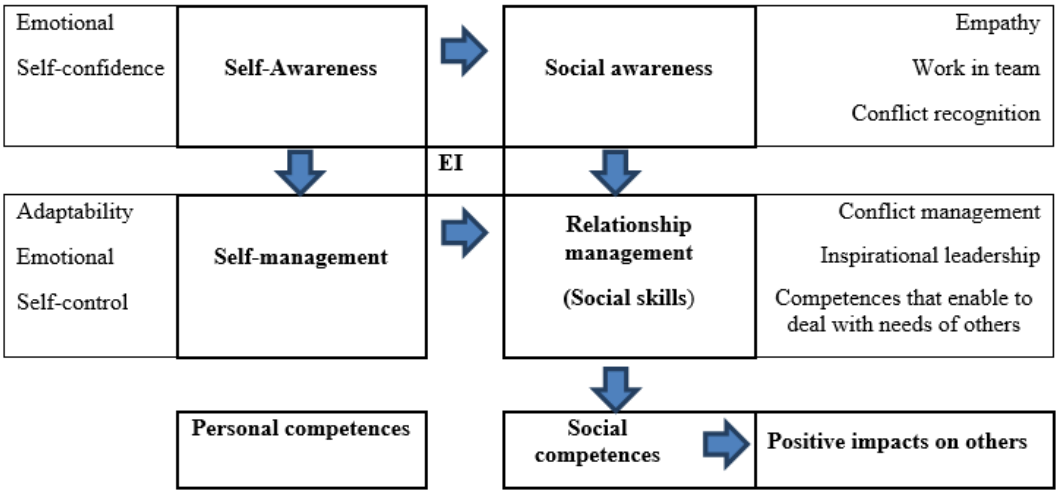

Figure 1: Emotional intelligence (EI) and social competences.

sustainable energy and renewable energy can be considered equal, since in general, renewable energy sources (such as solar, wind, geothermal, .. energy) are also sustainable sources of energy. However, the fundamental dilemma remains with regard to nuclear energy, because it is difficult to define. Some scientists classify nuclear energy as a form of sustainable energy, while others do not.

Another significant aspect of sustainable energy is that the conveyances of production and consumption of this energy fall year after year. Sustainable energy markets are also expanding, partly thanks to the support of government policies, and there is an increasing progress in the transition from fossil to sustainable energy. Ecology, economics, politics and culture are the four fundamental areas that ensure sustainable development [7].

Among the major issues associated with life on Earth today are pollution and the excessive use of non-renewable energy. The use of fossil fuels and other non-renewable resources causes excessive depletion of the stock of these energy products and consequently intense pollution of our living environment. Such a lifestyle has negative consequences for life on Earth today, but we must be aware that this will have an even greater influence on the living environment of future generations. Not being aware of these consequences will have a devastating effect on life on Earth in the future.

We therefore decided to explore how young people are looking at the current environmental issues. We tried to explore whether young people are indifferent to the problems presented, or are aware of the consequences of the current way of life, and are ready to do something for a cleaner environment for future generations.

Environmental issues and Green4u project

The basis of energy consumption are the available energy resources. According to Lah [8], energy sources enable the production, generation and extraction of energy.

Energy resources are basically divided into non-renewable (coal, petroleum, natural gas) and renewable (solar, wind, geothermal, biomass) sources.

"A critical component of sustainability is natural capital – the natural resources and natural services that keep us and other forms of life alive and support our economies. Natural resources are materials and energy in nature that are essential or useful to humans. These resources are often classified as renewable /. . . / or nonrenewable /. . . /. Natural services are functions of nature, such as purification of air and water, which support life and human economies. Ecosystems provide us with such essential services at no cost" [9](p.6).

Today's technology allows us to exploit both non-renewable and renewable sources. The problem of today's mankind is the over-exploitation of natural resources based primarily on non-renewable fossil fuels and consequent pollution of the environment. The main causes for this are "population growth, wasteful and unsustainable resource use, poverty, exclusion of environmental costs of resource use from the market prices of goods and services, and attempts to manage nature with insufficient knowledge" [9](p.14) More attention should be paid to renewable energy sources that are less burdened by increased security of energy supply.

The Green4U project was created in partnership with the Turkish-German University (lead partner), the Faculty of Natural Sciences and Mathematics of the University of Maribor, KID Kible, ZentralWeb Gmbh from Germany and ZETA from Turkey, as a part of the Erasmus+ program.

"The main objectives of the project are to increase awareness and competences of youth for green energy, so that they will acquire skills on climate change, ecosystems, energy production and conservation, management of waste and recycling, pollution, and carbon footprint etc" [5]. One of the project aims was also the development of mobile and computer games, which would enable young people to acquire many competences, especially in the field of environmental protection and the acquisition and use of green energy. The main purpose of the project was to encourage individuals as well as larger communities, in particular young people, to reflect on ecological issues in order to change the awareness of environmental problems. The project was based on activities that were directly linked to environmental problems and the production of green energy. The program focused mainly on young people between 13 and 25 years of age.

Green4U Academy in Slovenia

As part of our study course, we attended lectures on Energetics and the Environment, in which we dealt with technical protection of the environment. During this time, we were given the opportunity to participate in this project. With the help of professors, we prepared activities for the participants of the Academy. We transferred our study knowledge to the preparation of the contents, which we then presented.

The Academy was based on a research problem at the time when it expired June 26 - July 1, 2018 in Maribor, at the University of Maribor and KID Kibla. The academy was attended by 13 high school students from Turkey.

For the participants, we prepared research-problem seminars on the topic of carbon footprint, renewable energy sources and technical environmental protection, in which the participants actively participated. Their participation in the seminars was positive, since the topics of the seminars opened many discussions. It was interesting to observe their attitude to the subject matter. We also organized practical seminars, focusing on calculation of the carbon footprint, the production of electric current by means of solar energy and the production of a natural water filter. As part of our organized excursions, we visited the Fala hydroelectric power plant, where we learned in more detail about the process of obtaining electricity through water resources.

"The Fala HPP is the oldest power plant in the Slovene section of the Drava River. /. . . / Within the dam structure complex, the old power house being an important item of technical heritage has been preserved. Its units, comprising double horizontal Francis turbines and generators on the same shaft, were closed down in stages as a result of the construction of the new powerhouse. Today the old powerhouse is an interesting vantage point for visitors allowing them to become acquainted with both the old and current methods of operating the power plant" [10].

We also visited the *Vrbanski* Plato pumping station, which is managed by *Mariborski vodovod* (the company that oversees the city's water distribution system). It is one of eight pumping stations from where the city of Maribor is supplied with drinking water. *Mariborski vodovod* "has the largest water distribution network in the country, our distribution network consists of over 1.400 kilometers of water supply system and 221 facilities. Eight water sources and some smaller reservoirs provide the water supply. Annually, we pump 14,7 million cubic meters of drinking water which supplies seventeen municipalities in northeastern Slovenia and more than 200 thousand users or more than eleven percent of the Slovenian population" [11].

As participants we then attended the Academy in Germany (2–7 September 2018 in Potsdam). Students from Slovenia and students from Turkey and Germany took part in it. The last, third academy, took place in the Turkish town of Köycegiz (20–25 January 2019), where students from Slovenia and students from Turkey participated.

Research

Through the participation in the Green4U project, we had an opportunity to check how young people are facing environmental problems. We were interested in the attitudes of young people towards environmental problems and the environment in general. As a method of work for obtaining the desired results, we decided to interview and discuss. The survey included 128 young people from three different countries: 36 students from Turkey, 29 students from Germany and 63 students from Slovenia. The age ranged from 13 to 25 years.

We wanted to obtain answers to the following questions:
- What does green energy represent for you?

- Are you using renewable energy sources? For what/which purposes?
- List the polluters of the environment that you consider the most problematic.
- In your opinion, what are the consequences to the environment caused by individual polluters?
- How do you think pollution affects people?
- What is your opinion on environmental issues in the environment in which you live?
- Do you separate waste and in what way?
- What do you think about drinking water as a natural asset?
- What is your message to the following generations?
- What would you change for a cleaner tomorrow?

Results

The analysis of the results showed that young people mostly understand that the concept of green energy is a form of energy, which is derived from natural resources and is environmentally friendly. Many young people also connect this notion with clean environment and care for the environment. About 60% of young people reported using renewable energy sources, most of them for water heating. We also inquired about the opinion of young people about polluting agents. Almost half of them think that the largest environmental pollutant is industry, and one of the main topics of the industry is land transport. Among the main polluters, young people mostly include households and agriculture, which is shown in Figure 2.

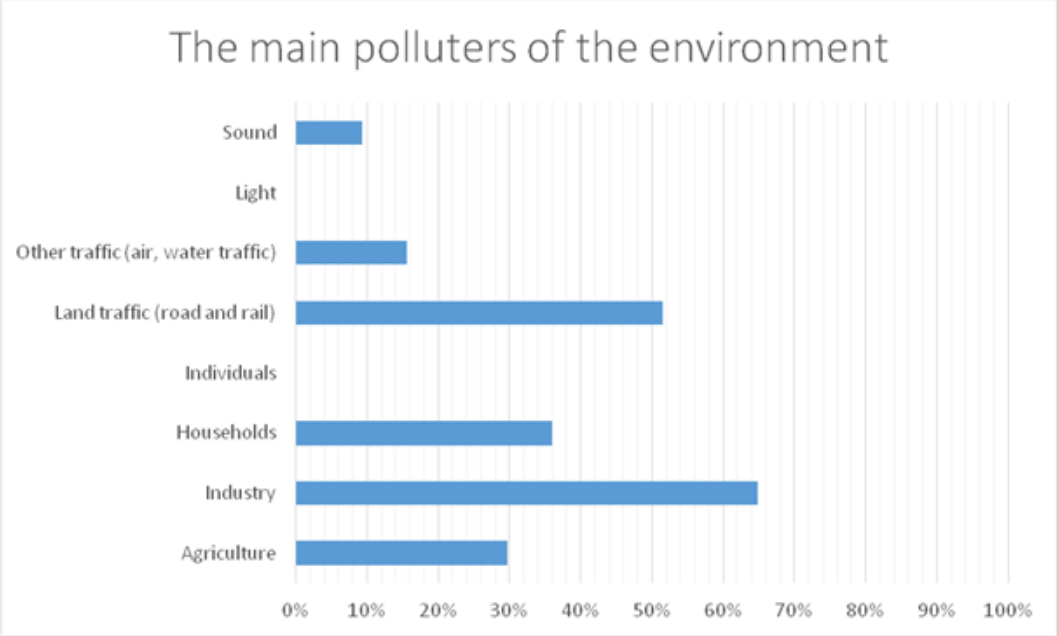

Figure 2: Young people's opinion on which environmental pollutants are most problematic.

When asked what is most affected by different types of pollution, young people reported that agriculture has the greatest impact on soil pollution and global warming. They believe industry to be the greatest source of water and air pollution, but not a major factor in global warming. It is also interesting to note that young people consider that an individual person is the biggest source of water pollution, and soil pollution (second most affected by individuals). Land traffic was reported as being the most important source of air and soil pollution, as well as a source of sound pollution (also known as environmental noise). Respondents report other types of traffic (i.e., air and water traffic) to be the major pollutants of water and air, but contribute less to global warming. Quite expectedly, participants see the excessive use of artificial light to be the main source of light pollution, and, similarly, they believe noise to be the major source of sound pollution. The data are shown in Figure 3.

