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Potential analysis of new energy with emphasis on sustainable

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ABSTRACT

Given that fossil energy sources are scarce and their excessive use makes the environment vulnerable, their use as a fuel is unreasonable. In recent years, urban planners have been designing low-energy cities such as Masdar in the UAE. In a city like Tehran that is plagued by a variety of environmental problems, optimizing energy consumption in urban areas is a necessity. The purpose of this study was to evaluate the potential of renewable energy type In District 4 of Tehran and its applicability in different sectors to achieve sustainability. The research method is applied-developmental. The information is based on the documentation and field method. According to experts, the main variables of the research are considered three dimensions of solar, wind and geothermal energy. The data were collected by a questionnaire from a sample of 76 statistical experts. In the areas of functionality and productivity of each type of energy, the statistical analysis of PLS and in order to investigate the potential evaluation of feasible zones, in three main dimensions with 21 zones, T-test statistical model was used. Since Tehran's District 4 is large and has a variety of uses, Considering the results of the research, it is appropriate to start equipping specific land use (military, forestry, parks, industrial areas, etc.) to develop renewable energies as a first step. At the same time, the municipality, as the most important developer of this type of energy, along with the Renewable Energy Organization, should develop this part of the energy in public spaces such as passageways and so on.

Keywords— *Renewable Energy, Sustainable Development, District 4 Tehran, Urban Areas*

1. INTRODUCTION

The path taken today to use modern energy to achieve sustainable development goals can be seen as a scientific challenge for its realization in the new era. Today's cities, with their ever-expanding development, are large members of the energy consumer which Iran's metropolises are not exempt. Metropolis like Tehran with only 12% of the country, accounts for 15% of the level of air pollution in the country [1]. Paying attention to new approaches in the field of energy infrastructure and its kind in the future can be a viable solution to many bio-urban problems. Tehran according to the Tehran Electricity Distribution Company, it consumes about 20% of the country's total electricity consumes about 20% of electricity of the whole country. These statistics show that the need to paying attention to other aspects of energy production can be an inevitable necessity, as Tehran metropolis has serious problems with the supply and distribution of pollution in the energy production and consumption sector. Meanwhile, renewable energies as a sustainable solution in the field of energy production and pollution of urban air in recent years has received much attention. Renewable energies are energies with a sustainable production process and continuous replacement capability, which according to this definition, sustainable production process, is the use of natural or artificial cycles, which can continuously convert raw materials into the desired energy and can be continuously replaced if utilized or needed for storage [2].

Energy resources can be non-renewable or renewable; however, currently, the world is dominated by the usage of non-renewable energy such as fossil fuels. These are unsatisfactory because of their depletion and environmental concerns. For instance, currently, more than a half of the air pollution is contributed by energy globally. The use of non-renewable energy is considered the principal provider to climate change, which is about 60% of the total greenhouse gas emissions; therefore, decrease of carbon concentration is a key goal in long-term climate objectives [3,4]. Thus, the use of renewable energy is considered as alternative to the realization of sustainable development now and in the future. Furthermore, according to the Energy Watch Group, a global electricity system that relies on renewable energy is possible at every hour throughout the year and is most cost-effective compared to nuclear power and fossil fuels present [5,6,7]

Generally, energy efficiency is defined as the relationship between production, services and energy costs [8,9,10]. Therefore, through energy efficiency, energy saving by maintaining the same energy consumption as expected without reduction, production

and comfort levels, guaranteed supply, promotion of sustainability and environmental protection are also available as desirable targets. This sustainability process involves saving various energy sources used such as oil, coal, natural gas, etc. [11,12].

The group of fossil fuels (coal, oil and natural gas) used worldwide as a source of energy represents a very high percentage of the primary energy used. This is leading to its depletion and resulting in the increase of [13,14,15].

To ensure sufficient, efficient, environmentally friendly, and sustainable energy supply, the use of renewable energy resources is the best option for substituting non-renewable energy use. Globally, renewable energy resources entail hydropower, solar, wind, wave, geothermal power, waste energy such as gases from landfills, incineration, biomass, and liquid biofuels. Notwithstanding its significance, renewable energy still embodies only a low ratio of the current global energy production, supply, and consumption. Renewable power generation is over 23% (hydro 16% and non-hydro renewables 7.1%) [16,1].

