

Profiling and reporting statewide energy outlook based on data analytics

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Abstract. The new energy production and consumption revolution have made a huge leap since humans entered the 21st century. Generally, researchers can categorize energy twofold: traditional and green resources. Also, a handy work for governors nowadays is evaluating regional energy utilization by checking different energy indexes. However, the diversity of energy resources hinders managerial personnel from effectively judging energy utilization performance. The selection of appropriate KPIs can be quite exhaustive and confusing. In this paper, the data analytics assists and validates the methodology for picking up energy indicators. Then, data visualization provides four portfolios of statewide energy performance. It extends the analysis to the future, and the forecasting visualization offers the possible trends for four states. The discussion and comparison of these four states' performance finalize this paper.

Keywords: Renewable energy, data analytics, visualization, KPI, Energy utilization.

1. Introduction

In this report, we are analyzing and evaluating the performance of using renewable energy for four states in America: Arizona, New Mexico, and Texas [2]. By conducting the visual analytics for various key indicators, we come up with the following conclusion: California has the best profile among all these states, followed by Texas; the last two are Arizona and New Mexico.

We initiated our analysis by selecting the best indicators for representing the performance of using renewable energy. As we ranked the variations among available measures for four states and connecting to the context of renewable energy utilization, we derived the following eight metrics from the top 20% fluctuant measurements (see in supplement R scripts).

Table 1. Key indicators and evaluation fields.

Indicator [6]	Description	Evaluation field
TETXB	Total end-use energy consumption. Billion Btu	Overall state-wide energy consumption level.
FFTCB	Fossil fuels, total consumption. Billion Btu	Key non-clean energy use.
PATCB	All petroleum products total consumption. Billion Btu	Key non-clean energy use.
NGTCB	Natural gas total consumption (including supplemental gaseous fuels). Billion Btu	Key clean energy use.
CLEIB	Coal consumed by the electric power sector. Billion Btu	Key non-clean energy use.
RETCB	Renewable energy total consumption. Billion Btu	Overall state-wide renewable energy consumption level.
ELISB	Net interstate sales of electricity and associated losses (negative and positive values).	The economic efficiency of critical power sector.
HYEGB	Hydroelectricity produced by the electric power sector. Billion Btu.	The clean electricity production ability.

2. Energy profile for four states

2.1. Energy Profile for Arizona

Taking the overall consumption level of Arizona, we noticed that, from the preceding years, the fossil and coal resources made the largest contribution. In contrast to the traditional energy sources, emergent cleaner energy sources: natural gas and renewable energy, are relatively low.

To get rid of the magnitude of total energy consumption, we standardized Arizona's energy mix components to find the exact portions. We can conclude that conventional energy takes control in this state by ranking different measures. As we supplemented another typical non-clean, traditional energy source: petroleum, it displayed as the second large amount for all energy consumption. This solidified our previous observation [5].

To reflect the time-series performance of Arizona renewable energy usage, we picked out metrics related to electricity production. Electricity production plays dual roles in a state's renewable energy utilization. It interconnects the use of traditional, non-clean energy and the generation of renewable, clean energy. Compared with Arizona's coal consumption in electricity production, its hydroelectricity production maintains a low level. Also, although coal consumption is soaring during these years, interstate electricity sales keep dropping. This should remind us of its inefficiency in managing renewable energy.

From a macro view of Arizona's state-wide energy utilization, it suggests this state does not catch up to using more clean energy resources. The highest total renewable energy consumption only covers about 12.5% of its highest total energy end-use consumption.