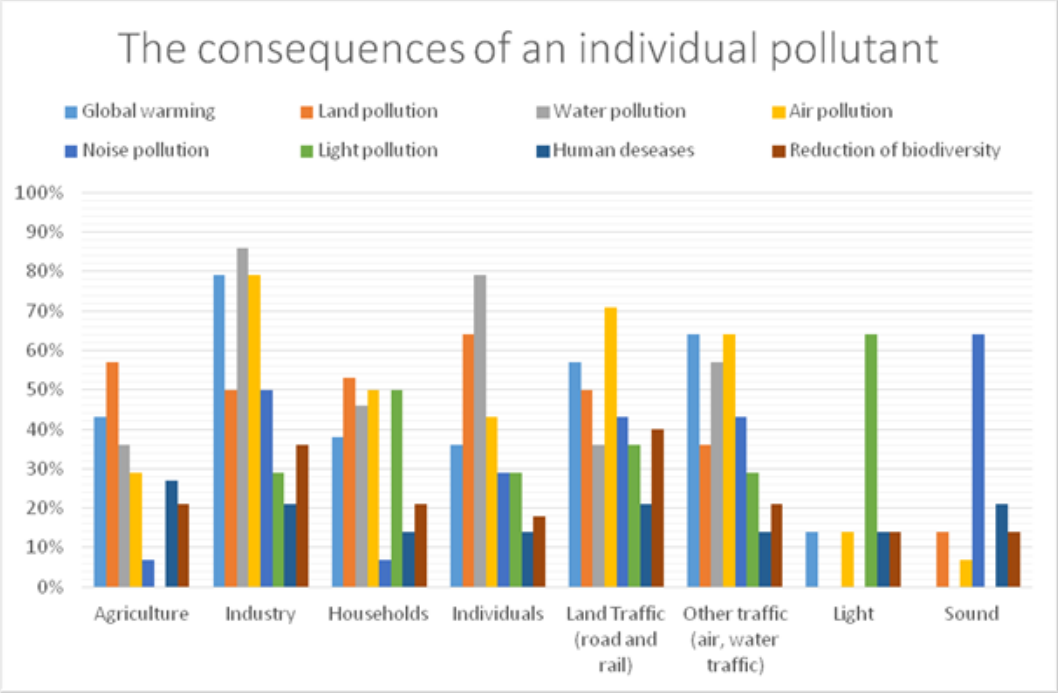

Figure 3: Youth opinion on the consequences of individual pollution.

We found that as much as 75% of young people are separating waste, mostly paper, glass and plastic. Most young people think that environmental issues in the environment in which they live are important and that they should pay more attention to them. Consequently, they are not satisfied with how environmental issues are treated in the home environment. The answer to the question is whether environmental pollution affects people, as shown in Figure 4

As we can see in Figure 3, most of them believe that environmental pollution contributes to forms of cancer in humans, respiratory diseases and skin diseases. Many also consider that the contaminated environment has an impact on

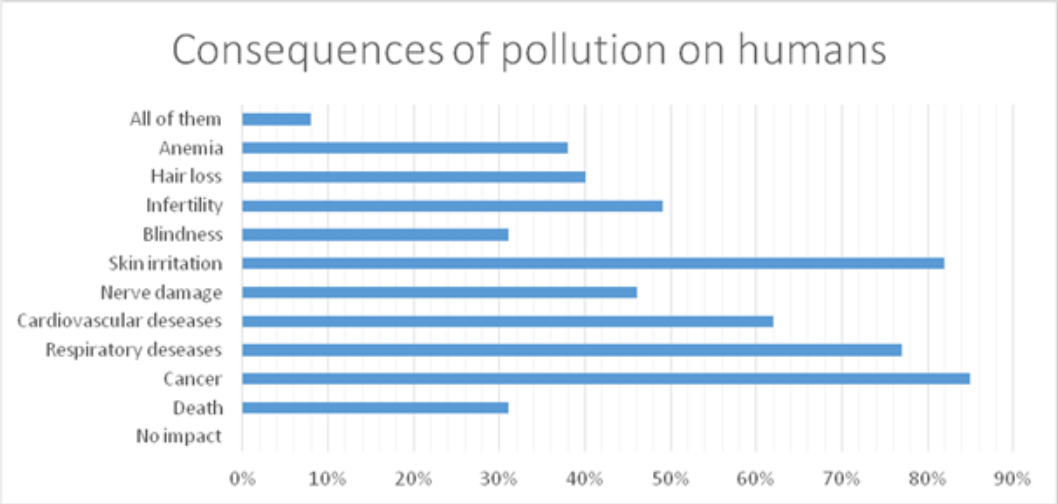

Figure 4: The answer to the question is if pollution has consequences on human health.

the cardiovascular system and on infertility. Some, however, believe that the contaminated environment has an impact on all of these diseases and problems, as they believe that the contaminated environment contributes to a certain degree of illness.

When asked what they think about water as a natural resource, young people mostly agree that water must be clean, that it must be accessible to everyone and that it is much healthier than other drinks. Some reported not having access to drinking water, which means they have to buy bottled water; they wish this situation would improve, so that they would be able to drink tap water.

Through interviews, we learned that young people are taking care of the environment by separating waste, using public transport, turning off lights, and using recycled products. To the question of what they would pass onto future generations, participants mostly reported that they would tell them to look after our planet, because we only have one Earth, and that they should act immediately. Some would also advise them to try to fix what the previous generations did to the planet. An example of such a message: "Please be respectful of the environment and leave it clean, because there are millions of people living in the same place as you." Young people also expressed interesting mottos, such as the following: "Every action has a reaction, we've got one planet, one chance."

The results of the interview also showed that young people separate between renewable and non-renewable sources of energy. We found that young people are mostly aware of environmental pollution, and are familiar with different pollutants of the planet. They are aware that pollution affects both animals and humans. There were some differences between certain groups: young people from Slovenia and Germany are separating waste and taking care of a clean environment in the sense that they do not throw away waste in nature, while young people from Turkey are not so aware of the importance of sorting waste, and mostly do not separate waste. We also found that the majority of young people first hear about

environmental problems at school, and only later they begin to obtain information on environmental problems from other sources, e.g. the media.

Discussion

As our research revealed, young people are quite well aware of environmental problems. We found that they understand the consequences of environmental pollution, that they themselves are trying to contribute to a cleaner environment and that, in general, they want to improve things. They are also aware that they can make a big contribution to a cleaner environment and that if all people would share that opinion, environmental problems could actually be reduced. During the Green4U project, we received numerous reviews and discussions on environmental issues. It turned out that young people from Turkey were quite surprised at how we look at environmental problems in Slovenia. Young people from Turkey were very surprised that, despite the awareness and care for the environment, we consumed irrigation drinking water (e.g. for washing cars). The access to drinking water is of course self-evident to Slovenes, since most of us use groundwater as a source of drinking water, which is widely accessible in our area. In some areas of Turkey, on the other hand, water is not clean enough to be safe to drink.

At the Academy in Germany, everyone was touched by professor Schellnhuber's speech in the city hall. Among other things, he said: "We need 10 crazy ideas, of which we can chose one that we can work on," and "In the end, it will be 1/1000 of a degree, that might decide between human extinction and survival," and last but not least "Every little act of environmental protection works. Don't think that your actions do not count as you are just 1 person out of millions. They do count, and they might save the entire human race."

The most emotional moment was in Turkey when we looked at the tortoise hospital. These creatures are in special care where they can receive help for injuries or illnesses that are the result of a contaminated environment. We were deeply touched by the sight of the turtles' damaged shells and the fact that these injuries were largely caused by humans.

In conclusion, the Green4U project touched us profoundly and prompted us to think about environmental problems. It encouraged us to become more aware of the consequences of our actions, and change our life habits. We believe that similar projects should be organized more often to raise awareness among young people about such problems.

Conclusion

The analysis of the results of project Green4U clearly points to the effectiveness of the proposed research- and problem-based strategies of learning (supported by collaborative teaching/learning) for developing social competences. Nonetheless, a more detailed research with a larger sample of students would have to be conducted in order to receive even more relevant results. The development of historical mem-

ory in humans is a gradual process happening over a long period of time. Little by little, lesson by lesson, it is going to alter our own awareness by constructing and adding new elements on the level of intuitive thinking. The kind of research work that was performed in the project Green4U is crucial for developing a complete, integrated, well-rounded personality of a youth, for creating positive interpersonal relationships, and for constructing a tolerant society of the future.

The fact is that humanity should be more committed to making greater use of renewable energies, as this would greatly contribute to a better life for future generations. The environment in which we live should be protected in order to remain at least as it is, or, if it is still possible, to improve it so that future generations will have a decent life. Therefore, it would make sense to organize more projects like this in order to encourage young people (and to the extent possible, even older generations) to become aware of the importance of a "healthy environment" and sustainable development, that is to say, environment and development that is human-friendly. It would be sensible for countries or different organizations to try and set up projects such as Green4U, thus spreading awareness about the importance of a clean environment, more exploitation of renewable energy sources and less (or zero) use of plastic and other non-degradable and unnatural material. We believe that raising awareness is a long-term process that will not end in a few days or months. It is going to take many years, if not decades, before people will be able to change their mindset and become more aware of the fact that planet Earth is the only place where human life is possible. This is why our perspective and our level of awareness about the significance of a healthy environment needs to start changing as soon as possible. Since at the end of the Green4U project we can now speak from our own experience, we can confirm that this project has indeed greatly affected our views and our level of awareness about the environment. Through numerous activities we had the opportunity to get to know and understand why a "healthy environment" is important for people. The project encouraged us to change our lifestyles and also to increase our concern for the environment. If we ever have a chance, we will definitely take part in similar activities in the future. We will, of course, always draw attention to environmental issues.

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Investigating Household Electricity Consumption of Engineering Students

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Abstract

Sustainable development is becoming a much bigger issue as depletion of major fossil fuels, global warming and air pollution while renewable energy plants can't satisfy current electricity consumption amounts. For a sustainable development not only ratio of renewable energy sources have to expand in total electricity production, but also human behaviour has to be modified to provide a resilient grid structure.

A portion of the electric power capacity goes active only during peak consumption hours to cope with demand and they are generally idle during base load and mean load sections during day. An extravagant approach to match demand is to build new plants according to overall energy strategy especially when most peaker power plants require fossil fuels which cause emissions during power generation cycles. A better approach would modify demand to find a solution which has optimal usage of system resources.

Residential electricity consumers are one of the main reasons for generation of peak loads. With increasing variety and utility in consumer electric goods, household electricity consumption is becoming much more dominant in total electricity consumption. Various techniques and strategies are implemented in developed countries to prevent consumers from having increased electricity consumption during peak hours. Household consumers are one of the hardest consumer type to predict load patterns as it is heavily dependent on physical conditions (climate, building age, building insulation etc.), variations in appliance characteristics (quantity, energy efficiency) and human behavior [1]. Seasonal variations and distinct differences between workdays and holidays were observed in previous studies.

In this study, engineering students from various departments are asked to fill home energy survey. Dominant parameters such as building characteristics, household energy usage frequencies for major consuming machinery and portion of household energy activity is investigated. Household consumption statistics of developing countries are compared to find relations. Also their interest in hot topics on energy efficiency methods and energy awareness are investigated.

Keywords: Residental electricity consumption, energy efficiency awareness, electricity consumption parameters.

Introduction

Starting from the Industrial Revolution, generation of heat and power has been vital in every aspect of human civilization. Early efforts were mainly limited to fossil based fuels operated by machines which would not meet up to date counterpart performances. While they provided great comfort with availability of energy, heat and power it came with the cost of depletion of fossil fuels, global warming, greenhouse gasses emissions and pollutants emitted [2, 3].

Sustainable development is the ability to develop while not jeopardizing development rights of future generations. Therefore severe set of actions need to be taken in order to slow/stop threat of our energy generation habits. There is an optimism with development of renewable energy sources [4]. While renewable energy systems look promising their randomness due to nature of their sources and some of them having geographical requirements is a serious concern. Expected full conversion of transportation systems/vehicles from fossil fuels to electrical vehicles will provide reduction in pollutants generated but it will increase global electrical energy demand even more [5]. Taking all these challenges into consideration, planning of future in terms of energy requires more intelligent approach.

