Preliminary draft; not for quotation or circulation.

Potential Expenditure Impacts of Significant Renewables Requirements in 2025: A Preliminary Analysis

Jay Griffin and Mike Toman[*]
RAND Corporation
April 25, 2007

INTRODUCTION

RAND currently is assessing the potential impacts of requiring 25% renewables use in the US electricity and ground transportation motor fuels sectors (people and goods) by 2025. The *tentative* results shown in this presentation reflect ongoing revision of RAND analysis initially published in November 2006. Results in this presentation will focus on the potential impacts on consumer energy expenditures. The completed analysis also will consider potential impacts on CO2 emissions.

Ultimately, the economic effects of these renewables requirements will depend on the cost of the renewables relative to fossil energy alternatives. Significant uncertainty continues to surround potential long-term renewables costs and the potential rate of progress in lowering these costs over the next 20 years. Accordingly, RAND has built a simple analytical model populated by bottom-up figures for unit costs of different renewable and fossil energy technologies in order to investigate the question of relative expenditures under different scenarios regarding cost drivers over time.

Our base case with no additional renewables requirements is benchmarked to the Energy Information Administration's (EIA)2006 Annual Energy Outlook (AEO06) 2025 Reference Case. Both fossil input and final demand markets are assumed to adjust to demand and price changes, affecting both consumer expenditures and CO2 impacts. Sensitivity analyses include exploration of different energy supply and demand elasticities. Our unit cost figures represent *only* steady-state comparisons; we give no consideration in this analysis to the important issue of adjustment dynamics and costs – for example, the cost of initial capacity for a new technology relative to more mature technologies.

ELECTRICITY SECTOR

We have created a simple model for fossil and renewable electricity supply. Using EIA's 2025 AEO capacity figures for our base case, we divide projected fossil capacity and new renewable capacity across base, shoulder, and peak periods based on their characteristics. This allows us to analyze different types of investments in an admittedly rough manner without building a more complex investment and dispatch model.

[*] Contact: 703-413-1100, x5189; mtoman@rand.org.

New renewable electricity to meet the 25% utilization target substitutes for nonrenewable electricity based on technical characteristics (e.g., firm vs. intermittent) and incremental cost. This information is used to calculate the incremental cost of substituting increased renewables for the various renewable resources: Alternative renewable resources in the power sector substitute for fossil resources in a (roughly) cost-effective manner. With firm power resources such as biomass and geothermal, we consider differences in the levelized cost of renewable and the levelized cost of nonrenewable. For biomass co-firing, we consider the difference in fuel costs plus the cost of retrofitting a power plant to co-fire biomass. As in other studies, wind is a difficult special case – its deployment reduces fuel demand, and we also assume that each MW of wind capacity displaces a fraction of a MW of capacity in base and shoulder periods.

Cost estimates for renewable and nonrenewable technologies in the results shown today come from EIA AEO 2006 Reference Case. We are in the middle of incorporating other cost figures from the National Renewable Energy Laboratory and EIA to reflect expert judgments of technologists in those labs about the potential for advances of specific technologies.

Potential geothermal and wind capacity figures come from Sandia National Laboratory and EIA respectively. Biomass capacity is one of the most important, yet uncertain and controversial, drivers of the analysis. We use capacity figures from Oak Ridge National Laboratory, but we also consider other capacity scenarios – taking into account in particular the competition for biomass between power generation and bio-fuels production.

The net expenditure change for electricity with a requirement for 25% renewables is the increase in electricity costs from additional renewable energy use, plus savings from reducing natural gas and coal use and savings in other sectors from a lower market equilibrium price for natural gas. We assume average cost electricity pricing for simplicity. Clearly the price impacts would be more complex with marginal cost pricing.

BIOFUELS

Analyzing the implications of 25% renewable fuel supply presents large challenges: Alternative fuels currently are expensive and new technologies are not yet in the commercial stage. Corn-based ethanol is being produced commercially and in growing quantities, but it relies at present on a tax preference and its expansion competes with food crops for high-quality agricultural land. Land capacity constraints may limit production of non-crop biofuels. At the same time, biofuels technologies have been improving and there is a large potential cost reductions from learning – although experience shows that initial capital costs are higher, and plant efficiency levels are lower, than estimated prior to the start of commercial production.

Our results today consider three basic scenarios for the longer-term cost of supplying renewable fuels. One assumes little or no progress from today’s costs; another assumes that goals of current renewable R&D programs are largely realized; and the third assumes partial realization of those goals. All of our results implicitly assume sufficient progress in biomass collection, and in fuel yield per unit of biomass, that the 25% renewables target can be realized through domestic sources. This is a significant assumption that we are continuing to investigate. In our scenarios, biofuels may in fact be obtained from several different types of processes. In addition to cellulosic ethanol production, which has received so much attention, we also implicitly allow for the possible use of biomass gasification and gas liquefaction.

