Revealing the Impact of Extreme Events on Electricity Consumption in Brazil: A Data-Driven Counterfactual Approach

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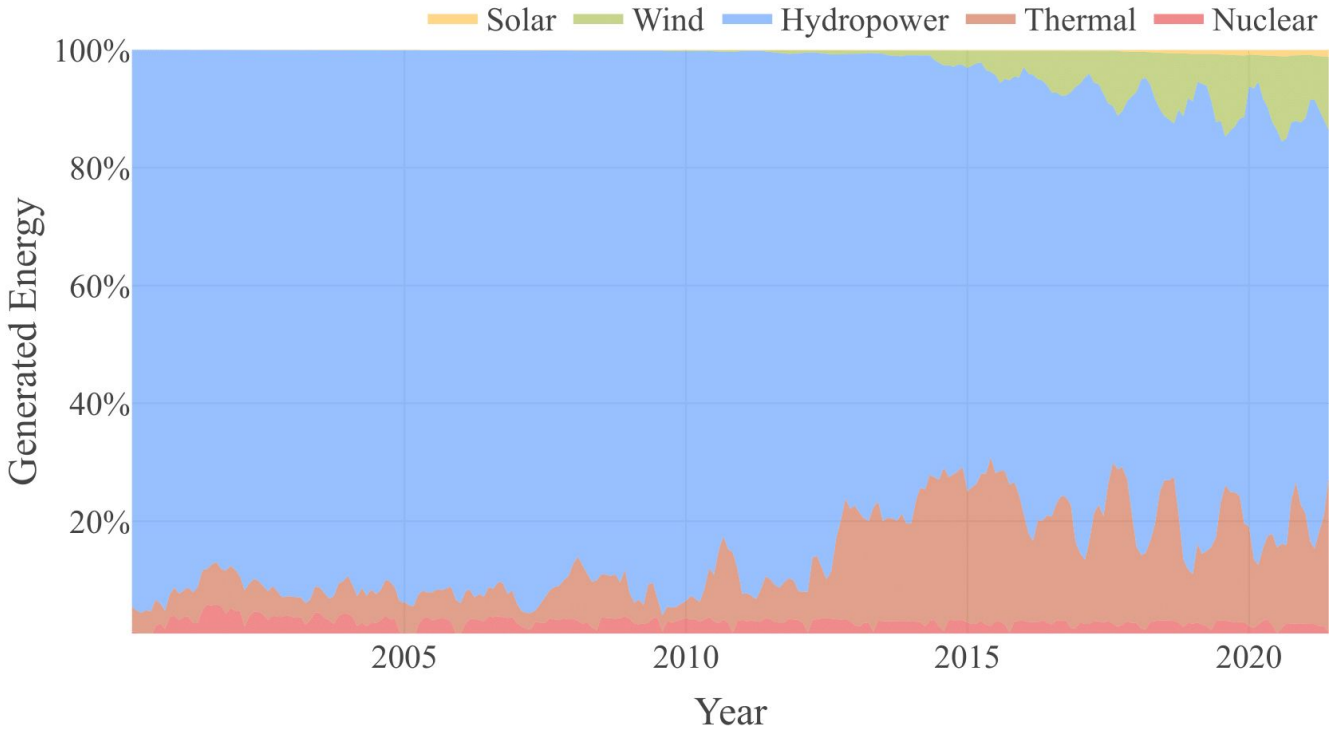
BACKGROUND