Demand Side Management is providing financial incentives to electricity customers to change their consumption behaviour. In Demand Side Management plan is not to match supply to demand but to modify demand to provide an optimal solution to management of system resources. This intelligent approach will also provide a reduction in electricity prices as 20% of the installed capacity goes active only 5% of the time therefore causing idle investments. By reducing peak electricity demand alone, it is possible to provide reduction in electricity prices. By giving financial incentives to consumers, it is possible to shift operating schedule of major electricity consuming appliances such as dishwasher, washing machine and dryers to base load hours while electricity demand is low [6].

Adapting to Demand Side Management requires tackling of some challenges. Enabling technologies and customer awareness is two of the most important of them. Enabling technologies include smart grid, micro generation, energy storage systems, local and regional energy management systems, conversion to electrical vehicles and plug-in hybrid electrical vehicles. Smart grid provides intelligence to grid as it allows two-way communication between customer and utility companies [7]. Smart grids provide information flow as well as energy flow [8]. Through load scheduling and energy storage during base load periods to consume it when demand is rising, it is expected that if such challenges are achieved it will provide a more manageable and efficient energy network [9].

Conventional approach to energy systems were to match supply according to demand. While major electricity customers such as industrial and commercial consumers have a certain routine consumption plan, residential customers are not easy to predict [10, 11]. Conventional black-box based techniques are insufficient to accurately predict electricity demand of residential customers as it is heavily dependent on household demographics, building characteristics, climate, resident behaviour, electrical appliances owned by each customer and their operating sched-

ules [12, 13].

Literature Survey

Various utility company and government led case studies are performed in order to provide insight towards residential electricity consumption. Depending on their aim and study length, survey based or monitoring based studies are performed [14].

REMODECE Project spanning over 12 European countries, aimed to provide a better understanding towards European Union household consumption while evaluating their energy saving potentials. After 2 weeks monitoring of 1300 households, they find that switching to best technology available electrical appliances would save 1300kWh annual electrical energy saving for an average monitored household [15].

Some studies focused on standby power consumption of electrical appliances in residents. Standby power consumption occurs when electrical appliances are plugged but not performing their primary duty. Options such as display clock, programmable operating schedules, memory and remote control are some of the reasons why appliances draw continuous energy. Many studies have focused on assessment, prevention and reduction of standby power [16].

A study made in Ankara covers 260 household measurements on 1746 appliances. Surveyed homes are picked to provide a meaningful small model for Turkey household electricity users. Study claims to be the first work on Turkey which studies standby consumption measurements in the country and an extensive comparison with literature data is performed. According to the data, Turkey has one of the least average standby power(22W) and average annual standby consumption (95kWh/yr) values when compared to major EU countries, USA, Taiwan and China [**?**].

Another study in Canada by measuring and recording 75 different household's appliances and their usage patterns, then performing standby power measurements in 1 PC store and 3 electronic retail superstore at Halifaxanalyzes total standby consumption potential. They compare appliances and see whether an aim of 1W maximum standby power is realistic or not. Their findings prove that 1W limit for standby power is achievable and it would provide 59% annual reduction in standby consumption [18].

Household energy audits and linking them with their smart meter monitoring also provides greater insight into household electricity consumption. One of the most promising ones is performed by Commission for Energy Regulation in Ireland [19].

Other studies have investigated links between household energy audits and onsite measurements. A study performed in Portugal clusters and investigates annual electricity consumption profiles and expands their analysis by linking their findings with surveys spanning over urban and rural areas of Évora [20]. Our previous works have focused on classification of different consumers using their monthly average load profiles. Our aim is to group customers in a way which will provide less peak to average load ratio for select customer group. In a power buy day ahead market

scenario, utility companies may provide discounts for select customers in a district to provide a win-win situation [21].

Another previous study investigates relations between survey data and load profiles, after analyzing their relation, tries to predict monthly average electricity load profiles using survey data. One of the interesting research findings is expected effect of old appliances which enhances household electricity consumption [22].

Methodology

To investigate household consumption and their energy awareness, survey is conducted on a group of students from varying departments of engineering faculty regarding their household demographics, residence physical conditions, HVAC and water heating system and appliances owned by household and their usage frequency. From a total of 190 surveys, 148 of them are selected to be able to provide reliable information regarding household consumption characteristics. Survey ID is assigned to each paper to provide privacy and questions are as following:

Participant Information

Age, Gender, Department, Class

Household Statistics

People living under 18 years old, people living older than 18 years old, How many of the people are active consumers during day(for each age group).

Building characteristics

Floor, Apartment/detached house, Insulation, Window frames, Amount of lighting in each room, room amount, floor area, building age

HVAC

Amount of portable fans, amount of A/C devices, Which method is used for room heating, which method is used for water heating

Home appliances

Amounts for each electrical household appliances (i.e microwave oven, electric cooker, coffee/tea machine, fridge dishwasher, deep freezer, washing machine, cell phone, PC, laptop, internet modem, cable tv decoder, tv etc.) , daily usage frequency for each electrical appliance

Efficient energy usage awareness

Seasonal average electricity bill, do you own smart meter, have you heard of dynamic pricing, what is your willingness to change your consumption behavior if you are provided with financial incentives, do you know about carbon footprint, which vehicles do you use when coming to university, how many times do you travel with plane annually. After gathering survey data, a comparison of findings are performed between survey data and other statistics of same/similar topic. Surveyed students shows some disparity in gender and age available on Table 1 and Table 2. Surveyed students are mostly from Mechatronics and Electrics-Eletronics Engineering (Table 3).

Table 1: Survey demographics (age).

Age	18 years old	19 years old	20 years old	21 years old	22+ years old
# of students	3	38	41	38	63

Table 2: Survey demographics (gender).

Gender	Male	Female
# of students	149	34

Research Findings

Survey data has been compared with available data from developed countries. One of the first investigation is towards energy saving via insulated buildings. Istanbul has a climate where you can experience characteristics of all 4 seasons annually. During winter, a proper insulation can prevent requirement for a heavy heat load and during summer it can greatly reduce air conditioning needs. In Figure 1 insulation characteristics for different building ages are provided. Using statistical data available in Figure 2, average expected consumption can be predicted. Figure 1 also provides the information that great energy savings can be achieved through insulation of old buildings.

Survey stats expanding over a total of 673 people over 189 households. with a total of 89 desktop computers there is 0,55 desktop computers per household. With a total of 323 laptop computers there are 2 laptop computers per household. With 606 cell phones, an average of 3,7 cellphones per household . According to TUIK report 21779 dated 21/08/2016. Cell phone ownership, desktop and laptop computer ownership is greater than Turkey average.

Despite having energy awareness, engineering students and their households shows much more electricity consumption potential due to intense usage of ICT products.

As comparison of smart meter awareness, majority of ICU engineering students know about smart meters. Table 4 also shows that majority of those having knowledge also has smart meters installed at their residency. When compared with statistics from UK available on Figure 3, study shows great similarity.

Table 3: Survey demographics (department)

Department	Electric-Electronics Engineering	Industrial Engineering	Mechatronics Engineering.
# of students	84	27	72

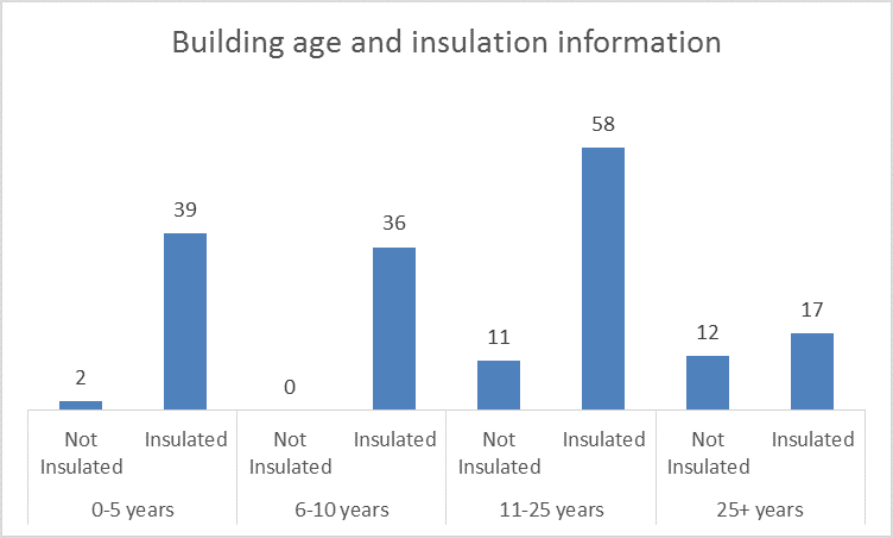

Figure 1: Building age and insulation graph for ICU survey.

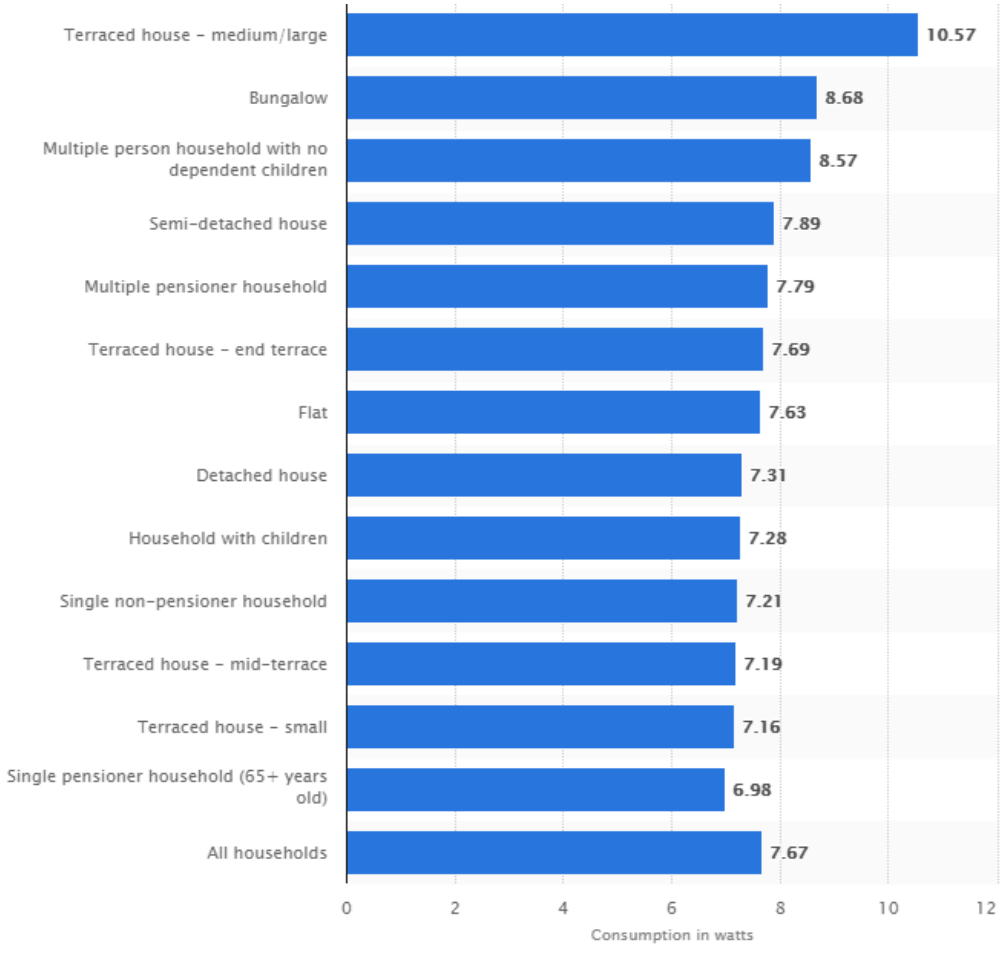

Figure 2: Average maximum household power demand in England [23]

Table 4: Survey energy awareness findings.

