Forecasting US Natural Gas Production into year 2020: A comparative study

SPE 91413

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US Natural Gas Production
(1949-2002)
Introduction

US Natural Gas Consumption
(1949-2002)

By Sector, 1949-2002

- Industrial
- Residential
- Electric Power
- Transportation
- Commercial

Trillion Cubic Feet
Introduction

Annual Energy Outlook (2025)
EIA’s National Energy Modeling System (NEMS)
Introduction

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Artificial Neural Network

Back propagation
3 Layers NN
Introduction

Annual Energy Outlook (2025)
EIA’s National Energy Modeling System (NEMS)

Assumptions
- Gas price (1.5% / year)
- Gas depletion (1.45% / year)
- Drilling of gas exploratory wells (3.5% / year)
- Drilling of oil/gas exploratory wells (2.5% / year)
- GDP (2.1% / year)

Back propagation
3 Layers NN

Artificial Neural Network

Energy Information Administration
Back propagation
3 Layers NN

Inputs
- Number of gas exploratory wells
- Oil/gas completed exploratory wells
- Oil exploratory wells
- Gas depletion wells
- Footage drilled in gas exploratory wells
- Proved reserves
- Gas wellhead prices
- Growth rate of the growth domestic product
**Introduction**

Annual Energy Outlook (2025)
EIA’s National Energy Modeling System (NEMS)

Artificial Neural Network
- Back propagation
- 3 Layers NN

Results
- 2000-2012 Increase 0.5% per year
- 2013-2020 Double Increase
Introduction

**INPUT PARAMETERS:**

- **GAS PRICE**
  - Input to the NN
  - Forecast approach

**UNCERTAINTIES**
US Natural Gas Forecasting Model using the state-of-the-art in intelligent systems

USING IDEA™
1. Research of information and available data:

American Petroleum Institute
Energy Information Administration

Data 1947-2002
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Data 1947-2002

- US Crude oil reserves
- US Total wells reported as completed
- US exploratory wells and footage
- Supply of US dry natural gas
- Estimated natural gas reserves
- US natural gas production
- Gross domestic product
- Population
1. Research of information and available data:

American Petroleum Institute
Energy Information Administration
Data 1947-2002

2. Input variables selection and evaluation:

Fuzzy Combinatorial Analysis

Apparent trends identification

Parameter’s influence on the US Natural Gas evaluation
1. Research of information and available data:

American Petroleum Institute
Energy Information Administration
Data 1947-2002

2. Input variables selection and evaluation:

- US natural gas production from previous year
- Growth domestic product
- US population
- Average depth of oil and gas exploratory wells
- Annual gas depletion rate
Methodology

US Natural Gas Production $\rightarrow$ Time Series

Recurrent Neural Network

Feedback loop

Training

Fuzzy Cluster

Calibration

Verification
**Estimated Gross Domestic Product**
Potential Trend 2003-2020

**Estimated Average Depth of Oil/Gas Exploratory Wells**
Potential Trend 2003-2020

**Probability Distribution Function (PDF)**

- **Input Parameters**
  - Maximum
  - Most Likely
  - Minimum
Methodology

Forecasting US Natural Gas Production

PDF for each input parameter

500 neural model runs

PDF of the US Natural Gas Production
Results

US Natural Gas Production Forecast Model

Training → Data 1947-1997
Calibration → Data 1998-2002
Verification → Data 1998-2002

US Natural Gas forecasting from 2003 to 2020 using all available models

- Actual Production
- Stochastic Model
- EIA Model
- Texas A&M Model
- WVU Model

Actual Production
US Natural Gas Forecasting from 2003-2020
Using the WVU Model

![Graph showing gas production from 1940 to 2020 with actual production data and WVU model predictions. The graph includes a verification dataset from 1998-2002.](image-url)
Forecasting comparison of five different models for prediction of US Natural Gas (2003-2020)
Conclusions

A gas-forecasting was developed to predict the US natural gas production until 2020

The WVU Model was built based on Recurrent Neural Network (Time Series)

Fuzzy combinatorial analysis → Identify the most influential parameters

Fuzzy cluster analysis → Guiding the partitioning of the data

Monte Carlo Simulation → The uncertainties of the inputs

Probability Distribution Function
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Thank you for your attention
Questions and Comments