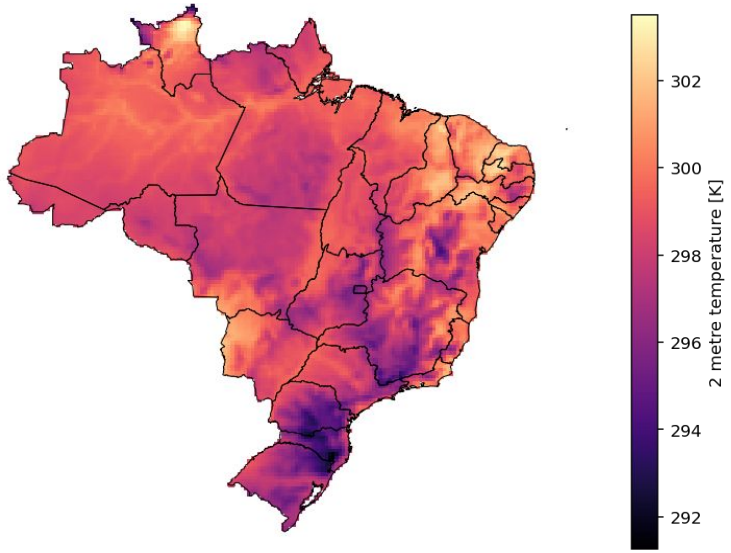
Brazil and clean energy



DATA

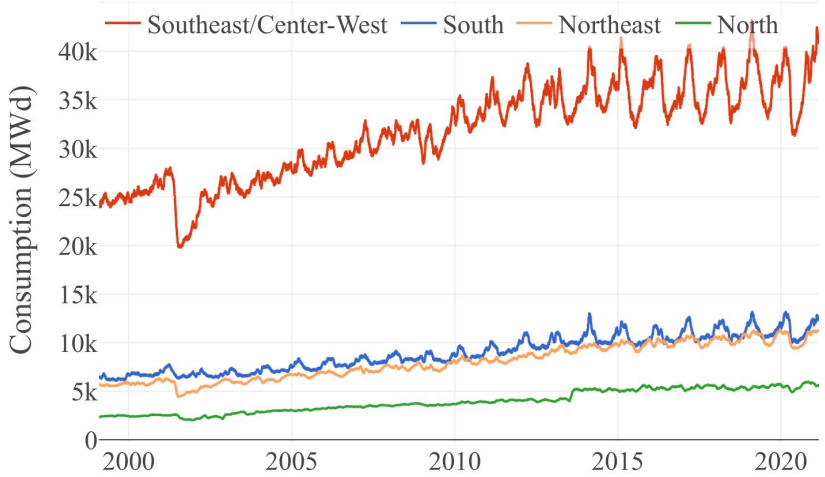
Weather

*D*erived from the ERA5 dataset, consisting of global hourly estimates from 1950 to 2021 for atmospheric variables.



Energy

Sourced directly from the Brazilian National Energy System Operator website containing daily energy consumption measures dating back to 1999.



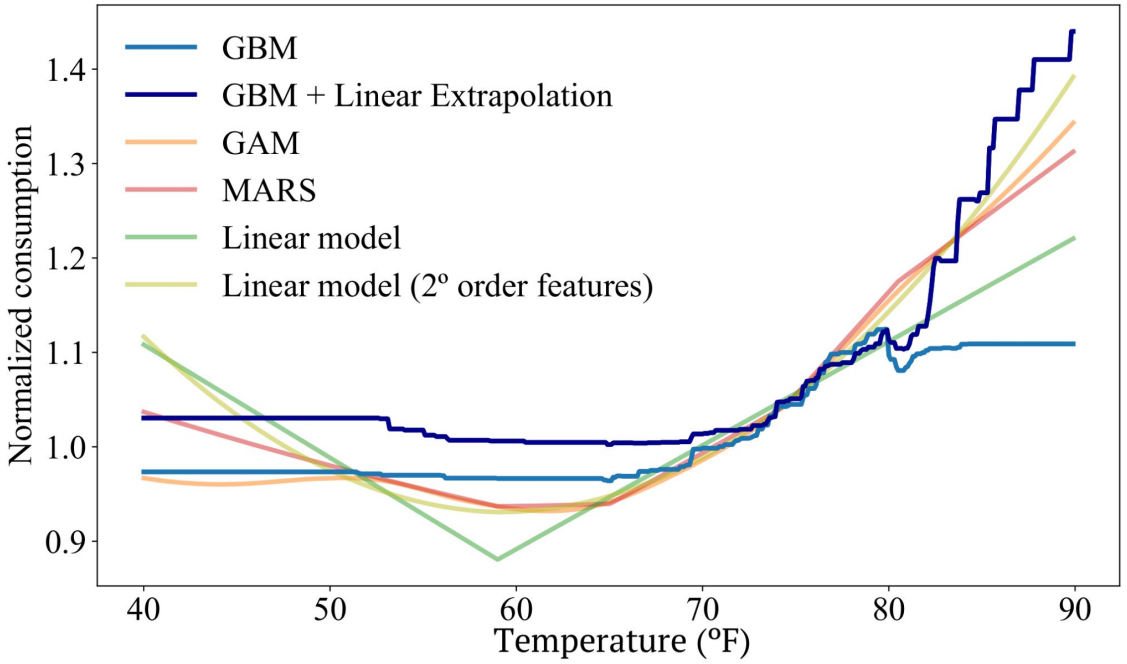
PROPOSED APPROACH

Counterfactual Model

- **Remove atypical events from the data:**
  - Outages
  - Extreme events
- **Normalize demand by projected load growth:**
  - Consumption nearly doubled in 20 years.
  - Remove load growth trend from series before fitting.
- **Train a model on data from 2000 to 2019.**
- **Evaluate on relevant extreme events:**
  - Heatwaves
  - COVID-19 pandemic