	18-19 years old		**20-21 years old**		**22+ years old**	
	Owns smart meter	Doesn't own smart meter	Owns smart meter	Doesn't own smart meter	Owns smart meter	Doesn't own smart meter
Knows about dynamic pricing	3	1	4	4	11	3
Doesn't know about dynamic pricing	16	10	34	25	20	15
Knows about carbon footprint	24		54		39	
Doesn't know about carbon footprint	12		23		28	

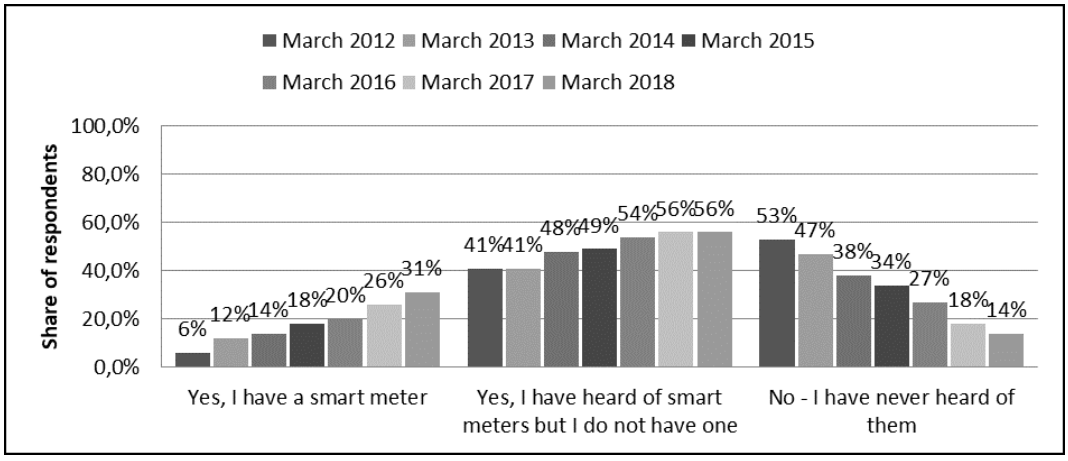

Figure 3: Level of smart meter awareness in the United Kingdom (UK) 2012-2018 [24].

Conclusion

It has been observed that younger people show greater interest in installing smart meter. Relatively more adapting nature in younger ages.Younger people Show greater interest in installing smart meter. Relatively more adapting nature in younger ages.

Even though they are showing concerns towards sustainable development, as being engineering students having greater interest in technological development

and ICT products their appliance amount is higher than TUİK statistics.

Future Focus

Conducting student survey again may provide progress of energy awareness as years develop providing data to comment on freshmen knowledge and development of energy awareness on previously investigated students after 2 years. Survey may include age of each appliance to investigate possible savings can be achieved provided with break-even points.

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A Study on the Modelling of Electrical Energy Consumption and Energy Density of Turkey and Comparisons With Other Countries

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Abstract

The aim of this study is to investigate whether there is any similarity between Turkey's electricity consumption and energy density characteristics with other countries of the world and also determine which countries have high similarity for those characteristics. Countries with high levels of similarities in electricity consumption and energy density have been determined and the relations between them have been also examined. For this purpose, the statistics of the World Bank for 183 countries between the period of 1971-2012 have been analyzed separately. Correlation coefficients have been calculated for each of the countries according to the statistical results, and whether the r values found were close to one; 21 countries with high similarity rate have been determined by regression equations for these countries and similarities between Turkey's electricity consumption and energy densities have been investigated then analysis and conclusions have been performed.

Keywords: Electrical Energy Consumption, Energy Density, Energy Efficiency, Statistical Analysis, Correlation Analysis

Introduction

Energy is an indispensable production input for the continuation of the production process. Energy means the ability of an object or system to do work. It is a value that is not directly measurable and can be found through work that needs to be done to change the state of a physical system, or through different calculations based on the type of energy.

The importance of energy as a production input has been neglected until the oil crises of the 1970s. Two oil crises, especially in the 1970s, revealed the importance of energy and energy was considered as a production factor and started to be added to the production function. A study by the IEA (International Energy Agency) was also included in the energy production function and applied to some developing

countries that were taken into consideration for the 1981–2000 period. In the study, it is concluded that energy plays an important role in the countries which are in the intermediate stage of economic development because of its contribution to economic growth (IEA, 2004).

When it is divided into energy components, it is seen that electricity is the highest quality of energy component and its share in energy consumption increases rapidly [1]. Electricity can be produced by natural gas, oil, coal and bio-fuels respectively. This view is also supported by the price per unit of energy, which is proportional to the marginal products of these fuels [2].

Electricity is one of the most energy-efficient components of socio-economic infrastructure. For this reason, it has wide usage areas in every aspect of daily life. As consumption of various goods and services in each country along with economic development similarly also in Turkey is increasing and the most important of this component is the use of electricity. On the other hand, being one of the basic input used in the industry, the use of new goods to increase the quality of life is dependent on electricity with increasing the dependence on electrical energy [3].

Turkey, in terms of energy use is largely dependent on foreign countries. Especially in petroleum and natural gas this dependency is in higher positions. If new sources or substitution of these resources cannot be put into use, this dependency is expected to continue in the future [4].

Electrical energy has a significant share in energy consumption. Electricity consumption during the period examined in our study have shown an average annual increase of 8.7% with a still electricity consumption in Turkey has reached the level of OECD countries [5].

Energy consumptions in each sector is increasing and variations of sector shares in total consumption are also changing. While the industrial sector has the largest share in the consumption of electricity in sectoral basis, residential share of electricity using is followed. While the share of the industrial sector in total usage is decreasing in the period examined in our study, the share of housing consumption is increased due to the expansion of urbanization and transmission network. The decrease in the share of industrial sector could be thought to be effective in the use of alternative energy and increase in autonomy. A similar increase is observed in the trade sector. It can be said that the share of electricity consumed in official departments has not changed almost in the period [3].

Energy Efficiency and Energy Density for Turkey

Energy density is one of the important indicators of energy efficiency, an indicator that is used throughout the world and represents the amount of primary energy consumed per GDP (Gross Domestic Product). The lower the energy density of a country, the lower the energy used to produce unit output in that country, the less energy is used and the more efficient use of this energy [6]. The amount of TEP (tons of oil equivalent) which is generally consumed for $1000, is preferred as an indicator of energy density in international publications.

As it can be said that energy density is the amount of energy consumed to produce a dollar of goods or services; low energy density of a country; means the production of goods or services with less energy. Despite Turkey's per capita energy consumption falling around one-fifth of the OECD average, Turkey's energy density is twice the OECD average. In other words; Turkey uses twice the amount of energy used in OECD countries to produce a dollar of goods or services. Overall reduction of energy density for Turkey also have been started to take some steps. In the 2010-2014 Strategic Plan of the Ministry of Energy and Natural Resources in Turkey; increasing energy efficiency is defined as one of the main objectives. In the strategy document, it is vital that increasing energy efficiency with preventing waste energy and reducing energy density in all of the processes from energy production to utilization within the framework of the objectives of ensuring energy supply security, reducing the risks arising from external dependence and increasing the effectiveness of the struggle against climate change. With the measures to be taken in the 2010-2014 Strategic Plan of the Ministry of Energy and Natural Resources, it is aimed to ensure that 15% less energy will be used in industry, 27% in buildings and 7% in transportation sector until 2020. Similarly, in the National Climate Change Strategy Document (2010-2020), in the energy section under Greenhouse Gas Emission Control, energy efficiency potential in buildings will be determined, priority projects will be determined for building materials and technologies that will ensure energy efficiency in cooperation with industry, infrastructure will be provided for energy identity certificate application in buildings, energy management in compliance with standards will be implemented in industrial and building sectors in the long term. For Turkey, it is aimed that Energy Density of up to 2020 will be reduced to a lower level with respect to the 2004, which will be supplied by improvements in the buildings and also facilities of public organizations (WWF-Turkey, 2011).

Turkey is a rapidly developing the industrialization activities, rapidly orientation to the new technologies, increasing population and rising living standards lead to higher energy consumption each year. Due to the rapid increase in demand, it is expected that only 20% of the total energy supply will be met by domestic production in 2020. In our country which cannot use all of the resources effectively in terms of energy resources will lead dependency on foreign sources and due to this fact it will be the main objective to provide energy needs adequately, reliably and economically. Efficient use of energy is the most important tool in achieving this goal.

It is of particular importance in terms of Turkey's obligations in the EU harmonization process and the Kyoto protocol adopted in May 2008.

Turkey is also known that the potential energy savings of 20-30% in different sectors where energy is used intensively. When the 15% electricity saving potential is recovered, investment of 6.5 billion TL in natural gas power plant can be prevented or USD 3.0 billion per year may not be imported [7].

Electricity Production and Consumption Characteristics for Turkey

Turkey is a very rich country in terms of its own energy resources. The extent to which these energy resources can be used efficiently will contribute to the national economy. For this reason, it is important to reduce the cost of electricity generation or to produce from less costly sources.

In 1971, the overall production of electrical energy was 11243 GWh and increased by 13.4% compared to the previous year, but in 1976 the overall production was 18283 GWh and increased by 17% with respect to the previous year. Also in this year, per capita consumption of electricity increased by 11.6% compared to the previous year with total consumption increase rate of 13.4%.

In 1976, per capita consumption increased by 20% compared to the previous year by 417.9 kWh, while the general consumption increased by 17% compared to the previous year by 16903GWh.

In 1981 the overall production was 24673 GWh and increased by 6% compared to the previous year. Also in 1981, consumption per capita increased by 7.2% compared to the previous year by 571.6 kWh, whereas the general consumption increased by 6%. In addition, in 1986, the overall production amounted to 39695 GWh and increased by 16% compared to the previous year while per capita consumption increased by 8% by 695 kWh compared to the previous year.

In 1991 the overall production was 60246 GWh and increased by 4.7% compared to the previous year while in 1991 per capita consumption increased by 5.6% compared to the previous year by 961.3kWh.

Also in 1996, the overall production was 94862 GWh and increased by 10% compared to the previous year but in 2001, the overall production was at 122725 GWh and decreased by -1.8% compared to the previous year and this decrease is inevitable due to the economic crisis. Per capita consumption in 2001 decreased by -0.9% to 1604.2 kWh compared to the previous year while overall consumption decreased by 1.8% as it has been mentioned above.

In 2006, per capita consumption increased by 9.6% compared to the previous year by 2169.4kWh, while overall consumption was 149826 GWh up 3.1% with respect to the previous year.

Also in 2010, production per capita increased by 9.2% compared to the previous year by 2477kWh, while overall production increased by 4.2% compared to the previous year.

Turkey 's growing external dependence on energy in 2011 was 56%, while 72.4% of primary energy in electricity. Between 2011 and 2011, electricity prices increased by 109%. In addition, total energy imports reached 54 billion dollars by the end of 2011 and led to an increase in the import-export gap.

Electricity consumption and energy density values of Turkey and other countries with the data requirements for comparison have been obtained from Energy Ministry of Turkey and mainly also World Bank database. This data used to focus to establish the regression and correlation model of the electricity consumption and energy density characteristics between Turkey and other countries and this

correlation and statistical analyses have been performed with SPSS (see Table 1).

Data, Model and Method

Correlation Analysis and Correlation coefficient

The direct expression of interest between two variables is called correlation. The linear correlation coefficient is shown as r in the analysis [8]. The statistical method used to determine the degree of correlation or correlation between two variables is called Correlation Analysis. The variable to be estimated is called the dependent variable, while the variable used for the estimation is called the independent variable.

