Energy Economics Letters
ISSN(e): 2308-2925
DOI: 10.18488/journal.82.2018.51.23.30
Vol. 5, No. 1, 23-30

URL: www.aessweb.com

PREDICTION OF ENERGY CONSUMPTION OF TURKEY ON SECTORAL BASES BY ARIMA MODEL

Suat Ozturk[1]
Feride Ozturk[2+]

[1]*DERAC, Zonguldak Bülent Ecevit University, Zonguldak, Turkey*
Email: suatozturk@beun.edu.tr Tel: (+90)372 291 1526
[2]*Department of International Trade and Business, Zonguldak Bülent Ecevit University, Zonguldak, Turkey*
Email: feride.ozturk@beun.edu.tr Tel: (+90)372 291 1397

(+ Corresponding author)

Article History
Received: 3 October 2018
Revised: 8 November 2018
Accepted: 10 December 2018
Published: 11 January 2019

Keywords
ARIMA
Forecasting
Energy consumption
Turkey
Sectoral energy consumption
Energy policy

JEL Classification:
C50, C52, Q40, Q47.

ABSTRACT

Prediction of sectoral or total energy consumption for any country is very important issue to plan both short and long-term energy strategies and policies. In this study, the historical energy consumption data of four sectors and their total from 1970 to 2015 is used in a class of autoregressive integrated moving average (ARIMA) models to predict both sectoral and total energy consumption of Turkey for the next 15 years. The results indicate that Turkey's sectoral and total energy consumption will be following an upward trend during the forecast period. Energy consumptions of industry, transport, residential-commercial and public service and agriculture sectors and their total will continue to increase at an annual average rate of 1.59 %, 4.66 %, 2.97 %, 2.46 % and 3.93 %, respectively, in the next 15 years.

Contribution/ Originality: In a large number of empirical studies, total energy consumption has been predicted for various countries while the empirical work related to sectoral energy consumption prediction is scarce. In addition, the studies that predicted the sectoral energy consumption is generally consider one sector of the economy. The contribution of this study is to predict energy consumptions of industry, transport, residential-commercial and public service and agriculture sectors and their total for Turkey from 2016 to 2030.

1. INTRODUCTION

Turkey is roughly located at the intersection point of Europe and Asia from the east to the west with Africa and Europe from the south to the north and has 774,815 km^2 surface area (Bilgili *et al.*, 2012). According to Turkish Statistical Institute (TSI), Turkey's population regularly average annual increase of 1.8% from 34.8 million in 1970 to 78.7 million in 2015 and increased by 126% in 45 years. The population of Turkey is estimated to be over 88 million by 2030 (Turkish Statistical Institute, 2013). Hence, it is expected that the country's energy needs will further increase in the near future.

An increase in population, fastening economic growth and development have led sectoral energy demand to rise up over the centuries. Energy demand of developing countries approximately increases between 6% and 8% per year (Karaaslan and Gezen, 2017). Therefore, predicting future energy needs is vital to determine and plan energy policies and strategies investing in various sectors to meet future energy demand.

In the related literature, many studies used various methods to forecast future energy demand of Turkey and other countries at total or sectoral bases. Sözen (2009) made a future projection of energy dependency of Turkey using an artificial neural network (ANN) model. Hamzaçebi (2007) estimated Turkey's net electricity energy consumption on sectoral basis applying ANN. Dilaver and Hunt (2011) forecasted an industrial electricity demand for Turkey by structural time series model (STSM). Jobert and Karanfil (2007) used notion of Granger and instantaneous causality to find sectoral energy consumption by source and economic growth in Turkey. Sözen *et al.* (2007) forecasted sectoral energy consumption of greenhouse gas emissions in Turkey and mitigation policies using ANN. Dilaver and Hunt (2011) applied underlying energy demand trend (UEDT) and STSM models to forecast Turkish residential electricity demand. Liu *et al.* (2016) combined a grey neural network and input-output forecasting models to predict primary energy consumption of sectors of Spanish economy. Chai *et al.* (2016) analyzed energy demand of transportation sector in China using an exponential smoothing, ARIMA and multi regression methods. Azadeh *et al.* (2008) predicted electricity consumption of industrial sector in Iran by ANN. Sen *et al.* (2016) applied ARIMA for forecasting energy consumption of pig iron manufacturing in India. Yuan *et al.* (2016) compared ARIMA and Grey models for forecasting primary energy consumption of China. Li *et al.* (2012) forecasted short-term electricity consumption for Asian developing countries using an adaptive Grey-based approach. Ghedamsi *et al.* (2016) used a bottom-up model to predict energy consumption for residential buildings in Algeria. Pukšec *et al.* (2013) forecasted long-term energy demand of Croatian transport sector using EDT model. Cabral *et al.* (2017) predicted electricity consumption in Brazil by Spatial ARIMA model. Hussain *et al.* (2016) predicted electricity consumption in Pakistan via ARIMA model.

