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Prospects for renewable energy education (REE) in elevating youth energy and environmental awareness in Jordan

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Academic Dissertation

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ABSTRACT

Renewable Energy Education (REE) is an evolving public education approach that ultimately aims to elevate public awareness and cultivate their support toward renewable energy (RE) development. Young citizens are the pacesetters of RE development if equipped with the necessary knowledge and skills. There is, however, a lack of research studies aimed at exploring and understanding young citizens' perceptions and attitudes toward RE, particularly in developing countries. Jordan is an example of a fossil fuel-addicted country, yet it is endowed with enormous RE potential. This dissertation provides a synthesis drawn from exploring school students' knowledge, perceptions, and attitudes toward RE and their perceptions toward protection of the environment (Paper 1, IV). This study also investigated knowledge, perceptions, and attitudes towards RE among secondary school teachers (Paper II). The nature of interactions between students, home, school, and the role of mass media were also explored (Paper III).

The results showed that females, residents of urban areas, and students of private- mixed schools were more knowledgeable of the uses and the nature of renewable energy technologies (Paper I). The study found that males seem to support nuclear power, while females favored renewables (Paper 1). Females attributed the responsibility for environmental protection to society as a whole, while males attributed it specifically to the government. However, females appeared very skeptical about the role of science/technology, and interventions from developed countries on environmental protection (Paper IV). The students' knowledge of bioenergy appeared very weak (Paper I). Although teachers supported RE they appeared skeptical about its future development in Jordan (Paper II). The teachers thus supported nuclear power and oil shale resource utilization as a means for economic development. The students denoted their parents as a prime source of information while they indicated that the internet was an important tool to acquire information.

The study suggests that educated and well-informed young citizens may convey their knowledge to their illiterate parents. TV and school activities appeared of great importance for females whilst males preferred to receive information from parents and school teachers (Paper III). The study highlighted the need to revisit the current public education policies in Jordan in order to craft new policies aimed at fostering a better knowledge of RE, its uses and benefits with special focus on females' preferences and needs. The study also suggests developing the RE knowledge capacities of teachers to ensure successful implementation of newly crafted educational policies. The study further suggests developing public outreach campaigns through mass media with the aim of eliminating uncertainty among the public regarding future energy choices.

Keywords: Renewable Energy Education, Jordan, School Students, Perceptions, Attitudes, Policies

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Joensuu, December 2015

Anas Zyadin

LIST OF ORIGINAL ARTICLES

This dissertation consists of three peer-reviewed articles and a conference paper, which are referred to by their Roman numerals, I-IV. All of the published articles are reprinted with solicited permission from the publishers.

I Zyadin, A., Puhakka, A., Ahponen, P., Cronberg, T., Pelkonen, P. (2012). School students' knowledge, perceptions, and attitudes toward renewable energy in Jordan. Renewable Energy 45:78–85. http://dx.doi.org/10.1016/j.renene.2012.02.002

II Zyadin, A., Puhakka, A., Ahponen, P., Pelkonen, P. (2014). Secondary school teachers' knowledge, perceptions, and attitudes toward renewable energy in Jordan. Renewable Energy 62:341–348. http://dx.doi.org/10.1016/j.renene.2013.07.033

III Zyadin, A., Puhakka, A., Halder, P., Ahponen, P., Pelkonen, P. (2014). The relative importance of home, school, and traditional mass media sources in elevating youth energy awareness. Applied Energy 114: 409–416. http://dx.doi.org/10.1016/j.apenergy.2013.09.072

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The author's contribution

Anas Zyadin had the main role in data collection and writing the manuscripts. Paavo Pelkonen helped set the general framework and objectives of the studies, helped improve the research survey tools, and also commented on the manuscripts. Pirkkoliisa Ahponen assisted in the development of the research survey tools and commented on the manuscripts. Antero Puhakka helped in the creation of the survey tools, significantly helped in statistical analysis and commented on the manuscripts. Pradipta Halder co-authored Paper III, commented on the manuscript and assisted in the statistical analysis. Rania Papasozomenou co-authored paper IV for her contribution in writing the manuscript. Tarja Cronberg suggested navigational measures to develop the current studies and for future research activities.

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1. INTRODUCTION

1.1 Energy and the wealth of societies

Energy, whether we consider it a commodity, an ecological or strategic resource, and/or a social necessity (Roy et al. 2007) will always be a quintessential element for the provision of food, health care, shelter, and many other intrinsic and instrumental needs for every living human being on the planet. Today, our energy needs largely come from conventional fossil fuel resources, such as oil, natural gas, and coal, with a lower proportion coming from renewable resources, such as solar, wind, biomass, and hydro. The transition from conventional to renewable is a huge challenge and it is urgently needed to mitigate climate change and preserve the remaining natural ecosystems and resources for future generations. At the transition crossroads, there are several checkpoints between global energy supply and energy demand.

One important checkpoint is that global demand for energy is projected to increase by 30-35% in the coming decades with India, China accounts for 65% of this energy demand and Middle East accounts for 10% (International Energy Agency [IEA] 2013). One key explanation to the staggering increase in global energy demand rests on understanding the demographic trends in the world. According to the United Nations Population Prospects, the world population was 1 billion in the year1800, 2 billion in 1930, 7 billion in 2011, and is projected to reach 8 billion in 2024 and 9 billion by 2046 (Seitz and Hite 2012). It took 130 years to add one billion people to the world population during the period of 1800-1930, and only 81 years to add 5 billion people in the period of 1930-2011. Moreover, global population growth trends predict that the largest population growth in the future will be in the developing countries, with India, Africa, and Middle East countries expected to account for the majority of the increase. Another noteworthy demographic trend is the age structure among developed and developing nations. The age structure of the more developed nations is generally column shaped, while it is usually pyramid shaped in the developing nations (Seitz and Hite 2012). The wide base of the pyramid consists of a large proportion of youngsters under 15-years of age. Young citizens require substantial investments in education, healthcare facilities, and safe drinking water before they become independent, enter the workforce and become economically productive. Later on, young citizens require substantial resources to meet their staple food, housing, and employment demands, which require further energy investments. In developed nations, intensive economic activities accompanied by innovations are required to sustain high and advanced economies in order to compensate for the lack of younger workers, to maintain a high-standard of living, and simultaneously guarantee pensions and healthcare for the increasing number of retirees (Seitz and Hite 2012).

Another checkpoint is the energy poverty associated with the income gap. The income gap has expanded between poor and rich, in both developed and developing countries. For instance, despite the availability of technical solutions, two in every five people globally still rely on wood, charcoal, or animal waste to cook their food, and one in five people lack access to electricity (IEA 2013). In 2010, approximately 25% of the people in developing countries still lived in extreme poverty, 1 billion people still lacked clean drinking water, 1.5 billion had no access to electricity, approximately 3 billion lacked adequate sanitation, and 2.6 billion lacked clean cooking facilities (Practical Action 2013). The situation is aggravated by the fact that many poor households have no access to energy-efficient housing or transport. According to the International Finance Corporation (IFC) the poor spend US$37 billion globally in low quality energy solutions for lighting and cooking.

In response to the aforementioned challenges, renewable energy has witnessed a remarkable growth in the past few decades and has been prescribed as a panacea for the many of today's socio-economic and environmental challenges (Scheer 2012). The energy imperative today requires a radical shift from fossil fuels to a 100% renewables share in the primary mix by 2050 to avoid disastrous environmental degradation, mitigate energy poverty, and contain the climate change phenomenon (Scheer 2012).

1.2 Renewable energy development

Due to a number of unprecedented geopolitical and economic events, such as the Arab spring, the economic crisis in 2008-2009, the Russian-Ukraine dispute over Crimea, the negative publicity associated with coal-fired power plants, the Fukushima nuclear incident in 2011, and the growing public awareness and concerns over climate change, numerous countries around the world have adopted new energy and environmental policy reforms. The cornerstone of such modern policies have embraced two general approaches; supply-side management and demand-side management. Supply-side management suggests harnessing local [renewable] energy resources, including forest-based bioenergy and first generation biofuels. The demand-side management involves decreasing sectorial energy consumption through the introduction of energy-efficient technologies, new green coding for residential buildings to save energy, the advancement of electric and hybrid vehicles for the transportation sector, and the promotion of energy conservation behavior(s) and curtailments particularly at the household level.

The economic crisis that hit the financial markets hard in the United States and European Union (EU) in 2008-2009 and the disastrous Fukushima Daiichi nuclear incident in Japan in 2011 are the two major events that have ushered in a renaissance in renewable energy technologies, particularly after the bold decisions made in many European countries to drastically relinquish their dependence on nuclear power. The high and turbulent fossil fuel prices have made power generation from renewable energy technologies technically feasible, economically competitive and reliable. Since 2004, the number of countries promoting renewable energy with direct policy support has tripled, from 48 to over 140, and a growing number of developing countries are setting renewable energy targets and implementing support policies (Bloomberg 2014). Renewable energy technologies are not only seen as tools for improving energy security, mitigation and adaptation but also as beneficial investments that reduce dependence on imported fuels, improve local air quality and safety, improve energy access, increase economic development and create jobs. Renewable energy costs have also plummeted in recent years and several technologies are now cost-competitive with conventional generation technologies, even before environmental impacts and other externalities are considered. In addition, growth in renewable energy has led to an increase in the number of manufacturers, the scale of manufacturing, and the number of jobs related to the installation and servicing of renewable technologies (Bloomberg 2014). A sharp decrease in the price of solar panels and wind turbines has meant that renewable energies in 2013 accounted for over 43% of new generating capacity globally while raising the share of renewables to 8.5% of global electricity supply (Bloomberg 2014).

Moreover, the growth in bioenergy development and first-generation biofuels has been remarkable, particularly in Europe and North America (Junginger et al. 2014). In the EU, renewables and biofuels initiatives, such as the Biofuels Directive (2003/30/EC), the Renewable Energy Directive (Directive 2009/28/EC) and the recent EU Energy Roadmap 2050, have led to significant increases in biofuel production and significant renewable

capacity installations in member states via tax exemptions, feed-in tariffs, and/or as blend components with fossil fuels. The EU has dominated biodiesel production globally, while North America has dominated ethanol production (Junginger et al. 2014). Forests constitute the largest source of biomass, especially in the Nordic sphere, which becomes available when the opportunity and transportation costs are favorable for energy production, and the negative consequences for biodiversity conservation, soil fertility and local usage are within acceptable limits (Pelkonen et al. 2014).

Despite successful implementation and new capacity installations over the last few years, the progress in renewable energy development has been deemed insufficient. The International Energy Agency (IEA) recently published a report entitled "Energy Technology Perspectives 2013: Pathways to a Clean Energy System", which stated that "*while progress has been made on development and deployment of clean energy, the current rate is too slow*" and "*it will not be enough to limit global warming to two degrees Celsius*". It further notes that US$24 trillion of further investment is needed by 2050 in the 2°C global warming scenario (IEA 2013). In their survey-based study, Zyadin et al (2014) concluded that a lack of governmental policies, competition from fossil fuels (conventional and non-conventional), and a lack of public awareness and support are three key factors hindering large-scale renewable energy development. Policy uncertainties, the high-upfront investments for Concentrated Solar Power (CSP), geothermal, and off-shore wind, and the hydraulic fracking boom in North America are in the vanguard of factors hindering renewable energy development worldwide (Zyadin et al. 2014).

Furthermore, traditional power supply systems and nuclear power firms have also sought to slow-down the progress in renewable energy development for purely economic reasons and to maintain their market shares in energy supply markets (Sheer 2012). What has become clear is that renewable energy development requires skilled operators, trained technicians, and more researchers to fill the technicalities gap (Kandpal and Broman 2014). Other forms of impediments to renewable energy development has arisen from the lack of public awareness, misunderstanding, and unwillingness to change lifestyle, described in the academic arena as *social acceptance* (Wustenhagen et al. 2007; Assef and Frostell 2007; Yuan et al. 2011; Cohen et al. 2014; Stigka et al. 2014). While this issue has been largely neglected in the 1980s, new experiences from renewable energy projects have shown that this issue is fundamental to guarantee successful implementation of renewable technologies in all the countries of the world (Wustenhagen et al. 2007; Kandpal and Broman 2014). Public opposition has been characterized by the NIMBY (not in my backyard) response. It means "*while someone may enjoy the idea of new [energy] infrastructure from a distance, they are opposed to bearing the costs of having this infrastructure in their proximity*" (Cohen et al. 2014, p. 2). Furthermore, the lack of public awareness and participation in the renewable energy evolution may have arisen from the notion that energy is conceived or approached differently by different individuals and groups (Roy et al. 2007). For instance, energy might be viewed as a "commodity", "ecological resource", "social necessity", and "strategic material" depending on the views and values of the individual (e.g. energy or power utility, business, environmentalist, capitalist or socialist, NGO, etc.). Since the sustainable development debate has developed, a new facet of 'energy as a social necessity' has emerged, which Devine-Wright (2004) describes as 'energy citizenship'. Other reasons for public misconceptions and lack of energy awareness are referred to as '*out of sight and out of mind'* syndrome (Pasqualetti 1999): the siting of power plants away from residential areas disconnects people from issues related to the source of electricity, environmental and health risks and thus creates negative reactions to proposed new generation plants, notably onshore

wind turbines (Devine-Wright 2005). Controversies and debates in the media, between power firms and research institutions over the value of different energy pathways (e.g. nuclear or fossils vs renewables; centralized vs decentralized) has undermined the value of renewables and confused the public (Roy et al. 2007).

