Improving Oil and Gas Price Forecasts

By

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Problem Statement

The Univ. of Utah and Utah Div. of Air Quality's (UDAQ) prior work on modeling emissions from oil and gas operations in the Uinta Basin has shown that many emissions sources and activities (drilling and well completions, oil and gas production rates, etc.) can be accurately predicted as a function of oil and gas prices[1]. At present, the U.S. Energy Information Administration's (EIA) Annual Energy Outlook (AEO) forecasts (and their historically observed range of errors) are used as the basis for the UDAQ emissions model. While this approach is sufficient for tracking prices over the short-term (≤ 5 years, see Figure 1), it has several key limitations when it comes to making long-term (10-20 year) forecasts:

- The model's accuracy is tied to the accuracy of EIA's AEO (e.g. the median model result will always follow the AEO reference forecast).
- There are very few data points available for estimating the range of error in EIA's AEO forecasts over a 10-20 year range.
- Given the wide range of observed AEO forecasting errors, the uncertainty in the price forecast is the greatest source of uncertainty in the entire emissions model.

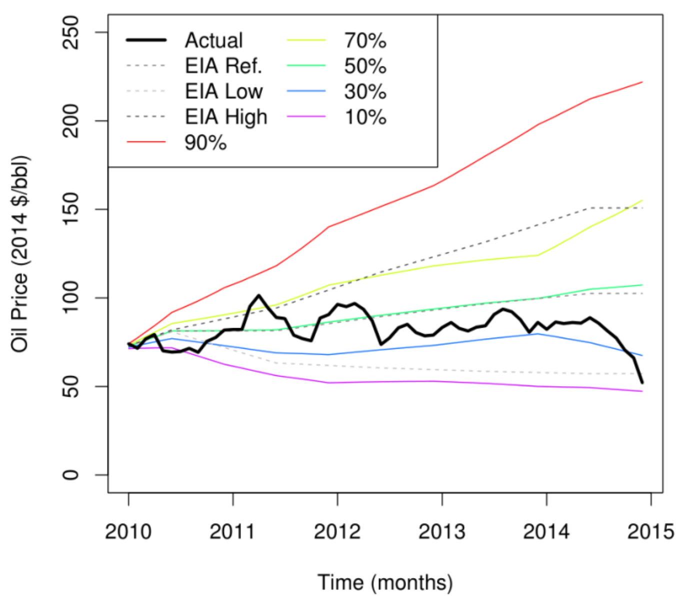

Figure 1: Wellhead oil price forecasts (in 2014 dollars per barrel) using the existing UDAQ model from Jan. 2010 – Dec. 2014, using EIA's 2010 AEO as the base forecast. Actual oil prices are shown in black, AEO forecasts are shown as dotted lines, and various percentiles of the model's modified AEO forecast are shown as colored lines.

Without a reliable method for forecasting prices the existing UDAQ model cannot reasonably be used to make long-term forecasts. Therefore we propose the development of an improved energy price forecasting method which will allow the UDAQ emissions model to make long-term (10-20 year) predictions.

[1] Wilkey, J., K. Kelly, I.C. Jaramillo, J. Spinti, T. Ring, M. Hogue, and D. Pasqualini. 2016. "Predicting Emissions from Oil and Gas Operations in the Uinta Basin, Utah." Journal of the Air & Waste Management Association 66 (5): 528–45. doi:10.1080/10962247.2016.1153529.

Forecasting Issues and Opportunities

Commodity prices are generally considered to be difficult to predict. Markets have many ups and downs due to geo-political factors as well as economic forces and technological changes. In particular, long-term oil and gas price forecasts have proven notoriously inaccurate (see Figure 2).

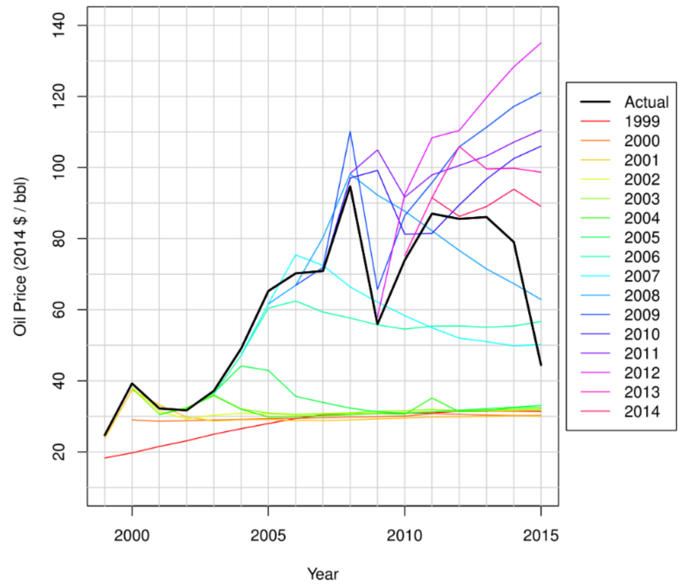

Figure 2: AEO 2000 – 2014 price forecasts for oil (colored lines) vs. actual annual average oil price (black line).

While all forecasts are wrong, some can still be useful. The ideal energy price forecast for the UDAQ emissions model would:

- Follow the average trend in energy prices over the modeling period (however long that modeling period happened to be).
- Fully cover the random variations in prices within the 10th-90th percentiles of the model's results.
- Have as small of an uncertainty range as possible.

