***ENERGY AND CAPACITY MARKET EFFECTS OF CARBON MITIGATION POLICIES IN RESTRUCTURED MARKETS***

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**Overview:**

The Obama administration has directed the EPA to propose greenhouse gas regulations for existing power plants through Section 111(d) of the Clean Air Act. We examine the cost of carbon mitigation in restuctured markets under two policy instruments, a carbon price and renewable portfolio standards (RPS). From an economist’s perspective, where wealth transfers are neutral, we find that a carbon price is (as expected) the most cost effective mechanism. This research adds a perspective that is relevant to policy makers: in the short term, how will these policies affect consumers?

To estimate the effect of policies on market clearing prices in restructured markets, we constructed an hourly economic dispatch model of the generators in PJM, ERCOT, and MISO. In the short term, we find that a rational consumer may prefer a RPS if natural gas prices exceed $7/MMBTU. At high gas prices, the increase in energy supply decreases market clearing prices to an extent that favors the RPS. Relying on a carbon price if gas is expensive requires a high carbon price to induce fuel switching to low-carbon generation, leading to wealth transfers from consumers to low carbon producers. We find that both policies have consequences in capacity markets and that the RPS is more cost effective than a price on carbon for consumers only if existing capacity supply remains adequate.

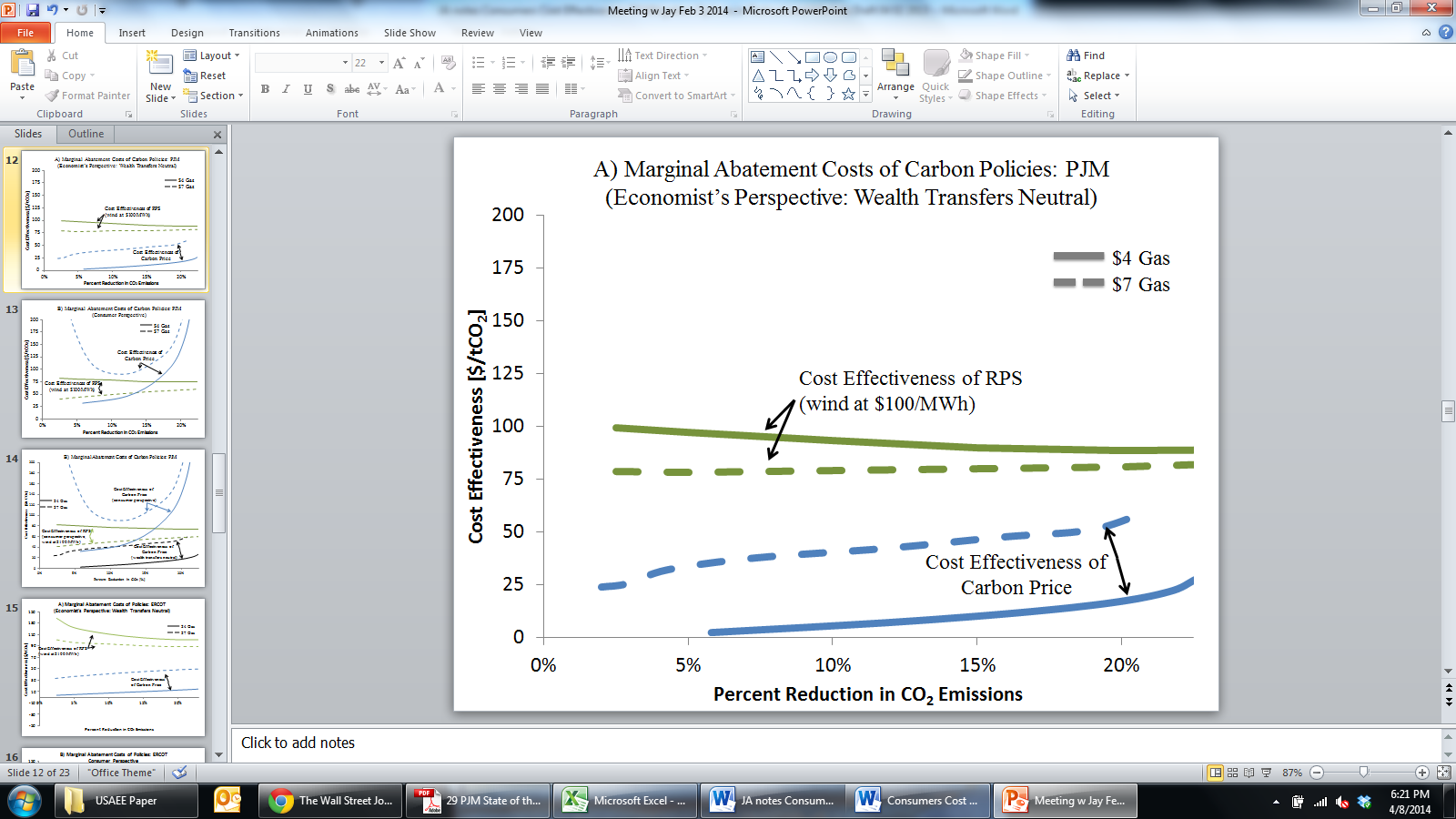
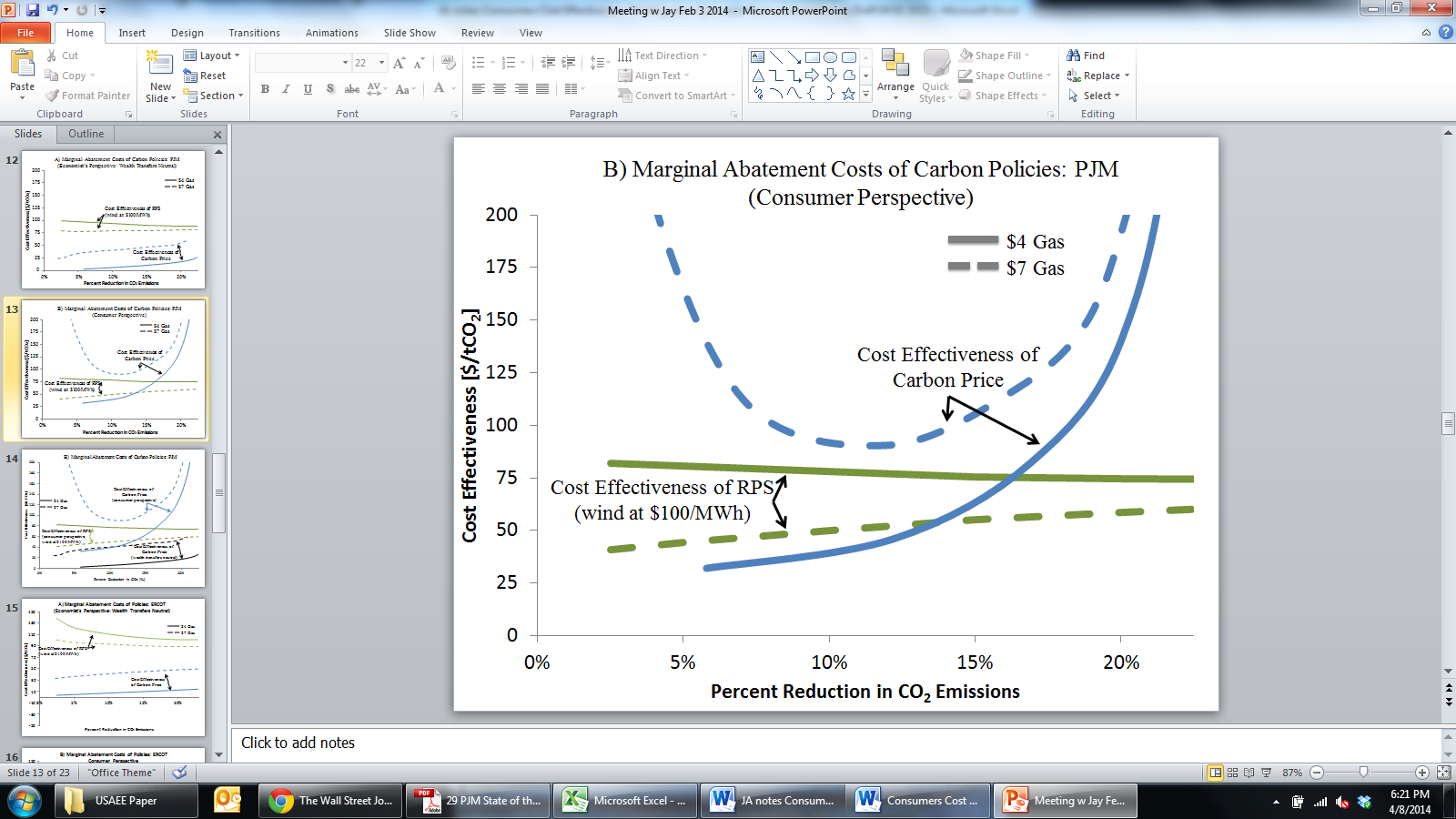
**Methods:**