Broadly speaking, the factors that influence social acceptance have been categorized into three domains: personal, socio-psychological (attitudes, values, perceptions), and contextual (type and scale of the project) (Cohen et al. 2014). Other researchers have alluded to the "emotional attachment" to the place of residence as a barrier to wind farm installation for example (Van der Horst 2007). Overall, issues such as the physical appearance (visual impact) of energy installations, procedural aspects of the energy project implementation, degree of trust in governmental institutions, the perceived benefits and risks, suspicions towards foreign investors, and the degree of public involvement in planning and decision making are some social barriers (Cohen et al. 2014; Stigka et al. 2014; Wustenhagen et al. 2007). The realization of the importance of public acceptance and support has led to a plethora of investigations aimed at improving our understanding of public perceptions and attitudes towards various modern technologies, such as smart grids (Ngar-yin Mah et al. 2012), nuclear power (Stoutenborough et al. 2013; Siegrist et al. 2014), solar technologies (Yuan et al. 2014), carbon capture and storage (aka. CCS) (Ha-Duong at el. 2009), and country-wise social barriers to wind farms, such as in the United States (Sovacool 2009) and Canada (Richards et al. 2012). These studies found that the perceived risks, the cost burden and prices are some social fears that have influenced critical public perceptions toward renewables and clean technologies. Moreover, people appeared to largely support simple solar applications (solar water heaters) rather than complex ones such as Photovoltaic (PV). Furthermore, these studies have also revealed knowledge gaps and weaknesses, misunderstanding, and miscommunication among the surveyed public (young and adults), which have also led to public opposition to varying degrees. There are also a considerable proportion of people who feel weak and incapable of involvement in the planning process of energy transition and who tend to trust that politicians and policymakers will make the best energy-related decisions and policies (Sheer 2012). In the Arab world, countries with enormous fossil fuels resources, such as the Gulf States and/or countries with heavy reliance on imported fossil fuels, such as Jordan and Lebanon, have created a fossil fuel-based lifestyle marked by consumerism which is difficult to change. Furthermore, the lack of public awareness regarding energy choices (nuclear, fossil, or renewables) and the perceived benefits of renewables is a key factor hindering renewable energy development. To overcome such a social obstacle, experts suggest the adoption of new long-term public educational strategies aimed at elevating public awareness and understanding of renewable energy, and to highlight their benefits to the environment and society.

1.3 Renewable Energy Education (REE)

While our understanding of the social barriers to clean energy projects has improved, efforts to tackle such issues, however, have not received enough momentum (Cohen et al. 2014). A cost-effective measure to cultivate public acceptance and garner their support is through the improvement of public energy knowledge and literacy, and a re-orientation of public education to adopt renewable energy education strategies in formal and informal settings (Kandpal and Broman 2014; DeWaters and Powers 2011; Mälkki et al. 2014; Yazdanpanah et al. 2015; Ntona et al. 2015). Education and training in the area of energy in general, and in new and renewable sources of energy in particular, is of great importance (Kandpal and Broman 2014) as from a technical perspective large-scale development of renewable energy

technologies requires an adequate number of well-trained and competent personnel (Kandpal and Broman 2014; Simona et al. 2012; Jennings 2009). In addition, the majority of socio-cultural and institutional barriers to renewable energy development, energy conservation, and environmental protection can be largely overcome if all stakeholders (end users, policymakers, politicians, private sector leaders, NGOs, public or charity associations, school pupils etc.) are made "energy conscious" and environmentally aware. This can be achieved by equipping the aforementioned stakeholders with updated and easy-to-understand relevant information, capacities, and skills in a dynamic, transparent, interactive, and communicative learning environment (Dias et al. 2004; Jennings 2009; Kandpal and Broman 2014). Education should be aimed at fostering public knowledge of new or complex issues in order to fully understand the issues, identify realistic solutions, reach reasonable conclusions, and thus influence policy making at local or national levels (Stoutenborough et al. 2013). A well informed and environmentally aware public may support policies that prioritize the national interests over the individual interests (also referred to as *social orientation*) (Kollmuss and Agyeman 2000). It can also be argued that easy-to-digest knowledge would encourage an individual's reactive thinking of a given problem and thus may induce changes to his/her attitudes and behaviors accordingly (Barr 2007). Without a basic understanding of energy generation and its uses, and how to conserve it, individuals and communities may not be able to make informed decisions on issues, such as technology choice, energy use at the domestic level, and national and international policies (DeWaters and Powers 2011; US. Department of Energy 2013). The US Department of Energy defines energy literacy as "*an understanding of the nature and role of energy in the universe and in our lives. Energy literacy is also the ability to apply this understanding to answer questions and solve problems*". An energy-literate person is therefore "*able to make informed energy and energy use decisions based on an understanding of impacts and consequences*" (US. Department of Energy 2013).

Since technology does not operate on its own and technology alone does not automatically lead to social justice, reform or development, and individuals usually grow up in different, deeply inherited socio-cultural contexts, it is important to involve and investigate the individual's values, attitudes, beliefs, and orientations in order to: (1) promote individual's behavioral change to a more environmentally-friendly one,(2) provide effective implementation of actions that will ultimately help address environmental issues and expand renewable energy development, (3) lock-in the gains from such behavioral change and avoid rebound effects (such as when oil prices dropped drastically in 2008 and 2014) (Stern 2000; Kollmuss and Agyeman 2002; Dias et al. 2004; Owens and Driffill 2008). In this context, education appears as a pivotal tool to galvanize environmentally-friendly attitudes, especially in young citizens (*see section 2.1 below for more on this topic*).

Renewable energy education (REE) is a relatively juvenile and recent initiative (Kandpal and Broman 2014; Jennings 2009). In its essence, REE seeks to seed and disseminate, formally and informally, various topics, information, and issues related to renewable energy resources and technologies independently. It also seeks to improve functional knowledge and understanding of facts, concepts, principles and technologies for harvesting renewable resources in a sustainable and innovative manner (Kandpal and Broman 2014). Furthermore, the REE program aims to target school students at primary, secondary, vocational and high schools, colleges, and in any relevant institution or organizations (Kandpal and Broman 2014). REE may also involve the education of policymakers, midcareer training, and inter or intra career training in order to elevate public awareness of renewable energy and to expand the employment opportunities in the renewable energy sector (Kandpal and Broman 2014).

1.4 Jordan as a case study

Jordan is heavily reliant on imported fossil fuels to meet its energy demands (Hrayshat 2007). Energy security and independence have emerged as national concerns due to geopolitical disputes (Arab Spring), energy price hikes (2008-2009), and the need to find an affordable and reliable source of power to boost the economy. For instance, the natural gas supply from Egypt through the Arab Gas pipeline has been bombed almost 30 times causing devastating economic losses to the Jordanian economy, estimated at US$5 million daily (Daily News 2014). The Jordanian government has relinquished fossil fuel subsidies and introduced new pricing mechanisms in the power sector. These economically tough measures and policies have changed the energy consumption behavior of Jordanian citizens; people with higher incomes have switched to electric heating whilst lower income people have installed solar water heaters on the roofs of their homes. Preceding governments have established the institutional guidelines and regulations for the introduction of nuclear power reactors and the setting of bilateral agreements to utilize the oil shale resources discovered in Jordan; estimated at approximately 60 billion tones. These policy orientations and prospects are confronted by a plethora of financial, technical and political obstacles. The public grudgingly accept foreign investments in the oil and gas resources and are terrified by the siting of nuclear power stations in their locality.

In recent years, increased financial burdens and a deepened energy crisis have emerged with the influx of over 1.5 million Syrian refugees following 4 years of civil war in Syria. Energy and fresh water demand have increased exponentially and securing a reliable power supply has become the government's main focus. However, Jordan is endowed with abundant solar radiation, considerable wind energy potential and under-utilized resources in the bioenergy sector (Al-Rousan and Zyadin 2014). A number of policies that support the development of renewable energy have been formulated and recently adjusted to meet the demand of investors for governmental support, transparent customs and duty regulations, and pricing mechanisms. The two key national policies include: "The Master Strategy of Energy in Jordan (2007-2020)" and the recently ratified "Renewable Energy and Energy Efficiency Law" (Ministry of Energy and Mineral Resources [MEMR] 2014). Although these policies aim at fostering renewable energy development, progress has been slow and is hampered by pro-nuclear power proponents and other institutional barriers, such as the lack of knowledge and expertise of the public bodies to speed up the development process. The private sector has held back investment due to uncertainties in public policies and concerns over regional political turmoil and instability in the Middle East region. So far, the development of renewable energy projects are mainly a small demonstration sites with no real implications on the power sector. A number of shortcomings in policymaking in the energy sector have also been noted. These purely economic policies quintessentially lack measures to elevate energy efficiency and promote energy conservation across the vital sectors. In that sense, the domestic sector consumes 43% of the final energy production and this proportion is increasing steadily (see Figure 1 and Figure 2, Paper III). In other words, these policies may be regarded as "crisis reactive" rather than "future oriented". Another important issue in Jordan, as with many other Middle Eastern countries, is the demographic and age distribution of the Jordanian population. Almost 80% of the Jordanians live in three major cities (Amman, Irbid, and Zarqa). Young graduates (mainly) permanently move to Amman seeking better infrastructure, public service, and jobs. Consequently, lifestyle, food habits, energy and fuel consumption have radically changed. The age distribution of the Jordanian population shows that the country is young; about 33% of the population is under 15 years of age (Department

of Statistics, 2013). Although young people require substantial health care, shelter, food, and education resources before becoming economically productive however it reveals the magnitude of power the young people possess if properly educated to induce changes to their societies together with the proper and modern policies. It also points to the importance of public education and public education policies and strategies, which determine education outcomes and influence the direction that society as a whole is heading.

The Jordanian public education system has successfully produced large numbers of skilled people to feed and upgrade all vital sectors, including the education system, in both the internal market and in the markets of neighboring Arab countries. In 1999, the kingship was passed to HM King Abdallah II, who has visions for economic reforms. In addition, HM Queen Rania has embraced visions and plans to develop the educational sector in Jordan through computerization and upgrading of teaching infrastructures, institutions and governance. Notable changes and reform to the education system have indeed occurred since 2000. Thereafter, education policies have been aimed at "education compulsory to all citizens", linking education to the local and regional market needs through Knowledge Economy, and the continuation of upgrading and elevating the quality of the education (Massadeh 2012). These measures have led to a division of secondary education into Comprehensive Secondary Education (Academic &Vocational) and Applied Secondary Education (Training Centers & Apprenticeship). In the vocational and applied education domain, the aim is to produce skilled technicians to lead the development of the economy and elevate poverty, while academic (scientific) education aims to diversify educational outcomes in order to embrace e-commerce, information management, and computer sciences, to meet the technological development in the field of communications and international trade (Massadeh 2012). Currently, there are 6355 schools in Jordan (public, private, other-governmental, UNRWA) of which 3545 (56%) are public schools. The number of teachers has risen to over 110,000 and the total number of students has reached 1.7 million. These remarkable figures re-inforce the need to rethink educational policies in order to embrace new approaches toward environmental protection, renewable energy development, and ultimately, pave the way toward sustainable and resilient societies.

Given the daunting environmental and socio-economic challenges outlined above, elevating the cognitive capability of young people in Jordan is critical and highly recommended. Of particular importance is the cultivation of public acceptance and support toward large-scale renewable energy development. To our knowledge, no studies have been conducted to date that empirically illustrate the status quo of environmental education and the degree of social acceptance to renewable energy development in Jordan and in the Arab countries in general. Moreover, few studies have examined the level of environmental awareness and perceptions among the young people in Jordan.

1.5 Objectives and Research Questions

The main aim of this research was to conduct interdisciplinary and contemporary research studies in order to explore the prospects and role of education in elevating energy and environmental awareness in young citizens in Jordan. The main research objectives are:

1) To explore and investigate school students' level of knowledge, perceptions of, and attitudes toward renewable energy resources (Paper I).

2) To explore and investigate secondary school teachers' level of knowledge, perceptions of, and attitudes toward renewable energy resources (Paper II).

3) To explore and investigate the relative importance of home, school, and mass media on elevating youth energy and environmental awareness (Paper III).

4) To investigate the level of environmental awareness and the nature of perceptions among young school students (Paper IV).

The study outcomes may assist the education authorities in Jordan to craft new education strategies with the aim of increasing knowledge levels in regard to renewable energy in young people and to enhance their environmental awareness. The outcomes of this study may also provide insights for educational authorities in other Arab countries. The study also seeks to contribute to the scientific literature by focusing on environmental attitudes and factors that shape and influence environmental behavior, by specifically studying an example from a developing country.