In this study, energy consumption data of industry, transport, residential-commercial and public service, and agriculture sectors and their total of Turkey for 1970-2015 is utilized to predict energy consumption for the period of 2016-2030. The energy consumption projection of the sectors are carried out with a class of univariate ARIMA models. It is believed that the present study will contribute to the limited amount of research in the related literature on Turkey's energy consumption in sectoral bases and will be reference to both policy planers and makers. The rest of the study is organized as follows. Section 2 describes data sources and empirical methodology used. Section 3 presents the results of the ARIMA models in predicting yearly energy consumption of sectors of the economy and their total for the next fifteen years and policy implications. The last section contains concluding remarks.

2. DATA AND METHODOLOGY

This study is based on historical data on energy consumption of industry, transport, residential-commercial and public service, agriculture sectors and their total for the 1970-2015 period. The data is extracted from website of Turkish General Directorate of Energy. The energy consumption variables are measured in ton of oil equivalent (toe). E-Views 9 statistical software is used to estimate a class of univariate ARIMA models.

ARIMA models were introduced by Box and Jenkins (1970). These are the most popular class of models for forecasting time series and have been broadly used. ARIMA depends on autocorellation patterns in the series because it uses the information in the series itself to make forecast without involving independent variables (Box and Jenkins, 1976).

ARIMA (p, d, q) model has three parameters: (1) order of autoregressive process (AR), (2) the order of difference to make non-stationary series stationary (I), and (3) the order of moving average process (MA), represented respectively by “p”, “d” and “q”.

The equation of the generalized univariate ARIMA model is

$$Y_t = \mu + \alpha_1 Y_{t-1} + \ldots + \alpha_p Y_{t-p} - \theta_1 e_{t-1} - \ldots - \theta_q e_{t-q} \quad (1)$$

where the differenced time series value is Y_t, unknown parameters are α and θ, and independent identically distributed error terms are e. p is the number of autoregressive terms (AR) and q is the number of lagged forecast errors (MA) in the prediction equation .

3. EMPIRICAL RESULTS AND POLICY IMPLICATIONS

As stationary is essential in ARIMA forecasting, first ADF (Augmented Dickey-Fuller) unit root test is realized with and without a time trend variable. If unit root is found, it means that time series are non-stationary, using non-stationary series will result in spurious regression. ADF test results are given in Table 1. The results indicate that stationary situation is obtained in the first differences of all energy consumption variables. Therefore, first differences of the variables are included as dependent variable in each univariate ARIMA model, meaning that process I of the ARIMA models are determined as (1). Then, all the univariate ARIMA models are estimated in the following form:

$$Y_t - Y_{t-1} = \mu + \alpha_1 Y_{t-1} + \ldots + \alpha_p Y_{t-p} - \theta_1 e_{t-1} - \ldots - \theta_q e_{t-q} \quad (2)$$

where, $Y_t - Y_{t-1}$, is the first difference of energy consumption variable, namely an industry, transport, residential-commercial and public service, agriculture sectors and their total, unknown parameters are α and θ and independent identically distributed error terms with zero mean are e.

Table-1. The ADF Unit Root Test Results

Variables		Level	First Difference
Industry	wc	-1.73	-7.36*
	wct	-2.14	-7.62*
Transport	wc	-0.58	-5.81*
	wct	-2.89	-5.73*
Residential, Commercial and Public Service	wc	-2.02	-3.06**
	wct	-1.82	-3.22***
Agriculture	wc	-2.14	-6.53*
	wct	-1.75	-6.66*
Total Energy	wc	-2.04	-6.85*
	wct	-2.74	-7.27*

Notes: *, **, and *** indicate significant at 1%, 5%, and 10%, respectively. wc and wct are the test statistics for a unit root with a constant and with constant and trend. ADF lag lengths are selected based on Schwartz information criteria (SIC).

The order of the models parameters and thus the best fitted ARIMA models are selected based on Akaike information criterion (AIC). Figure 1 and Table 2 indicate that the ARIMA (1, 1, 1), ARIMA (0, 1, 0), ARIMA (0, 1, 0), ARIMA (1, 1, 2) and ARIMA (0, 1, 0) models give the smallest AIC for, an industry, transport, residential-commercial and public service, agriculture sectors and their total, respectively.