The Correlation Coefficient determines the extent to which the two variables change. In many cases, it is not determined certainly which of the variables of the model are independent variables, which is dependent variable. In such cases, the correlation coefficient, which is a proportional measure, is used to determine the degree of the relationship [9]. Correlation coefficient $-1 \leq r \leq 1$ will takes a value between -1 and +1. If the sign of the correlation coefficient is positive, the value of one of the variables increases (decreasing) while the other increases (decreases); if negative, the value of one of the variables increases (decreasing), the other indicates the value decreasing (increasing), that means an inverse relationship. Correlation coefficient can be calculated with formula as follows [9]:

$$r = \frac{\sum x_i y_i}{\sqrt{\sum x_i^2 y_i^2}} = \frac{\sum \left(X_i - \acute{X}\right)\left(Y_i - \acute{Y}\right)}{\sqrt{\sum \left(X_i - \acute{X}\right)^2 \left(Y_i - \acute{Y}\right)^2}} \tag{1}$$

where x represents independent variable; y represents dependent variable. Regression analysis determines the relationship as an equation between dependent variables and an independent variable or variables. By using independent variables as (x, x_1, x_2, x_3, ..., x_n), the general linear regression formula between this dependent variable y with respect to those independent variables can be written as follows:

$$y = b_0 + b_1 * x_1 + b_2 * x_2 + b_3 * x_3 + b_4 * x_4 + b_5 * x_5 + ... + b_{n+1} * x_{n+1} \tag{2}$$

Here b_0, b_1, b_2, b_3, b_4, ... b_{n+1} are unknown parameters. The simplest regression model is the model in which the dependent variable is assumed to change linearly with respect to x. Namely;

$$y^* = a + bx \tag{3}$$

can be defined as a linear regression model. The linear estimation equation y in y=a+bx can be controlled by calculating the correlation coefficient r which can be calculated the following formula:

Table 1: Turkey Annual Electrical Energy Consumption and Other Characteristic Values.

Years	Turkey Annual Electricity Consumption (GWh)	İncrease Rate Over the Years (%)	Population	Exchange Rate of USD Dollar (TL/$)	Turkey's PerCapitaelectricity consumption (kwh/person)
1971	8 798	13,43	36 245 756	0,0000149	242,73
1972	10 113	14,95	37 054 168	0,0000142	272,92
1973	11 142	10,18	37 884 870	0,0000142	294,10
1974	11 989	7,60	38 730 367	0,0000139	309,55
1975	14 084	17,47	39 585 821	0,0000144	355,78
1976	16 903	20,02	40 446 729	0,0000161	417,91
1977	18 979	12,28	41 316 297	0,0000180	459,36
1978	20 159	6,22	42 206 204	0,0000243	477,63
1979	21 004	4,19	43 132 612	0,0000311	486,96
1980	21 792	3,75	44 105 216	0,0000760	494,09
1981	23 358	7,19	45 130 008	0,0001112	517,57
1982	25 008	7,06	46 198 027	0,0001626	541,32
1983	26 145	4,55	47 285 732	0,0002255	552,92
1984	29 526	12,93	48 360 679	0,0003667	610,54
1985	32 416	9,79	49 399 630	0,0005220	656,20
1986	35 025	8,05	50 393 538	0,0006745	695,03
1987	39 407	12,51	51 349 154	0,0008572	767,43
1988	42 121	6,89	52 278 499	0,0014223	805,70
1989	46 355	10,05	53 200 802	0,0021217	871,32
1990	50 131	8,15	54 130 268	0,0026086	926,12
1991	52 938	5,60	55 068 880	0,0041718	961,31
1992	58 222	9,98	56 012 109	0,0068724	1039,45
1993	63 180	8,52	56 959 988	0,0109846	1109,20
1994	65 940	4,37	57 911 273	0,0296087	1138,64
1995	71 782	8,86	58 864 649	0,0458451	1219,44
1996	78 935	9,96	59821978	0,0814049	1319,50
1997	86 935	10,13	60783217	0,1518650	1430,25
1998	93 227	7,24	61 742 674	0,2607243	1509,93
1999	96 940	3,98	62 692 616	0,4187829	1546,27
2000	104 520	7,82	63 627 862	0,6252185	1642,68
2001	103 542	-0,94	64 544 914	1,2255880	1604,19
2002	108 621	4,91	65 446 165	1,5072260	1659,70
2003	117 099	7,81	66 339 433	1,5008850	1765,15
2004	126 774	8,26	67 235 927	1,4255370	1885,51
2005	136 750	7,87	68 143 186	1,3435830	2006,80
2006	149 826	9,56	69 063 538	1,4284530	2169,39
2007	163 353	9,03	69 992 754	1,3029310	2333,86
2008	170 604	4,44	70 923 730	1,3015220	2405,46
2009	165 088	-3,23	71 846 212	1,5499600	2297,80
2010	180 212	9,16	72 752 325	1,5028490	2477,06
2011	196 431	9,00	74 724 269	1,6749550	2667,47
2012	206 489	5,12	75 627 384	1.7925	2730,34

$$r = \frac{\sum_{i=1}^{n} y_i x_i - n\acute{y}\acute{x}}{\sqrt{\left(\sum_{i=1}^{n} x_i^2 n\acute{x}^2\right)\left(\sum_{i=1}^{n} y_i^2 - n\acute{y}^2\right)}} \tag{4}$$

If $r = \pm 1$, there is a possible linear relationship between x and y. Usually the linear relationship increases as the r value approaches 1. If $r = 0$ it means that y and x can be independent [8].

If the sign of the correlation coefficient is positive, the value of one of the variables increases (decreases) and the other increases (decreases). If the sign of the correlation coefficient is negative, the value of one of the variables increases (decreases) while the value of the other decreases (increases); in other words, there is an inverse relationship in this case (see Figure 1).

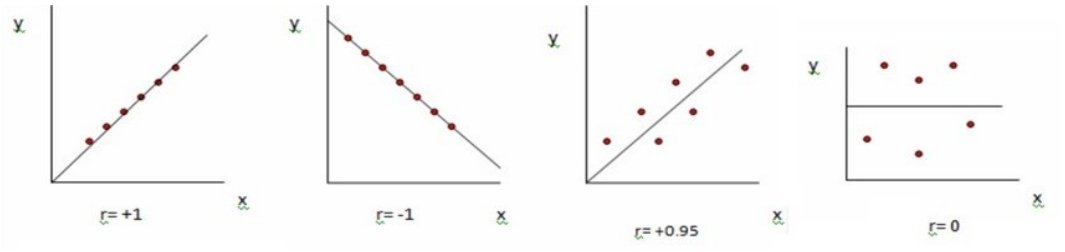

Figure 1: Correlation Coefficients Meanings.

Comparison of Turkey's and Different Countries' Electricity Consumption Characteristics

In our study we investigate whether there is any similarity between Turkey's electricity consumption and energy density characteristics with other countries of the world and also determine which countries have high similarity for those characteristics. Countries with high levels of similarities in electricity consumption and energy density also will be determined and the relations between them will be also examined. For this purpose, the statistical data of electricity consumption and energy density values for 183 countries between the period of 1971-2011 from the World Bank database have been analyzed separately. Correlation coefficients for electricity consumption and energy density values of this countries' with Turkey's electricity consumption and energy density values have been calculated for each of the countries. Then according to those statistical results, it has been determined that which countries will have the r values close to one; after that 21 countries have been selected with high similarity rate. Similarity rates have been determined by regression equations for these countries and similarities between Turkey's electricity consumption and energy densities have been investigated. As an example for our study only Argentina and Turkey comparision and statistical results will be given only for statistical analysis on the similarity of energy characteristics between

our country and other 21 countries (Figure 2 and 3). For instance of the similarity analysis about electricity consumption, firstly elecricity consumptions for the period of 1971-2012 plotted graphically and similarity has been determined then independent variable has been assigned to Turkey's electricity consumption and dependent variabe has been assigned to Argentina's electricity consumption values and correlation coefficient has been calculated and same methodolgy has been applied for energy densities also. Then all of the 21 countries similarity comparision values for electrical energy consumption and energy density values have been analysed in the same way. Turkey's and selected 21 different countries' electricity consumptions and energy density values were compared and all of the similarity values have been given in Table 2.

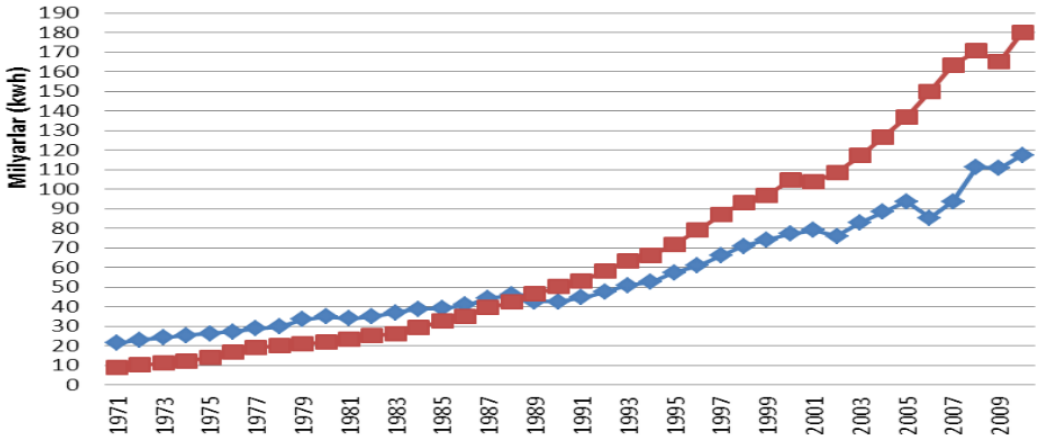

Figure 2: Argentina - Turkey Electricity Consumptions.

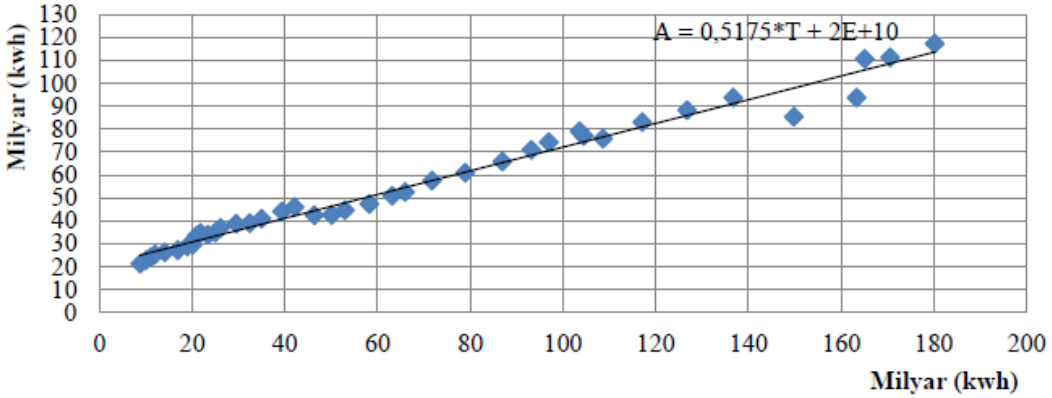

Figure 3: Comparison of Argentina – Turkey Electricity Consumption Characteristics Results.

Results

Considering the ease of use of electricity and its prevalence in all areas, it can be expected that the increase in consumption will increase the welfare of the society. The use of many tools and equipment that make everyday life easier depends on electricity. Accordingly, it can be said that there is a parallel development between per capita national income increase and per capita electricity consumption. While electricity consumption per capita decreases in the contraction periods of the economy, this decrease is less than per capita income drop. Per capita consumption during the period showed only a negative decrease in the 2001 and 2009 crisis. As a result, a steady increase in electricity consumption per capita can be mentioned.

