THE NEMS CONFERENCE

TRANSPORTATION DEMAND PANEL

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PANELISTS:

Barry Cohen, Moderator
David Chien, Presenter
K.G. Duleep, Reviewer
Margaret Singh, Reviewer
John DeCicco, Reviewer

AUDIENCE PARTICIPANTS:

Dan Santini
Lou Fulton
Steve Bernow
Paul Leiby
Dave Litz
Tom Nais

EIA

PROCEEDINGS

MR. COHEN: Thank you all very much for coming today. I am excited today to be serving as your moderator in an area of great interest, an area where on a daily basis the newspapers are full of debates on whether we should have higher CAFE standards, higher taxes on carbon, or fuel specific taxes.

One thing is clear, I think. If we are going to save oil in this country, it is going to be in the transportation sector. If we are going to substantially reduce our reliance on imported oil, it is going to happen in the transportation sector. And so I am very happy to see a very large turnout today. Because if we are going to be successful in our analysis of these issues, it is going to be because we coordinate with you and others in prioritizing the issues we need to be addressing.

First let me introduce some of my distinguished colleagues today. On my right is the talented David Chien. David Chien is a world famous collector of glass bottles. In addition, he has been able to raise in captivity species of tropical fish that no one else in the world has been able to prompt to reproduce.

Aside from that, he is the principal analyst responsible for putting together the Transportation Energy Research and Forecasting model (TERF). I came up with the acronym (TERF) but it is his responsibility to make sure it is in the integrating system and it is meeting your needs.

To my immediate left we have K.G. Duleep. Any time I read testimony, K.G. Duleep's name is there as an expert witness in front of Congress. Not every engineer in the country will agree with his estimates of what each technology's fuel efficiency improvement will be. But I have never heard an engineer have any problems with Mr. Duleep's integrity and his forthrightness in spelling out what his assumptions are.

To my furthest left we have Margaret Singh, from Argonne National Laboratory. She has been working with the DOE Policy Office for many years and has a wide range of experience in analysis of transportation issues. Most recently she has been involved in investigating alternative fuel use in fleet vehicles. She recently wrote a detailed report describing what the fleet vehicle population looks like, who owns it, where is it, and what are the possibilities for switching to alternatively fueled vehicles.

Just let me make one personal observation. I was reading my own bio in preparation for indicating who we have on our panel and it said I have been here since the early days of the Federal Energy Administration. It occurred to me, I didn't appreciate how good we had it back then.

Twenty years ago when someone asked me, "What is the basis of your forecast?" I had an answer ready. We were following "historical trends." That answer served me very well. It was relatively easy to achieve high T statistics and high R squared values. Today that just doesn't cut it and it's not surprising. For example, we are faced with a situation now where the number of people over 60, as a proportion of our population, is going to increase dramatically.

Over the past 20 years, when we were estimating econometric relationships of passenger travel, people over 60 accounted for about one fifth of the total population. That share is going to increase by perhaps a third over the next 20 years. That is going to have dramatic effects on what we do in terms of forecasting the level of travel.

In the past 20 years we were reasonably comfortable predicting new car fuel efficiency on the basis of incremental improvements to conventional technologies. Well, you don't have to be a legal scholar to read the Energy Policy Act of 1992 or the Clean Air Act Amendments of 1990 and see that future predictions will be far more difficult to make.

Zero emission vehicles are going to be forced into the market. Low emission vehicles are going to be forced into the market. The simple economics of the situation do not account for the bigger political questions. So just following historical trends is not going to be sufficient for the NEMS project.

Our last speaker will be Mr. John DeCicco from ACEEE. Mr. DeCicco has been very involved in analyzing the envelope of what is possible in terms of fuel efficiency. Many of you are familiar with the publications of ACEEE and their forecasts. They evaluate what is technically possible given current knowledge. And it is very useful for us to have that as a backdrop for our forecasting analysis.

Given the number of people, it is probably going to be useful to hold questions for our panel until the end.

Thank you.

The first speaker will be David Chien.

MR. CHIEN: Good morning. Welcome to the NEMS transportation demand model presentation.

The first thing I would like to say is that we would like to welcome questions during this session. The reason for holding this meeting is not only to present the model and review the model, but also to display this in an open forum. Your comments will help us to improve the model.

The second thing that I would like to mention is that this is a very large modeling effort. And we have tried our best to match the tasks to the resources that we have.

To give you an example of what I mean, in the fuel technology exogenous input data base we have 9 regions, 16 technologies, 6 vehicle attributes, 3 size classes, and 26 years.

To begin my discussion I would like to turn to the flow chart of the NEMS transportation model within the NEMS system.

There are two forms of the model planned. There is an integrated mainframe model and a PC stand-alone model that will be developed in the future.

Transportation Demand
in the
National Energy Modeling System

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David Chien
Energy Information Administration

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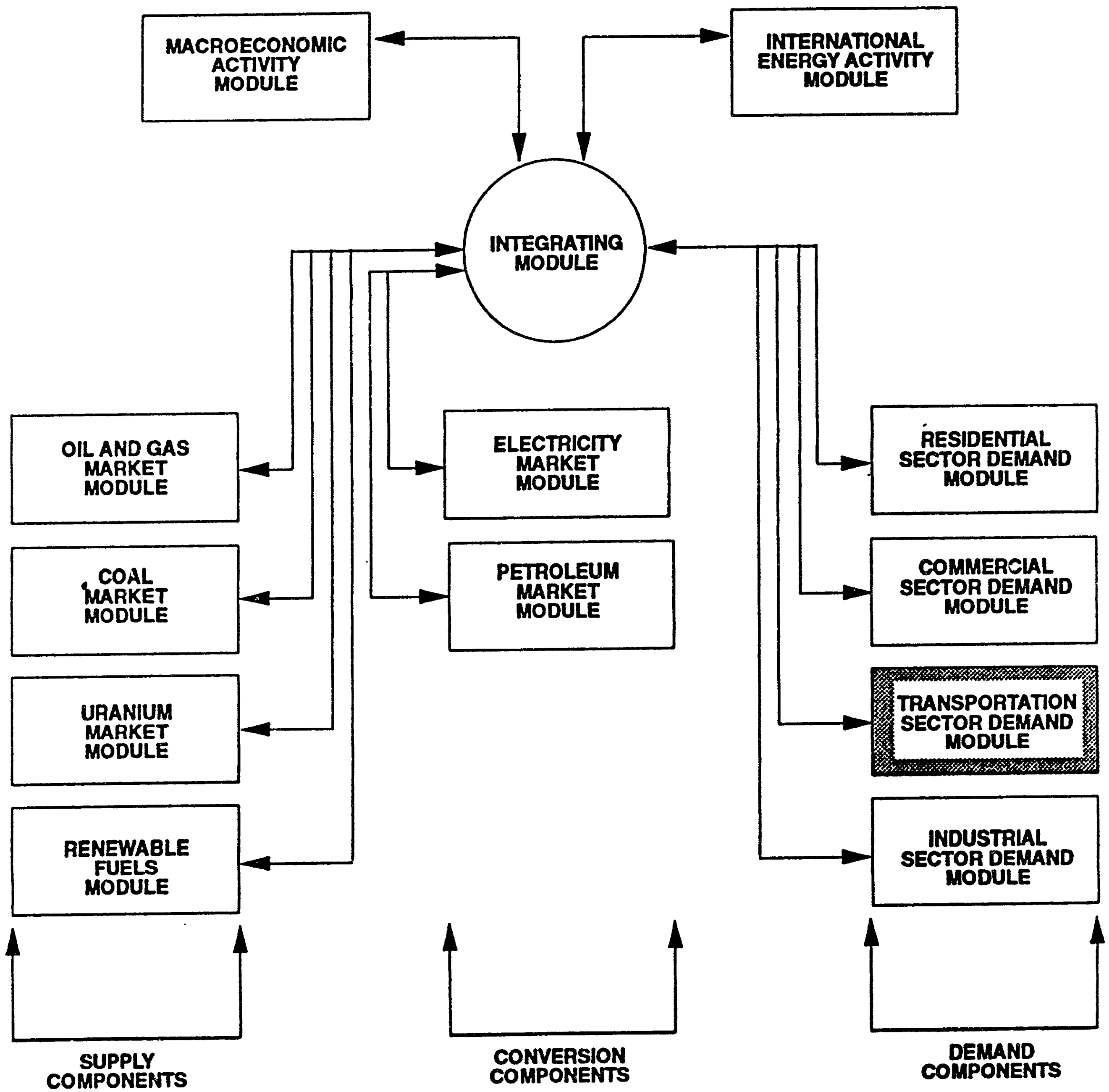
Transportation Sector Demand in the NEMS



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The model uses an iterative convergence methodology between supply and demand similar in concept to the cobweb theory in economics. Although we may not completely always reach equilibrium, the iterative convergence methodology tries to minimize that distance between the two, between supply and demand.

Now to review the components of NEMS, on the far righthand side you can see the demand modules. There is the residential, the commercial, and then there is highlighted in white the transportation area as well as the industrial model.

On the far left are the supply modules. We have an oil and gas market module, the coal module, the uranium, renewable, electricity market module, and the petroleum market module.

Directly in the center we have the integrating module which equilibrates fuel consumption and energy prices within the supply and demand modules.

And at the far top lefthand corner we have the macroeconomic model. This model provides macroeconomic model inputs and drivers used in the transportation model, such as real disposable income, population, total car and light truck sales, and industrial SIC outputs for freight energy use calculations.

On the top righthand corner we have the international energy module which supplies NEMS with an estimate to the world oil price. This estimate is contingent on both U.S. and worldwide demand production.

The goal of the NEMS transportation model is to provide forecasts of transportation sector energy use over the horizon from 1990 to 2015.

Now I would like to review some of the new features of the NEMS transportation model.

