A Model for Natural Gas Consumption Forecast

10th International Conference on "Energy and Climate Change"
11-13 October 2017
Athens, Greece

University of Belgrade
Faculty of Mining and Geology

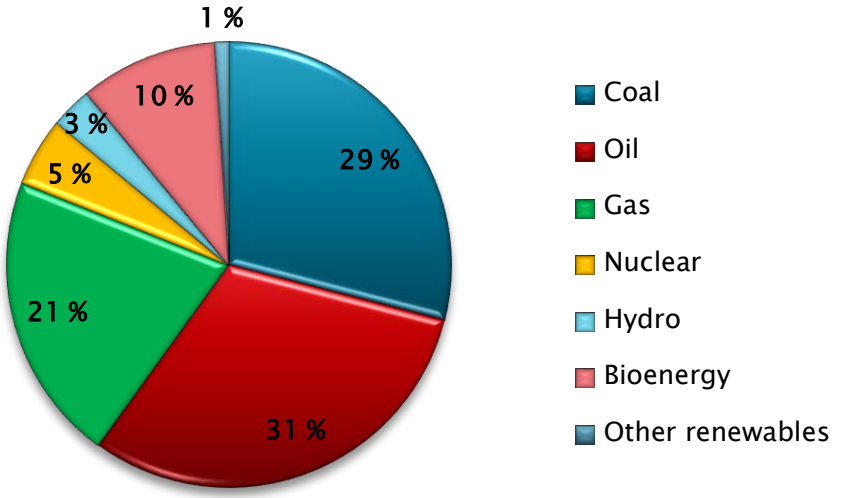
MSc. Milica Ivić
Faculty of Mining and Geology
University of Belgrade
Serbia

Introduction

- **Natural gas:**

the most attractive energy sources , effective, reliable and efficient

- Establish efficient natural gas market?
- **Forecasting**
  - Artificial Neural Network – ANN
  - Multiple Linear Regression – MLR
  - Curve Fitting Model – CFM
  - Average Model – AM



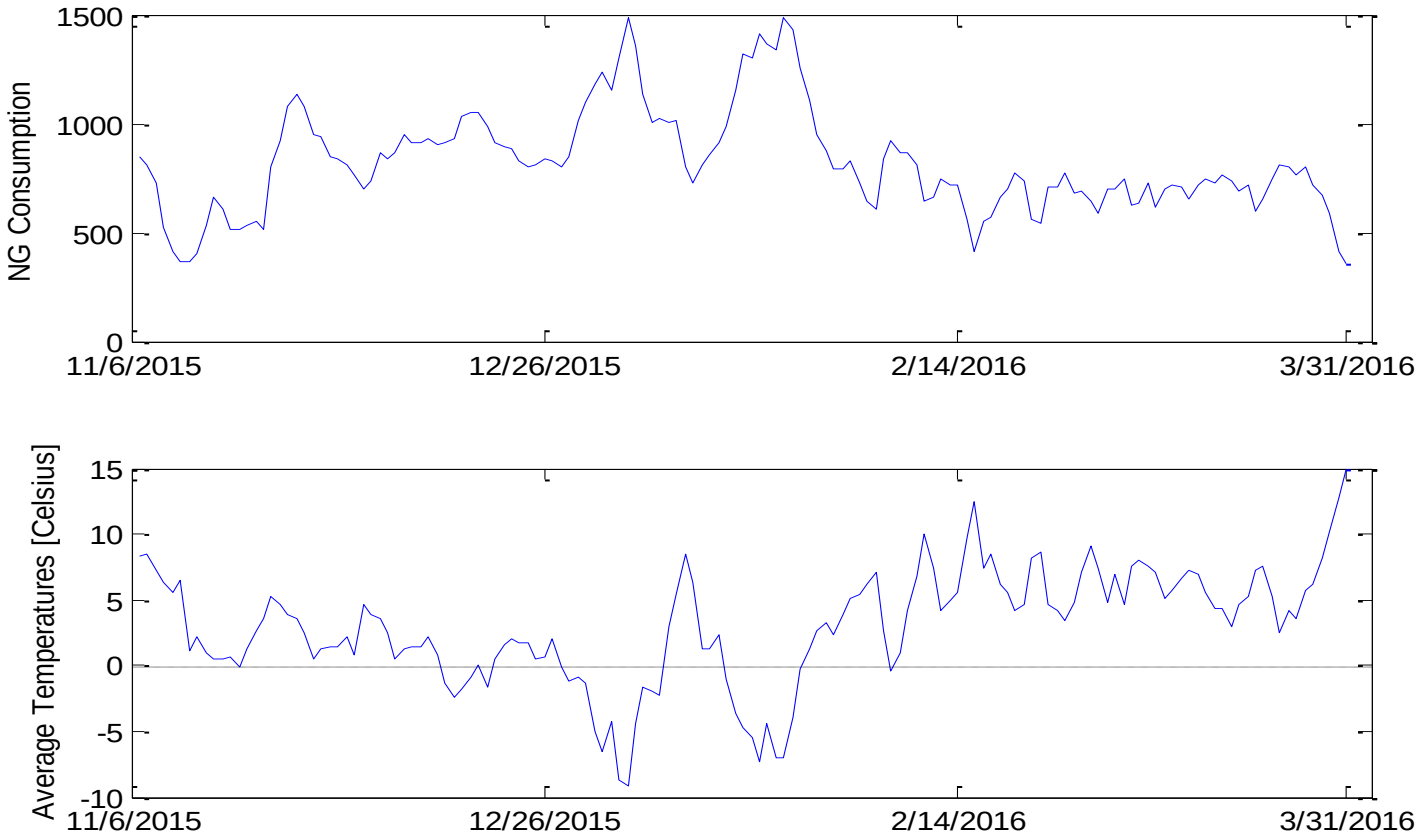
Parameters for Forecast of Natural gas consumption

The most important factors that have influence on NG consumption are temperature and past consumption behavior.