Turkey has similar power consumption characteristics of the power consumption with a high proportion of 21 different countries; however, a very weak linear relationship was found with these countries based on energy density. As a given example of statistical analysis, electricity consumption in Turkey and Argentina characteristics have been determined by a linear relationship and it is very strong positive correlation 0,990; also according to the results of this analysis correlation analysis made for the corresponding energy density values and 0.246 correlation value has been found between Argentina and Turkey and it shows that weak positive linear relationship. Electricity consumption and energy density characteristics of the relationship between those states and as a result of other twenty countries and Turkey are shown in Table 2 as follows:

Discussion and Conclusions

Turkey's electricity consumption characteristics similar output with high power consumption characteristics of 21 different countries which selected from 183 countries worldwide. In addition, a very weak linear relationship was found with these countries based on energy density. These results have been confirmed by the correlation analysis.

As a result of analysis, highest similarity rate has been found between Turkey and Iran with 99.8% correlation coefficient for electricity consumption rate characteristics and it will show for very strong positive linear relationship. However despite the high characteristic relationship with 99.8% correlation coefficient for consumption, there is a 23.6% very weak positive linear relationship with energy density for Iran. The highest ratio for consumption will show that Iran has a similar electricity consumption characteristics with our country and we can use this result for electrical energy production, consumption and distributions strategy of our country and Iran so that important lessons can be learned from this analysis.

Electrical power consumption characteristics between Turkey and Brazil with 97.5% correlation coefficient. And this value is the lowest value in this analysis among the selected 21 countries.

In terms of energy density relationship: Mexico has the highest linear relationship with 54.4% correlation; Thailand has a negative linear relationship with -52.3% correlation; Egypt has also negative relationship with -1.1% and also there

Table 2: Comparison with Other Countries Turkey Between Electricity Consumption Characteristics and Energy Density.

Countries	Electricity Consumption Relation Correlation Value and Status	Energy Density Relation Correlation Value and Status
Turkey - Brazil	0,975 strong positive linear relationship	-0,495 weak negative linear relationship
Turkey – United Arab Emirates	0,992 very strong positive linear relationship	0,380 weak negative linear relationship
Turkey - İndonesia	0,997 very strong positive linear relationship	-0,340 weak negative linear relationship
Turkey - Philippins	0,991 very strong positive linear relationship	0,348 weak positive linear relationship
Turkey - İndia	0,995 very strong positive linear relationship	0,071 very weak positive linear relationship
Turkey - İran	0,998 very strong positive linear relationship	0,236 weak positive linear relationship
Turkey - Spain	0,989 very strong positive linear relationship	0,236 weak positive linear relationship
Turkey - İndia	0,989 strong positive linear relationship	0,064 very weak positive linear relationship
Turkey - İsrael	0,995 strong positive linear relationship	0,430 positive linear relationship
Turkey - Kuveyt	0,986 strong positive linear relationship	0,200 positive linear relationship
Turkey - Malesia	0,989 strong positive linear relationship	-0,120 weak positive linear relationship
Turkey - Mexico	0,981 strong positive linear relationship	0,544 positive linear relationship
Turkey - Egypt	0,996 very strong positive linear relationship	0,055 very weak positive linear relationship
Turkey - Pakistan	0,987 strong positive linear relationship	-0,122 weak positive linear relationship
Turkey - Portugal	0,981 strong positive linear relationship	0,209 weak positive linear relationship
Turkey - Singapore	0,988 strong positive linear relationship	-0,011 weak positive linear relationship
Turkey - Portugal	0,992 strong positive linear relationship	0,149 weak positive linear relationship
Turkey - Chile	0,992 very strong positive linear relationship	0,119 weak negative linear relationship
Turkey - Tailand	0,993 strong positive linear relationship	-0,523 negative linear relationship
Turkey - Greece	0,978 strong positive linear relationship	0,515 negative linear relationship

is a negative relationship for Singapore as -1.1% correlation values. Looking at the energy density correlations between Turkey and other countries, Mexico can be considered to be the best country with 0,544 positive linear relationship.

In terms of energy density relationship: Mexico has the highest linear relationship with 54.4% correlation; Thailand has a negative linear relationship with -52.3% correlation; Egypt has also negative relationship with -1.1%. Although electricity consumption decreases during the contraction periods of the economy, this decrease is less than the per capita income drop. During the considered period, electricity consumption decreased only negatively in the 2001 and 2009 crisis; but it can be said that a steady linear increase in electricity consumption can be mentioned as a result; however, the decrease in energy density is not sufficient for our country and analyzes and similar lessons can be learned with similar countries.

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Critical Review of Sustainability Reports of Banking Sector in Turkey

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Abstract

One of the important sectors fighting the global warming is the banking sector. Banks can affect and lead all the other sectors by providing investing and lending choices. Especially of interest are energy investments than can affect the environment. When all the employees of the bank and branches are considered, the banks themselves have to fight climate change as an organization as well. Sustainability reports published annually is perhaps the best indicator for researchers to decide how well a certain bank has achieved this endeavour. According to total assets of the Turkish banks in March 2018, seven out of ten biggest bank have been publishing their sustainability reports annually for the last five years. However, only four banks include the emissions from branches whereas three banks cover the general directorate only. A closer look at these four banks show that they all report Scope 1 and Scope 2 emissions and only three report Scope 3 emissions. Scope 1 emissions are direct emissions from equipment and processes owned or directly controlled by the company. Scope 2 emissions are indirect emissions from energy related and emanating mainly from electricity or from district heating purchased from third parties. Scope 3 emissions are other indirect emissions related to a company's activities, but from sources not owned or controlled by the company such as transportation. This paper presents a critical overview of the major Turkish Banks and suggest a more complete lists of emission sources and a more integrated approach to the problem of environmental sustainability.

Keywords: Carbon footprint, Banking sector, Sustainability report

Introduction

As a result of human activities, the amount of greenhouse gases in the atmosphere has increased, especially since the industrial revolution. Increasing concentrations of greenhouse gases in the atmosphere are regarded as the main cause of global warming.

Due to increasing and critical danger of global warming, it is inevitable to take necessary precautions. Therefore, some standard criteria have been formed by

different organizations like International Organization for Standardization (ISO) and British Standard Institution (BSI). Some of the main carbon related standards commonly applied worldwide which provide the requirements and guidelines are as below:

- PAS 2050: Specification for the assessment of the life cycle greenhouse gas emissions of goods and services;
- ISO14064: Greenhouse gases;
  - ISO 14064-1: Greenhouse gases — Part 1: Specification with guidance at the organization level for quantification and reporting of greenhouse gas emissions and removals,
  - ISO 14064-2: Greenhouse gases — Part 2: Specification with guidance at the project level for quantification, monitoring and reporting of greenhouse gas emission reductions or removal enhancements,
  - ISO 14064-3: Greenhouse gases — Part 3: Specification with guidance for the validation and verification of greenhouse gas assertions,
- ISO14067: Greenhouse gases — Carbon footprint of products — Requirements and guidelines for quantification and communication;
- GHG Protocol which is an idea of the World Resources Institute (WRI) and World Business Council for Sustainable Development (WBCSD).

In this study, GHG Protocol is being considered. In order to prepare a corporate-level GHG emissions inventory, the GHG Protocol provides requirements and guidance for companies and other organizations [1]. In this protocol, greenhouse gas emissions are considered in three scopes. Scope 1 emissions are direct emissions from equipment and processes owned or directly controlled by the company. Scope 2 emissions are indirect emissions from energy related and emanating mainly from electricity or from district heating purchased from third parties. Scope 3 emissions are other indirect emissions related to a company's activities, but from sources not owned or controlled by the company such as transportation. One of the important sectors fighting the global warming is the banking sector. Banks can affect and lead all the other sectors by providing investing and lending choices. Especially of interest are energy investments than can affect the environment. Banking sector has been a focused market since the business was deregulated. Clients' demand for some services in banking sector led to an increase in the number of branches to serve a geologically scattered client base [2]. Therefore, the increase in number of branches also contributes to the increase in carbon footprint of the bank.

When all the employees of the bank and branches are considered, the banks themselves have to fight climate change as an organization as well. Sustainability reports published annually is perhaps the best indicator for researchers to decide how well a certain bank has achieved this endeavor.

Main focus of this study is Turkish Banking system. Thus top ten deposit banks according to the total assets, which are given in Table 1, are considered for

Table 1: Top Ten Banks According to Total Assets in Turkey, September 2018.

	Name of the Bank	Total Assets	Number of Branches	Number of Employees
1	Türkiye Cumhuriyeti Ziraat Bankası A.Ş.	551,994	1,778	24,440
2	Türkiye İş Bankası A.Ş.	444,334	1,357	24,658
3	Türkiye Garanti Bankası A.Ş.	410,777	930	18,574
4	Akbank T.A.Ş.	392,457	782	13,485
5	Yapı ve Kredi Bankası A.Ş.	390,170	867	18,088
6	Türkiye Halk Bankası A.Ş.	387,323	987	18,874
7	Türkiye Vakıflar Bankası T.A.O.	353,410	950	16,747
8	QNB Finansbank A.Ş.	180,876	542	12,079
9	Denizbank A.Ş.	147,315	718	11,990
10	Türk Ekonomi Bankası A.Ş.	112,416	504	9,553
	Total Top 10 Deposit Banks	*3,371,072*	*9,415*	*168,488*
	Total 47 Banks in Turkey	***3,993,867***	***10,505***	***193,343***

Table 2: Carbon Emission Sources and Scopes for a Typical Bank.

Emission Source	Details	Scope I	Scope II	Scope III
ENERGY CONSUMPTION (for all branches and other buildings)	Consumed natural gas	✔		
	Consumed fuel oil	✔		
	Consumed diesel oil	✔		
	Consumed coal	✔		
	Consumed electricity		✔	
TRANSPORTATION (for all branches and other buildings)	Company Car (Owned by company)	✔		
	Company Car (Leased)			✔
	Private Car			✔
	Public Transportation			✔
	Staff Service			✔
	Intercity Busses			✔
	Motorcycle			✔
	Cab rides			✔
	Air Transportation			✔
	Hotel Stay			✔
WASTE (for all branches and other buildings)	Solid Waste			✔
INDUSTRIAL PRODUCT USE (for all branches and other buildings)	Refrigerants	✔		
	Lubricating Oils and Greases	✔		

this study [3]. Number of branches and employees for these banks are also shown in this table.

Seven out of ten biggest banks have been publishing their sustainability reports annually for the last five years. According to GHG Protocol, carbon emission can

occur from various sources and processes. Table 2 summarizes these sources for the banks.

This paper presents a critical overview of the major Turkish Banks and suggest a more complete lists of emission sources and a more integrated approach to the problem of environmental sustainability.

Review of Sustainability Reports of the Turkish Banks

One of the biggest advantages of the sustainability reports of the banks are that they can be compared through their reports in terms of environmental sustainability. When the sustainability reports of the Turkish banks are examined, it is found that four banks are reporting the greenhouse gas emissions for all the buildings including their branches, two reporting their general directorate buildings and one reporting the general directorate and other service buildings. However, excluding branches is not the right approach, since the branches which are scattered all over Turkey have great impact on the emissions of the bank. The summary of which bank reports what buildings in terms of GHG emissions can be seen from Table 3. The amount of GHG emissions in 2016 and 2017 according to banks' sustainability

Table 3: The Buildings Covered in Sustainability Reports by the Seven Leading Turkish Banks.