Today, the use of green energy in urban areas reflects areas where the scientific community of large-scale urban renewable energy production is interested as a solution for sustainable energy development. Because it can be considered a sustainable solution to meet the growing demand for energy in cities and to reduce greenhouse gas emissions [17,18,19,6] as an important principle of sustainability in energy issues. Research is essential to achieving energy efficiency and profitability in sustainable renewables over time and its use in urban areas can be considered one of the most important energy and urbanization challenges of today [20,21,22].

The present paper seeks to explore the potential for utilization and coverage of various renewable energy sources and the practical implementation of related technologies for Security of sustainable development in district 4 of Tehran. This research is set into two sections: In the first part, the feasibility of renewable energy type at the regional level is studied and in the second part, the methods and parts that have the potential to use any acceptable energy are evaluated. Since renewable energies like hydroelectric and tidal have no potential, so they are not applicable in the region and the status and feasibility of using solar, wind, and geothermal energy are discussed.

2. METHODOLOGY

This study seeks to identify the factors affecting the use of new energy at urban levels, with emphasis on Tehran's district 4. The research method is applied-developmental. This research is attempting to evaluate the potential use of new energies in the district Tehran's district 4. Accordingly, the research data collection tool, which was done in 1977, is based on the documentary method and the field method. So that in order to select the main and measurable variables to analyze the problem, books, theses, and related articles were first studied and after identifying the different metrics for utilization and potential assessment of new energies, after the comments of professors and experts on the subject, three main dimensions (solar, Wind and geothermal) were selected in the areas of applicability and productivity, which are analyzed in the statistical analysis of Smart PLS. Also, to investigate the potential evaluation of zones with applicability in three main dimensions of solar energy with 9 zones (Residential units, military zones, passages, open green zones, industrial zones, industrial complexes, government applications, commercial and transportation applications), wind energy (military zones, green and open zones, industrial zones, residential complexes, government and commercial applications) and geothermal (military zones, green and open zones, industrial zones, residential complexes, government and commercial applications), are studied in the statistical model T-test, that each of them has 9 zones. The statistical population of the research includes active specialists and experts in the development and utilization of new energy. The selected statistical sample consists of 76 people that the questionnaire compiled in two parts are distributed between them. (The first part is the usability and productivity of the desired energy and the second part of is the potential evaluation of the desired zones). The target statistical population includes specialized PhD graduates in civil, urban planning, energy economics, geography and urban planning and experts with at least 8 years of experience in the field of renewable energy development in the municipality of the district and the Tehran new energies organization. Among the target statistical sample, 76 people have expressed readiness to contribute to this study. Statistical sample comments were present at all stages of the study and that is why the type of sampling is considered as counting all the samples. The descriptive characteristics of the target statistical sample are shown in Table (1).

Table 1. Descriptive characteristics of the statistical sample of the research

Field of study / organ	Number
Civil PHD	7
Urban Planning PHD	21
Energy Economy PHD	14
Geography and Urban Planning PHD	13
Municipality experts	11
New Energies Organization experts	10

As mentioned, the three types of energies discussed in this study have metrics and criteria that you can see these indices and criteria are related to each one in the statistical analysis of the T-test in the figure below.

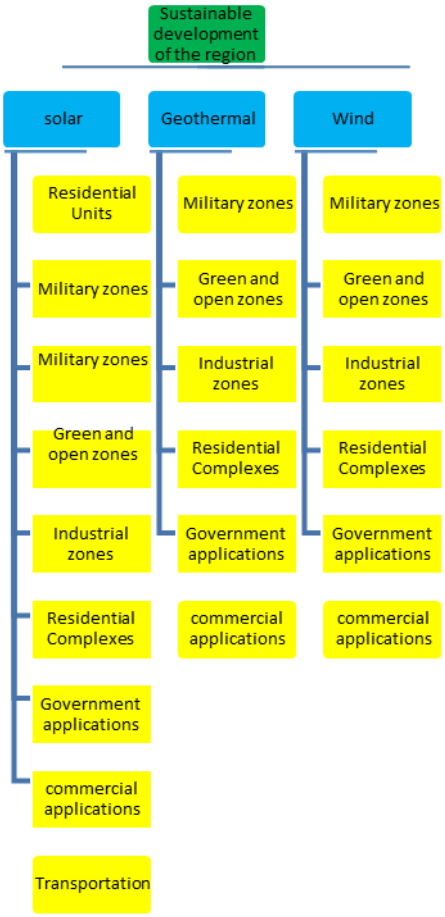

Figure 1. Conceptual model of research based on statistical analysis of T-test

The present study investigates three main dimensions of modern energy, namely wind, solar and geothermal energy that each of them has been examined in two parts: Feasibility and efficiency (Cost-Benefit) in PLS analysis.

