



Energy to GDP per Capita Comparison

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Agenda

Introduction

Description / Definitions

Initial Comparison

Investigating Change

Technology / Future Growth

Summary

Introduction

- There has been a consistent axiom since the beginning of the industrial revolution that energy drives commerce.
- This project compares how the consumption and production of energy compares to the gross domestic product (GDP) per capita at the state and national level focused on understanding the trajectory for movement away from fossil fuel as our primary energy source and its alignment to the nation's leading fiscal metric.

Description / Definitions

Description

- Analysis utilized energy & economic related data sets from the Bureau of Economic Analysis, US Census Bureau, Energy Information Agency, & International Information Agency.
- Years Reviewed: 1970, 1980, 1990, 2000, 2010, 2020

Definitions

GDP: The total monetary value, or market value, of finished goods and services produced within a country during a period.

GDP per capita: Economic metric that breaks down a country's economic output per person.

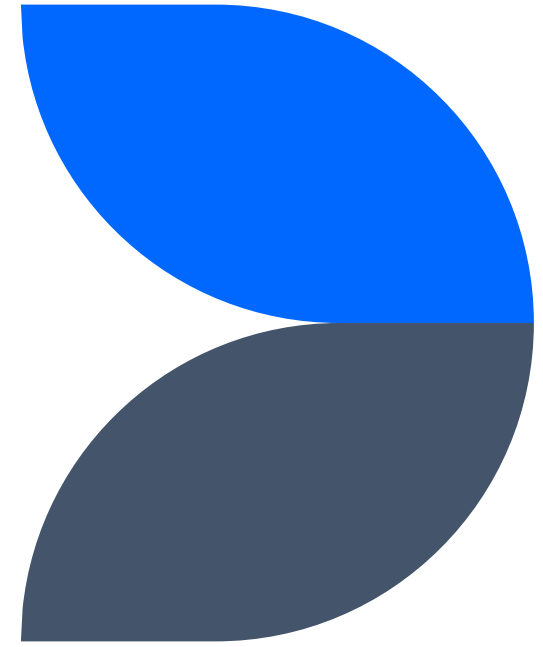
Fossil Fuels: Includes Coal, Crude Oil, & Natural Gas

Nuclear: Nuclear electric power production in Btu, which also equals consumption, is the nuclear electricity net generation multiplied by the average heat rate of the nuclear power plants.

Renewables: Includes Biofuels, Geothermal, Hydroelectric, Solar, Wind, Wood, & Biomass Waste

Initial Comparison

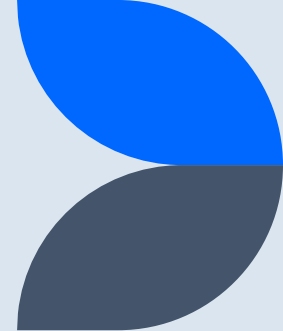
Consumption / Production / GDP per Capita



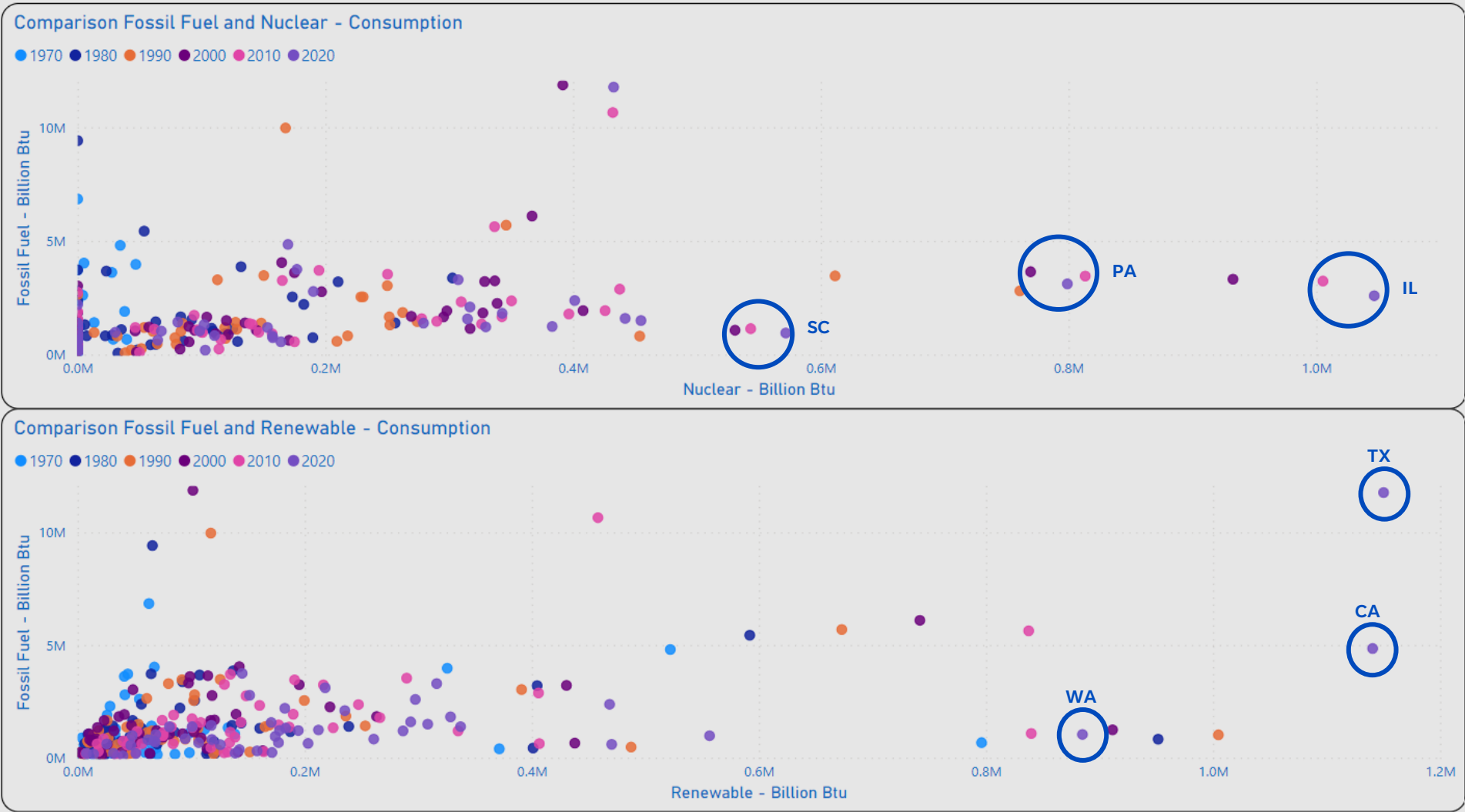
Consumption / Production



- Most States Remained Under 5M (BN Btu) for Consumption and Production
- The Range of Values for GDP per Capita Appeared to Begin a Wider Dispersion in 2000
- 2020 Outliers for Consumption: TX & CA
- 2020 Outlier for Production: TX
- Outliers for GDP per Capita Included: MA, NY & WA



Energy Mix - Fossil Fuel to Alternatives

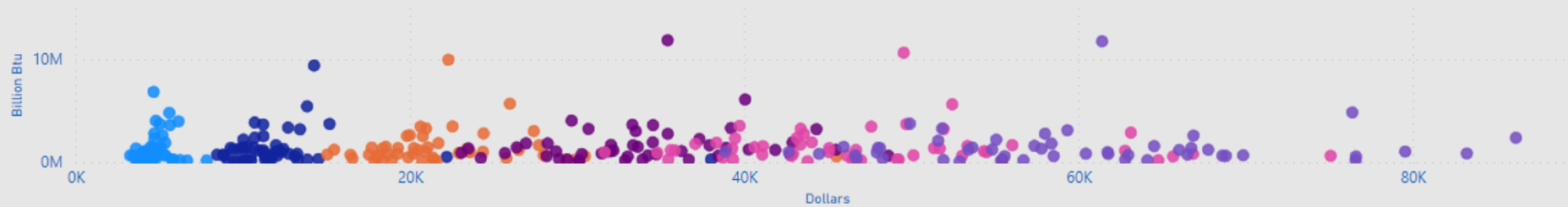


- IL, PA, SC Lead the US in Consumption of Nuclear Energy
- As of 2020 Several States Have Not Integrated the Use of Nuclear Energy: IN, MT, OK, SD, WY & VT
- As of 2020 TX, CA, & WA Lead the US in Consumption of Renewable Energy
- Distribution of Values for the Majority of States Remains < 200K (BN Btu) for Renewable Consumption

