



## Hummer versus Prius “Dust to Dust” Report Misleads the Media and Public with Bad Science

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### Abstract

The CNW Marketing Research, Inc.’s 2007 “Dust to Dust: The Energy Cost of New Vehicles From Concept to Disposal” caught the interest of the media and the public with its claim that a Hummer H3 SUV has a lower life-cycle energy cost than a Toyota Prius hybrid. Closer inspection suggests that the report’s conclusions rely on faulty methods of analysis, untenable assumptions, selective use and presentation of data, and a complete lack of peer review. Even the most cursory look reveals serious biases and flaws: the average Hummer H1 is assumed to travel 379,000 miles and last for 35 years, while the average Prius is assumed to last only 109,000 miles over less than 12 years. These selective and unsupported assumptions distort the final results. A quick re-analysis with peer-reviewed data leads to completely opposite conclusions: the life-cycle energy requirements of hybrids and smaller cars are far lower than Hummers and other large SUVs. CNW should either release its full report, including methods, assumptions, and data, or the public should ignore its conclusions. Unfortunately, “Dust to Dust” has already distorted the public debate.

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### Introduction

In March 2007, an automotive marketing company CNW Marketing Research, Inc. (CNW) announced the release of a private study on the comparative life-cycle energy costs of a wide range of automobiles.<sup>1</sup> The public version of the report<sup>2</sup> included a remarkable conclusion: counting all lifetime energy inputs, the massive Hummer H1, H2, and H3 sport utility vehicles (and many other large SUVs) use less energy per mile driven than the highly touted Toyota Prius hybrid (and many other smaller vehicles). These findings were reported widely and uncritically by newspapers,<sup>3</sup> blogs, and industry accounts, including glowing mentions by syndicated conservative columnist George Will<sup>4</sup> and at least one policy group.<sup>5</sup>

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<sup>1</sup> “Dust to Dust: The Energy Cost of New Vehicles From Concept to Disposal.” CNW Marketing, <http://cnwmr.com/nss-folder/automotiveenergy/>. This is an update of a similar report released a year earlier.

<sup>2</sup> Methods, sources, and original data have never been released, and according to the company, no independent review was conducted.

<sup>3</sup> See, for example, the commentary “Hidden cost of driving a Prius,” by James Martin in the *Philadelphia Inquirer*, April 4, 2007’ “US data trashes Prius claim of ‘greenest car,’” by S. O’Grady in the *UK Independent*, November 6,

The report's conclusions are completely at odds with what the science currently says about vehicle energy requirements. This, of course, does not mean the conclusions are wrong. It does, however, mean that the authors must provide supporting evidence and analysis in a format that can be reviewed and tested. As noted by French mathematician and astronomer Pierre Simon Laplace: "The weight of evidence for an extraordinary claim must be proportioned to its strangeness." Or as Carl Sagan said: "Extraordinary claims require extraordinary proof."

CNW has provided no such proof. The little supporting evidence that it has released suggests that the contentions in the report are, at best, unproven, and are likely wrong: the result of faulty analysis, untenable assumptions, manipulation and misuse of facts and data, numerical mischaracterization, and inadequate review. Analyzing the limited portions of the report and data that have been released reveals several major flaws and the violation of several fundamental tenets of good science. We present this analysis below. When these flaws are corrected, the conclusions change radically.

## **Lack of Peer Review**

The study notes, indeed brags, that no outside organization saw the report before it was released.<sup>6</sup> This is one of the report's most egregious faults. All scientific and analytical studies benefit from outside, independent review, and real science requires such review. Peer review is a fundamental requirement for identifying errors, methodological flaws, and data mistakes prior to publication.

Furthermore, CNW has failed to release any reviewable information on methods, data, data sources, or assumptions that would permit independent scrutiny of the conclusions. The absence of this information violates a fundamental rule of science requiring access to details about how an analysis is done. Namely: would another scientist come up with the same results? Although a large (450+ page) public report is available from the consulting company, this report mostly consists of repetitive and uninformative tables of data on automobile energy requirements. It provides almost none of the actual data on which the conclusions are based, and none of the details of the analysis and methods that would permit the unusual claims to be verified.<sup>7</sup>

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2006; "Selling to young hardly Element-ary," by Jim Mateja in the Chicago Tribune, April 27, 2007; and many more.

