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Research Article

Off and Onshore Technologies in New Materials for Sun Energy Applications Using Markov Chains Approach

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Abstract

Objective: The objectives of this research work are to: determine the major sources of available green energy to be harnessed for the community benefit, generate an energy optimization control system that will control deforestation impact and help mitigate climate change in general.

Methods: The method of the research involved: the primary data which were collected using a structured questionnaire. The finite stage method of Markov Chains was applied for sub-optimal and optimal solutions. The said application is a dynamic programming, which comprised of: with and without maintenance models.

Results: The result showed that wind energy had negative (-) value of ₦1,015 trillion, Solar energy had ₦150.35 billion, hydropower had ₦158.90 billion, Biogas had ₦146.17 billion, and Wave energy had ₦52.96 billion.

Conclusion: The work concluded: (i) that Hydropower has the highest (surplus) returned on investment of about ₦158.90 billion, followed by Solar energy of ₦150.35 billion, Biogas of ₦146.17 billion, Wave energy of ₦52.96 billion and Wind power of negative value (- ₦1,015 trillion) deficit which should be used for small irrigation agriculture of about 30 hectares only, (ii) that there should be no maintenance in the 5-year green-energy sources of minimum capacity utilization for Ideato, Orlu, Onuimo, Owerri and Mabaitoli local government areas respectively, (iii) the Green Energy Regulatory Council be set up by the government to encourage sources to terminate deteriorating landscapes in the Southeast region and (iv) the use of green energy sources by the communities will help to balance the ecosystem and the water cycle, thereby restoring our climate.

Keywords: technologies, new materials, sun energy, applications, Markov approach

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1 INTRODUCTION

The fossil fuels are mainly carbon based. Fossil fuels are burned with oxygen to get its useful energy. Examples are the use of coal in power plants and petrol in automobiles. The combustion of fossil fuel results in the formation of carbon dioxide (CO_2). The CO_2 is released to the atmosphere after combustion of the fuels. This gas absorbs the infrared part of radiation from the earth and reradiates it back to the earth creating the effect of greenhouse. Greenhouse effect of CO_2 increases the average global temperature of the earth. The prehistoric concentration of CO_2 was 280ppm (parts per million) which has now increased to about 380ppm in 2022. Other gas like methane, nitrous oxide, and chlorofluorocarbon (CFC causes damage to ozone layer) which are also greenhouse gasses and their concentration in the atmosphere is also increasing as a result of man activities. This increasing temperature has resulted in erratic weather patterns, floods, droughts etc.

1.1 General Background

The world today is faced with the threat of climate change. The temperature of the earth is rising so rapidly in recent times such that there is general fear that with the present trend the situation would be very difficult to cope with in the near future if urgent measures are not taken. Biological and climatic changes which cause global warming were mainly induced due to human activities. All the vulnerable that cause changes to the planet are mainly due to humans, interventions and activities according to Aruofor[1].

The effects of climate change prompted the World Meteorological Organization in its 40th Executive Council in 1988 to establish a new international scientific assessment panel to be called the International Panel on Climate Change (IPCC). The 2007 IPCC's fourth and final Assessment Report revealed that there is a considerable threat of climate change that requires urgent global attention. The Report further attributed the present global warming to largely anthropogenic practices.

Nigeria, which occupies the western part of Africa, ranks among the countries on the list possessing a vast expanse of forest land, the swamp forest in the extreme southern part of the country, the tropical rainforest in the southwestern axis and the wooded savannah in the middle belt according to Ogundele et al[2]. Nigerians total land area equates 947,800km^2, forest covers 10% of the total land area, with over 4,600 plant species identified. The area of trees cover is 10Mha, with over 189 metric tons of biomass per hectare; above the ground level are 79.37% while below the ground are 20.63% biomass per hectare. However, irrespective of the rich and abundant nature of the country, there is an excessive exploitation of these forest resources which is of great concern and threat to the economic, social and environmental importance.

The effect of deforestation was predominantly observed by Ojekunle[3] and deforestation led to the decreased maximum relative humidity, increased air temperature and evaporation rate, and increased soil temperature. Severity of global warming due to deforestation was clearly explained by Venkataramanan[4].