GDP per Capita – Energy Mix

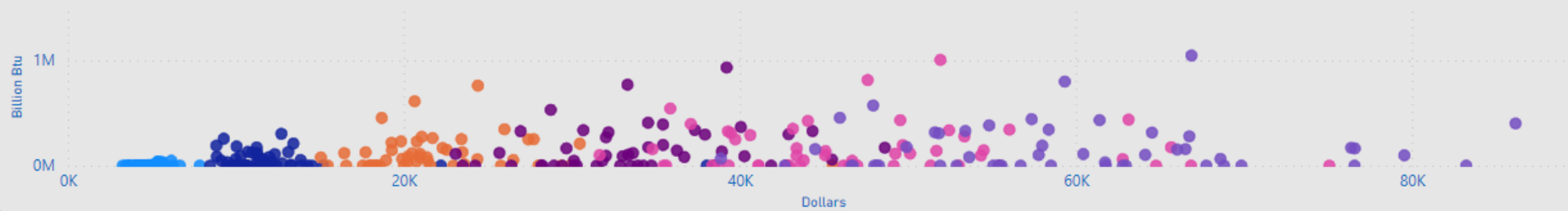
Comparison GDP per Capita - Fossil Fuel Consumption

● 1970 ● 1980 ● 1990 ● 2000 ● 2010 ● 2020



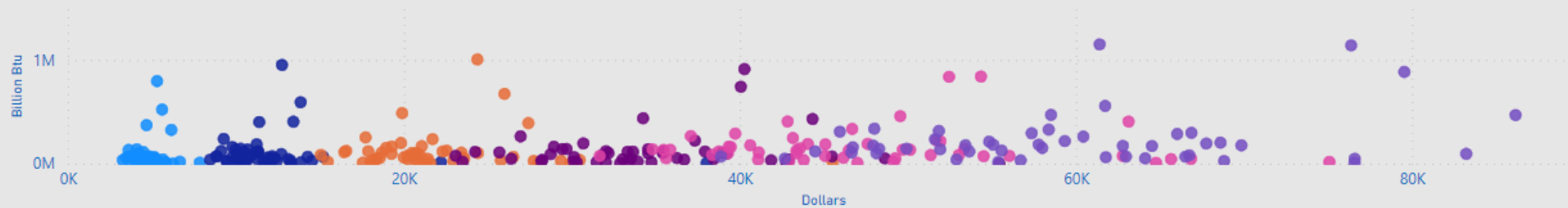
Comparison GDP per Capita - Nuclear Consumption

● 1970 ● 1980 ● 1990 ● 2000 ● 2010 ● 2020



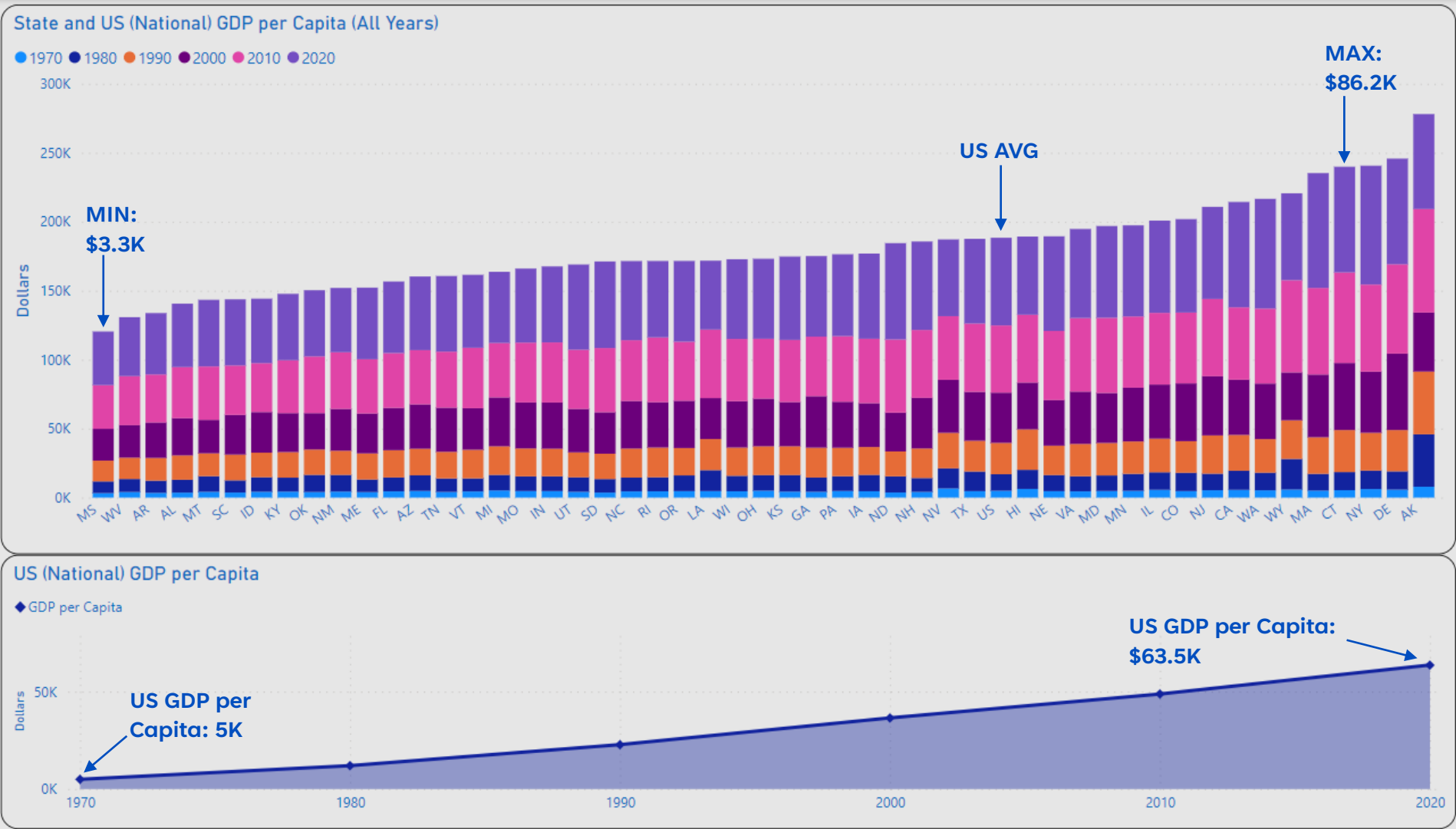
Comparison GDP per Capita - Renewable Consumption

● 1970 ● 1980 ● 1990 ● 2000 ● 2010 ● 2020



- Review of Distribution for Individual Energy Types Remains Generally Consistent with Initial Consolidated View for Consumption / GDP per Capita

