BUSINESS STUDENTS' EVALUATION OF ENERGY SOURCES

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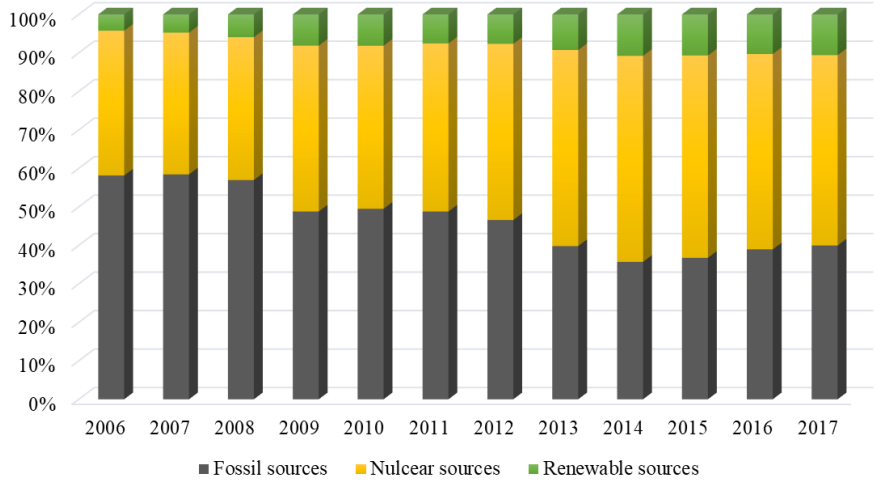
Abstract
Understanding the students' opinions about energy sources allows exploring the factors of acceptance. It can contribute to supporting the changes in energy production and utilization. Focus on business students must have an emphasis since they may be the company decision-makers in the future. The study analysis the return, availability, environmentally friendly nature, knowledge requirement of the application, and future role of some renewable energy sources and nuclear power. The sample consists of 150 randomly selected students. The results show the dominance of solar energy and the marginalization of biomass energy. The students' opinions differ from the professional approach on the energy sources that raise educational challenges.

Introduction
However, it is fundamentally agreed that the depletion of fossil energy sources is inevitably approaching, the changes are slow. Finding alternative energy sources is an important but multifaceted challenge. Energy dependence is a complex social and technical challenge of the present age [1].
According to Wolsink [2], both policymakers and researchers offer renewables to solve environmental problems. It must be preferred to fossil fuels and nuclear power. The European Union and the Hungarian government highlight and force renewables [3] [4]. Figure 1 shows the trends limited to electricity production as an example that underlines the restraint in fossil sources along with a high contribution of nuclear power.

Figure 1. The proportion of energy sources in the amount of electricity produced 2006-2017 (based on https://www.ksh.hu/thm/3/indi3_1_2.html)



The role of the nuclear way is questionable. In some opinions, renewable and nuclear energy are two plausible alternatives to fossil sources in energy production [5]. Busu [6] formulated the idea to reduce CO_2 emissions, and one of the solutions involves increasing the use of renewables. Both methods have several advantages and challenges, including the availability or social acceptance of the technology [7]. The effectiveness of nuclear energy production is obvious, but the advantages are limited to this life cycle phase. There are several risks to consider in a life-cycle approach, especially managing nuclear waste [8] [9]. Not incidentally, the impacts of nuclear accidents [10] are horrifying.
Beyond the technical and environmental issues, there are social and managerial considerations. Among these, the acceptance of technology is emphasized in our research. Related models [11] confirm the impact of background, knowledge level, intentions, and other factors. A higher level of acceptance of technology can boost up its application.

Experimental

The direct evaluation of energy generation technologies uses a pairwise comparison with five items (this means ten pairs of statements):

- biomass energy,
- nuclear energy,
- solar energy,
- hydropower,
- wind power.

The respondents are asked to make a pairwise comparison of the items from 5 perspectives:

- Return: In your opinion, which power generation technology has the highest financial return on investment?
- Availability: In your opinion, which technology is the most accessible?
- Environmentally friendly nature: In your opinion, which technology is environmentally friendly overall?
- Knowledge: In your opinion, which energy generation technology can be utilized more simply, in general, i.e., with less specialized knowledge?
- Future: In your opinion, which power generation technology will be the most decisive in the coming decades; which one will we use more?

