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**Critique of NESCAUM Scenarios and Analysis**

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Charles River Associates was retained by API to perform a critical independent review of the scenarios and analyses being performed by NESCAUM in their economic analysis of a Low Carbon Fuel Standard for the Northeast and Mid-Atlantic regions (NE/MA). All opinions, analyses and conclusions contained herein are the authors'.

We appreciate the opportunity to comment on NESCAUM's proposed scenarios and study design. The modeling team in Charles River Associates' Climate and Sustainability Practice has had extensive experience in building and using energy-economy models for the analysis of climate policies, including several recent studies of Low Carbon Fuel Standards (LCFS).

- As part of a study for National Mining Association of the Lieberman-Warner Bill (S.2191), CRA analyzed a nationwide LCFS proposal to reduce emissions by 10% by the year 2020.
- As part of a study on AB 32 requested by California ARB, CRA assessed the cost of California's LCFS program and compared costs under different assumptions about the availability and costs of alternative transportation fuels (http://www.crai.com/uploadedFiles/analysis-of-ab32-scoping-plan.pdf).
- For Consumer Energy Alliance, CRA assessed the economic impacts of a Federal LCFS (http://consumerenergyalliance.org/wp/wp-content/uploads/2010/06/CRA-LCFS-Final-Report-June-14-2010.pdf).
- CRA is currently reviewing the assumptions and assessing the modeling approach used by others in analyzing the cost-effectiveness of various proposed state level LCFS programs in the Western US.

NESCAUM faces many of the same issues and challenges that we did in our studies. The many basic uncertainties about new fuels technology and life cycle analysis of emissions compelled CRA to develop high and low cost scenarios. CRA, though, was able to use a single, integrated energy-economy model, but NESCAUM must also cope with the added complexity of having to reconcile an energy and transportation sector model with a separate, and not necessarily consistent, regional economic model. Our comments, therefore, are based on actual experience in conducting comparable studies.

The major points of our review are that the NESCAUM proposed scenarios:

- Do not incorporate a wide enough range of uncertainty;
- Assume the key conclusions of the study;
- Hide significant costs of an LCFS in the construction of their reference cases; and
- Require unrealistic penetration rates for alternative fuel vehicles.

We also identified in the proposed cost-benefit and economic impact methodologies a number of assumptions and definitions likely to lead to a very one-sided view of the economic impacts of an LCFS.

## Range of uncertainty

During our research on the different LCFS proposals, it became clear to us that uncertainty surrounded many of the key input parameters. The unknowns greatly complicated the issue. Opinions differ regarding emission factors. They also differ about the cost and rate at which major new technologies would be commercialized and about resource availability. Taken together these many unknowns lead us to conclude that any balanced analysis would have to consider the range of outcomes for all key input parameters.

This range could then be used to build optimistic and pessimistic scenarios that spanned an appropriate spectrum of possible outcomes. The former scenario should contain the most likely positive outcome for each key input parameter, and the latter one should contain the most likely negative outcomes. Only in this way can the analysis capture the full range of plausible outcomes.

## Assuming the conclusions

Based upon CRA's research and analysis, we conclude that the scenarios proposed in the NESCAUM study fail to follow this methodology. Instead, each scenario assumes that at least one major technology will succeed. Nothing guarantees this outcome. In fact NESCAUM presents no case for assuming that it will happen. In effect, NESCAUM is *assuming* the key conclusion from the study, i.e. that technology forcing is a given.

On top of that, each of the winners is given an exaggerated margin of success – so that the success scenarios provide overly optimistic outcomes that are not balanced by potential failures to achieve technology goals. Because the NESCAUM scenarios do not account for a wide enough range of possible outcomes, the results understate the full range of outcomes and costs that might result from an LCFS policy. This leads to an overall bias in the results.