The NEMS transportation model contains many policy handles. These permit the user to forecast the impact of many of the policies upon the transportation sector modes of travel that are designed either to reduce fuel consumption or emissions levels. Some of these policies are listed below, like the Clean Air Act Amendments of 1990, the Energy Policy Act of 1992, and various fuel efficiency legislation such as the corporate average fuel economy, feebates, gas guzzler tax or gasoline taxes, and also the Intermodal Surface Transportation Efficiency Act of 1991.

We have a modal shares module which allows for shifting across modes, so that we can handle such factors as increased mass transit usage.

Now to review some of the other general features of the model.

Consumption is divided among the nine Census divisions using a regional sharing methodology that incorporates regional data that are specific to each mode. The model allows the user to account for region-specific policies, such as the low emission vehicle program of California that is now being instituted in New York and Massachusetts, as well as the Clean Air Act and the Energy Policy Act.

Goals

o Provide forecasts of transportation sector energy use within the NEMS integrated framework

o Provide the level of detail needed for policy analysis for each mode of travel

- Clean Air Act Amendments of 1990
- Energy Policy Act of 1992
- Fuel Efficiency Legislation
- Intermodal Surface Transportation Efficiency Act of 1991

The transportation model has been designed to allow the modeler to override any of the exogenous inputs easily and to do this within a user friendly framework of a Lotus 1-2-3 spread sheet.

There are also many endogenous calculations in the model which may be overridden by the user as well, based on, for example, supplementary off-line analysis or scenario development. For example, the model will endogenously estimate the market penetration of electricty vehicles. However, the user can develop "what if" scenarios based on alternative levels of market penetration.

For many users of the model, the detailed reports are a very important model feature. Those reports will contain such items as consumption by fuel type and technology, sales shares, horsepower and fuel efficiency by size class, sales, stock and VMT by technology, and regional emissions levels.

Now to review the NEMS transportation sector energy use by mode.

Auto and motorcycles represent the largest portion of fuel consumption, at 39.3 percent. Trucks comprise the second largest share of fuel consumption, of which 54.7 percent of these trucks are light duty trucks. When you combine the autos and the light trucks, you have light duty vehicles and these represent the largest portion of fuel consumption at 57 percent, following by freight trucks, air, marine and rail.

Now to review the modeling approach. We have modeled the modes of travel accounting for the largest fractions of energy use within a detailed technology-based framework. For example, in cars and light trucks we have 16 technologies. In the freight truck section we have five technologies. In the commercial aircraft module we have a vintaging stock model which consists of two size classes, narrow and widebody airplanes, with six fuel efficient technologies that are dependent on jet fuel price and a time technology availability factor.

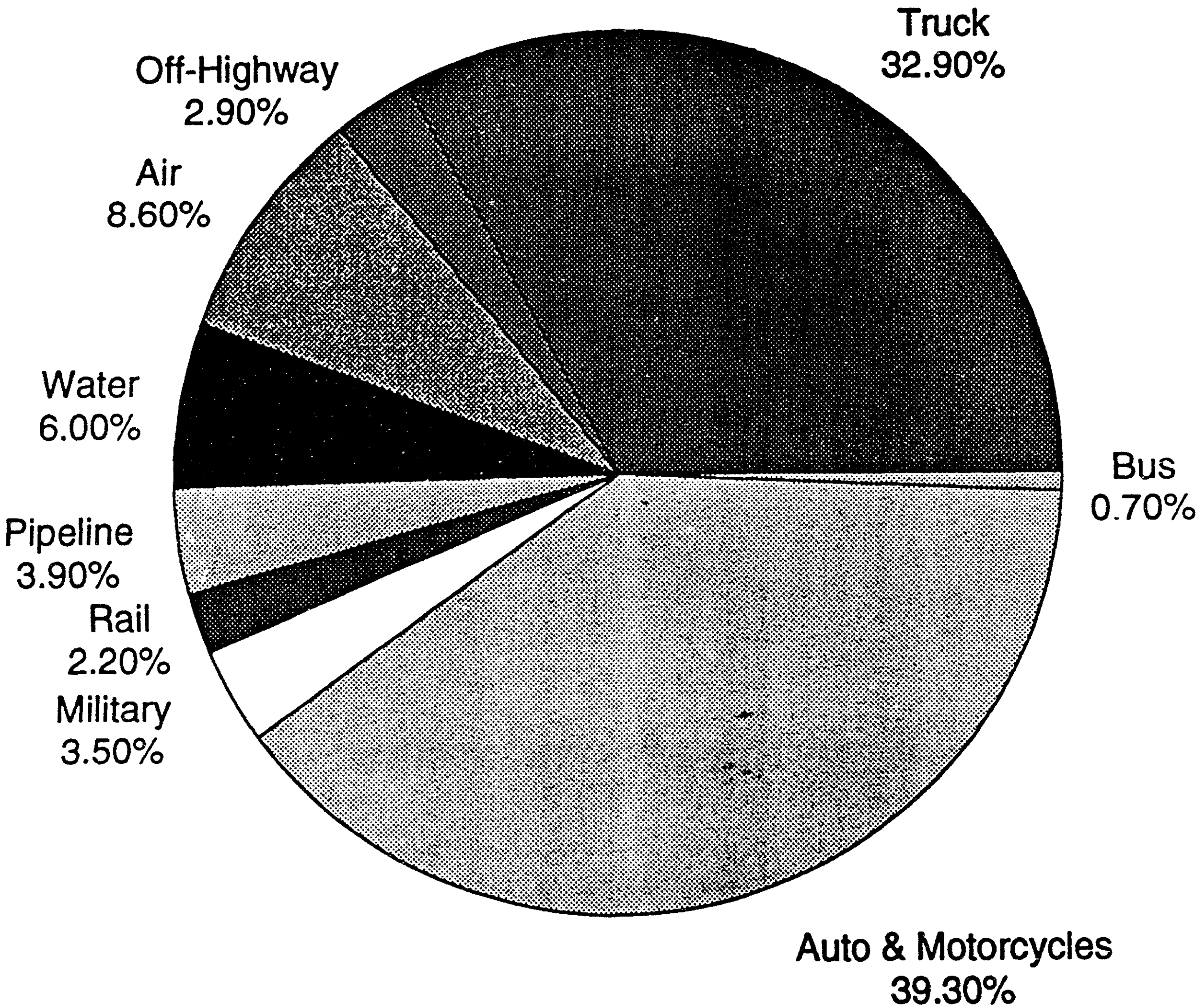
We also have considered minor energy consuming modes because of their potential for policy initiatives. For example, the Energy Policy Act targets alternative fuel use in school buses.

The model can also handle "what if" scenarios based on structural shifts in transportation. Increased funding for mass transit for example, may increase the sector's reliance on such modes. We have transit, intercity, school and commuter buses explicitly listed in the model. And there are also additional breakouts for military fuel consumption.

The light duty fleet composition has been expanded considerably. We have expanded the stock vintages from four to ten vintages in the current model. This allows the modeler to capture policies designed to target some of the older vehicles with poor fuel efficiency and high level of emissions.

There are also six size classes corresponding to the EPA size classes for cars and light trucks. This is a very important addition to the model because it allows the modeler to measure the impacts of policies that target sales, sales shifts to smaller vehicles within and across size

Transportation Sector Energy Use by Mode



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Modeling Approach

- Modes of travel accounting for large fractions of energy use are modeled within a detailed structural framework

  - cars and light trucks
  - freight trucks
  - commercial aircraft

- Minor energy consuming modes are included because of potential policy initiatives such as

  - proposals to introduce alternative fuel use in school buses
  - increased funding for mass transit

Light-Duty Vehicles: Fleet Composition

- 10 Stock vintages
- 6 car and 6 light truck size classes
- Fleet vehicles (10 or more vehicles)
- Alternative fuel vehicle characterizations

  - CNG vehicles
  - Electric
  - Fuel Cell (methanol or liquid hydrogen)
  - Methanol
  - Ethanol

- Fuel-saving technology characterizations

  - lean burn engines
  - variable valve timing
  - 5-speed automatic transmissions

Light-Duty Vehicles: Fuel Economy in New Vehicles

- o Endogenous fuel efficiency projections by size class of vehicle

  - explicitly compares the cost of a fuel efficiency improvement to the discounted value of fuel savings

  - considers tradeoff between vehicle performance and fuel economy

  - lower fuel prices result in higher average horsepower estimates by size class as well as lower fuel economy

  - estimates the effect of government safety and emissions regulations on fuel economy

Light-Duty Vehicles: Fuel Consumption

o Endogenous estimates of size class market shares

- fuel prices
- demographic constraints

o Vehicle-miles traveled (VMT)

- fuel cost of driving a mile
- per capita income
- distribution of the driving age population

o Fuel consumption estimated by technology classes, to such policies as feebates, gas guzzler tax or gasoline tax, just to name a few.

To give you an example, within a size class such a switch would be, say within a large size class, moving from a Lincoln Town Car to a Ford Crown Victoria. The second type of shift across the size classes would be moving from a compact Corolla to a subcompact Geo Metro or a Yugo.

We also have a separate commercial fleet vehicle sales and stock module. This allows the model to measure the impact of alternative fuel sales to the commercial fleet population through various policies, such as the Energy Policy Act and the Clean Air Act.

The characterization of alternative fuel vehicles has been expanded from seven technologies in the old model to 16 technologies in the NEMS model. These include CNG, LPG vehicles, various configurations of electric vehicles, fuel cell, methanol and liquid hydrogen types, various combinations of methanol and ethanol vehicles.

As I mentioned before, an important part of the model design is a user friendly interface to facilitate analysis of alternative scenarios. For example, if you wanted to add other vehicle characterizations or additional technologies, you may do that.

Expanding the number of technologies considered (16 technologies) allows the modeling of individual stocks of alternative fuel vehicles. This is very important because there are certain policies, such as the low emission vehicle program, which specifically target electric vehicles.

Another part of the alternative fuel module will be that higher real fuel prices will result in greater alternative fuel vehicle sales.

Now to go into a little bit more detail, there will be an endogenous sales module which implements a discrete choice methodology. It utilizes a three stage nested logit specification which endogenously calculates sales shares among the alternative fuel vehicles based on six vehicle attributes. Those are vehicle price, vehicle range, emissions level, fuel availability, fuel price, and fuel efficiency.