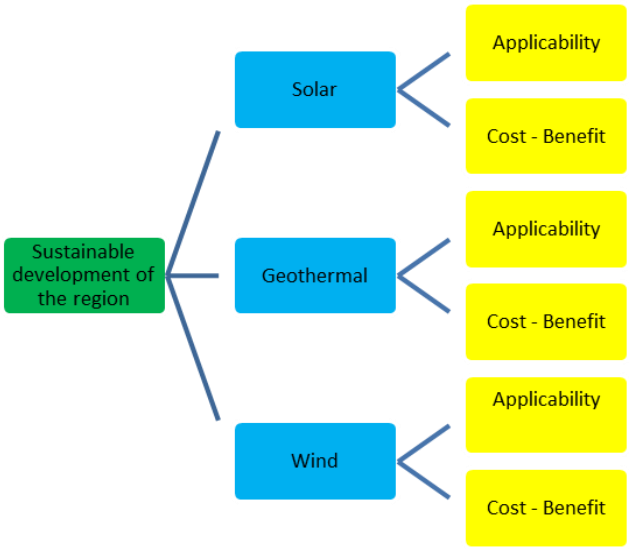

Figure 2. Conceptual research model based on statistical analysis of PLS

3. SCOPE OF STUDY

Tehran Region 4 is located on the southern slope of Alborz Range and northeast of Tehran Metropolis and is the largest and most populous area is among the 22 districts of Tehran. This area covers an area of 6123.9 hectares with a population of 917261 (in 2015) [23]. The above figures show that this area accounts for 7.2% of Tehran's total area and 10.5% of Tehran's total population. Tehran District 4, has 9 districts and 20 neighborhoods and after district 22, it has the largest privacy limit. This area is bounded on the north by Area 1 and on the west by Anchor Street at Area 1 and in the Pasdaran by Area 3, on the south by the Resalat Street border at Districts 7 and 8, and near Damavand St. by District 13, on the south. Thus, district 4 has zones 1, 3, 7, 8 and 13 in common and adjacent bodies. In terms of land use in Region 4, 11.1% and 10.5%, respectively, of the textured area of the city and 18% of the open and green areas and its expandable lands are much more than other areas of Tehran, respectively. The existence of Sorkheh Hesar, Lawizan and Lashkarq Parks has added to the attractiveness of the area and its contribution to regional performance levels. The presence of the industrial district of East Tehran has increased the possibilities for job creation, production and added to the trans-regional physical mobility [24].

4. DATA ANALYSIS

As mentioned, research data are collected in the field form and finally, they are analyzed in the two research models according to the intended objectives. For the purpose of usability and efficiency of the desired energy type, structural equation modeling was used which was discussed in the first section. In the second section, statistical analysis of t-test was used to evaluate the potential of the zones for energy type application.

4.1 New Energy Potential Analysis and Impact on Sustainable Development of the Region (PLS Statistical Analysis)

The structural equation model in PLS software was used to determine the direct and indirect effects of each of these variables on the use of new energy in the four districts of Tehran, which its results are shown in charts (3 and 5) and tables (2 to 5). It is worth noting, three variables related to the type of usable sustainable energy (wind, solar and geothermal) were used to define the dependent variable. Therefore, the mean of each variable is calculated and the dependent variable is the final mean of all variables.

