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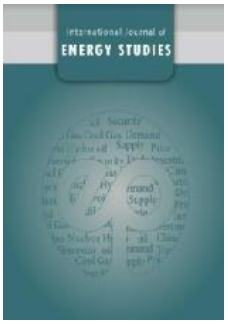

Research Article

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The model of "free Investment and centralised management" in renewable energy production projects

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Highlights

- The economic advantages of the "Free Investment & Centralised Management" model were calculated
- Turkey's solar, wind and biomass energy potential were calculated
- The environmental advantages of the "Free Investment & Centralised Management" model were mentioned

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ABSTRACT

A significant increase is observed in electricity generation with renewable energy in Turkey in recent years. However, obviously, Turkey also utilizes a very small slice from that it has the potential of renewable energy. Depending on existing laws and regulations, renewable energy investments are carried out by private enterprises rather than public enterprises. However, especially, the renewable energy cooperatives, seen in many countries, have not yet been found in Turkey. It is an undeniable fact that this situation has both advantages and disadvantages. If Turkish citizens could freely invest even in small amounts, a new system would emerge that the state can regulate these investments and ensure energy supply security and it would provide that the renewable energy that could be the locomotive of Turkey. In this study, the advantages of the method which can do utilized renewable energy capacity owned by Turkey in a short time were investigated over the current situation with the model of "Free Investment & Centralised Management" in renewable energy production projects. In particular, the potential of solar, wind, and biomass energy types of Turkey in the regional base was compared with current installed power and it revealed the way to run about renewable energy. Studies show that Turkey has potential of at least 87 GW in solar energy, at least 114 GW in wind energy and 56 GW in biomass energy at installed power. With the implementation of the "Free Investment & Centralised Management" model, it is evaluated to be that estimated at least 500 billion dollars at cushion of capital will be saved to national production in Turkey, the amortization period of each renewable energy investment will be shortened by at least 15 months, the shorter amortization period would contribute to Turkey's national capital about 4 billion Turkish Liras annual, at least 100 million tons of CO_2 will be reduced annually in greenhouse gas emissions released into the environment.

Keywords: *Renewable energy systems, Energy economy, Energy cooperative*

1. INTRODUCTION

Today, the human beings implement two methods to obtain energy. The first of those is the traditional method, which are fossil fuels such as petrol, coal and natural gas. This is the method commonly used all over the world. The other method is the production from renewable energy sources. These are limitless resources such as the sun, wind, biomass, hydrogen, geothermal and wave energy. Nations who want to obtain energy from fossil fuels have an obligation to obtain, find, extract or buy raw materials with rich calorific value. For this reason, traditional energy sources such as petrol, natural gas and coal threaten the economic independence of countries experiencing difficulties in accessing these resources.

"Energy, which is one of the most important elements of industrialization" [1]. Turkey is a country that can be shown as an example of this approach. As it is known, natural gas and coal are among the resources used not only for heating systems but also for electricity generation. "Turkey is a poor country in terms of this resources" [1]. After the recent discovery of natural gas reserves, it is seen in Turkey, there are 400 billion m^3 of natural gas and a small amount of petrol that can use on behalf of the country. But this is not sufficient lignite coal and natural gas for Turkey's future, because the calorific value of lignite is low and the amount of natural gas is limited in Turkey. It is considered that the existing natural gas resources can be used for a maximum of 8 years as long as new resources are not found. Because according to the data of the Energy Market Regulatory Authority of Republic of Turkey (EPDK), Turkey's natural gas consumption realized as 53.8 billion m^3 in 2017 [2]. In addition, "according to Turkey's 2016 report of the Institute for Energy Economics and Financial Analysis (IEEFA), Turkey's electricity energy deficit which is, the proportion of imported fuel required to run its grid reached 6 percent of GDP by 2014, and oil and natural gas accounted for more than 90 percent of that deficit" [3].

"High current account deficits stemming from energy import dependency make substitution of fossil energy with renewable energy a necessity for Turkey. Although Turkey has a great potential in terms of renewable energy, it has not begun to utilize this great potential until recent years" [4]. All these data, information, and the current situation are once again reminded the importance of renewable energy for Turkey to us. There are also different studies in the literature that support this view [5].