Name of the Bank	All the Buildings Including Branches	General Directorate Only	General Directorate and Other Service Buildings Excluding Branches
Ziraat Bank	x		
Is Bank		x	
Garanti Bank	x		
Halk Bank	x		
Akbank	x		
Yapı Kredi Bank			x
Vakıf Bank		x	

reports are given in Table 4. The results indicate that four out of seven banks have increased their carbon emissions in 2017 when compared with 2016 figures. Is Bank having the highest increase, 22.2%, whereas Garanti Bank has the lowest increase, 2.2% in one year. Akbank, Yapı Kredi Bank and Halk Bank have decreased their total carbon emissions by 7.74%, 2.11% and 1.88% respectively.

From Table 4, it can be seen that the carbon emissions vary between 23,620 tons of CO_2-e to 87,663 tons of CO_2-e with an average of 60,290 tons of CO_2-e for 2017. Such a straight comparison of the emissions by the banks may be misleading because they all have varying numbers of branches and employees. In order to have more accurate and understandable comparison, Table 5 was prepared for the four banks which show emissions totaling from all the buildings including their branches. All the banks given in Table 5 have a minimum of 750 branches and

Table 4: Amount of GHG Emissions of the Seven Leading Turkish Banks.

Name of the Bank	Amount of GHG in 2016 (tons CO_2-e)				Amount of GHG in 2017 (tons CO_2-e)			
	Scope 1	Scope 2	Scope 3	Total	Scope 1	Scope 2	Scope 3	Total
Ziraat Bank	36,478	48,395	-	**84,873**	33,429	54,234	-	**87,663**
Is Bank	4,455	17,663	1,431	**23,549**	4,886	21,428	2,461	**28,775**
Garanti Bank	10,924	57,259	3,181	**71,364**	11,835	58,628	2,494	**72,957**
Halk Bank	14,047	30,427	32,804	**77,278**	14,869	31,864	29,096	**75,829**
Akbank	8,082	38,761	4,515	**51,358**	7,515	36,115	3,753	**47,383**
Yapı Kredi Bank	20,417	54,095	13,138	**87,650**	15,975	54,183	15,644	**85,802**
Vakıf Bank	12,422	4,279	6,085	**22,786**	12,982	3,966	6,672	**23,620**

Table 5: GHG Emissions of the Seven Banks with Respect to Two Indicators Chosen.

Name of the Bank	GHG Emissions (tons CO_2-e) / Number of Employees	GHG Emissions (tons CO_2-e) / Number of Branches	Notes
Ziraat Bank	3.12	45.97	Does not report Scope 3 emission
Garanti Bank	3.87	76.96	-
Halk Bank	4.25	78.74	-
Akbank	3.41	59.15	-
Average	*3.66*	*65.21*	-

at least 13,000 employees. This table shows total GHG emissions with respect to number of bank employees and number of branches for 2017. Instead of fourfold difference between bank emissions of any two banks; results shown in Table 5 indicate much closer when per employee and per branch emissions are compared. It should be noted that the average emission values are calculated to be 3.66 tons CO_2-e per employee and 65.21 tons CO_2-e per branch. Never the less, one would expect a better agreement among the banks in terms of these two indicators simply because they are all deposit banks.

Apart from the figures of GHG emissions, banks are reporting their emissions in accordance with the scopes. Ziraat Bank is the only bank not reporting Scope 3. From Table 4, the average Scope 3 emissions for the banks is around 10,000 tons CO_2-e annually, which may constitute 5 to 40 percent of the total emissions. Since Scope 3 essentially includes emissions from transportation and there are considerable differences between the banks, Table 6 is prepared to show what transportation emissions sources are reported by the banks. As it can be seen from the Table 6, none of the banks consider the commuting options of the employees apart from the staff service. Additionally, for the other sources it can be seen that there is no uniformity except company cars.

When the industrial products use and resulting emissions are considered, all

Table 6: Emission Sources for Transportation for Banks.

Emission Sources for Transportation	Is Bank	Garanti Bank	Halk Bank	Akbank	Yapı Kredi Bank	Vakıf Bank
Company Car	x	x	x	x	x	x
Private Car						
Public Transportation						
Staff Service	x		x	x	x	
Intercity Busses	x		x			
Motorcycle						
Taxi	x					
Air Transportation	x	x	x		x	x
Hotel Stay			x			

Table 7: Total Loans and Renewable Energy Investment Financed.

Name of the Bank	Total Loans and Receivables 2017 (million TL)	Renewable Energy Investment Financed (from Sustainability Reports*) (million TL)	% share
Ziraat Bank	65,614	N/A	-
Is Bank	35,909	3,125.2	8.70%
Garanti Bank	23,632	N/A	-
Halk Bank	30,840	173.00	0.56%
Akbank	28,681	966.53	3.37%
Yapı Kredi Bank	36,606	828.98	2.26%
Vakıf Bank	36,259	N/A	-

**The average dollar currency is taken as 3.5 TL/$ for the year 2017.*

except Akbank and Vakıfbank report the emissions from refrigerants. In addition, only Vakıfbank gives lubricating oils and greases related emission figures. Thus, a considerable amount of Scope 1 emissions is not being reported in this manner. The renewable energy investment financed for these banks are gathered from their sustainability reports. Unfortunately, three banks have no details for these values. Besides the financed investments, total loans and receivables which are given in the statistics of Banks Association of Turkey are summarized in Table 7 [4].

Unfortunately, credit and finance provided to renewable energy projects is rather insignificant as it can be seen from Table 7.

Results and Conclusion

In this paper, sustainability reports of the major banks in Turkey is considered and compared with each other. Seven banks considered have a share of approximately 70% in terms of total assets, number of branches and number of employees in the Turkish banking sector as shown in Table 8. Based on the average per employee and per branch values given in Table 5, the total banking sector will have approximately

Table 8: Share of the Seven Banks with Sustainability Reports in The Turkish Banking Sector, September 2018.

	Name of the Bank	Total Assets	Number of Branches	Number of Employees
1	Türkiye Cumhuriyeti Ziraat Bankası A.Ş.	551,994	1,778	24,440
2	Türkiye İş Bankası A.Ş.	444,334	1,357	24,658
3	Türkiye Garanti Bankası A.Ş.	410,777	930	18,574
4	Akbank T.A.Ş.	392,457	782	13,485
5	Yapı ve Kredi Bankası A.Ş.	390,170	867	18,088
6	Türkiye Halk Bankası A.Ş.	387,323	987	18,874
7	Türkiye Vakıflar Bankası T.A.O.	353,410	950	16,747
	Total Top 7 Deposit Banks	*2,930,465*	*7,651*	*134,866*
	Total 47 Banks in Turkey	*3,993,867*	*10,505*	*193,343*
	% Share of the Banks Considered in This Study in Total	**73.4%**	**72.8%**	**69.8%**

emitted 765,000 tons CO_2-e annually in 2018. According to the 2018 report of TUIK, Turkey's GHG emissions for 2016 is 496,1 Mt CO_2e [5]. Thus, the banking sector will have a share of approximately %1,5 of GHG emissions of Turkey. It is quite insufficient and embarrassing to have only four banks among forty-seven banks in Turkey reporting total emissions coming from branches as well as general directorate and other service buildings. All the major banks should be reporting on all the buildings that they have banking operations at.

A guideline should be established for the banks on how to report their emissions including all three scopes. As it was discussed in Table 6, transportation related emissions lack uniformity among the banks. The guideline should address what transportation emissions should be reported by the banks. A wider range of transportation options should be considered especially commuting of the employees. Similarly, information should be given on refrigerants, lubricating oils and greases related emissions.

In order to improve the sustainability reports in the future, two remedies are suggested. Renewable energy investment alone should not be taken as a positive credit point. Instead the banks should report investment of GHG producing conventional power plants finance as well. The difference between the two should be reported and if the result is towards renewable energy, then a positive credit should be assigned to that bank.

Reporting electricity, natural gas, diesel oil etc. consumption directly as single sum neither serves the purpose nor identifies energy saving options within the buildings and the branches. For example, electricity consumption may be due to heating of the building, cooling of the building and use of electronic equipment of the employees. Unless these processes are identified with proper shares, it would be impossible to prioritize the energy saving options and actually estimate the investment levels for each energy saving options.

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Marine Corrosion Protection via Nanocoatings

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Abstract

Corrosion is a naturally occurring process that is defined as degradation of materials over a period due to environmental exposure. Corrosion of metals in this way presents us with various engineering problems. It is not only caused by material loss, but also the cost of installation of new material, such as loss of time and unexpected accidents.

The need for fuel-saving, low-emission and reducing maintenance or repair costs have made it compulsory for the coating systems to be sturdier and more user-friendly in terms of practice according to new regulations. With rapid developments, coatings and paint technology has been adapted to the environment by the applications of water-based coatings, solvent-free and solvent-less coatings that follow new health and safety trends.

In this study, literature study has been made on understanding controlling corrosion and coating techniques that can be used to limit the effects of corrosion in addition to standard applications on marine structures. The concerted efforts due to develop environmentally friendly and cost-effective marine coatings are gleaned. An investigation has been made in order to evaluate the efficiency of polymeric coatings on the steel and other metal plates by coating them in order to reduce corrosion in a variety of circumstances.

Keywords: Marine, Corrosion, Corrosion control, Nanocoatings

Introduction

Corrosion is a naturally occurring process that is defined as degradation of materials over a period due to environmental exposure. This reaction of the metal and the alloys with the environment, causing undesirable changes in chemical or other properties (see Figure 1). Corrosion of metals in this way presents us with various engineering problems. Corrosion is not only caused by material loss, but also the cost of installation of new material, such as loss of time and unexpected accidents.

The purpose of the study is to compose an understanding on controlling corrosion and give satisfying information on coating techniques that can be used to limit the effects of corrosion in addition to standard applications.

Figure 1: Corrosion seen on ship's components.

Corrosion Control

The marine environment is harsh, and all marine structures must be protected against corrosion. In the protection of the structures in marine environment from corrosion, the first thing to be considered is the selection of suitable materials and the development of preventive design strategies. However, these alone are not enough. Corrosion problems in structures can be prevented by applying various protection methods.

There are two main protection systems, coatings and cathodic protection systems to protect ships from corrosion in extreme corrosive marine environments. Coatings are highly used on the top protection method due to their low costs, suitability and ease of application. Today, protection methods are used together to complement each other. However, one of the methods can be applied according to conditions [1].

Cathodic Protection

Cathodic protection is the basic principle of corrosion protection method based on electrochemical corrosion theory. Cathodic protection is the process of removing the anodic currents on the metal surface by making the metal to be protected into a cathode of an electrochemical cell to be formed. This can be achieved by matching the metal to be protected with a more active metal (galvanic anode or sacrificial anode) or by applying external current.

Coatings

Coatings provide protection against moisture in the environment, dissolved gases, acids and others. Furthermore, the application of coatings provides with resistance to interior and exterior deterioration in addition to thermal and electric isolation.

Advances in Marine Coatings

Although maritime transport is not as fast as air transport, it is still the preferred method for larger, heavier and more bulky goods. It is also less expensive, less taxed and there are almost no restrictions for destinations. In short, maritime transport has a large share in the driving force behind the global economy.

Historically, after the restriction of the chromium (VI) use, the studies on ecofriendly marine coatings have boomed rapidly. Figure 2 shows the increase in research and development related with coatings for corrosion prevention made after 1990's.