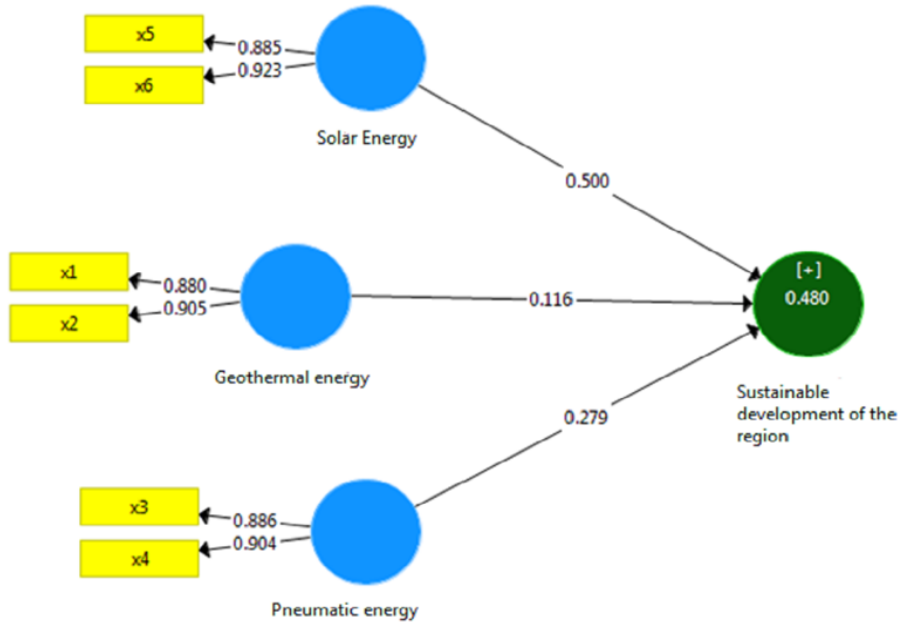

Figure 3. Structural Equation Modeling (with Standard Coefficients)

According to Figure (3), it can be said that independent variables independent variables of the study explain significantly (0.480) of the dependent variable changes. In addition, all components have a strong and appropriate factor load on the variables studied. So that in all cases the factor loadings are more than 0.4 and, in most cases, the factor loadings on the variables are more than 0.8 which indicates that structural equation modeling is desirable for confirmatory factor analysis. In addition, the above model shows the direct and indirect effects of each of the criteria of use and application of new energies at regional level (as independent variables) on regional stability (as dependent variable) in the form of path coefficients. Its contents are reported in the form of tables (2) to analyze the findings of the above model (Figure 3).

Table 2. Direct effects of variables with Bootstrap test results

Index / Effects	Original Sample	Sample Average	Standard Deviation	T Statistics	P Value
Wind Energy -> Sustainable Development Zone	0/279	0/277	0/104	2/678	0/008
Solar Energy -> Sustainable Development Zone	0/500	0/500	0/118	4/229	0/000
Geothermal Energy -> Sustainable Development Zone	0/116	0/120	0/097	1/195	0/232

Source: Research Findings

The following results can be deduced based on the table in Table 2, which shows the direct effects of the variables along with the Bootstrap test results (with 76 replicate volumes), the following results can be extracted:[1]

- Solar energy variables (with effect level of 500 and significance level of 0.000), Wind energy (with effect level 0.279 and significance level 0.008) and geothermal energy (with an effect of 0.116 and a significant level of 0.223) are, respectively, the most important variables that have a direct impact on the development and utilization of new energy at the study area.
- According to the conceptual model of research, the only variable that fully illustrates the impact on regional stability, is the solar energy variable (With effect level of 500 and significance level of 0.000)
- According to the conceptual model of research, wind energy variable (with an effect of 0.279 and a significant level of 0.008), at the second level of importance, - usability and efficiency - has a positive effect in terms of performance.
- According to the conceptual model of the research, geothermal energy variables (with an effect of 0.447 and a significant level of 0.223) at the third level of importance, - usability and efficiency - has a positive effect in terms of performance.

[1] In this section, only significant effects have been studied.

It should be noted that in order to examine the linearity of the variables in Table (3), the results of the VIF test are presented.

Table 3. Variables in Linear Effect Index (VIF)

Criteria	Sustainable development of the region
wind energy	1/206
Solar Energy	1/176
Geothermal energy	1/056

Source: Research Findings

According to the contents of Table 4, it is found that the on-line index (VIF) value for all variables is less than 5, which indicates that there is no linearity between the variables and their acceptability.

Table 4. Test results validity of measurement model (fitting of research model)

	Acceptable domain	Saturated Model	Results
SRMR	Less than 0.08	0/075	Appropriate
d_ULS	Less than 0.95	0/157	Appropriate
d_G1	Less than 0.95	0/174	Appropriate
Chi-Square	Less than 3	2/101	Appropriate
NFI	More than 0.09	0/554	Appropriate

Table 5. Test Results Validity of Measurement Model (Fitness of Research Model)

	Saturated Model	Estimated Model
SRMR	0/075	0/075
d_ULS	0/157	0/157
d_G1	0/174	0/174
d_G2	0/157	0/157
Chi-Square	81/101	81/101
NFI	0/554	0/554

Source: Research Findings

Table (5) shows the overall results of the validation of the validity indices of the appropriate model for the research.