Table 1. Electricity generation and rates by energy resources [6-7]

Year	Installed Power (GW)	Annual Generation (GWh)	Utilization Rates of Resources in Generation (%)				
			Coal	Liquid Fuels	Natural Gas	Hydraulic	Renewable
2018	88 551	304 802	37.2	0.1	30.3	19.7	12.7

As can be seen from Table-1, in electricity production in Turkey in 2018, only 12.7% of the resources used are renewable resources. We can say that Turkey needs to invest much more than in recent years for the view to be more positive, the imports of energy resources to be decreased, the energy costs to be reduced that causing the annual current account deficit and among with the environmentally friendly renewable resources to be more intensive use. "The secure and reliable supply of electricity is a crucial service, both as a consumer good and as a production input to other goods and services" [8].

In this paper, a method will be presented as an alternative to Turkey's current renewable energy investment policies. In order to constitute this whole framework, first of all, the investment model we want to present will be summarized and then Turkey's solar, wind and biomass energy potential will be demonstrated. After evaluating Turkey's renewable energy potential, the economic advantages of the mentioned investment model will be analyzed to compare to the current investment models.

2. THE MODEL OF "FREE INVESTMENT & CENTRALISED MANAGEMENT" IN RENEWABLE ENERGY PRODUCTION PROJECTS

The following positive outcomes are foreseen with the method we are trying to summarize as a "The Model of 'Free Investment & Centralised Management' in Renewable Energy Production Projects".

- To increase significantly in the rate of utilization of renewable energy in electricity generation,
- To decrease in energy-related annual current account deficit while ensuring national energy supply security,
- To decrease in power plant investment costs,
- To have more stable and highly efficient production with strict plant controls,
- To decrease in carbon emissions and to earn income with low carbon emissions,
- To have opportunity to evaluate the most advantageous lands, investments, projects by a single authorized institution,
- To terminate the unconscious investor period and to reduce power plant operating costs,

- To participate the commmon citizens in energy production and creation of new earning ways,
- To participate the savings to the production economy that are not in use in the economy.

In order to better understand the model we mentioned, first of all, it is necessary to explain what the expressions “Centralised Management” and “Free Investment” mean.

2.1. Centralised Management

The most important points that gain positive momentum to Turkey's renewable energy policy are the legislation in force. Especially, it is seen that the private sector and entrepreneurs are encouraged within the scope of the Law On Utilization Of Renewable Energy Sources For The Purpose Of Generating Electrical Energy (No:5346) and Renewable Energy Support Mechanism (YEKDEM) in Turkey [9]. However, it is also possible to make existing legislation more useful.

In this paper, the point we support with the expression “Centralised Management” is that it would be a more advantageous policy taking control to rather than the encouragement of the private sector by the government all mentioned renewable energy investments. On this basis, “Centralised Management” policy, there is a need for a public institution that will plan, evaluate, audit, operate and bring into production all renewable energy investments. We can call this institution “Energy Cooperative Center (ECC)”. In particular, Energy Cooperative Center (ECC) absolutely must depend on the Republic of Turkey Ministry of Energy and Natural Resources, must be empowered its duties and powers by presidential decree, should be an institution that will make execution and audit activities in the field of renewable energy. Its purpose is; to provide profit, cooperation and solidarity in renewable energy investments, to contribute to national energy, to combine the advantages of the cooperative system with state guarantee, and to encourage the energy sector to be nationalized rather than current policies for privatization.

The duties and authorities of the Energy Cooperative Center (ECC), which will use the cooperative system, which is the stronghold of the spirit of unity, in renewable energy investments by protecting it from prejudices and negative consequences with state guarantee, should be as follows:

- To plan all renewable energy projects needed across the country,
- To determine the most suitable sites for solar, wind, biomass plants,

- To conduct the necessary feasibility studies,
- To calculate the approximate costs of the projects,
- To promote the project and to offer the projects to the public,
- To determine the project share sales price and selling shares,
- To conduct the planned project or transfer it to the subcontractor,
- To make provisional and final admissions,
- To operate and to control power plants,
- To make connection agreements with electricity distribution companies,
- To take advantage of YEKDEM purchase guarantee,
- To share monthly profits with shareholders.