For forecasting daily natural gas consumption parameters are:

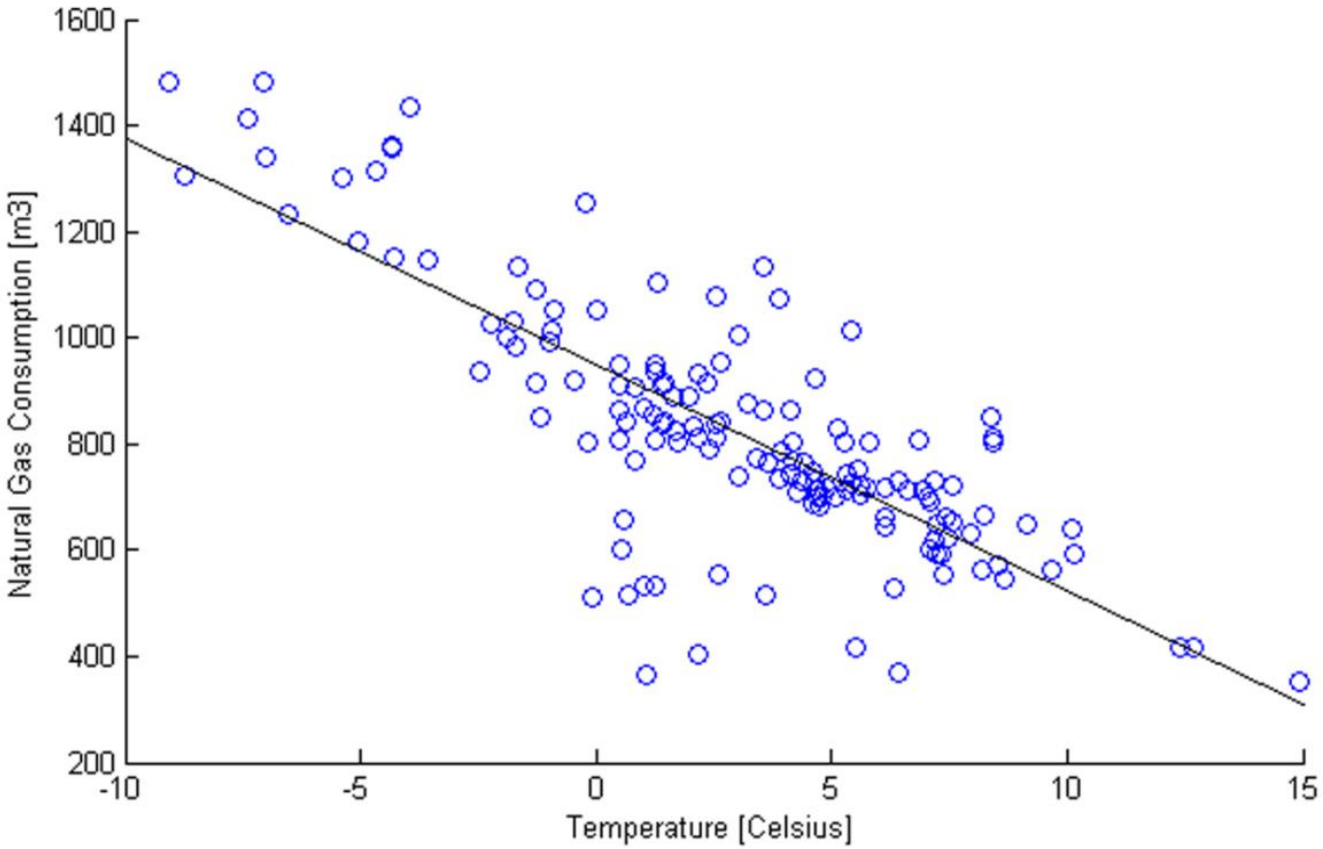
- Average daily temperature (historical data and forecast for selected day),
- Daily natural gas consumption (historical data),
- Day in the week for which forecast is required,
- Other factors (wind, thermal memory, solar radiation…)

Temperature



The influence of average daily temperature to gas consumption at selected MRS

- *Temperature*



Daily gas consumption and average temperatures at selected MRS

- Average daily temperature
- Forecasted temperature ($\Delta t = t_{k+1} - t_k$)

- *Previous day consumption* – provides to take into account previous behavior of consumption in order to have precise prediction of future consumption. Forecasting for "next day" is made using information about consumption of previous day.

- *Day in the week* – NG consumption varies through the different days during week.

Day	Numerical value
Saturday and Sunday	1
Friday	0.5
Other days	-1

- *Other factors*

(wind, thermal memory, solar radiation, cloudiness, holydays …)

