Development and Update of Long-Term Energy and GHG Emission Macroeconomic Accounting Tool

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Project ID: VAN006

Project Overview

Timeline	Barriers
Start Date: October 2013 End Date: Project continuation and direction determined annually by DOE	• Constant advances in technology • Computational models, design, and simulation methodologies • Lack of quick analysis tools and lack of comprehensive historical database
Budget	**Partners**
Total Project Funding (DOE) • $230,000	Interactions • NAS, NPC, ACEEE, Universities, NESCAUM, and other users • National Renewable Energy Lab • TA Engineering, Inc. • Energy Information Administration (EIA)

Relevance: Tools Provide Energy and GHG Analysis by Vehicle Technology, Freight Mode and Fuel Types, Relevant to EERE Interests, Answers to Key Questions

- What are the long-term energy and GHG emissions impacts of alternative technological, regulatory, and policy scenarios for both highway and non-highway transportation?
- What are the long-term energy and GHG emissions impacts of increased alternative fuels (such as electricity, biofuels) and LNG use by highway vehicles and freight modes?
- How much upstream energy, in production of feedstock and fuel, is consumed under alternative scenarios?
- How much reduction in petroleum consumption and GHG emission would be achieved under an alternative scenario?

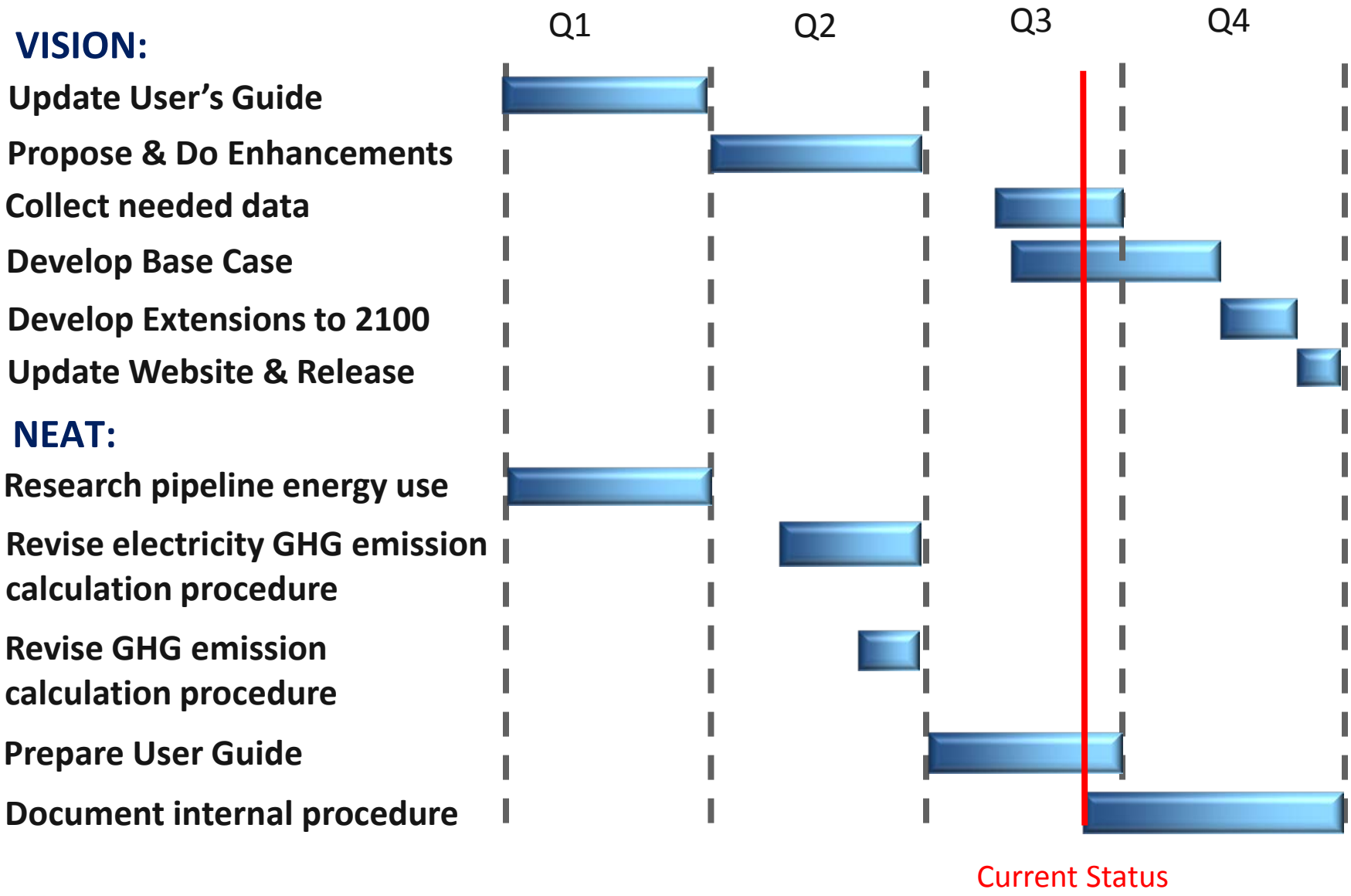
Objectives: Develop Transparent, and User Friendly Spreadsheet Models That Estimate Energy Demand and GHG Emissions

