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Future Of Oil In Global Economy

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Abstract

In the economically growing world, oil has become the heart of all commercial activities and development. But the oil sector is facing an uncertain future. Firstly, it is a non-renewable energysource, and secondly, it is a significant contributor to carbon emissions. There is an increase in the consumption of alternative energy sources as substitutes for crude oil to overcome these issues. This paper aims to forecast the demand for oil in the coming years and analyze whether renewable energy sources can fulfill the oil demand. Three forecasting models — the Trend analysis model, the Growth rate model, and the ARIMA model — are employed to estimate the production and consumption of oil and renewable energy sources in 2050. The study's findings suggest that the increasing renewable energy production is not enough to fulfill the enormous increase in oil demand. It is also evaluated that renewable energy is possibly a good substitute for oil but not a perfect one. And hence, oil is likely to remain a significant source of energy even in the future.

Keywords: oil, renewable energy, trend analysis model, growth rate model, ARIMA model

1. Introduction

Oil is the primary feedstock for most economic activities and is an essential resource of energy[1].The fast economic growth has turned oil into the most traded commodity worldwide. According to the World Oil Outlook (2020), oil represented approximately one-third of energy demand worldwide. Crude oil is the plinth of many products. We are encircled by oil from clothing to transportation, medical, beauty products, furniture, electronics, etc. Precisely, oil is one of the vital commodities affecting us in numerous ways.

Oil is crucial for the enrichment of economies in both developed as well as developing countries. Empirical work found evidence of a significant bidirectional causal association between the consumption of oil and economic development. (Al-Mulali, 2011; Behmiri and Manso, 2013; Yuan, 2008; and Park and Yoo, 2014). According to B.P. Statistical Review of World Energy: 2020, oil consumption reached 100 million barrels per day in 2019 from 86 million barrels per

[1]BP. Statistical review of world energy, (http://www.BP.com);2016)

day in 2010. Despite the global pandemic COVID-19, when the world economies shattered, theoil demand grew by 0.9 million barrels per day or 0.9% in 2019. EIA forecasts that global oil consumption will reach 97.7 million barrels per day by the end of 2021, which is increased by 5.4 million b/d from 2020. Overall, 1.5 million barrels per day increase in the consumption of oilevery year since 2010.

It is reasonable to consider oil as the heart of the worldwide economic system. On the flip side, there is a breakdown. Firstly, being a non-renewable source of energy, one day we will probablyrun out of crude oil[2]. Secondly, the burning of oil gives rise to pollution and increases the alreadyalarming level of global warming. For that reason, oil is a contributory factor to greenhouse emissions (Bouwer 2019, IPCC 2014). The primary factors like energy shortages, global warming, deviations in oil prices, and the potential monopoly actions of OPEC are the foremost reasons to find alternative ways to balance the oil demand.

Oil has its advantages as well as disadvantages. Renewable energy resources are the only viable energy options that are environment-friendly and sustainable. Solar energy, coal mine methane, wind power, geothermal energy, nuclear energy, natural gas, LNG, and hydrogen fuel are various renewable energy resources that are a close substitute for oil. Many large economies, including the U.S., China, India, and several European nations, have resorted to large-scale use of solar energy. China is pushing big time towards renewable energy and has installed a large quantity ofphotovoltaic. India, also beset by pollution, is making a $160 billion plan for solar energy expansion[3].

The International Energy Outlook[4] reported that the fastest-growing energy source would be renewable energy. It stated that from 2007 to 2035, world renewable energy generation (electricity) and renewable energy consumption would go up by an estimated average of 3% and2.6% per year, respectively. Consequently, the renewable energy (electricity) share will be 23% in 2035, which was 18% in 2007. Hydroelectricity and wind energy are expected to be

[2] Millennium Alliance for Humanity and the Biosphere. “When Fossil Fuels run out, what then?

[3] Renewable Energy World, “US to support India’s $160 billion solar energy push.” Accessed April 29, 2020

[4] https://www.iea.org./reports/world-energy-outlook-2010

significant contributors to overall renewable energy (electricity) generation at 54% and 26%,respectively.