For consumers in restructured markets, the costs of policies are quantified by difference in market clearing prices net of any related change in tax revenue. A carbon price creates tax revenue but increases market clearing prices. Renewables require consumer funded subsidies, but the increase in energy supply lowers market clearing prices. An hourly dispatch model of each region was necessary to account for how these changes affect carbon emissions and consumers’ net costs.

The dispatch model calculates marginal costs for all generators then dispatches the least expensive generators necessary to meet load on an hourly basis. We assumed that fuel costs remained constant except for natural gas which we varied from $4-$7/MMBTU. We limit the analysis to the short term by assuming demand and the mix of generators in each region stays the same as it was in 2012. We assume demand remains constant, as it has been in the U.S. from 2005 through 2012. The U.S. EIA has projected existing capacity to remain adequate until 2023, so we model a mix of generators identical to that in 2012. Power plant fuel costs, heat rates, variable O&M costs, and carbon intensities for each region were obtained from Ventyx Velocity Suite. We find that new capacity will not be induced with a moderate carbon price and our assumed range for natural gas prices. Therefore, the carbon price lowers emissions through fuel switching.

**Results:**

In Figure 1 below, we show the results of polices from two perspectives in PJM. In Figure 1(a), wealth transfers are considered neutral as economists would assume. In Figure 1(b), costs are considered from the consumers’ perspective. In PJM, a carbon price leads to a windfall profit for low carbon (nuclear) generators who do not change their position in the dispatch stack. From the perspective of consumers, the RPS may be cost effective because it lowers market clearing prices and carbon emissions.

   
***Figure 1:*** *Cost effectiveness of carbon mitigation policy options in PJM using 2012 data as the baseline. Figure 1(a) shows the marginal abatement costs of policies if transfer payments are neutral. The marginal cost of abatement is equal to the carbon price. Figure 1(b) shows the marginal abatement costs of policies from the consumer perspective.*

**Conclusions:**

Policy-makers may find a RPS to be an attractive option because a RPS does not depend on a low natural gas price to accomplish reasonably cost effective mitigation from the perspective of consumers. A RPS can be risky, however, because it adds energy supply but little capacity supply. A RPS would increase dependence on capacity markets by undercutting fossil generators’ profits in energy markets. On the other hand, a carbon price lowers capacity market bids of new NGCC plants by increasing profits in energy markets. A carbon price also does more to ensure the continued operation of nuclear generators by increasing their profits.

The ability of policy to cost effectively reduce carbon emissions with renewables will depend on time frame being considered and the assumed window within which existing capacity supply remains adequate. In the long run, the capacity supply may shorten if demand accelerates or the oldest plants providing capacity in the U.S.—coal and nuclear—retire. Under such circumstances, policy makers may favor a carbon price in order to decrease dependence on volatile capacity markets. For a policy maker concerned with minimizing consumer costs, the preferred policy approach should reflect his beliefs about the future surplus of capacity and the continued operation or nuclear generators. In order for an RPS to be cost effective for consumers, nuclear generators must be retained and capacity additions must be sufficiently inexpensive in order to prevent substantial increases from current capacity market prices.