2. METHODOLOGY

2.1 Literature Review

At the heart of environmental social sciences, it is believed that historic human interactions with the environment has led to the current state of the environment worldwide. Therefore, the quality of the environment seems to be strongly linked to and influenced by human behavior, thus there is a need to understand such behavior and the driving factors that shape and guide such behavior. Furthermore, technological innovations require individuals to accept and understand them in order to be able to use them in correct and sustainable ways (Torgler and García-Valiñas 2007; Steg and Vlek 2009). In this regard, formal and informal education is considered as one approach as by increasing public knowledge the public is helped to make informed decisions based on cognitive understanding of a given problem or issue (Steg and Vlek 2009). Concrete environmental and energy-related knowledge is a combination of consistent and scientifically-sound facts, concepts, and an individual's personal experiences occurring within certain socio-economic and environmental contexts (Zsoka et al. 2013). Knowledge increases an individual's understanding and awareness of a given problem or situation and thereby helps an individual to develop elaborative opinions, meaningful perceptions, and constructive criticisms of benefits and risks. Stern (2000) suggested that personal environmental norms and willingness to engage in behaviors that are consistent with those norms are influenced by available information. For example, the dissemination of transparent, consistent, and easy-to-digest information to the public regarding the benefits of recycling (Vicente and Reis 2008; Barr 2007), the consequences of environmental degradation (Sánchez and Lafuente 2010), the benefits and risks of biotechnology or genetically modified organisms (GMOs) (Qin and Brown 2007), and the curtailments of energy use (Attari et al. 2010) would assist the public to act correspondingly.

While some research evidence has pinpointed a link between the provision of information and possible behavioral change (Zsóka et al. 2013), other studies, however, have paradoxically argued that knowledge alone may not necessarily inflict changes in attitudes or behavior (Kollmuss and Agyeman 2002; Bamberg and Möser 2007), which in some instances can cause confusion and greater helplessness (Owen and Videras 2006). Knowledge of the causes and solutions for environmental problems appears to be more difficult for children to comprehend (Evans et al. 2007), and there exists a public "cognitive

bias" of approving information that is perceived to be aligned with their beliefs and disregarding information that are perceived contradictive (Steg and Vlek 2009). These arguments are somewhat valid since attitudes themselves are influenced by a variety of social, political, and cultural factors aside from informational exhortation (Owen and Videras 2006), and that the state of the environment might have a stronger impact on the development of attitudes toward environmental protection (Stern 2000; Zsóka et al. 2013; Owen and Videras 2006; Kollmuss and Agyeman 2002).

In addition to knowledge, the study of the nature, formation, and change in attitudes is the beating heart of social psychology (Milfont and Duckitt 2010). Hence, there are a cornucopia of studies and plethora of theories investigating attitudes and behavioral relationships with sometimes perplexing findings. The basic premise for studying attitudes rests on the notion that adults presumably hold stable attitudes and that attitude has a potential advantage in understanding and predicting human behavior and that attendance to attitude brings change in behavior. With several reported definitions in hand, eminent researchers in the field have arrived at a consensus that some characteristics of attitudes are: (1) being latent, hypothetical or psychological constructs, (2) acquired and learned but not innate, (3) cannot be measured directly but rather inferred from overt actions or minute facial expressions, (4) evaluative in nature and multidimensional, (5) attitude may be explicit or implicit, global or local, (6), attitude may have an impact on a closely-related behavior if they both correspond in terms of action, target, content, and time elements, (6) attitudes may consist of, derive from, or interact with cognitive, affective, and behavioral elements. The cognitive element consists of perceptions, concepts and beliefs, the affective element consists of feelings and emotional responses about the attitude object, and the behavioral elements include the overt actions and responses to the attitude object (Fabrigar et al. 2005; Crano and Prislin 2008; Milfont and Duckitt 2010).

I quote the recent definition of attitude from Crano and Prislin, 2006. p. 347):

"*An attitude represents an evaluative integration of cognitions and affects experienced in relation to an object. Attitudes are the evaluative judgments that integrate and summarize these cognitive/affective reactions. These evaluative abstractions vary in strength, which in turn has implications for persistence, resistance, and attitude-behavior consistency*"

Furthermore, the literature also suggests that values, social norms, beliefs, intentions and motivations, and locus of control are a set of inextricably interconnected, intuitively interwoven psychological antecedents that influence and steer human behavior(s) in a favorable or unfavorable manner (De Groot and Steg 2007; De Groot and Steg 2010; Stern 2000). To elaborate, Pooley and O'Connor (2000) suggested that for environmental educators interested in changing environmental attitudes, emotions and beliefs rather than knowledge need to be targeted in the environmental programs.

Other approaches have taken into consideration the factors that promote or inhibit pro-environmental behavior. To do so, researchers developed a number of theories to explain various types of environmental behaviors. For instance, the Theory of Reasoned Action (TRA) (Ajzen and Fishbein 1980) was developed in response to research on the weakness of attitudes predicting behaviors and later on extended to become the influential Theory of Planned Behavior (TPB) to include the Perceived Behavioral control (Ajzen 1991). The basic premise of the TPB theory is that people are essentially rational and make systematic use of information available to them (Kollmuss and Agyeman 2002), and an individual makes reasoned choices and seeks alternatives to maximize benefits with the lowest costs of money, physical efforts, and social approval for example (Steg and Vlek 2009). The implementation of TPB theory was deemed successful in explaining behaviors, such as travel mode choice,

purchase of energy conservation appliances, water use and meat consumption (Steg and Vlek 2009; Bamberg and Schmidt 2003; Kaiser and Gutscher 2003; Harland et al. 1999). Other scholars have examined environmental values and found that individuals, who subscribe or hold more ecocentric and altruistic values are more likely to engage in pro-environmental behavior (De Groot and Steg 2007; Kollmuss and Agyeman 2002). Other scholars have attempted to measure environmental concern through a designed scale, such as the New Environmental Paradigm Scale (NEPS) (Dunlap et al. 2000). Studies that deployed the NEPS showed an association between higher environmental concern and pro-environmental behavior to some extent (Steg and Vlek 2009). Another line of research has focused on moral obligation to engage in environmental-friendly behavior. These studies are based on the norm-activation model (Schwartz and Howard 1981) or the value-belief-norm (VBN) theory of environmentalism (Stern 2000). Studies that deployed the VBN theory appeared successful in explaining low-cost or light-green behavior (policy acceptance) but not high-cost behavior, such as reduced driving (Steg and Vlek 2009). To summarize, research studies concluded that there are other considerations that explain people's willingness to change their behavior, such as socio-economic and cultural factors, the importance to identify which behavior need to be targeted and changed, which measures are suitable to induce long-lasting changes in behavior, and how to assess the interventions or measures over the long term (Steg and Vlek 2009; Kollmuss and Agyeman 2002; Owen and Videras 2006). What appeared appealing to scholars is that a combination of interventions is needed to induce changes in human behavior. Broadly speaking, a combination of interventions means the development of public educational initiatives, which are accompanied by effective public policies and maintained by economic incentives and available physical infrastructure and technical facilities.

Since values and attitudes operate within wider socio-economic and cultural frameworks, numerous research attempts have aimed at investigating "objective" factors that influence or shape human behaviors. In the socio-economic domain, objective factors such as age, gender, marital status, educational achievements, house type and size, income status and occupation, place of residence (urban vs rural areas), religious beliefs, social capital, political orientation and interest are factors that have been intensely examined by a plethora of research studies (see Torgler and García-Valiñas 2007). However, results have not been consistent and some discrepancies were found when one factor was investigated. The reasons for the problems have varied from self-reporting, the questionnaire design, and/or unintentional bias (*see section 2.2 below for more on this issue*). Studies found that young people were more willing to pay (WTP) for improved air quality in Sweden than retired people (Carlsson and Johansson-Stenman 2000). In general, young people seem to be more concerned about the environment.

Gender issues have received ample research focus and in many contexts (Torgler and García-Valiñas 2007). For instance, Torgler (2006) have argued that women report significantly higher tax morale than men. Research has also shown that females seem more inclined toward energy conservation (Carlsson-Kanyama and Linden 2007), more aware and concerned about the environment (Jenkins and Pell 2006; Torgler and García-Valiñas 2007) and show greater support for renewable energy compared to males (Zyadin et al. 2012). Studies have also shown that females, with few exceptions (García-Valinas et al. 2011), are more inclined toward volunteering and joining charity and environmental associations regardless of age, marital status, or the level of their parental responsibilities (Zelezny et al. 2000). In developed societies women have become more independent, very well educated, raise less children, are entitled to social and economic benefits from employment, and have

spare time for other activities. In the developing countries, however, women are still dependent on men, have far less time to engage in other activities as they are fully occupied in raising large families- a deeply rooted norm in Arab masculine societies. Indeed, there is a lack of research studies on these aspects in the Arab countries.

Formal and informal education seem to positively correlate with the tendency to engage in pro-environmental activity and exhibit higher environmental preferences (Torgler and García-Valiñas 2007; Zsóka et al., 2013). Furthermore, studies suggest that knowledge is acquired not only through routine schooling but also through various channels, such as direct life experience (Hutchison 1998), social interactions (Zsóka et al. 2013; Halder et al., 2011;George and Kaplan 1998), mass media (Sampei and Usui 2009) and the internet (Aslanidou and Menexes 2008). The economic status (income) of an individual is also a significant consideration (Torgler and García-Valiñas 2007). Studies have shown that income is positively correlated with an individuals' propensity to protect the environment, WTP, join environmental organizations, and purchase green electricity at slightly higher prices (Martinsson et al. 2011; Torgler and García-Valiñas 2007; Dupont 2004). People who live in their own house appear more willing to conserve energy than people who live in rented accommodation (Martinsson et al. 2011). Also, married people with children appear more willing to pay for environmental services (WTP) than single people or childless couples (Dupont 2004). People who have political trust in governmental institutions appear more willing to adopt public environmental policies (Konisky et al. 2008). As none of these socio-economic factors have been studied in Jordan to date, some caution must be exercised when drawing comparisons with other studies due to inherent socio-economic and cultural differences.

2.2 Attitude measurement techniques

Numerous methods and techniques exist within the scope of environmental social sciences to collect and analyze qualitative and quantitative data; however, surveys and questionnaire-based studies are commonly used instruments to address psychophysiological societal issues and challenges. Within the scope of social psychology, the study of public attitudes remains a quintessential research orientation. In this regard, environmental or energy-related attitudes are defined as latent construct or psychological predispositions that cannot be measured or observed directly but rather inferred from the overt responses and actions of an individual (Milfont and Duckitt 2010). These responses can be explicitly inferred from overt behavior (such as approaching or avoiding the object) and verbal statements (e.g. answers to an attitude question) to covert responses, such as imperceptible facial expressions (Schwarz 2012). Since the response of an individual is influenced by many other variables, the answers to attitude questions by respondents are, therefore, highly context-dependent and raise complex theoretical issues (Schwarz 2012). Attitudes can be measured directly through explicit self-reports (attitude questionnaire), which is the most feasible procedure as it is done in representative sample surveys (Schwarz 2012; Strack and Schwarz 2007). The rationale behind using questionnaires is based on the premise that people have introspective access to information (chronological or temporary) or previous experiences in their memory related to an object in order to form an attitude judgment, and people are aware of what they like or dislike (Schwarz 2012; Strack and Schwarz 2007). In cases where no answers are found in the memory, people need to form a mental representation of the attitude object and of a standard against which the object is evaluated. Hence, the judgment is disproportionately influenced by the first few pieces of information that come to mind (Schwarz 2012). One key challenge to the self-report method is that, in some sensitive cases, people edit their answers

before they communicate them and that minor variations in the questions wording, format, or sequence can greatly influence the obtained results (Schwarz 2012). Other attitude measuring methods, which require special skills and more resources, include implicit measurement techniques, such as Sequential Priming Procedure, Evaluative Priming, and Response Competition Procedure (Schwarz 2012). The justification behind the use of these implicit measures rests on the theoretical assumption that "*attitudes exert a systematic influence on people's performance… and that the size of this influence can serve as an index of the underlying attitudes*" (Schwarz 2012). Unlike direct explicit measures, indirect implicit measures do not require the assumption that people are aware of their attitudes; people may hold attitudes of which they are not aware they hold. Another motive for their use is to dilute the effect of context dependency that often occurs with direct explicit measures (Schwarz 2012). Other sophisticated methods of observing attitude change involve, for instance, the observing of sweat gland activity of the skin (electrodermal measurement), or monitoring the reactions of facial muscles (electromyography), or measuring brain activity through brain imaging techniques (electroencephalography). However, these measures do not reflect the direction of the evaluative response; they can be distorted by unrelated facial movements, or they do not lend themselves to a direct assessment of positive or negative responses respectively, rendering their use limited (Schwarz 2012). In summary, self-report measurements remain the most widely used and accepted research tool despite their weaknesses and disadvantages (Milfont and Duckitt 2010). In an attempt to develop and upgrade attitude measurement techniques, researchers have developed and proposed several models. In this regard, three scales have been largely developed and used: the Ecology Scale, the Environmental Concern Scale, and the New Environmental Paradigm (NEP) Scale (see Milfont and Duckitt 2010). These measures examine multiple expressions of concern and examine various environmental issues. However, several shortcomings have been observed in using such measures: they may have become outdated since many new environmental issues have emerged (Milfont and Duckitt 2010), given the socio-cultural differences they are not a *global tool* that can be used in developed and developing countries alike (Sarigöllü 2009), and they do not include adequate renewable energy-related or energy conservation attitudinal items. As a result, a new string of survey studies that examine the social dimensions of energy related issues have been developed by various researchers (country-wise) around the globe. In Europe, the Relevance of Science Education (ROSE) project is currently in use to address contemporary environmental issues, and we have adopted some of its items in our studies (Jenkins and Pell 2006).

