TO: SGEC Membership

FROM: Staff State Energy Team

DATE: October 4, 2016

SUBJECT: Cost of Ownership Calculator

The Governor’s recent executive order [EO 2016-3] [1] challenges New Hampshire state government to lead by example in energy decision-making. In the transportation sector leading by example means purchasing vehicles that will have the lowest overall lifetime cost, when costs include the purchase price, operating costs, and the potential costs associated with climate change. State and federal policy does not currently capture the costs of carbon emitted into the atmosphere creating the false impression that there are no costs. The goal of this exercise is to adopt a simple calculator that will make those costs visible so that we can voluntarily choose vehicles that have the lowest cost to taxpayers today and tomorrow.

The executive order calls for the state fleet to reduce its greenhouse gas emissions 30% below 2010 levels by 2030 [1] and directs the state to “create a method by which the total cost of ownership for a specific vehicle is to be calculated, with such calculation including a cost of carbon factor”. Continuing that “The SGEC shall provide recommendations on the cost of carbon factor to be used…” (EO2016-03, 12e) [1]

New Hampshire Department of Administrative Services (DAS), in cooperation with New Hampshire Department of Environmental Services (DES) and New Hampshire Office of Energy and Planning (OEP) presents SGEC with a draft ‘Cost of Ownership Calculator’ for review and discussion. The calculator (Appendix A) allows us to select several factors including expected prices of gasoline, electricity, and maintenance per mile, for example. Detailed descriptions, sources, and calculations for the variables are available in Appendix B. The most difficult of these choices is the ‘cost of carbon’.

Section I introduces the Cost of Ownership Calculator, Section II discusses the cost of carbon variable and Section III lists other items for discussion.

SECTION I. Cost of Ownership Calculator

Cost of Ownership calculators are used in the automotive industry to calculate and compare the cost of owning a vehicle over a typical vehicle lifetime. Consumer calculators are widely available [1] and include factors like original purchase price, maintenance costs, fuel costs, as well as financing, taxes and fees. The State is developing a cost of ownership calculator [2] that meets the State Fleet specific purchasing needs. Appendix B outlines the variables included in the state total cost of ownership calculator as well as sources and calculations.

Recent cost of ownership research from MIT [2] has concluded that many hybrid and electric vehicles are already cheaper over the course of the vehicle lifetime than most comparable gasoline vehicles, mainly due to the difference in fuel and maintenance costs. When federal rebates are also included these vehicles far out-compete gasoline counterparts.

1 Kelly Blue Book: http://www.kbb.com/new-cars/total-cost-of-ownership/?r=523092152735346370
Edmunds True Cost of Ownership: http://www.edmunds.com/tco.html
2 Appendix A
The state cost of ownership calculator will similarly allow for comparison of different vehicles, both gasoline and electric, to understand their cost to the state beyond the initial purchase price.

SECTION II. The cost of carbon

Typically, the cost of ownership of a vehicle has been determined by looking at the purchase price of the vehicle in addition to the total fuel cost over and the maintenance costs over the useful life of the vehicle. These however, reflect only the direct costs of ownership. As human-caused climate change has grown in importance in the policy arena the role that carbon dioxide (CO\(_2\)) plays has grown in importance. Carbon dioxide, also referred to as CO\(_2\), is the most important of the greenhouse gases (GHG) that are causing climate change. CO\(_2\) acts by trapping very small amounts of heat in the atmosphere. As human activity has released tremendous amounts of CO\(_2\), principally through the combustion of fossil fuels, more heat has been trapped in the Earth’s atmosphere causing the long-term weather patterns, therefore the climate, to change.

As fossil fuels are the overwhelming source of energy that powers our vehicle fleet, transportation fuels are an important source of GHG emissions. According to the US Department of Energy’s Energy Information Administration, every million-BTUs (MMBtu) of E-10 gasoline burned in a vehicle produces 18.95 pounds \(3\) of CO\(_2\). CO\(_2\) will stay in the atmosphere for decades and will add to the costs that society has to pay to adapt to a changing atmosphere. Scientists of many disciplines have attempted to predict the range of costs and benefits that result from CO\(_2\) from impacts on agriculture and human health to fisheries and recreation to increased destruction from higher intensity hurricanes. There is uncertainty and disagreement in those predictions, however most estimates predict damages to significantly outweigh any benefits from increased CO\(_2\) levels. Economists take these damage estimates and estimate the monetary value of the damages (and benefits) and, of course, there is uncertainty and disagreement here as well.

