Chapter 10
Modeling Energy Portfolio Scoring:
A Simulation Framework

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ABSTRACT

U.S. regions are expected to follow the national trend towards investment in renewable energy as part of their electricity portfolio. The progress of energy portfolios that typically involves traditional methods, such as centralized nuclear and coal-fired generation, and towards cleaner- and renewable-source generation will impact economic growth and public health. Renewable electricity production must strike a balance among cost, reliability, and compatibility. The economic and health benefits obtained from developing an efficient energy portfolio make renewable energy alternatives an important consideration for regions endowed with natural resources. A portfolio mix of production method that considers the economic benefits while limiting adverse health and environmental impacts is attractive. This research proposes a System Dynamics simulation framework to support policy-making efforts in assessing the impact of energy portfolios. The authors demonstrate the utility of the framework by means of analyzing data that pertain to the U.S. Hampton Roads - Peninsula Region.

1. INTRODUCTION

The development of the modern economies has been significantly influenced by the availability of energy derived from abundant fossil fuels (Toman and Jemelkova 2010). The growing demand of the industrialized and emerging economies suggests that requests for affordable energy is likely to remain (Sorrell, Speirs et al. 2010). Electricity generation is traditionally classified as non-renewable (i.e., conventional)

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and renewable (i.e., non-conventional) sources. Non-renewable sources of energy production include fossil fuels that are extracted from finite deposits. Nuclear fuel may also be included in this category. Electricity production and distribution from non-renewable sources contribute to particulate air pollution which has been related to health threats, climate change, and reductions in the quality of the built environment (Haines, McMichael et al. 2010).

Since renewable sources are derived from primary sources such as wind and solar energy, they have been termed 'clean' sources (Bilgen, Kaygusuz et al. 2004). It has been contended that the utilization of these sources may have comparatively fewer public health effects while maintaining and inducing economic growth since stimulates job creation, and therefore, consumption (Johnstone, Haščič et al. 2010, Wei, Patadia et al. 2010, Timilsina, Kurdgelashvili et al. 2011). However, there are limiting issues associated to the utilization of these sources that include economies of scale, incompatibility with existing power infrastructure, reliability, and negative impacts on viewscape (Jacobsson and Johnson 2000, Painuly 2001, Jacobsson and Bergek 2004).

The development of wind and solar electricity as a sustainable source of energy may have a positive impact on both health- and environment-related issues for a region. These forms of electricity production are becoming widely accepted as reliable as advances in engineering and technology are progressively becoming more efficient. The cost of renewable energy production, many forms of which may be produced domestically if not relatively close to the point of consumption, may be insulated from the severe price swings associated with a heavy reliance on fossil fuels (Akella, Saini et al. 2009). However, there may be economic cost associated to growing regional portfolio's share of renewable sources. Fossil-based energy production generated electricity is still at a substantial competitive advantage cost-wise relative to its renewable-based energy production counterparts (McVeigh, Burtraw et al. 2000, Palmer and Burtraw 2005). Some have disputed, though, that these shortcomings stem from the fact that the market cost for electricity generated from fossil fuel does not consider critical exogenous variable of energy production related to poor air, water, and ground quality and the attendant public health issues (e.g., Ratliff and Smith (2005)). That is, external to the compilation of the price of electricity to the consumer are the quality of life and medical costs imposed upon the communities. Internalizing these externalities into the cost of fossil-based electricity would, intuitively, lessen the price competitive advantage of fossil- over renewable-generated electricity.

Although the identification and quantification of these factors external to those parties explicitly involved in the transaction may be difficult and counterintuitive to established approaches, the inclusion of these externalities into the cost structure may be necessary for informed policy formation (Haines 2001, Hirschberg, Heck et al. 2004, Oikonomou, Becchis et al. 2009). These costs may be borne by the consumers either directly or indirectly (Menegaki 2008).

The increased production and distribution costs related to newly emergent renewable energy production is largely transferred to the consumer in the costs of goods and services (Menanteau, Finon et al. 2003). Likewise, educational and governmental institutions are also large consumers of energy whose costs are essentially passed along to taxpayers (Owen 2006). Potentially, this may generate an adverse economic effect for the region since an increasing portion of a regional income is spent on energy, therefore, leading to less available resources for investment or purchasing of goods and services. In addition, some territories such as the US territory may present dissimilar sources for renewable energy among endowed regions. Thus, if a region becomes a net-exporter of electricity generated by renewable sources, regional job creation and retention of wealth may materialize (Lund and Münster 2003). An evaluating