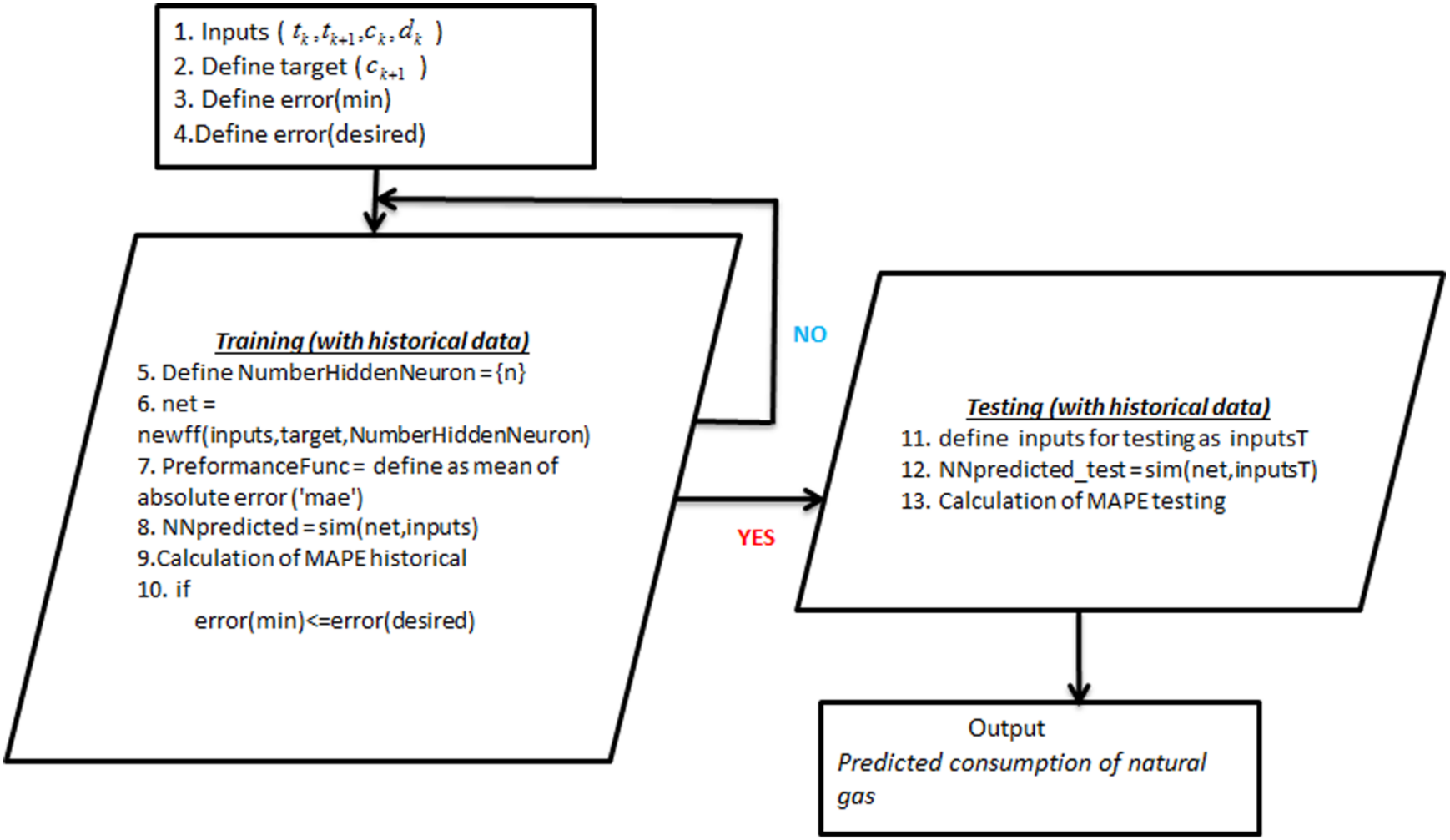
10x1 input vector is defined for all proposed algorithms for forecast of natural gas consumption. It consists of scalars:

(e.g. : for k-th day)

- average daily temperature (t_k),
- forecasted temperature, for day ahead (t_{k+1})
- daily consumption of natural gas (c_k), as well as of 7x1 row vector (d_k) that represent corresponding day of the week.