2.2. Free Investment

As can be understood from the duties of the Energy Cooperative Center (ECC), such as the public offering of the projects, the sale of shares, we can express the "Free Investment" as that all planned projects allow citizens to invest. "Free Investment" includes 6 (six) important parameters:

(1) Public Offer: The citizens or private companies should be able to invest in these projects. Because the main benefit is offer opportunities for investment to the citizens. In this way, it will be ensured that even citizens in the low-income group participate in energy production and create profit gates.

(2) Share Purchase: In project share sales, only one share can be sold to an applicant in the first sales period. In this way, all the advantages obtained with this proposed model will be prevented from being gained by a single company with a strong capital structure. If sufficient investors cannot be reached in the first sales period, multiple share sales will become possible. Share prices will be determined by the Energy Cooperative Center (ECC), and the number of investors may vary depending on the approximate cost.

(3) Profit Guarantee: Project profit tables will be announced before the share sales. The investors will know that their profit is under government guarantee.

(4) New Investment Model: It will be possible to compare it with small-scale investments such as real estate property, landed property, precious metals, foreign currency or interest. It will be possible to bring the cushion of capital and interest-free current accounts to the economy.

(5) Interest-Free Income: The savings cushion of capital due to (Islamic) religious sensibilities will be brought into the economy. This is an opportunity for those looking forward for an interest-free investment model.

(6) Riskless Operating: The operational responsibility will be entirely in the Energy Cooperative Center.

3. TURKEY'S RENEWABLE ENERGY POTENTIAL

On this chapter of this paper, Turkey's solar, wind and biomass potential is examined separately.

3.1. Solar Power

We can compare Turkey's solar energy potential with Germany. Because Germany is the 4th country that uses its solar energy potential at the highest level and has the world's largest solar power plant (SPP) installed power with 45 GW installed power as of 2019. "Turkey's monthly average sunshine duration and radiation values are higher than benefiting from solar energy many leading countries in the world. Turkey's sunshine duration is more than 3 times compared to European countries" [10].

According to data [11] of Germany Federal Ministry for Economic Affairs and Energy the Germany's solar power installed capacity is 45 GW while according to 2020 September Installed Power Report [12] of Turkish Electricity Transmission Corporation Turkey's solar power installed capacity was only 6.361 GW in the year 2018. According to data [13] of German Meteorological Service (Deutscher Wetterdienst) Germany's average annual global radiation value measured between 1981-2010 was 1,054 kWh/m^2 while according to data [14] of Turkey Solar Energy Potential Atlas (GEPA) Turkey's annual global radiation value is 1,527 kWh/m^2. Parallel to this, Germany's annual sunshine duration is 1,683 hours [15] while according to data [14] of GEPA Turkey's annual sunshine duration is 2,741 hours. Table-2 can be examined in terms of see in the figures the solar energy policies of Germany and Turkey in point to using the their potential.

Table 2. A comparison of Turkey and Germany's solar energy potential

Parameters	Equations	Turkey	Germany
a. Population (Million)	a	82	83
b. Annual Solar Potential (kWh/m^2)	b	1 527	1 054
c. Area of Country (km^2)	c	783 562	357 386
d. Total Solar Potential (GWh)	d = b x c	1 196 499 174	376 684 844
e. Installed Power (GW)	e	6.361	45
f. Annual Sunshine Duration (h)	f	2 741	1 683
g. Annual Generation (GWh)	g = e x f	17 436	75 735
h. Utilization Rates of Potential (%)	**h = g x 100 / d**	**0.00146**	**0.0201**
Result	**We can say Germany utilize 13.76 times more than Turkey about utilizing the existing solar energy potential**		

As can be seen from Table-2, although Turkey has 3.18 times (Parameter-d) more solar potential than Germany, Germany's solar power installed capacity is approximately 7 times (Parameter-e) more than Turkey's solar power installed capacity. In addition, while Germany utilizes 0.02% of its solar energy potential, Turkey utilizes 13.76 times less than Germany of its solar energy potential. As a result of this review, it appears that the short-term target of Turkey's solar power installed capacity can be increased up to at least 87 GW (6.361 GW x 13.76) proportionally to increasing electricity demand.