To give you an idea of what the three stages consist of, the first stage would be answering a question such as how many alternative fuel vehicle sales will be calculated versus conventional vehicles. The second stage would determine how many electric, CNG or LPG vehicles there will be, sales there will be within the number of alternative fuel vehicles based on the first stage. The third stage is a little more specific. This will tell you how many of each type of configuration, say, of electric vehicles will be sold. There will be a breakout for dedicated electric vehicles, electric hybrids, electric hybrids with two-stroke, and such.

The first stage allows the modeler to maintain more control (often legislatively mandated) over the total level of alternative fuel vehicle sales. That is one of the reasons why we opted for this three stage procedure.

The second stages requires regional fuel prices as inputs to the logit, so that the model is responsive to regional factors which may be favorable to certain technologies or fuels.

I would like to make the distinction between the market driven sales that the logit analysis predicts versus those that are legislatively driven because of the low emission vehicle program, the Clean Air Act and the Energy Policy Act. These will be included in the model as a lower bound constraint on alternative fuel vehicle sales.

For the conventional vehicles there are over 50 fuel saving technology characterizations specific to size class, such as lean burn engines, variable valve timing and five speed automatic transmissions.

A new analysis capability of the model that considers fuel economy for conventional vehicles is the model that was developed by K.G. Duleep of EEA. It includes six EPA size classes each for cars and light trucks, and allows for the delineation of those two types of shifts that I had mentioned before within a given size class and across size classes. It permits the modeling of gasoline taxes, gas guzzler taxes, feebates, and other size class specific policies.

As I mentioned earlier, the model user can edit any of the exogenous input files. Some of the key parameters that a scenario such as a what-if kind of scenario, you might want to change things like real gasoline prices, income per capita, the payback period, the discount rate, the regulatory cost for failure to meet CAFE, and the CAFE level.

There are endogenous fuel efficiency projections by size class. This allows for variable penetration levels of new fuel efficient technologies within each class.

The decision rule for the model explicitly compares the cost of a fuel efficiency improvement to the discounted value of fuel savings. It considers trade-offs between vehicle performance and fuel economy. So that the model includes a performance-demand equation which is dependent upon personal disposable income and fuel prices. Then performance is traded off against fuel economy. Lower real fuel prices will result in higher average horsepower estimates by size class as well as lower fuel economy. There are also estimates of the effects of government safety and emission regulations on fuel economy, such as air bags, tier one and tier two levels of the Clean Air Act, side impact and roof crush tests.

With respect to fuel consumption, the model endogenously estimates the size class market shares based on a fuel cost which is calculated by fuel price divided by fuel efficiency; also demographic constraints such as income per capita; and a time factor. There are specific elasticities for each size class.

The Vehicle Miles Traveled (VMT) calculation in the model is dependent upon three things: one is a cost of driving -- a fuel cost of driving per mile which is fuel price divided by the fleet fuel economy; personal disposal income per capita and an age effect which captures changes in the age distribution of the driving population.

Fuel consumption is estimated by technology. So that higher stock numbers of alternative fuel vehicles translate into higher VMT and consumption estimates by these technologies.

For the freight module we have modeled trucks, rail and waterborne travel. These estimates are based on NEMS forecasts of regional industrial SIC output. The model design

Freight Transport

- Trucks, rail and waterborne travel estimates are consistent with NEMS' forecasts of industrial output

- Model design allows for freight vehicle efficiency and system improvements based on energy prices

- Alternative fuel use in trucks
  - CNG
  - Methanol/ethanol

allows for variable freight vehicle efficiency by technology and system improvements based on energy prices. By system improvements, we are basically talking about increasing load factors such as increased use of HOV lanes.

Alternative fuel use in trucks will include CNG, methanol and ethanol, and some of the others, such as gasoline, diesel and low heat resistant diesel.

Freight trucks have three size classes corresponding to the FHWA sizes of single unit light, other, and combination trucks.

For the air transport model, this is based in part on the air transport energy use model by Oak Ridge National Laboratory and David Greene. The categories of air travel are domestic travel, international travel, dedicated air freight. There is also additional air fuel consumption calculated outside of the air module that I wanted to mention, which is military jet fuel consumption and general aviation.

Commercial air travel demand will be estimated based on ticket cost, which is based in part on jet fuel prices and economic activity.

Endogenous estimates of new aircraft efficiency are based on jet fuel prices and a time parameter representing the availability of a technology. This is a case where the user may want to go in and alter the annual rate at which the retrofit of older aircraft with new technology occurs.

There is a stock vintaging model with two size classes, wide and narrow body. These classes are included so that you can alter the size composition of the stock of aircraft based on such dynamic changes as the continuing development of the hub and spoke system, airport congestion, growth in the long haul market, and lower cost and longer range of widebody aircraft.

Additionally, these size classes permit variable fuel efficiency estimates and technology penetration levels across size classes.

Vintaging in the air model is by a logistic curve rather than assumed retirement at year 25 or a specified year.

Regionalization within the air fuel consumption estimates are based on the number of major and minor hubs within a given census division.

Last, we have the flow chart of the transportation sector emissions analysis by transportation mode.

We have emissions coefficients listed for all the different modes that I previously mentioned. All filter into the calculation of total transportation sector emissions.

On the far lefthand side we have emission factors by technology, fuel, and travel characteristics. These incorporate the Clean Air Act, Title I and II, and the low emission

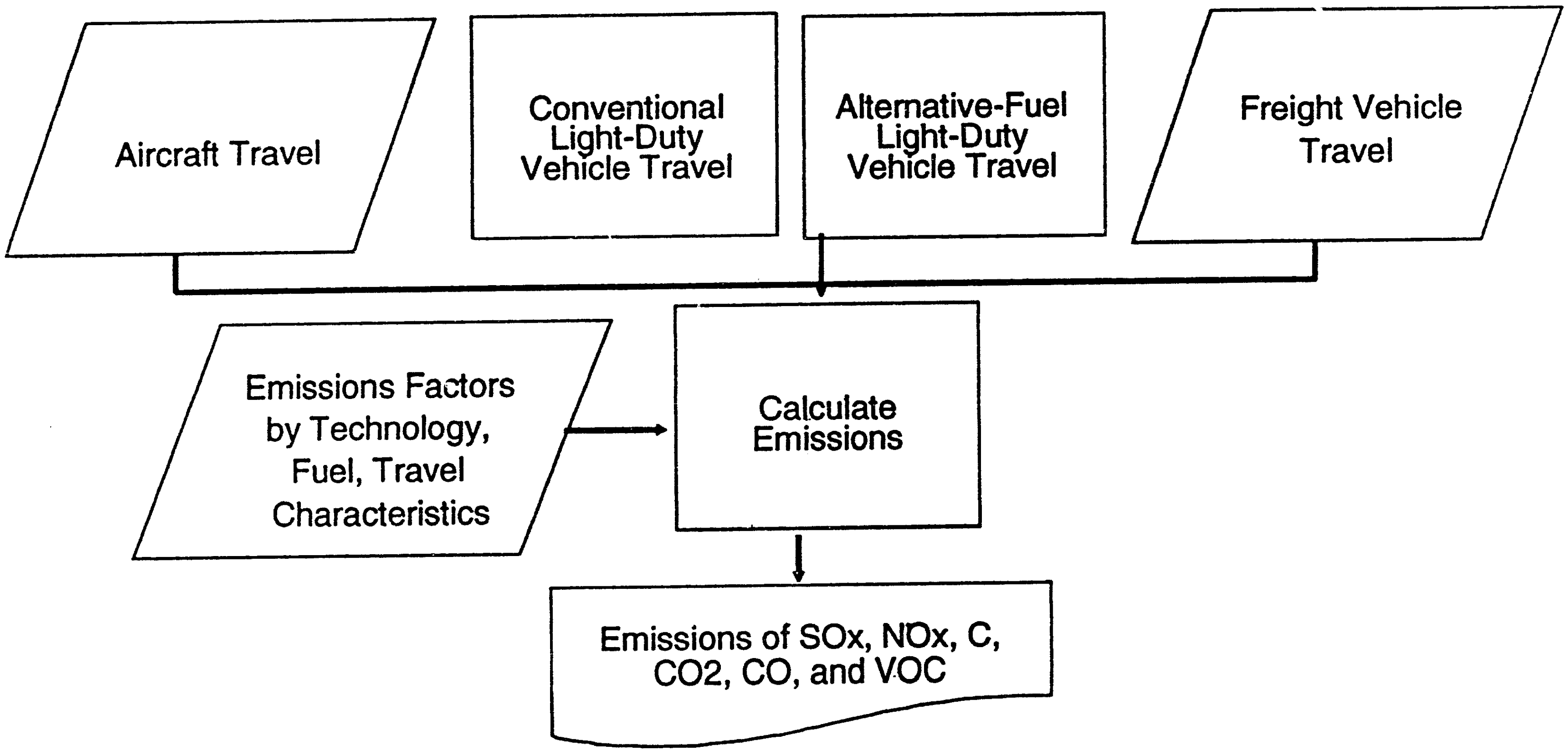
Air Transport

- Categories of Air Travel
  - Domestic travel
  - International travel
  - Dedicated air freight
  - Military jet fuel consumption

- Commercial air travel demand will be estimated based on:
  - ticket cost (including jet fuel prices)
  - economic activity

- Endogenous estimates of new aircraft efficiency based on jet fuel prices

Transportation Sector: Emissions Analysis



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vehicle program based on California Air Resource Board mandates.

These factors are also based in part on the EPA mobile 4.1 emissions model. And a review of some of the emissions that we will be looking at are SOx, NOx, carbon, carbon dioxide, carbon monoxide, and VOC's. Emissions will be by mode and Census division.

We have tried to include as many policy options as we possibly can, in trying to meet as many of the reviewers comments that have been sent to us. And we greatly appreciate those comments or any further comments that people may wish to make.