NESCAUM does not present justification for these bold assumptions. NESCAUM does not justify the view that the new technologies will appear at the cost, and time, with the characteristics assumed. Furthermore, there is no discussion of technology pathways, the adequacy of incentives from LCFS to promote R&D, nor the R&D breakthroughs that will result in technology commercialization. Time and again the economic literature has stressed the profound uncertainties of R&D outcomes,[1] but NESCAUM seems to pay little heed. Finally, the consequences from the failure of new technologies to emerge are ignored in the scenarios.

The expectation of the "technology-forcing role of LCFS" appears to be the only justification for the assumption that technology outcomes will be whatever is required to make compliance with the LCFS possible at negligible cost. Nothing is adduced to suggest that these mandates, by one region, will have the characteristics needed to force technology to improve. In contrast research that we have done would suggest otherwise.[2]

From experience, there is clear evidence that the success of technology forcing is not a given. Rather there is clear evidence from other attempts to mandate technology, e.g., EV mandates in California that show a number of unintended responses can occur. For instance, mandates that are perceived by developers as unachievable are ignored. Local or regional mandates are met in ways that are not consistent with the policy objective such as redirecting supplies or through leakage. Only mandates that hit a sweet spot involving a reachable goal that is not otherwise likely to be met can be successful. Finding that spot requires careful analysis of current technology status and R&D activities, in order to aim successfully between overly ambitious specifications and specifications that will be met even without the program. Given the inherent uncertainties of R&D, there is no guarantee of success in this endeavor. Therefore, a basic premise upon which the scenarios are based is flawed.

Furthermore, the scenarios go beyond just assuming that new technically feasible technologies will emerge and instead assume that these new vehicle technologies will emerge at costs comparable to currently available technologies (i.e. no incremental costs for: FFV vehicles in the Biofuel Future scenario, CNG Future vehicles in the CNG Future scenario, or EVs and PHEVs in the Electric Vehicle Future scenario). Also, issues related to the blend wall are avoided by assuming sufficient FFV vehicles will be available for sale and purchased by consumers and refueled with E-85. Similar issues are ignored in assuming the emission reductions attributable to electric vehicles.

## Biofuels will be limited by the blend wall

The NESCAUM cases do not address the implications of the blend wall. The 10% blend wall today means that the market for ethanol can be met by current capacity of corn ethanol plants. Corn ethanol capacity was overbuilt, and current operational capacity plus idle capacity is more than sufficient to meet current market

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[1] Kenneth J. Arrow "Economic Welfare and the Allocation of Resources for Invention" in *The Rate and Direction of Inventive Activity: Economic and Social Factors*; Richard Nelson (ed). Princeton, Princeton University Press, 1962. See also Richard R. Nelson, and Sidney G. Winter (1977). "In Search of Useful Theory of Innovation," *Research Policy*, 6(1): 36-76.

[2] Lane, Lee, David Montgomery, and Anne E. Smith (2009). "R&D Policy" in CEDA Growth No. 61, "A Taxing Debate: Climate Policy Beyond Copenhagen." Available at: http://www.aei.org/docLib/Lane-et-al-R-Dpolicy.pdf.

needs. Thus the blend wall implies that cellulosic ethanol does not have a ready market and as a result, private investors appear reluctant to invest in it. Furthermore, EPA has scaled back its requirements for cellulosic ethanol, which gives investors further pause about the viability of a market for cellulosic ethanol.