However, the forest, apart from providing a large proportion of the global supply of timber, fuel, and a wide range of non-wood products and environmental functions, they support sustainable agriculture, stabilize soils and climate, regulate water flows, give shade and shelter, and provide a habitat for pollinators and the natural predators of agricultural pests and contribute to the food security and income for hundreds of millions of people. Yet, agriculture remains the major driver of deforestation which has prompted a global warming issue amidst other ethical factors according to the Food and Agricultural Organization (2010)[5].

Going by this trend, deforestation has thus been described as the major problem facing the forest ecosystem in Nigeria. Some of these problems include climatic variation, loss of soil and water resources, desertification, socio-economic challenges, human and livestock health risk, farm and aquatic loss, etc. The degradation of the forest ecosystem has obvious ecological effects on the immediate environment, but it may also affect distant areas. For instance agricultural plains or valleys that depend upon forest highlands for their water may suffer flooding or drought as a result of the destruction of the forests. Deforestation can result in erosion which in turn may lead to desertification hence the loss of forest may run counter to what is for many developing countries the most urgent of all needs-fuel wood for cooking and heating. The extent of deforestation in any particular location or region should be viewed with economic, ecological and human consequences in mind. This is because forest degradation may in many ways be irreversible. Hence, the natural forests have reduced drastically and its impacts on climate change are increasing. As an activity that disrupts the neutrality of biodiversity due to actions carried out in the name of development, serious environmental concern such as pollution, desertification, erosion, drought, and flooding, etc., has been linked to deforestation and industrial waste; thus, constituting a major problem affecting the daily lives of Nigerians and a source of concern to the government according to Ogboru and Anga[6].

A global temperature rise has been highlighted as a threshold which the planet cannot exceed without seeing the worst effects of climate change. Measures for minimizing deforestation and managing climate change were developed according to Eme and Okodugha[7]. Hence, this prompted the need for this research intent. However, to keep temperatures from rising more than 1.5°C, there is a need to shift the trajectory of CO_2 emissions such that we have zero emissions by 2050 according to Eme and Ifeanyi[8]. A most reliable way to check it is through the use of the renewable energy resources of solar, wind, hydro and others as this will go a long way to mitigate deforestation along with reducing the effects of climate change. Hence, forest is a natural resource of critical economic and environmental importance possessing characteristics of both renewable and non-renewable resources which can be explored to achieve this. Although, Nigeria specifically, rural areas are faced with a great challenge on poor quality supply and Energy shortages are the greatest challenge to energy despite Nigeria's enormous domestic endowments in renewable and non-renewable primary energy resources are continuously affecting domestic energy supply and translating into great threat on Nigeria's forestry in accordance with Al-Amin[9] and Eme[10].

1.2 Problem Statement

The problems of the study involve the following: (i) Deforestation had led to a decline in forest cover, forest degradation, impoverishment of the soil and general deterioration in environmental condition, (ii) Deforestations have led to frequent occurrence of erosion, flooding and siltation of water bodies, (iii) Forest degradation risks the quality of life in forest communities and beyond, militates against the stability of climate and local weather, threaten the existence of other species and undermine the valuable services provided by biological diversity, (iv) About 5% of the forests in Nigeria are lost yearly through the industrial, commercial and other urban-related activities, and (v) Failure to stabilize climate by deforestation is a large threat to biodiversity.

1.3 Research Aim and Objectives

The aim of this study was to analyze the effect of deforestation; a climate conflict and optimization of energy green sources using a finite stages model of the Markov Chains.

The overaching purpose of this research was to assess the effects of deforestation on the study area (Imo State) and harness the resulting energy sources for community development in order to control the gross effect of deforestation and mitigating climate change control. In line with that, objectives were set to help realize this ultimate purpose. The specific objectives of the study were to: (i) Find out the effects of deforestation in the study area, (ii) Identify and analyze the factors that influence deforestation in the study area, (iii) Determine the major sources of available energy to be harnessed for the community benefit, (iv) Identify, the best Integrated Renewable Energy System (IRES) configuration that can be utilized to solve the energy demand problem of the community, and (v) Generate an energy optimization control system that will control deforestation impact and help mitigate climate change in general.

2 MATERIALS AND METHODS

The research methodology involved the following: the primary data which were collected using a structured questionnaire. Data relevant to the study from ministries of Water Resources, Agriculture, Power, etc, were obtained on the subject matter with the application of the Markov Chains.