The preferences are presented by the frequencies of ratings and a relative weight based on the eigenvector method of Saaty [12]. The consistency of the individual evaluations is checked by the Kendall method [13]. Weight calculation is limited to the cases with a perfect consistency that means a clear preference list of the respondents. The ratio of these cases is 70% for return, 78% for availability, 78% for environmentally friendly nature, 82% for knowledge, and 72.7% for the future role. Kendall's coefficient of concordance is calculated for measuring the group level consensus for pairwise comparison (v) [14]. The value is the study is expressed in percentages of the maximum available value.
The results are based on a voluntary online survey among business students of Hungarian higher education institutions. 150 randomly selected responses of the University of Miskolc are used for the analysis. The data collection period was the fall semester of 2020. The sample's representativeness is not checked; the study can be considered a pilot, and the interpretation of the conclusions cannot be generalized.

Results and discussion

The pairwise comparison allows a comprehensive assessment of the energy sources and the technology related to them. In a hypothetical case where an energy source is preferred over all

others by each respondent, its value in Table 1 was 100%. The table shows the agreement level by comparing the number of preferences to the maximum available value. The calculations are performed for the total sample and the respondents with a clear preference order (K=1).

Table 1 %

	return		**availability**		**environmentally friendly nature**		**knowledge**		**future**	
	Total	*K=1*	Total	*K=1*	Total	*K=1*	Total	*K=1*	Total	*K=1*
hydropower	46.8	*48.6*	48.7	*48.1*	49.7	*47.9*	53.3	*53.0*	33.7	*31.9*
solar energy	76.8	*80.2*	83.3	*87.8*	79.0	*81.8*	72.0	*73.8*	77.0	*81.0*
nuclear energy	37.8	*36.2*	22.5	*19.2*	6.5	*4.1*	14.3	*11.6*	48.8	*49.3*
wind power	54.7	*55.2*	57.0	*57.5*	64.0	*65.8*	67.0	*68.7*	48.7	*47.7*
biomass energy	33.8	*29.8*	38.5	*37.4*	50.8	*50.4*	43.3	*42.9*	41.8	*40.1*
group-level consensus		*21.3*		*35.1*		*46.0*		*27.9*		*19.5*

The dominance of solar energy is remarkable. It is considered the most important energy technology in each aspect of the evaluation. According to the future role, solar energy is followed by nuclear energy; however, in other aspects, it is undervalued. Wind power has a high acknowledgment by the respondents, but the installation of the turbines is legally limited. Biomass energy has a less relevant role.

In contrast, Žnidarec et al. [15] emphasize that solar, biomass, and geothermal (not included in the survey) potential is relevant in the region, while wind and hydropower potential is marginal. The students' evaluation is not in line with the professional opinion.

It is to note that the group level consensus is reflects shared opinions, especially on the future role and the return of the investment. The highest value is found in environmentally friendly nature.

The results of weight calculations are in Table 2. The normalized eigenvectors allow a ratio-scale comparison of the results within each evaluation aspect (by rows in the table). It is to note that a comparison between these is not feasible. The scores show the relative preferences of the respondents. The dominant role of solar energy is confirmed, especially in its availability, return, and future role. Figures 2 and 3 visualize the scores.

Table 2. Normalized weights calculated with the eigenvector method

	hydropower	**solar energy**	**nuclear energy**	**wind power**	**biomass energy**
return	0.249	0.890	0.174	0.317	0.125
availability	0.169	0.949	0.057	0.234	0.109
environmentally friendly nature	0.216	0.836	0.015	0.445	0.237
knowledge	0.334	0.692	0.051	0.600	0.216
future	0.119	0.922	0.250	0.210	0.171

Solar energy has subject to general optimism. Its availability, return, and future role monopolizes the opinions, while the utilization is considered simple. Access to wind power is considered similarly easy, but its future role is lower than even nuclear energy. Biomass energy is acknowledged the third in its environmentally friendly nature, but other aspects are evaluated

low. Figure 3 skips solar energy to show the differences of the evaluations on other energy sources more spectacularly.