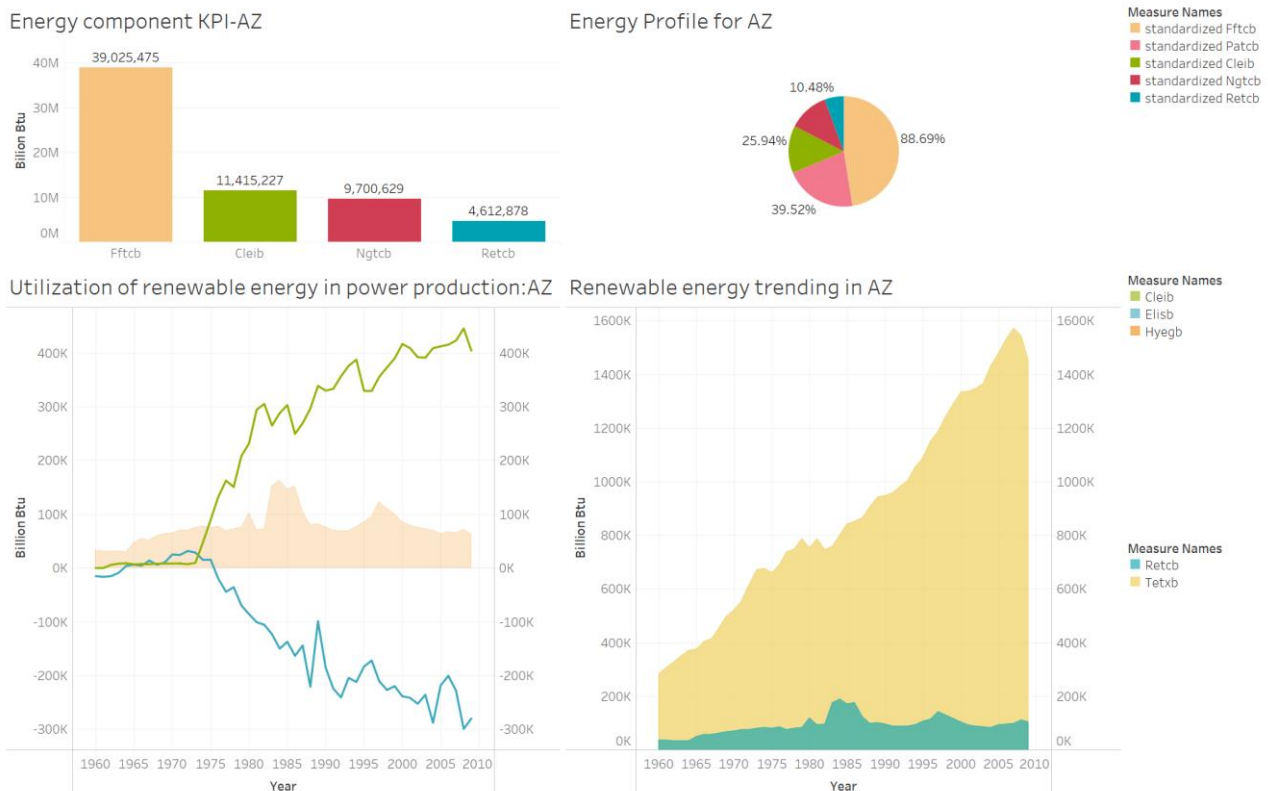


Fig. 1 Performance of Arizona.

2.2. Energy Profile for California

In overall performance, California's clean and renewable energy ranks top, and its usage of coal drastically drops to a much lower amount than the natural gas and total renewable energy consumption.

We should note that, although the traditional energy sources, such as petroleum and fossil still take the top 2 portions as we standardized their contributions to the state-wide energy mix, the natural gas utilization climbs up to the third place. Natural gas almost becomes one-third of the total end-use energy. Also, even if we omit the effect of the fundamental level of the energy consumption in California, the coal consumption remains at a minimal amount, less than 1% of total end-use energy [4].

The time-series analysis strongly supports the efficiency of California’s utilization of renewable energy. As the electricity production sector consistently improves its hydroelectricity output level, its interstate electricity sales also grow. It releases the information that their productions are broadly welcomed in other states, and this renewable energy can be considered a valuable, useful new resource. At the same time, its usage of coal to produce electricity maintains a steady low amount despite its growing sales. Its aggregated renewable energy usage shows a solid contribution. About 12.5% of total end-use consumption comes from their utilization of clean energy, and this conclusion came up with the benchmark of the highest figure.