2.3 Questionnaire construction and pre-testing

A pre-tested and self-instructed (supervised by teachers) questionnaire was designed (see Annex 1) for school students to assess their level of knowledge, perceptions, and attitudes toward renewable energy (Article I), environmental knowledge and environmental attitudes (Article IV), and the role of home, school, and mass media in elevating youth energy and environmental awareness (Article III). The questionnaire was initially developed in the English language and was later translated into Arabic. The questionnaire was pre-tested in a tenth-grade classroom (age 16 years) and with 25 students in a public school in Amman, Jordan. Any ambiguous terms or misunderstood statements were rephrased. The pre-tested school and the students were excluded from the subsequent survey study.

The first part of the questionnaire was designed to elucidate the most important source of information for the student. Here, we presented a table of nine potential information sources ranging from friends to school teachers (see Annex 1 for full list). Immediately afterwards,

the students were asked to indicate (using the source number) their preferred source to acquire information in the future.

Section two of this study (titled Renewable Energy) consisted of four sub-sections. To investigate their level of knowledge, a table of seven energy sources was presented to students and their task was to indicate (by cross-mark) whether the presented source was renewable or not. Thereafter, a further 5-point Likert scale question was presented to students with seven statements referring to solar, wind, geothermal, and bioenergy (Annex 1). The students were asked to cross-mark their level of agreement using the 5-point Likert scale of answering i.e. *Strongly Agree, Agree, I do not know, Disagree, and Strongly Disagree*.

Section three investigated and analyzed the perceptions of the students as to how to meet the growing needs for energy in Jordan in the future. We provided the students with five scenarios that we believed are the most commonly communicated options at the national level, including the contentious debate on building nuclear power plants. The degree of agreement to those statements was also a 5-point Likert-scale question i.e.: *Strongly Agree, Agree, I do not know, Disagree, and Strongly Disagree.*

The fourth section was designed to gain insight into the attitude of students towards renewable energy and environmental issues. We provided the students with five statements (three closely related to volunteering and willingness to pay and two related to renewable energy) using a 5-points Likert-scale questions similar to the knowledge and perception questions.

Although not commonly used in survey studies (as alluded to during the peer-review process) the objective of the final section of this part of the study was mainly to investigate the self-reported level of knowledge and compare it to the measured level of knowledge. In this question, the students were asked to cross-mark their perceived level of knowledge on a 5-point Likert scale question i.e. *Very Weak, Weak, I do not know, Good,* and *Very Good.* Regarding the study objective devoted to investigate the students' level of awareness of the environmental problems in Jordan and their perceptions to whom the responsibility to protect the environment shall be attributed (Article IV), two categories of Likert-scale questions were used. The students were given a list of ten selected enviromental problems in Jordan and they were asked to determine the level of their importance on a scale of 4 i.e. *(very important, important, not important, not a problem).* Thereafter, the students were given five statements representing perceptions to whom the responsibility to protect the environment shall be attributed. Some of these items were adopted from the ROSE project (Jenkins and Pell 2006). The format of the questions was a 5-point Likert scale question as follows: *Strongly Agree, Agree, I do not Know, Disagree,* and *Strongly Disagree.*

The final section of this questionnaire consisted of sub-sections. The first was a categorical question aimed at identifying the level of parental education, separately for the father and the mother *(College, Diploma, Secondary, Primary, Illiterate, I do not know,* and *I do not want to answer).* The following questions were related to the housing type *(House in rural village, House in city, Apartment in city, Bedouin tent,* and *I do not want to answer),* number of rooms excluding kitchen and living room *(one room, two rooms, three rooms, more than three rooms, I do not know,* and *I do not want to answer),* and a blank space to indicate the number of brothers and sisters. The last piece of this questionnaire was an open-ended question: *In your opinion, why do people not care about the environment in Jordan and what are the best ways to protect the environment*?

The second survey study investigated the approach of the school teachers and investigated their measured and self-reported level of knowledge of renewable energy and their perceptions of the challenges to renewable energy development in Jordan. Two statements

contained global dimensions, and two separate sections assessed their interest in the development of renewable energy education, and their willingness to purchase clean energy or participate in elevating public awareness of renewable energy. The questionnaire was first developed in the English language and later translated into Arabic. The questionnaire was pre-tested with 25 randomly selected teachers. The pre-test responses were analyzed and minor changes were introduced to the original version.

The first part of the questionnaire was devoted to the biographical and educational background of the teachers (Annex 2). It consisted of five questions as follows: (1) gender, age, and marital status, (2) number of teaching years, number of weekly teaching hours, (3) the teacher's disciplines, (4) the most recent academic degree achieved, and finally (5) the level of school teaching. The next question is Part I of the level of renewable energy knowledge investigation. Here we presented a table of nine energy sources (fossil fuels and renewables). In the adjacent columns, the teachers were requested to indicate whether this source of energy is currently used in Jordan (Yes, No), whether it is widely available in Jordan (Yes, No), and whether the source is: *Renewable, Non-renewable, I am not sure*. Part II of the knowledge investigation involved ten statements (items) that considered solar, wind, and geothermal energy sources and several fact-related questions- two items were intentionally falsified to elaborate on the teachers' conscious responses. Another set of statements (nine items) were constructed to investigate teachers' perceptions toward renewable energy development in Jordan. We included three statements that demonstrated the challenges to renewable energy development in Jordan (cost, space, and expertise). Since oil shale exploitation and nuclear power prospects are pressing issues, we included two statements regarding their use and development (Annex II). The next section consisted of the self-reported level of knowledge in the teachers. The question consisted of four options: *Good, Adequate, Weak, I am not sure*. The final part of the questionnaire investigated the attitude of the teachers toward renewable energy (five items), what teachers need to enhance renewable energy education at the school level (five items), and what obstacles to in-class renewable energy education they may consider important (five items). The question was a 5-point Likert scale as follows: *Strongly Agree, Agree, I am not sure, Disagree,* and *Strongly Disagree.*

2.4 Data collection

Two cities were considered for data collection in this study. **Al-Karak** city, with a population of 100,000, is located about 120 km south of Amman and is representative of a rural area with many villages. The residents of Al-Karak city are within the low-income level, highly dependent on the public sector for employment and on agriculture and livestock as a secondary source of income. People in Al-Karak city are highly reliant on kerosene-based units for space heating in winter. The city maintains social integrity through tribal law. The capital city, **Amman**, was selected as an urban area. It accommodates over 2 million people, which includes Syrian and Palestinian refugees. Amman enjoys a relatively modern infrastructure, is the center for commercial and economic activities, and home of key public institutions, ministries, NGOs, and semi-governmental agencies. In Amman, the number of private schools (profit-oriented) is exceptionally high, which are semi-controlled by the Ministry of Education.

Table 1: Data distribution between gender and place of residence
[a] includes Badia region (desert), [b] include sub-urban

Target Group	Total responses	Gender		Place of resident		Number of Schools
		male	female	rural	urban	19
Students	617	356	261	218	399	
Teachers	260	146	114	157[a]	103[b]	25

The procedure for data collection required formal permission from the Ministry of Education. A committee within the Ministry scrutinized the questionnaire and thence granted permission for the distribution of the questionnaire into all public and private schools in Jordan. The Ministry also provided the researcher with a list of the public schools, contact information, and school locations. Our key independent variables were gender and place of residence. According to the Department of Statistics [DoS] (2013), the gender ratio in Jordan is 48.5% female and 51.5% male. 82.6% of the people live in urban areas (cities) and 17.4% live in rural areas (including Bedouins). For this study, a number of public schools were randomly selected by stratified random sampling from rural and urban areas.

As we described above, the public education system in Jordan is designed to accommodate females and males separately, particularly after the primary education phase. When selecting the schools, the school principal was first contacted to arrange an appointment and upon arrival the researcher briefly explained the motives of the questionnaire to the school principal and to the teacher who were to supervise the process. At the end of the data collection process, a total 617 responses from school students and 260 responses from school teachers were collected (Table 1).

2.5 Data and research technical and logistical limitations

There are a number of shortcomings in any survey-based studies that delimits its generalizability. Attitudes questionnaires are taken as a snap-shot of time (Jenkins and Pell 2006) rendering the obtained results unstable, since the same sampled population may experience attitude change as they mature (get older) or develop different life expectations. Self-report questions are highly context dependent (Schwarz 2012) and can only be generalized to people within the same socio-economic or cultural status and outlook (Al-Sa'd, 2007). It is difficult to develop a survey tool that embraces all the possible underlying attitude-related psychological behaviors (Schwarz 2012), especially as human interactions with existing or new technologies create a new set of behaviors that researchers may not be aware of (Stern 2000). As mentioned above, any slight changes in the wording, format, or sequence of the questionnaire may influence the obtained results. Finally, self-reported attitude measures may not correspond perfectly with overt behavior toward the attitudinal object (Schwarz 2012).

In our studies some of the shortcomings involve data representation, which is mainly related to time and resource limitations. Nonetheless, the sample size of 617 school students and 260 school teachers make statistical analysis reasonable and acceptable to some degree. Another limitation includes the exclusion of the 173 schools of the United Nations Relief and Works Agency for Palestine Refugees (UNRWA), which we believe require a separate study given the differences in education orientation. The study also excluded the public schools

maintained by the Armed Forces in poor-pocket zones and also omitted the vocational schools. These schools are either limited in number or have no upper level secondary education. Furthermore, politically sensitive, religious or ethnicity related items were not included in the survey study because the education authority may have rejected the questionnaire based on these sensitive issues. Overall, the studies outlined in this thesis are among the first studies of their kind, particularly for Arab countries, and will provide a basis to launch further and more in depth research studies in the future.

3. A SYNTHESIS OF THE RESULTS

3.1 Knowledge and attitudes of school students toward RE development

The findings of this study revealed links between the place of residence, schooling type, gender variables and the students' knowledge of and attitudes toward renewable energy. The students, in general, managed to distinguish renewable from non-renewable resources to a certain level (Paper I, Table 1&2). Some confusion among the students was identified regarding a correct understanding of geothermal energy, natural gas, oil shale, and nuclear power. Results of the Chi-square test showed that females were more capable of correctly identifying the nature of energy sources compared to males. The test also showed that the residents of urban areas were more capable of identifying the correct nature of energy sources, although this was not statistically significant. The students of the private mixed schools were more capable of identifying the renewable energy sources compared to their counterparts in rural and urban schools. The results clearly indicated that the students *do not know* enough about bioenergy, particularly how biodiesel and bioethanol are produced. Regarding knowledge of renewable energy sources, two-thirds of the students appeared aware of the modern use of solar applications and wind turbines but appeared unfamiliar with geothermal energy and its uses. Several non-parametric statistical tests (Chi-square, Mann-Whitney, and Kruskal Wallis) were deployed to reveal differences in gender, place of residence and schooling systems. The results of these tests showed that females, residents of urban areas, and students of private mixed and urban schools were more knowledgeable of the uses of renewable energy technologies compared to males, residents of rural areas, and students of rural public schools, respectively. These differences, however, were not statistically significant in all of the cases (see Paper I, Table 4).

The perceptions of the students in regard to proposed future energy scenarios revealed some misconceptions and highlighted the students' misunderstanding on some energy issues (Paper I, Table 5). On one hand, 70% of the students supported policies that promoted the utilization of local oil shale resources and 50% supported the development of nuclear power (statement 2 and 5 respectively). On the other hand, 87% of the students showed explicit support for the utilization of renewable energy resources, and 81% further supported the utilization and processing of organic wastes. The Chi-square test revealed a clear significant difference for the three study's variables (gender, place of residence, and school type). In terms of gender differences, females were clearly supportive of renewable energy and organic waste utilization, while males tended to largely support the development of nuclear power (Paper I, Table 6). The residents of rural areas were more supportive of a continuation of gas and oil importation and the utilization of oil shale resources, and the development of nuclear power (statements1, 2, and 5). The residents of urban areas showed more support for the utilization of renewables and organic wastes. Similar findings were found for the students of rural public schools in comparison to students of urban public schools. The attitudes of

students towards renewable energy revealed clear positive attitudes toward renewable energy development in Jordan. For instance, the majority of the students (over 80%), showed a willingness to pay additional money to receive clean energy at home, although 20% did not agree on this statement. The students largely agreed (82%) to install solar panels at their homes if they could afford it (Paper 1, Table 8). Residents of urban areas showed more willingness to pay additional money for clean energy compared to residents of rural areas. Gender and schooling system did not reveal any significant differences. The self-assessment by the students of their level of renewable energy knowledge showed close proximity to the measured level of knowledge (Paper I, Table 9). About 50% of the students rated their knowledge as *good* and about 20% rated it as *very good*. The remaining 30% of the students rated their knowledge as *very weak* or indicated that *they do not know*. No statistical differences were evident for this part of the study regarding gender, place of residence, and schooling system.