The U.S. EPA has published its own ‘social cost of carbon’ (SCC) \(4\) calculation (Table 1 Social Cost of Carbon Estimates 2015-2050) and it is a reasonable place to start in New Hampshire’s cost of vehicle ownership calculator. The EPA social cost of carbon estimates were developed by an interagency working group using three well known integrated assessment models (IAMs) which combine climate processes, economic growth, and feedbacks between the two into a single economic modeling framework. The models take different approaches to measuring costs and benefits related to climatic changes over the short and medium term (up to 100-200 years). The SCC represents the average of these model results \(5\).

Because the social cost of carbon is looking at investment over the medium and long term, discount rates are also a part of the SCC discussion. A discount rate reflects the opportunity cost of money. For individuals, money is worth more in your hand than given to you at a later date. The rate at which this money loses its value in the future is the discount rate. A high discount rate means that investments will lose a higher amount of value when you eventually reap their returns in the future. You would rather have the money than make the investment. A lower discount rate means that you believe the investment now will lose little value into the future. The EPA SCC estimates given different discount rates follow below:

Table 1 Social Cost of Carbon Estimates 2015-2050 (In 2007 Dollar per metric ton CO\(_2\))

<table>
<thead>
<tr>
<th>Year</th>
<th>5% Average</th>
<th>3% Average</th>
<th>2.5% Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>2015</td>
<td>$11</td>
<td>$36</td>
<td>$56</td>
</tr>
<tr>
<td>2020</td>
<td>$12</td>
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</tr>
<tr>
<td>2025</td>
<td>$14</td>
<td>$46</td>
<td>$68</td>
</tr>
</tbody>
</table>


**Discount Rate and Statistic**

<table>
<thead>
<tr>
<th>Year</th>
<th>5% Average</th>
<th>3% Average</th>
<th>2.5% Average</th>
</tr>
</thead>
<tbody>
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<td>2030</td>
<td>$16</td>
<td>$50</td>
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</tr>
<tr>
<td>2050</td>
<td>$26</td>
<td>$69</td>
<td>$95</td>
</tr>
</tbody>
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Assuming a discount rate of 3%, EPA estimates for 2016 that every ton of CO₂ in the atmosphere will cost $36. For 2017 the social cost of carbon is $37.40. OEP proposes using that 3% discount rate figure adjusted annually using published information. The DOE’s use of the EPA ‘cost of carbon’ was recently upheld [7] in federal court.

Alternatives abound. We could use a low discount rate – say 2.5% – and derive a cost of $56 per ton, reflecting our collective desire to avoid intergenerational shifts of these costs. Or we could use a higher discount rate – say 5% – and derive a cost of $11 per ton, reflecting an outlook that investments in adjustments now are worth less in the future. Many economists recognize that social discount rate calculations differ from individual discount rates. Individuals care only about investment impacts in a finite sphere of their existence—so long as environmental damage occurs after they are dead; they will not consider factoring those costs into their future investments. However, societies must think in longer terms and about the public good [8]. Some economists have proposed that the value of natural capital or climate policy investments should be calculated using a negative discount rate, meaning it is an asset that will in fact become more valuable in the future [8]. The World Bank has published a paper [9] detailing various studies regarding valuing the cost of carbon. These damage assessments produce estimates ranging from $1 per ton to $130 per ton.

Alternative approaches to addressing climate change also include estimating the cost not of the damage but of the mitigation strategies needed to reduce or avoid the damage. Cap-and-trade programs like RGGI start with a fixed target for emissions and then let an auction determine the value of those emissions. Carbon taxes on fuels can be imposed and adjusted until consumption meets some target; the taxes required would reveal the actual cost of the policy goal.

For the purposes of this calculator and implementing the Executive Order, we recommend that SGEC adopt EPA’s recommended social cost of carbon with a 3% discount rate adjusted annually. The calculator uses this figure in Scenario 2.

**Section III. Other Items for discussion**

1. **Infrastructure Costs**: This cost is not currently included in any aspect of the calculator. DOT has a 15 cent surcharge per gallon charged at its pumps that covers some, but not all, infrastructure and administration costs. This surcharge is included in the calculator’s conventional fuel cost. SGEC needs to decide whether and how to incorporate infrastructure costs into EV options.
   a. Is it appropriate to include EV infrastructure costs in a “cost of ownership” calculation?
   b. How can the state consider EV infrastructure costs in vehicle selection decisions?

2. **Any comments or feedback on the other input variables described in appendix B**
Sources