Breaking the blend wall has its own set of challenges. EPA is currently assessing the viability of raising the ethanol content of gasoline to 15%, but has postponed making a decision nearly a year.[3] Vehicle manufacturers are hesitant to warrant that new conventional vehicles will operate without difficulty on gasoline containing more than 10% ethanol. Vehicles currently on the road may have even more problems, particularly older vehicles. NESCAUM uses EPA assumptions for the number of FFVs that will be built. It dismisses in its scenario analysis the risk that consumers will not purchase the more expensive vehicle in sufficient numbers to justify continued production as well as the risk that fueling stations might not be available in sufficient numbers and in enough convenient locations to achieve the assumed sales. Yet even if NESCAUM's optimistic assumptions, including technology availability, fuel cost, and vehicle penetration, are not met, the LCFS still requires that the fuel suppliers must meet the LCFS standard. Any deviation from NESCAUM's optimistic assumptions will cause the price of motor fuels to consumers to rise enough to drive motor fuel demand down to a level at which a 10% improvement in carbon intensity (CI) can be achieved with lesser amounts of low carbon fuels. The clearest case is one in which there is only enough low carbon fuel of any kind that is useable by the fleet to achieve for example a 5% improvement in carbon intensity at reference case fuel consumption. Since the standard must still be met, the only alternative is reducing total fuel consumption, and this will be achieved because fuel suppliers will bid up the price of the constrained supply of low carbon fuels until the pump price rises high enough to choke off demand. This same outcome will occur if the low carbon technologies fail to appear, or new vehicles able to use them are not produced in sufficient numbers, or the refueling infrastructure required to support consumer adoption, fails to materialize.

## Scenario implications for vehicle penetration

NESCAUM proposes three scenarios. In each one, they choose one winning technology that is assumed to contribute six percentage points toward the ten percentage point reduction target in fleet average carbon intensity. We built a spreadsheet model to estimate what these scenarios imply about the winning technology's penetration rate in terms of share of new vehicles sales in 2022.

To be consistent with NESCAUM, the model assumes each scenario's total fleet vehicle miles travelled (VMT) remains the same as in the baseline. For simplicity, we consider only two vehicle types for each scenario – a petroleum-fueled and an alternative-fueled vehicle type:

- Scenario 1 considers electric vehicles (BEVs and PHEVs) and Petroleum;
- Scenario 2 considers CNG and Petroleum; and
- Scenario 3 considers biofuels (cellulosic ethanol and Petroleum).

[3] http://green.autoblog.com/2010/06/21/epa-postpones-decision-on-e15-ethanol-blend-again-more-testing/

The percentage of the vehicle stock in 2022 that must be alternative fueled is determined by the LCFS constraint[4] that requires the carbon intensity to be 94% of that of petroleum fuels. For example, in the case of CNG vehicles:

(a) x*CI(CNG) + (1-x)*CI(petroleum) = 0.94 * CI(petroleum)
(b) x = share of vehicle fleet that is CNG powered
(c) Taking the optimistic CI value for CNG and the CI for gasoline, we find x to be 23%.

The same computation can be made for the other two scenarios.

To compute the penetration rates, we make some time invariant assumptions for this simple vehicle turnover model. For the scrappage rate, we used the historical retirement (scrappage) and took the ratio of retirements to vehicle stock in 2005. For the growth rate of the stock of vehicles, we used the national growth rate in vehicle stock. This rate was about 2.3%/year (3 year growth rate from 2005 to 2008). The carbon intensities were taken from the corresponding NESCAUM scenarios:

- PHEVs 37.9 g/MJ;
- BEVs 47 g/MJ
- CNG: 68 g/MJ (Note ignore fact that EER is 0.9 for LDVs, which would actually lead to higher CI)
- Cellulosic ethanol: Average of new EtOH1 and EtOH2, and assumed dispensed as E85

After inputting these assumptions, we adjusted the vehicle penetration rate over time to attain a 6% reduction in carbon intensity by 2022 for each of the two vehicle type fleets.

The growth and scrappage rates combine to determine the evolution of the vehicle stock. The penetration rate for the alternative fuel vehicle determines the split of new vehicles between conventional and alternative fueled. For the penetration rate, we attempt to represent the classic s-shaped curve while also inputting realistic ramp rates where possible.

[4] In this simplified analysis, the LCFS we examine only involves the two vehicle types of interest and NESCAUM's requirement that a six percentage point reduction in the fleet average carbon intensity results from the winning technology.