As I mentioned before, we tried to trade off items such as computer run time and model detail. I would just like to leave with one comment that my father said to me a long time ago. "All things are possible, but if possible don't try them all."

Thank you very much.

MR. COHEN: Thank you, Dave.

Our next speaker will be K.G. Duleep, who will provide additional information on perhaps the most controversial area the model -- how do you forecast new car fuel efficiency?

A recent NRC report tried to provide a whole range of forecasts of what new car fuel efficiency might be in the future. The one sentence that sticks in my mind is, "forecasting new car fuel efficiency is a risky business." With that, I will hand it over to Mr. Duleep.

MR. DULEEP: Thank you, Barry. Good morning, ladies and gentlemen.

Although I am a reviewer, I am also one of the people who are responsible for at least some elements of the model. So part of what I am going to talk about today is to give you an overview of how the fuel economy forecast is developed and what kinds of regulation can be assessed in the current stage and what could be done with further improvements.

The fuel economy model (FEM) at this stage covers only light duty vehicles, which are cars and light trucks (up to 8,500 pounds).

For heavy duty trucks, fuel economy is largly exogenous if I am correct, Barry. There is some implicit model there but it is not as explicit as the case for light duty trucks and cars.

The way we have gone about developing this model I think represents a fairly significant advance over what has been done to date and is based on all the knowledge that has been gained over the years in having EEA work for the DOE Policy Office, where we have been working on CAFE related issues, fuel economy forecasts, how manufacturers react, what technologies there are, and so on.

It incorporates all those elements and some subjective decisions that we have had to make along the way to how manufacturers respond. It is almost a supply oriented model. In a sense it assumes that manufacturers somehow forecast what consumers will want to buy and build cars

NEMS

Fuel Economy Model (FEM)

- **FEM forecasts car and light truck fuel economy at the market class level and by domestic/import status, as well as at the fleetwide level**

- **FEM builds from the knowledge base developed for DOE's Policy Office on forecasting vehicle fuel economy**

- **FEM utilizes retail fuel price and consumer disposable income as well as CAFE standards**

- **Outputs are only for new vehicle fuel economy at all levels of disaggregation, but not for fleet fuel economy**

- **Model already includes penalties associated with known and likely future emissions and safety standards** accordingly.

What it does utilize as inputs at this point are retail fuel prices and consumer disposable income. These variables tend to drive many of the car vehicle choices and technology choices. It also has CAFE standards only at the current time. In other words, the only regulatory policy it can model is CAFE standards. And as you will, even that, there are obviously some limitations as to how you could model that.

It can output fuel economy by size classes. And in fact, although David mentioned six, we actually have seven size classes in there. One is luxury, because of the fact that the luxury car markets have been growing very rapidly in the last -- it in fact doubled in the last ten years as the income distribution has been changing. More people are buying Mercedes and BMW's, or Lexus, I should say.

Finally, in the sense that there are other regulations that affec fuel economy -- mainly safety and emissions -- those are built in. There is no choice on that matter. It is a fact that we were aware that these standards were going to come onstream in the next two decades. Those fuel economy penalties associated, if any, with those standards have been built into the model.

For those who have not been actively involved in this topic, it may surprise you to know that in the last 15 years the fuel economy of cars has doubled. It has gone from 14 to 28 miles per gallon, or so. Most of that has not been accomplished through size changes. It has been accomplished through technology, really, and cars have become lighter.

By size, again, I don't mean exterior size, which has in fact become -- has been reduced, but the fact that the interior passenger room has remained approximately constant for quite a long time, although there have been some up and down movements right after oil shocks and so on. But if you look at 1990 and you look back at, say, '78 or '77, the interior size of passenger cars has not changed very significantly.

So what has really happened is that the vehicle technology has changed quite dramatically in the last 15 years. Most of it actually happened in ten years, and then since then things have been changing.

The size class mix has been an issue only when fuel prices change rapidly. There was a big shock in 1979 and people rushed towards small cars and diesels, and so on. But barring those specific periods, size class mixes have not changed as rapidly as people normally tend to think.

Lastly, performance changes which have traditionally not been as important have become very important in the last few years.

Again, some of the new cars today have performance levels that exceed the muscle car era of the late 60's. I am sure many of you were around then, and if you remember all those, you know, Chrysler Hemis and things like that, cars of today can actually go faster than many of those cars from that era. Cars today have enormous amounts of horsepower, although that

FUEL ECONOMY OVERVIEW

- **The single largest influence on new vehicle fuel economy is new technology adoption. Technological change has been responsible for most of the increase in fuel economy over the last 15 years.**

- **Size class mix shift is important during periods of rapid fuel price change (shock), but is not a large contributor to fuel economy change if fuel prices and incomes are relatively stable**

- **Performance changes have become particularly important since 1988, but the trend is difficult to forecast. Performance can account for fuel economy changes of the same magnitude as those associated with size class mix changes**

- **Use of alternative fuels currently not intagrated with FEM** has been accomplished through technology rather than just engine size.

Lastly, I should mention that the current alternative fuels model was developed separately. It is not integrated into this, which is perhaps a criticism that I will address later.

The methodology that we utilize to predict conventional vehicle fuel economy is really developed from the old TCSM that some of you may be familiar with that was developed for the Policy Office, although it has been improved substantially.

What we do is we start from a baseline that is actually an actual baseline of the 1990 vehicle fleet in this case, where we look at vehicle prices, what kinds of cars are sold, what the actual technologies in each car were, and by these different size classes, and then estimate everything incrementally from the baseline. That is, all these changes are estimated as changes starting from a baseline.

Each aspect of the three aspects that I talked about are separately modeled. The way we do that is first we assume that the vehicle stays the same in terms of consumer attributes of space and performance, and estimate technological changes that can happen to the vehicle.

Once we do that, we go in and estimate how performance changes, which is essentially a consumer choice item. That is, the consumer chooses to buy more performance either by buying a larger engine or by choosing a different kind of model. And so in these instances we look at it as a specific consumer demand item. We adjust the fuel economy either downward or upward, depending on whether performance increases or decreases. All of this is carried out at a size class level.

Then finally we take the different size classes and aggregate upwards based on the demand for cars and trucks at different size classes.

That is the overall view of the methodology. The central component to all of this is how technologies are adopted and, in fact, this is perhaps the most controversial element of all fuel economy modeling.

What we do have, as David mentioned, is a detailed listing of every possible improvement that can be made to cars in the next 35 years or 40 years. And these are estimated based on what we know about R&D and what we know manufacturers are doing.

And the fact is that, you know, cars have been around for 100 years so there are mature technologies from the standpoint that it makes it easier to forecast what can happen to them, because literally people have thought of -- at least conceptually have thought of everything that can be done to a car in the foreseeable future.

From that standpoint there are no surprises. Nobody is going to invent coal fusion or something, an equivalent for cars that will enable them to get fantastic MPG values, because they are all bound by these fairly traditional Newtonian laws.

The way we do model this, is that we have some estimates of when different technologies

METHODOLOGY

- Analytical process developed from earlier TCSM used in CAFE analysis

- Four step process
  - Start from baseline of vehicle price, fuel economy and technology
  - Estimate technological changes likely at the market class level, and resultant fuel economy assuming constant performance
  - Estimate change in performance based on econometric demand equations and resultant fuel economy
  - Estimate the size class mix based on an econometric demand model

TECHNOLOGY ADOPTION METHODOLOGY

- The adoption criteria in EEA's model for any technology, T, in any class, i^*, depends on
  - the technology being available
  - it not be superseded by any other technology
  - the year when it is first introduced in the marketplace
  - its cost-effectiveness

- Year of first availability is determined by EEA based on current tooling plans, R&D efforts, and expert opinion of manufacturers for post-2000 technologies

- The technology need <u>not</u> be introduced in the first year available if it is not cost-effective

- Tooling constraints limit how fast a technology can penetrate all models in the particular class. Hence, a maximum market penetration (P_{max}) is set as a function of time from year of first introduction, not first availability

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* This discussion is correct only for an industry-wide forecast.

become available and also that certain technologies supersede other technologies. In effect, there are technologies that come in and then go out as newer technologies come onstream and these become outdated.

A key element of how far it can go is cost effectiveness. We also look very specifically at how fast manufacturers can introduce technologies. There is a limitation to prevent, for example, all cars changing over three years to some radical new technology, in the sense there is a tooling constraint built in that determines the rate of how fast new models are introduced.

The key element of this is what we are calling the cost effectiveness algorithm, which essentially determines, if industry is going to introduce a technology, is it going to be sold, and there is a decision element here that essentially depends on a variety of factors. Fuel price is just one of them.

Historically, we have been looking at fuel price being the only driver that would be recognized during the last few years. That is not true. It is a component, obviously. Fuel prices go up, manufacturers do introduce more technology.

But then there are other factors, too. For example, value of performance. Now many of you who are car enthusiasts know that four valve engines, for example, have recently become very popular. The fact is, they make a lot of horsepower.

There is a consumer valuation of having a little badge on the side of his car that says four valve or high output engine, or something like that. So that there is clearly some incentive above and beyond a fuel saving aspect for the manufacturer to introduce technology. We actually explicitly try and value performance.

There is also a regulatory value. That is, manufacturers may introduce technologies due to the fact that they have to meet the CAFE regulations. So it may not be completely cost effective at the margin but they may sell, well, we have to exceed a certain standard. And so to meet that, there is a regulatory value. All of these are factored in by the technology incremental price, which is adding a technology onto a car increases the price by some factor.

The ways we have evaluated these various factors are documented and will appear in the complete model documentation. Essentially the value of performance is something that is the newest factor in this and is sort of the potential value, if you will. That is, if the manufacturer introduces a four valve and takes all the benefits as horsepower, then what is the value likely to be.

The way we measured this is by looking at actual prices of cars with four valve engines or high output engines, or different types of engines, and what people are charging for them and how much consumers are willing to pay.

It assumed that there is an implicit balance between supply and demand in this case, which is obviously true, and that the prices really reflect the real world transaction cost of what people are willing to pay for performance.