<sup>4</sup> George Will: "Use a Hummer to Crush a Prius," April 12, 2007. Will is syndicated in over 450 papers. His April 12, 2007 column also appeared under the apt title "Fuzzy Climate Math."

<sup>5</sup> Shikha Dalmia of the Reason Foundation, July 19, 2006, "Have You Hugged a Hummer Today?"

<sup>6</sup> Although CNW president Art Spinella has conducted all public responses and discussion, the authorship of the report is not explicit. The report itself states: "...no company, institution, organization or other group has been asked to judge the methodology or results prior to being published by CNW Marketing Research, Inc." ("Dust to Dust" page 364). Drafts of this analysis were reviewed by A. Lovins, W. Slaughter, M. Hoofnagle, I. Hart, H. Cooley, H. Hauenstein, and L. Schewel. I thank them for their suggestions. Errors are, of course, my responsibility alone.

<sup>7</sup> Although the size of the report is often touted as an indication of how thorough it must be, most of it consists of repetitive tables, and more than 160 pages at the end are e-mails, reproductions of newspaper accounts, and other materials unrelated to the analysis.

## Selective Choice and Presentation of Data

When the conclusions of an analysis differ substantially from similar studies done elsewhere, and when those other studies are not cited or included, it raises serious concerns about the selective choice of information. Comparing “Dust to Dust” with the readily available, peer-reviewed scientific literature from the energy and automotive sectors suggests that CNW’s basic assumptions and data differ dramatically from comparable assessments.

Reading CNW’s report and the accompanying pieces they provide reveals numerous misuses of facts and data.

### ***Example #1: Biased Mileage Assumptions and Faulty or Unjustified Data***

The report’s major indicator is total energy use per mile traveled, which is calculated by dividing the energy cost by the lifetime mileage. The most obvious manipulation of data is the company’s choice of total vehicle lifetime miles for each vehicle. For reasons not explained in the report, the Hummer H3 is assumed to travel 207,000 miles in its lifetime. Even more remarkable, the Hummer H1 is assumed to travel 379,000 lifetime miles. The Prius is assumed to travel only 109,000 miles.<sup>8</sup>

After readers of “Dust to Dust” questioned Prius’s assumed lifetime miles, CNW provided a note revealing that they had assumed early Priuses traveled only 6,700 miles per year, which translates into the low lifetime mileage assumption used in the study.<sup>9</sup> Digging further into the study reveals that the odd lifetime mileage assumptions are further biased by unjustified overall lifetime assumptions. A table in “Dust to Dust” lists extraordinarily precise assumptions (to four significant figures) about “Years of Service.” Even a cursory look at this table shows peculiarities, such as the assumed 34.96 year average lifetime for the Hummer H1.<sup>10</sup> These assumptions about lifetime and total miles completely bias the final results.

While we have been unable to find any supporting evidence for the CNW data, either in the report itself or in any published literature, we have found contradictory evidence. Published studies suggest that CNW’s assumption (and thus their conclusion) is incorrect, reporting that Prius owners drive their vehicles distances similar to other sedans – on the order of 15,000 miles per year.<sup>11</sup> An independent assessment conducted by the Rocky Mountain Institute, using the lifecycle model developed by Argonne National Laboratory (GREET 2.7),<sup>12</sup> also suggests that both “lifetime energy” and “energy per mile” for the Prius are far lower than for the Hummer

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<sup>8</sup> “Dust to Dust” pages 21 to 24.

<sup>9</sup> This assumption was revealed in “Why 100,000 Miles for Prius?” posted on the CNW website. It has no citations or listed author, although “Art” is the file author. <http://cnwmr.com/nss-folder/automotiveenergy/> (April 10, 2007). We note here that this conflicts with page 40 of “Dust to Dust,” which shows the Prius’s (equally implausible) average annual mileage as 9,146 miles.

<sup>10</sup> “Dust to Dust,” page 44.