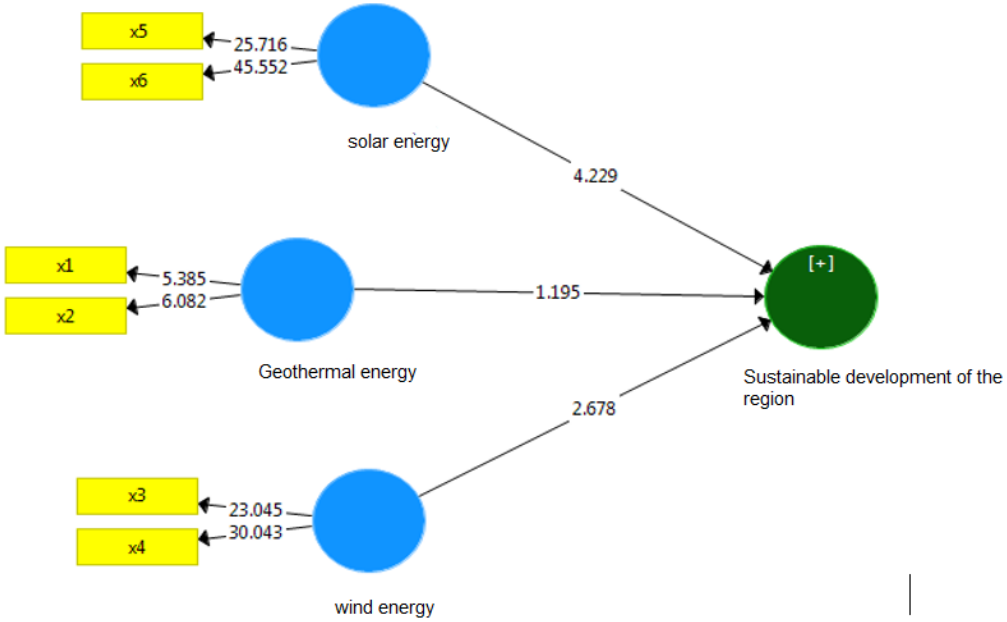

Figure 6. Non-standard path coefficients in conceptual research model

According to the above figure, it can be seen that the coefficients of impact of all independent and dependent variables were greater than 1.94, which is statistically acceptable.

4.2 Evaluation of the use of new energy in existing zones

In this section, the three types of energy discussed in this study are discussed, considering the criteria specified for each measurement, and their applicability to sustainable development of Tehran's fourth district.

4.2.1 Wind energy

In continuation and in order to evaluate the use of new energy in existing zones, which in this section is to evaluate the potential of the region in terms of applicable energy efficiency indicators, independent single-sample t-test was used. Prioritization of the sample's views on the potential for successful application and implementation of Area 4, has been investigated. The mean score of

the answers varies between 2.89 and 3.65, which indicates the potential of this energy in terms of applicability and the potential of the region for its use in achieving sustainable development. For more accurate results in Table (6), the results of the T-test are presented for the questions measured in the wind energy variable.

Table 6. T-test test results for questions measured in the wind energy variable

Factor	Test Average = 3					
	T-test	Degrees of freedom	The significance level	Average difference	confidence interval of 0.95 for the average differences	
					Lower limit	Upper limit
Military zones	2.802	75	.006	.31579	.0912	.5403
Green and open zones	6.691	75	.000	.65789	.4620	.8538
Industrial zones	3.545	75	.001	.44737	.1960	.6988
Residential Complexes	1.631	75	.107	.22368	-.0495	.4969
Government applications	-1.340	75	.184	-.10526	-.2617	.0512
Commercial uses	-.806	75	.423	-.09211	-.3196	.1354

Source: Research Findings

The contents of Table (6) indicate that the average difference of the potential components of each criterion for the establishment and application of wind energy as a sustainable energy for business usage criteria (significance level 0.423) and its applicability to government applications (significance level 0.184) and executive ability in residential complexes (significance level 0.107) with average test level is not significant or its feasibility is moderately assessed. Therefore, the viability of wind energy in these three components is evaluated at an intermediate level. In addition, the difference of average component of application and applicability in military zones (Significance level 0.006), green and open zones (significance level 0.000), industrial zones (significance level 0.001) are positive and significant with average test level which demonstrates the viability and applicability of this type of sustainable energy in these areas at the regional level. In other words, district 4 of Tehran city is ranked above average or desirable level in the above three components (or zones) (outdoor, green, military and industrial) which in case of careful planning, can be used and executed by wind energy.