3.2. Wind Energy

The wind energy potential by provinces and the existing wind energy installed power in these cities are shown in a single chart to see Turkey's wind energy potential and to what extent does it use this potential.

Table 3. Turkey's wind energy potential by provinces and utilization rates of potential [16-17]

City	Potential Area for Installation (km^2)	Potential Installed Power (MW)	Existent Installed Power (MW)	Utilization Rate* (%)
Adana	179.74	898.72	0	0.000
Adıyaman	239.38	1 196.88	27.5	2.298
Afyon	172.05	860.24	316.45	36.786
Ağrı	0.05	0.24	0	0.000
Aksaray	0	0	0	No Potential
Amasya	239.9	1 199.52	139	11.588
Ankara	0	0	0	No Potential
Antalya	234.08	1 170.4	0	0.000
Ardahan	1.84	9.2	0	0.000
Artvin	1.96	9.76	0	0.000
Aydın	504.75	2 523.76	216.2	8.567
Balıkesir	2 765.47	13 827.36	1 163.5	8.414
Bartın	12.32	61.6	0	0.000
Batman	1.58	7.92	0	0.000
Bayburt	0	0	0	No Potential
Bilecik	61.73	308.64	40	12.960
Bingöl	12.29	61.44	0	0.000
Bitlis	4.42	22.08	0	0.000
Bolu	23.42	117.12	0	0.000
Burdur	11.63	58.16	0	0.000
Bursa	776.34	3 881.68	128.4	3.308
Çanakkale	2 602.51	13 012.56	594	4.565

Çankırı	63.07	315.36	0	0.000
Çorum	31.23	156.16	0	0.000
Denizli	47.71	238.56	74.8	31.355
Diyarbakır	127.01	635.04	0	0.000
Düzce	0	0	0	No Potential
Edirne	694.02	3 470.08	85.6	2.467
Elazığ	205.68	1 028.4	0	0.000
Erzincan	76.54	382.72	0	0.000
Erzurum	3.55	17.76	0	0.000
Eskişehir	8.22	41.12	0	0.000
Gaziantep	53.38	266.88	65.55	24.562
Giresun	32.1	160.48	0	0.000
Gümüşhane	0.21	1.04	0	0.000
Hakkari	5.89	29.44	0	0.000
Hatay	682.8	3 414	364.5	10.677
İçel	706.24	3 531.2	218.7	6.193
Iğdır	0.35	1.76	0	0.000
Isparta	284.62	1 423.12	61.2	4.300
İstanbul	835.39	4 176.96	294.1	7.041
İzmir	2 370.86	11 854.32	1 549.5	13.071
Kahramanmaraş	414.48	2 072.4	86.4	4.169
Karabük	14.67	73.36	0	0.000
Karaman	186.72	933.6	0	0.000
Kars	0.67	3.36	0	0.000
Kastamonu	102.98	514.88	0	0.000
Kayseri	377.06	1 885.28	275.1	14.592
Kilis	0	0	0	No Potential
Kırıkkale	0	0	0	No Potential
Kırklareli	615.87	3 079.36	199.6	6.482
Kırşehir	0	0	168	No Potential
Kocaeli	15.57	77.84	10.2	13.104
Konya	372.02	1 860.08	165.5	8.897
Kütahya	38.03	190.16	0	0.000
Malatya	279.01	1 395.04	11.7	0.839
Manisa	1 060.46	5 302.32	689.95	13.012
Mardin	101.78	508.88	0	0.000
Muğla	1 034.19	5 170.96	197.25	3.815
Muş	0	0	0	No Potential
Nevşehir	1.65	8.24	0	0.000
Niğde	12.42	62.08	0	0.000
Ordu	455.15	2 275.76	0	0.000
Osmaniye	143.62	718.08	265.3	36.946
Rize	0	0	0	No Potential
Sakarya	0.4	2	0	0.000
Samsun	1 044.5	5 222.48	17.5	0.335
Şanlıurfa	0.05	0.24	0	0.000
Siirt	3.01	15.04	0	0.000
Sinop	298.22	1 491.12	0	0.000
Şırnak	0	0	0	No Potential
Sivas	328.5	1 642.48	155.3	9.455
Tekirdağ	925.33	4 626.64	174.2	3.765
Tokat	600.5	3 002.48	140.7	4.686
Trabzon	3.38	16.88	0	0.000
Tunceli	2.62	13.12	0	0.000
Uşak	1.86	9.28	54	581.897
Van	3.88	19.36	0	0.000
Yalova	106.62	533.12	106.85	20.042
Yozgat	215.3	1 076.48	0	0.000
Zonguldak	0	0	0	No Potential
TURKEY	**22 834.85**	**114 174.08**	**8 056.55**	**7.056**