<sup>11</sup> See, for example, “Diesel and Hybrids Don’t Mix: Perceptions of the Interested Public and Actual Driving Behavior of New Car Owners,” D. Gerard, P. S. Fischbeck, and S. Mathews, Center for the Study & Improvement of Regulation, Carnegie Mellon University, November 2006.

<sup>12</sup> Greenhouse gases, Regulated emissions, and Energy use in Transportation model. [http://www.transportation.anl.gov/software/GREET/greet\\_2-7\\_beta.html](http://www.transportation.anl.gov/software/GREET/greet_2-7_beta.html)

H3, even when using conservative assumptions about energy required for materials and fabrication of the Prius.<sup>13</sup> Changing just the total lifetime mileage assumption reverses the conclusions: the Prius (and comparable automobiles) consume far less energy over their lifetimes than larger vehicles, especially the largest SUVs like Hummers.

This peculiar “lifetime mileage” assumption is repeated throughout the report for all hybrid vehicles reviewed. Table 1 shows CNW’s lifetime mileage assumptions for comparable hybrid and non-hybrid model cars.

**Table 1: Unusual vehicle lifetime mileage assumptions in the CNW Report for similar conventional and hybrid makes.**

Vehicle Make	Conventional	Hybrid
Honda Accord	209,000	117,000
Honda Civic	178,000	113,000
Toyota Highlander	156,000	140,000
Ford Escape	161,000	127,000

Source: CNW “Dust to Dust” (2007)

### **Example #2: Incorrect Distribution of Lifetime Energy Costs**

Another example of an unusual assumption and choice of data is the reported distribution of energy across the different phases of vehicle life. The CNW results suggest that the majority of energy is consumed during the production of the vehicle. These results are at odds with every other study we’ve seen on the energy life-cycle costs of automobiles. Other studies independently conclude that the vast majority of energy is consumed during “vehicle operations,” with lesser quantities used during materials acquisition, fabrication, and vehicle disposal. For example:

- A report produced by a British research firm concluded that more than 90% of all energy used in the motor industry went to vehicle operation; less than 10% went to manufacturing and production.<sup>14</sup>
- The British auto industry trade group estimated in their 2006 sustainability report that life cycle CO<sub>2</sub> emissions – a strong proxy for energy – are allocated 10% to manufacturing; 85% to use; and 5% to disposal.<sup>15</sup>
- The Center for Sustainable Systems of the University of Michigan, which pioneered and refined the tool of life-cycle assessment, conducted a joint project with Chrysler, Ford,

<sup>13</sup> See, “Hummer-Prius Comparison” by H. Hauenstein and L. Schewel. May 2007.

[http://www.rmi.org/library\\_trans](http://www.rmi.org/library_trans)

<sup>14</sup> L. Elghali, V. McColl-Grubb, I. Schiavi and P. Griffiths. 2004. “Sustainable resource use in the motor industry: a mass balance approach.” Viridis Report VR6. Transport Research Ltd.

<sup>15</sup> “The UK Automotive Sector: Toward Sustainability.” 2006. Society of Motor Manufacturers and Traders. [www.smmmt.uk.co](http://www.smmmt.uk.co)

General Motors, the Aluminum Association, the American Iron and Steel Institute, and the American Plastics Council. They analyzed the life-cycle energy costs of the 6 systems, 19 subsystems, and 644 discrete parts and components composed of 73 different materials comprising a typical North American mid-sized car and concluded that more than 85% of all energy is the result of using the car, not making, assembling, repairing, or disposing of it.<sup>16</sup>

- A comprehensive energy life-cycle analysis of a Volkswagen Golf Mark 3 concluded that 73% of total energy is consumed during the use and disposal phases, 11% in materials production, 8% in vehicle manufacturing, and 8% in fuels manufacturing.<sup>17</sup>
- The MIT study, “On the Road in 2020,” reported on a comprehensive energy life-cycle analysis and found that 80% to 90% of all energy was used in the operation stage; 7% to 12% in the materials production stage, and the remainder in vehicle assembly, distribution, and disposal.<sup>18</sup>
- A 2006 study from Argonne National Laboratory concluded that around 75% of all hybrid and internal combustion vehicle energy use comes from the operation of the vehicle. The rest comes mostly from producing the fuels and the manufacture and disposal of the vehicle and its materials.<sup>19</sup>