2.1 Energy Methodology Model and Optimization Strategy Using Markov Chains

The research methodology model involved some treatment or actions using the Gardner example of the Markov Chains for the decision making in terms of application of fertilizer / maintenance or no application of fertilizer / maintenance with a finite number of years of gardening seasons or activities. Thus, this action resulted in gains or losses depending on the state of soil condition for the season, it could be said the other way round that productivity for the season is dependent on

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the soil condition (i.e., excellent, good, fair, weak and poor). The state of the soil condition in a particular year helps the Gardner in his decision / action to apply or not to apply fertilizer in the next gardening season.

Consequently, the above Gardner's example is an experimental model which was used to assess the performance of prototypes (green energy sources) as an optimal solution to climate conflict. The Gardener example is a decision problem to either apply or not to apply fertilizer / maintenance within the season, if the same conception of model is used to assess the performance of the maintenance of green energy sources in the five local government areas of Imo state. Therefore, interpretation of the above on the application of fertilizer or no fertilizer on the system (prototype) means maintenance or no maintenance on the system.

3 RESULTS AND DISCUSSION

The Table 1 with maintenance and Table 2 without maintenance below show net benefit and gross benefit data respectively derived from developmental projects designs and discussion of the experimental results described also hereunder.

3.1 Finite-stage Simulation Model Optimization

Optimal solutions of the renewable energy source were dependent on the following: (i) The major sources of available energy to be harnessed for the community benefit based on the above data, (ii) IRES configuration that can be utilized to solve the energy decision / demand problem of the communities, and (iii) Generate an energy optimization control system that will control deforestation impact and help mitigate climate change in general.

Lets us consider a case of gross benefit in which the model of using the Gardener's decision problem of no application of fertilizer / maintenance is (K=1) as in the computation below of V_1^K

V_1^1=(0.23×13.92)+(0.20×-449.02)+(0.22×-181.14)+(0.20×-1470.70)+(0.15×-336.34)=-471.04, Wind energy

V_2^1=(0×13.60)+(0.31×0.29)+(0.25×0.18)+0.24×29.15)+(0.20×2.77)=7.69, Solar energy

V_3^1=(0×13.66)+(0×1.31)+(0.39×0.58)+(0.35×32.53)+(0.26×3.56)=12.54, Hydropower

V_4^1=(0×13.84)+(0×0.81)+(0×0.39)+(0.56×30.89)+(0.44×3.18)=18.70- Biogas

V_5^1=(0×24.17)+(0×0.61)+(0×-0.19)+(0×26.17)+(1×2.08)=2.08, Wave energy

Interpretation of result in K=1: (i) Thus, if the five renewable energy source project is excellent, a single transition yields- 471.04 for that year; if it is good, the yield is 7.68; if it fair, the yield is 12.54; if it is weak, it yield is 18.70, if it is poor, the yield is 2.08. In this case of the Gardener's decision problem of non application of fertilizer we have solved the decision problem using the data summarized above in the above Table 1 and their probability matrices, given horizon of 5 years only (N=5) because the model developed has five minimum number of stationary polices or finite state.

Similarly, let us also consider the case of net benefit in which the model used the gardener's decision problem of application of fertilizer / maintenance is K=2 as computed below for V^k_1

V_1^2=(0.25'12.25)+(0.22'-408.20)+(0.14'-167.67)+(0.18'-1337)+(0.11'-315.76)=-385.09, Wind energy

V_2^2=(0.20′12.36)+(0.29′0.26)+(0.24′0.16)+(0.17′26.50)+(0.10′2.52)= 7.34, Solar energy

V_3^2=(0.17′12.42)+(0.27′1.19)+(0.30′0.53)+(0.19′29.57)+(0.07′3.24) =8.44, Hydro power

V_4^2=(0.14′12.56)+(0.19′0.74)+(0.16′0.35)+(0.33′28.08)+(0.18′2.89)=11.74, Biogas

V_5^2=(0.14'11.77)+(0.23'0.55)+(0.10'-0.17)+(0.08' 3.79)+(0.45'1.89)=4.54, Wave energy

Discussion of result in K=2: (i) Consequently, if the case of application of maintenance to the five renewable energy source project is excellent, a single transition yields - 385.09 for that tear; if it is good, the yield is 7.34; if it is fair, it yields 8.44; if it is weak, it yields 11.74; if it is poor, the yield is 4.54. In this case of the Gardener's decision problem of application of fertilizer, we had solved the decision problem using the data summarized in the above Table 2 and their probability matrices, given a horizon of 5 years only (N=5) because the model development has also minimum number of stationary policies or finite state.