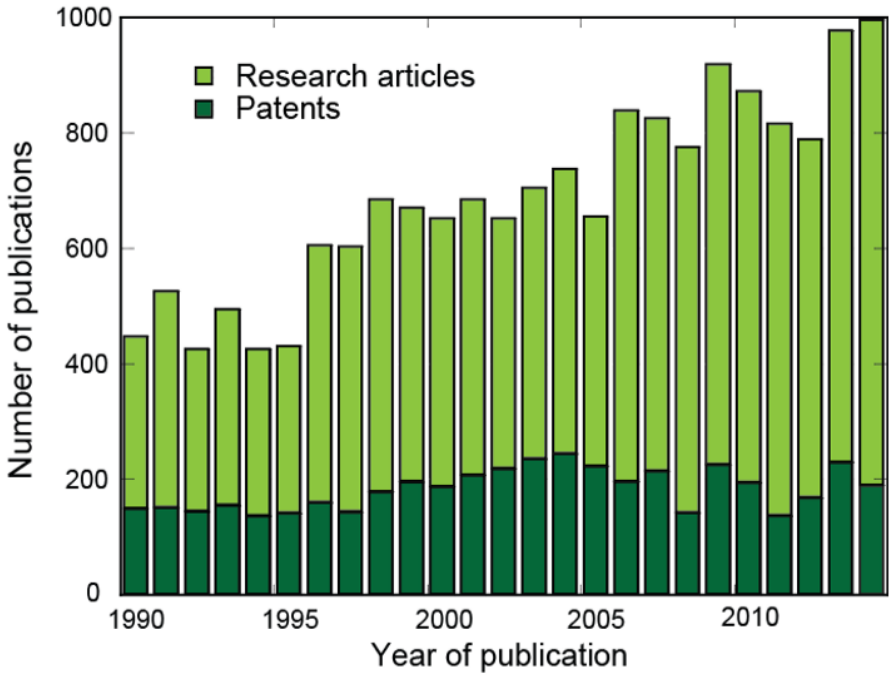

Figure 2: The increase of researches and patents [2].

It has become inevitable for the coating systems to be sturdier and more user-friendly in terms of practice according to new regulations. The marine industry encourages the manufacturers for inventing new cost saving and environmentally friendly coatings. With rapid development in coating technology, coating and paint technology has been adapted to the environment by the development of water-based coatings, solvent-free and solvent-less coatings that follow new health and safety trends. Also, the need for fuel-saving, low-emission and reducing maintenance

or repair costs are the reasons which triggered the applications of anti-corrosive and anti-fouling coatings by the ship owners and shipyards around the world (see Figure 3).

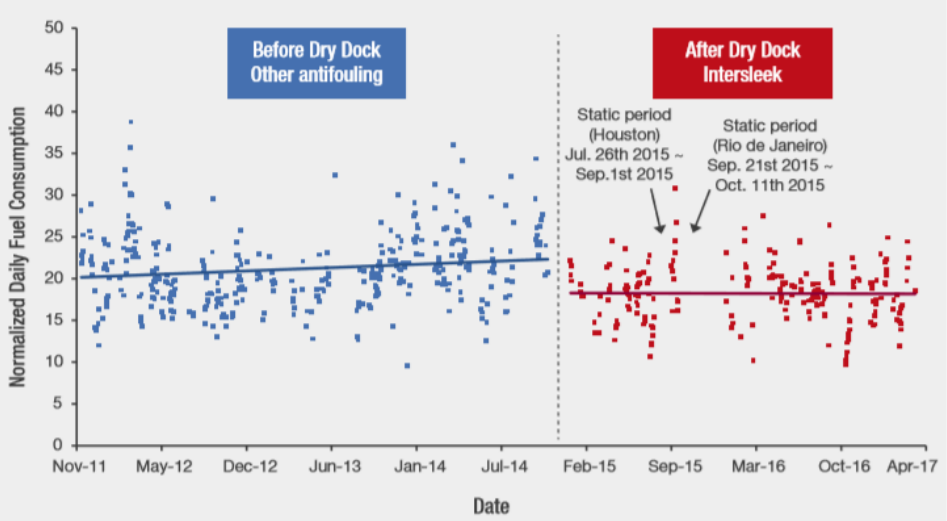

Figure 3: 10% fuel savings achieved by using a new-developed coating [3].

Superhydrophobic surfaces have received increased attention owing to their nanostructures and special abilities which provide great contribution to the marine needs in terms of their anti-adhesion, anti-fouling, drag reduction and corrosion inhibition abilities. Superhydrophobic surfaces also inspired by nature such as lotus leaves seen on Figure 4 and can be obtained by using two approaches in micro-scale and nanoscales. These surfaces can be easily damaged during cleaning or any scrap, so that the use of coatings is generally preferred for electronic devices instead of the clothing area which is prone to continuous movement. For objects subject to continuous friction, such as boats, the coating must be renewed periodically for a high degree of protection. However, composing superhydrophobic surfaces on alloys or metals, especially ships and marine structures, have been the basic concern of scientists and scholars for decades [4].

A few experiments, which aimed in demonstrating the efficiency of the super-hydrophobic and hydrophobic coatings to mitigate corrosion have been mentioned. The logic of these coatings for minimizing the friction and corrosion is simply explained. The literature review is made on the superhydrophobic coatings which have been studied in terms of anti-adhesion, self-cleaning, anti-biofouling, drag reduction and corrosion inhibition properties.

Eventually, it is inferred that the majority of studies have not given any information about the exact number of experiments while getting the desired results, the water contact angle dead bands and scan rate levels. Particularly, they have not stated if the metals subjected to a chemical compound before testing or not.

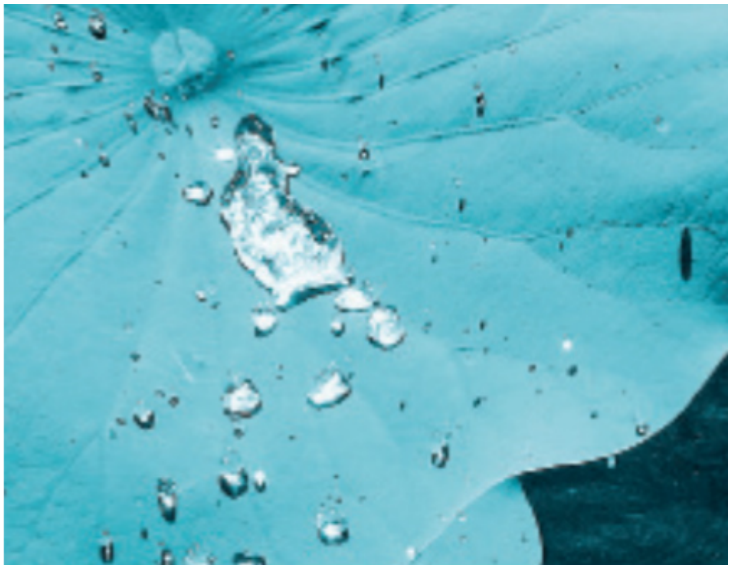

Figure 4: Water reflectivity of the lotus leaves.

Experimental

Nanotechnology covers the development of materials with superior properties and performance by using nanoscale in various industries such as surface applications, electrical-computer technology, medical fields, aerospace research, biotechnology-agriculture and environment-energy. Depending on the publications and the studies related to nanotechnology, we will see nanotechnology developed in new coating system carrying the features above in coming years due to their abilities to fill the tiny holes and preventing the corrosive thing to scatter under the subgrade. During laboratory study, it is intended to compose hydrophobic polymeric surfaces on steel and other metal plates by electrospinning process (Figure 5).

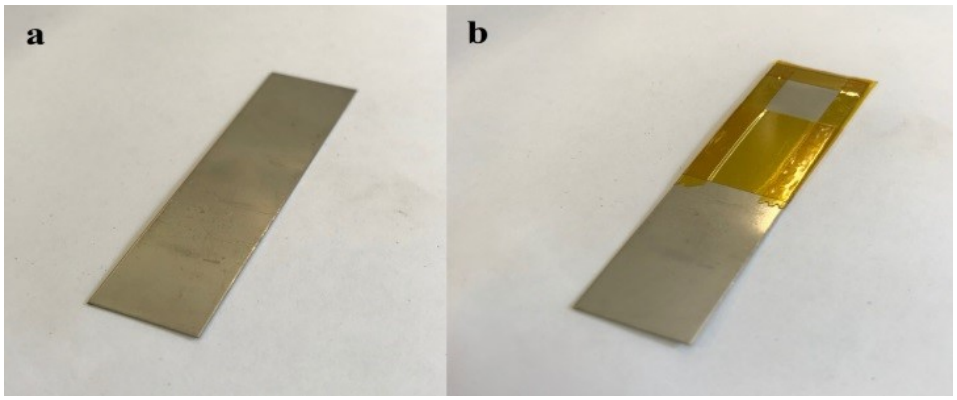

Figure 5: (a) The naked steel and (b) The coated steel.

The morphology and surface roughness of the obtained surfaces are characterized by scanning electron microscopy (SEM) (Figure 6. Finally, the corrosion

resistance of surfaces are evaluated by Tafel extrapolation method.

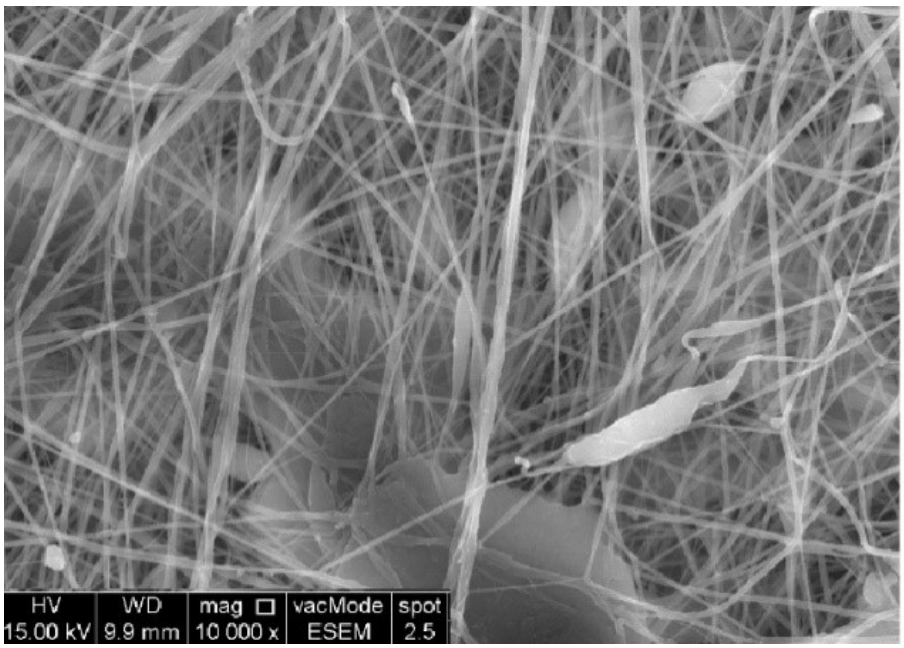

Figure 6: SEM image of surface coated by nanofibers .

Conclusion

Consequently, it is noted that there has been a great effort to develop a novel, environmentally friendly and cost-effective marine coating. It is believed that these efforts will lead to the long-term effective prevention of fouling and corrosion for all types of marine structures, while minimizing the need for maintenance and repair. If these coatings could be used for minimizing the friction and corrosion, it is obvious that the emission rate sourced from ships would decrease considerably.

An investigation has been made in order to evaluate the efficiency of polymeric coatings on the steel and other metals by coating them in order to reduce corrosion in a variety of circumstances. During laboratory study, it is intended to compose polymeric surfaces on steel plates by electrospinning process. The morphology and surface roughness of the obtained surfaces have characterized by scanning electron microscopy (SEM). Finally, the corrosion resistance of surfaces evaluated by Tafel extrapolation method.

Although superhydrophobic and hydrophobic coatings seem very efficient due to their unique properties, it is learned that there is no application of superhydrophobic, and hydrophobic coatings used for corrosion control on marine structures so far [5]. It is hoped that with the aspirations and the experiences achieved from valuable studies will come off with the new ways for corrosion control on marine structures.

Furthermore, in case the desired nanocoating is obtained for minimizing the friction and corrosion, the stability and design parameters of the newly built ships

must be considered and calculated in terms of viscous pressure resistance in future works.

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