VISION	NEAT
1. Construct transparent, flexible, and user friendly analytical tools for evaluation of alternative scenarios:	
Highway vehicle technologies and fuels	Freight demand, mode shares, energy intensities, and fuels
2. Consider full fuel cycle energy use and GHG emissions rates	
3. Allow user to specify own scenario:	
Light and heavy duty highway vehicles	Commodity level freight movement, mode shares, modal energy intensities, and biofuel use
4. Provide a comparison of alternative scenario results with Base Case results	
5. Set analysis horizon:	
2100	2050

Objectives (Cont'd): VISION Focus on Highway Technologies while NEAT Focus on Freight Movements

VISION		NEAT	
Annual Energy Outlook Economic Factors Population	Input	Freight Analysis Framework Annual Energy Outlook	Input
Vehicle Survival Age Dependent Usage On-Road Fuel Economy	Incorporate	Mode Shares	Incorporate
Feedstock and Fuel Production Pathway	Accommodate	Feedstock and Fuel Production Pathway	Accommodate
Vehicle sales, stock, fuel economy, annual use, energy use and emission	Develop	Freight ton-miles, energy intensities, energy use and emission	Develop

Milestones



Note: Model update and release time is subject to data availability

VISION: Highway Vehicle Technologies Energy and GHG Emission Accounting Tool

Approach: Evaluate Highway Vehicle Technologies

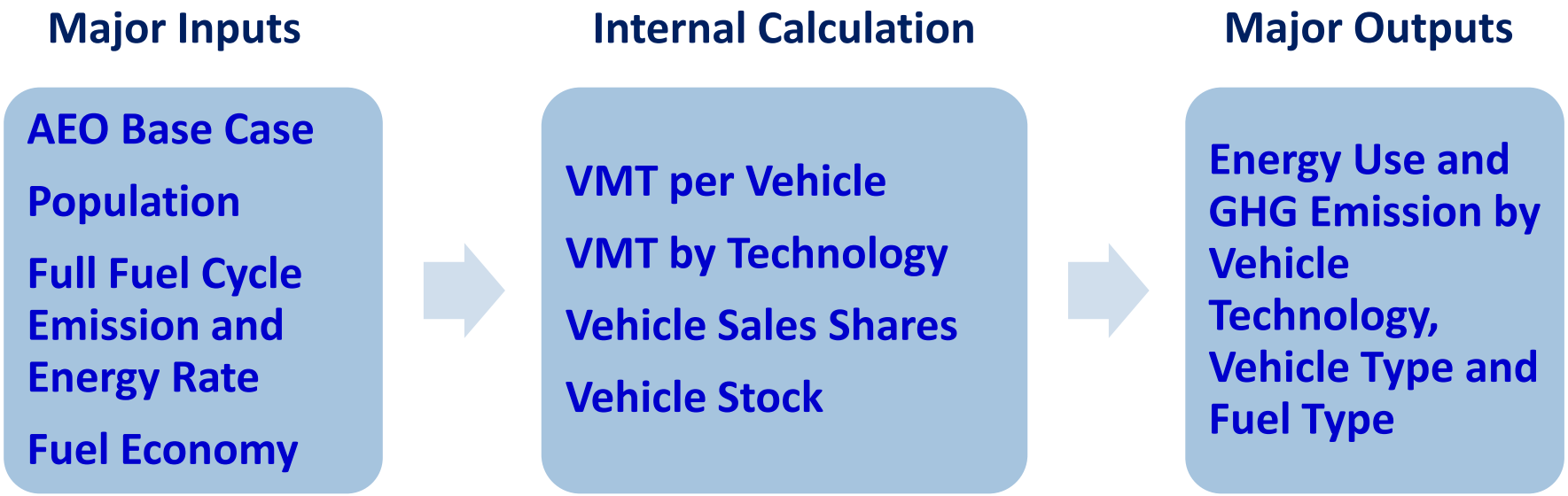
Vehicles	Technology & Fuel
 Cars	4 ICE (Gasoline, Diesel, Ethanol, CNG) 3 HEV (Gasoline, E85/H2, Dsl) 3 PHEV (2 Gasoline, 1 Diesel) 1 Electric Vehicle 1 Fuel Cell Vehicle
 Light Trucks	
 Class 3-6 Trucks	Gasoline ICE, Diesel ICE, CNG ICE, Diesel HEV
 Class 7&8 Single Unit Trucks	Gasoline & Diesel ICE, CNG ICE, Diesel HEV
 Class 7&8 Combination Trucks	Diesel ICE and LNG ICE

Feedstock/Pathways

- Crude oil (Gasoline, Diesel)
- Nature gas (FT diesel, NG)
- Soybeans (Bio-diesel)
- Corn, corn stover, switchgass, woody biomass, forest residue, sugarcane (Fuel ethanol)
- Coal, NG, Nuclear, Renewable (Electricity)
- NG, Coal, Biomass, Water (Electrolysis—low/high temp, Thermo-chem conversion) (Hydrogen*)

*Could be produced centrally and/or at station.