- *Utilization Rate = (Existent Installed Power x 100) / (Potential Installed Power)

In the light of the information obtained, we can say that Turkey's potential area for wind power installation is 22,834.85 km^2 and this area is suitable for wind power plant installation with an

installed power of more than 114 GW. However, this potential is only used around 7% yet and that's about 8 GW.

3.3. Biomass Energy

Turkey's total biomass energy potential is shown in the following Table-4.

Table 4. Turkey's total biomass energy potential [18]

Resources	Total Theoretical Energy Equivalent (TOE/Year)	Potential Installed Power (MW)	Existent Electricity Generation Plants		Utilization Rate* (%)
			Number	Installed Power (MWe)	
Animal/Herbal Waste	29 769 642	49 452.00	79	363.332	0.73
Municipal Waste	3 373 011	5 603.05	111	544.029	9.71
Forest Residues	859 899	1 428.42	8	104.952	7.35
TOTAL	**34 002 552**	**56 483.47**	**198**	**1 012.313**	**1.79**

- *Utilization Rate = (Existent Installed Power x 100) / (Potential Installed Power)

According to this information obtained, we can say that Turkey's annual biomass energy potential is around 34 million TOE (Ton Equivalent Oil) and the meaning of this amount is approximately 56.5 GW of potential installed power but unfortunately Turkey utilizes only 1.79% of its total biomass potential.

4. COMPARISON OF EXISTING INVESTMENTS WITH ECC INVESTMENTS

This chapter is included the economical comparison of the investments made in the current system and the investments made with the Energy Cooperative Center (ECC) which is mentioned in the second chapter of this paper.

4.1. Solar Energy Investment Benchmark

Table-5 below is a benchmark chart. It is compared a solar power plant (SPP) investment to be made by the Energy Cooperative Center (ECC) with an installed capacity of 10 MW and a rooftop solar system to be made by personal initiatives with an installed capacity of 12 kW. At the same time, the change in the amortization periods in both investments is presented. The values mentioned are approximate real values.

In this sample, the stages of a 10 MW SPP investment to be made by ECC are as follows:

- Planning a SPP project for the needs of the region –> 10 MW (Estimated)

- Determining the investment cost –> 900,000 $ / MW : While determining the investment cost, it was evaluated that 1 MW SPP investment costs were approximately $ 1,000,000 but an additional 10% discount would be possible for 10 MW SPP investment [19-21].
- Determining a profit table (Table-5, Parameter-k) –> 4,479 Turkish Liras (TL) : With the increases due to annual inflation, it is guaranteed that profit sharing will be at least 20 years.
- Determining the share price and selling shares –> 144,500 TL (Table-5, Parameter-e)
- Taxes are not included in the calculation. Tax and operating expenses belong to ECC.

In this sample, the stages of a 12 kW SPP investment to be made by personal initiative are as follows:

- It is an on-grid investment for individual needs.
- Investment cost is taken from an EPC company in Turkey.
- Taxes are not included in the calculation.
- It is assumed to benefit from YEKDEM purchase guarantee [22].