Model	LogL	AIC*	BIC	HQ
(1,1)(0,0)	-399.622610	17.548809	17.707821	17.608376
(0,2)(0,0)	-399.920991	17.561782	17.720795	17.621349
(2,0)(0,0)	-400.085885	17.568952	17.727964	17.628518
(0,1)(0,0)	-401.651383	17.593538	17.712798	17.638214
(1,2)(0,0)	-399.917004	17.605087	17.803853	17.679546
(0,3)(0,0)	-399.917374	17.605103	17.803869	17.679562
(3,0)(0,0)	-399.949831	17.606514	17.805280	17.680973
(2,1)(0,0)	-399.961237	17.607010	17.805776	17.681469
(2,2)(0,0)	-399.348721	17.623857	17.862376	17.713208
(0,0)(0,0)	-403.463442	17.628845	17.708351	17.658629
(4,1)(0,0)	-398.631790	17.636165	17.914436	17.740407
(1,0)(0,0)	-402.756340	17.641580	17.760839	17.686255
(0,4)(0,0)	-399.908685	17.648204	17.886722	17.737554
(1,3)(0,0)	-399.916987	17.648565	17.887083	17.737915
(4,0)(0,0)	-399.930919	17.649170	17.887689	17.738521
(2,3)(0,0)	-398.931177	17.649182	17.927453	17.753424
(2,4)(0,0)	-398.339221	17.666923	17.984947	17.786057
(4,2)(0,0)	-398.630387	17.679582	17.997607	17.798716
(3,3)(0,0)	-398.641926	17.680084	17.998108	17.799218
(3,4)(0,0)	-397.665119	17.681092	18.038870	17.815118
(4,4)(0,0)	-396.705119	17.682831	18.080362	17.831749
(4,3)(0,0)	-397.858580	17.689503	18.047281	17.823529
(3,2)(0,0)	-399.904711	17.691509	17.969781	17.795751
(1,4)(0,0)	-399.914617	17.691940	17.970211	17.796182
(3,1)(0,0)	-402.062648	17.741854	17.980373	17.831205

(a)

Model	LogL	AIC*	BIC	HQ
(0,0)(0,0)	58.136119	-2.440701	-2.361195	-2.410917
(1,2)(0,0)	60.955407	-2.432844	-2.234078	-2.358385
(4,4)(0,0)	65.609026	-2.417784	-2.020253	-2.268866
(0,1)(0,0)	58.425217	-2.409792	-2.290533	-2.365117
(1,0)(0,0)	58.338284	-2.406012	-2.286753	-2.361337
(4,1)(0,0)	62.294235	-2.404097	-2.125826	-2.299855
(1,3)(0,0)	60.955637	-2.389376	-2.150857	-2.300025
(0,2)(0,0)	58.925915	-2.388083	-2.229071	-2.328516
(2,0)(0,0)	58.840357	-2.384363	-2.225351	-2.324796
(1,1)(0,0)	58.723165	-2.379268	-2.220256	-2.319701
(0,4)(0,0)	60.251499	-2.358761	-2.120242	-2.269410
(1,4)(0,0)	61.115442	-2.352845	-2.074574	-2.248603
(2,1)(0,0)	58.942746	-2.345337	-2.146571	-2.270878
(3,0)(0,0)	58.941633	-2.345288	-2.146523	-2.270830
(0,3)(0,0)	58.937167	-2.345094	-2.146329	-2.270636
(2,3)(0,0)	60.416887	-2.322473	-2.044202	-2.218231
(3,2)(0,0)	60.242624	-2.314897	-2.036625	-2.210655
(2,2)(0,0)	59.229043	-2.314306	-2.075788	-2.224956
(4,0)(0,0)	59.045459	-2.306324	-2.067806	-2.216974
(3,4)(0,0)	61.991516	-2.303979	-1.946201	-2.169953
(3,1)(0,0)	58.961619	-2.302679	-2.064161	-2.213329
(4,2)(0,0)	60.584562	-2.286285	-1.968261	-2.167151
(3,3)(0,0)	60.429461	-2.279542	-1.961517	-2.160408
(4,3)(0,0)	61.392864	-2.277951	-1.920173	-2.143925
(2,4)(0,0)	59.769999	-2.250870	-1.932845	-2.131736

(b)