Approach: Create a Long Term Base Case

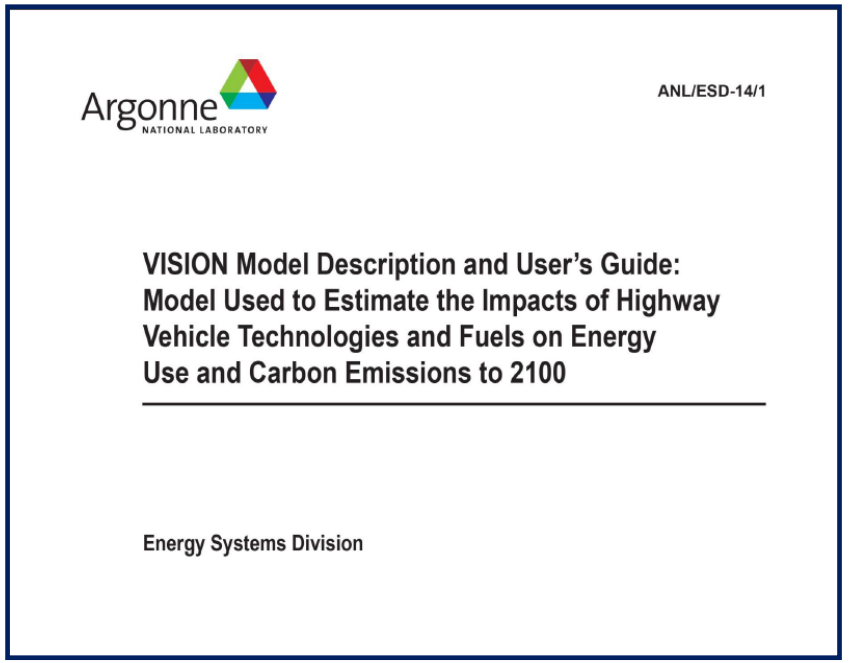


- Light Vehicles (Car and Light Truck)
- Heavy Vehicles (GVW Class 3-8)
  - Medium: Class 3-6 Truck
  - Heavy: Class 7-8 Single Unit and Combination Truck

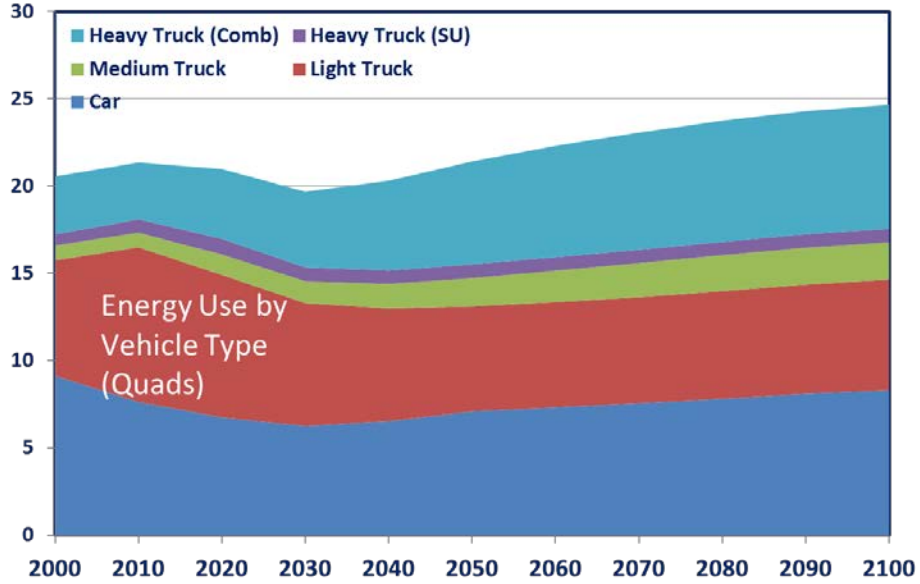
Accomplishment: Updated User Guide and Model Description

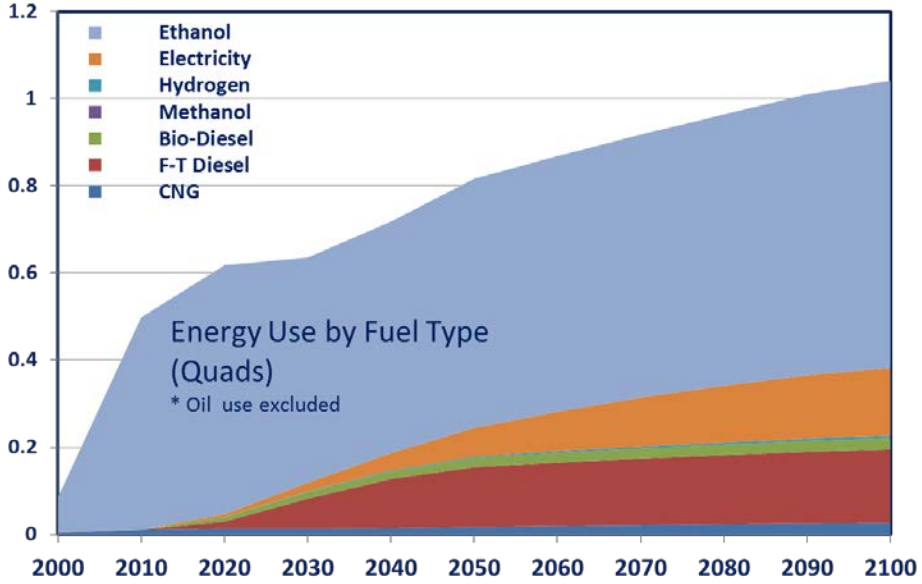
- A new document combines two older files, "Description of Model Used to Estimate the Impact of Highway Vehicle Technologies and Fuels on Energy Use and Carbon Emissions to 2050" and "VISION 2008 User's Guide“.
- Include new features that have been added to the model since 2004
- Available on ANL’s VISION website for users to download