Table 5. Comparison of ECC SPP (10 MW) and personal initiative SPP (12 kW)

Parameters	Equations	ECC SPP	Rooftop SPP
a. Installed Power (kW)	a	10 000	12
b. Investment Cost ($)	b	9 000 000	17 000
c. Dollar Price (TL, November 2020)	c	8.5	8.5
d. Investment Cost (TL)	d = b x c	76 500 000	144 500
e. Share Price (TL)	e	144 500	144 500
f. Number of Investors	f = d / e	530	1
g. Daily Sunshine Duration (h)	g	7	7
h. Monthly Sunshine Duration (h)	h = g x 30	210	210
i. YEKDEM Purchase Guarantee ($)	i	0.133	0.133
j. Monthly Income (TL)	j = a x h x i x c	2 374 050	2 849
k. Monthly Profit per Person (TL)	k = j / f	4 479	2 849
m. Annual Inflation	m	%10	%10
n. Construction Time (Year)	n	2	1
p. Share's Present Value (TL)	$p = e \times (1 + m)^{n}$	174 845	158 950
r. Amortization Period (Month)	r = p / k	39	55
s. Operating Time (Month)	s	240	240

4.2. Wind Energy Investment Benchmark

Table-6 below is a benchmark chart. It is compared a wind power plant (WPP) investment to be made by the Energy Cooperative Center (ECC) with an installed capacity of 30 MW and a wind power plant investment to be made by personal initiatives with an installed capacity of 1 MW. At

the same time, the change in the amortization periods in both investments is presented. The values mentioned are approximate real values.

In this sample, the stages of a 30 MW WPP investment to be made by ECC are as follows:

- Planning a WPP project for the needs of the region –> 30 MW (Estimated)
- Determining the investment cost –> 1,346,376.253 $ / MW [23].
- Determining a profit table (Table-6, Parameter-k) –> 6,923 TL : With the increases due to annual inflation, it is guaranteed that profit sharing will be at least 20 years.
- Determining the share price and selling shares –> 500,000 TL
- Taxes are not included in the calculation. Tax and operating expenses belong to ECC.

In this sample, the stages of a 1 MW WPP investment to be made by personal initiative are as follows:

- The investment cost and the capacity factor are taken from academic studies [24].
- It is assumed that there is only one investor. Taxes are not included in the calculation.
- It is assumed to benefit from YEKDEM purchase guarantee [22].

Table 6. Comparison of ECC WPP (30 MW) and personal initiative WPP (1 MW)

Parameters	Equations	ECC WPP	Another WPP
a. Installed Power (kW)	a	30 000	1 000
b. Investment Cost ($)	b	40 391 288	1 750 000
c. Dollar Price (TL, November 2020)	c	8.5	8.5
d. Investment Cost (TL)	d = b x c	343 325 948	14 875 000
e. Share Price (TL)	e	500 000	14 875 000
f. Number of Investors	f = d / e	687	1
g. The Capacity Factor	g	0.35	0.35
h. Annual Working Time (h)	h = 365 x 24 x g	3 066	3 066
i. YEKDEM Purchase Guarantee ($)	i	0.073	0.073
j. Annual Income (TL)	j = a x h x i x c	57 073 590	1 902 453
k. Monthly Profit per Person (TL)	k = (j / f) / 12	6 923	158 537
m. Annual Inflation	m	%10	%10
n. Construction Time (Year)	n	2	1
p. Share's Present Value (TL)	$p = e \times (1 + m)^{n}$	605 000	16 362 500
r. Amortization Period (Month)	r = p / k	87	103
s. Operating Time (Month)	s	240	240

5. OTHER INDIRECT BENEFITS OF ECC INVESTMENTS

In this chapter, indirect benefits of the investments to be made with ECC are briefly presented.

5.1. The Contribution of Decrease in Amortization Period to the National Capital

In order to calculate the contribution of the decrease in amortization period to the national capital, first of all, it is useful to show the average annual renewable energy installed power increase between 2008 and 2018. The data are shown in Table-7.

Table 7. Annual average renewable energy installed power increase between 2008-2018 [6-7]

Parameters	Equations	VALUE
a. 2008 Renewable Energy Installed Power (GW)	a	0.251
b. 2018 Renewable Energy Installed Power (GW)	b	11.2
c. Renewable Energy Installed Power Increase (GW)	c = b - a	10.949
d. Annual Average Renewable Energy Installed Power Increase (GW)	d = c / 10	1.0949

As it is presented in Table-5 and Table-6, we can assume that the amortization period would be shorter than the current situation by 16 months in an environment where both solar and wind energy investments are made with ECC in Turkey. We can calculate the contribution of this situation to the national capital on an annual basis as shown in Table-8.