Model	LogL	AIC*	BIC	HQ
(0,0)(0,0)	76.044055	-3.219307	-3.139801	-3.189523
(2,2)(0,0)	79.573893	-3.198865	-2.960346	-3.109514
(1,1)(0,0)	77.378145	-3.190354	-3.031342	-3.130787
(0,1)(0,0)	76.116163	-3.178964	-3.059704	-3.134288
(1,0)(0,0)	76.094882	-3.178038	-3.058779	-3.133363
(3,2)(0,0)	79.801879	-3.165299	-2.887028	-3.061057
(2,3)(0,0)	79.767472	-3.163803	-2.885532	-3.059561
(2,0)(0,0)	76.630163	-3.157833	-2.998821	-3.098266
(0,2)(0,0)	76.578860	-3.155603	-2.996590	-3.096036
(1,2)(0,0)	77.443359	-3.149711	-2.950946	-3.075253
(2,4)(0,0)	79.934350	-3.127580	-2.809556	-3.008447
(4,2)(0,0)	79.866746	-3.124641	-2.806617	-3.005507
(3,3)(0,0)	79.829299	-3.123013	-2.804988	-3.003879
(3,0)(0,0)	76.637968	-3.114694	-2.915929	-3.040236
(2,1)(0,0)	76.633946	-3.114519	-2.915754	-3.040061
(0,3)(0,0)	76.596339	-3.112884	-2.914119	-3.038426
(4,3)(0,0)	80.455444	-3.106758	-2.748981	-2.972733
(4,0)(0,0)	76.796591	-3.078113	-2.839594	-2.988762
(3,1)(0,0)	76.683972	-3.073216	-2.834698	-2.983866
(1,3)(0,0)	76.637767	-3.071207	-2.832689	-2.981857
(0,4)(0,0)	76.619113	-3.070396	-2.831878	-2.981046
(4,1)(0,0)	76.799236	-3.034749	-2.756478	-2.930507
(1,4)(0,0)	76.695916	-3.030257	-2.751986	-2.926015
(3,4)(0,0)	76.010284	-2.913491	-2.555713	-2.779465
(4,4)(0,0)	76.022042	-2.870524	-2.472993	-2.721606

(c)

Model	LogL	AIC*	BIC	HQ
(1,2)(0,0)	-312.036444	13.784193	13.982959	13.858652
(0,3)(0,0)	-312.290878	13.795256	13.994021	13.869714
(0,2)(0,0)	-313.450964	13.802216	13.961228	13.861783
(0,4)(0,0)	-311.942795	13.823600	14.062118	13.912950
(2,2)(0,0)	-312.021903	13.827039	14.065558	13.916390
(1,3)(0,0)	-312.029049	13.827350	14.065868	13.916700
(2,1)(0,0)	-313.425655	13.844594	14.043359	13.919052
(4,1)(0,0)	-311.717799	13.857296	14.135567	13.961538
(3,2)(0,0)	-311.726413	13.857670	14.135942	13.961912
(1,4)(0,0)	-311.738358	13.858189	14.136461	13.962432
(3,3)(0,0)	-310.837125	13.862484	14.180508	13.981618
(3,1)(0,0)	-312.917656	13.865985	14.104503	13.955335
(2,0)(0,0)	-315.430855	13.888298	14.047310	13.947865
(2,4)(0,0)	-311.650783	13.897860	14.215885	14.016994
(4,2)(0,0)	-311.716991	13.900739	14.218763	14.019873
(3,4)(0,0)	-310.775390	13.903278	14.261055	14.037303
(1,1)(0,0)	-316.345196	13.928052	14.087064	13.987619
(4,4)(0,0)	-310.405812	13.930687	14.328218	14.079605
(3,0)(0,0)	-315.424369	13.931494	14.130260	14.005953
(4,0)(0,0)	-314.600971	13.939173	14.177691	14.028523
(4,3)(0,0)	-311.650098	13.941309	14.299086	14.075334
(0,1)(0,0)	-318.298931	13.969519	14.088778	14.014194
(0,0)(0,0)	-319.329240	13.970837	14.050343	14.000620
(1,0)(0,0)	-319.043206	14.001879	14.121138	14.046554
(2,3)(0,0)	-319.398817	14.191253	14.469524	14.295495

(d)