However, alternative energy sources will replace only a minor portion of the gap between declining production and the increasing oil demand. Omri (2015) confirms that renewable energymay be a compliment but not a perfect substitute for oil. Also, plastics, most of which are derived from petroleum, will continue to be important for various consumer and industrial applications. Shipping and airline industries may not immediately move from oil-based fuels. As per the Institute for Energy issues, most energy plants operating on solar and wind need steady power backups in the event of slow wind or weather being cloudy. In addition, solar panels and wind farms are quite expensive at present.

Foreseeing the future demand for oil when there is a rise in the consumption of renewables as a substitute for oil, two different theories are shelled out. According to OPEC, a group of oil- exporting countries, the demand for oil will increase in the future as the emerging world is goingto guzzle more and more of it. In 2019, one-third of global energy demand was represented by oil and is expected to continue to be the principal contributor to the energy mix by 2045, accounting for more than 27% (WOO, 2020). There is a different approach as mentioned by theInternational Energy Agency; the possibilities of oil being the major source of energy are strong,but if appropriate actions on climate change by environmental activists in the world, then oil demand could start spiraling downward.

Considering both aspects, the objective of this paper is to forecast the demand for oil in the future, despite moving from non-renewable to renewable energy. Three different forecasting models are employed to estimate oil and renewable energy demand and production in 2050. Based on forecasting results, it has been analyzed whether renewable energy production is sufficient to fulfill oil demand in the future. The remaining article is organized as follows.
Section 2 briefly reviews the related literature, section 3 discusses the data and the econometric method, section 4 talks about data analysis and interpretation and section 5 is discussion, and section 6 concludes the article.

2. Literature Review

Over the last few years, the relationship between oil consumption and economic growth has been extensively examined. The empirical studies (Wolde-Rufael and Menyah, 2010; Tsani, 2010) provide evidence of the positive relationship between oil consumption and economic growth.
One of the foremost studies by Lee and Chang's (2005) found unidirectional causality fromconsumption of oil to economic growth. Another group of studies also found bidirectional causality in consumption of oil and economic development (Yuan, 2008, Al-Mulali, 2011,Behmiri and Manso, 2012, Park and Yoo, 2014)

It has also been studied that increasing oil consumption contributes to economic growth on the one hand and causes environmental degradation on the other. A group of studies (Halicioglu,2009; Kim et al., 2010, Lean and Smyth, 2010; Pao and Tsai, 2010) has exposed thatenergy consumption and CO2 emissions are also positively correlated. Alam (2015) also found a significant dynamic causal relationship between oil consumption and CO2 emissions in developing economies. The finding of such researches extends concerns over global warming issues and proposes increasing renewable

energy consumption.

Sadorsky (2009) investigated the rationales of renewable energy consumption using panel cointegration techniques in the G7 countries and shows renewable energy consumption and carbon emissions are negatively correlated. Apergis (2018) also suggests that the rise in renewables consumption negatively correlates with CO2 emissions. Apart from rising attention to global warming, unpredictability in oil prices has led to the upward attractiveness of renewable energy to lower oil dependence.

The studies of Sadorsky (2009) and Omri and Nguyen (2014) found that the increase in oil priceis one of the motivators for increasing demand for renewable energy. Salim and Rafiq (2012) and Omri (2015) also observed that variation in oil prices significantly affects renewable energy demand. In contrast to these studies, Payne (2012) suggests that oil prices do not affect renewable energy consumption.

Some studies revealed a positive relationship between economic growth and renewable energy consumption (Menegak, 2011, Apergis and Payne, 2012; Salim and Rafiq, 2012; Tugcu, 2012;Omri, 2014). Salim and Rafiq (2012) studied the effect of renewable energy consumption on economic growth in emerging economies and found a positive relationship between them.

A group of studies researched the association between trade and demand for energy (Narayan, 2007, Lean and Smyth, 2010, Sadorsky, 2011, 2012). Trade openness tends to have a positive effect on renewable energy demand and boosts economic growth. Still, the impact of open trade on renewable energy demand has not been adequately investigated.

The studies mentioned above suggest carbon emission, volatility in oil price, and economic development are the foremost reasons to give rise to renewable energy as a substitute for oil. Still, how do countries move towards oil alternatives also depends on whether the country is oil-exporting or oil-importing? Oil exporters are not motivated to transform their energy production/consumption into renewable energy, and oil importers are searching to lower their economic and political dependence on oil (Deniz, 2019).