Table 1 shows the resulting required share of vehicle stock and new vehicle sales for the alternative vehicle in question. These shares assume that the alternative fuel vehicle causes the 6% reduction in overall carbon intensity of the fleet.

**Table 1: Share of new vehicle sales and stock of vehicle type by scenario in 2022 (for key scenario vehicle only)**

| NESCAUM Scenario | Vehicle Type | New Vehicle Sales (% of 2022 Sales) | Vehicle Stock (% of Stock) |
|---|---|---|---|
| Scenario 1 Electricity Future | EV | 38% | 13% |
| Scenario 2 Biofuels Future | FFVs | 36% | 11% |
| Scenario 3 CNG Future | CNG | 68% | 23% |

To meet the 6% reduction in 2022 with electric vehicles, would require somewhere around 35% to 40% of all new vehicles to be electric. This penetration rate is quite dramatic when one considers the introduction rate of other new vehicle technologies such as hybrids. "Historic technology adoption rates for motive power in the transportation sector have followed logistic functions with the time required to advance from 0% to 10% market penetration ranging from 14 to 19 years."[5] Even more dramatic is the penetration rate required for CNG vehicles. Because of their higher carbon intensity, more than 65% of new vehicle sales would need to be CNG vehicles. In both the CNG and EV cases, the fueling infrastructure and vehicle manufacturing sector would need to change tremendously, as would consumer preferences and acceptances.

The sales rate of FFVs in Scenario 2 seems plausible from a technological standpoint. That is, assembly lines currently produce FFVs and could probably produce the requisite number of vehicles. Scenario 2, however, implies a great and unlikely change in consumer behavior and optimistic forecasts about the development of biofuels.[6] This scenario would require all E85 to take the form of cellulosic ethanol, because it is the only biofuel in NESCAUM's list with sufficiently low carbon intensity to meet the 6% reduction with the assumed vehicle population. This appears highly unlikely given current and projected investment and production levels. If cellulosic ethanol is not available in sufficient quantities and low cost, this scenario turns

[5] Balducci, P. J., "*Plug-in Electric Vehicle Market Penetration Scenarios*," Department of Energy, Pacific Northwest National Labs, (2008).

[6] NESCAUM describes scenario 2 as being "consistent with high biofuel penetration: relatively fast innovation in biofuels, relatively low feedstocks costs and lower fuel CI, adequate supply of feedstocks from the region."

into one in which total fuel use must be driven down by high prices to comply with the LCFS. NESCAUM does not provide for this possibility and has no way to analyze it.

The electric vehicle scenario (Scenario 1) suffers from an additional problem. The amount of change in the electric sector infrastructure to handle the great number of electric vehicles would likely be technologically infeasible without large costs. A study produced for the ISO/RTO Council in conjunction with Taratec suggests that a total of 1.5 million plug-in electric vehicles **nationwide** would be feasible in 2019 and 2.25 million would be optimistic. Our scenario suggests that the number of EVs in the NE/MA states alone would need to be at least four million in 2019 to reach the required number by 2022.[7]

All of these scenarios illustrate the great difficulty of achieving the LCFS without significant reduction in VMT and increases in new car fuel economy beyond the CAFE standards assumed in the reference case. Both of these changes will impose significant costs on consumers that NESCAUM does not address.

The highly questionable feasibility of the EV and CNG scenarios as well as the optimistic assumptions for biofuels in Scenario 2 suggest the need for NESCAUM to consider more plausible scenarios in order to capture the possible range of technological development.