The AEO-based method in the UDAQ model for handling energy price forecasts meets some but not all of these goals. It fully covers random price fluctuations, but fails to track average price trends whenever the AEO forecast fails as well (which it does quite often, as seen with the 1999-2005 AEOs in Figure 2). Additionally, the uncertainty range is quite broad (approx. $175/bbl range after five years), and the limited number of AEO forecasts available at 10-20 year ranges (all of which are essentially the same forecast as shown in Figure 2) raises questions about the usefulness of the AEO-based method for long-term forecasting.

However there are a number of other forecasting methods which may prove more useful for making long-term forecasts, such as:

- The inclusion of additional/alternative price forecasts from other sources (Kiplinger's, the UK's Department of Energy & Climate Change, Department of Finance and Natural Resources of Canada, the World Bank, and the International Monetary Fund, etc.). Forecasts from these sources could either be used instead of the AEO forecast (if they prove more accurate over the long term) or they could be combined into a composite/meta forecast.
- Using standard quantitative models for energy price forecasting (auto-regressive integrating moving average (ARIMA), Markov Switching Model of Conditional mean, etc.)[2]. The existing model includes one such model for Geometric Brownian Motion (GBM), but other models could be trained and cross-validated to determine if they produce forecasts that are closer to the ideal than the existing AEO-based method.

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[2] Bashiri Behmiri, N., and J.R. Pires Manso. 2013. "Crude Oil Price Forecasting Techniques: A Comprehensive Review of Literature." SSRN Electronic Journal, 30–48. doi:10.2139/ssrn.2275428.

- Finally, the model could be revised to provide more concise methods for the user to specify (and effectively bypass the uncertainty of) the energy price forecast. These could include options for the user directly specifying a single average price for the entire modeling period or a distribution of prices (e.g. a normal distribution with mean *x* and standard deviation *y*).

Work Plan

The objective of this work is to identify and develop a long-term forecasting method (or set of methods) for the UDAQ emissions model that are closer to the "ideal" forecasting model described previously. The work will start with the collection of published forecasts from other agencies and organizations besides EIA (World Bank, IMF, etc.) as well as a review of the energy price forecasting literature to find potential quantitative models that could be fitted to historical prices in the Uinta Basin. The performance of these models will be assessed using cross-validation techniques, and recommendations will be given to UDAQ and BLM (in the form of a report) on which model(s) should be implemented. In consultation with UDAQ and BLM, any requested modeling options will be added to the emissions model. The schedule for the project is given below in Table 1.

Table 1: Gantt chart for project.

Task	Description	Month		
		1	2	3
1	Collect alternative long-term forecasts	X		
2	Review literature for energy price forecasting models	X		
3	Assess best forecasting method(s)	X	X	
4	Report to UDAQ and BLM with recommendations on which method(s) to implement in emissions model		X	
5	Add UDAQ and BLM requested forecasting methods to model		X	X
6	Update model's User Manual to document forecasting method changes.			X

Project Personnel

The two people that will carry out the proposed work plan are Dr. Jon Wilkey and Dr. Terry Ring. Jon Wilkey will be working fulltime as a Post-Doc on implementing the proposed work plan, and is the primary author of the existing UDAQ emissions model. Terry Ring will act as the supervisor and PI for the project. Short CVs detailing the experience and qualifications of both Jon Wilkey and Terry Ring are attached to this proposal. The contact information for these personnel are:

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Jonathan Wilkey

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Education

PhD in Chemical Engineering, University of Utah May 2016
Combined BS/MS in Chemical Engineering, University of Utah May 2012

Skills

- Programming: R, Matlab, SQL, LaTeX, VBA, C++
- Software: Aspen Plus, ProMax, COMSOL, AutoCAD, MathCAD, Office, Polymath
- Certifications: FE

Experience

Univ. of Utah Dept. of Chemical Engineering **Salt Lake City, UT**
Research Associate **Dec. 2006 – Present**
Applied process design, cost estimation, data analysis, and life-cycle assessment techniques to determine the economic and environmental impacts of oil and gas development in Utah. Wrote software tools used by state regulators to forecast emissions from oil and gas operations.

Dept. of Energy National Energy Technology Laboratory **Pittsburgh, PA**
Engineering Intern **May 2009 – Aug. 2009**
Organized and led field study of methane emissions in Allegheny National Forest to test methods for identifying abandoned oil wells.

EmiSense **Salt Lake City, UT**
Engineering Intern **Oct. 2007 – May 2008**
Fabricated and tested multilayered ceramic devices as part of a R&D effort to create high performance emissions sensors for diesel engines.

Publications

Wilkey, J., K. Kelly, I.C. Jaramillo, J. Spinti, T. Ring, M. Hogue, and D. Pasqualini. 2016. “Predicting Emissions from Oil and Gas Operations in the Uinta Basin, Utah.” *Journal of the Air & Waste Management Association* 66 (5): 528–45.

Wilkey, J. 2016. “Economic and Environmental Impacts of Oil and Gas Development on the Uinta Basin.” Doctoral Thesis, University of Utah.

Wilkey, J., J. Spinti, M. Hogue, and K. Uchitel. 2013. “A Market Assessment of Oil Sands and Oil Shale Resources.” Institute for Clean and Secure Energy, Salt Lake City, UT.

Kelly, K.E., J.E. Wilkey, J.P. Spinti, T. a. Ring, and D.W. Pershing. 2014. “Oxyfiring with CO2 Capture to Meet Low-Carbon Fuel Standards for Unconventional Fuels from Utah.” *International Journal of Greenhouse Gas Control* 22 (March). Elsevier Ltd: 189–99. doi:10.1016/j.ijggc.2014.01.002.