COST EFFECTIVENESS

- Cost effectiveness as defined by EEA is determined by
  - net present value of fuel saved (FS)
  - value of performance (P)
  - regulatory value (R)
  - technology incremental price (C)

- Net present value of fuel saved is simply the discounted cash flow over a fixed period of time associated with fuel savings due to technology adoption

- Value of performance is the potential value to the manufacturer in dollars per HP, for those technologies that can be used to increase HP

- Regulatory value is the avoided cost of fines associated with not meeting CAFE standards (set to zero in RCG forecast)

- Cost Effectiveness = $\frac{FS + P + R}{C} - 1$

  If it is zero, its value to the manufacturer exactly balances sales price

In a very simple way you can think of the cost effectiveness as being the value of fuel saved, the performance value, and the regulatory value, divided by the technology incremental price.

So in effect, if those two balance -- and you subtract one from that, so that if everything is in balance, if a technology is completely neutral, then in fact the cost effectiveness is zero. In other words, the benefits that the consumer receives from the technology exactly balances what he has to pay up front to get the technology.

Many models used need to have all or nothing decision rules. So if a technology was cost effective, we used to go out and say, if it is cost effective, everyone adopts it.

But that is really not true, because there is a range of consumers out there who have different discount rates and expectations of fuel prices, or what they are willing to pay for performance. At the same time there is a range of manufacturers out there who want to appeal to different segments of the market.

You have manufacturers like Hyundai, for example, who target the low end market and may introduce less technology than what might be determined through a cost effectiveness analysis. Then you have others on the extreme ends, like Mercedes, who essentially have consumers who are willing to pay the price.

The idea is that there is a distribution of consumers and manufacturers, which leads to technologies, even if they are not cost effective, being introduced in some cars. So you can see that, you know, very advanced cost ineffective technologies, like aluminum bodies, you can actually buy them in the market today in the Acura NSX. But since it cost $60,000, there are not a lot of people who buy those cars.

In essence, for some technologies market penetration occurs regardless of cost effectiveness. The way we model that is through essentially an exponential curve which says that even if it is very cost ineffective, there is some small market penetration; if it is very cost effective, the market penetration goes up to almost 100 percent.

In any particular year, obviously the market penetration of a technology is governed by various factors, including the tooling constraint, the cost effectiveness constraint, and then the fact that certain cars can't have certain technologies because they don't really go together.

So that in a sense the other two aspects of the model, which are the size class and performance demand models, are actually just simple econometric models.

To be honest, the size class model is not a very good one. And the reason for that is that the econometric models have performed very poorly in predicting size class demand. Historically, they have failed to anticipate a large number of trends in terms of how people are buying cars. And there is a lot of dispute as to whether in fact there are time trends or whether certain groups of consumers actually prefer small or large cars regardless of fuel price. So that aspect of the model is perhaps the weakest aspect.

MARKET PENETRATION DETERMINATION IN EEA MODEL

- Technology market penetration is based on
  - maximum penetration possible due to technological constraints (M_{max}). For example, technology improvements to automatic transmissions do not apply to the fraction of vehicles with manual transmissions
  - production and tooling constraint limits (P_{max})
  - cost effectiveness

- Cost effectiveness based market penetration recognizes that not all consumers and manufacturers have the same discount rates and fuel price expectations. Hence a cost effectiveness based market penetration is given by

  $$M_{CE} = \frac{1}{1 + e^{-2CE}}$$

  This is equal to ~100% for very cost effective technology and about ~0% for cost-ineffective technology

- Actual market penetration in any year is given by

  $$M = M_{max} * P_{max} * M_{CE}$$

- Older technologies can be superseded by newer technologies so that market penetration may be lower than calculated value

POTENTIAL AREAS
NEEDING FURTHER IMPROVEMENT

- Light-Duty Vehicles
  - size class demand model
  - incorporation of other regulatory options (e.g., gas guzzler tax, feebates)
  - improved light truck representation

- Alternative Fuels Vehicle Model
  - consistency with gasoline vehicle model
  - vehicle attributes and pricing
  - better class resolution
  - modeling of competition effects

- Freight Model
  - inadequate representation of heavy-duty truck technology
  - lack of commodity detail
  - lack of competitive effects with rail/air

- Better coordination between sub-models

The performance by class size model is also being developed with fairly limited data. And again, here is a question about whether in fact if fuel prices continue to stay low and incomes go up, will people buy more and more performance, or is there some limit to how much performance people will buy. I thought there was but I have been proved wrong often enough to know that that is probably not true. And so in a sense, the model is fairly unconstrained.

If you have a scenario where fuel prices are very low, incomes increase rapidly over the next decade, you can wind up with cars, with average cars performance increasing another 20 or 30 percent. Whether that is true or not is hard to say, because you are already starting from such a high base. But in fact those things can happen and are technologically feasible.

Let me just briefly talk about the areas where we might need further improvement. And this is by way of some critique.

Clearly an improved size class demand model, and that is in the works -- we are looking at various aspects of demand modeling and improving the logit model. We are using a different kind of logit model that seems to do better, although, again, its ability to predict far out in the future can be questioned.

Right now, as I mentioned, only CAFE is modeled. However, while we do differentiate between domestic and import we do not differentiate by manufacturer. The fact is that CAFE applies to each manufacturer and you don't have manufacturer representation.

So in a sort of broad sense we account for CAFE. If the manufacturers fail to meet CAFE, there are values placed on meeting the regulation, more technologies are introduced. But it doesn't really quite capture it from a policy perspective.

There are a host of other regulatory options that are being discussed right now. One of them is obviously on the books today, the gas guzzler tax, which it doesn't actually capture because we are looking at average cars instead of individual cars.

But there are other things like feebates, which are fees for cars that don't meet a particular fuel economy level, and rebates for cars that do meet them, that those are not yet in the domain that can be modeled at this particular version of the model.

Light trucks are also not very well represented because, again, some of the trends in light trucks are quite recent. An example is the boom in the sports utility vehicle sales. That is difficult to capture and not clear how long that trend will continue.

Other areas that we -- I know one particular area that Margaret Singh is going to talk about extensively is the alternative fuels vehicle model. Here our biggest criticism is that it is done completely separately from the forecast of the gasoline model. In fact, there is a lot of interaction in this particular arena. And exactly how you would cause these interactions to occur and what specific trade-offs you make I think are quite important.

For example, it is clear that electric vehicles are going to be relatively small, urban commuter type vehicles. And so the impact on size class is far more than others. And yet you could think of a situation where supposing you do have a 100 mpg tiny conventional, small urban car. The attractiveness of the electric vehicle is clearly diminished substantially by the presence of this particular vehicle.

There are also other further ideas that are quite difficult to capture. People talk about electric vehicles being suitable for the urban commuter but then that is the same person that mass transit is also going after. So in effect, if you expand mass transit, what does that do to the electric vehicle market.

Those are all more difficult questions. But even the first order interactions I think have not been taken into account, at least in this version. And that is something that I think would be a good idea to do.

And then the competition between alternative fuels vehicles is not fully assessed yet. But that is something that Margaret will discuss.

In the freight model right now, I think that the heavy duty truck technology representations are quite simplistic relative to how much sophistication there is in the light duty model. And perhaps that is an area where future improvements could occur.

And again, there is this whole issue of the competition with rail and air and the intermodal competition, facts that I think again are not being quite captured in the current model.

And lastly, I think the coordination between submodels could perhaps improve in the next phase of the design, simply because that first phase-in model, a lot of different people working on different things without complete knowledge of how various pieces interact.

I think these are areas that, if EIA focuses on, they could have a very good model indeed.

Thank you.

MR. COHEN: Thank you.

Our next speaker will be Margaret Singh, to fill us in on alternative fuel use issues.

MS. SINGH: The focus of my comments, as Barry has said, is on the alternative fuel use methodology used in NEMS, in the NEMS transportation model. And basically it is because that is where I have been concentrating my work on in the last few years. So I have a better appreciation for that portion of the model than the rest.

I do want to make one comment. Barry said that I had helped develop a seminal piece of information on fleet and alternative fuel use in fleets. I hope it is not the seminal piece because there is just a tremendous lack of information on fleet use and garaging and refueling characteristics.

Review of NEMS Transportation Demand Model

by

Margaret K. Singh
Argonne National Laboratory
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February 2, 1993

Focus of comments

- Alternative fuel use methodology used in NEMS transportation model (TERF).
- Reason: My work recently has concentrated on alternative transportation fuels.
- Comments are more from the perspective of a potential user of NEMS than a modeler.

The projections that we made were based on just a lot of assumptions and there is more information needed before one would get the seminal report.

Also, my comments really are given more from the perspective of being a potential user of NEMS than a modeler.

This is a general comment. I looked at the model and then I read all the reviews, or many of the reviews that had been sent in to EIA. And I just want to point out that the overwhelming conclusion of the reviewers of this model is that the approach is sound, it is pragmatic, it is on the right track, it reflects an understanding of the U.S. transportation system and how it uses energy, and it is very positive.

So any comments I make on the alternative fuel use section of the model really are only offered in the attempt to try to help make a good model better. And there are a couple of words in here I might rephrase at some point in time.

Basically, I have about six to seven concerns with the alternative fuel components of the model. And I want to go over each one.

One is the use of what David says is a three stage approach. I call it the two stage approach to forecast alternative fuel vehicles.

Another is the projections of alternative fuel use by fleet light duty trucks; third is the movement of fleet vehicles into the household market; fourth is the alternative fuels I think are missing in a bus submodule; fifth is a need to include the alternative fuel provisions of EPACT, the Energy Policy Act, into the current policy variables in the baseline; and the sixth is the electric vehicle emissions.

As David said, there is a three stage approach to forecast alternative fuel vehicles. I am going to focus on the first two stages that he reviewed.

Basically, the alternative fuel vehicle module uses a two stage approach to project alternative fuel vehicle market penetration. The first stage compares conventional vehicles versus -- conventional gasoline technology versus a single representative alternative fuel technology. And then in the second stage the individual alternative fuel vehicles are compared against one another, and there are 16 of them, or 15, but within a total use estimate that is developed in the first stage. And then the third stages goes on to disaggregate even further.