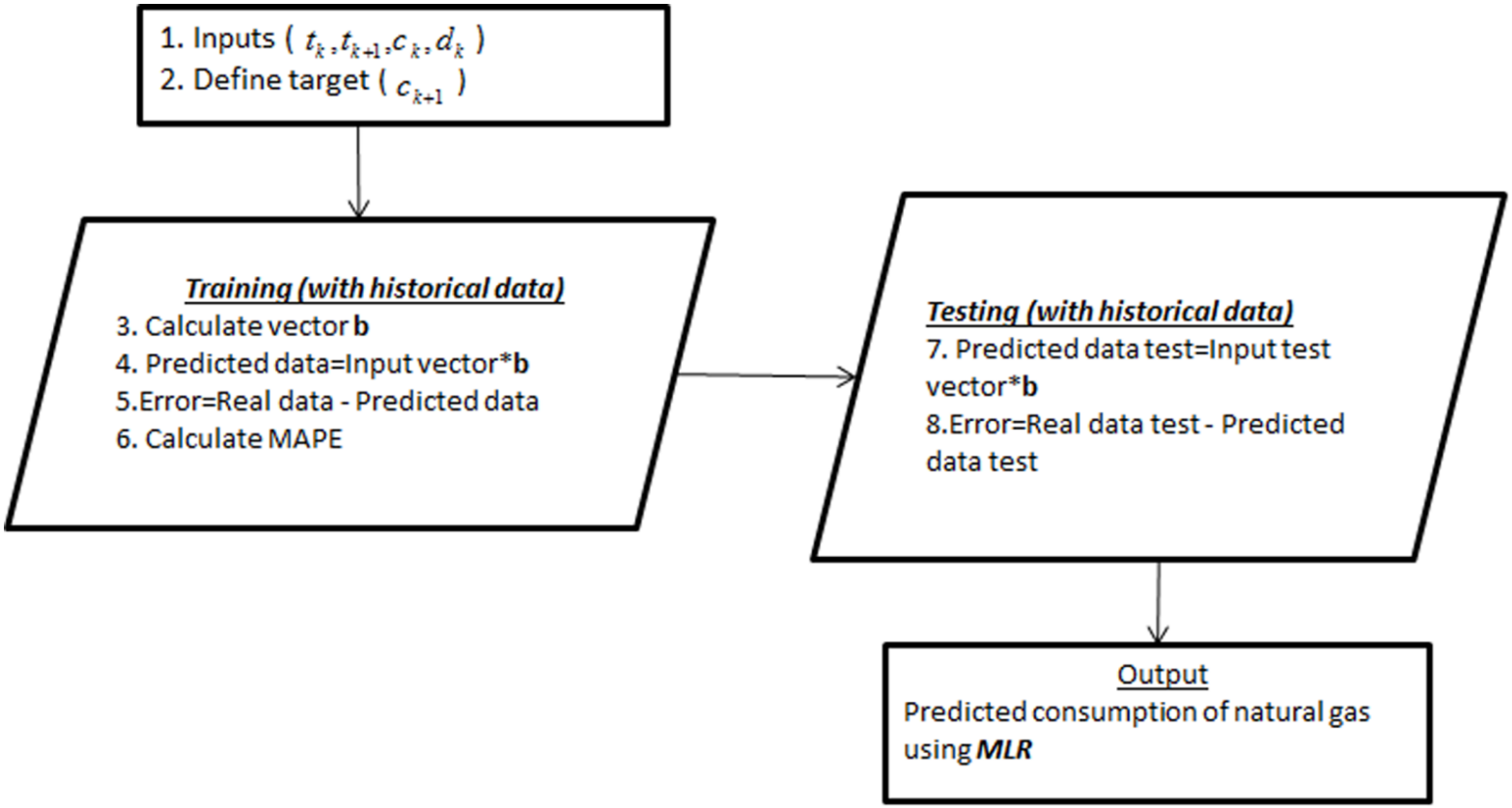
Artificial Neural Network

- n-dimensional vector input



Multiple Linear Regression

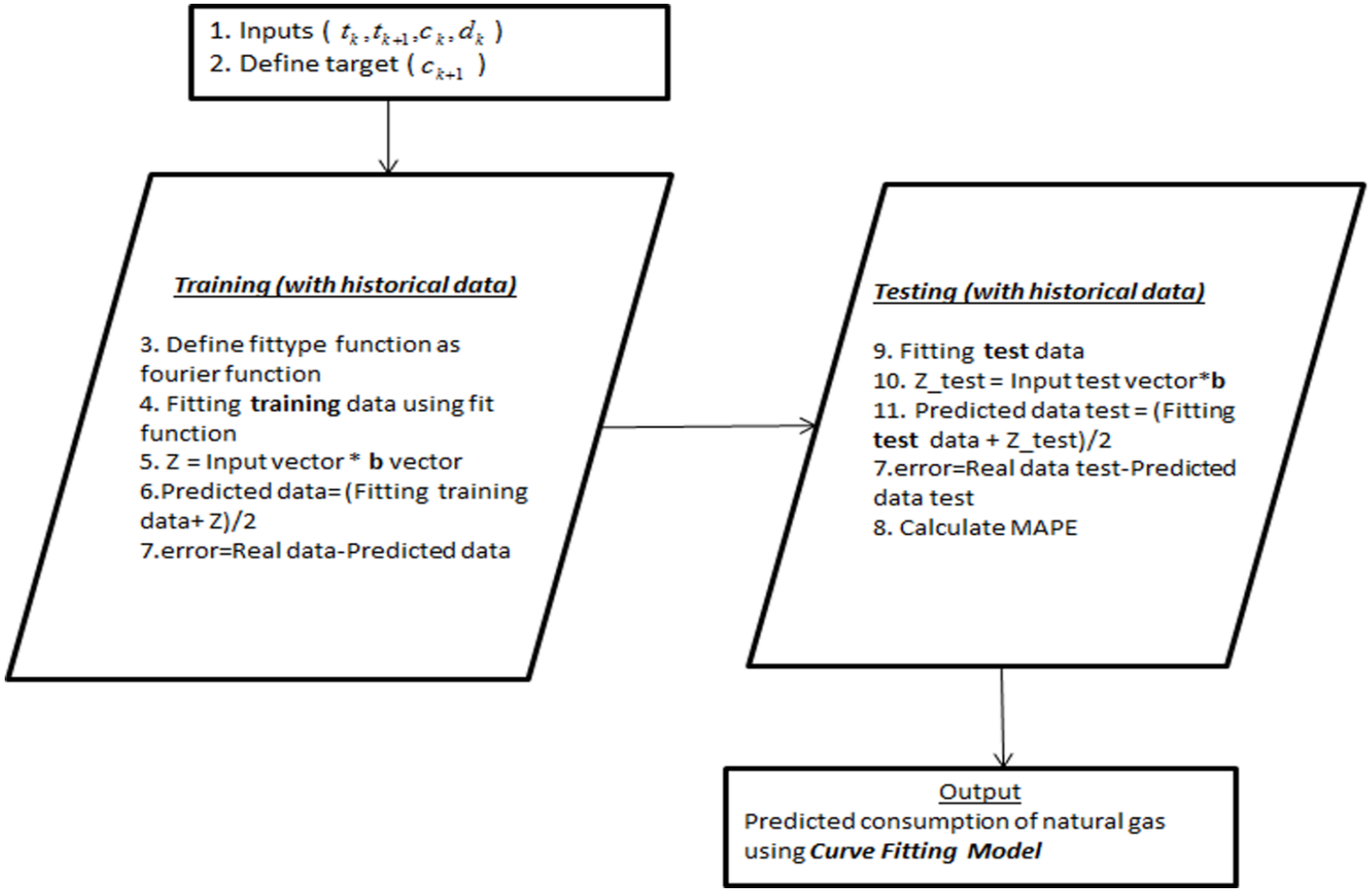
- $\hat{Y} = b_0 + b_1 \cdot X_1 + b_2 \cdot X_2 + \ldots + b_n \cdot X_n$
- Where: $b_o, b_1 \ldots b_n$–fitted coefficients
- $\hat{Y}$ – predicted value(response)
- X – all independent variable that influence output