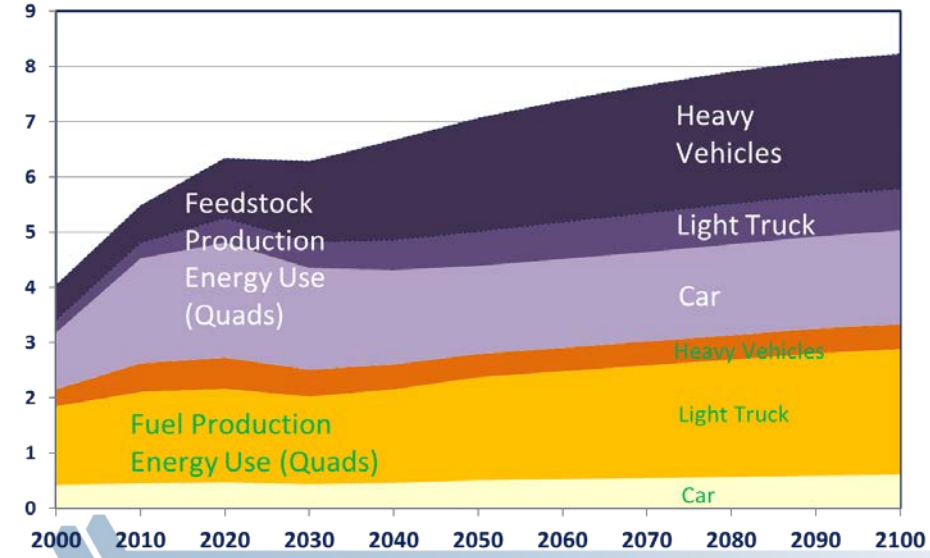
http://www.transportation.anl.gov/modeling_simulation/VISION/index.html

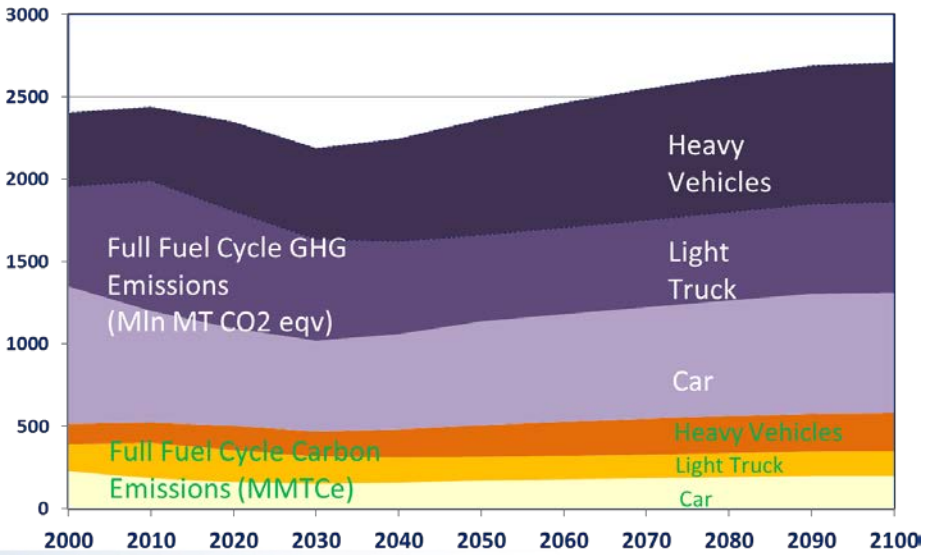


Accomplishment: Long Term Base Case for Both Light and Heavy Vehicles by Fuel Type and Vehicle Type









Accomplishment: VISION Has Been Widely Used by Government Agencies and Research Institutes

- DOE Vehicle Technology Program : Annual use in study of VT program government performance and results
- DOE Hydrogen and Fuel Cells Program:
  - Potential Transportation Oil Savings with FCVs
  - Impact of proposed FreedomCAR and Fuel Initiative
- DOE Policy Office: Demand estimates for DOE's study of premium diesel fuel availability issues
- Other Agencies Include DOE Biofuels Program, EERE/Office of Weatherization and Intergovernmental Program, Energy Information Administration
- DOT – NHTSA:
  - How to reduce LDV fuel use by 5% in 2010
  - Estimate the LDV MPG that would be required to save 1 million barrels per day (mbpd) by 2015
- We coordinated with the following agencies in their own use of VISION model in scenario analysis
  - CBO, GSA, White House – Economic Council and Technology Office
  - National Academies: Transitions to Alternative Vehicles and Fuels
  - National Petroleum Council: Advancing Technology for America's Transportation Future