3.2 The Manager's / Gardner's Decision Problem

Because the value of V_1^k will be used repeatedly in the computation, they are summarized for convenience. It is to be recalled that k=1, do not fertilize or do not maintain and k=2 represent fertilize or maintain as in the Tables 1-6 below.

3.2.1 Discussion and Interpretation of Result in Table 4

From the computation of the stage 5, the Wind energy is -471.04 and -385.09 for without maintaining respectively with negative sign indicating that the said energy supply is not favorable to the population of the five local government areas. Thus, the population is negative compared to the price of installation of wind energy. Therefore, the price is not a reasonable investment.

Solar energy is 7.68 for without maintenance and 7.34 for with maintenance, having 7.68 as the optimal value. In hydropower 12.54 is the optimal value (without maintenance). Biogas optimal value is 18.70 (without maintenance), and Wave energy has the optimal value of

Table 1. With Maintenance-net Benefits of N1.089 Billion Released in 2022 for Capital Project to the Local Government Areas of Ideato, Orlu, Onuimo, Owerri, and Mbaitoli under Various Objections

Developmental Projects	Objectives				
	Ideato LGA Economic Redistribution	Orlu LGA Economic Redistribution	Onuimo LGA Economic Redistribution	Owerri LGA Economic Redistribution	Mbaitoli LGA Economic Redistribution
Wind energy source	12.65	-408.20	-164.67	-1337	-315.76
Solar energy source	12.36	0.26	0.16	26.50	2.52
Hydroelectric energy source	12.42	1.19	0.53	29.57	3.24
Biogas energy source	12.58	0.74	0.35	28.08	2.89
Wave energy source	11.97	0.55	- 0.17	23.79	1.89

Table 2. Without Maintenance-gross Benefits, N1.089 Billion Released in 2022 for Capital Project to the Local Government Areas of Ideato, Orlu, Onuimo, Owerri, and Mbaitoli under Various Objectives

Developmental Project	Objectives				
	Ideato LGA Economic Redistribution	Orlu LGA Economic Redistribution	Onuimo LGA Economic Redistribution	Owerri LGA Economic Redistribution	Mbaitoli LGA Economic Redistribution
Wind energy source	13.92	-449.02	-181.137	-1470.7	-336.34
Solar energy source	13.60	0.29	0.18	29.15	2.77
Hydroelectric energy source	13.66	1.31	0.58	32.53	3.56
Biogas energy source	13.84	0.81	0.39	30.89	3.18
Wave energy source	24.17	0.61	- 0.19	26.17	2.08

Table 3. Summary of Computation of V_1^1 and V_1^2 used in Stages 5 to 1

V_1^k	V_1^1	V_1^2
1	-471.04	-385.09
2	7.68	7.34
3	12.54	8.44
4	18.70	11.74
5	2.08	4.54

Table 4. Stage 5, Computation of Optimal Solutions for K=1 and K=2

V_1^k	V_1^1	V_1^2	$F_5^{(i)}$	K*
1	-471.04	-385.09	-471.04	1
2	7.68	7.34	7.68	1
3	12.54	8.44	12.54	1
4	18.70	11.74	18.70	1
5	2.08	4.54	4.54	2

4.54 (with maintenance).

3.2.2 Discussion and Interpretation of Results as Shown in Tables 5-7

The negative (-) value of -836.10 of the Wind energy shows that the project is not advisable to be engaged in for the five communities as a source of supply. Rather advocates for a smaller size supply such as (30 hectares of land for small irrigated farm) and does not require any maintenance of the system within the 5 years minimum capacity utilization.

The other four green energy sources such as: Solar energy, Hydro-electric power, Biogas energy and Wave energy are optimal investment for the five local government areas of Imo State namely; Ideato, Orlu, Onuimo, Owerri, Mbaitoli, and Hydropower as the best option with the return on investment of ₦86.23 billion.