3. Data and Econometric Methods

Forecasting models are employed on monthly data of total production and consumption of oil and renewable energy from January 1997 to December 2020. The data of all these energy variables is extracted from the official website of the U.S. Energy Information Administration (EIA). Trend forecasting (Maxwell and Delenay, 2004), growth rate or semi-log forecasting, andARIMA forecasting models are employed with the help of E-Views 11 statistical software.

The Trend analysis model deals mainly with the recognition of trends presented by surfaces or lines. It is used to determine an equation that will help project the historical data into the future to analyze and forecast trends and patterns. Same as trend forecasting, growth rate forecasting models predict the future based on past data. In this series, we take a log of the time series to getthe exponential or continuous compounded growth rate of the time series and then forecast the value of the time series

based on the growth rate. It is also called the semi-log model as this model only considers the log of the explained variable.

In time series, ARIMA models are considered the most significant model of forecasting. It forecasts future values of a time series based on equation consisting of its historical values andlags of the forecasted errors. This model involves dependent variables so that these variables use the information provided by the data itself to predict future values. This model has three parameters say- p, d, q. These three parameters are - autoregressive process order represented by 'p', difference order to get stationary series represented by 'd' and moving average process orderrepresented by 'q'.

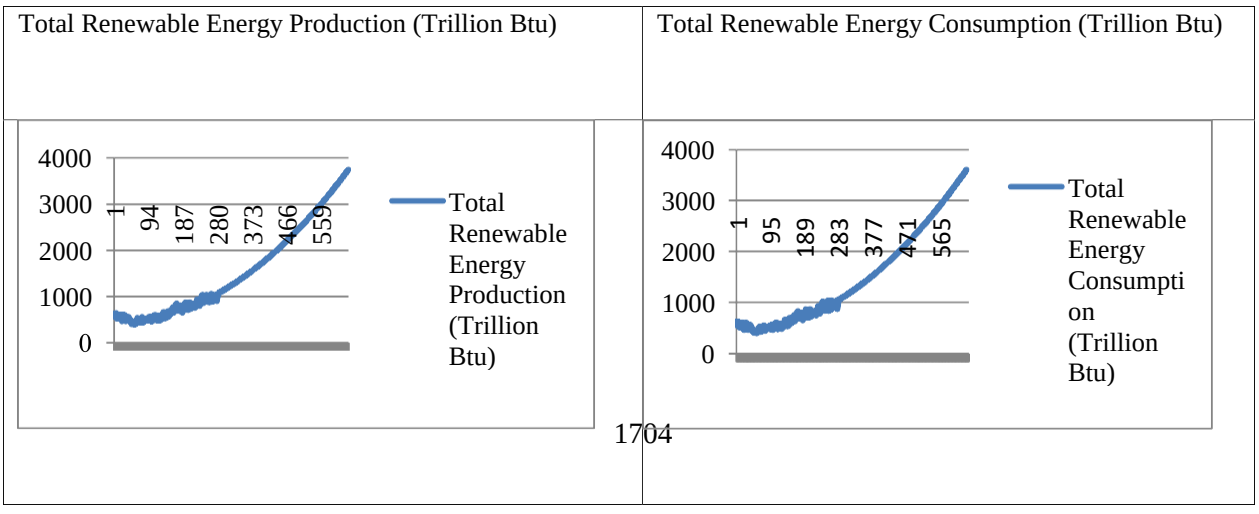
4. Data Analysis and Interpretation

4.1 Trend analysis forecasting:

Results of trend forecasting analysis found a significant positive trend in all four-time series. Renewable energy consumption and production and oil production and consumptionincreased by 1.86,1.91,20.09,0.09 respectively, as shown in table1. According to trend forecasting, the forecasted values of renewable energy consumption and production and oil production and consumption on Jan'2051 are 3600 (trillion BTU), 3736 (trillion BTU), 68639(thousand barrels per day), 109 (million barrels per day) respectively. Table 1 represents the result of trend analyzation and table 2 shows forecasting graphs as per the trend forecasting equation.