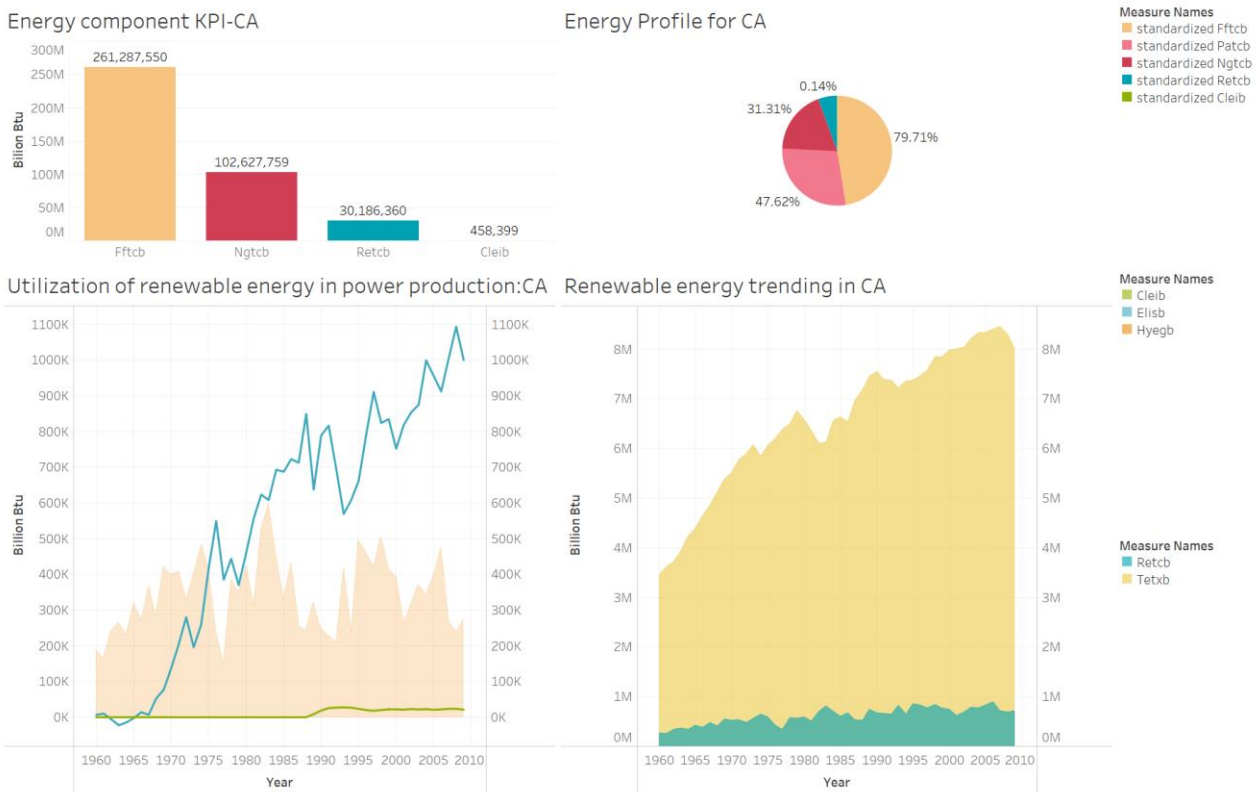


Fig. 2 Performance of California.

2.3. Energy Profile for New Mexico

By exploring the cumulated performance from the KPI panel, the most significant contributor to total energy consumption are fossil fuels. It further indicates minimal renewable energy usage compared to all three other energy resources. Also, we merely compared the total renewable energy usage and the segmented traditional energy resources. It may imply that renewable energy usage in New Mexico falls to a minor stage which is far behind all conventional energy usage.

From the standardized pie chart view, the total fossil fuel exceeds the total energy end-use consumption. It supports that in New Mexico, the general usage of fossil fuels spread out of the consumers’ sector; it may also extend to other sectors such as the production sector.

