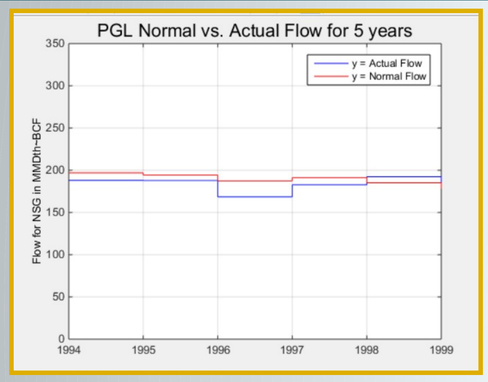
Analyzing Algorithms for Weather Normalized Gas Consumption

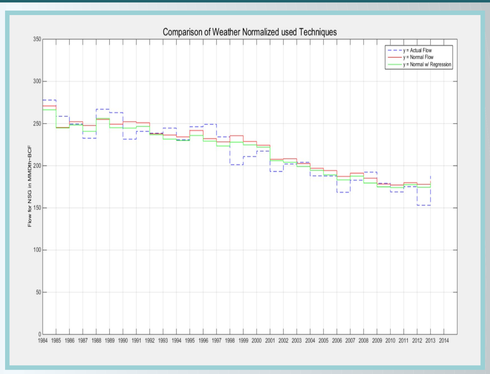
Maria Dela Sancha

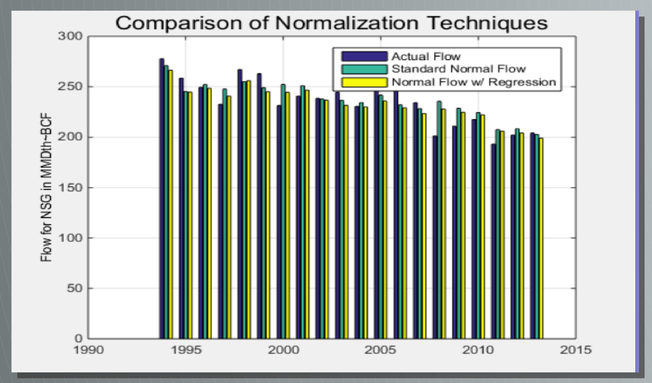
Marquette MSCS REU & Gas-Day Lab

BACKGROUND

- Understanding the overall gas consumption trend in the previous years, the present and potentially in the future is a crucial step in energy saving ideas
  - Labs like Gas-Day help Natural Gas utilities ensure that they have sufficient gas for their customers
- Many factors influence gas consumption; the economy, heating and cooling systems in a building, building structure, type of building (residential or commercial), occupancy of building, operations, but one of the most important ones is the weather
  - Innovations and improvements in some of these factors has declined the overall energy usage which can be more clearly seen in a range of 30 years
- We Correlate temperature and flow with HDD; which is the amount of degrees below a base temperature from which a house needs to be heated





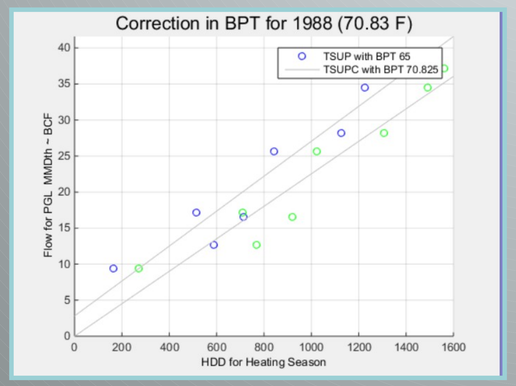


PURPOSE

- In order to calculate a correct base load we weather normalize demand that helps us understand
  - what the demand would have been had the weather been normal
  - true gains and loses of energy saving ideas
  - Ultimately normalizing demand means to take out the effect weather has on demand
- We understand when normalized usage is suppose to be higher or lower than the usual but we don't know how high or how low
- How can we understand which technique is better without knowing what perfectly normalized demand looks like
- **Problems We face**
  - Variability
  - Outlier uncertainty
  - Sample size uncertainty

MATERIALS AND METHODS

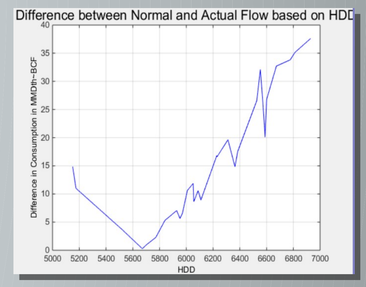
- **American Gas Association Standard technique**
  - Normal Use = $BaseLoad + Total\ usage\ (\frac{normalHDD}{Actual\ HDD})$
  - BPT of 65º F
  - Factor = $\frac{Totalusage}{Actual\ HDD}$
- **Regression Analysis**
  - Normal use = TotalUsage + (beta coefficient of regression)(NormalHDD – ActualHDD)
  - Adjusted Base Temp
  - Factor is the beta coefficient of the regression between HDD of the heating season and Temperature sensitive use
  - What does Normal Flow mean?
    - Constant decreasing or increasing flow
    - Constant normalization factor for similar temperatures
    - Minimum variability
  - **Testing technique**
    - Regression analysis between HDD and change in normalization
    - Leave-one-out cross validation technique to compensate for minimum data
      - Left out year will be used to make an estimate and then compared to actual data
    - Build prediction intervals on sampled data
      - Determine how many times our prediction fell between these intervals
    - Compare the overall success rate

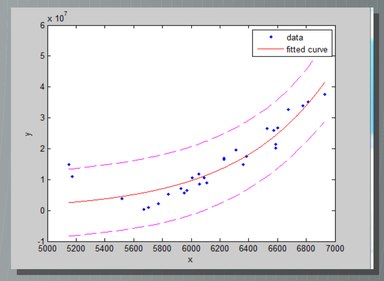


RESULTS

Regression technique
- 79.99%

Standard AGA
- 58.22%





CONCLUSIONS

- Why did the Regression Analysis have a higher success rate?
  - The normalization factor depends on both normal and actual HDD
    - HDD depends on a BPT, which means when calculating the amount yearly having a balance point temp with 3 deg. difference can make a difference
    - An accurate BPT will calculate the correct HDD which is the one of the key components in relating flow with temperature
  - Beta coefficient is a stronger coefficient for the effect HDD has on Flow
- Other fluctuating factors like the economy cause the errors in predictions
- **Future research**
  - Why is accuracy still low?
    - This factor is supposed to change because of innovations
  - Use data from various Op areas to increase sample size for 5 years, then determine new factor with these results
  - Simulator with 100% controlled factors
  - While these techniques are accurate for most years; they aren't for years with extreme temperature, why?
    - How is the Weather normalization factor affected with extreme temps.

REFERENCES

1. AGA Statistics and Load Forecast Methods Committe. "Load Forecasting Methods." F20495 (1995): 97-107. Abstract. (n.d.): n. pag. Print.
2. Bower, Richard S. "Weather Normalization and Natural Gas Regulations." *The Energy Journal* 6.2 (1985): 101-15. Web.