University of Belgrade
Faculty of Mining and Geology

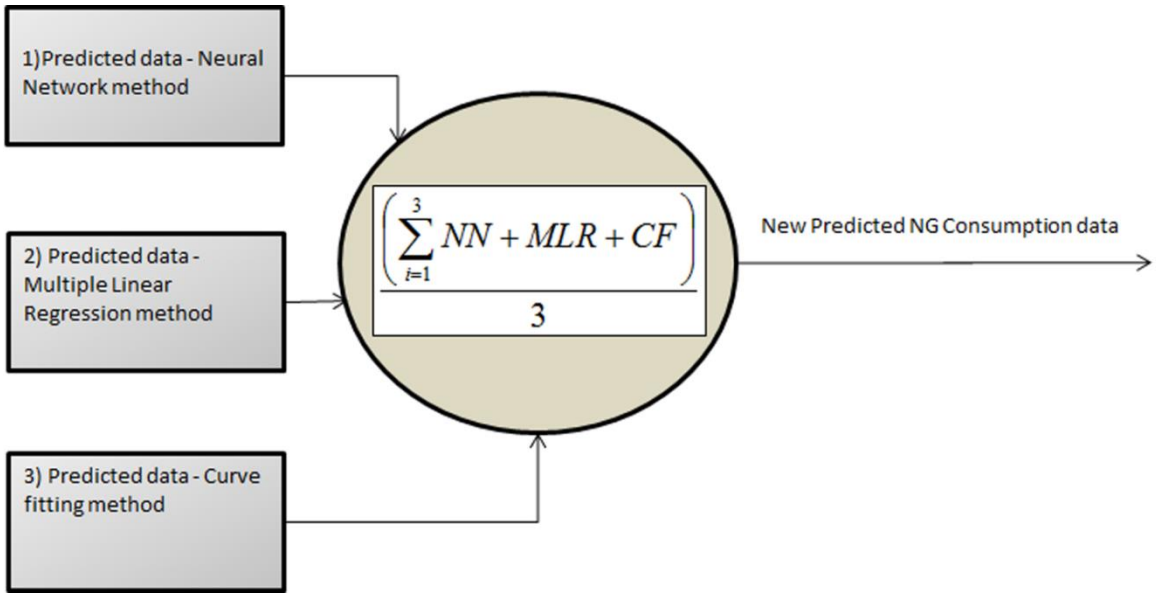
Curve Fitting Method

- $f(x)_{fit} = a_0 + \sum_{n=1}^{8} a_n cos(n \cdot x \cdot \omega) + \sum_{n=1}^{8} b_n sin(n \cdot x \cdot \omega)$
- Fourier equation