Model	LogL	AIC*	BIC	HQ
(0,0)(0,0)	73.533935	-3.110171	-3.030665	-3.080388
(0,1)(0,0)	73.948345	-3.084711	-2.965451	-3.040035
(1,0)(0,0)	73.804027	-3.078436	-2.959177	-3.033761
(0,2)(0,0)	74.622009	-3.070522	-2.911510	-3.010955
(2,0)(0,0)	74.565450	-3.068063	-2.909051	-3.008496
(1,2)(0,0)	75.456723	-3.063336	-2.864570	-2.988877
(2,2)(0,0)	76.261385	-3.054843	-2.816324	-2.965492
(0,3)(0,0)	74.942695	-3.040987	-2.842221	-2.966528
(3,0)(0,0)	74.615694	-3.026769	-2.828004	-2.952311
(2,1)(0,0)	74.593797	-3.025817	-2.827052	-2.951359
(1,3)(0,0)	75.511857	-3.022255	-2.783736	-2.932904
(1,1)(0,0)	73.509045	-3.022132	-2.863120	-2.962565
(3,3)(0,0)	77.360868	-3.015690	-2.697665	-2.896556
(3,2)(0,0)	76.274049	-3.011915	-2.733644	-2.907673
(0,4)(0,0)	74.949764	-2.997816	-2.759297	-2.908465
(4,0)(0,0)	74.783463	-2.990585	-2.752067	-2.901235
(3,1)(0,0)	74.668192	-2.985574	-2.747055	-2.896223
(1,4)(0,0)	75.598177	-2.982529	-2.704258	-2.878287
(3,4)(0,0)	77.530847	-2.979602	-2.621824	-2.845576
(4,4)(0,0)	78.481656	-2.977463	-2.579933	-2.828546
(4,2)(0,0)	76.274452	-2.968454	-2.650430	-2.849321
(2,4)(0,0)	76.274150	-2.968441	-2.650417	-2.849307
(4,1)(0,0)	74.796868	-2.947690	-2.669418	-2.843448
(2,3)(0,0)	73.471744	-2.890076	-2.611804	-2.785834
(4,3)(0,0)	73.484976	-2.803695	-2.445917	-2.669669

(e)

Figure-1. Model Selection Criteria Tables: (a) industry, (b) transport, (c) residential-commercial and public service, (d) agriculture, and (e) sectors total.

Table-2. Evaluation of Various ARIMA Models Based on AIC

Dependent Variable	ARIMA (p, d, q)	AIC
Industry	ARIMA (1, 1, 1)	17.55
Transport	ARIMA (0, 1, 0)	-2.44
Residential, Commercial and Public Service	ARIMA (0, 1, 0)	-3.22
Agriculture	ARIMA (1, 1, 2)	13.78
Sectors Total	ARIMA (0, 1, 0)	-3.11

According to the study results, the energy consumptions of all the sectors are expected to increase by the end of 2030. Figure 2 (a) and Table 3 indicate that there is an ascending energy consumption of industry in Turkey with respect to forecasted industrial energy consumption values. The energy consumption of industry will continue to increase at an annual average rate of 1.59 % and will reach to 41 million toe in 2030 with 26.7 % increase from its value in 2015.

The energy consumption forecast in transport sector is presented in Figure 2 (b) and Table 3. It is expected that energy consumption of transport sector will rise 4.66 % on average in the next 15 years and will be over 49 million toe in 2030 with 98 % increase from its value in 2015. In the case of residential-commercial and public service sector's energy consumption, obtained results show that energy consumption will be over 50 million toe in 2030 (Figure 2 (c)) with an increase of 2.97 % at an annual average rate (Table 3). Its value in 2030 increases 55 % regarding its 2015 level.