4.2.2 Solar

In the following, the analysis of the independent T-Test single sample test and the solar energy index criteria will be studied. The average score of the answers varies from 3.26 to 3.86, which have shown success rate desirability of district 4 of Tehran in terms of solar energy usage above average. To obtain more accurate results in Table (8), the T-test results for the questions measured in the solar energy variable are presented.

Table 7. T-test test results for questions measured in the solar energy variable

Factor	Test Average = 3					
	T-test	Degrees of freedom	The significance level	Average difference	Confidence interval of 0.95 for the average differences	
					Lower limit	Upper limit
Residential unit	3.634	75	.001	.42105	.1902	.6519
Military zones	2.020	75	.047	.26316	.0036	.5227
Passages	4.246	75	.000	.47368	.2514	.6959
Open green zones	3.371	75	.001	.39474	.1615	.6280
Industrial zones	3.894	75	.000	.51316	.2506	.7757
Industrial complexes	7.690	75	.000	.86842	.6435	1.0934
Government applications	2.636	75	.010	.32895	.0803	.5776
Commercial applications	5.988	75	.000	.68421	.4566	.9118
Transportation	5.436	75	.001	.32145	.0513	.8746

The difference between the average potential components of each criterion for the establishment and application of solar energy, As a sustainable energy available in residential units (significance level 0.001), military zones (significance level 0.047), area passages (significance level 0.000), green and open zones (significance level 0.001), industrial zones (significance level 0.000), residential complexes (significance level 0.000), government uses (significance level 0.010), commercial complexes (significance level of 0.000) and transportation (level of significance 001/0) are positive and significant with test level which demonstrates the viability and applicability of this type of sustainable energy in these areas at the regional level. In other words, district 4 of Tehran is ranked above average or desirable in the eight components mentioned above that can be implemented efficiently with proper productivity.

4.2.3 Geothermal energy

In the following, in order to evaluate the applicability of the desired energies at district 4, we evaluate geothermal energy with 6 criteria in the independent single-sample T-Test test. The mean score of the answers varies from 2.73 to 3.62, which indicates a moderate degree of desirability of the Tehran Fourth Region in terms of geothermal energy utilization at a moderate level.

Table 8. T-test test results for questions measured in geothermal energy variables

Factor	Test Average = 3					
	T-test	Degrees of freedom	The significance level	Average difference	Confidence interval of 0.95 for the average differences	
					Lower limit	Upper limit
Military zones	4/762	199	0/000	0/395	0/231	0/558
Green and open zones	-0/697	199	0/487	-0/060	0/229	0/109
Industrial zones	-1/356	199	0/177	-0/115	-0/282	0/052
Residential Complexes	-3/572	199	0/000	-0/270	-0/419	-0/120
Government applications	7/351	199	0/000	0/620	0/453	0/786
Commercial applications	3/604	199	0/000	0/270	0/122	0/417

Source: Research Findings

The contents of Table (8) indicate that the average difference of the potential components of each criterion for the establishment and application of geothermal energy as a sustainable energy for residential complex criteria (significance level 0.000) and its applicability in government applications (significance level 0.000) and executive viability in commercial complexes (significance level 0.000) given that the t-score was obtained, all three measures were negative. In addition, their mean difference is negative and as a result, the level of significance is negative and they either do not executable or, given the current conditions, have not good efficiency. Therefore, the applicability of geothermal energy in these three components is poorly evaluated. Also, the difference between the average of usability and applicability components in military zones (significance level 0.16), green and open zones (significance level 0.008), industrial zones (significance level 0.014) with appropriate test level is positive and significant which demonstrates the usability and applicability of this type of sustainable energy in these areas at the regional level. in the other words, district 4 of Tehran, in the above three components (open and green zone, military and industrial) are ranked above average or desirable that can be evaluated with regard to geological conditions and cost and productivity.