Table 8. Annual contribution to national capital of Turkey of shortening amortization periods with ECC

Parameters	Equations	Value
a. 2008 Renewable Energy Installed Power (GW)	a	0.251
b. 2018 Renewable Energy Installed Power (GW)	b	11.2
c. Renewable Energy Installed Power Increase (GW)	c = b - a	10.949
d. Annual Average Renewable Energy Installed Power Increase (GW)	d = c / 10	1.0949
e. Decrease in Amortization Period (Month)	e	16
f. Annual Working Time (h)	f	2 400
g. Working Time in Amortization Period (h)	g = (f / 12) * e	3 200
h. Total Generation (GWh)	h = d * g	3 504
i. Total Generation (kWh)	$i = h * 10^6$	3 504 000 000
j. YEKDEM Purchase Guarantee ($/kWh)	j	0.133
k. Dollar Price (TL)	k	8.5
m.Annual Average Contribution (TL)	**m = i * j * k**	**3 961 272 000**

If it is assumed that whole renewable energy investments completed every year are made with ECC, parameter-m shows the contribution of electricity generated during the 16-month amortization period to national capital. So, renewable power plants was installed approximately 1.1 GW (Table-8, Parameter-d) every year between 2008-2018 in Turkey. However, if these investments are made with ECC, the amortization period can be shortened to almost 16 months. It can be stated that most of the excess electricity generated by these power plants during 16 months was spent on the repayment of imported technology and costs. All these expenditures add approximately extra 4 billion TL (Parameter-m) per year to the national capital. If renewable

energy investments are made with ECC policies, the decrease in the amortization period will be reflected to the national capital as an annual gain of approximately 4 billion TL.

5.2. Reduction in Greenhouse Gas Emissions

"In wind power plants, 977.84 $kgCO_2$-eq less greenhouse gas are released per unit (MWh) of electricity than coal-fired thermal power plants. On the other hand, in solar PV power plants, 923.25 $kgCO_2$-eq less greenhouse gas per unit (MWh) electricity generation are released compared to coal-fired thermal power plants" [25]. According to this:

- If it had been wind power plants all instead of thermal power plants that generated 37.2% of the 304,802 GWh of electricity in Turkey in 2018, 111 million tons of CO_2 less greenhouse gases would have been released to the nature in 2018.
- If it had been solar power plants all instead of thermal power plants that generated 37.2% of the 304,802 GWh of electricity in Turkey in 2018, 106 million tons of CO_2 less greenhouse gases would have been released to the nature in 2018.

5.3. Contribution of the Power Plants' Salvage Value to the National Capital

It is considered that salvage value of wind and solar power plants which is calculated in the 4th chapter of this paper are at least 20 percent [23]. In this case, the salvage values of the power plants that have completed their economic life will also have a positive contribution to the national capital. With a simple calculation;

Table 9. Salvage value calculations of power plants to be built with ECC

Parameters	Equations	ECC WPP	ECC SPP
a. Installed Power (kW)	a	30 000	10 000
b. Investment Cost ($)	b	40 391 288	9 000 000
c. Dollar Price (TL, November 2020)	c	8.5	8.5
d. Investment Cost (TL)	d = b x c	343 325 948	76 500 000
e. Salvage Value (TL)	e = d * %20	68 665 190	15 300 000
f. Salvage Value per kW (TL)	f = e / a	2 289	1 530

When Table-8 and Table-9 are evaluated together, it is possible to reach the following results;

- It can be interpreted that if the annual average renewable energy installed power increase was entirely through solar energy investments, then solar power plants with an annual average installed power of 1.0949 GW (Table-7, Parameter-d) would be scrapped. As shown in the following account, from solar power plants that have been invested without

spending state resources with ECC, the saving of approximately 1.6 billion TL can be contributed annually to the national capital.
1.0949 GW/Year * 106 kW/GW * 1,530 TL/kW = 1,675,197,000 TL/Year