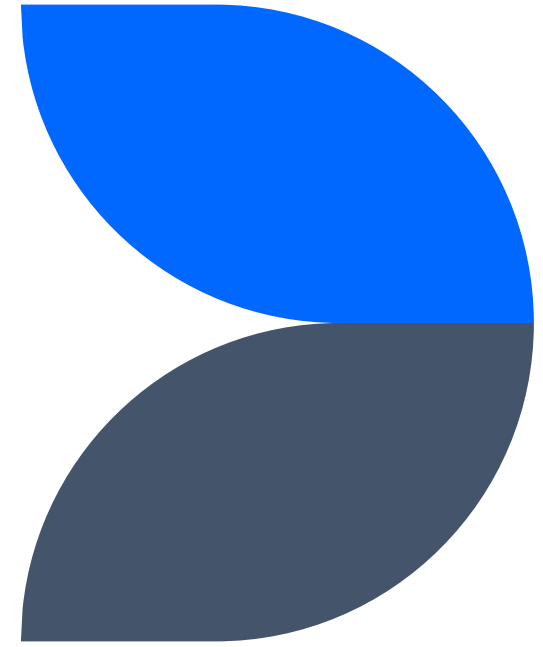
GDP per Capita



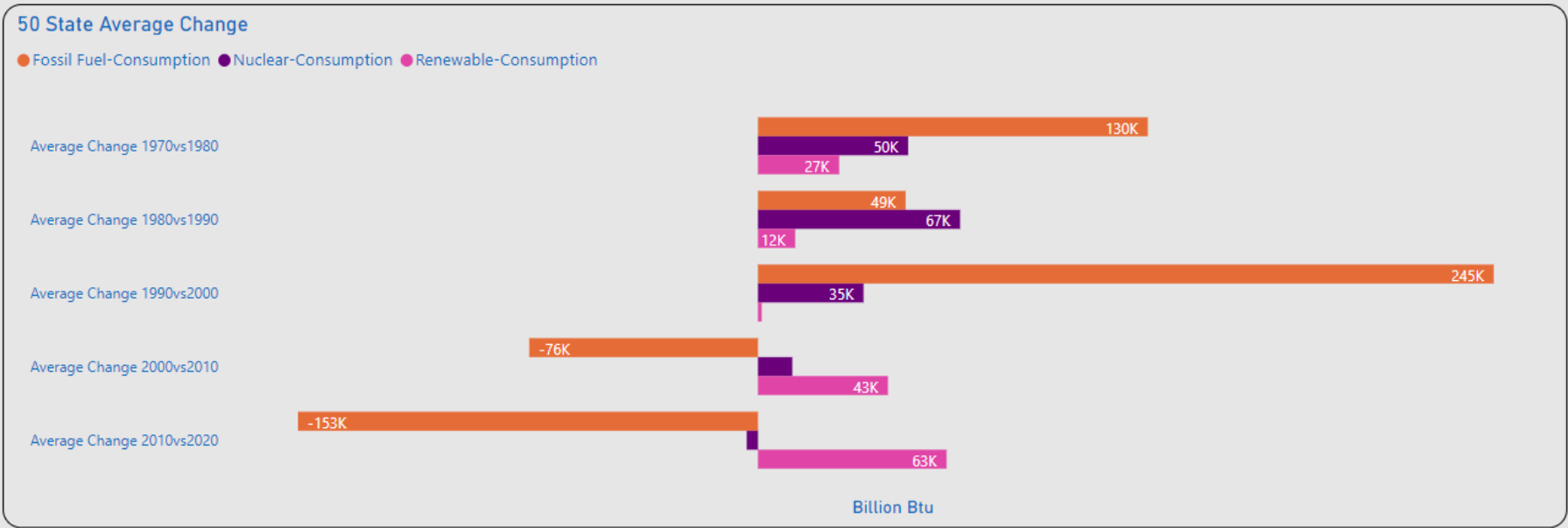
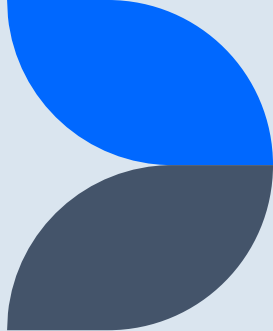
- US GDP per Capita Ranged from \$5K in 1970 to \$63.5K in 2020
- MAX GDP per Capita: 2020 NY \$86.2K
- MIN GDP per Capita: 1970 MS \$3.3K
- Overall Increase can be Expected to Continue

Investigating Change

Consumption / Production / GDP per Capita

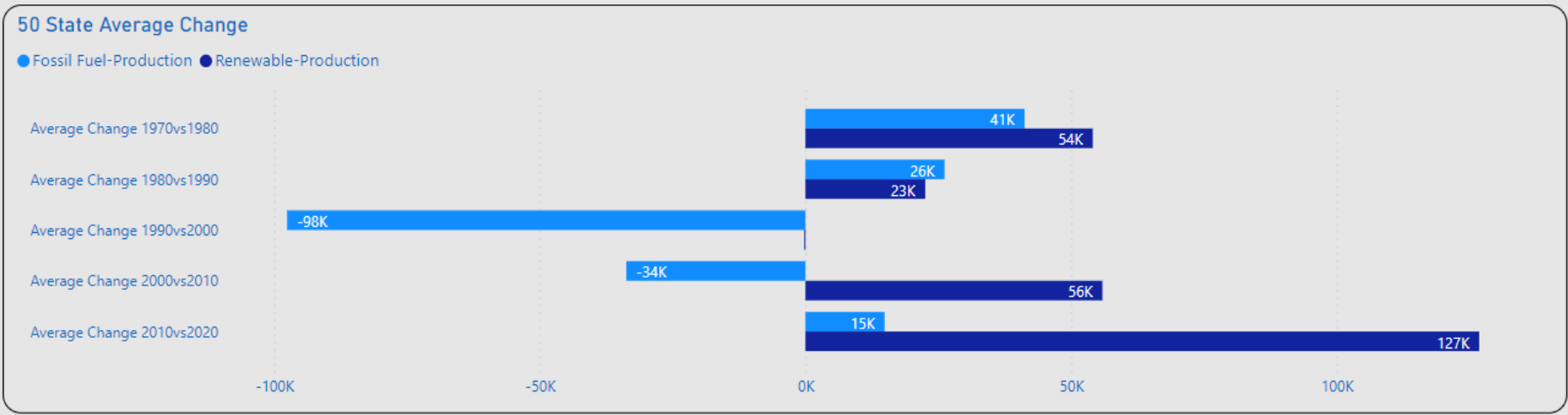


Amount of Change



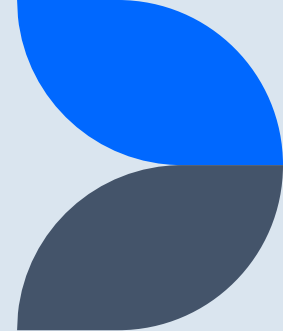
Significant Changes Consumption

- 1980vs1990: Nuclear(+)
- 1990vs2000: Fossil Fuel(+)
- 2010vs2020: Fossil Fuel(-)
- 2010vs2020: Renewables(+)



Significant Changes Production

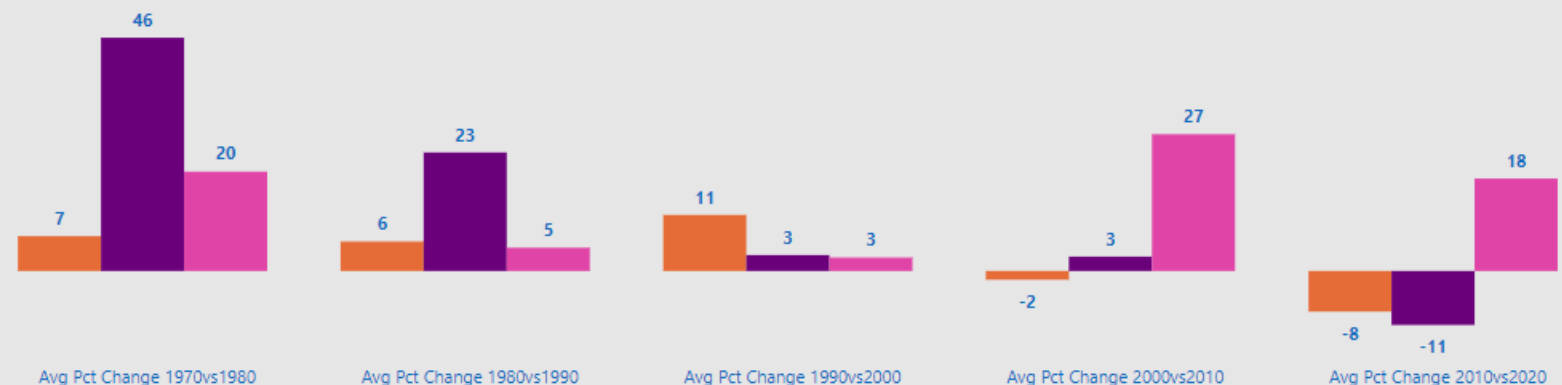
- 1990vs2000: Fossil Fuel(-)
- 2010vs2020: Renewable(+)



Percent of Change

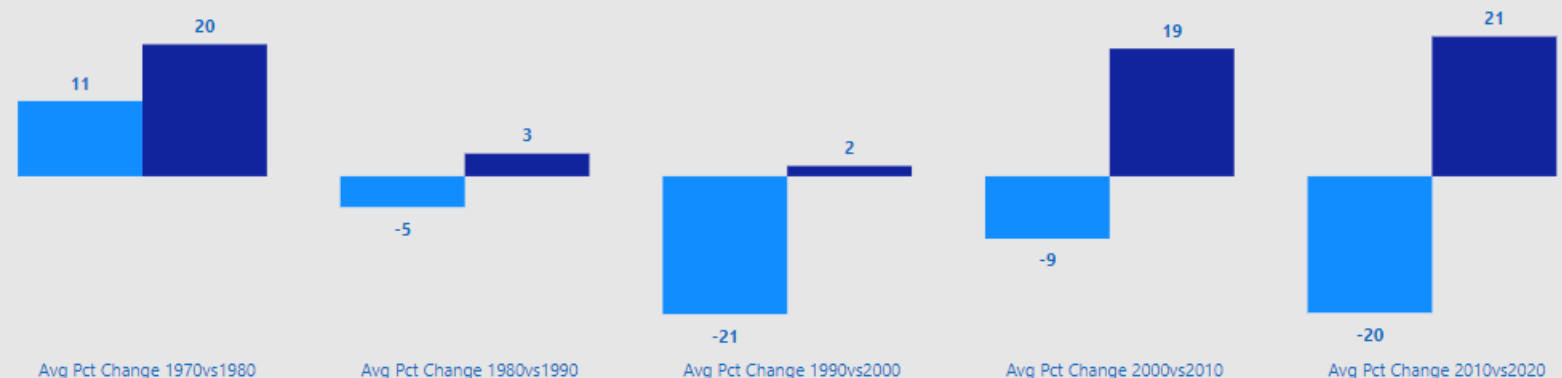
50 State Average Percent of Change - Consumption