University of Belgrade
Faculty of Mining and Geology

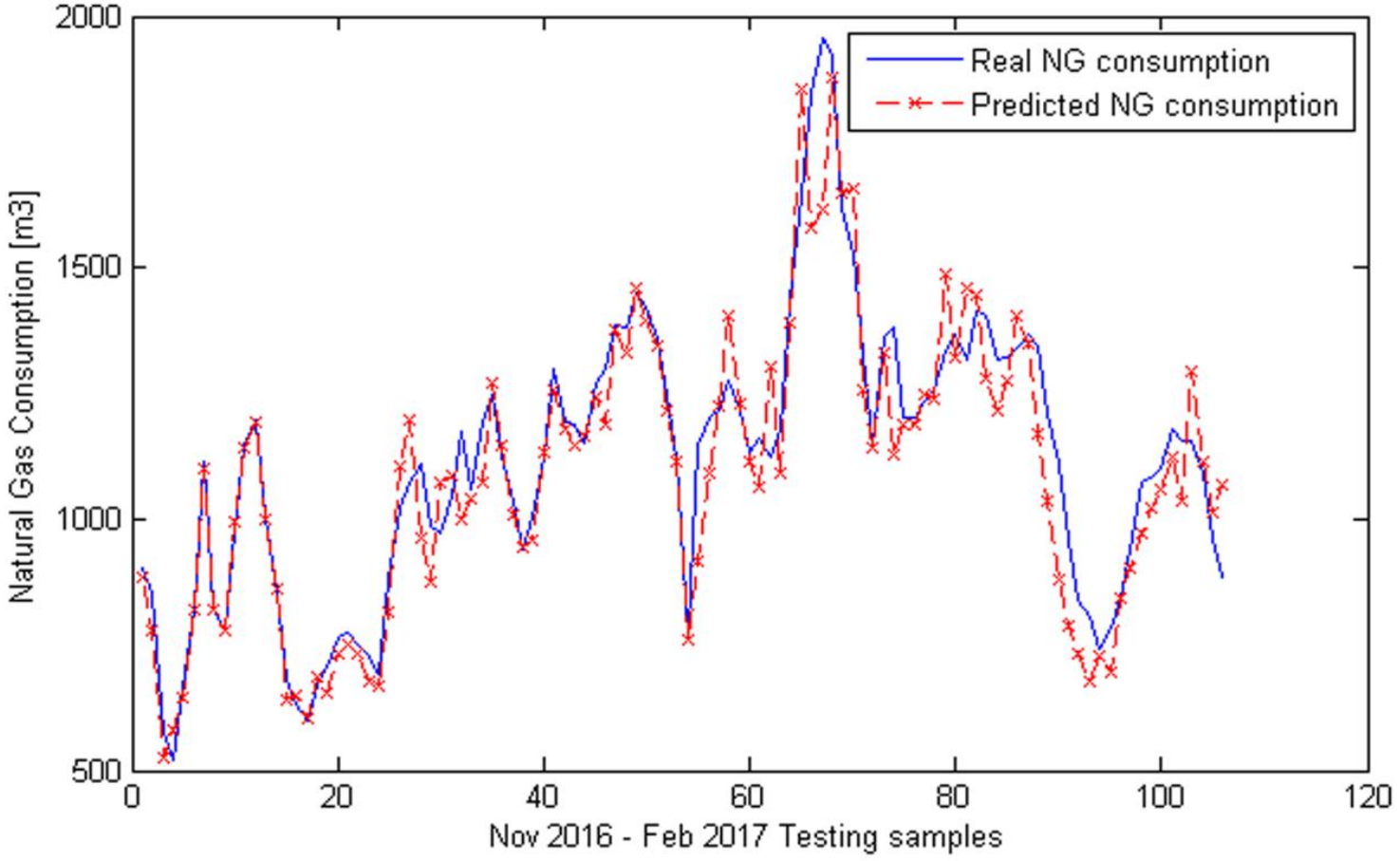
Average Model



- After creating three different models for forecasting natural gas consumption, the fourth model in actually average model of previous three. In Average Model algorithm are incorporated algorithms of ANN, MLR and CF.
- Average Model represent hybrid algorithm because it includes different methods inside one algorithm.
- Predicted gas consumption data represent average values based on predicted data from ANN, MLR and CF.