3.2 Knowledge and attitudes of school teachers toward RE development

In this study, a knowledge gap and misconceptions in regard to energy resources among the teachers were identified. Oil and natural gas are the main sources of energy used in Jordan. With the exception of the extensive use of roof-top Solar Water Heaters (SWHs), the proportion of renewables in the energy mix is very small. In this study, the teachers appeared unaware of the energy use and availability in Jordan, although 98% of them appeared very well aware of the solar energy potential in Jordan. Teachers appeared familiar with renewable energy sources, such as solar, wind, and hydro. However, they appeared not well aware of the nature of nuclear power, coal, natural gas, and geothermal. The level of knowledge of the teachers was further tested using 10 statements, 3 of which were falsified. The teachers showed an awareness of the technology-concept of renewables (solar, wind), however teachers were either not sure or had never heard of Photovoltaics (PV) technology (Paper II, Table 2). Eleven percent of the teachers have never heard of biodiesel. Teachers were not well informed of the energy situation in Jordan where 25% of the teachers appeared unsure and 64% believed that half of primary energy was imported (in reality it is around 96%). Some 20% of the teachers were not sure or were unaware of potential of biogas production from the processing of municipal sewage waste. 14% of the teachers were not sure whether energy demand will increase or decrease in the future (items 6 and 10 respectively). Many of the teachers did not know that firewood is a key energy source in many developing countries (item 8). There were no statistically significant differences in the bio-demographic variables (gender, age, marital status, place of residence) in regard to general energy-related knowledge of the participating teachers. Other variables related to work profile and characteristics, such as teaching load, teaching experience, and the teacher's disciplines did not show significant differences, although science teachers appeared more acquainted with the presented set of knowledge items, in comparison, to literature, religious, and sports teachers for example.

The perceptions of teachers towards renewable energy use and development in Jordan were tested by presenting nine statements. The teachers optimistically perceived the development of the renewable energy sector in Jordan as a means for energy independence and economic growth (items 1 and 2). The teachers, however, appeared somewhat skeptical since they largely believed that renewables are still expensive (item 3), particularly in the light of a lack of local expertise (item 6). It is also noteworthy that 70% of the teachers supported the nuclear power option (item 4) and 85% of them saw the utilization of oil shale

resources as a key future energy policy for Jordan (item 5). On a global scale and with different energy scenarios, 44% of the teachers appeared *not sure* regarding the use of agriculture crops to produce denatured ethanol (transportation fuel) and whether this process might create hikes in staple food prices (item 8). Another mode of misconception among the teachers was forest wood-based energy generation. Here, 70% of the teachers appeared critical and strongly disagreed that the harvest of wood from a forest is environmentally friendly (item 9). The non-parametric tests deployed to reveal any statistically significant differences did not show any noteworthy differences for the study variables. In regard to the teacher's attitudes toward green energy, the teachers showed positive attitudes and a willingness to adopt green and clean energy (Paper II, Table 5). For instance, 85% of teachers were willing to pay more in order to receive green energy at home, 89% would like to install solar water heaters at home, and 86% were also willing to drive hybrid or electric cars. It was also important to explore the teachers' willingness to volunteer to participate in outreach campaigns designed to raise public awareness of renewable energy and its benefits in Jordan. Highly educated, single and female teachers showed a higher willingness to install solar water heaters compared to less educated, married and male teachers. Finally, we examined the requirements of teachers to be able to deliver successful and effective renewable energy-related education at the public schools. In this regard, we provided the teachers with ten statements and arguments (Paper II, Table 6). All the participated teachers in this study either *agreed* or *strongly agreed* to the proposed measures to improve RE education at the public schools. 90% of the teachers seemed eager to learn more about RE (item 3), however 50% believed that they did not have enough knowledge of RE, 80% asked for training, 86% asked for better teaching materials, 90% asked for financial help, and around 77% asked for external help from experts to teach in classrooms (items 1-6). From their own point of view, the teachers believed that there was no time in their teaching schedule to teach RE-related topics and they recommended the development of a separate curriculum devoted to RE sciences, especially when there is an opportunity to include this curriculum in the school time periods. Almost one-third of the teachers disagreed with the suggestion that parents are a more important factor in regard to the students' knowledge of RE uses and benefits.

3.3 The role of home, school environment, and mass media in elevating youth energy and environmental awareness

In this study, the degree to which the students accessed various information sources revealed interesting findings (Paper III, Table 1). The students indicated their parents, the internet, the school curriculum, and school teachers as important sources of information. Parents scored the highest mean value and thus appeared the leading source of information for the students. Radio and school activities, on the other hand, appeared relatively weak sources of information. Socializing with friends appeared an excellent source of information for rural area residents and male students compared to the female and residents of urban areas. Internet and TV remained as important sources of information for the residents of urban areas. To summarize, social factors were of great importance to residents of rural areas, whereas mass media and internet were more favored by the residents of urban areas. The Principle Component Analysis revealed three key dimensions in the data. The SCHOOL dimension (teachers, curricula, and activities) had a higher mean value and appeared of high importance for the students in regard to information acquisition. The final part of this study aimed to explore the students' preferences regarding the source of information in the future. The

internet was the most preferable source of information followed by school teachers and TV. For male students, teachers and parents were the preferred sources of information, whereas TV and school activities were preferred by the female students. Residents of rural areas indicated that the internet would be their choice in the future, whereas TV remained the preferred choice for the residents of urban areas.

3.4 Environmental awareness and perceptions among young school students

Environmental awareness is also needed to involve the public in efforts to address and tackle key environmental challenges, such as water shortage in Jordan and in many of the Middle East and North African (MENA) countries (Zyadin 2013). To this end, we investigated the level of environmental awareness among school students and the nature of their perceptions by asking to whom environment protection should be attributed. Is it the government? Is it the developed countries? Is it science and technology? Or simply, is it the people?

To tackle these issues, ten environmental challenges were selected and presented to the students in order to determine the degree of importance of such challenges (Paper VI, Table 1). The lack of potable water was deemed the most important environmental challenge by the participating students. Water shortage (P=.008), air pollution (P=.004), and emissions from vehicles (P=.020) appeared more important for residents of urban areas compared to rural areas. 90% of the students indicated that people should do more to protect the environment, and 67% indicated that it is the responsibility of the government to protect the environment. Furthermore, the students largely disagreed with the statement that only science and technology, and developed countries should protect the environment. Our results also showed that approximately 15% of the students largely agreed that the protection of the environment was not their responsibility, which indicates an awareness gap. Our statistical approach showed that females and residents of urban areas have better environmental awareness compared to males and residents of rural areas. Moreover, females and residents of urban areas believed that it was the duty of society to protect the environment while males and residents of rural areas believed that it was the responsibility of government. Females appeared more critical, and largely disagreed that only developed countries or science/ technology should or could protect the environment.

4. DISCUSSION

Renewable energy and bioenergy technologies are seen as a panacea for climate change through limiting carbon emissions, the creation of a sustainable bio-economy, aiding poor people's aspirations, and guaranteeing energy security, safety, and independence (Panwar et al. 2011; GEA 2012; Scheer 2012; Bloomberg 2014). Renewables have also been advocated and prescribed as an alternative to the growing risks and threats from nuclear power, and as an alternative to "bridging technologies" such as carbon capture and storage, and an alternative to "bridging fuels" such as shale (natural) gas. However, meeting global energy demands will require a more ambitious renewable energy program than is currently the case thereby averting potential technological, economic, and social barriers to allow for smooth and confident investments in clean technologies (Scheer 2012; Richards et al. 2012). Social or public barriers have been identified and recognized as an impediment to the development of renewables in many countries around the world (Wustenhagen et al. 2007). In any modern society, young citizens are the cornerstone to transform current societies to more sustainable ones. They are the future policymakers, leaders, educators, and environmentalists

(Yazdanpanah et al. 2015; Ntona et al. 2015. They are, however, energy-intensive consumers themselves and their energy choices today determine and largely shape the future of subsequent generations. Young citizens can be an effective means of addressing many of today's challenges, especially in regard to energy demand, pollution, and even population growth. These motivations led us to conduct studies in Jordan; a renewable energy-rich yet fossil fuel-addicted country.

The main results of this study revealed some knowledge gaps and misconceptions among the students and the teachers alike. Similar conclusions were also proposed by other research (Liarakou et al. 2008; Spiropoulou et al. 2007; Kollmuss and Agyeman 2002; Owen and Videras, 2006; Halder et al. 2010; Halder et al. 2011; Halder et al. 2014). Similar misconceptions, discrepancies in understanding energy concepts, and lack of general renewable energy knowledge were indicated by Trumper et al. (2000) when they compared Israeli and Argentinian pre-service teacher students. In a study of 13-14 year old Turkish school students, Kılınc et al. (2009) found that over half of the students thought that renewable power generators could in some way harm plants, animals or humans that lived nearby. Similar lack of awareness and knowledge was also found for Turkish university students by Karatepe et al. (2012) who found that female students had more information and higher levels of awareness about RES than male students. In the US, energy literacy was measured with a written questionnaire completed by 3708 secondary students in New York State. The statistical scores suggested that the students lacked the knowledge and skills required to effectively contribute toward solutions, thus accentuating the need for education that improves energy literacy by impacting student attitudes (DeWaters and Powers 2011).

In the case of Jordan, this was not a surprising finding probably because RE concepts are not adequately covered in school curricula, teachers have not received sufficient information and knowledge of RE during their career development, and the level of RE development in Jordan has lagged behind global trends. Numerous studies have been conducted over the last decades to determine the drivers of environmentally responsible behavior patterns. It has become clear that knowledge of the problem and its causes, and knowledge of the necessary or needed actions are indispensable (Kollmuss and Agyeman 2002). Researchers also believe that, based on Ajzen and Fishbein's theory of planned behavior, knowledge increases an individual's ability to bring about change through his/her own behavior and leads to a greater sense of personal responsibility, which ultimately develops into consistent pro-environmental behavior (Kollmuss and Agyeman 2002; Zsóka et al. 2013). Major challenges exist in determining the type of knowledge required, how much knowledge each individual needs to possess, and what is the best tool to elevate the public knowledge? Is environmental knowledge of equal and similar importance in both the developed and developing countries? If we believe that countries are inherently different, then it might be prudent to consider and prioritize certain levels of information on certain issues for the country of interest. For example, knowledge on energy conservation in the Gulf States might be a top priority while saving biodiversity niches in forests might be more important in Scandinavia-since Scandinavians tend to save energy anyhow (Martinsson et al. 2011). In an era of tele-communication renaissance (industrial internet), smart phone applications, social media, Wi-Fi and high speed internet connection might be effective tools to elevate public knowledge and awareness in developed nations, while modern formal public education strategies might be more effective in developing nations, particularly because tele-communication applications in developing countries are not developed at the same level as in developed nations and embraced by young people as an entertainment tool. Another indisputable argument is that knowledge alone is neither sufficient to guarantee attitude changing nor

sufficient to garner public support for renewable energy projects. In green-minded societies, which are disposed to save the environment and natural resources, widely-accepted public policies might be an effective intervention, while in financially-constrained societies economic incentives are beneficial if not quintessential (Zyadin et al. 2014).

The varying perceptions of the students in regard to future energy planning might have been related or connected to other cultural aspects. For instance the students showed support for oil and gas importation and nuclear power development. In Jordan, teenagers, especially males, view driving a car as social prestige, raucous entertainment, and a masculinity value while nuclear power might be viewed as a military stock in war-time, especially in the light of unrelenting Israel-Arab disputes. Furthermore, in rural areas kerosene followed by natural gas cylinders are the main fuels for space heating in winter, thus fossil fuels remain quintessential for rural livelihoods. Space heating units, such as the widely used kerosene-based *Sobba*, have an important social value with family members gathering around for warmth and entertainment. In this context, Sovacool (2009) has argued that people tend to overestimate "visible" or physical energy use, such as electric lighting, and underestimate "invisible" energy use, such as water heating (DeWaters and Powers 2011).

The gender differences also evolved from socio-cultural aspects where females appeared more environmentally conscious yet exhibited critical perceptions toward the use of science and technology and explicitly disagreed with external interventions led by developed countries to protect the environment. Females, who are religious or live in a tight religious environment, may view external interventions as anti-Islamic movements, and this finding provides evidence as to why women show more support for Islamic parties or movements in many Arab States (Kabatilo 2014). Females in Jordan appeared critical and somewhat devalued democracy, political parties, and freedom of expression because of their external origin from the West. For instance, 32% of females regarded political parties in Jordan as "undesirable or wrong" compared to 14% of males (Kabatilo 2014). Another explanation might be that the women's roles as caregivers and nurturers may lead to compassion and a higher concern toward life and the environment (Torgler et al. 2007). This impression is especially true in the case of Jordan where females value family and raising children obsessively and passionately due to the deeply-rooted cultural and religious values in these societies.

In this study, teachers appeared unable to differentiate between energy uses and availability in Jordan, and showed a low knowledge of renewables especially advanced technologies such as PV. Their lack of knowledge and awareness was also reflected in their perceptions of renewable energy development in Jordan. The teachers, as did the students, supported nuclear power and oil shale utilization. In recent years, nuclear power and oil shale discoveries have received greater mass media attention than RE resources, which probably further explains why the public appear ambivalent and possess varying perceptions regarding future energy planning. It is, however, understandable that the teachers might not be well informed about RE since it is a relatively new issue in Jordan and teachers have no access to information in their schools. An important socio-economic issue here is that teachers, in general, earn the lowest wages in Jordan (400-600 euros monthly) compared to other public sectors, which probably leads to different priorities in life, for instance, income come first. Teachers might not seek to expand their knowledge or involve in environmental (energy and water) outreach campaigns without financial stability and satisfaction. For instance, one of reasons for the remarkable success of the Finnish education system is the well-developed teacher college education accompanied by the remarkable employment benefits received by the teachers (Uusimaki and Turunen 2013. This partly explains why teachers perceive

economic development, through oil shale or even nuclear power, as a mean for better wages and more employment opportunities in the future.