### **Example #3: Inconsistent Data Manipulation**

The CNW study applies a special “heavy charge for design and development” to the Prius and other hybrids.<sup>20</sup> E-mail correspondence from the CNW president suggests that CNW divided the costs of developing automotive technology and a car itself over the number of cars produced to date, explicitly penalizing newer car technologies, such as hybrids.<sup>21</sup> Similarly, CNW reportedly divided the costs of building a factory over the small number of cars it has produced to date, not total production – a classic example of inappropriate amortizing.<sup>22</sup> Whether this is the actual

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<sup>16</sup> Center for Sustainable Systems, University of Michigan. 2005. Personal Transportation Factsheet. Ann Arbor, Michigan (August). See also, Keoleian, G.A., K. Kar, M. Manion, and J. Bulkley. 1997. Industrial Ecology of the Automobile: A Life Cycle Perspective. SAE R-194. Society of Automotive Engineers, Warrendale, PA CSS97-04, and G.A. Keoleian and D.V. Spitzley. 2006. “Life cycle based sustainability metrics.” In M.A. Abraham (editor) *Sustainability Science and Engineering: Defining Principles*. Elsevier B.V. Amsterdam, pages 132-135.

<sup>17</sup> G. W. Schweimer, M. Levin. Life Cycle Inventory for the Golf A4. Volkswagen AG, Forschung, Umwelt und Verkehr, Wolfsburg 2000. [http://www.volkswagen-umwelt.de/download/sachbilanz\\_golf\\_a4\\_englisch.pdf](http://www.volkswagen-umwelt.de/download/sachbilanz_golf_a4_englisch.pdf).

<sup>18</sup> M. A. Weiss, J.B. Heywood, E.M. Drake, A. Schafer, and F.F. AuYeung. 2000. “On the Road in 2020.” Energy Laboratory Report #MIT EL 00-003. Massachusetts Institute of Technology, Cambridge, MA. [http://www.cleanairnet.org/transport/1754/articles-69297\\_resource\\_1.pdf](http://www.cleanairnet.org/transport/1754/articles-69297_resource_1.pdf)

<sup>19</sup> “Development and Applications of GREET 2.7 – The Transportation Vehicle-Cycle Model.” Argonne National Laboratory, Energy Systems Division, ANL/ESD/06-5, A. Burnham, M. Wang, and Y. Wu. November 2006.

<sup>20</sup> “Dust to Dust,” page 352.

<sup>21</sup> From CNW, *Why 100,000 Miles for Prius?* “As for Hummer [*sic*], much of the design, development and manufacturing energy costs are spread across more than just this single model.” <http://cnwmr.com/nss-folder/automotiveenergy/> (April 10, 2007).

<sup>22</sup> <http://www.truedelta.com/blog/?p=66>. Art Spinella, the editor of the report noted in an interview quoted at hybridcars.com that if the study were repeated in three years time, the results would be “totally different.” [www.hybridcars.com/environment-stories/dust-to-dust-energy-costs.html](http://www.hybridcars.com/environment-stories/dust-to-dust-energy-costs.html).

method used, and whether this same method was applied to other vehicle models, will only be determined if the full methods and calculations are released for review.

## Errors in Methods of Analysis

Without detailed information about the analysis, clues about the kinds of errors can only be gleaned from the results. An example that raises serious questions is the vastly different conclusions the CNW report presents for two Toyota models, the Scion xA and xB. These two cars are engineered with the same processes, built on the same assembly line and chassis, transported and shipped together, distributed through the same dealer network, have the same engines, displacement, power, torque and transmissions, are about the same weight (within 25 kilograms), and have very similar fuel consumption ratings. Yet the CNW study assumes the lifetime mileage of the xA to be 156,000 miles and the xB to be 189,000. The lifetime energy of these vehicles is, as a result, also very different, though no justification for these differences is provided, or apparent.<sup>23</sup>

Other errors in methods or analysis are suggested by the author's confusion over the difference between power and energy, and misuse of conversion units. For example, the report states: "A Joule is one watt per second of energy consumption," and "A 60 watt light bulb uses 60 Joules of energy."<sup>24</sup> These conversions are incorrect: a Joule is one watt-second of energy; and a 60-watt bulb uses 60 Joules *per second*. Whether these errors are simply typographical or propagate analytically through the analysis cannot be determined without the release of the full report.