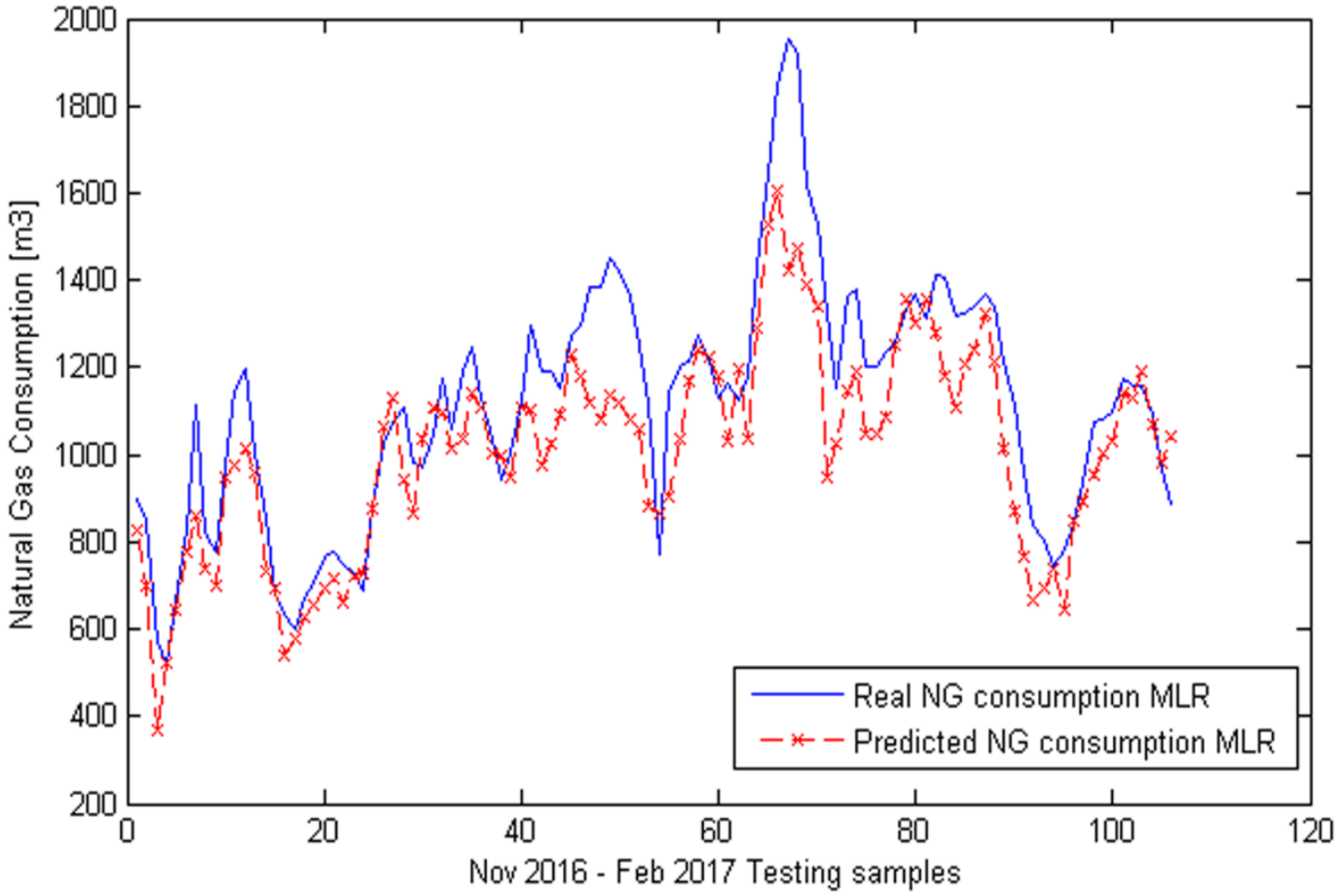
Results and discussion

- Forcasts by Neural Network Model for testing data



Results and discussion

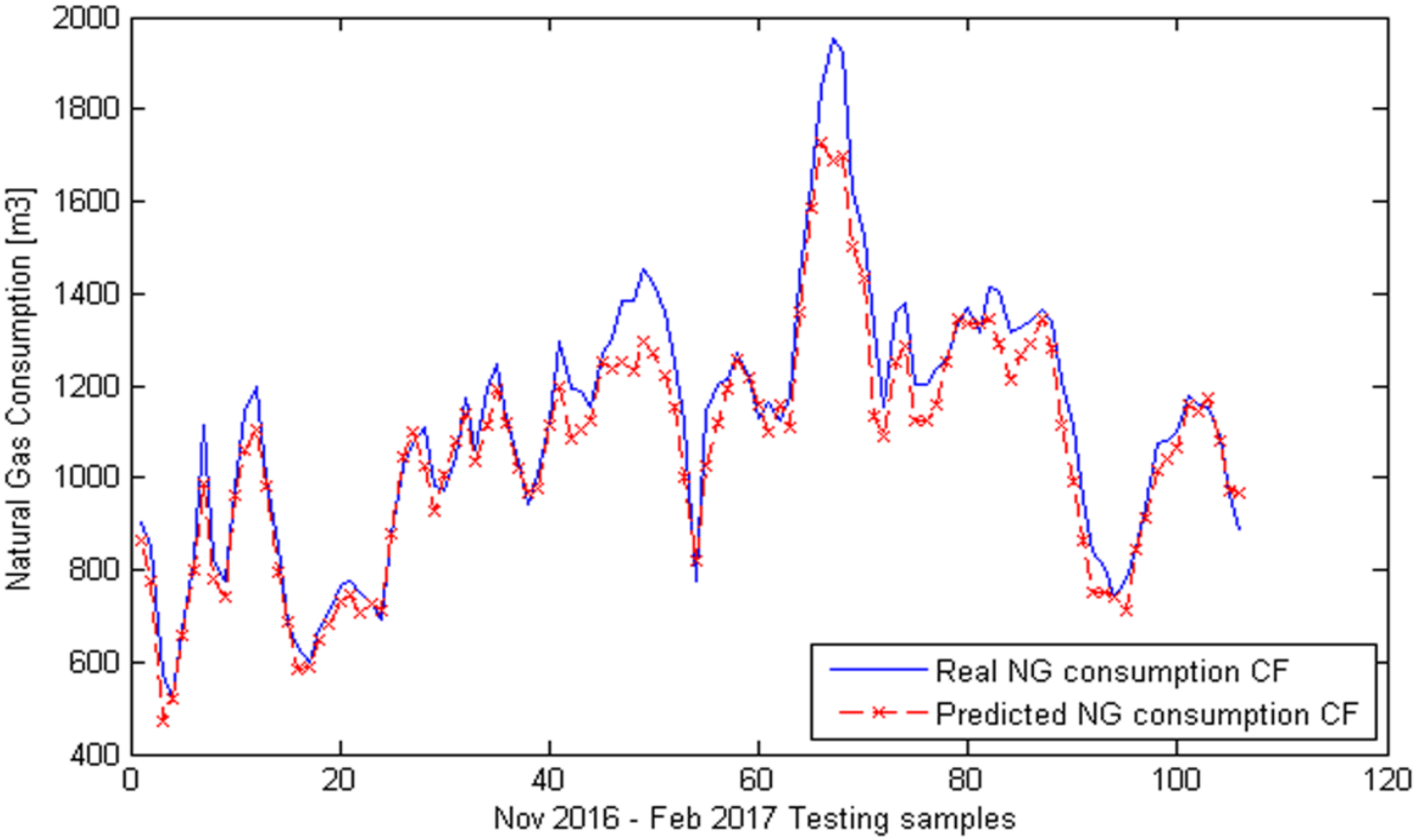
- Forcasts by Multiple Linear Regression model for testing data