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Table 5. Stage 4, Computation of the Optimal Solutions for K=1 and K=2

	$V_1^k+P_i^kF_3^1+P_{i2}^kF_3^2+P_{i3}^kF_3^3+P_{i4}^kF_3^4+P_{i5}^kF_3^5$			Optimal Solution
	K=1	K=2	$F^1_{(4)}$	
1.	-471.04+(0×-471.04)+(0.20×7.68)+(0.22×12.54)+(0.20×18.70)+(0.15×4.54)=-570.66	-385.05+(0.25×-471.04)+(0.22×7.68)+(0.14×12.54)+(0.18×18.70)+(0.11×4.54)=-495.49	-579.66	1
2.	-7.68+(0×-471.04)+(0.31×7.68)+(0.25×12.54)+(0.24×18.70)+(0.15×4.54)=-570.66	7.34+(0.20×-471.04)+(0.29×7.68)+(0.24×12.54)+(0.17×18.70)+(0.10×4.54)=-77.99	-570.66	1
3.	12.54+(0×-471.04)+(0×7.68)+(0.39×12.54)+(0.35×18.70)+(0.26×4.54)=25.16	8.44+(0.17×-471.04)+(0.27×7.68)+(0.304×12.54)+(0.19×18.70)+(0.07×4.54)=-61.93	25.16	1
4.	18.7+(0×-471.04)+(0×7.68)+(0×12.54)+(0.56×18.70)+(0.44×4.54)=31.17	11.74+(0.14×-471.04)+(0.19×7.68)+(0.16×12.54)+(0.33×18.70)+(0.18×4.54)=-5.93	31.17	1
5.	2.08+(0×-471.04)+(0×7.68)+(0×12.54)+(0×18.70)+(0.1×4.54)=6.62	4.54+(0.14×-471.04)+(0.23×7.68)+(0.1×12.54)+(0.08×18.70)+(6.62×4.54)=-54.85	6.62	1

Table 6. Stage 3, Computation of Optimal Solutions for K=1 and K=2

	$V_1^k+P_i^kF_3^1+P_{i2}^kF_3^2+P_{i3}^kF_3^3+P_{i4}^kF_3^4+P_{i5}^kF_3^5$			OptimalSolution
	K=1	K=2	F2	
1.	570.66+(0×-570.66)+(0.20×18.36)+(0.22×25.16)+(0.20×31.17)+(0.15×6.62)=-685.48	-495.49+(0.25×-570.66)+(0.22×18.36)+(0.14×25.16)+(0.18×31.17)+(0.11×6.62)=-624.25	-685.48	1
2.	18.36+(0×-570.66)+(0.31×18.36)+(0.25×25.16)+(0.24×31.17)+(0.20×6.62)=39.15	-77.99+(0.20×-570.66)+(0.29×18.36)+(0.24×25.16)+(0.17×31.17)+(0.11×6.62)=-188.66	39.15	1
3.	25.16+(0×-570.66)+(0×18.36)+(0.39×25.16)+(0.35×31.17)+(0.26×6.62)=47.60	-61.93+(0.17×-570.66)+(0.27×18.36)+(0.30×25.16)+(0.19×31.17)+(0.07×6.62)=-154.67	47.60	1
4.	31.17+(0×-570.66)+(0×18.36)+(0×25.16)+(0.56×31.17)+(0.44×6.62)=51.54	-5.98+(0.14×-570.66)+(0.19×18.36)+(0.16×25.16)+(0.33×31.17)+(0.18×6.62)=-83.21	51.54	1
5.	6.62+(0×-570.66)+(0×18.36)+(0×25.16)+(0×31.17)+(1×6.62)=13.24	-54.85+(0.14×-570.66)+(0.23×18.36)+(0.1×25.16)+(0.08×31.17)+(0.45×6.62)=-133.02	13.24	1