Whereas we assumed that more expensive renewable electricity sources were averaged in with less costly sources in electricity, assumptions about policy implementation for renewable fuels are crucial for ascertaining impacts on market prices and expenditures. Our results today consider 3 possible implementation scenarios:

(1) market price of all fuels = nonrenewable fuel retail price
(MC + markup);
additional renewables enter through direct government subsidy

(2) market price of all fuels is equalized by a revenue neutral tax and subsidy;
nonrenewable fuels are taxed to subsidize biofuels

(3) market price of all fuels = renewables retail price;
in this case significant economic rent accrues to nonrenewable producers

FINDINGS WITH THE MODEL

Because our numerical findings remain tentative, subject to change, and have not yet been fully reviewed internally or externally by RAND, we are not including them in this document. We expect to have the full report available through RAND's web site (www.rand.org) by early summer.

BROADER CONSIDERATIONS

Behind analysis of how renewable energy requirements might affect consumer expenditures or other economic metrics and US CO_2 emissions are some larger questions:

- What national objectives are served by increasing use of renewable energy in the United States?
- How would requirements for renewable energy use interact with other policies and measures for attaining these objectives?
- What are some key next steps for successfully expanding renewable energy use, given its contribution to national goals?

In these final comments we briefly consider these questions in turn.

Increased use of renewable energy resources in the US has the potential both to reduce CO_2 and, in the case of motor fuels, to lessen consumption and imports of petroleum. Increased use of bio-energy also offers the potential for increasing rural incomes through expanded markets for feedstocks.

Each of these points may seem to be a self-evident benefit, but some care is needed to put the contribution of renewables to national energy goals into perspective. The US does not yet have binding national goals for CO_2 mitigation, though efforts toward that end are picking up momentum. Renewable energy, as well as energy efficiency improvement, will be at the heart of the responses needed for meeting any such goals. The question is not whether expended renewables use would be useful in this context, but how to achieve it. We turn to this point below in addressing the second question.

Concerns over energy security also have increased in the last few years, and high levels of oil import dependence are seen by a number of observers to be at the heart of the problem. However, to understand the role of renewables in this context, it is necessary to break the energy security issue into constituent parts. Expanded renewable energy use will reduce US oil imports and payments for these imports; but unilateral action by the US would do little to reduce world oil prices, their volatility, or revenues reaped by unfriendly oil exporters. These, rather than the size of the oil import bill itself, arguably are the more serious policy concern. It follows that increased use of renewables to promote energy security would need to be coupled with other measures, including increased energy efficiency, greater energy substitution capacity, and advances in energy technology to promote global increases in renewable alternatives to petroleum.

Arguments for expanding biomass-based renewables production to increase rural incomes and reduce rural poverty need to be considered first through the lens of existing price and income support programs for agriculture that have significant costs and cause distortions in agricultural markets. To the extent that such efforts are inevitable, and that renewables expansion can provide similar or greater benefits at lower cost than existing programs, there is an advantage for expanding bio-energy. Changes in environmental impacts also need to be weighed, along with the *net* CO_2 reductions achieved from bio-energy relative to other forms of renewables. Finally, it is necessary to evaluate the extent to which gains from increased renewables production are being enjoyed by feedstock producers. If, instead, feedstock processors pay competing growers a price only barely adequate to cover the cost while enjoying the economic rents from a renewable energy mandate or subsidy, the social policy goal is not being realized.

Turning now to the second and third questions noted above, it is clear that any policy for requiring increased renewable energy use will interact directly with policies to reduce CO_2 (or promote energy security in the case of oil) through regulations or economic incentives. The *relative* expenditure impact for achieving a target level of renewable use will be lower if, for example, the relative cost for suppliers of fossil energy sources are raised through a carbon cap-and-trade system. At the same time, however, an independent goal for expanding renewable energy use is less relevant since a policy instrument for mitigating CO2 emissions already is in place. Moreover, a technology-neutral carbon policy will achieve desired CO2 mitigation at least as cost-effectively through a range of market responses.

Our results illustrate how important it will be in contemplating policies for increased renewables use (and more aggressive CO2 mitigation) not just to encourage further progress in renewables technologies, but also to reduce the uncertainties surrounding future renewables costs and capacities. This is especially the case in the context of bio-fuel alternatives to petroleum. Both the desirability of different targets for expanding renewables use, and the speed with which such targets would be approached, are sensitive to these considerations.

Policies such as carbon cap-and-trade provide an automatic and powerful economic incentive for the further improvement of low-carbon energy options, including renewables. At the same time, a number of observers would argue that the role for government support goes beyond funding for basic R&D; that in the earliest stages of technology transition from research to commercial use, the government can provide net social benefits from co-financing informative experiments in commercial scale operation and mitigating financial risks. Requirements for use of renewable energy similarly provide policy mandated market support, but in a way less specifically targeted to the transition to commercial scale operation. Future research on energy, technology, and climate policies could fruitfully explore further the relationships among RD&D financing, carbon constraints, and energy use requirements in the development of beneficial policy packages.