Economic and Stability Analysis of Alternative Measures and Policy Drivers for Deep Greenhouse Gas Reductions in Electric Power Generation: The Electricity Supply and Investment Model (ESIM)

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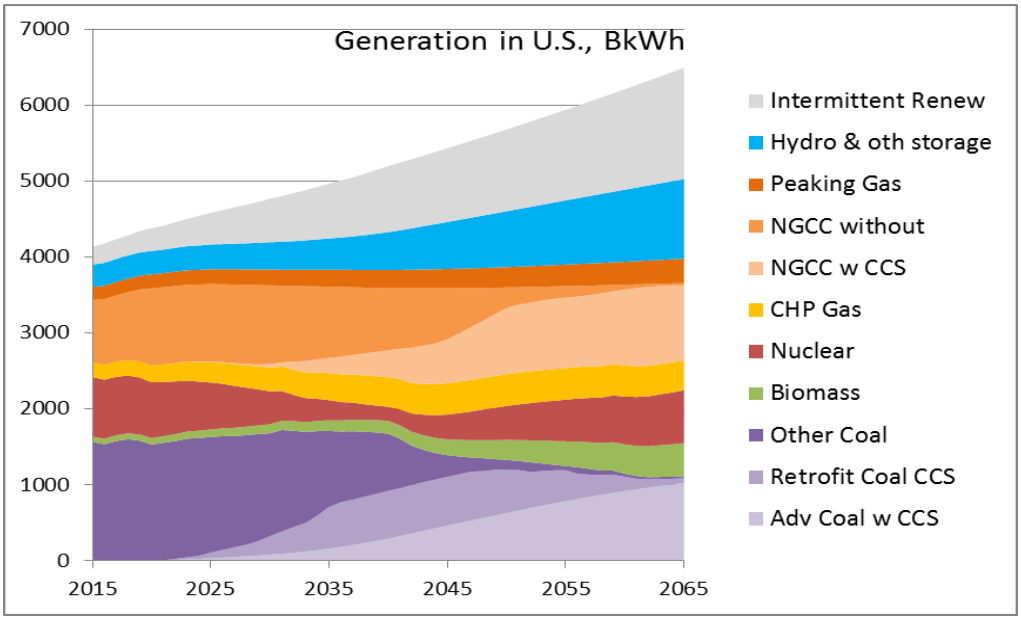
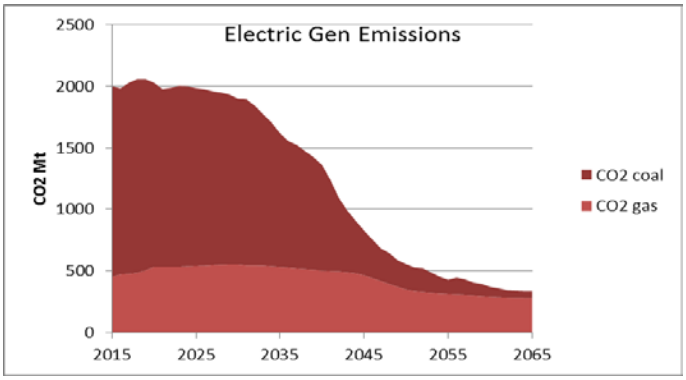
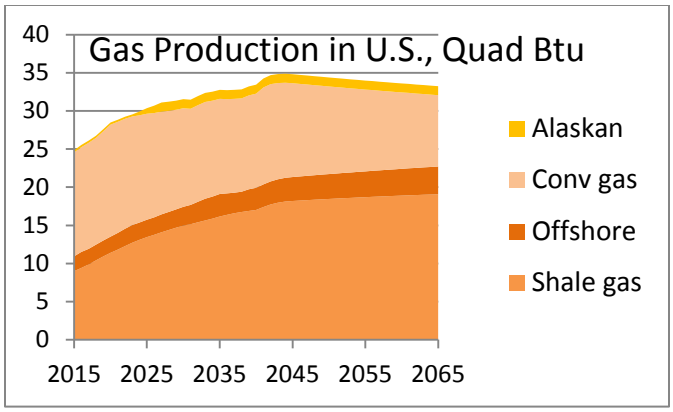
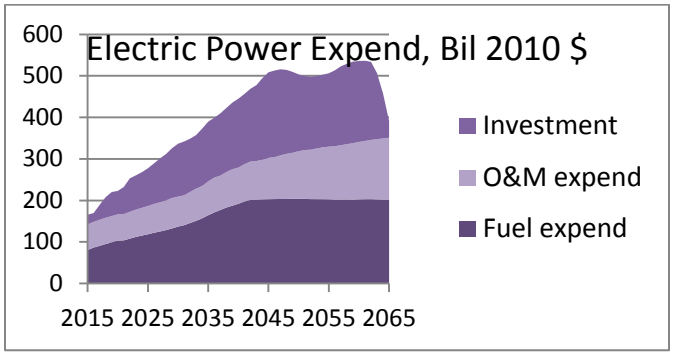
The ESIM capability is designed to simulate pragmatic, least-cost electric generation choices to achieve deep CO_2 reductions (for given input parameters), as shown in the figure below. For coal, we will need to phase out existing plants, retrofitting some with carbon capture and storage (CCS) and replacing others with advanced generation technologies and co-production plants. In addition to use in conventional biomass units, biomass is also used to co-fire coal plants, including industrial fluidized bed plants, and is used as a feedstock for advanced bio-processes. The existing nuclear fleet will need to be replaced with advanced generation nuclear technology in the United States and in the rest of world. Natural gas use will grow in peaking, combined heat and power (CHP), and combined-cycle applications (NGCC), some of which will need CCS. Over half of the renewable generation will be variable, with the remainder being partially dispatchable (e.g., hydro and geothermal and advanced storage). The ESIM model captures the negative effects of intermittency on base-load nuclear and coal units and on intermediate and peak-load gas back-up capacity requirements. The model also includes an inventory of existing power plants and 31 new generation technologies.