MAIN RESULTS

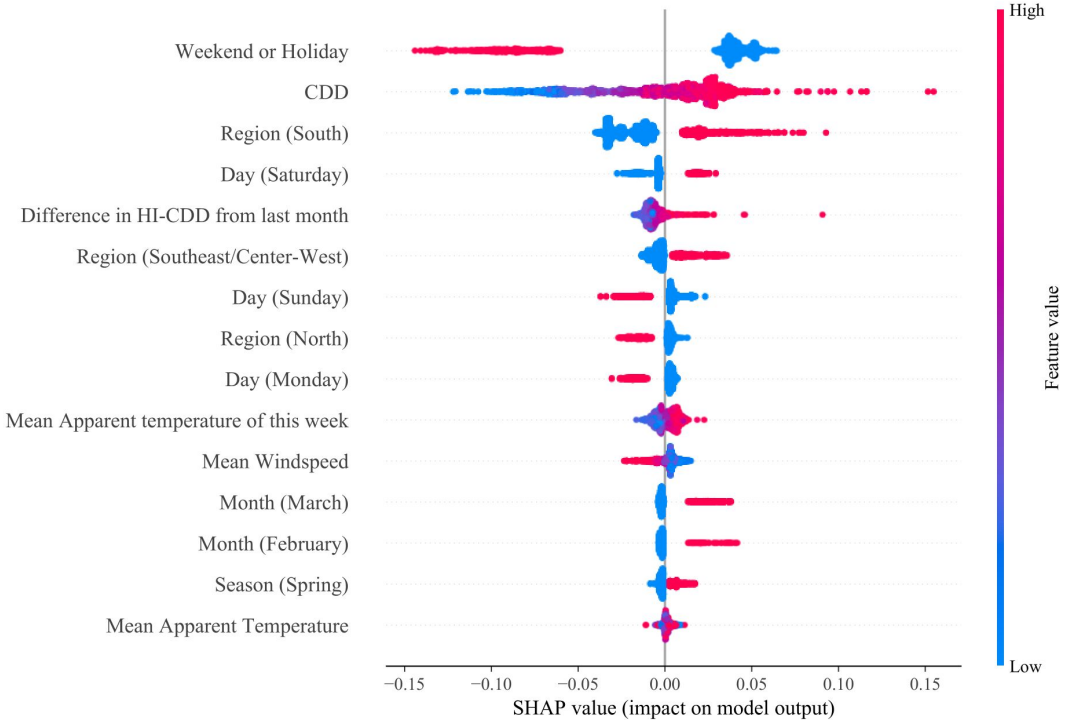
Enable GBM to extrapolate



	Model	Overall	
		R^2	MAPE
Simple Features	Linear Regression	.788	2.76%
	GAM	.783	2.78%
	MARS	.787	2.78%
	SVM	.616	3.95%
Second order and logarithm features	Linear Regression	.790	2.74%
	GAM	.784	2.79%
	MARS	.788	2.73%
	SVM	.649	3.72%
	LightGBM	**.854**	**2.64%**
	LightGBM + Linear Extrapolation	.848	2.69%

MAIN RESULTS

Explicability



Overall
R^2 0.854 +/- 0.022
MAPE 2.7% +/- 0.3%

North
R^2 0.619 +/- 0.063
MAPE 2.6% +/- 0.2%

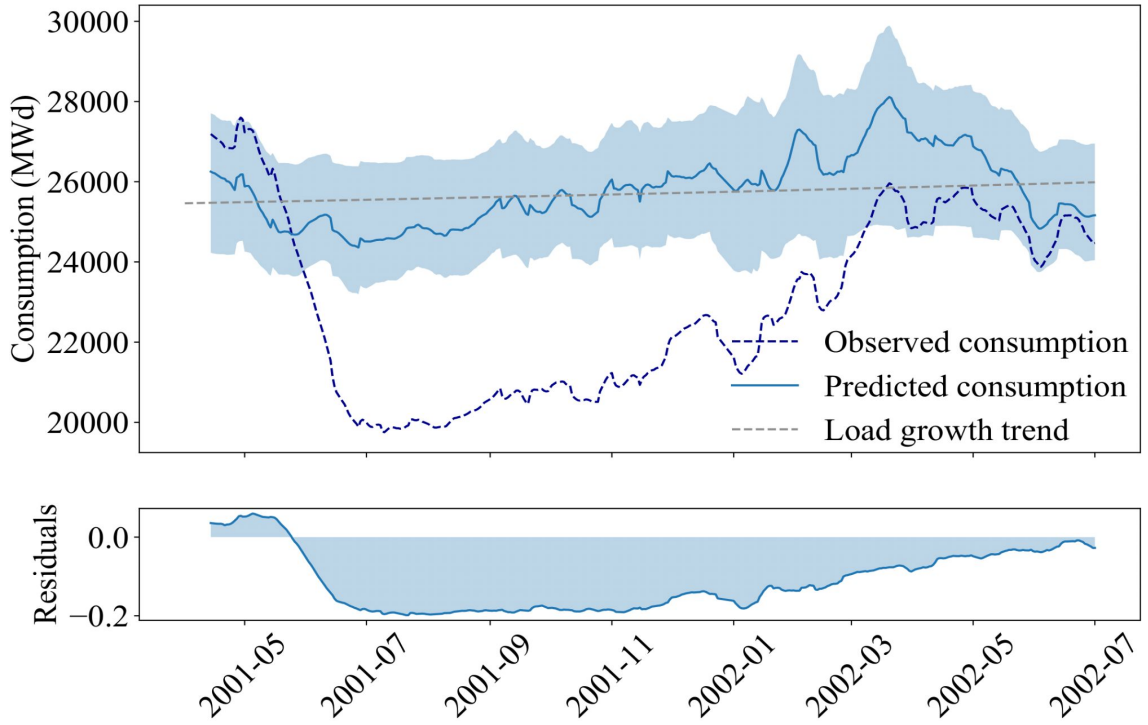
Northeast
R^2 0.773 +/- 0.048
MAPE 2.3% +/- 0.3%