NEAT: Non-Highway Energy & GHG Emissions Accounting Tool for Long-Term Energy and GHG Impact Evaluation

Approach: Develop a Base Case of 36 Commodity Sectors and 5 Modes

Commodity	Freight Mode	Major Inputs	Major Outputs
36 Commodities Select 30 from FAF Add 6 energy related commodities (corn for ethanol, biomass, fuel ethanol, biofuels, natural gas, and hydrogen)	**5 Modes** Truck Rail Domestic marine Air freight Pipeline	**AEO** **FAF** **Railroad Facts** **VIUS** **TEDB**	**Energy Demand and GHG Emission by Freight Mode and Fuel Type**

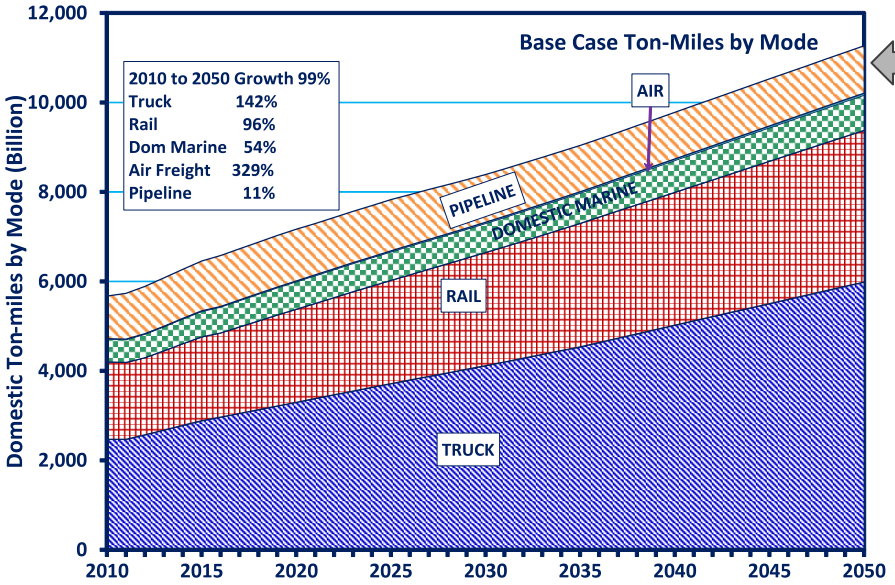
Approach: Use Full Fuel Cycle Energy Use and GHG Emissions Rates for 11 Fuels and 5 Modes from GREET 2013

Mode	Fuel
 Truck	Petroleum diesel, Bio-diesel F-T diesel, Pyrolysis diesel Liquefied natural gas – LNG
 Domestic Marine	Petroleum diesel, F-T diesel, Pyrolysis diesel Residual fuel oil
 Rail	Petroleum diesel, F-T diesel, Pyrolysis diesel LNG (to be added)
 Air Freight	Petroleum jet fuel, HR/F-T jet fuel, Pyrolysis jet fuel
 Pipeline	Natural gas Electricity by primary fuel

Estimate GHG emissions and upstream energy use

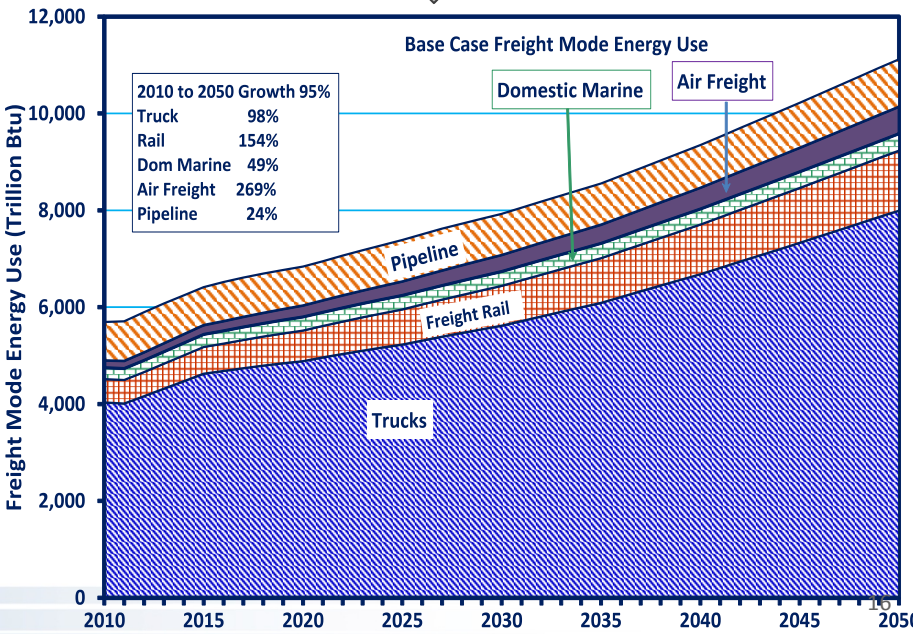
- Compute upstream energy and GHG emissions
- Compute exhaust GHG emissions