Fossil Fuel-Consumption Nuclear-Consumption Renewable-Consumption



50 State Average Percent of Change - Production

Fossil Fuel-Production Renewable-Production



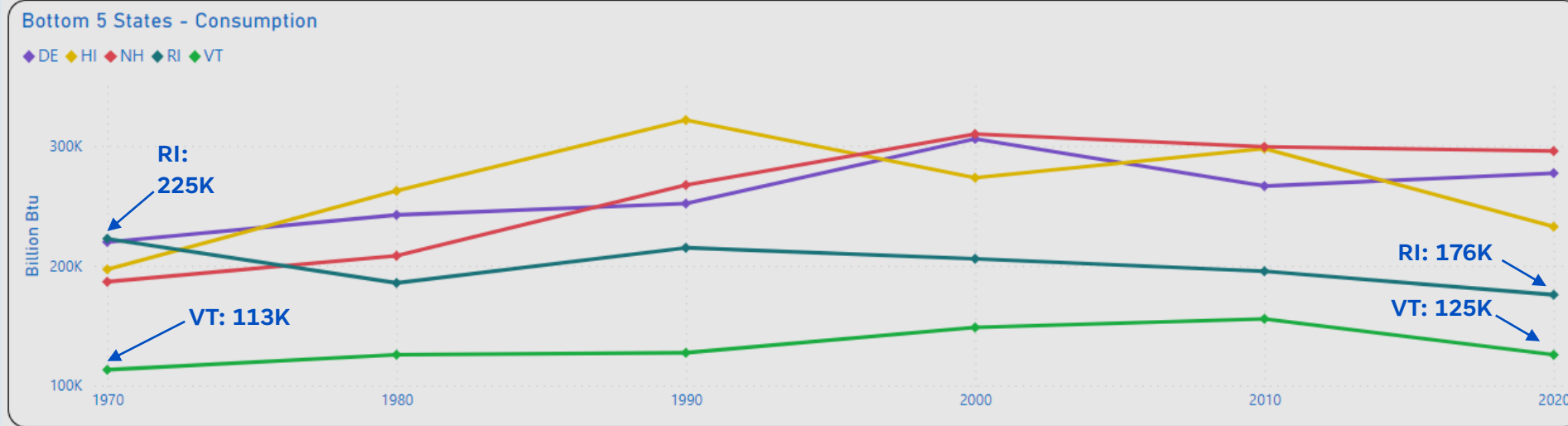
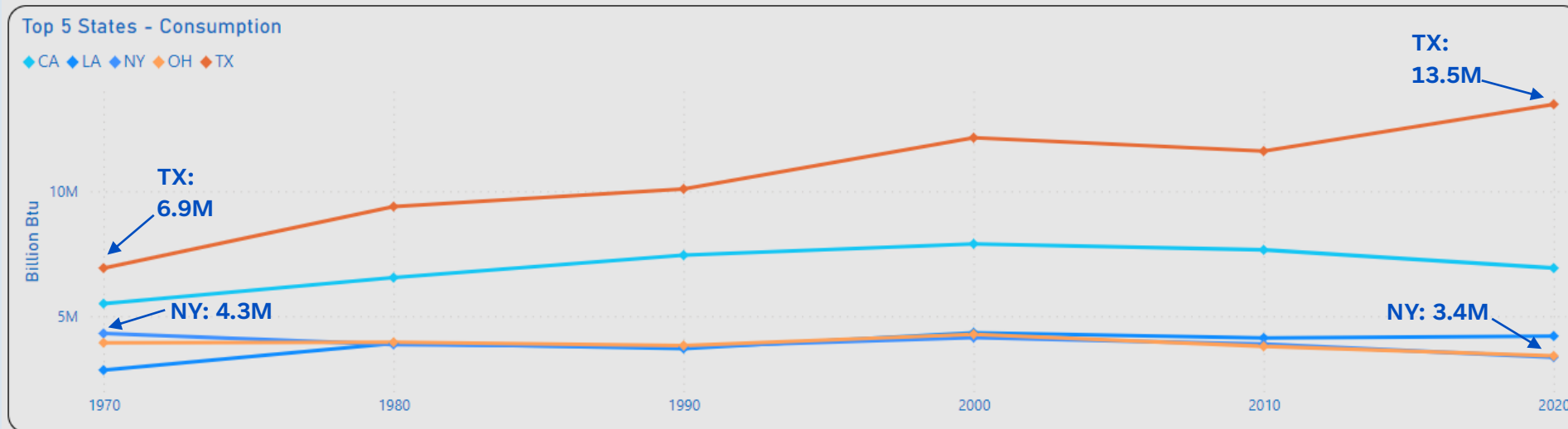
Consumption

- 1970vs1980: Nuclear(+)
- 2000vs2010: Renewable(+)
- 2010vs2020: Fossil Fuel / Nuclear (-), Renewables(+)

Production

- Overall Fossil Fuel(-)
- Overall Renewable(+)

Top 5 / Bottom 5 – Change Consumption



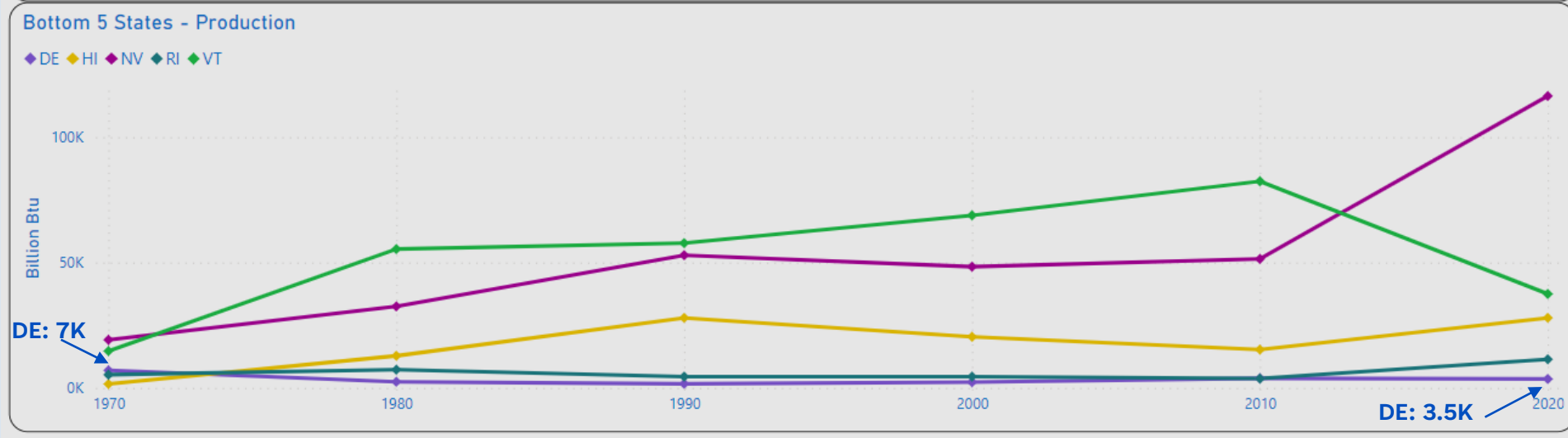
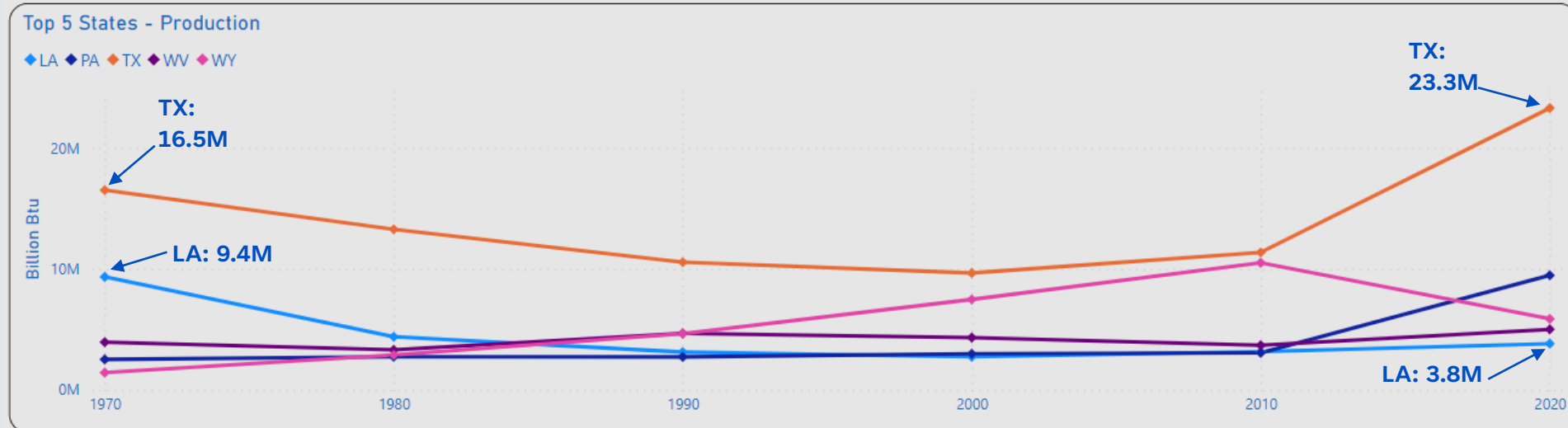
Top 5 Consumption