In addition, NESCAUM should consider scenarios that allow demand destruction of VMT to reduce the required amount of new alternative fuel vehicle sales; and/or large costs for fuel and vehicle infrastructure to be incorporated to achieve of the aimed for alternative fuel vehicle penetration levels. Currently, none of the NESCAUM scenarios investigates the possible risks of the mandates if none of the technologies turns out to be a silver bullet. Should that outcome occur, either the standards must be abandoned or modified, or if they are enforced as written in the scenarios the result will be to drive delivered fuel prices up to the point at which motor fuel demand (VMT) is driven down to a level consistent with available low carbon supplies. This fuel consumption and corresponding VMT reduction is more likely. Furthermore, the higher the carbon intensity of available fuels, the higher the quantity of new fuels required. This outcome cannot be fully represented in any of the models being proposed for use in the NESCAUM analysis, so that the costs of a failure scenario will never be assessed.

## Hiding cost in the Reference Case

The range of potential costs associated with an LCFS is further underestimated by shifting these costs to the reference cases. By assuming in the reference cases the successful implementation of other policies to reduce emissions, the analysis transfers the costs associated with an LCFS on to these other policies whose costs are ignored in this analysis. The NESCAUM reference cases assume successful implementation of all these other carbon reduction policies. This includes not only policies that have been promulgated at the regional level, but also those policies which are not yet fully defined. For instance, the NESCAUM analysis assumes full implementation of an RFS2 program by EPA. However, EPA is currently reviewing the

[7] "*Assessment of Plug-in Electric Vehicle Integration with ISO/RTO Systems*," ISO/RTO Council and Taratec, (2010).

specifications of the program in light of the lack of investment in capacity to produce advanced biofuels.[8] The EPA has delayed its decision until year's end.

There is also uncertainty in the minds of investors which brings in doubt about the success of these other policies. For example, investors are wary of the government's resolve to continue fuel subsidies for various biofuels. Congress has already allowed the subsidy for biodiesel to lapse, which has resulted in the shutdown of existing biodiesel capacity. The subsidy for ethanol will also be up for renewal. Investors are wary of investing in biofuel projects whose success is dependent upon government subsidies when government actions have sent conflicting signals. Ignoring the risks associated with the availability of these biofuels by assuming that these fuels are readily available to meet the policies assumed in the reference cases as well as a regional LCFS policy again understates the uncertainty and costs of an LCFS policy. At least some of the scenarios examined should reflect an outcome where base case policies are not fully successful.

## Overly optimistic assumptions

In addition to considering only success scenarios, NESCAUM selects much too optimistic assumptions about key factors for both their optimistic and "pessimistic" or less optimistic cases. The optimistic cases adopt unjustifiable assumptions for carbon intensity, discount rate, and social cost of carbon emissions. Even the less optimistic cases choose unsupportable favorable assumptions about social costs and discount rates.

Optimistic carbon intensities are taken from the very bottom of the EPA range. These numbers are based on very specialized assumptions about the nature of the indirect land use effects of producing certain feedstocks. The connections between indirect land use effects, outside the United States, and the LCFS are highly speculative and unstable. Negative carbon intensities only arise when effects on certain markets are anticipated to lead to price changes that will motivate, for example, reduced deforestation in tropical regions as an induced effect. Other low (but positive) numbers for carbon intensity come from assuming a particular source, such as landfill methane. NESCAUM makes this assumption even though the fuel from that source is likely to be produced in the baseline and will therefore represent 100% leakage if shifted to LCFS.

## Carbon Intensity Factors

The choice of values for emission factors can significantly affect the results of the analysis, and many uncertainties arise in selecting the right values to use. For example with CNG, the assumed source of the natural gas is crucial. NESCAUM's CNG Future scenario assumes that the natural gas supplying CNG comes from one source, capture of methane from a landfill, which has an inherently low emission factor. Attributing natural gas supply to a single source is not appropriate and leads to understating the costs associated with the CNG Future scenario.

[8] Facilities are expected to turn out up to 25.5 million gallons this year of cellulosic ethanol—far below the 250 million gallons that the U.S. Environmental Protection Agency (EPA) once wanted fuel makers to produce.