As we evaluate its performance in a time-series manner, it instead suggests the unhealthy condition in New Mexico is experiencing. In the electric power sector, along with its climbing coal consumption, hydroelectricity stays at a superficial output level compared with the total figure for coal. Also, it’s worth noting that the interstate electricity loss remains about half of its total coal consumption.

Judging from the marketing efficiency and energy output capability, New Mexico hasn't done a good job concerning utilizing renewable energy.

The poor performance can also be seen throughout the overall consumption level trend. We can conclude the existence of renewable energy in New Mexico is negligible to overall total energy consumption, only contributing 10% at the peak level.

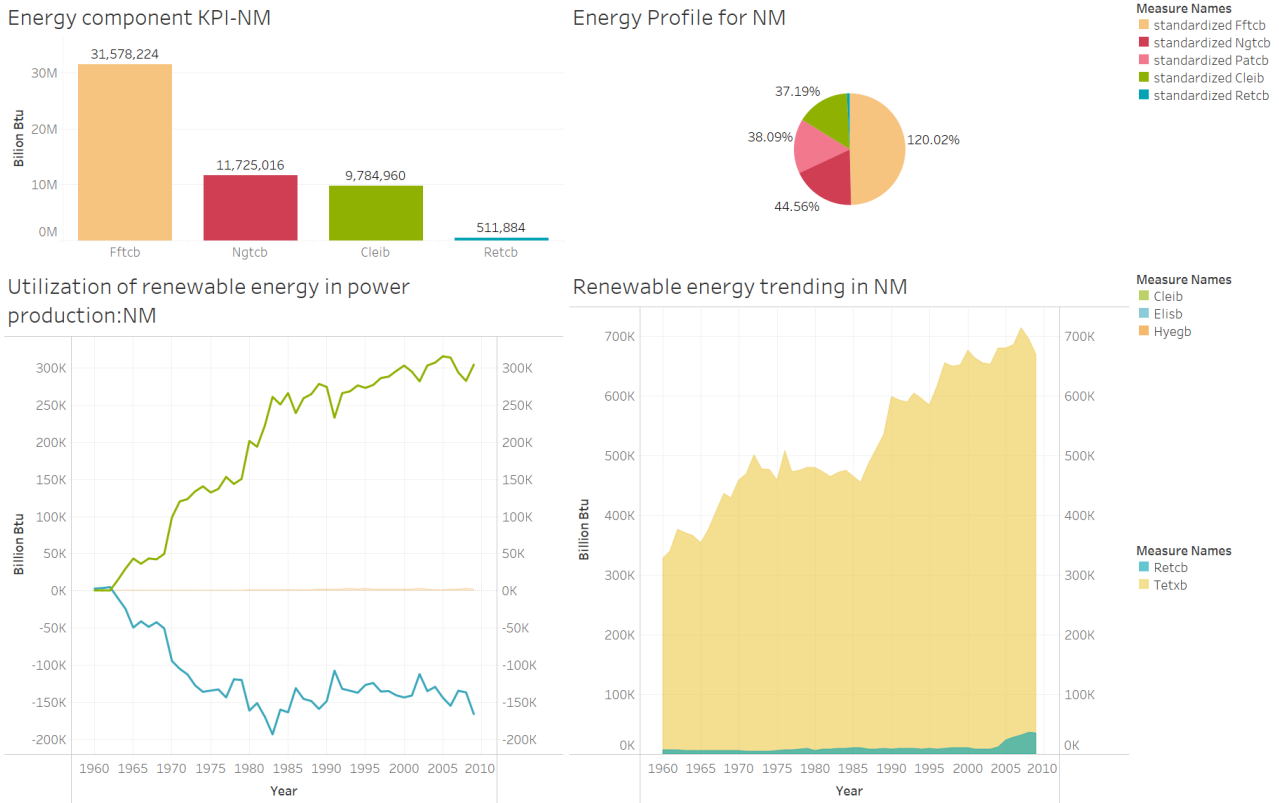


Fig. 3 Performance of New Mexico.