I have problems with this approach, and I think there were a number of other reviewers also that had problems with this use of one generic alternative fuel vehicle type to project total alternative fuel use in that first stage. It wouldn't appear to be very meaningful. As a user, I would be uncomfortable knowing that the results of the model were based on this approach.

I just find it difficult to imagine combing the characteristics of -- as somebody else said, a flex fuel methanol vehicle with an urban commuter electric car into one alternative fuel vehicle type, which then you compare against the conventional vehicle and come up with total alternative fuel use.

One general comment

- The overwhelming conclusion of reviewers of TERF is that:

    * The overall approach is sound.

    * The model reflects an understanding of the U.S. transportation system and how it uses energy.

- Any comments/criticisms of the model which I make are only offered to help make a good model better.

Concerns with AFV components of the model

- Use of 2-stage approach to forecast AFVs
- Projections of alternative fuel use by fleet LDTs
- Movement of fleet vehicles into household market
- Alternative fuels missing in bus submodule
- Need to include EPACT in current policy variables
- EV emissions

Use of 2-stage approach to forecast AFVs

- AFV module uses a two-stage approach to project AFV market penetration.

  * First stage compares conventional gasoline technology vs. a single representative alternative fuel technology.

  * Second stage compares AFVs vs. one another (15), but within total use estimate of first stage.

- Use of one generic AFV type to project total alternative fuel use would not appear to be very meaningful.

Use of 2-stage approach to forecast AFVs (cont)

- Alternative approach should be considered.

  * Independent expert reviewer suggested use of nested logit model

    or

  * Some additional disaggregation in the first stage

I think some alternative approaches need to be considered. The independent expert reviewer, who is David Greene of Oak Ridge, suggested use of a nested logit model. I am not expert enough to know how much more time that would take you to run the model with his suggestion. But I would request that you consider that, or alternatively, at least some additional disaggregation in the first stage.

You can disaggregate the alternative fuel vehicles into all gaseous fuels, all alcohol fuels, and electrics, and compare these against conventional vehicles, or dedicated vehicles versus flexible fuel vehicles and dual fuel vehicles versus conventional.

But I think that the model does need some additional disaggregation.

In terms of the projections of alternative fuel use by fleet light duty trucks, it was confusing to me and it was apparent that it was confusing to a number of other reviewers as to how the alternative fuel use in commercial light duty trucks is projected.

Total alternative fuel use by light duty trucks is projected in the alternative fuel vehicle shares module. Then commercial light duty truck alternative fuel use is projected in the freight model. It may simply be a matter of the way the report is written. But there appears to be an overlap.

In the alternative fuel vehicle shares module, the light duty trucks can use any one of 15 fuels. In the freight model, the commercial light duty trucks can only use three fuels. It needs to be clearly explained how these components are linked.

You obviously want to avoid duplication. I in particular would like to see that additional fuels are considered for use by commercial light duty trucks -- I guess you have methanol, ethanol and CNG in that section of the model. You need to add electricity. I mean, they need to be able to pick from the full slate of alternative fuels.

This is, okay, movement of the fleet vehicles into the household market. The movement of fleet vehicles into the household market may not be as adequately represented as needed for alternative fuel use projections. Here I am really relying on the reviews of others who are better able than I to see how this movement is modeled in the model. But they were concerned that this movement may not be what you really want.

The model clearly assumes movement of all fleet vehicles after four years to the household market. But as even the reviewers pointed out, many fleet vehicles are kept by fleets essentially for the life of the vehicles.

Leased and rental vehicles move into the household sector after one to two years. And the transfer of fleet light trucks is not like that of fleet cars.

Alternative fuel vehicle use is going to penetrate those different components of the fleet market differently.

Basically, what one reviewer pointed out was that the fleet vehicles most likely to be

Projections of alternative fuel use by fleet LDTs

- The model is confusing regarding the projection of alternative fuel use in commercial LDTs.

    * Total alternative fuel use by LDTs is projected in AFV shares module. Commercial LDT alternative fuel use is projected in freight model.

    * In AFV shares module, LDTs can use one of 15 fuels. In freight model, commercial LDTS can only use 3 fuels.

- How are these components linked?

Movement of fleet vehicles into household market

- The movement of fleet vehicles into the household market may not be as adequately represented as needed for alternative fuel use projections.

- The model assumes movement of all fleet vehicles after 4 years.

  * Many fleet vehicles are kept by fleets essentially for the life of the vehicles.

  * Leased and rental vehicles move into the household sector after 1-2 years.

  * The transfer of fleet light trucks is not like fleet cars.

Movement of fleet vehicles into household market (cont.)

- Alternative fuel use is likely to penetrate different fleet types at different rates.

  * The fleet vehicles most likely to be AFVs are those least likely to enter the household market.

- This is an important issue for the transition to alternative fuel use.

  * DOE/others need to have as accurate a representation of the potential for fleet turnover to the household market as possible.

alternative fuel vehicles are those least likely to enter the household market. Or alternatively, the fleet vehicles that are most likely to enter the household market are the leased and rental vehicles. They are the ones that are least likely to be alternative fuel vehicles. They are not required to use alternative fuel under the Energy Policy Act.

The Energy Policy Act is really focused on fleets of vehicles that are light trucks, not cars. And I think that what you need to do -- I guess what I am really trying to say is that this is an important issue for transition to alternative fuel use. You need some additional disaggregation of the fleet market in order to follow how the alternative fuel use in those fleet vehicles will go into the household sector.

I think at least one reviewer said this, that alternative fuel use is missing in the bus submodule. I wasn't sure after listening to David earlier whether it has been included or not.

Alternative fuels for truck freight are clearly in there. You need to have the potential for alternative fuel use in buses, school buses and transit buses, in the model because alternative fuels are already being used by school buses. The Energy Policy Act may in fact require the use of alternative fuels in the transit buses.

This is probably obvious and I won't spend much time on it. I read the June 1992 component design report and you only considered the Clean Air Act of 1990 and the California LEV program in terms of current policy variables.

If you haven't already, and I think it is obvious to you, you need to include the effects of the Energy Policy Act amongst your current policy variables. There are mandates for alternative fuel use in it.

In terms of electric vehicle emissions, I have been working on a study with EPRI of electric vehicle emissions. And maybe that is why I am particularly sensitive to this particular issue.

One of the variables used in the alternative fuel vehicle shares module to forecast alternative fuel use is the vehicle emissions level. The EVs are assumed to have zero emissions. The emissions from the power plants are not included at all. They are not even assigned emissions for CO_2, which is simply not correct.

For all other vehicles, projected emission levels are used. I believe that all the alternative fuel vehicles should be treated in the same manner. You either use projected emission levels for all, including putting the power plant related emissions on a per mile basis -- and there are studies that you could look at and get a range of estimates for the electric vehicles. Or you use emission standards like the zero emissions standard for all the vehicles, and you use the California LEV program or Phase 2, and you assess the cost for each fuel type of achieving those standards. I think that is an important addition to the model.

What I just talked about as far as EV emissions is kind of the input. Here I am talking about the output related to electric vehicle emissions.

Alternative fuels missing in bus submodule

- Alternative fuels for truck freight are included in the model. However, they are not included in the bus submodules and should be.

    * Alternative fuels are already being used in school buses and use in transit buses is being demonstrated.

    * Under EPACT, transit buses may be required to use alternative fuels.

Need to include EPACT in current policy variables

- TERF accounts for current AFV policies.

  * June 1992 Component Design Report only considered CAAA of 1990 and California's LEV program.

- Must add in EPACT.

  * Contains a variety of alternative fuel use requirements.

- This must already be obvious to the modelers.

EV emissions: Assumptions in AFV shares module

- One of the variables used in the AFV shares module to forecast AFV use is vehicle emissions levels.

  * EVs are assumed to have zero emissions; the emissions from the power plants are not included.

  * For all other vehicles, projected emissions levels are used.

- All AFVs should be treated in same manner.

  * Use projected emission levels for all, including power plant-related emissions on a per mile basis.
    or
  * Use emission standards for all vehicles.
    - Assess cost of achieving the standards.

EV emissions: Projections from NEMS

- TERF includes an emissions model to project vehicle emissions, except EVs. Emissions from power plants will be handled in the NEMS electricity model.

- Will a report on transportation sector emissions be able to provide an estimate of the emissions from electricity generation <u>specifically</u> associated with EVs?

    * If not, it will be incomplete.

    * If specific estimates are provided, state whether based on average or marginal power plant.

I know that there is this emissions model in TERF where you project vehicle emissions except for electric vehicles, if I am not mistaken. The emissions from the power plants which would provide the electricity for the electric vehicles will be handled in a NEMS electricity model.

So my concern is, when it comes time to write a report on the transportation sector and the emissions from the transportation projections, will you be able to provide an estimate of the emissions from electricity generation specifically associated with electric vehicles?

If you don't, the report is not complete. And if you do, if you do provide those estimates, I think it is important to state whether they are based on the average or the marginal power plant. And I will let you work out that issue of which it is.

Basically, as best I can tell and from the reviewers' comments, it is a good model overall. I just think that there are some refinements in that alternative fuel vehicle module and related sections that are desirable.

Thank you.

MR. COHEN: Our next speaker is John DeCicco.

MR. DeCICCO: The presentations by Margaret and Duleep were very helpful to me and I just want to thank them and also suggest that to the extent that, you know, some of this information, particularly which Duleep provided, should go at that level of detail into the NEMS documentation.

Generally, I would like to commend EIA for their efforts in maintaining and developing this indepth model of U.S. transportation energy use.

EIA's earlier versions of the transportation modules have been most valuable to us in our own energy policy analysis work. We used a version of the system developed for the national energy strategy as the basis for our own transportation sector modeling, when we prepared the America's Energy Choices Report.

Today I want to focus on a few areas, in some cases to suggest where new development efforts are needed, in order to emphasize the need to give priority to carrying out refinements that do seem to be reflected in the new design.