5. CONCLUSION

Using planning and urban planning methods to save fuel and energy at different urban levels and from every perspective we look at, is an important principle and necessity both nationally and internationally. Much of the environmental problems the world is currently facing, are related to the use of fossil fuels, especially in the construction sector. Apart from the harmful effects which wastes energy and fuel on the Earth's ecosystem, from the economic point of view, Waste of energy and fuel means the loss of resources that could be used for the sake of excellence and prosperity of society. Generally, if we consider the energy and fuel consumption of buildings at least 30%, every one percent saving and preventing its loss has enormous material benefits for the country.

This study seeks to answer the following questions:

1) Does District 4 of Tehran have the potential to use modern energy?
2) Which of the types of new energy studied in this study will have the greatest impact on the sustainability of district 4?
3) To what extent and in what areas are each of the new energies considered in this study applicable to sustainable development in Tehran's Fourth District?

In the first part of this study, the potential of the four districts of Tehran in three main sectors of new energy introduced in this study namely solar, wind and geothermal are discussed. According to the information in this section, solar energy, with its ease of use and applicability, has the most potential in all residential, commercial and ... Geothermal and wind energy are in the second section which have less potential due to the existing constraints. Things like 12901043 square meters of green and open zones, 6693355 square meters of office space, 19626460 square meters of residential use including an apartment, residential tower and villa, 939102 square meters of military usage in three plaques, relative humidity in Tehran as an important item in solar energy usage which is 8 months of average relative humidity between maximum 55% and minimum 10% and 4 months of the year the average relative humidity is between 80% to at least 27% which we also see good conditions for solar energy in this area, precipitation in the city of Tehran, according to data from the Synoptic station in eastern Tehran, shows that the highest rainfall is in the month of August with 42 mm of rainfall per month and the least rainy days are in August and January with no rainfall per year which has provided favorable conditions. The area is also at a good altitude and in terms of the angle of radiation and the wind, it's also good. The number of days with dust and pollutants also varies from zero days in April to 22 days in February that for a total of 150 days in the city of Tehran, we are witnessing pollution and dust. In general, the sum of these conditions indicates that the area has the potential to use modern energy, especially solar energy. As stated in the wind energy potential assessment section, the height of the area is suitable for this type of energy use and the wind speed also varies from 22 km / h in September to 8 km in August, according to the Synoptic station data, which has provided favorable conditions. The only problem in this section is the difficulty of using wind turbines inside the texture due to the compression and lack of facilities in this section. The use of this type of energy can be subject to large areas such as forests and regional parks and garrisons. There is a similar problem in the geothermal energy sector and it is a little difficult to use this type of energy in residential fine contexts. The use of this type of energy can be attributed to high-rise buildings and public and hot water applications in many cases. In the analysis of this study, pls statistical analysis was used to investigate the impact of each type of energy introduced on the stability of the region. So that the field data from the questionnaire were compiled and the data collection between experts as a case study has been analyzed. Based on the results of solar energy with a load factor of 0.500 has the highest weight and in the later stages, wind energy with a factor of 0.279 and geothermal with a factor of 0.116 are at the next levels in terms of impact on the stability of the area. In the third part of this chapter, in order to be able to apply any type of energy to the different sectors needed, according to the field data obtained from the experts' questionnaire, the specific user zones and the acceptability of each energy in each zone were measured.

Also, in the second part of the statistical analysis, t-test was used which studies the applicability of each of the energies in the specified zones. The results show that solar energy has a good level of significance in almost all zones and it is fully functional against wind and geothermal energies, which do not have this level of significance in all zones. Although they are economical in areas such as large military units, forest areas, and so on, but they are more expensive than solar. To promote these bills, a specific plan has been implemented; from surveying the use of solar, wind, and geothermal energy across 22 districts, to developing technical oversight guidelines for the operation and maintenance of panels, small-scale power plants and small-scale maintenance turbines. In addition, the municipality of Tehran can be in the first stage given the many buildings with very high energy consumption, try to reduce economic costs and improve the quality of the urban environment by implementation of comprehensive plans for energy efficiency optimization, implementation of guidelines and implementation of effective executive, educational, research and management strategies. Secondly, we try to introduce this trend in the private and urban sectors and encourage citizens to use cleaner types of new energy.

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