2.4. Energy Profile for Texas

We first examined Texas's overall level of energy usage. Fossil energy consumption is still ranked No.1 among all four key indicators. A promising sign of Texas' performance was the natural gas consumption; now, it overrides the amount of coal and won second place. We also learned that coal consumption falls behind the magnitude of total natural gas usage. Although its total renewable energy usage is not optimal, concluding from the above observations, this state has optimized the non-clean and traditional energy usage well.

As we filtered out the effect of Texas' total energy usage level by the standardized energy mix pie chart, it strengthened the previous judgment. The natural gas usage and the petroleum consumption hold an equal contribution to the total energy usage. And the coal consumption has been lowered to the tiniest level.

Supplementing its electric power sector's time-series performance implies a relatively favorable situation for Texas. The interstate sales of electricity production remain at a small, steady level; also, the total renewable energy utilization slowly begins to climb from 2005 to 2010. It is convincing that; this state has a future potential to improve overall renewable and clean energy usage [1].

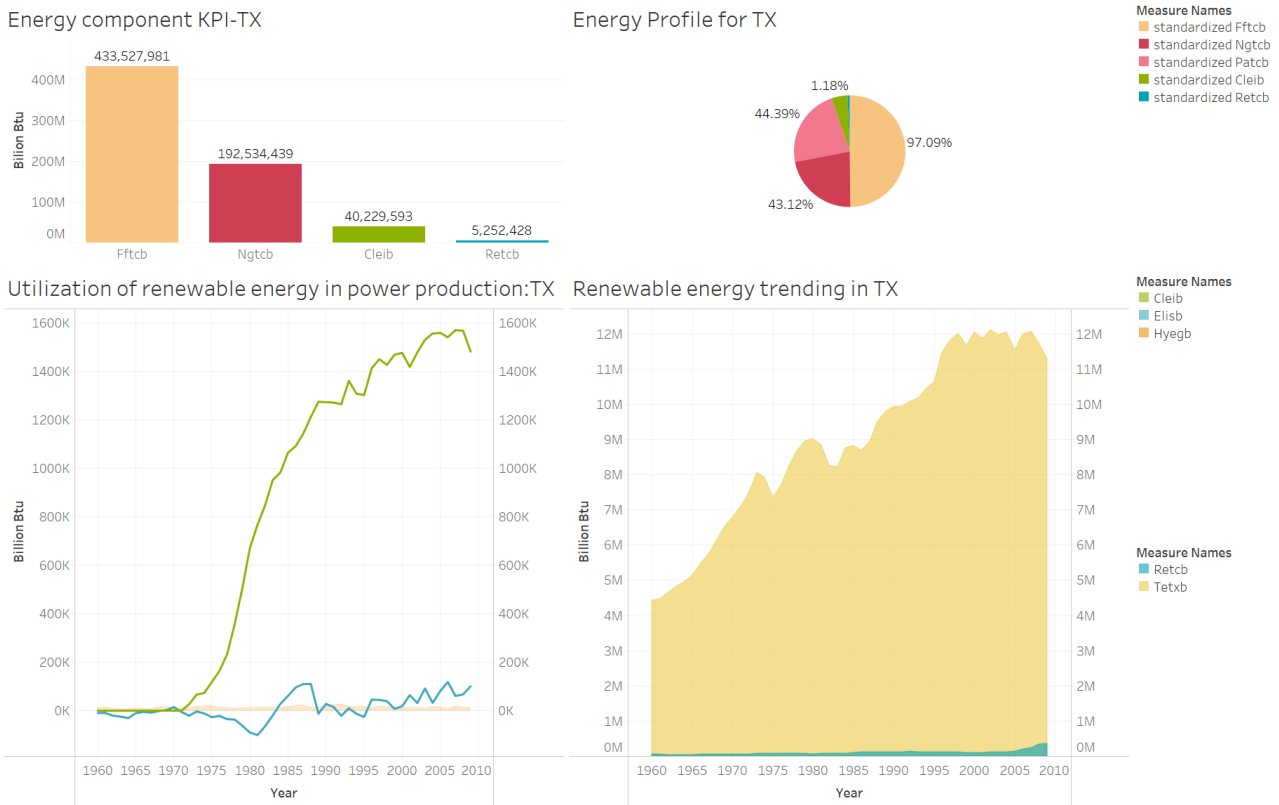


Fig. 4 Performance of Texas.