One way in which the design has been strengthened is through the provision of an accounting frameworking by which changes in mode shares and load factors can be treated. I would encourage EIA to fully implement and exercise the mode shifting capabilities.

The plans seem to call for a post hoc specification of mode shifts by means of exogenous inputs. Such an approach is reasonable, as the determination of long term policy driven shifts cannot be realistically modeled in aggregate.

What I am talking about here is not, say, shifts among various vehicle types but shifts

Summary

- Appears to be a good model overall.
- Some refinement in the AFV module and related sections is desirable.

among people who are using, say, transit versus cars or trucking versus rail.

The modeling specifications by which this is to be accomplished need to be spelled out in more detail. It would be helpful, for example, to think about and show how results drawn from regional transportation planning models might be used to set inputs for the mode share and system efficiency components of NEMS.

The incorporation of such mode shifting capability is an important first step. In a future phase of model development, EIA should research and develop ways to accommodate more profound shifts in the structure of transportation demand, as might be seen through major changes in land use.

This is a current area of research for the transportation planning modeling community. So it is, of course, premature to incorporate such developments into NEMS today. However, EIA should engage in dialogue with transportation modelers in order to start defining ways to link regional transportation demand results into the national modeling system.

In particular, current efforts by transportation modelers are greatly motivated by emissions concerns, under the realization that such changes in the structure of transportation could potentially have a large impact on air quality. A significant impact on energy use would also be anticipated.

Generally, mobile source emissions of criteria pollutants are much more sensitive to land use related factors, such as congestion and the number of trips, rather than, say, average trip length and aggregate VMT, than are energy use and CO_2 emissions. However, these are sensitive also.

But most importantly, to the extent that projections of criteria pollutant emissions will be important outputs, careful attention to these structural factors is crucial.

Much effort has gone into detailing various alternative fuel vehicle possibilities. Margaret is better equipped to comment on that, and I defer to all her comments in that area.

I do want to pick up on one thing that Duleep mentioned. Namely, watch out for maintaining technological consistency among alternative fuel vehicles and conventional vehicles.

Alternative fuel vehicles will begin to have a big impact when they move beyond niche markets. Common sense dictates that when this happens, expectations as well as economies of production will enforce a significant degree of technological commonality among all vehicles, even if they are powered by different fuels.

The implication is that there are likely to be linkages among vehicle types at the level of underlying vehicle-end use energy intensity, such as tractive energy requirements in Btu's per mile, as well as with respect to key driveability and performance characteristics.

I think electric vehicles are a good case in point. You know, if we consider, say, three key vehicle attributes size, acceleration -- performance and range, with a conventional vehicle you can get all three of these attributes at a certain level. With a plug-in electric vehicle, chances are you may only be able to get one or two of those at a comparable level.

Modeling that enables the choice of, say, 50,000 of these vehicles under a subsidized introduction program may not be credible in the longer run if we are looking at, say, the one million vehicle level, unless there is significant conformity of attributes among all vehicle types in each market segment.

So this, you know, draws one into the issue of how to treat potentially dramatic changes in so-called conventional vehicle energy use and emissions characteristics. I would say consider here the example of power-assisted electric hybrids, a vehicle with an electric drive train that you never plug in but which can possibly also run on a variety of fuels. Is this a conventional vehicle of much higher efficiency? Or is it an alternative fuel vehicle, and then of which type?

Realistically, such configurations need to be considered, even though much less analysis has been done to date relative to other alternative fuel designs.

I think the NEMS transportation work, you know, right now bears the burden of building on a number of years of alternative fuel vehicle modeling efforts which, for various reasons, have not been fully consistent with conventional vehicle technology. This is an area that generally needs better background research as well as database development.

And I don't see structural limitations in the model in this respect. Rather, there is a need to pay better attention to the database from which key model inputs and vehicle attributes will be drawn.

Because the NEMS effort forces EIA to provide a rational, self-consistent treatment of options, it may well be that EIA will have to take the lead role in enforcing consistency on DOE's analytic efforts in other vehicle and fuel related research programs on which EIA depends.

Another area where additional refinement is generally needed is the freight sector. For example, the growth in overnight and other priority services has resulted in rapid growth in the most energy intensive freight modes, air and truck.

On the other hand, congestion and other economic factors have resulted in countervailing forces, such as greater system efficiencies, growth in intermodal shipping, and the potential substitution of electronic communications.

What is being moved is changing as rapidly as how and where it is being moved. And freight is clearly one area where the ability to model transportation demand is severely limited by the available data.

EIA should work closely with its own survey people and those in the Departments of Commerce and Transportation to continually refine the understanding of trends in freight transportation.

Over the past decade data gathering work has not kept pace with needs. And EIA should urge a restoration and a coordinated expansion of the efforts in all relevant agencies that are needed to develop a better database for modeling freight transportation demand.

Nevertheless, even now there are some greater flexibilities that could be built into the NEMS transportation modeling modules.

I think the vectors which drive demand for freight services should be recast so that they are in a common dimension for all modes, for example, ton miles per year.

The current system treats freight trucks differently than, say, rail or water by modeling truck VMT directly as a function of output by industrial sector. This makes it awkward to consider mode shifting and intermodal transport.

The Argonne model does provide at least base year information at the ton mile activity level. And when we did our work, we were able to draw on that to develop our freight sector model, which could then reallocate freight activity by mode according to different mode share and load factor assumptions.

EIA should consider such refinements in their near-term model development work, which will make analytic exploration of options less awkward than in the current design.

EIA should also closely examine trends in material intensity of various industries.

I have not reviewed the industrial components of NEMS. But this is an area which we had re-examined when doing our own study two years ago.

Clearly, a shift in the pattern of underlying economic activity will impact freight energy demand in a significant way.

Then finally, there is a need to carefully treat what is perhaps the largest factor in determining the modeling result, namely the technology base changes in energy intensity of all modes.

The design report suggests to me that there is an adequate structure for handling any types of change that are foreseen. However, the more important and interesting aspects of the work were not in the design document I saw. But I did get a lot of that information by listening to Duleep today and have been aware of that work.

So I don't think I really need add any more on that except that I would encourage EIA to fully document these technology choice procedures and also generally to have, you know, a coordinated effort to get this information out and review it.

It appears from the work that I have seen Duleep doing, that it is a significant and much needed refinement of, say, the versions that went into the national energy strategy. But I guess the proof of the pudding is in the tasting and it will be good to see how these turn out, because for some of these trends we are sort of drawing on not a lot of years of data. And although we have, say, refined the models, I think we need to look carefully at how well they work. And I would like to see results before I can, say, give further suggestions on that area.

In summary, it has been a pleasure to review the new NEMS transportation design and to see the many updates and improvements that I am sure will yield a much stronger and flexible system.

I think EIA has made great progress in this area since my last look at the system a couple of years ago. Keep up the good work. Your efforts have been valuable in the past and are most important as we proceed with an ongoing process of forming and reforming U.S. energy policy. And we will continue to offer our assistance in any way we can.

Thank you.

MR. COHEN: I would like to take some questions now, if I may.

Just as a point of information, before the model is actually used to produce forecasts, EIA's own internal quality assurance criteria demand that we do fully document each and every one of our assumptions. So in addition to the rather lengthy component design report, ultimately there will be documentation reports four or five times at thick. But that is a very good point.

Yes?

MR. SANTINI: Dan Santini, Argonne National Laboratories.

One point for the near term functioning of the models or transportation model is that market niches for alternative fleet fuel vehicles are going to be critical, although John's point about the long term convergence is certainly reasonable for a 2030 to 2050 or 2040 time frame.

I want to compliment EIA for working to add performance. My understanding is the previous models didn't include performance. And it is a very useful addition to the modeling effort.

Duleep made the point that the current configuration leads to a continuing increase in value of increase in performance. There is a model that we use, the Lave/Train model. And to the best of my knowledge, it is the only one where somebody tried a squared term in the equation on the performance equation. And the result is that there is an estimate that the demand for performance is nonlinear.

And what happens is that the more elderly populations actually show a disbenefit for performance when you have the linear term and a squared term combined.

I think you are probably aware of -- David may be aware of that. We have shown some of the graphs on it.

And when we run our model with electric vehicles and alcohol fueled vehicles with the characterization that the electric vehicles are poor performance vehicles but other positive attributes, and the alcohol vehicles have slightly better performance than the gasoline equivalents, we end up with alcohol vehicles in the younger population and the electric vehicles in the older population.

And I don't think it is coincidental that a lot of the anecdotal stuff you will hear about electric vehicles, golf carts, being implemented outside of urban areas for air quality reasons is in retirement communities.

Another point I would like to make, Duleep was talking about the electric vehicle and whether it can compete with the gasoline vehicle, very good points. Even though the gasoline vehicle can achieve much higher fuel economy, if it behaves like an electric, it won't be able to achieve some of the other attributes, including emissions reduction.

Nevertheless, with regard to his comments, what has happened recently is that the manufacturer, GM, that was emphasizing the electric vehicle as a commuter vehicle, is starting to have second thoughts. And the ones that emphasize the electric in the fleets with much more intensive use and therefore greater emission savings -- that is Ford with the Ecostar and Chrysler with a van -- are continuing to do so. The market niches are evolving.

MR. COHEN: I would just say I agree with everything you said. Forecasting alternative fueled vehicle use, no matter what we do, is probably going to be the most uncertain thing in the model, which is why we break it up into three separate components, more to give the user the potential to override the endogenous model results.

Based on regulations, based on your own off-line analysis, your own modeling efforts, you may have a fine idea of what the mix of electric vehicles will be relative to alcohol vehicles. The model will be designed to implement whatever mix you want to input rather easily.

MR. FULTON: Lou Fulton, DOE Policy Office.

Dave, you mentioned that the TERF modeling team does face some constraints in terms of the run time and the data size of the model in relation to the whole NEMS system. And it was pointed out by -- some of the comments of the reviewers indicated that increases in the disaggregation of some components, especially outside of the light duty vehicle area where you already have a lot of disaggregation, would be desirable.