Accomplishments: Domestic Freight Sector Energy Use Growth (95%) are less than Ton-Miles Growth (99%) due to mode shift From 2010 to 2050 (Base Case)

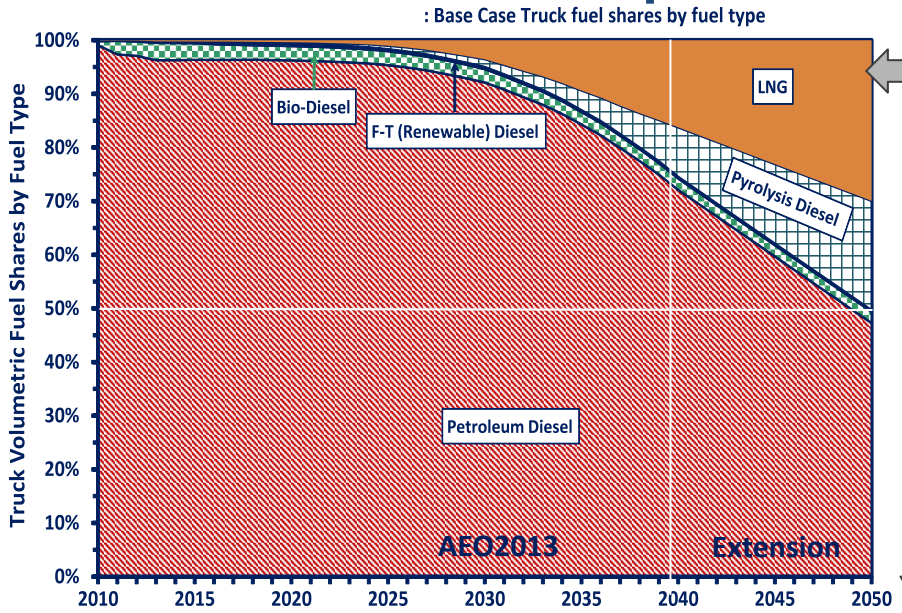


Ton-Miles Grow 99% From 2010 to 2050

Energy Use would Increase by 95% between 2010 and 2050



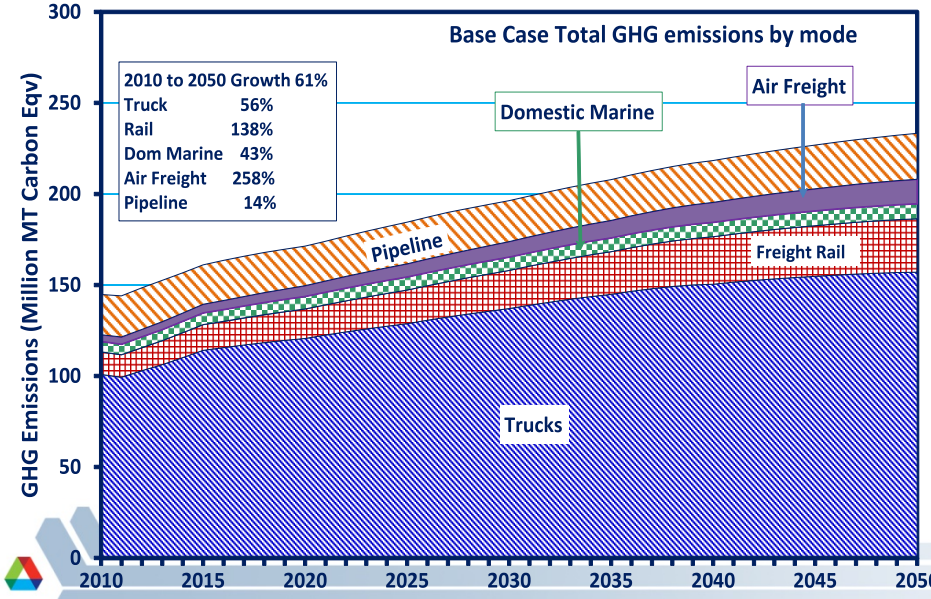
Accomplishments: Alternative Fuels Lower GHG Growth, Increase Upstream Energy Use