- MAX: TX 6.9M – 13.5M(BN Btu)
- Highest Decrease: NY 4.3M – 3.4M (BN Btu)
- NY & OH (-) Overall Consumption

Bottom 5 Consumption

- MIN: VT 113K – 125K (BN Btu)
- RI (-) Overall Consumption

Top 5 / Bottom 5 – Change Production



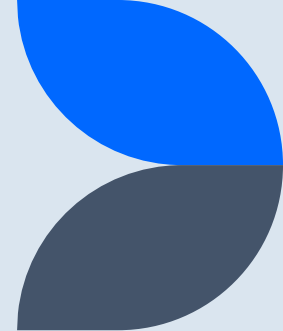
Top 5 Production

- MAX: TX 16.5M – 23.3M(BN Btu)
- Highest Decrease: LA 9.4M – 3.8M (BN Btu)
- TX, PA, WV, WY(+) Overall Production

Bottom 5 Production

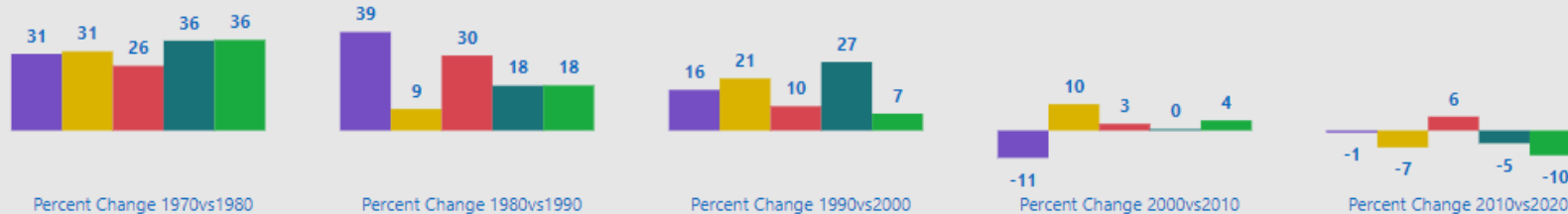
- MIN: DE 7K – 3.5K (BN Btu)
- HI, NV, RI, VT (+) Overall Production

Top 5 Energy Mix - Consumption



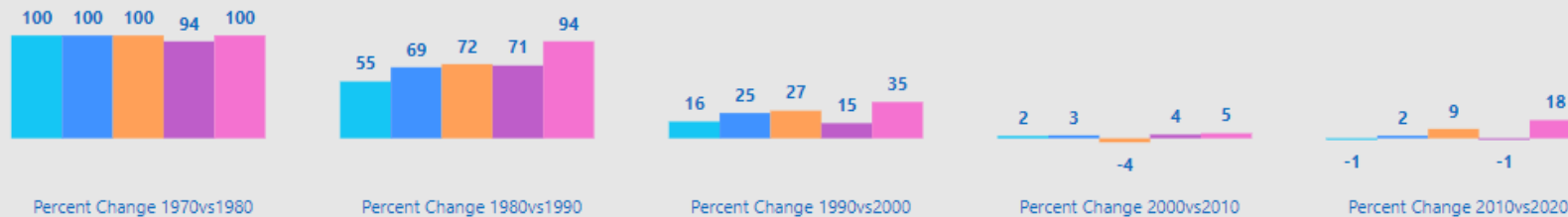
Top 5 States - Percent of Change in Fossil Fuel Consumption

AK AZ ND NV WY



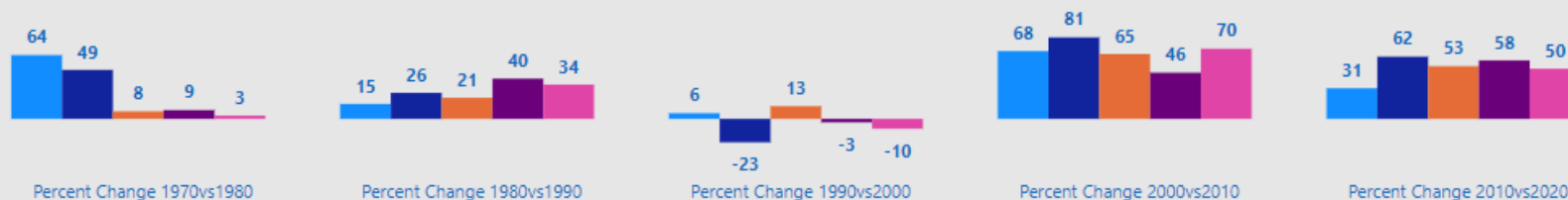
Top 5 States - Percent of Change in Nuclear Consumption

GA NC OH PA TN



Top 5 States - Percent of Change in Renewable Consumption

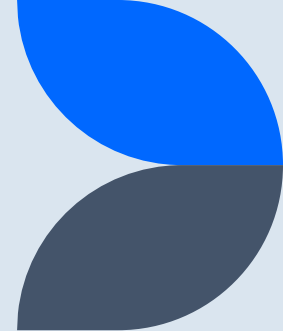
IA KS NM OK TX



Top 5 Energy Mix

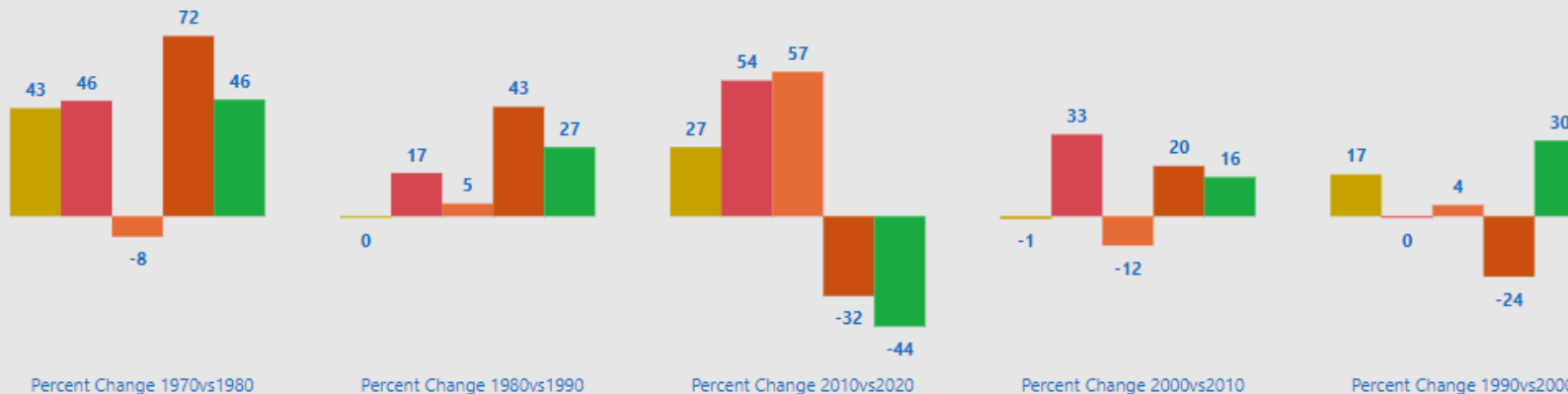
- Fossil Fuel and Nuclear Displays Highest Volumes of Increases 1970-2000
- Renewable Consumption Displays Significant Increases After 2000