I am just wondering to what extent you will be constrained in some of these other sectors in the future or whether there will be opportunities to get at that, or whether you would have to reduce the levels of disaggregation in some of these light duty areas in order to do that.

MR. COHEN: I think in general our approach is going to be to develop detailed analysis off-line and incorporate them within a reduced form in the main model, as a general approach.

To the extent we can incorporate, say, a shopping cart approach to technologies in the freight truck side, we might do that. But that may just be beyond the capabilities of the run time constraints. We don't know yet, frankly.

MR. BERNOW: I have a specific question following up on the observation about the EV's and electric power plants. And that is, my understanding of the integrated model is that electricity demand would ultimately be sent to the dispatch model.

MR. COHEN: That is correct.

MR. BERNOW: And I assume this would, as well. Notwithstanding that, I suspect that the amount of electricity demanded by EV's in the transportation model would likely be too small to have any effect, marginal or otherwise, on the way the dispatch model would dispatch. And therefore, I think the suggestion is wise that reporting from the transportation model should permit a finer level of analysis, or at least input assumption, than might occur to the integration. Just a suggestion, because I think the effect could get lost in the wash.

MR. COHEN: It raises a lot of questions about how will the electricity be generated to provide electricity for those vehicles, whether there are coal plants or nuclear plants supplying the electricity.

MR. BERNOW: I agree. But because it raises those questions, I suspect it would be best to answer them out loud and explicitly, rather than hoping that the model, through its vast integration, will be able to track something as small as this.

MR. SANTINI: I don't see any other hands, so along those lines on the potentially -- say on the alcohol fuel side, if alcohol fuels are more competitive in the light duty vehicle market as a gasoline substitute than in the heavy duty market, are you working with the refinery people to look at the chancc in balance between the product demands and so forth? I mean, that is going to be an automatic part of NEMS. But are you already worrying about that with the refinery peop'e, considering the flows back and forth so you will have the links there in the price mechanisms?

MR. COHEN: Those issues have been addressed in the interfaces of the various models, yes.

UNIDENTIFIED AUDIENCE MEMBER: I understand you have not included heavy duty vehicles into the transportation sector for alternative fuel vehicles. Is that true?

MR. COHEN: We have heavy duty trucks, combination trucks.

UNIDENTIFIED AUDIENCE MEMBER: Buses?

MR. COHEN: Several varieties of buses, and several varieties of trains.

UNIDENTIFIED AUDIENCE MEMBER: Okay.

MR. COHEN: The question was, are there alternative fuel capabilities in the bus module.

UNIDENTIFIED AUDIENCE MEMBER: Right, correct.

MR. COHEN: Yes, there are. The shares are not being modeled endogenously. It is more of an exogenous assumption at this point. So one can vary over time the CNG input into school buses over time.

UNIDENTIFIED AUDIENCE MEMBER: You have used the Clean Air Act amendments and also the Energy Policy Act, I presume, into the modeling. How about the Executive Order 12759 for federal fleets? That requires all federal fleets to gradually to have their fleets converted to be run on alternative fuels.

MR. COHEN: Yes. I hate to sound like a Prego Spaghetti Sauce commercial, but it is in there.

UNIDENTIFIED AUDIENCE MEMBER: It is in there?

MR. COHEN: Yes, it is.

UNIDENTIFIED AUDIENCE MEMBER: Okay.

MR. COHEN: A detailed stock model has been added that just accounts for fleet vehicles in the model.

UNIDENTIFIED AUDIENCE MEMBER: The reason I asked is it was not mentioned in the discussion. But it is there?

MR. COHEN: Yes, it is.

UNIDENTIFIED AUDIENCE MEMBER: What about liquefied natural gas? It is not a sizeable segment at this point at all. But presumably, with companies like Cummins and others developing LNG engines and presumably many people are using LNG in the foreseeable future, is that a part of the model? I know CNG is, methanol is, ethanol is, EV is. But is LNG a part?

MR. COHEN: Yes, it is.

UNIDENTIFIED AUDIENCE MEMBER: It is?

MR. COHEN: LNG is included as a fuel type, within a standard internal combustion engine, yes.

UNIDENTIFIED AUDIENCE MEMBER: Okay. Thank you.

MR. BERNOW: Steve Bernow. Notwithstanding David's father's admonition not to try everything, I think it is true of some of the things that John said. I would like to raise a few questions about the structure and also the behavioral relationships. These are thoughts that came to mind working with John and others on America's Energy Choices over the last couple of years.

As an ex or lapsed physicist, I like to think of things in terms of space, time and matter. And along each of those dimensions, a number of critical questions come up, at least for me, in the accounting structure and in the behavioral relationships.

Obviously, at least from my standpoint, it is very important to distinguish between PMT and VMT and to think of PMT -- if not PMT itself, but actual tasks and time allocation to tasks, as sort of the driving set of questions or activities.

On the physical side, issues of congestion or spatial organization which may differ very, very differently from one region to another or within regions between the kinds of tasks or urban and rural activities, are another set of relationships that seem to be very, very important, both for structuring and accounting system, again in the long run, but also for thinking through and maybe analyzing some of the behavioral relations.

Whether or not the infrastructure is in place, for example, may affect behavioral relations, and so on and so forth.

MR. COHEN: Absolutely.

MR. BERNOW: So obviously you can't try to do everything. But thinking ahead may be wise at this point.

MR. COHEN: Yes.

MR. LEIBY: Paul Leiby, Oak Ridge National Lab.

When you include the value for vehicle performance that is associated with the value for fuel octane -- and of course statistical studies show people are willing to pay substantially for higher octane fuel. This suggests that it would be interesting to examine the competition between alternative fuels and higher octane gasolines.

However, as I understand it, the petroleum market module has only a single grade of gasoline. Have you spoken with them about introducing premium gasoline and how that might interact with the behavior of your model?

MR. COHEN: To date we haven't. But it sounds like a good idea. Thank you.

MR. SANTINI: I was just going to piggyback on that point. David Gushee, Congressional Research Service, at Transportation Research Board meetings, suggested the hypothesis that reformulated gasolines might -- premium reformulated gasolines in the worst air quality areas might reach a price level that was so high that methanol could be competitive in performance oriented vehicles and that might be the initial market niche where it would develop.

So if he is right, this addition of the premium gasoline and the modeling of it could be very important potentially.

MR. COHEN: Yes, analyses such as these however, will most likely take place offline.

Another question?

MR. LITZ: Dave Litz, Department of Transportation.

You can't throw everything in there. I am wondering if there is any off-line capability or something that may be in the model in terms of some of the things that local governments are looking at, like congestion pricing and parking restrictions, emission taxes of various sorts, telecommuting, and also anything on any of the potentials of IVHS technologies.

MR. COHEN: Well, the framework is there. First of all, our regions are fairly large regions. They are Census divisions. So they typically encompass many states.

But if, for example, one wanted to assume that there were going to be increased HOV lanes in a certain region, that is a very simple input to the model that could be made by adjusting the load factor for cars.

If additional mass transit was going to be made in a specific area, it would be a straightforward assumption to move PMT, passenger miles traveled, out of cars, out of aircraft, into, say, fast trains or something like that.

So the framework is there to make exogenous inputs based on other analyses. It is not something that the model is going to do endogenously, however, based on the cost of developing a fast train system versus the cost of developing a more efficient aircraft system.

MR. DeCICCO: Among the parameters, do you include such things as average travel speed or average trip lengths as parameters?

MR. COHEN: No.

MR. DeCICCO: I guess in that regard, these are areas where the structure is not there to address some of the issues that will come up in trying to tie things with regional transportation modeling results, particularly in urban settings. These are like key parameters that regional transportation modelers look at and they are extremely important for emissions. That is a structural area to think about.

I also did have a simplifying suggestion, which may be welcome at this point, that came to mind. In terms of the light duty vehicles -- and you have expanded the capabilities there -- you might consider, say, by class or market segment, a linear decay approximation. I think, a linear decay approximation is probably as good as any of the data actually warrant and it would allow you to capture that by a variable representing the number of years before the thing croaks. And you can manipulate that. You know, you can make it croak earlier for scrappage.

But I think given the flux we have seen in vehicle lifetimes over the years, I am not sure that there really is greater certainty in the data to support anything more than linear decay.

MR. COHEN: Thanks. That is a good idea.

MR. CHIEN: Some people have mentioned average travel speed, congestion, and, say, possibly even the mix of the ratio of city to highway driving, and those kinds of factors that affect fuel economy and energy use.

We handle these factors to the extent we can quantify how they affect our on-the-road mileage factor. Our analysis here borrows heavily from some work that has been done by John Maples from Oak Ridge National Laboratory, through Phil Patterson, Department of Energy, in the Conservation Division.

MR. COHEN: So the fact that congestion increases will decrease the realized fuel economy from a new vehicle. Yes.

MR. NAIS: Tom Nais, DOE, Idaho Field Office.

My question was: how does the NEMS transportation model compare with the transportation sector of the national energy strategy model, which is the FOSSIL2?

MR. COHEN: It is much better.

Seriously, we work closely with the FOSSIL2 staff. They are working on a new model now. I think the acronym is IDEAS.

MR. NAIS: IDEAS, right.

MR. COHEN: In the past, they pretty much took the detailed results from our model and made their model behave like our model did. They didn't have a very detailed representation in Fossil 2 of the transportation sector. So we worked closely, at that time with Eric Peterson, in calibrating both models to produce fairly consistent answers.

MR. NAIS: Thank you.

MR. SANTINI: Dan Santini, Argonne National Labs, pretending to be Barry McNutt.

Barry is interested in re-reformulated gasoline, particularly maximizing the natural gas-based components of the gasoline. And it seems to me that it is something that could fall between the cracks if you didn't work with the refinery modelers. They need to consider the implications for natural gas prices and methanol prices.

So I would just suggest that you try to worry about it.

MR. COHEN: I think you are right. And you and Barry should continue to remind us of that. That is a very good point.

If there are no further questions, I appreciate your coming. Thank you very much.