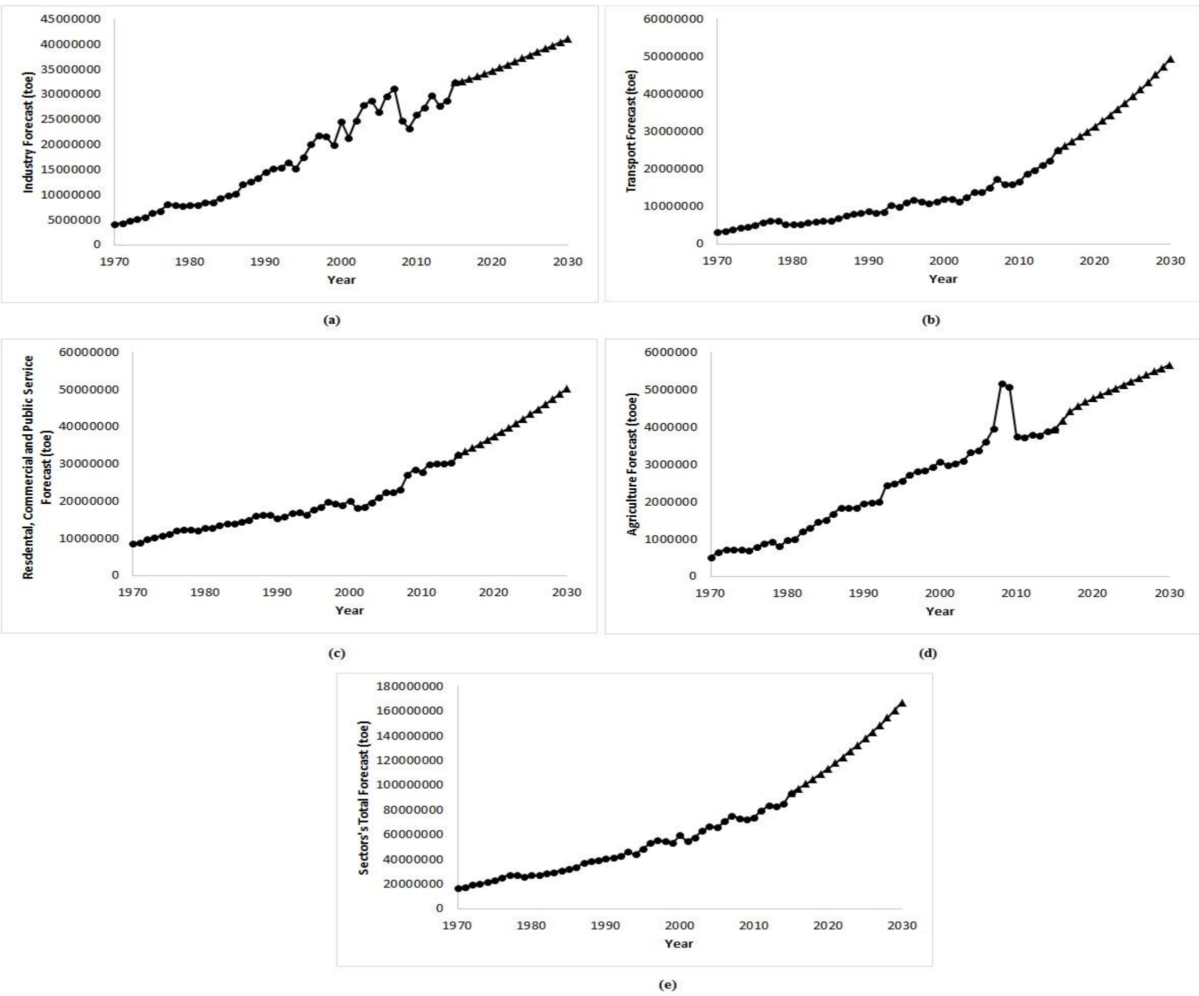

Figure-2. Forecasted and actual values of energy consumption (toe) for sectors in Turkey: (a) industry, (b) transport, (c) residential-commercial and public service, (d) agriculture, (e) sectors' total energy consumption.

The energy consumption of agriculture sector will increase at the annual average rate of 2.46 % in the next 15 years and its value will be over 5 million toe in 2030 with 43.9 % increase with respect to its value in 2015 as shown in Figure 2 (d) and Table 3. According to the forecasted total energy consumption of all sectors, it is expected to ascend at the annual average rate of 3.93 % and will be over 166 million toe in 2030 with 78.3 % increase from its 2015 level (Figure 2 (e) and Table 3).

Table-3. Forecasted Sectoral Energy Consumption for Turkey (toe)

Year	Industry	Transport	Residential-Commercial and Public Service	Agriculture	Sectors' Total
2016	32,599,424	26,098,590	33,289,681	4,169,712	97,216,398
2017	33,005,255	27,315,354	34,278,910	4,415,435	101,038,370
2018	33,504,651	28,588,845	35,297,534	4,558,161	105,010,599
2019	34,060,746	29,921,708	36,346,428	4,665,785	109,138,993
2020	34,651,198	31,316,713	37,426,490	4,761,447	113,429,690
2021	35,262,470	32,776,754	38,538,647	4,853,033	117,889,072
2022	35,886,358	34,304,866	39,683,853	4,943,230	122,523,771
2023	36,517,890	35,904,221	40,863,089	5,032,953	127,340,679
2024	37,154,055	37,578,141	42,077,367	5,122,514	132,346,958
2025	37,793,027	39,330,102	43,327,729	5,212,021	137,550,055
2026	38,433,701	41,163,742	44,615,246	5,301,509	142,957,707
2027	39,075,405	43,082,870	45,941,022	5,390,990	148,577,956
2028	39,717,733	45,091,472	47,306,195	5,480,470	154,419,159
2029	40,360,441	47,193,718	48,711,936	5,569,949	160,490,004
2030	41,003,377	49,393,974	50,159,449	5,659,427	166,799,518