- It can be interpreted that if the annual average renewable energy installed power increase were entirely through wind energy investments, the wind power plants with an annual average installed power of 1.0949 GW (Table-7, Parameter-d) would be scrapped. As shown in the following account, from wind power plants that have been invested without spending state resources with ECC, the saving of approximately 2.5 billion TL can be contributed annually to the national capital.
  1.0949 GW/Year * 106 kW/GW * 2,289 TL/kW = 2,506,226,100 TL/Year

6. CONCLUSION

In this paper, the advantages of "the Model of Free Investment & Centralised Management in Renewable Energy Production Projects" were presented together with economic data for Turkey to accelerate its renewable energy production projects, to increase efficiency of power production in Turkey, to transform renewable energy investments into an alternative investment opportunity for citizens. First of all, it was stated what the purpose was in the expressions of "Free Investment" and "Centralised Management" among with what advantages will be revealed. Then a public institution was proposed to carry out the audit and execution duties in that investment model. The duties and principles of this institution which is called the Energy Cooperative Center (ECC) were presented.

Obviously, the first and most important issue in the investment models offered is to determine the Turkey's renewable energy potential. For this, especially wind and biomass energy potential in Turkey examined province by province or region by region. Because, one of the most important tasks of ECC is to determine which type of investment is more advantageous in the specific region where electricity production is needed.

Germany's annual sunshine duration and global radiation value is lower than Turkey but despite Germany's solar power installed capacity is much more than Turkey. Because of this reason, it was compared Turkey's solar energy potential with Germany to determine the solar energy potential of Turkey. When technical values of Germany was compared with Turkey's technical

value, the following conclusion was reached that Turkey has the potential to reach at least 87 GW installed solar power. Actually at this point, the main object is to see that Turkey's installed solar power of 6.3 GW is far below its potential rather than specify Turkey's installed power potential.

Turkey also has high level potential in wind energy. In particular, it can be said that Turkey has the potential to over 114 GW installed power. Since it is known that the current installed power is around 8 GW, it is a fact that only about 7% of the potential is used.

The situation is no different for biomass energy. When Turkey's biomass energy potential examined region by region and type by type, it seems that there is a huge potential and however millions of TOE energy resources cannot be used every year, especially in animal and herbal wastes. Turkey has an installed power potential of 49.4 GW in animal and herbal wastes, 5.6 GW in municipal wastes and 1.4 GW in forest residues. However, it is known that it has only 1 GW of installed power sourced from biomass in total.

In the approximate calculations made with an example solar energy investment comparison, it was mentioned that the monthly profitability of the investments to be made with ECC can increase at very serious levels and the amortization period can be shortened by approaching 30%. Likewise, in the approximate calculations made with an example wind energy investment comparison, it was mentioned that there may be shortening of the amortization period approaching 15%. The advantages that can be obtained with ECC investments are not limited to these.

With the "Free Investment" policy which is one of the principles of the method, there is a possibility that cushion of capital can be brought into production which it is estimated at least 500 billion dollars in Turkey [26]. By calculating the effect of the shortening of the amortization period to national capital, it has been revealed that around 4 billion TL can be saved annually with ECC. It has been evaluated that a reduction in greenhouse gas is possible with ECC, this has shown that at least 100 million tons of CO_2 less emission to the environment annually can be achieved. The salvage values of the power plants that have been installed and whose economic life has been completed will also contribute significantly to the national capital. With the completion of the economic life of renewable energy plants, the capital of which is fully

provided by the contribution of citizens, the salvage values that will come out can be approximately 1.5-2.5 billion TL per year.

As a suggestion built on these results, it is regarded to be a method should be considered for renewable energy-rich countries such as Turkey that it was detailed of "The Model of Free Investment & Centralised Management in Renewable Energy Production Projects" which are presented in this paper.

Declaration of Ethical Standards

The authors of the paper submitted declare that nothing which is necessary for achieving the paper requires ethical committee and/or legal-special permissions.

Contribution of the Authors

Selman Demirkesen: Methodology, Formal analysis, Investigation, Writing – Original Draft, Visualization.

Halil İbrahim Variyenli: Conceptualization, Writing – Original Draft, Supervision, Project administration.

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