University of Belgrade
Faculty of Mining and Geology

Results and discussion

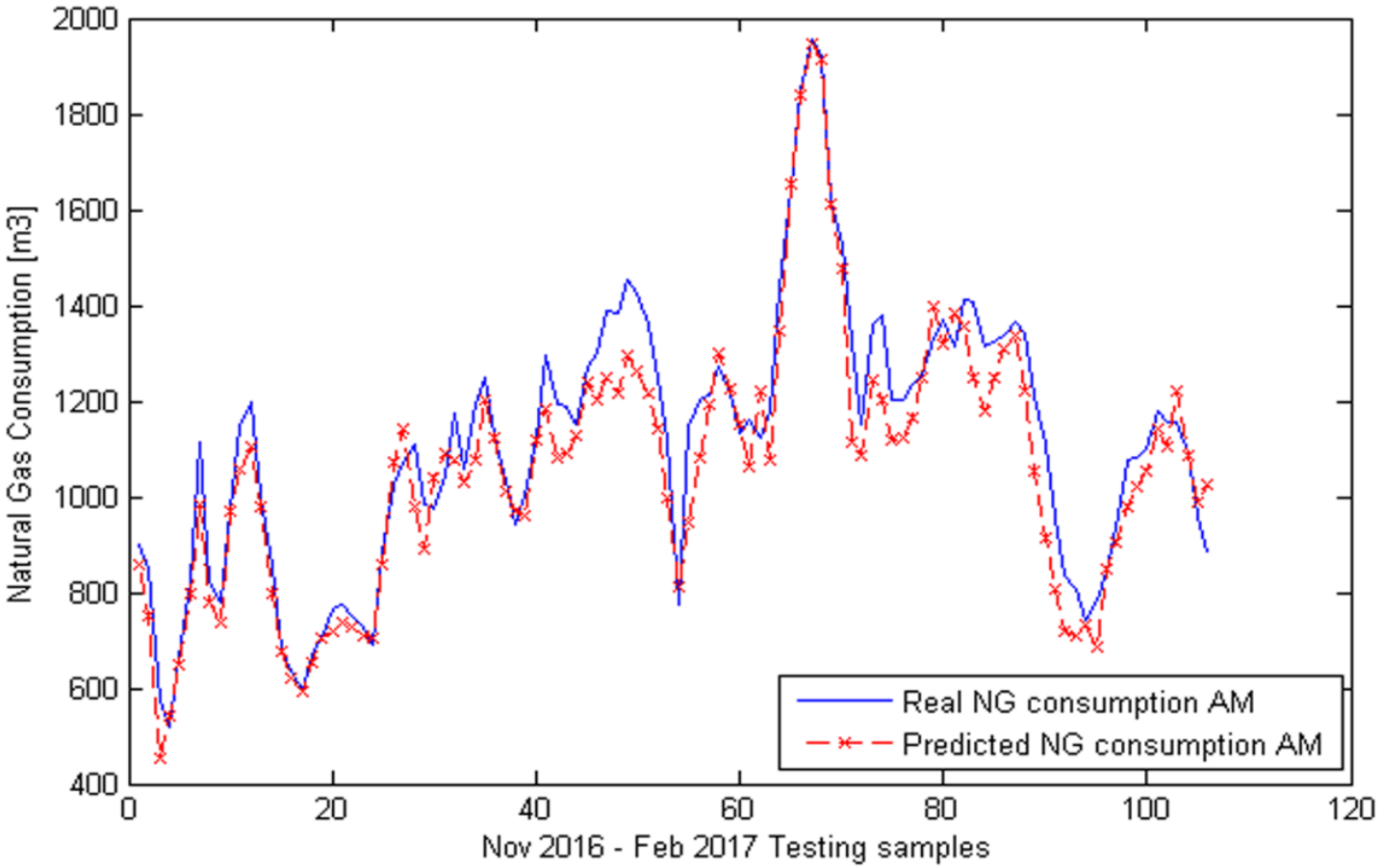
- Forecasts by Curve Fitting model for testing data



University of Belgrade
Faculty of Mining and Geology

Results and discussion

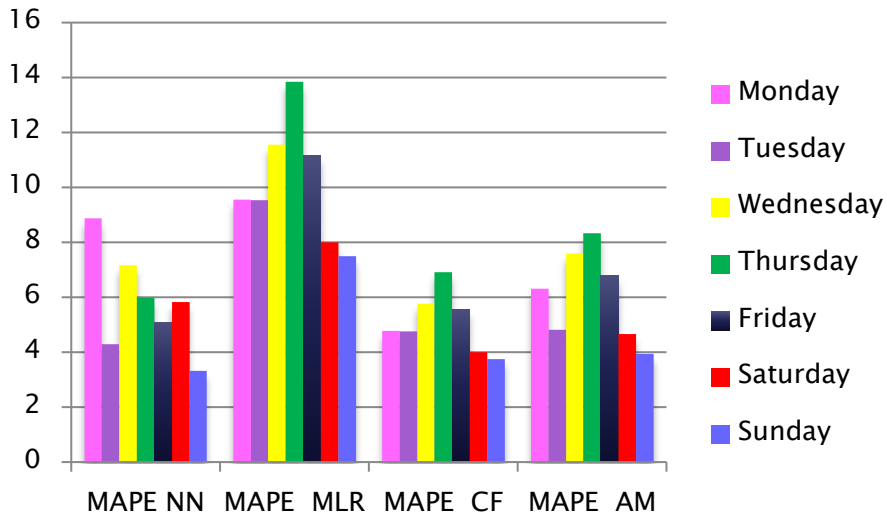
- Forecasts by Average Model for testing data

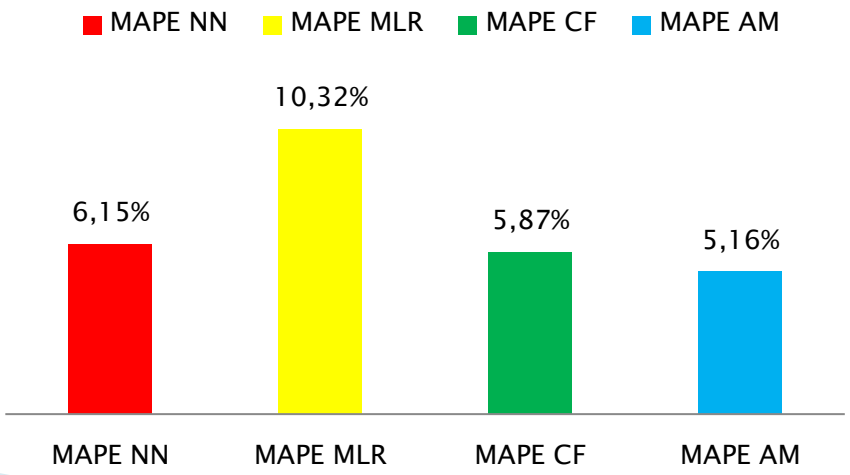


Evaluation

- *Of forecasted consumption is analyzed by using Mean Absolute Percentage Error(MAPE)*

- $MAPE = \frac{1}{N} \sum_{i=1}^{N} \left| \frac{data_{actual} - data_{predicted}}{data_{actual}} \right| \cdot 100\%$





Conclusion

- Little difference compared to measured actual consumption
- Three models have similar, relatively good results, and only MLR model shows significantly bigger mismatch with measured data
- Average Model provided the best results, $MAPE = 5.6\%$
- Proposed hybrid model could be helpful for a daily base planning of operation of distributive gas network
- Proposed model could be a part of fully automated system for forecast of natural gas consumption

Thank you for your attention

University of Belgrade
Faculty of Mining and Geology