Figure 2. Normalized weight scores by evaluation aspects

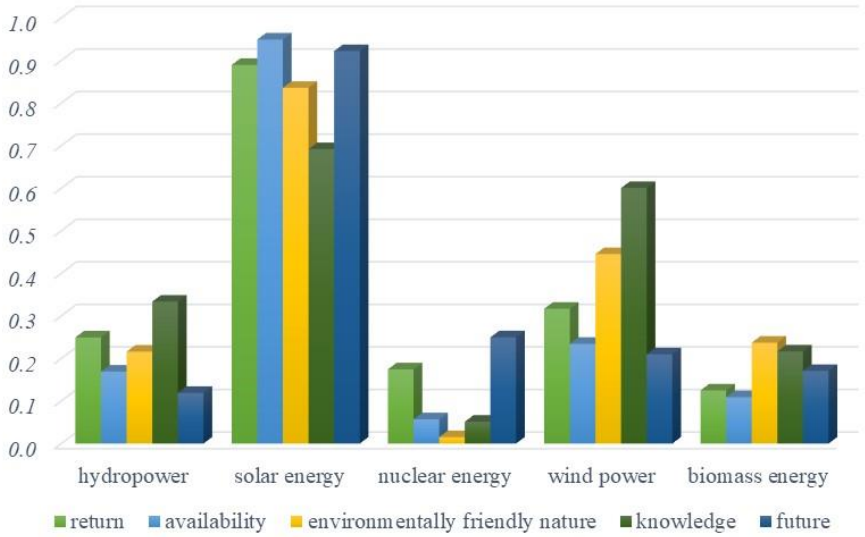
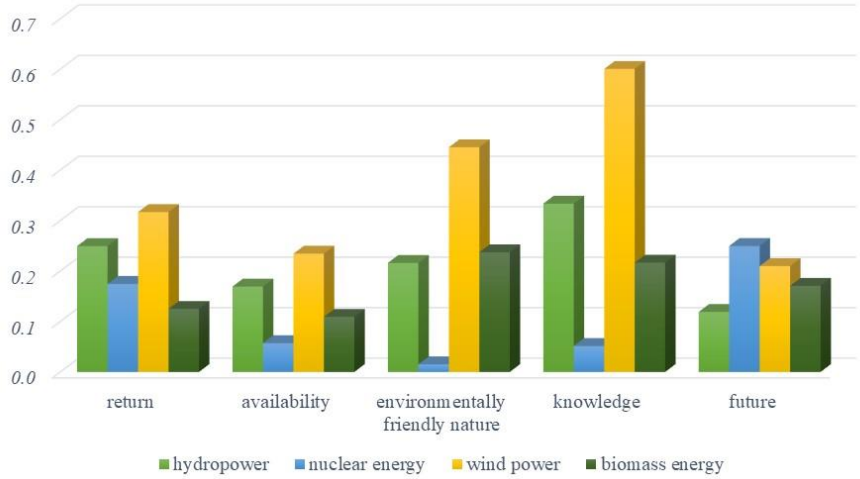


Figure 3. Normalized weight scores by energy sources, without solar energy



Conclusion

The results show the exceptional role of solar energy. Wind power is considered easy to apply, but its availability and future role are remarkably lower. Nuclear energy is found the least friendly to the environment and its return among the worst technologies, but there is confidence in its relevant future role compared to other energy sources.

Former results reported encouraging results on the future usage of renewable energy sources in Hungary [16] [17]. The backlog of knowledge on the topic was detectable, and it is confirmed in the present study. The students' evaluation and the professional opinions do not match.

Biomass energy must be mentioned as under-evaluated in each aspect of the analysis. Its role and opportunities are broader than imagined and expected by the business students. Since business students will become the decision-makers of companies or other institutions, the main implication of the study is giving a higher emphasis to teaching about energy issues.

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