Top 5 Energy Mix - Production



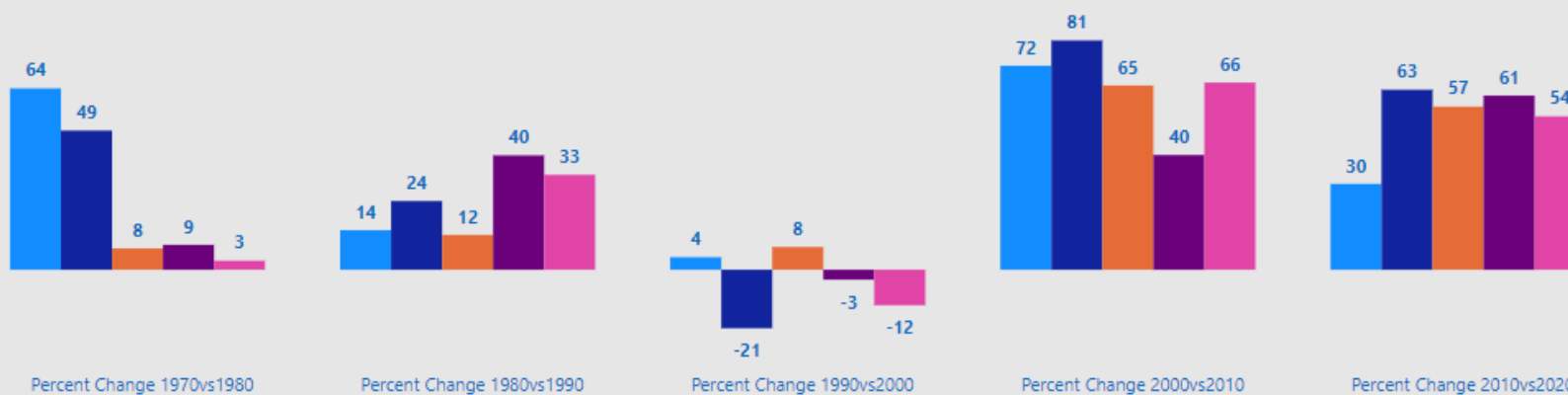
Top 5 States - Percent of Change in Fossil Fuel Production

CO ND NM SD WY



Top 5 States - Percent of Change in Renewable Production

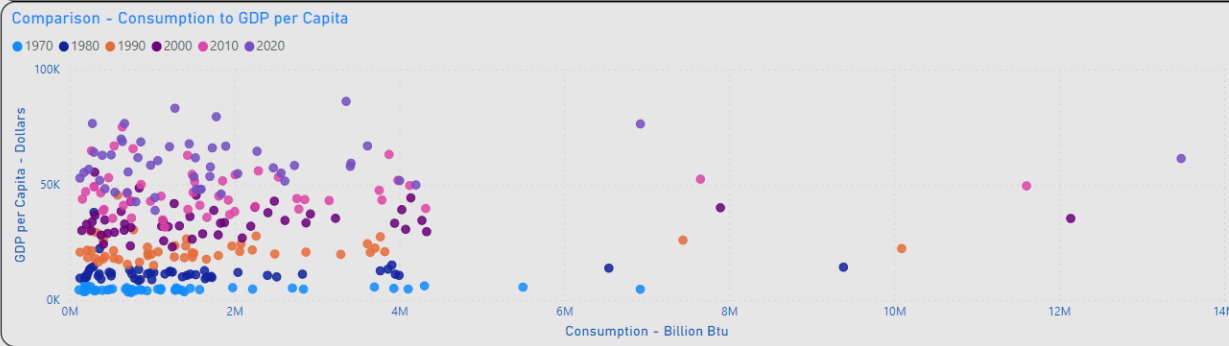
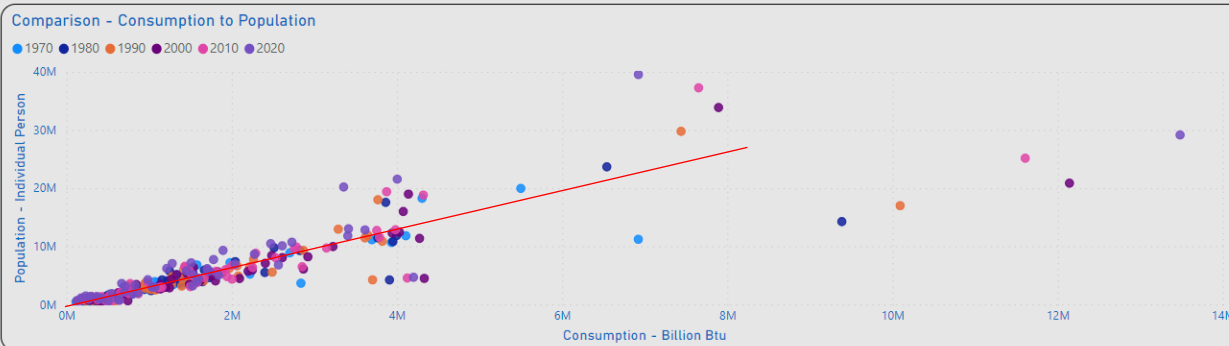
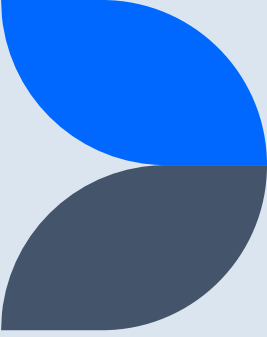
IA KS NM OK TX



Top 5 Energy Mix

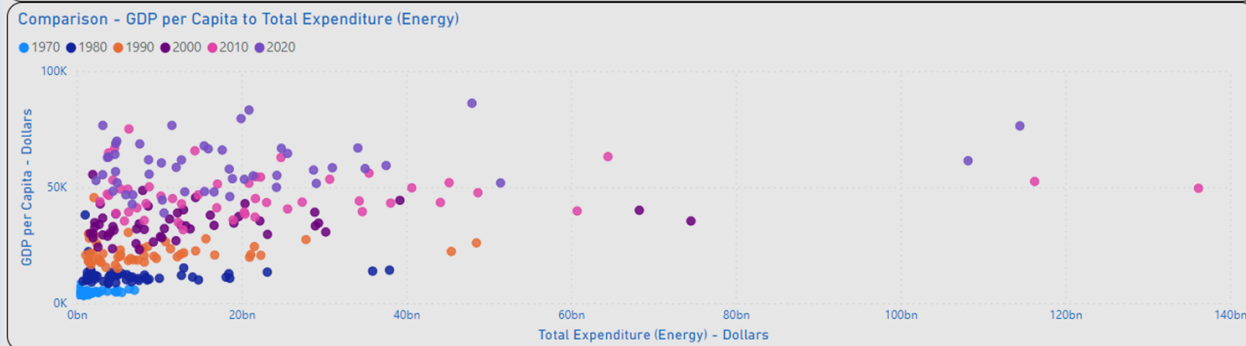
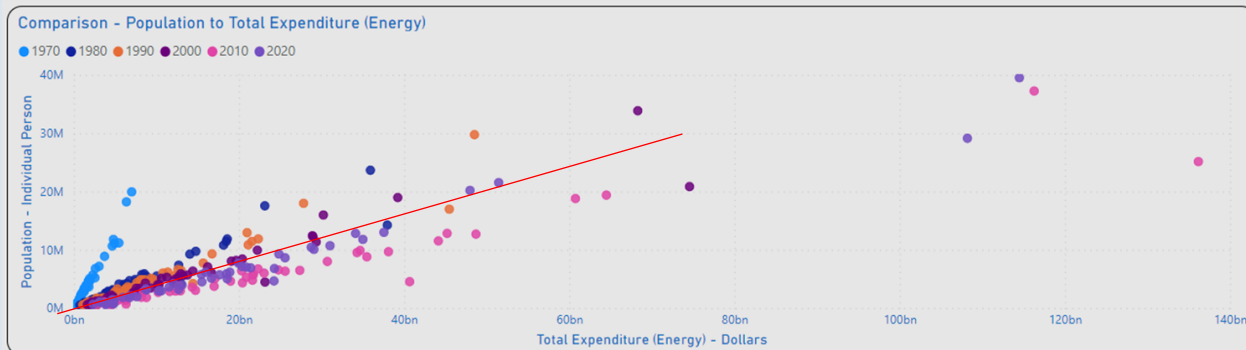
- Weakening of Fossil Fuel Production After 2000
- Renewable Production Displays Significant Increases After 2000