## Misuse of Certainty and Uncertainty; Misuse of Precision versus Accuracy

The report includes examples of the misuse of certainty and uncertainty, and a confusion of the difference between precision and accuracy. Extensive data in the form of numbers are presented in the report, always to a higher degree of certainty and precision than appears warranted – often to four or five significant figures.<sup>25</sup> For example, the lifetime figures for each vehicle model are reported to four significant figures (such as the 34.96 years for the Hummer H1 noted above).<sup>26</sup> The absurdity of this type of false "certainty" or "precision" can be seen in the following: the Mercury Mariner hybrid is reported to last 11.56 years; the Toyota Highlander Hybrid is reported to last 11.60 years, or 4219 days versus 4234 days.<sup>27</sup> CNW must thus be in possession of information that supports this precise difference of 15 days. We know of no such information. As a result, the report is filled with information that appears precise but in fact has little accuracy.

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<sup>23</sup> A discussion of this can be found at <http://townhall-talk.edmunds.com/direct/view/.f104323/221>, and detailed engineering information on the similarities between the Scion xA and xB are at Car and Driver: <http://www.caranddriver.com/previews/6642/2004-scion-xa-and-xb-page2.html>.

<sup>24</sup> See page 306 of "Dust to Dust." CNW Marketing.

<sup>25</sup> See any of the data tables in "Dust to Dust" for examples of "illusory precision" – the reporting of data or results with more precision than warranted. Precision does not imply accuracy.

<sup>26</sup> See the tables on pages 39-47 of "Dust to Dust." CNW Marketing.

<sup>27</sup> Assuming 365 days per year.

Uncertainty is also discussed twice in the published version of the report: once to describe the “statistical accuracy” of the report as “plus or minus 8.6 percent” and once to say that “The information contained is as accurate as we can make it currently although we believe it has an error margin somewhere between 11 and 14 percent.”<sup>28</sup> Despite these (conflicting) claims, it appears that the report’s authors made no actual scientific estimate of uncertainty. “Statistical accuracy” cannot be evaluated with the precision given because of the gross uncertainties in the data; and given the large number of factors that appear to have been considered, overall uncertainty is going to be a combination of the uncertainty associated with each single factor, and is thus going to be a substantially larger than the values claimed.

## **The Lack of Transparency in Regard to Funding**

As of May 2007, the company continues to refuse to provide information on the sources of funding for the analysis, other than to say that the report was “self-funded.” What this appears to mean is that funds from other clients (or profits from those funds) must have been used. By itself, this is certainly not evidence of error, but it violates fundamental principles requiring the transparency of research funding.<sup>29</sup>

## **Conclusion**

This short review and analysis calls into question the unsubstantiated conclusions of the CNW “Dust to Dust” report – it appears that the report suffers from fatal flaws. Indeed, correcting only a few of these flaws completely changes the conclusions. A full analysis, however, would require more information about the data, assumptions, methods, and calculations used in the report. CNW has not released this information for independent review. We call on them to do so. At that time, it may be possible to accurately review and assess the important question of life-cycle energy for automobiles. Until then, substantial peer-reviewed and verifiable research indicates that the only reliable ways to cut the use of fossil fuels in the transportation sector are to build more efficient automobiles, develop cars that use alternative energy sources, and drive fewer miles.

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For more information about the Institute’s **Integrity of Science** initiative, visit [www.integrityofscience.org](http://www.integrityofscience.org).

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<sup>28</sup> See page 15 and page 364 of “Dust to Dust.” CNW Marketing.

<sup>29</sup> The Pacific Institute’s Integrity of Science initiative, which supported this review, is funded by grants from the Open Society Institute, and the David and Lucile Packard Foundation.