The prediction results imply that the energy policies of Turkey need continuously evolve to meet rising energy demand of its sectors. As a part of Vision 2023, the government set up number of action plans, energy targets for 2023, and strategies on renewable energy and energy efficiency to meet the country's environmental goals and to ease rising import dependence. The energy goals to 2023 consist of fostering domestic energy sources, such as a 30% share of renewable energy in the electricity mix, decreasing energy intensity by 20% below 2010 levels by improving efficiency, and building three nuclear power plants (International Energy Agency (IEA), 2016).

Regarding renewable energy sources, Turkey has a great potential of hydro, solar, geothermal, and wind power. In 2015, the share of renewable energy among all energy consumption in Turkey reached to the highest point with 5.4%. Therefore, the government needs to evaluate more renewable energy sources to reduce country's external energy dependency. In this context, the government should set clear and long-term targets for subsectors in order to use of renewable energy sources up to 2023 and 2030, which will provide visibility for investors (IEA, 2016).

Turkey has a considerable potential to save energy in sectoral base but this potential is not determined since monitoring and evaluation have not been done. Therefore, collection of data on energy efficiency and reporting is very important in this context. Energy efficiency seems a main policy to follow up to boost economic productivity and energy security. The government should adopt a policy of setting upper limit on energy consumption to make investment, similar the policies pursued in China. Turkey had significant development in setting up the legal framework on energy efficiency in energy labelling and buildings. The institutional and governance structure of energy efficiency policies should be strengthened. For instance, as in other International Energy Agency member countries, Energy Efficiency National Agency with a clear view to reinforcing and enabling efforts in this policy plan across sectors of the economy. Furthermore, the government should adopt the National Energy Efficiency Action Plan to set quantitative productivity targets for the sectors and evaluate the progress towards to these targets (IEA, 2016).

4. CONCLUSION

The aim of this study is to predict energy consumptions of four sectors and their total for Turkey from 2016 to 2030. The historical data of sectoral energy consumptions are used from 1970 to 2015 and univariate ARIMA models are carried out for predictions. The best fitted ARIMA models are chosen according to AIC values among the estimated ARIMAs. The results indicate that sectoral-based energy consumption of Turkey will ascend permanently. Energy needs for industry, transport, residential-commercial and public service and agriculture sectors and their total will continue to increase at an annual average rate of 1.59 %, 4.66 %, 2.97 %, 2.46 % and 3.93 %, respectively in the next 15 years.

The predicted results present a guide for Turkey to determine energy strategy, policy and planning in the next 15 years. Turkey's energy strategy should be as follows; to ascend the ratio of renewable energy by allocating more resources to research and development on energy technologies on drilling, battery, sun panels, etc., to set long-term targets for subsectors of the economy in order to use of renewable energy sources, to reinforce governance structure of energy efficiency, to set quantitative productivity targets for the sectors of the economy and evaluate the progress towards the determined targets.

Funding: This study received no specific financial support.
Competing Interests: The authors declare that they have no competing interests.
Contributors/Acknowledgement: Both authors contributed equally to the conception and design of the study.

REFERENCES

Azadeh, A., S. Ghaderi and S. Sohrabkhani, 2008. Annual electricity consumption forecasting by neural network in high energy consuming industrial sectors. Energy Conversion and Management, 49(8): 2272-2278. Available at: https://doi.org/10.1016/j.enconman.2008.01.035.

Bilgili, M., B. Sahin, A. Yasar and E. Simsek, 2012. Electric energy demands of Turkey in residential and industrial sectors. Renewable and Sustainable Energy Reviews, 16(1): 404-414. Available at: https://doi.org/10.1016/j.rser.2011.08.005.

Box, G.E.P. and G.M. Jenkins, 1976. Time series analysis: Forecasting and control. Oakland, CA: Holden-Day.

Box, G.P.E. and G.M. Jenkins, 1970. Time series analysis: Forecasting and control. San Francisco: Holden Day.