Natural gas from all sources is fungible and tradable; hence, added demand for gas attributable to CNG vehicles will draw on one source of supply at one time and another incremental source at another time. Thus, CNG vehicles should not be depicted as drawing natural gas from a single dedicated and low carbon source; rather, they will be drawing supply from a changing mix of sources in the U.S. market. The appropriate emission factors will vary accordingly. Since the U.S. market is integrated, to account for this variation, NESCAUM should, at the very least, have used a value that is derived from the all sources of natural gas production in North America.

With biofuels, the life-cycle emissions of individual biofuels lead to even more uncertainty. Life cycle emissions include both direct and indirect impacts. Determining direct emissions can be challenging. However, accurately determining the indirect effects is highly uncertain and a subject for future research. As a result, the range of potential emission factors for a given biofuel can be quite large. Evidence of this is cellulosic ethanol and the range of estimates provided by EPA. Scenario design needs to recognize this uncertainty in the construction of the scenarios and allow for realistic optimistic and pessimistic scenarios.

## Estimating program benefits, the social cost of carbon emissions, and discount rates

There is no justification for assuming a social cost of carbon as high as that chosen by NESCAUM. The stated justifications for the values chosen are oversimplifications and misreading of the available literature. In particular, it is not correct to infer from Weitzman's work that a zero discount rate should be used. Rather, Weitzman's work implies that under certain conditions the expected damages from climate change are unbounded, and that the social cost of carbon is unbounded. Thus, it is impossible to stop with a zero discount rate after citing Weitzman, because Weitzman's paper concludes that any measure that reduces carbon, no matter what its cost, should be undertaken. This guidance is not helpful. Rather, the type of unbounded losses posited by Weitzman argues for a different way of comparing risks such as stochastic dominance. [9]

There is abundant support for the assumption that the low end of the range of the program's benefit is zero, and that the high end estimate that NESCAUM used to estimate benefits is a very unlikely extreme value.

There is a strong argument for valuing of the benefits of a regional LCFS at zero. The U.S. social cost of carbon (SCC) estimates the damage to the U.S. that an added metric ton of emissions would do. The SCC multiplied by the number of GHG tons that the program would avoid, would serve to estimate program benefits. If, though, the program does not lower total global emissions, there are no benefits to measure. Leakage and the shuffling of fuels that would likely occur due to economics or to existing renewable fuel standards could negate any reduction in emissions in NE/MA. Thus there is a strong case to be made that a significant impact of the LCFS would be to shuffle more of those reference case fuels into any NE/MA with the resulting leakage of greenhouse gas emissions to regions where they would have otherwise been consumed.

[9] Richard Tol, unpublished paper.

Even if leakage and fuel shuffling do not completely offset the NE/MA LCFS, the avoided damages attributable to those changes will not be as NESCAUM describes. Marginal damages depend on the level of GHG concentrations at which they are measured. If the goal for global concentrations is set at a high level (e.g. 750 ppm) then damages from an additional ton of $CO_2$ (due to higher concentrations during the period of its residence in the atmosphere) will be higher than if the goal is set at a low level (350ppm) at which point most of the damaging consequences have been eliminated. The NESCAUM cost-benefit analysis needs to be specific about what global policy objective toward greenhouse gas emissions it assumes, in order to judge whether a specific policy should be adopted in pursuit of that goal. The same problem arises in calculating marginal damages from criteria pollutants, which it is accepted should be done assuming that future air quality standards are met. Moreover, if those standards are set, as the Clean Air Act requires, without regard to cost, it follows that the standards will be set so that the social cost of air pollution damages exceeds the marginal cost of control. Under these circumstances, there is no justification for adding co-benefits for criteria air pollutants to the measures designed to achieve reductions in greenhouse gas emissions.