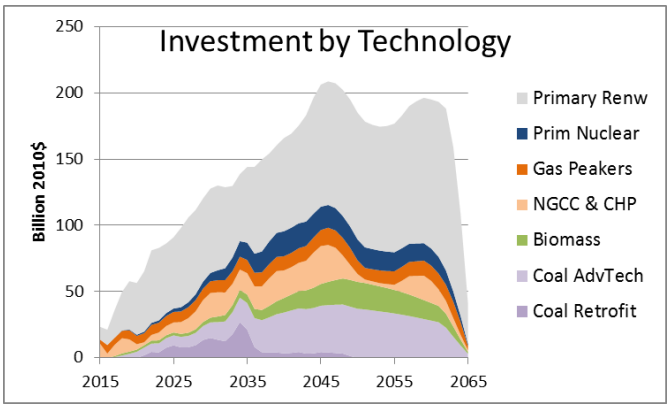




By 2050, CO_2 emissions are substantially reduced compared with the 2015 level; some CO_2 from gas remains in peaking and CHP applications. We used a medium CO_2 emissions charge to drive least-cost environmental dispatch. Too high a CO_2 price would be disruptive, quickly closing down existing coal power plants without CCS retrofit.







Gas production is based on the Energy Information Administration (EIA) drilling model, which can run different gas supply scenarios. Gas production in the figure to the left results from ESIM computing the gas price path that equilibrates gas supply and demand. During the phase-out transition period for existing older coal units, the market price of gas is impacted by the economics of retiring these units.

Instability/volatility can arise from investments in NGCC being run at base-load and displacing existing coal units, which drives up gas spot prices. The higher the price on CO_2, the greater is the tendency for instability.

The second figure to the left shows the paths of expenditures for fuel, operating and maintenance (O&M) costs, and capital outlays. The real levelized cost of electricity generation is about 7.5 cents/kWh (excluding transmission and distribution costs and utility taxes). This cost is higher than today's electric rates but affordable by most consumers and probably consistent with a continued international competitiveness for U.S. industry.

The last figure breaks down capital outlays by technology type. Renewable investment is high because of low capacity factors. Construction costs per kW capacity are based on EIA data.

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References

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