Table 7. Stage 2, Computation of Optimal Solutions for K=1 and K=2

	$V_1^k+P_i^kF_3^1+P_{i2}^kF_3^2+P_{i3}^kF_3^3+P_{i4}^kF_3^4+P_{i5}^kF_3^5$			Optimal Solution
	K=1	K=2	F2	
1.	685.48+(0.23×−685.48)+(0.20×39.15)+(0.22×47.60)+(0.20×51.54)+(0.15×13.24)=−836.10	−24.25+(0.25×−685.48)+(0.22×39.15)+(0.14×47.60)+(0.18×51.54)+(0.11×13.24)=−789.11	−836.10	1
2.	39.15+(0×−685.48)+(0.31×39.15)+(0.25×47.60)+(0.24×51.54)+(0.20×13.24)=78.20	−188.66+(0.20×−685.48)+(0.29×39.15)+(0.24×47.60)+(0.17×51.54)+(0.10×13.24)=−319.18	78.20	1
3.	47.60+(0×−685.48)+(0×39.15)+(0.39×47.60) +(0.35×51.54)+(0.26×13.24)=87.65	−154.67+(0.17×−685.48)+(0.27×39.15)+(0.30×47.60)+(0.19×51.54)+(0.07×13.24)=−265.15	87.65	1
4.	51.54+(0×−685.48)+(0×39.15)+(0×47.60) +(0.56×51.54)+(0.44×13.24)=86.23	−83.21+(0.14×−685.48)+(0.19×39.15)+(0.16×47.60)+(0.33×51.54)+(0.18×13.24)=−168.73	86.23	1
5.	13.24+(0×−685.48)+(0×39.15)+(0×47.60)+(0×51.54)+(1×13.24)=26.48	−133.02+(0.14×−685.48)+(0.23×39.15)+(0.10×47.60)+(0.08×51.54)+(0.45×13.24)=−225.65	26.48	1

3.2.3 Discussion and Interpretation of the Final Result as Shown in Table 8

The Markov finite model finally converges shown in Table 6 as the final best / optimal solution for the green energy sources with logical allocation of funds as follows: (a) Wind energy source yields ₦1,015.49 trillion, with a negative (-) value and should not have investment fund for communities uses rather only be for small irrigated agriculture of about 30 hectares, (b) Solar energy source yields- ₦150.35 billion naira, (c) Hydropower energy source yields ₦158.90 billion naira, (d) Biogas energy source yields ₦146.17 billion naira and (e) Wave energy source yields ₦52.96 billion naira.

The above results in Table 6 are interpreted as follows: The optimal solutions on green energy sources for the five (5) LGA show that maintenance will not be required (K = 1), (a) $F_1(1)$ = The negative (-) value ₦1,015 trillion, if state of the green energy sources project (Wind energy) in year 1 is excellent, (b) $F_1(2)$ = ₦150.35 billion, if the state of the green energy sources project (Solar energy) in year 2 is good, (c) $F_1(3)$ = ₦158.90 billion, if the state of the green energy source project (Hydropower) in year 3 is fair, (d) $F_1(4)$ =

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Table 8. Stage 1, Computation of Optimal Solutions for K=1 and K=2

$V_1^k+P_i^kF_3^1+P_{i2}^kF_3^2+P_{i3}^kF_3^3+P_{i4}^kF_3^4+P_{i5}^kF_3^5$				Optimal Solution
	K=1	K=2	F21	
1.	−836.10+(0.23×−836.10)+(0.20×78.20)+(0.22×87.65)+(0.20×86.23)+(0.15×26.48) =−1,015.49	−789.11+(0.25×−836.10)+(0.22×78.20)+(0.14×87.65)+(0.18×86.23)+(0.11×26.48)=−986.16	−1,015.49	1
2.	78.20+(0×−836.10)+(0.31×78.20)+(0.25×87.65)+(0.24×86.23)+(0.20×26.48)=150.35	−319.18+(0.20×−836.10)+(0.29×78.20)+(0.24×87.65)+(0.17×86.23)+(0.10×26.48)=−387.53	150.35	1
3.	87.65+(0×−836.10)+(0×78.20)+(0.39× 87.65)+(0.35×86.23)+(0.26×26.48) =158.90	−265.15+(0.17×−836.10)+(0.27×78.20)+(0.30×87.65)+(0.19×86.23)+(0.07×26.48)=−396.13	158.90	1
4.	86.23+(0×−836.10)+(0×78.20)+(0×87.65)+(0.56×86.23)+(0.44×26.48)=146.17	−168.73+(0.14×−836.10)+(0.19×78.20)+(0.16×87.65)+(0.33×86.23)+(0.18×26.48)=−277.09	146.17	1
5.	26.48+(0×−836.10)+(0×78.20)+(0×87.65)+(0×86.23)+(1×26.48)=52.96	−225.65+(0.14×−836.10)+(0.23×78.20)+(0.10×87.65)+(0.08×86.23)+(0.45×26.48)=−336.32	52.96	1

₦146.17 billion, if the state of the green energy source project (Biogas) in year 4 is weak, (e) F_1 (5) = ₦52.96 billion, if the state of the green energy sources project (Wave energy) in year 5 is poor, then, the finite number of state, in Table 6 above should not be maintained for the minimum capacity utilization of five years for the five green energy sources of Ideato, Orlu, onuimo, Owerri, Mbaitoli communities respectively.

