PROJECTING ENERGY TRENDS INTO THE 21ST CENTURY

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Keywords: Economic growth, energy models, forecasting, fuel shares, oil consumption, oil production, OPEC, projections

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Summary

Several organizations routinely publish international energy outlooks that provide important perspectives on how the energy system might evolve over the next several decades. Several results appear robust to a range of different scenarios. They include energy use that expands but still grows by a percent per year less than the economy, faster energy use growth in the developing than the industrialized nations, energy use shifting towards greater electrification, and greater reliance upon natural gas and less reliance upon coal and nuclear.

Most projections see world oil prices rising at least as fast as inflation and often faster. Since these future trends run counter to the historical evidence, one may be concerned that future energy prices are being overestimated. Although past price projections have suffered from this problem, the projections for fuel supplies and demands have been much closer to actual levels.

Most readily available projections for international energy markets do not formally solve for a set of energy prices that balance supply and demand conditions for each fuel. More frequently, they determine energy demand outlooks based upon economic and demographic growth, prices, and detailed technical and cost information and then check those results with available estimates about resources and energy supply conditions. Without more details on the relative costs of different fuels, it is often difficult to

interpret and compare these outlooks on a consistent basis. However, there has been a move towards systems that determine fuel prices from multiple supply-demand balances as analysts have begun to investigate the effects of different world strategies for reducing such problems as global climate change emissions. Supply-demand balances are more important when investigating the effects of emissions constraints because the analyst can then estimate the costs of reaching different pollution targets.

1. Introduction

Well before the 1973 oil price shock, analysts frequently forecasted future energy market conditions. Today the US Energy Information Administration (EIA) and the International Energy Agency (IEA) routinely report energy outlooks based upon evolving technology, economics, and policy assumptions. We will refer to such systems as energy-projection frameworks. In addition, many energy-based models have been recast to help analysts project long-term energy patterns and their influence on global climate change. We will refer to these systems as integrated assessment (IA) models. This article briefly discusses the more readily available and routinely produced energy projections from the first group of models and highlights their most recently available estimates. It will focus on the underlying energy trends to provide a perspective on future emissions growth but will not directly examine the environmental implications of these energy projections.

2. Energy-Evaluation Systems

Energy models consider fuel supplies and demands in different regions with considerable detail. Supply conditions often include resource bases, performance characteristics of key technologies, break-even or required costs, and technical change. Demand conditions include economic and demographic growth, energy prices, and non-priced adjustments in an economy's aggregate energy intensity. Both technical change at the end use as well as the shift away from energy-intensive activities (e.g., the shift from metals production to information production) account for the observed, long-term trend of improving energy productivity (or declining energy intensity).

Energy models can differ in the method used for determining fuel prices, consumption, and production. Most energy-projection frameworks emphasize the demand for energy and use supply conditions informally to check on the reasonableness of their projections. However, supply conditions do not directly constrain energy demand by raising prices, at least not formally within the model. As a result, the full reporting of all fuel prices is often ignored when results are released. There are two reasons for ignoring a full supply-demand balance for determining all fuel prices. One factor is that market-clearing models have not performed well in the past, with small errors in either supply and demand conditions causing large errors in prices. These large errors occur due to the relatively low elasticities of energy supply and demand in the short to intermediate run. The second observation is that outside of external factors such as supply disruptions, the price of oil has been very stable (in real terms) over a long period of time. Therefore, analysts have focused on the supply and demand conditions consistent with fairly stable real prices.

IA frameworks frequently use the detailed supply and demand conditions to solve for prices and quantities that will satisfy both producers and end users. The quantity supplied for a particular fuel will expand only if the price increases to cover its higher costs. The quantity demanded for that same fuel will decline as its price increases. Moreover, changes in other substitute fuel prices could cause the entire fuel demand condition to shift outward. The model seeks to solve for an equilibrium where supply and demand conditions will not force prices to rise or fall during that period. Higher prices would attract more-expensive production but reduce consumption. Lower prices would attract consumers with lower energy values but reduce production. Supply and demand conditions are balanced at this market equilibrium.

3. The World Energy Projection System (WEPS)

The US Energy Information Administration (EIA) maintains the World Energy Projection System (WEPS) model, which is an extremely well-documented example of an energy-projection model. It links economic growth with income elasticities for energy to determine growth in international energy use in 14 Excel (spreadsheet) files. The projection period extends from the beginning year through 2020. The model computes total energy consumption and the use of coal, oil, natural gas, and other energy for a number of different countries. The user can change input assumptions for a country's economic growth, income elasticity, and the share of total energy by fuel type.

Oil and nuclear consumption are set exogenously according to results from other EIA models. When total energy use increases with higher economic growth or a higher income elasticity, the model first subtracts oil and nuclear consumption. Remaining energy is allocated to coal, gas, and other sources (excluding nuclear) according to sharing parameters. This procedure means that new oil and nuclear projections must be incorporated into the framework whenever total energy use increases.

The model is essentially a framework based upon income elasticities. Energy prices do not enter the system. Supplies do not directly constrain the consumption projection, although the user can incorporate such considerations by adjusting the sharing parameters informally.

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Biographical Sketches

Hillard G. Huntington is the Executive Director of the Energy Modeling Forum at Stanford University, where he conducts studies to improve the use of energy and environmental policy modeling. His research publications span a range of interests, including the modeling of restructured electricity markets, the control of greenhouse gas emissions, and energy demand and energy efficiency. He has been the President of the United States Association for Energy Economics, the Vice President for Publications for the International Association for Energy Economics, and conference chairman and program chairman of past conferences of those organizations. Dr. Huntington has served on various national and international panels, including a joint US-Russian National Academy of Sciences Panel on Energy Conservation Research and Development and the American Statistical Association's Committee on Energy Statistics. He is also a Life Member of Clare Hall at the University of Cambridge (United Kingdom).

Dr. Rodekohr is presently the Director of the Energy Markets and Contingency Information Division, which consists of approximately 25-30 economists and other professionals. He has worked in the energy analysis and forecasting area of the Federal government for more than 24 years. In his current position, Dr. Rodekohr is responsible for short-term energy market forecasting, contingency analysis, and financial statistics. These activities result in the following Energy Information Administration (EIA) publications:
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Dr. Rodekohr received a Bachelor of Science in Economics in 1970 from the University of Delaware. He obtained his Ph.D. in Economics from the University of Colorado in 1974, where he focused on econometrics and human resource economics. During his career he has authored numerous articles appearing in professional journals.