Time series	C	A	β	Trend component
Renewable energy consumption	516.0026	-0.447850	0.008014	1.868319
Renewable energy production	518.2375	-0.526500	0.008453	1.916535
Crude oil production	7035.859	-39.39967	0.207845	20.09719
Crude consumption ofoil	71.74897	0.126291	-0.000106	0.095640

Table1. Result of Trend analysis



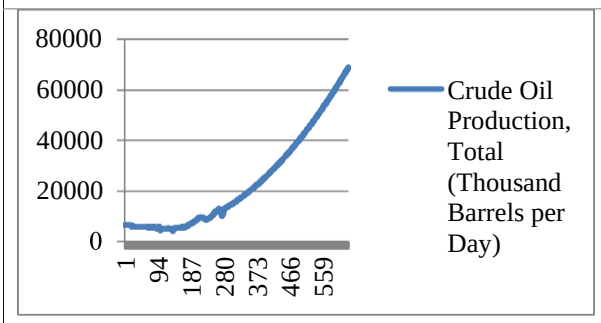
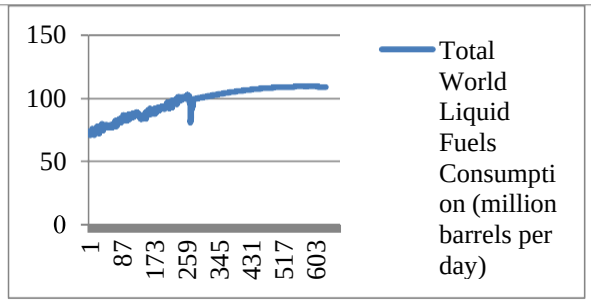
Crude Oil Production, Total (Thousand Barrels per Day)	Total World Liquid Fuels Consumption (million barrels per day)
	

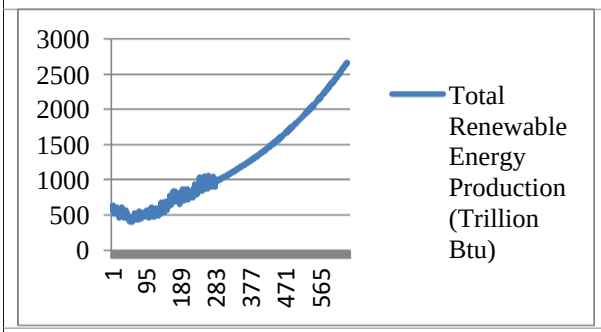
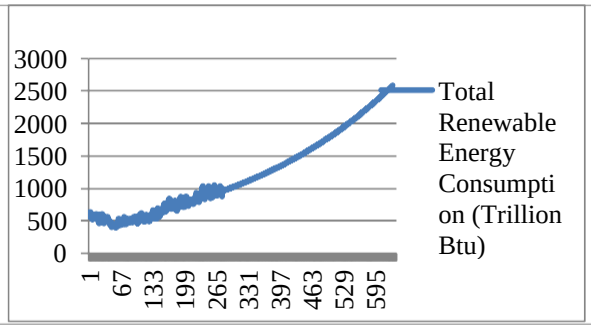
Table:2 forecasting graphs as per trend forecasting model

4.2 Growth model or semi-log model:

The growth rate model results state that the growth rate of renewable energy consumption and production and oil production and consumption are increased by 0.27, 0.27, 22.25, 0.11, respectively. And the forecasted values as per the growth rates of renewable energy consumptionand production and oil production and consumption on Jan 2051 are 2588 (trillion BTU), 2665 (trillion BTU), 24185 (thousand barrels per day), and 151 (million barrels per day) respectively.Table 3 represents growth rate analysis results, and Table 4 represents growth rate forecasting graphs of all variables.

Time series	Growth rate(α)	C
Renewable energy consumption	0.002727	6.086178
Renewable energy production	0.002779	6.081849
Crude oil production	0.222526	8.451624
Crude consumption of oil	0.001108	4.301751

Table3: growth model analysi

Total Renewable Energy Production (Trillion Btu)	Total Renewable Energy Consumption (Trillion Btu)
	
Crude Oil Production, Total (Thousand Barrels per Day)	Total World Liquid Fuels Consumption (million barrels per day)