Cabral, D.A.J., L.F.L. Legey and M.V. De Freitas Cabral, 2017. Electricity consumption forecasting in Brazil: A spatial econometrics approach. Energy, 126: 124-131. Available at: https://doi.org/10.1016/j.energy.2017.03.005.

Chai, J., Q.-Y. Lu, S.-Y. Wang and K.K. Lai, 2016. Analysis of road transportation energy consumption demand in China. Transportation Research Part D: Transport and Environment, 48: 112-124. Available at: https://doi.org/10.1016/j.trd.2016.08.009.

Dilaver, Z. and L.C. Hunt, 2011. Modelling and forecasting Turkish residential electricity demand. Energy Policy, 39(6): 3117-3127. Available at: https://doi.org/10.1016/j.enpol.2011.02.059.

Dilaver, Z. and L.C. Hunt, 2011. Industrial electricity demand for Turkey: A structural time series analysis. Energy Economics, 33(3): 426-436. Available at: https://doi.org/10.1016/j.eneco.2010.10.001.

Ghedamsi, R., N. Settou, A. Gouareh, A. Khamouli, N. Saifi, B. Recioui and B. Dokkar, 2016. Modeling and forecasting energy consumption for residential buildings in Algeria using bottom-up approach. Energy and Buildings, 121: 309-317. Available at: https://doi.org/10.1016/j.enbuild.2015.12.030.

Hamzaçebi, C., 2007. Forecasting of Turkey's net electricity energy consumption on sectoral bases. Energy Policy, 35(3): 2009-2016. Available at: https://doi.org/10.1016/j.enpol.2006.03.014.

Hussain, A., M. Rahman and J.A. Memon, 2016. Forecasting electricity consumption in Pakistan: The way forward. Energy policy, 90: 73-80. Available at: https://doi.org/10.1016/j.enpol.2015.11.028.

International Energy Agency (IEA), 2016. Energy policies of IEA countries: Turkey Available from https://webstore.iea.org/energy-policies-of-iea-countries-turkey-2016-review [Accessed 05.05.2017].

Jobert, T. and F. Karanfil, 2007. Sectoral energy consumption by source and economic growth in Turkey. Energy Policy, 35(11): 5447-5456. Available at: https://doi.org/10.1016/j.enpol.2007.05.008.

Karaaslan, A. and M. Gezen, 2017. Forecasting of Turkey's sectoral energy demand by using fuzzy grey regression model. International Journal of Energy Economics and Policy, 7(1): 67-77.

Li, D.-C., C.-J. Chang, C.-C. Chen and W.-C. Chen, 2012. Forecasting short-term electricity consumption using the adaptive grey-based approach—An Asian case. Omega, 40(6): 767-773. Available at: https://doi.org/10.1016/j.omega.2011.07.007.

Liu, X., B. Moreno and A.S. García, 2016. A grey neural network and input-output combined forecasting model. Primary energy consumption forecasts in Spanish economic sectors. Energy, 115: 1042-1054. Available at: https://doi.org/10.1016/j.energy.2016.09.017.

Pukšec, T., G. Krajačić, Z. Lulić, B.V. Mathiesen and N. Duić, 2013. Forecasting long-term energy demand of croatian transport sector. Energy, 57: 169-176. Available at: https://doi.org/10.1016/j.energy.2013.04.071.

Sen, P., M. Roy and P. Pal, 2016. Application of arima for forecasting energy consumption and ghg emission: A case study of an indian pig iron manufacturing organization. Energy, 116: 1031-1038. Available at: https://doi.org/10.1016/j.energy.2016.10.068.

Sözen, A., 2009. Future projection of the energy dependency of Turkey using artificial neural network. Energy Policy, 37(11): 4827-4833. Available at: https://doi.org/10.1016/j.enpol.2009.06.040.

Sözen, A., Z. Gülseven and E. Arcaklioğlu, 2007. Forecasting based on sectoral energy consumption of GHGs in Turkey and mitigation policies. Energy Policy, 35(12): 6491-6505. Available at: https://doi.org/10.1016/j.enpol.2007.08.024.

Turkish Statistical Institute, 2013. Ankara, Turkey. Available from http://www.turkstat.gov.tr/PreHaberBultenleri.do?id=15844 [Accessed 04.05.2017].

Yuan, C., S. Liu and Z. Fang, 2016. Comparison of China's primary energy consumption forecasting by using ARIMA (the autoregressive integrated moving average) model and GM (1, 1) model. Energy, 100: 384-390. Available at: https://doi.org/10.1016/j.energy.2016.02.001.