(a) The allocation of fund by government to the five green energy projects at various communities mentioned to be undertaken in Imo State is ₦0.6 billion when compared to the total return on the investment for the (five) years, a total yearly revenue of ₦508.38 billion naira is gotten from the five (5) energy sources.

(b) If the government fund allocation for the green energy system to the five LGAs of Imo State is ₦0.6 billion and is then deducted from ₦508.38 billion gotten from the investment, then the Imo State government will make a profit margin of ₦507.78 billion from the investment.

4 CONCLUSION

The work concluded that the optimal solution on green energy sources for the five (5) LGAs shows that maintenance will not be required (k = 1) for the 5 (five) -year- minimum capacity utilization, (i) $F_1(1)$ = The negative (-) value of ₦1.015 trillion, if the state of the green energy sources project (Wind energy) in year 1 is excellent, (ii) $F_1(2)$ = ₦150.35 billion, if the state of the green energy sources project (Solar energy) in year 2 is good, (iii) $F_1(3)$ = ₦158.90 billion, if the state of the green energy source project (Hydro power) in year 3 is fair, (iv) $F_1(4)$ = ₦146.17 billion, if the state of the green energy sources project (Biogas) in year 4 is weak, (v) $F_1(5)$ = ₦52.96 billion, if the state of the green energy sources project (Wave energy) in year 5 is poor, then from the finite number state of five years minimum capacity utilization as stated above, there should be no maintenance of the five green energy sources at Ideato, Orlu, Onuimo, Owerri, and Mbaitoli communities respectively.

The government's allocation of fund for the green energy sources at the various communities mention above in Imo State from 2015 to 2020 is ₦0.6 billion and compare to the total return on the investment for five (5) years, a total yearly revenue of ₦508.38 billion naira is gotten from the five energy sources. If the logical allocation of fund by the Markov model for the green energy sources at the five LGAs in Imo State is ₦0.6 billion is deducted from ₦508.38 billion, and then the five LGAs will make a profit margin of ₦507.78 billion from the investment.

It is evident that simulation modeling in Markovian decision theory in assessing the real life performance of a system can be effectively applied in optimum policy decision making in maintenance programming, allocation, and conjunctively managed competition of green energy sources.

From the Pearson Product Moment Correlation, r=0.99 confirms that there exist a strong correlation or relationship between the projects and response of the communities. In conclusion of this work, the problem is solved in the consideration of the five objectives of Ideato, Orlu, Onuimo, Owerri and Mbaitoli LGAs which were achieved optimally with five projects of Wind energy, Solar energy, Hydropower, Biogas and Tidal wave.

4.1 Recommendation

This work is recommended to the federal government of Nigeria for realization of her vision 2040 as follow: (i) there should be a Green Energy Regulatory Council for the implementation and the use of Markovian decision models for the regulations of climate change as it affects Nigeria, (ii) the existing regulatory agencies such as Council of Regulation for Engineering of Nigeria should apply the model to boast the need to use Markovian decision theory to solve the problems of climate change caused by deforestation as it affects the green energy sources, (iii) Green Energy Regulatory Council be set up to encourage sources and the use of green energy, as this will help to balance the ecosystem and the water cycle, thereby restoring our climate and halt the deteriorating landscapes in the region, (iv) There should be a green energy maintenance program in accordance with the Markov policy to avoid wastage of resources, and (v) The established Green Energy Regulatory Council should be implemented by the government for the collection of appropriate tariffs from utilities arising from Green energy projects.

4.2 Contribution to Knowledge

The contribution to knowledge is such that the finite stage models of Markov chains form an alternative to other simulation techniques.

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Conflicts of Interest

The authors declared no conflict of interest regarding the publication of this paper.

Author Contribution

All authors were involved in the designing, organizing and writing of the manuscript.

Abbreviation List

CO_2, Carbon dioxide

IPCC, International panel on climate change

IRES, Integrated renewable energy system

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