Occam's Razor



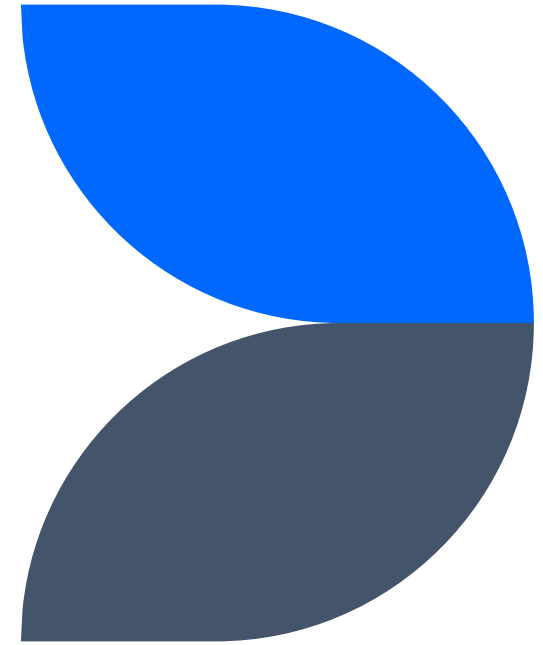
- Alignment of Population and Consumption Values Indicates a Strong Correlation
- Dispersion of GDP per Capita and Consumption Values Between GDP Indicates Lack of Correlation

Occam's Razor: The Simplest Explanation is Usually the Best One.

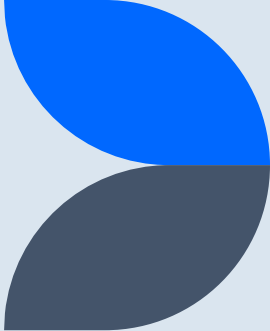


Technology / Future Growth

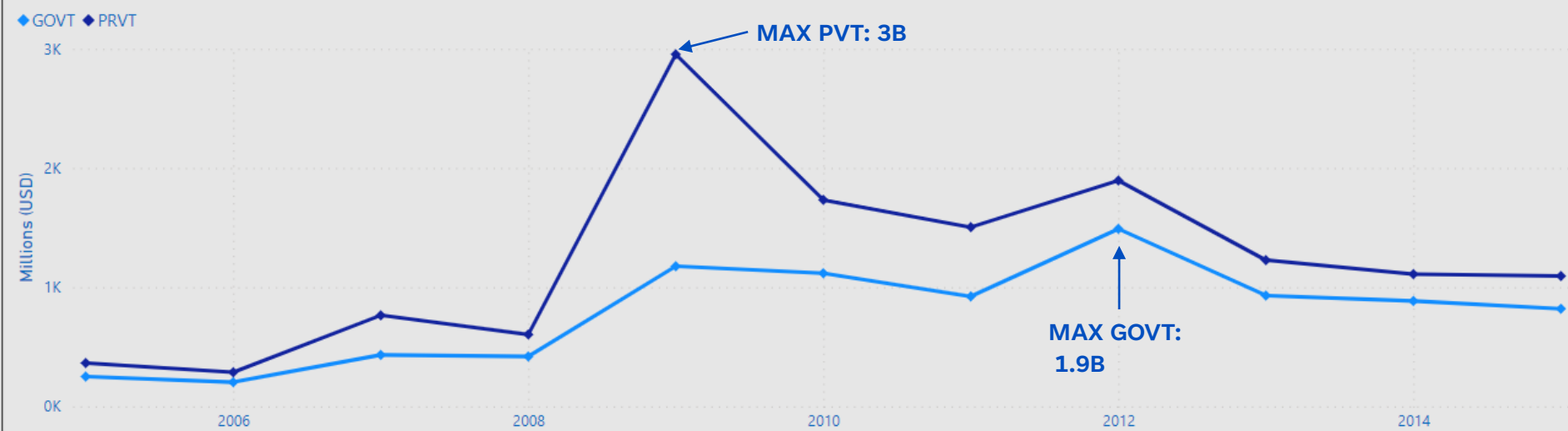
Consumption / Production / GDP per Capita