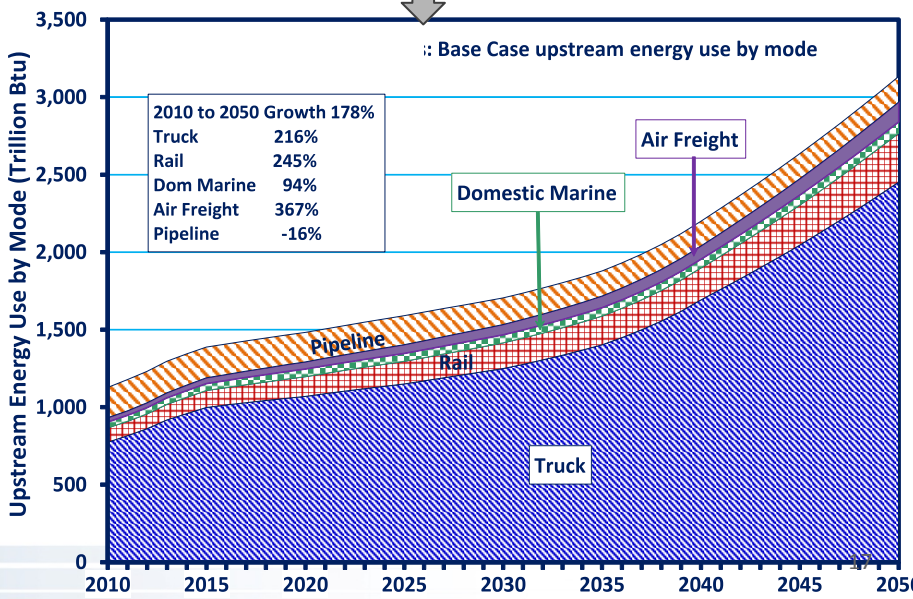


All Alternative Diesel Fuels and LNG in AEO 2013 Are Assumed to be Used Only by the Truck Mode

Alternative Fuels and Mode Shift Would Cause Lower GHG Emissions Increase of 61% During 2010-2050

However, Upstream Energy Use Would Grow by 178%, 2010 to 2050





Proposed Future Work

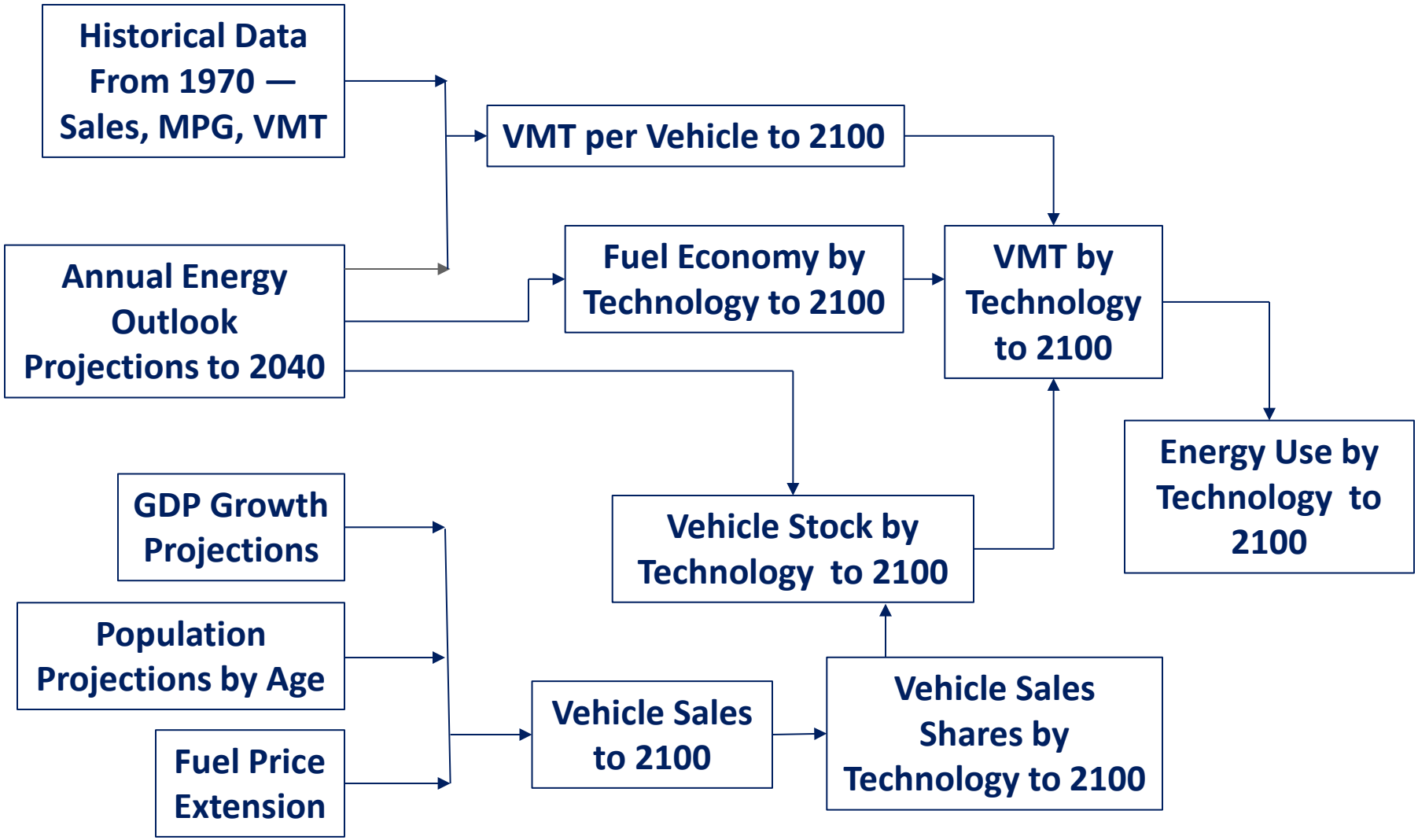
	Annual Update		Improvement	
	VISION	NEAT	VISION	NEAT
FY14	Update with AEO 2014 Develop base case Release model		Split BEV into two ranges: BEV100, BEV200	Develop user guide and model description Document internal calculation procedure
FY15	Update with AEO 2015 Develop base case Release model	Update with AEO 2015, FAF and GREET Release model	Enhance medium and heavy vehicle model internal calculation	Add international marine and other passenger modes (bus and rail)