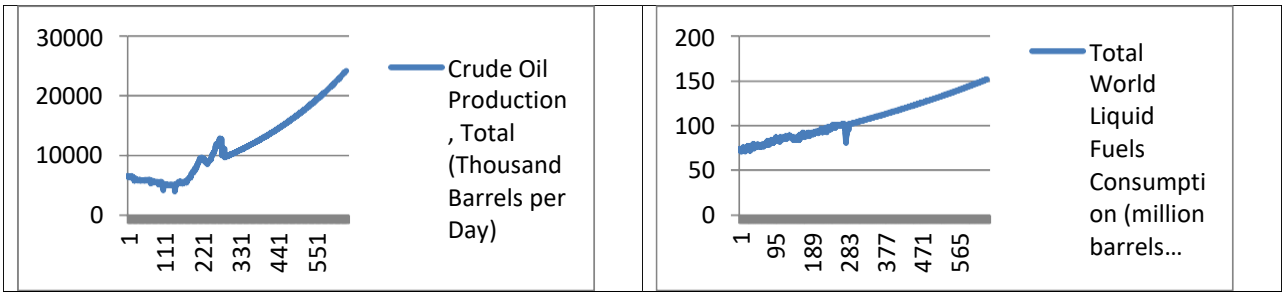


Table4: forecasting graphs as per growth rate model

4.3 ARIMA forecasting:

At the first step of ARIMA forecasting, the Augmented Dickey-Fuller unit root test is applied toidentify variables' stationarity or unit root. The results of the ADF test indicate all variables are stationary at first difference. Table 5 represents ARIMA forecasting equations, and Table 6 represents ARIMA forecasting graphs of all variables. The results of ARIMA forecasting showsthat forecasted values of renewable energy consumption and production and oil production and consumption are 1868 (trillion BTU), 1833 (trillion BTU), 19131 (thousands barrel per day), and 118 (million barrel per day) respectively.

ARIMA forecasting equation:

Total Renewable Energy Production (Trillion Btu)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.001759	0.001984	0.886448	0.3761
AR(1)	0.006108	0.009249	0.660381	0.5096
AR(12)	0.982717	0.010318	95.24630	0.0000
MA(1)	-0.131492	0.040896	-3.215307	0.0015
MA(12)	-0.776420	0.297651	-2.608489	0.0096
MA(8)	-0.092088	0.029227	-3.150805	0.0018
SIGMASQ	0.001630	0.000140	11.64361	0.0000

Total Renewable Energy Consumption (Trillion Btu)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.001961	0.001102	1.780264	0.0761
AR(1)	0.053801	0.026959	1.995641	0.0469
AR(6)	-0.034256	0.023315	-1.469222	0.1429
AR(12)	0.886662	0.029787	29.76641	0.0000
MA(1)	-0.383906	0.061922	-6.199860	0.0000
MA(8)	-0.150363	0.039270	-3.828913	0.0002
MA(12)	-0.465731	0.133149	-3.497812	0.0005
SIGMASQ	0.001784	0.000146	12.18894	0.0000

Crude Oil Production (Thousand Barrels per Day)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.001695	0.002778	0.609984	0.5424
AR(1)	0.404788	0.180716	2.239911	0.0259
MA(1)	-0.566519	0.184868	-3.064455	0.0024
MA(12)	0.150783	0.041816	3.605897	0.0004
SIGMASQ	0.000921	2.97E-05	30.98387	0.0000

Total World Consumption of oil (million barrels per day)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.000725	0.001063	0.681401	0.4962
AR(1)	-0.435975	0.115854	-3.763145	0.0002
AR(2)	-0.228765	0.049246	-4.645323	0.0000
AR(12)	0.341327	0.105624	3.231518	0.0014
MA(1)	0.149114	0.135149	1.103332	0.2708
MA(7)	-0.152691	0.082419	-1.852613	0.0650
MA(12)	0.204401	0.133631	1.529587	0.1273
SIGMASQ	0.000315	1.95E-05	16.09751	0.0000