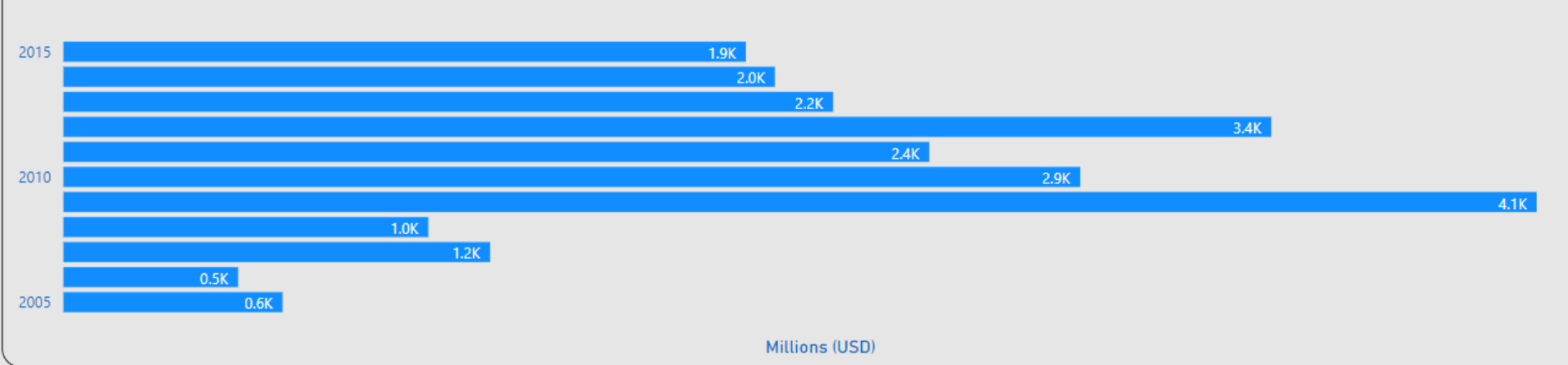
Advancing Renewable Tech



US and Private Industry Research and Development Budget - Renewables



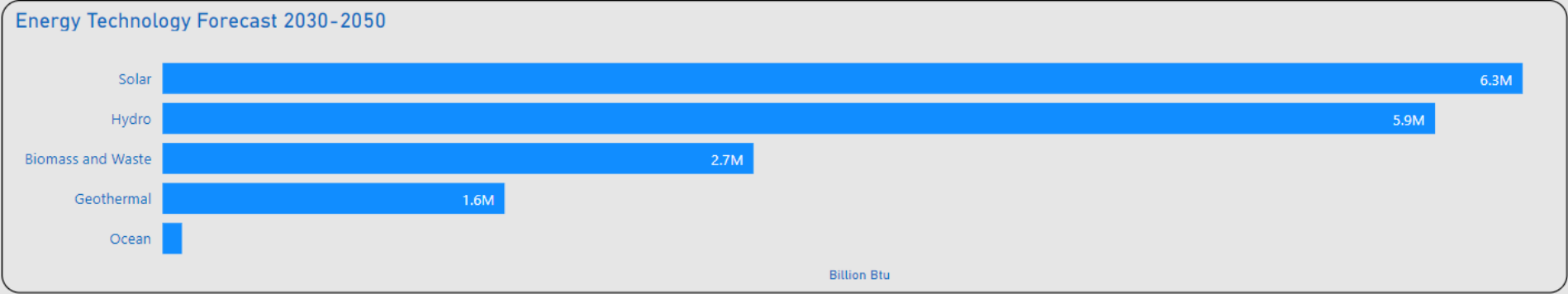
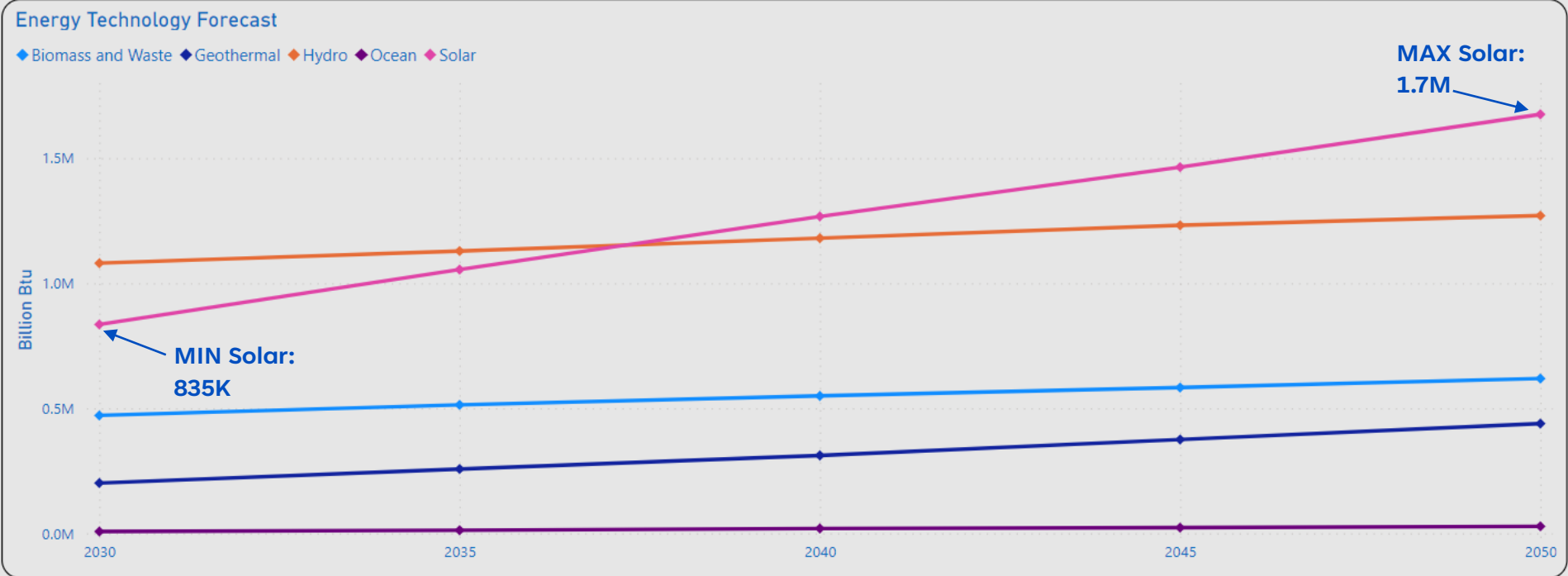
US and Private Industry Research and Development Budget - Renewables



R&D Investment

- MAX Private Industry: 3B / 2009
- MEDIAN Private Industry: 1.2B
- MAX US Government: 1.9B / 2012
- Median US Government: 786M
- ~15B Invested in R&D 2005-2015

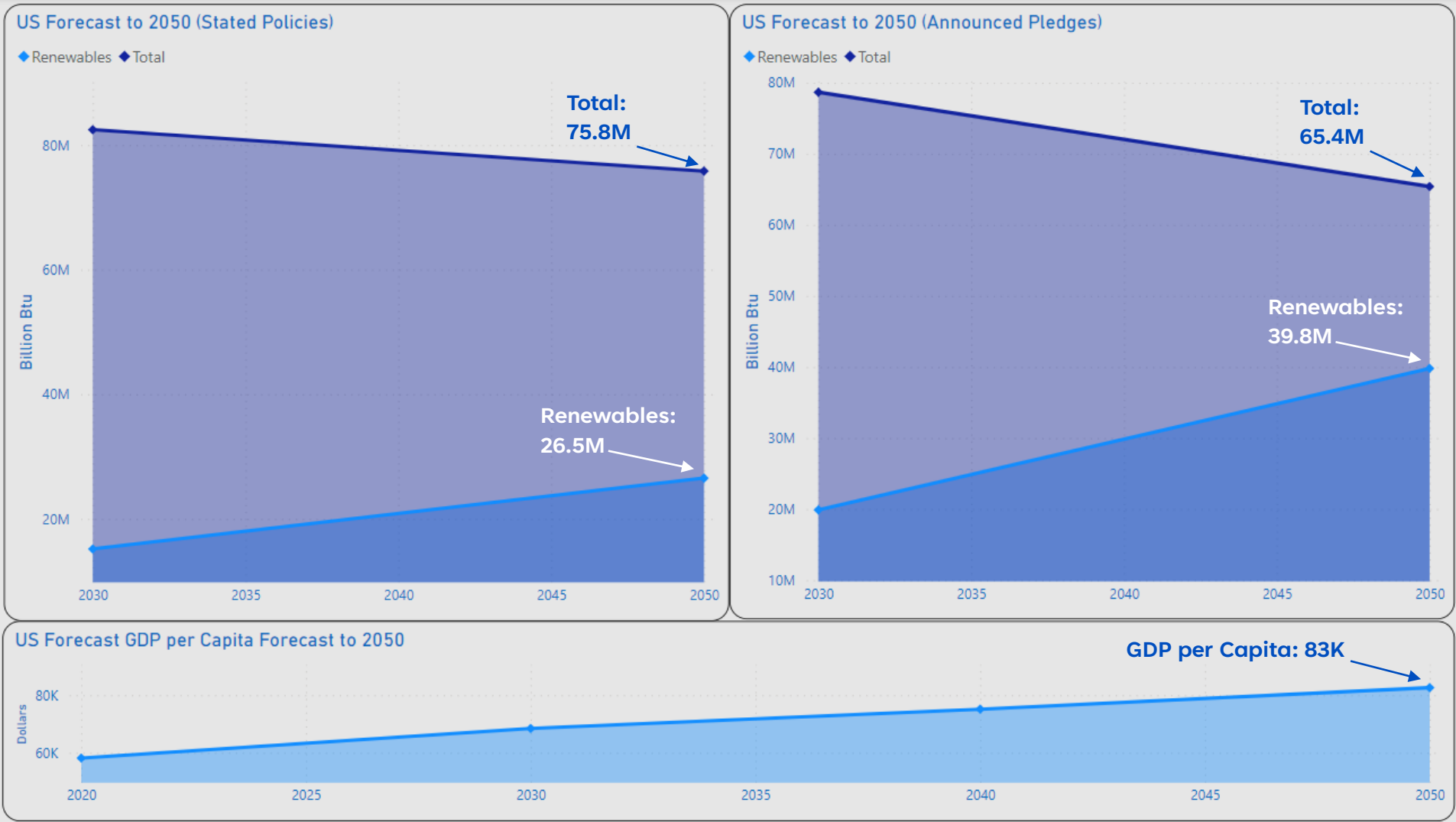
Advancing Renewable Tech



Tech Projections

- Solar Appears to be the Clear Leader in Renewable Advances / New Adoption
- Solar MAX: 1.7M (BN Btu) / 2050
- Solar MIN: 835K (BN Btu) / 2030
- ~16.6M (BN Btu) in Renewables Forecasted Between 2030 & 2050

2050....Heading In The Right Direction



Stated Policies:

- 35% of US Energy Supply Projected for Renewables
- 74% Increase from 2030

Announced Pledges:

- 60.9% of US Energy Supply of US Energy Projected for Renewables
- 100% Increase from 2030

GDP per Capita:

- 83K
- 30.7% Increase from 2020

Summary

- Population has the Greater Impact on Consumption vs. GDP per Capita (Occam's Razor)
- Fossil Fuel Expected to Continue Declining
 - Continued Usage Expected
- Renewables Expected to Continue Increasing
 - Technological Innovation / Availability
 - Government Policy / Regulation

Thank you

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Closing Notes

Technology:

- Excel: Extract Transform Load, Minor Analysis
- PostgreSQL / pgAdmin: Analysis, Prepare Data for Visualization
- Microsoft Power BI: Analysis, Visualization

Data Sources:

- Energy Information Administration (EIA):
 - State Energy Data System 1960-2020: <https://www.eia.gov/state/seds/seds-data-complete.php?sid=ND#StatisticsIndicators>
- Bureau of Economic Analysis (BEA):
 - Regional Data Tools: <https://apps.bea.gov/regional/>
- United States Census Bureau:
 - Historical Population Change Data (1910-2020): <https://www.census.gov/data/tables/time-series/dec/popchange-data-text.html>
- International Energy Agency (IEA):
 - Energy Technology RD&D Budgets: <https://www.iea.org/data-and-statistics/data-product/energy-technology-rd-and-d-budget-database-2#>
 - World Energy Investment 2023 Datafile: <https://www.iea.org/data-and-statistics/data-product/world-energy-investment-2023-datafile-2>
 - World Energy Outlook 2022: <https://www.iea.org/data-and-statistics/data-product/world-energy-outlook-2022-free-dataset>