In 2012, teachers marched in the streets in Amman to express their grievances regarding low wages and the health care system, and demanded constitutional approval for the establishment of the Teachers' Association. The teachers in this study, however, showed a high willingness to know more about renewable energy, and to teach about renewable energy if their requirements are fulfilled: resources, training, time, and separate curricula. Similar findings and recommendations were suggested by Liarakou et al. (2008) for the Greek secondary school teachers and by Halder et al. (2014) for Indian teachers in regard to bioenergy issues and development. This study also found higher female awareness and more propensity and tendency to adopt renewable energy compared to male teachers. It is not surprising since female teachers are also homemakers and caregivers, who seek to save resources and find new means to reduce electricity bills for example, particularly in the aftermath of newly ratified energy policies and taxes, which led to higher electricity prices in Jordan.

The students and the teachers in this study have generally shown positive attitudes toward adopting clean energy. Our findings also mirror the willingness to volunteer and willingness to pay (WTP) for the environment directly through taxes or indirectly through installing solar panels. Volunteering in general is the foundation of civil society. It helps build collective and cooperative behavior that decreases the costs of government operations to protect the environment. It may also serve as a political tool on formal institutions driving the abolishment or modification of existing laws and regulations that are perceived to inflict harm to public goods and natural resources (García-Valinas et al. 2011). Volunteering is often influenced by socio-economic and demographic factors, and the ability of individuals to participate in volunteering networks, however, environmental social norms proved to have strong relationship with volunteering in non-profit, non-governmental organizations (García-Valinas et al. 2011). Researchers have also found a positive and strongly significant relationship between WTP for environmental protection and joining an environmental group (Brown et al. 1996). Liebe et al. (2011) argued that income is not necessarily a precursor for WTP but significantly influences how much a person is willing to pay. In our study, income seems to have an influence on attitudes. For example, rural areas (lower incomes) showed a higher willingness to volunteer, while urban areas (higher incomes) showed more a willingness to pay. In regard to gender issues, studies have shown that women, with a few exceptions (García-Valinas et al. 2011), are more inclined toward volunteering and joining charity and environmental associations regardless of age, marital status, and whether they had children or not (Zelezny et al. 2000). Our results contradict, to some extent, the accepted wisdom that residents of urban areas show a higher level of environmentalism (Shen and Saijo 2007) and that families that live in urban areas, with higher incomes and a better educational outlook, are generally more environmental conscious and caring (Barr 2007).

A noteworthy finding of this study is the students' appreciation of social factors, such as the role of parents in molding students' attitudes, values and behaviors. Parents provide strong financial support for college education and for marriage purposes. Family issues are embedded in long-standing and culturally-rooted values and norms in Jordanian society. Therefore, students are subjugated to some degree by the attitudes, values and behaviors of their parents. In rural areas, where basic entertainments and sports facilities are inadequate or sometimes unavailable, students spend much more time with friends in their locality and thus influence each other's perceptions of various daily life issues. In his dissertation regarding students' attitudes toward vocational training, Al-Sa'd (2007) argued that friends

influence their friends' higher education choices. From the students' point of view, teachers were almost equally important as parents in the acquisition of information. Parents who are illiterate or educationally unfortunate rely on teachers to instill knowledge and assign a pedagogical role to their offspring. In Jordan, teachers have always been a pivotal role in public education and their role in educating societies is perceived indispensable. Females, for mainly cultural and religious reasons, spend much more time at home than males and therefore may appreciate TV as another important source of information in addition to school activities – a social environment with lots of freedom and spare time with friends. A key finding here is that well–informed and environmentally–aware students are able to convey their knowledge to their illiterate or less aware parents and probably help change their attitudes and behavior regarding issues, such as water and energy consumption and conservation. The overall findings of this study are in agreement with the many studies in the field of environmental education and energy literacy, namely that public awareness is important and must be accommodated in comprehensive public environment and energy education policies (Jennings 2009; Kandpal and Broman 2014; Yazdanpanah et al. 2015; Ntona et al. 2015). In a lecture delivered at Stanford University, UN Secretary-General Ban Ki-moon outlined three ways to achieve this "Great Transition": by advancing sustainable development (SD), helping people meet their aspirations for democracy and dignity, and empowering women and young people (UN Press 2014).

5. CONCLUSIONS AND RECOMMENDATIONS

One key conclusion of this study is that there is a lack of knowledge and awareness among school students and school teachers that needs to be immediately and effectively addressed. Moreover, social norms and beliefs, culture, and societal values are of crucial importance when crafting new public policies and need to be understood and embedded in any framework of solutions. Mass media and social media are becoming more and more influential on the behavior and values of young citizens so new measures are therefore needed to utilize opportunities in the digital world. Public education needs to be interactive, contemporary, and able to accommodate emerging problems and effectively deal with challenges and societal difficulties.

My main recommendation to the Jordanian government and the education authorities is the establishment of a comprehensive, dynamic, interactive and inclusive RE and environmental public education strategy. All stakeholders, governmental staff members and officials, religious clerics, NGO members and leaders, school students and teachers, and rural housewives, must be informed, educated, and trained in all available communication means and in all available learning settings. The main objectives are to elevate public awareness of renewable energy and encourage decentralized clean energy development actions. It must also embrace objectives for resource management and energy and water conservation measures at the household level. A well-crafted education policy will foster economic development by linking the education outcomes with the market needs, for example, by providing more skilled people in the field of RE development. It will also reduce the unemployment rate and boost the economy by exporting local expertise to neighboring countries and thus increase the flow of remittances back to Jordan. It will help address the population growth challenge by empowering women and by increasing gender equity. In her inauguration speech at the Abu Dhabi Media Summit 2014, HM Queen Rania Al Abdulla of Jordan stressed the need for a modern and improved education strategy to combat terrorism and create new employment opportunities to empower young Arab people. She further

stressed that the education strategy to be crafted should be long-term and should start with a comprehensive and inclusive qualitative education for all. She also highlighted the urgent need for Arab women education and to improving their skills to positively influence the future generations. She added that female education leads to economic development, improved child care, and empowers societies against radicalism and extremism. Our recommendations are in line with Her Majesty's viewpoints and our work sheds further light on which aspects should be included in new education policies and strategies.

My recommendations are presented to each interest group separately as follows:

Recommendations for **policymakers**, **decision makers, and leaderships**

- Laws, regulations, and fiscal incentives for energy efficiency and energy saving in all vital sectors are essential and must be aligned with policies and incentives for renewable energy development.
- New policies for elevating public awareness of renewable energy and energy conservation is immediately required. Mass media must be deployed with consistent, transparent, and easy- to- understand messages.
- Objectively work toward removing disputes and controversies in mass media, and among ordinary citizens, regarding the future choices of the energy system (renewables instead of nuclear).
- Successful energy policies from other countries, such as the Renewable Energy Resources Act from Germany can be adopted as a model for policy development and implementation.

Recommendations for the **education authorities in Jordan** are:

- Revisit the current public education policies and accentuate environmental awareness and renewable energy development as a new means for sustainable societies.
- Find a gender balance by removing masculine values in the school curricula.
- Empower females with knowledge, skills, and tools to become pacesetters to assist society in addressing and tackling challenges such as population growth.
- Establish household training programs for females to learn more how to conserve energy and water.
- Develop a new school curriculum with a title such as Renewable Energy Sciences.
- Include renewable energy applications in vocational training at the upper secondary school level to provide technicians with the necessary skill sets.
- Provide secondary school teachers with training courses and workshops to elevate their knowledge of renewable and clean energy technologies.
- Provide schools with financial resources to help teachers link the students with real life examples of renewable energy, such as wind turbine and PV demonstration sites.
- Develop renewable energy education at the university level and at all levels with sufficient resources and expertise.
- Provide scholarships for elite and ambitious students for higher education in renewable energy in European institutions as part of long term planning to improve local knowledge of renewable energy.

Recommendations for the **NGOs**

- Assist local associations that exist in almost every village in Jordan to adopt small-scale and decentralized renewable energy development projects by educating the leaders and members of these associations.

- Create economic opportunities through encouraging roof-top solar water heater (SWH) or organic waste collection, and water harvesting for all society (village) members through incentives and/or via monthly installments.
- Provide training for illiterate housewives and modern homemakers to elevate their awareness of the benefits of SWHs for example.

A general recommendation for all **Arab states** arose from this study:

Modern public education must be prioritized immediately as a national strategy and equipped with sufficient resources. Cutting military expenditure, abolishing, at least partially, fossil fuel subsidies, ensuring gender equity in the school curricula and empowering young females could help navigate the pathway towards sustainable and developmental states. Successful public education strategies will help address pressing challenges, such as population growth, consumerism, energy and water conservation, and radicalism.

6. FUTURE RESEARCH LINES

This study has opened new channels for research in environmental social sciences. For instance, knowledge and attitudes regarding renewable energy and environmental challenges among rural women and homemakers, and religious clerics is of great interest. Religious clerics, Muslim and Christian alike, play a pivotal role in changing people's behaviors and attitudes, especially in Muslim societies. Exploring their attitudes and elevating their awareness will in turn assist in crafting successful public education policies. Another important line of research involves the level of knowledge of policymakers and their attitude toward renewable energy. A high level of understanding by policymakers in regard to renewables and their environmental and economic benefits may help boost renewable energy development and drive efforts away from nuclear power. Another equally important research need, therefore, involves an exploration of the publics' knowledge and attitude toward nuclear power.

7. REFERENCES

Al-Rousan A., Zyadin A. (2014). A Technical Experiment on small-scale Biogas Production from Dairy Farm. Journal of Sustainable Bioenergy Systems. Journal of Sustainable Bioenergy Systems 2014; 4: 10-18. http://dx.doi.org/10.4236/jsbs.2014.41002

Ajzen I. (1991). The theory of planned behaviour. Organizational Behavior and Human Decision Processes 50 (2): 179–211. http://dx.doi.org/10.1016/0749-5978(91)90020-T

AL-Sa'd A. (2007). Evaluation of Students' attitudes towards vocational education in Jordan. Doctoral Thesis, Malmö Studies in Educational Sciences No. 32, Holmbergs, Malmö.

Aslanidou S., Menexes G. (2008). Youth and the Internet: Uses and practices in the home. Computers & Education 51:1375–1391. http://dx.doi.org/10.1016/j.compedu.2007.12.003

Assef G., Frostell B. (2007). Social sustainability and social acceptance in technology assessment: A case study of energy technologies. Technology in Society 29: 63–78. http://dx.doi.org/10.1016/j.techsoc.2006.10.007

Attari S.Z., Dekay M.L., Davidson C.L., De Bruin W.B. (2010). Public perceptions of energy consumption and savings. PNAS 107(37): 16054–16059. http://dx.doi.org/10.1073/pnas.1001509107

Bamberg S., Schmidt S. (1999). Regulating transport: behavioral changes in the field. Journal of Consumer Policy, 22, 479–509. http://dx.doi.org/10.1023/A: 1006391723214

Bamberg S., Möser G. (2007). Twenty years after Hines, Hungerford, and Tomera: a new meta-analysis of psycho-social determinants of pro-environmental behavior. Journal of Environmental Psychology 27: 14–25. http://dx.doi.org/10.1016/j.jenvp.2006.12.002

Barr S. (2007). Factors Influencing Environmental Attitudes and Behaviors: A U.K. Case Study of Household Waste Management, Environment and Behavior 39(4): 435-473. http://dx.doi.org/10.1177/0013916505283421

Bloomberg New Energy Finance. (2014). Global Trends in Renewable Energy Investments 2014. Frankfurt School of Finance & Management. http://www.fs-unep-centre.org [Cited 10 August 2014].

Brown T.C., Champ P.A., Bishop R.C., McCollum D.W. (1996). Which response format reveals the truth about donations to a public good? Land Economics 72 (2): 152–166.

Carlsson F., Johansson-Stenman O. (2000). Willingness to pay for improved air quality in Sweden. Applied Economics 32(6): 661–669. http://dx.doi.org/10.1080/000368400322273

Cohen J.J., Reichl J., Michael Schmidthaler M. (2014). Re-focusing research efforts on the public acceptance of energy infrastructure: A critical review. Energy 67: 4–9. http://dx.doi.org/10.1016/j.energy.2013.12.056

Crano W. D., Prislin R. (2006). Attitudes and persuasion. Annual Review of Psychology 57: 345–374. http://dx.doi.org/10.1146/annurev.psych.57.102904.190034

De Groot J.I.M., Steg L. (2007). Value orientations and environmental beliefs in five countries: validity of an instrument to measure egoistic, altruistic and biospheric value orientation. Journal of Cross-Cultural Psychology 38:318-332. http://dx.doi.org/10.1016/j.jenvp.2010.04.002

De Groot J.I.M., Steg L (2010). Relationships between value orientations, self-determined motivational types and pro-environmental behavioral intentions. Journal of Environmental Psychology 30: 368-378. http://dx.doi.org/10.1016/j.jenvp.2010.04.002

Devine-Wright P. (2004). Towards zero-carbon: Citizenship, responsibility and the public acceptability of sustainable energy technologies' in Buckle C. (ed). Proceedings of Conference C81 of the Solar Energy Society, UK Section of the International Solar Energy Society, 21 September, London, pp51–62

Devine-Wright P. (2007). Energy Citizenship: Psychological Aspects of Evolution in Sustainable Energy Technologies. In: Murphy J. (ed). Governing Technology for Sustainability. London, UK: Earthscan, pp. 63-89.