3. The best state for renewable energy

In this section, we connected the examination from historical data with the possible prediction for each state. Evaluating both the critical power sector and the overall renewable energy, the performance of California was the best. We justify it for two major reasons.

From figure 5, California's electricity sector was the only state with a relatively large base and steady growth in its hydroelectricity production for upcoming years. Also, compared with all three other states, it's the No.1 winner in keeping the total coal consumption minimal. Other states, however, fail to control the continuous, massive climb-up of the total coal consumption, and some may even have little clean energy produced [3].

From figure 6, California provides a satisfying level in promoting renewable energy utilization in the past and future. Although we might discover that New Mexico may have a soaring incremental for the following years, its stability and baseline level cannot compete with that of California, as California's base figure of renewable energy usage is 1 million.

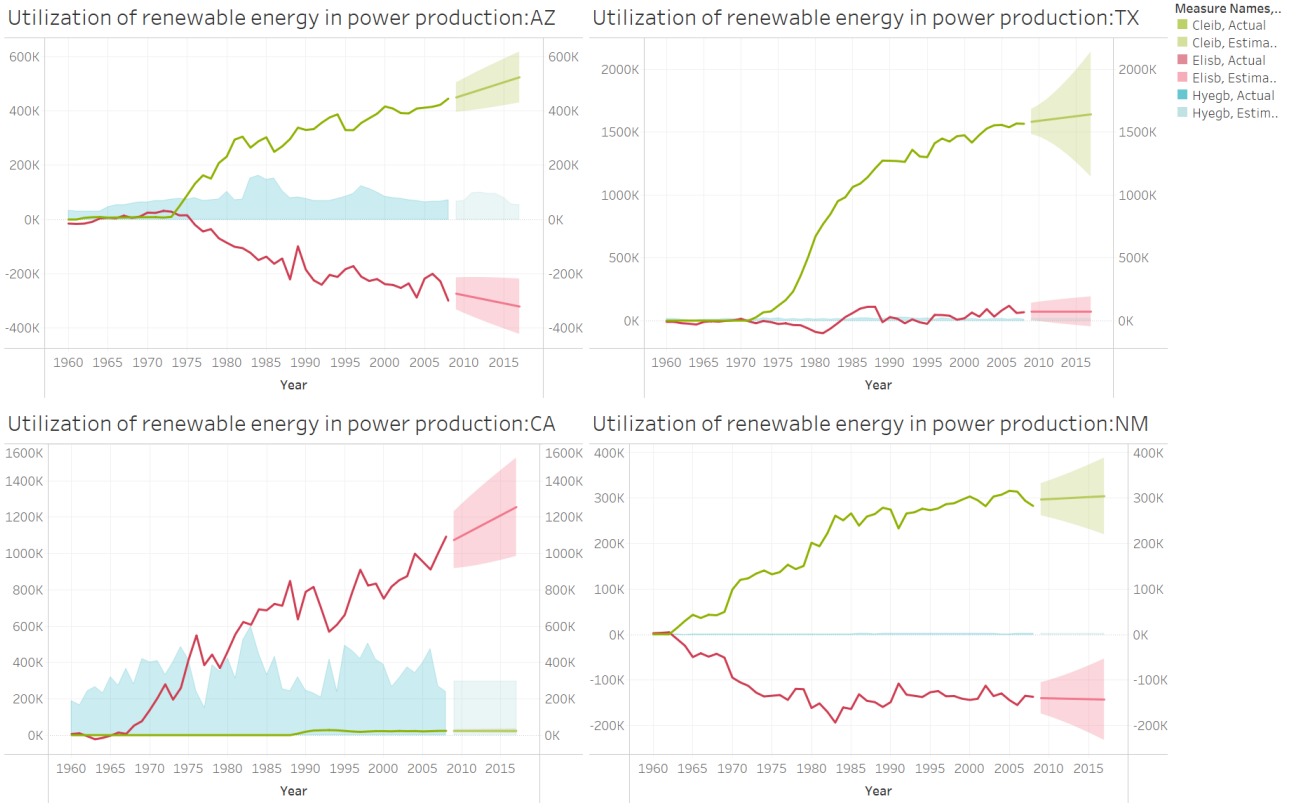


Fig. 5 Forecasting and evaluating cross-state clean energy performance

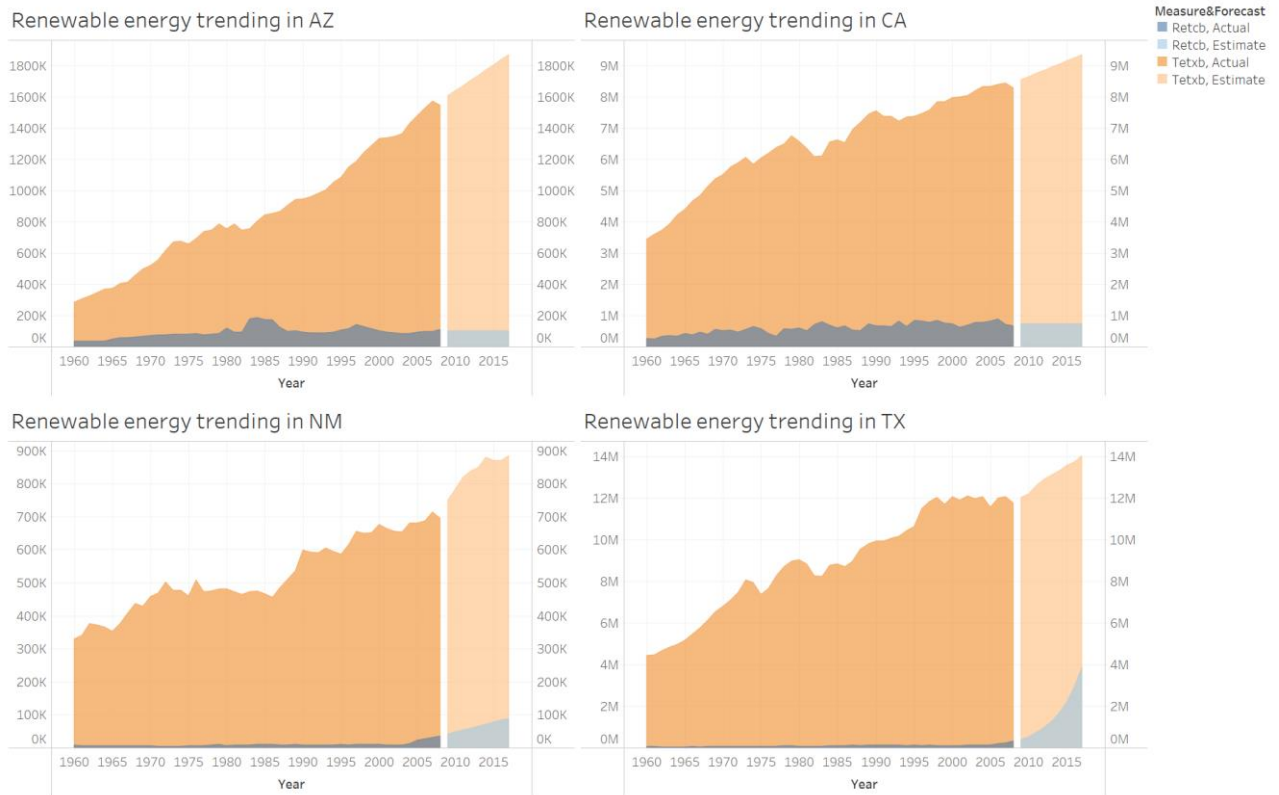


Fig. 6 Forecasting the macro-trend of renewable energy.

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