Table 5 ARIMA forecasting equations

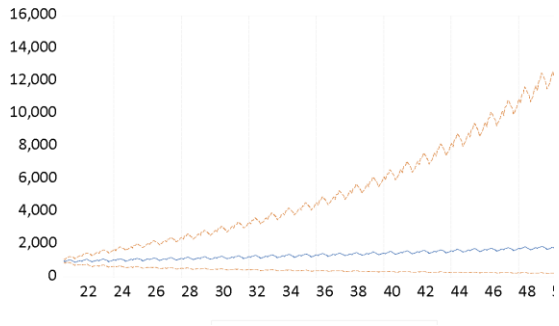
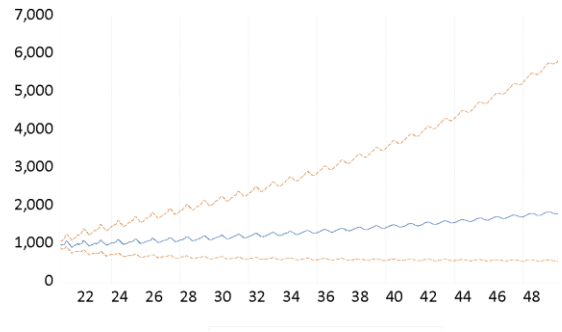
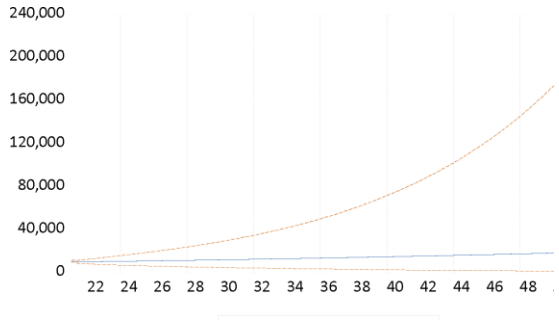
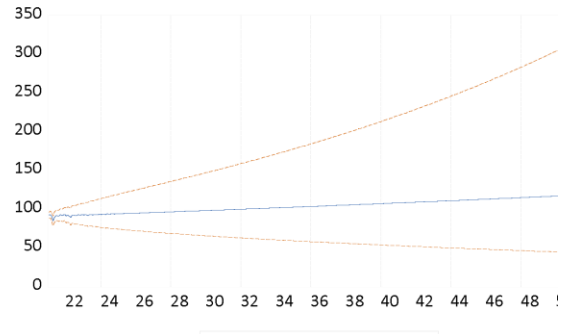
Total Renewable Energy Production (Trillion Btu)	Total Renewable Energy Consumption (Trillion Btu)
	
Crude Oil Production, Total (Thousand Barrels per Day)	Total World Consumption of oil (million barrels perday)
	

Table 6: ARIMA forecasting graphs

5. Discussion

Results of all three forecasting models suggest a significant increase in production and consumption in both oil and renewable energy sources. Due to numerous reasons, the oil demandwill increase, particularly economic growth, urbanization, and rising consumer demand and affordability. It remains to be understood whether that increase in renewables production is sufficient to fulfill the increased demand for oil in 2050.

From the results, it can be analyzed that renewable energy sources can only replace a fraction ofoil demand. Some other reasons also justify the conclusion of the study:

1. The increase in renewable energy production does not seem sufficient to fulfill the increasing demand for oil in the economically growing world.
2. Although, the governments globally are aggressively focused on the adoption of electric passenger cars. It hardly pays attention to other transport sectors, for example, trucking (land freight transport), jet fuel, marine/bunker fuel, and aircraft and ships. Even if there is an increase in renewable energy production, it is also not possible to fulfill the demandof all transport sectors in the coming years.
3. The petrochemical industry is the largest growing consumer of crude oil. Although some developed countries pay attention to cleaner production ways, there aren't enough options available to reduce the demand for petrochemicals in the next 20-30 years.

6. Conclusion

This paper tries to predict the future of oil in the global economy with the help of three forecasting models-trend forecasting, growth forecasting, and ARIMA forecasting on monthly data of production and consumption of oil and production and consumption of renewable energythroughout Jan'97-Dec'20. The result suggests that the demand or consumption of oil will increase in the next 30 years. Though there will be an increase in the oil production or renewableenergy alternatives, it is still inconceivable that renewable energy can fulfill the increasing demand for oil in the economically growing world.

The researcher suggests that the cumulative use of renewable energy sources across the globe, improvement in battery technologies, electric cars, increased energy efficiency for all modes oftransport, increased awareness. Stricter policy towards the consumption of plastic, recycling of plastic, etc., will all play a significant role in bringing down our dependency on oil. But it seemshighly unlikely for the demand for oil to go down to zero. Even then, oil is likely to remain a significant energy source for almost the next four to five decades.

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