DeWaters J.E., Powers S.E. (2011). Energy literacy of secondary students in New York State (USA): A measure of knowledge, affect, and behavior. Energy Policy 39:1699–1710. http://dx.doi.org/10.1016/j.enpol.2010.12.049

Dias R.A., Mattos C.R., Balestieri J.A.P.(2004). Energy education: breaking up the rational energy use barriers.Energy Policy 31: 1339–1347. http://dx.doi.org/10.1016/S0301-4215(03)00100-9

DoS (Department of Statistics). (2013). Annual Report 2012. http://www.dos.gov.jo/dos_home_e/main/index.htm [Cited July 2014].

Dunlap R. E., Van Liere K. D., Mertig A. G., Jones R. E. (2000). Measuring endorsement of the new ecological paradigm: a revised NEP scale. Journal of Social Issues, 56(3): 425–442. http://dx.doi.org/10.1111/0022-4537.00176/pdf

Dupont D.P.(2004). Do children matter? An examination of gender differences in environmental valuation. Ecological Economics 49: 273–286. http://dx.doi.org/10.1016/j.ecolecon.2004.01.013

Fabrigar L.R., MacDonland T.K., Wegener D.T. (2005). The structure of attitudes. In Albarracín D., Johnson B.T., Zanna M.P. (eds). The handbook of attitudes. Mahwah, NJ: Lawrence Erlbaum.

García-Valinas M.A., Macintyre A., Torgler B. (2012). Volunteering, pro-environmental attitudes and norms. The Journal of Socio-Economics 41: 455– 467. http://dx.doi.org/10.1016/j.socec.2011.07.001

GEA. Global Energy Assessment. (2012). Toward a Sustainable Future. Cambridge, Cambridge University Press and International Institute for Applied Systems Analysis.

George R., Kaplan D. (1998). A structural model of parent and teacher influences on science attitudes of eighth grades: evidence from NELS: 88. Journal of Science Education 82: 93–109.

Guivarch C., Hallegatte S. (2013). 2°C or not 2°C? Global Environmental Change 23 (1): 179-192.

Ha-Duong M., Nadaï A., Campos A.S. (2009). A survey on the public perception of CCS in France. International Journal of Greenhouse Gas Control 3:633–640. http://dx.doi.org/10.1016/j.ijggc.2009.05.003

Halder P., Pietarinen J., Havu-Nuutinen S., Pelkonen P. (2010). Young citizens' knowledge and perceptions of bioenergy and future energy implications. Energy Policy 38:3058–3066. http://dx.doi.org/10.1016/j.enpol.2010.01.046

Halder P., Nuutinen S., Pietarinen J., Pelkonen P. (2011). Bioenergy and the youth: analyzing the role of school, home, and media from future policy perspectives. Applied Energy 88 (4): 1233–1240. http://dx.doi.org/10.1016/j.apenergy.2010.10.017

Halder P., Sari Havu-Nuutinen S., Janne Pietarinen J., Anas Zyadin A., Pelkonen P. (2014). Subject Knowledge and Perceptions of Bioenergy among School Teachers in India: Results from a Survey. Resources 3:599–613. http://dx.doi.org/10.3390/resources3040599

Harland, P., Staats, H., Wilke, H. (1999). Explaining pro environmental behavior by personal norms and the theory of planned behavior. Journal of Applied Social Psychology 29: 2505–2528. http://dx.doi.org/10.1111/j.1559-1816.1999.tb00123.x

Hrayshat E. (2007). Analysis of renewable energy situation in Jordan. Renewable and Sustainable Energy Reviews 8(11): 1873–1887. http://dx.doi.org/10.1016/j.rser.2006.01.003

IEA. International Energy Agency. 2013. World Energy Outlook 2013. http://www.worldenergyoutlook.org/publications/weo-2013/ [Cited 20 July 2014].

IEA. International Energy Agency. (2013). Tracking Clean Energy Progress 2013. www.iea.gov [Cited July 2014].

IFC. International Finance Corporation. (2012). From Gap to Opportunity: Business Models for Scaling Up Energy Access. International Finance Corporation, Washington DC, USA.

www.ifc.org.
http://www.ifc.org/wps/wcm/connect/corp_ext_content/ifc_external_corporate_site/home [Cited June 2013].

Jenkins E.W., Pell R.G. (2006). Me and the environmental Challenges: A survey of English secondary school students' attitudes towards the environment. International Journal of Science Education 28 (7): 765-780.
http://dx.doi.org/10.1080/09500690500498336

Jennings P. (2009). New directions in renewable energy education. Renewable Energy 34:435-339.
http://dx.doi.org/10.1016/j.renene.2008.05.005

Junginger M., Goh C.S., Faaij A. (Eds.). (2014). International Bioenergy Trade: History, status & outlook on securing sustainable bioenergy supply, demand and markets. Springer Science+Business Media Dordrecht, ISBN 978-94-007-6981-6.

Kaiser F. G., Gutscher H. (2003). The proposition of a general version of the theory of planned behaviour (TPB): predicting ecological behaviour. Journal of Applied Social Psychology 33: 586–603.
http://dx.doi.org/10.1111/j.1559-1816.2003.tb01914.x

Kandpal T.C., Broman L. (2014). Renewable energy education: A global status review. Renewable and Sustainable Energy Reviews 34: 300–324.
http://dx.doi.org/10.1016/j.rser.2014.02.039

Kabatilo F. (2014). Democratization processes and the democratic culture in the Arab Countries: The case of Jordan. Dissertation in the Social Sciences and Business Studies No 86. University of Eastern Finland, Faculty of Social Sciences and Business Studies.

Karatepe Y., Nes SV., Keçebas A., Yumurtac M. (2012). The levels of awareness about the renewable energy sources of university students in Turkey. Renewable Energy 44:174–179.
http://dx.doi.org/10.1016/j.renene.2012.01.099

Khoury R. (2013). The Epic Arab Trek between God and Gun. Agence global.
http://www.middle-east-online.com/english/?id=60527 [Cited July 2014].

Kılınc A., Stanisstreet M., Boyes E. (2009). Incentives and disincentives for using renewable energy: Turkish students' ideas. Renewable and Sustainable Energy Reviews 13:1089–1095.
http://dx.doi.org/10.1016/j.rser.2008.03.007

Kollmuss A., Agyeman J. (2002). Mind the gap: why do people act environmentally and what are the barriers to pro-environmental behavior? Environmental Education Research 8: 239-260.
http://dx.doi.org/10.1080/13504620220145401

Konisky D.M., Milyo J., Richardsson Jr.,L.E. (2008). Environmental policy attitudes: issues, geographical scale, and political trust. Social Science Quarterly 89 (5): 1066–1085.
http://dx.doi.org/10.1111/j.1540-6237.2008.00574.x

Liarakou G., Gavrilakis C., Flouri E. (2008). Secondary school teachers' knowledge and attitudes towards renewable energy sources. Journal of Science Education and Technology 18:120–129.
http://dx.doi.org/10.1007/s10956-008-9137-z

Liebe U., Preisendörfer P., Meyerhoff J. (2011). To Pay or Not to Pay: Competing Theories to Explain Individuals' Willingness to Pay for Public Environmental Goods. Environment and Behavior 43(1) 106–130.
http://dx.doi.org/10.1177/0013916509346229

Malkki H., Kari Alanne K., Hirsto L. (In Press). A method to quantify the integration of renewable energy and sustainability in energy degree programmes: a Finnish case study. Journal of Cleaner Production 1–8.
http://dx.doi.org/10.1016/j.jclepro.2014.10.012

Martinsson J., Lundqvist L.J., Sundström A. (2011). Energy saving in Swedish households. The (relative) importance of environmental attitudes. Energy Policy 39: 5182-5191. http://dx.doi.org/10.1016/j.enpol.2011.05.046

Massadeh N. (2012). Higher Education and its Privatization: An analytical Case Study on Jordan from a Historical Perspectives. Eobanus Verlag UG, Erfurt, Germany. ISBN 978-3-9814241-5-7

MEMR (Ministry of Energy and Natural Resources). Legislations.
http://www.memr.gov.jo/Default.aspx?alias=www.memr.gov.jo/english [Cited January 2015].

Milfont T. L., Duckitt J. (2010). The environmental attitudes inventory: A valid and reliable measure to assess the structure of environmental attitudes. Journal of Environmental Psychology 30: 80-94.
http://dx.doi.org/10.1016/j.jenvp.2009.09.001

Ngar-yinMah D., Van der Vleuten J.M., Hills P., Tao J. (2012). Consumer perceptions of smart grid development: Results of a Hong Kong survey and policy implications Energy Policy 49:204–216.
http://dx.doi.org/10.1016/j.enpol.2012.05.055

Ntona E., Garyfallos Arabatzis G., Kyriakopoulos, GL. (2015). Energy saving: Views and attitudes of students in secondary education. Renewable and Sustainable Energy Reviews 46:1–15.
http://dx.doi.org/10.1016/j.rser.2015.02.033

Owen A.L., Videras J. (2006). Civic cooperation, pro-environment attitudes, and behavioural intentions. Ecological Economics 58: 814-829.
http://dx.doi.org/10.1016/j.ecolecon.2005.09.007

Owens S., Driffill L. (2008). How to change attitudes and behaviours in the context of energy. Energy Policy 36:4412–4418.
http://dx.doi.org/10.1016/j.enpol.2008.09.031

Panwara N.L., Kaushikb S.C., Kotharia S. (2011). Role of renewable energy sources in environmental protection: A review. Renewable and Sustainable Energy Reviews 15:1513–1524.
http://dx.doi.org/10.1016/j.rser.2010.11.037

Pasqualetti M. J. (2000). Morality, space and the power of wind-energy landscapes. The Geographical Review 90:381–394.
http://dx.doi.org/10.1111/j.1931-0846.2000.tb00343.x

Pelkonen P., Mustonen M., Asikainen A., Egnell G., Kant P., Leduc S., Pettenella D. (Eds). (2014). Forest Bioenergy for Europe. European Forest Institute, ISBN 978-952-5980-11-0. www.efi.int [Cited January 2015].

Pooley J.A., and O'Connor M. (2000). Environmental Education and Attitudes: Emotions and Beliefs are what is Needed, Environment and Behavior 32: 711-723. http://dx.doi.org/10.1177/0013916500325007

Practical Action. (2013). Poor people's energy outlook 2013: Energy for community services, Rugby, UK: Practical Action Publishing. www.practicalactionpublishing.org [Cited 27 July 2014].

Qin W., Brown J.L. (2007). Public reactions to information about genetically engineered foods: effects of information formats and male/female differences Public Understanding of Science 16: 471–488.
http://dx.doi.org/10.1177/0963662506065336

Richards G., Noble B., Belcher K. (2012). Barriers to renewable energy development: A case study of large-scale wind energy in Saskatchewan, Canada. Energy Policy 42:691–698. http://dx.doi.org/10.1016/j.enpol.2011.12.049

Roy R., Caird S., Stephen P. (2007). People centred eco-design: consumer adoption of low and zero carbon products and systems. In: Murphy J. ed. Governing Technology for Sustainability. London, UK: Earthscan, pp. 41–62.

Sampei Y., Usui M.A.(2009). Mass-media coverage, its influence on public awareness of climate-change issues, and implications for Japan‘s national campaign to reduce greenhouse gas emissions. Global Environmental Change 19: 203–212. http://dx.doi.org/10.1016/j.gloenvcha.2008.10.005

Sanchez M.J., Lafuente R. (2010). Defining and measuring environmental consciousness. Revista Internacional de Sociología, 68 (3), 731–755.
http://dx.doi.org/10.3989/ris.2008.11.03

Scheer H. (2012). The energy imperative: 100 per cent renewables now. Earthscan, New York, ISBN 978-1-84971-433-4.

Schwartz S. H., Howard J. A. (1981). A normative decision-making model of altruism. In J. P. Rushton (Ed.), Altruism and helping behaviour: Social, personality and developmental perspectives (pp. 189–211). Hillsdale, NJ: Erlbaum.

Schwarz N. (2012). Attitudes Measurement. In. Crano W.D., Prislin R. (eds). Attitudes and Attitude Change. Frontier of Social Psychology, Psychology Press, Taylor & Francis Group, London.

Seitz J.L., Hite K.A. (2012). Global Issues, an Introduction. Wiley-Blackwell, 4th Edition, New York. ISBN 978-0-470-65564-1.