South
R^2 0.887 +/- 0.023
MAPE 3.1% +/- 0.6%

Southeast/Centerwest
R^2 0.850 +/- 0.019
MAPE 2.5% +/- 0.3%

MAIN RESULTS

Impact of Extreme Events



Due to a hydric crisis, in 2001 the Brazilian government enacted a series of policies targeted at reducing energy consumption by 20%.

In the same period, we observed residuals of between 18% and 21%.

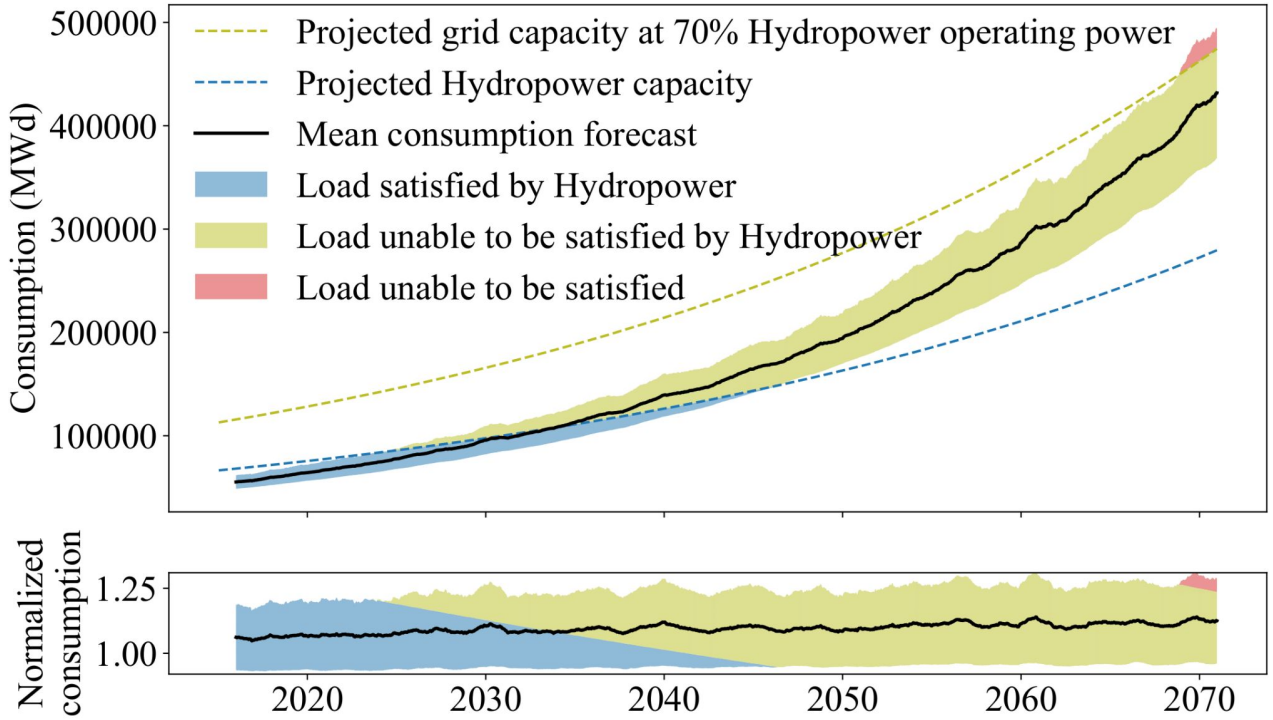
MAIN RESULTS

Future Projections

IPCC CMIP6 ACCESS-ESM1.5 SSP5-8.5 scenario following Brazilians Electric Energy Trading Chamber projections for load growth.

We can expect considerable thermal usage by 2035.

Brazil will be unable to sustain its own consumption by 2070.



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