The best available work on SCC is a meta-study by Tol. This study compared 211 estimates of the marginal cost of carbon. The huge range underscores the striking uncertainties in the literature. However, Tol found that "…many of the high estimates have not been peer reviewed and use unacceptably low discount rates." The median estimate for a metric ton of $CO_2$ converted to year 2000 dollars was $5.92. Tol estimates that taking account of the wide range of uncertainty surrounding this estimate would raise the total to $7.40. These estimates of the SCC are in line with earlier modeling results which showed that attempts to impose more stringent GHG control regimes were likely to incur net costs.[10]

U.S. policy should be based on marginal damages to the U.S. from $CO_2$ emissions in the U.S., as stated in relevant OMB circulars on cost-benefit analysis and suggested in the draft. If avoided damages are the basis for SCC, then U.S. SCC is smaller than the world average. Estimates for the U.S. will depend on both U.S. vulnerability and on the geographic distribution of impacts. The consensus appears to be that richer countries are less vulnerable than poorer, and that temperature increases will cause less harm in temperate regions like the U.S.[11] The U.S. SCC must be, therefore, less than the world average, and basing U.S. SCC on the ratio of U.S. GDP to world GDP would cause a significant upward bias.

For its high SCC estimate NESCAUM relies on the Stern review's very high estimate. Stern's estimate was for the world as a whole not for the U.S., but many other problems affect the Stern result. Tol refers to

[10] David L. Kelly and Charles D. Kolstad. "Integrated Assessment Models for Climate Change Control" in *International Yearbook of Environmental and Resource Economics 1999/2000: A Survey of Current Issues*, Henk Folmer and Tom Tietenberg (eds). Cheltenham: Edward Elgar, 1999.

[11] Eric A. Posner and Cass Sunstein "Climate Change Justice" AEI-Brookings Joint Center for Regulatory Studies

Stern's "dodgy analysis,"[12] and he notes that the Stern Review cherry picked studies that suggested extremely high damages.[13] Based on his meta-study, Tol concludes that there is only a 1% probability that marginal damage exceeds Stern's estimated $85/metric ton SCC in year 2000 dollars.

As Nordhaus points out, Stern's SCC estimate depends on his use of an extremely low discount rate.[14] In order to calculate the net present value cost of an LCFS, the correct discount rate to use is the marginal social return on investment, which measures what society would have earned on other investment foregone in order to make the investment in more costly fuels and vehicles to use them. A 7% real discount is a reasonable, and probably conservative, estimate of the long run, real, pre-tax return on investment in the U.S., but may not be indicative of a value needed to drive these types of investments.

## Conclusions

The design of the NESCAUM reference cases and scenarios biases the analysis and understates the incremental costs of a regional LCFS policy. The design of the cases ignores a number of important issues and as a result assumes greater flexibility and lower costs to comply with an LCFS than actually exists.

The design of the scenarios creates the image that policymakers only need to decide between low cost biofuels, no additional cost electric vehicles, or no additional cost natural gas vehicles. Important issues such as fuel infrastructure constraints (e.g., blend wall constraints on the use of biofuels, electricity grid upgrades, and natural gas fueling infrastructure), consumer resistance to purchasing new higher cost vehicles are washed away by the convenient choice of assumptions. In a similar way, by assuming unrealistic values for cost of carbon, the benefits of an LCFS become exaggerated relative to its cost.

Thus the NESCAUM study, as currently formulated, is not defensible as its conclusions rest upon an incomplete and unrealistic set of input assumptions and scenarios. It will provide policymakers with a misleading and one sided unrealistic view of the consequences of an LCFS policy.

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[12] Richard S. J. Tol (2008). The Social Cost of Carbon: Trends, Outliers and Catastrophes. *Economics: The Open-Access, Open-Assessment E-Journal*, Vol. 2, 2008-25. http://www.economics-ejournal.org/economics/journalarticles/2008-25.

[13] Tol, Richard S.J. (2006). "The Stern Review of the Economics of Climate Change: A Comment," *Energy & Environment*, 17(6): 977-981.

[14] Tol, Richard S.J. (2006). "The Stern Review of the Economics of Climate Change: A Comment," *Energy & Environment*, 17(6): 977-981.