Shen J., Saijo T. (2007). Re-examining the relations between socio demographic characteristics and individual environmental concern: evidence from Shanghai data. Journal of Environmental Psychology 28:42–50.
http://dx.doi.org/10.1016/j.jenvp.2007.10.003

Siegrist M., Sütterlin B., Keller C. (2014). Why have some people changed their attitudes toward nuclear power after the accident in Fukushima? Energy Policy 69: 356–363. http://dx.doi.org/10.1016/j.enpol.2014.02.026

Simona N.O., Alkemade F., Marko P.H. (2012).Why does renewable energy diffuse so slowly? A review of innovation system problem. Renewable and Sustainable Energy Reviews 16:3826–3846.
http://dx.doi.org/10.1016/j.rser.2012.03.043

Sovacool B.K. (2009). The cultural barriers to renewable energy and energy efficiency in the United States. Technology in Society 3:365–373.
http://dx.doi.org/10.1016/j.techsoc.2009.10.009’

Spiropoulou D., Antonakaki T., Kontaxaki S., Bouras S. (2007). Primary teachers’ literacy and attitudes on education for sustainable development. Journal of Science Education and Technology 16:443–50.
http://dx.doi.org/10.1007/s10956-007-9061-7

Steg L., Vlek C. (2009). Encouraging pro-environmental behaviour: An integrative review and research agenda. Journal of Environmental Psychology 29: 309–317. http://dx.doi.org/10.1016/j.jenvp.2008.10.004

Stern P. (2000). Toward a coherent theory of environmentally significant behaviour. Journal of Social Issues, 56:407-424.
http://dx.doi.org/10.1111/0022-4537.00175

Stigka E.K., Paravantis J., Mihalakakou G.K. Social acceptance of renewable energy sources: A review of contingent valuation applications. (2014). Renewable and Sustainable Energy Reviews 32: 100–106.
http://dx.doi.org/10.1016/j.rser.2013.12.026

Stoutenborough J.M., Sturgess S.G., Vedlitz A. (2013). Knowledge, risk, and policy support: Public perceptions of nuclear power. Energy Policy 62: 176–184. http://dx.doi.org/10.1016/j.enpol.2013.06.098

Strack F., Schwarz N. (2007). Asking questions: Measurement in the social sciences. In M. Ash & T. Sturm (Eds.), Psychology's territories: Historical and contemporary perspectives from different disciplines (pp. 225–250). Mahwah, NJ: Erlbaum.

Torgler B. (2006). The Importance of faith: Tax morale and religiosity. Journal of Economic Behavior and Organization 61: 81–109.
http://www.crema-research.ch/papers/2003-08.pdf

Torgler B., García-Valiñas M.A. (2007). The determinants of individuals' attitudes towards preventing environmental damage. Ecological Economic 63: 536 – 552. http://dx.doi.org/10.1016/j.ecolecon.2006.12.013

Trumper R., Raviolo A., Shnersch A.M. (2000). A cross-cultural survey of conceptions of energy among elementary school teachers in training – empirical results from Israel and Argentina .Teaching and Teacher Education 16: 697– 714. PII:S0742- 051X(00)00020-2

UNDP. (United Nations Development Programme). (2011). Arab Development Challenges Report 2011: Towards the Developmental State in the Arab Region, United Nations Development Programme, 2011. www.undp.org [Cited February 2013].

United Nations News Centre. (2013). "At Stanford University, Ban offers direction on navigating a world in transition".
http://www.un.org/apps/news/story.asp?NewsID=43950&Cr=development&Cr1=#.VLeU3yuUdnV [Cited January 2015].

US. Department of Energy. (2014). Energy Literacy: Essential Principles and Fundamental Concepts for Energy Education. A Framework for Energy Education for Learners of All Ages. Washington, DC 20585.
http://eere.energy.gov/education/energy_literacy.html [Cited July 2014].

Uusimaki L., Turunen T.A. (2013). Teacher education: Keeping up with the Finns: An interview with Dr. Tuija Turunen. Interviewer: Liisa Uusimaki. International HETL Review, Volume 3, Article 3, http://www.hetl.org/interview-articles/keeping-up-with-the-finns/

Van der Horst D. (2007). NIMBY or not? Exploring the relevance of location and the politics of voiced opinions in renewable energy siting controversies. Energy Policy 35:2705–14. http://dx.doi.org/10.1016/j.enpol.2006.12.012

Vicente P., Reis E. (2008). Factors influencing households' participation in recycling. Waste Management Research 26 (2): 140–146.
http://dx.doi.org/10.1177/0734242X07077371

Wustenhagena R., Wolsink M., Burer M.J. (2007). Social acceptance of renewable energy innovation: An introduction to the concept. Energy Policy 35: 2683–2691. http://dx.doi.org/10.1016/j.enpol.2006.12.001

Yazdanpanah M., Komendantova N., Ardestani RS. (2015). Governance of energy transition in Iran: Investigating public acceptance and willingness to use renewable energy sources

through socio-psychological model. Renewable and Sustainable Energy Reviews 45: 565–573.
http://dx.doi.org/10.1016/j.rser.2015.02.002

Yuan X., Zuo J.,Chun yuan Ma C.Y. (2011). Social acceptance of solar energy technologies in China—End users' perspective. Energy Policy 39: 1031–1036. http://dx.doi.org/10.1016/j.enpol.2011.01.003

Zelezny L.C., Chua P., Aldrich C. (2000). New Ways of Thinking about Environmentalism: Elaborating on gender differences in environmentalism. Journal of Social Issues 56: 443–457.
http://dx.doi.org/10.1111/0022-4537.00177

Zsóka, Á., Szerényi. Z.M., Széchy, A., Kocsis, T. (2013). Greening due to environmental education? Environmental knowledge, attitudes, consumer behavior and everyday pro-environmental activities of Hungarian high school and university students. J Cleaner Product 48:126–38.
http://dx.doi.org/10.1016/j.jclepro.2012.11.030

Zyadin A. (2013). Water Shortage in MENA Region: An Interdisciplinary Overview and a Suite of Practical Solutions. Journal of Water Resource and Protection 5: 49–58. http://dx.doi.org/10.4236/jwarp.2013.54A008

Zyadin A., Halder P., Kähkönen T., Puhakka A. (2014). Challenges to Renewable Energy Development; A bulletin of perceptions from international academic arena. Renewable Energy 69: 82–88.
http://dx.doi.org/10.1016/j.renene.2014.03.029

8. APPENDIXES

School student's questionnaire and Secondary school teacher's questionnaire (English).

Appendix: School Students Questionnaire

Section (1) source of information
1.1 please determine how important the following sources to get energy-related information? Mark (X)

Source	Nothing	Weak	Good	Excellent
1- Friends				
2- Parents				
3- Internet				
4- Television and satellite				
5- Radio				
6- Newspapers and magazines				
7- School curricula				
8- School activities				
9- School teachers				

1.1 please indicate the level of your agreement to the following statements? Please mark (X)

Statement	Strongly disagree	disagree	Don't know	agree	Strongly agree
It's the government's duty to protect the environment					
Only developed countries should protect the environment					
The people should care more to protect the environment					
only science and technology can protect the environment					
The environmental problems are not my business					

1.3 My level of information about environmental problems in Jordan is?

Very good good don't know poor very poor

Section (2) renewable energy
2.1 Which of the following is considered a renewable source?

Energy source	Yes	No
Fossil fuel		
Coal		
Sun power		
Wind power		
Geothermal power		
Nuclear power		
Natural gas		

2.2 indicate the level of agreement to the following statements (mark (X) in the box you choose

Argument	Strongly disagree	disagree	Don't know	agree	Strongly agree
Sunshine can be used to produce electricity					
Wind turbines are used to harvest the wind energy and convert it to electricity					
Geothermal energy is the utilization of the radioactive heat of the earth magma					
Bioenergy is the energy produced from processing the plant residues					
Biodiesel is produced from plant oils					
Bioethanol is a form of energy can be produced from plant residues					
Organic wastes can be used to produce energy in form of gas and liquid					

2.3 How the growing energy consumption will be met in the future, indicate (X) in the box that suits your answer

Argument	Strongly disagree	disagree	Don't know	agree	Strongly agree
Oil and natural gas import					
Utilize the oil shale resources					
Utilize the renewable energy sources					
Utilize the organic wastes to produce energy					
Build nuclear power					

2.4 indicate the level of agreement to the following statements (mark (X) in the box you choose

Argument	Strongly disagree	disagree	Don't know	agree	Strongly agree
I would like to join an environmental society					
I would like to do voluntary work to protect the environment					
In the future, I would like to pay tax to protect the environment					
In the future, I would like to pay tax to receive energy from renewable source					

2.3 My knowledge about renewable energy is?

Very good Good I don't know Poor very poor

Section (3) personal information

Your gender **Male** **Female**

Your Age. …(years)……

3.2 Please choose the level of your father's education? *Please circle one answer*

University degree Diploma degree High school primary school I don't know

3.3 Please choose the level of your mother's education? *Please circle one answer*

University degree **Diploma degree** **High school** **primary school** **I don't know**

3.4 3.4 I live with my parents in

Split house in urban area split house in rural area apartment in urban area Bedouin tent

3.5 number of rooms in my parents' house excluding the kitchen and the living room

one room two rooms three rooms four rooms I don't know

3.6 I have ……..**brothers and** …….**sisters**

Why do you think people do not care about the environment? Optional …

Appendix 2: Secondary School Teachers Questionnaire

Question one: Demographic and teaching profile

1- A- Sex: ☐ Male ☐ Female Your age ( ) years Marital status

……...

2- Your teaching experience **(** **)** years Number of teaching hours per week……

3- Number of schools you have taught in**:** ……

4- Subjects you teach to students often (1)…… (2)……..……

5- Highest education you have received (including current studies) *please tick one*

☐ High school ☐ Society college diploma ☐ Bachelor degree ☐ Master degree

6- Grades you currently teach ☐ High school and Tawjihi ☐ High school only ☐ Tawjihi only

Question two: please mark 'X' to one option for each of the presented energy items in the table below.

Energy Item	Produced in Jordan?		Renewable	Not-Renewable	I am not sure	Never heard of
	Yes	No				
Solar			☐	☐	☐	☐
Nuclear power			☐	☐	☐	☐
Wind			☐	☐	☐	☐
Coal			☐	☐	☐	☐
Fire wood			☐	☐	☐	☐
Hydro			☐	☐	☐	☐
Natural gas			☐	☐	☐	☐
Oil			☐	☐	☐	☐
Ocean tides			☐	☐	☐	☐

Question three: The following questions contain 10 statements with four options available for you to choose from. Please read the statement carefully and decide which option to choose by marking 'X' in the small square.

Statements category I	True	False	I am not sure	Never heard of
Solar panel is used to concentrate sun waves to heat up water for household use	☐	☐	☐	☐
Photovoltaic is an advanced technology used to covert wind energy to electricity	☐	☐	☐	☐
Windmill is an example of converting wind energy to electrical energy	☐	☐	☐	☐
Hotsprings are a form of geothermal energy	☐	☐	☐	☐
Biodiesel is a fuel produced from plant oils only	☐	☐	☐	☐
Municipal sewage wastes can be processed to produce bio-gas	☐	☐	☐	☐
Less than 50 % of primary energy production in Jordan is through imported fossil fuels	☐	☐	☐	☐
Fire wood is main source of energy in many developing countries	☐	☐	☐	☐
The global energy demand is projected to decrease in the future	☐	☐	☐	☐
CO_2 emissions-from burning fossil fuel- is one cause of climate change	☐	☐	☐	☐

Question four: you have statements in the table below, please read the statement and indicate to which extent you agree or disagree with them. Please mark 'X' in the corresponding small square.

Statements category II	Fully agree	Agree	I am not Sure	disagree	Fully disagree
Developing renewable energy in Jordan will create energy independence in the long-run	☐	☐	☐	☐	☐
Growth in renewable energy sector can enhance economic growth in Jordan	☐	☐	☐	☐	☐
Renewable energy utilization is currently an expensive economic strategy in Jordan	☐	☐	☐	☐	☐
Nuclear power plant deemed viable energy option for Jordan in the next ten years	☐	☐	☐	☐	☐
The discovered oil shale resources will be the future of energy production in Jordan	☐	☐	☐	☐	☐
The lack of local experts may hinder the large scale development of renewable energy in Jordan	☐	☐	☐	☐	☐
Renewable energy development require large land area	☐	☐	☐	☐	☐
The production of biofuels (such as bioethanol) from agricultural crops may create food crisis in some developing countries	☐	☐	☐	☐	☐

In some developed countries, a part of energy is commercially produced from combusting forest biomass. This type of energy production is environmentally friendly	☐	☐	☐	☐	☐

Question five: you have statements in the table below, please read the statement and indicate to which extent you agree or disagree with them. Please mark X in the corresponding small square.

Statements category III	**Fully agree**	**Agree**	**I am not Sure**	**disagree**	**Fully disagree**
I feel I do not have sufficient knowledge to teach energy related topics to my students	☐	☐	☐	☐	☐
I need further training to develop my skills in teaching energy related topics	☐	☐	☐	☐	☐
I would like to learn more about renewable energy	☐	☐	☐	☐	☐
I need better teaching materials related to renewable energy	☐	☐	☐	☐	☐
I need to invite experts from (university, company, etc.) to teach my students about renewable energy	☐	☐	☐	☐	☐
I need financial resources to take students for excursions to renewable energy pilot-projects	☐	☐	☐	☐	☐
I have no time to teach my students topics outside the required curricula	☐	☐	☐	☐	☐
I recommend developing renewable energy curricula to be taught separately for students	☐	☐	☐	☐	☐
I think parents are more important than teachers in helping students to become energy conscious	☐	☐	☐	☐	☐
I think, There are opportunities to include topics related to renewable energies in the present school science curricula	☐	☐	☐	☐	☐
I am willing to pay more to receive clean energy at my home	☐	☐	☐	☐	☐
I would like to work voluntarily to raise public awareness of renewable energy in Jordan	☐	☐	☐	☐	☐
In future, I would like to drive a car that runs by electricity instead of gasoline	☐	☐	☐	☐	☐
I would like to install a solar panel at my home	☐	☐	☐	☐	☐
Renewable energy is, indeed, not of my interest	☐	☐	☐	☐	☐

Question six: my knowledge about renewable energy is\ please tick 'X' to one option.

☐ Good ☐ Sufficient ☐ weak ☐ I am not sure