Summary

- **Relevance**
  - Develop transparent tools to provide flexible energy and GHG scenario analysis by vehicle technology (VISION), freight mode and fuel types (NEAT), relevant to EERE Interests, answers to key questions
- **Approach**
  - VISION: Bases on vehicle sales, stock, VMT, MPG, economic and population information, fuel type/share, upstream energy emission and energy use rates.
  - NEAT: Bases on ton-miles, energy intensity, fuel type/share, upstream energy emission and energy use rates by commodity and mode
- **Technical Accomplishments**
  - Create a base case of full fuel cycle energy and GHG emission reduction by vehicle technology and freight mode
  - VISION is widely used by government agencies and research institutes, and has more than 300 registered users
- **Collaborations**
  - Work with EIA, ORNL, TA Engineering, NREL and other research institutes on data collection and model testing
- **Future Work**
  - Annually update the model with most current data
  - Annually enhance the model with new features
  - Develop an website for VISION and NEAT for making the tools widely available

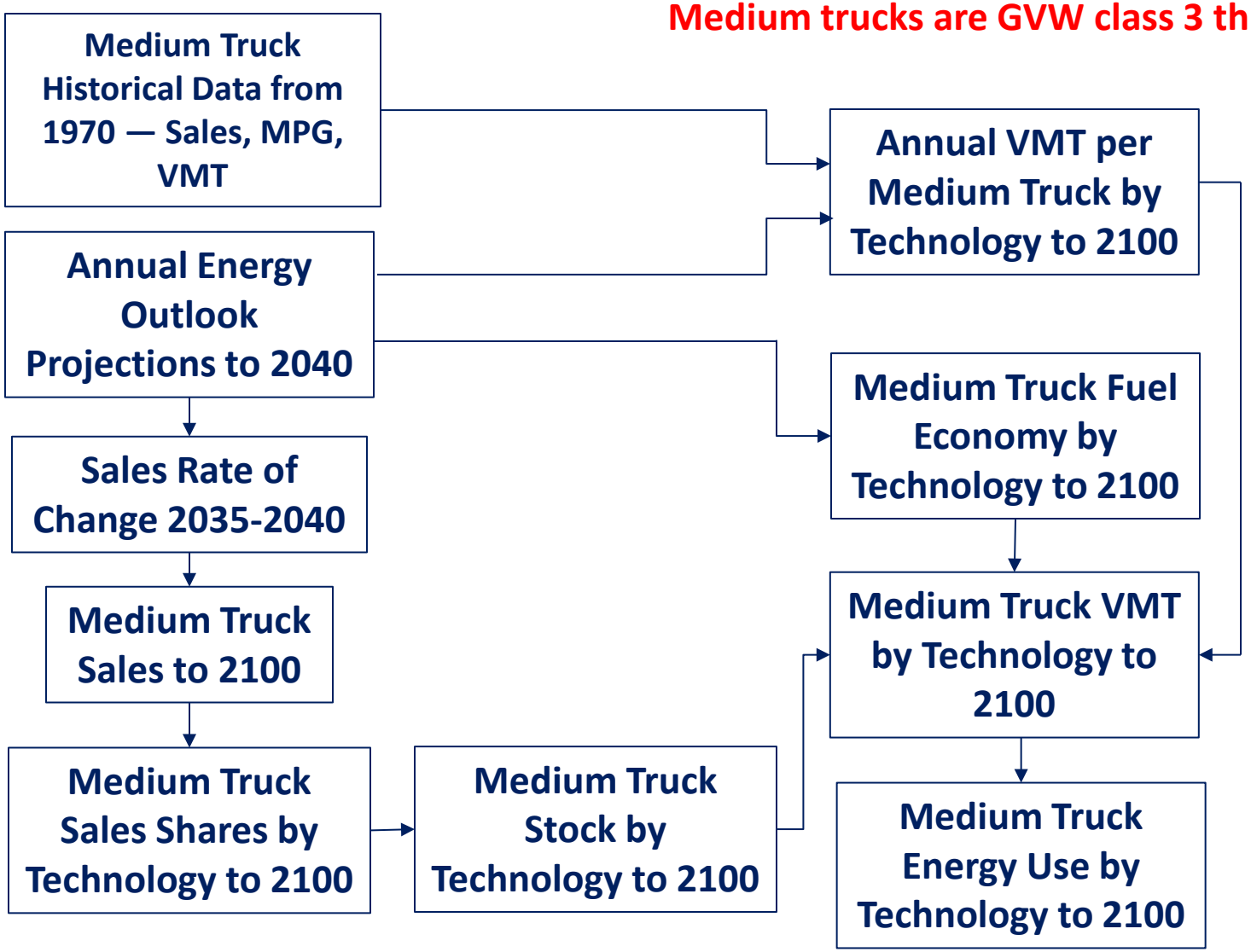
Technical Back-up Slides

VISION Approach: Create a Light Duty Long Term Base Case



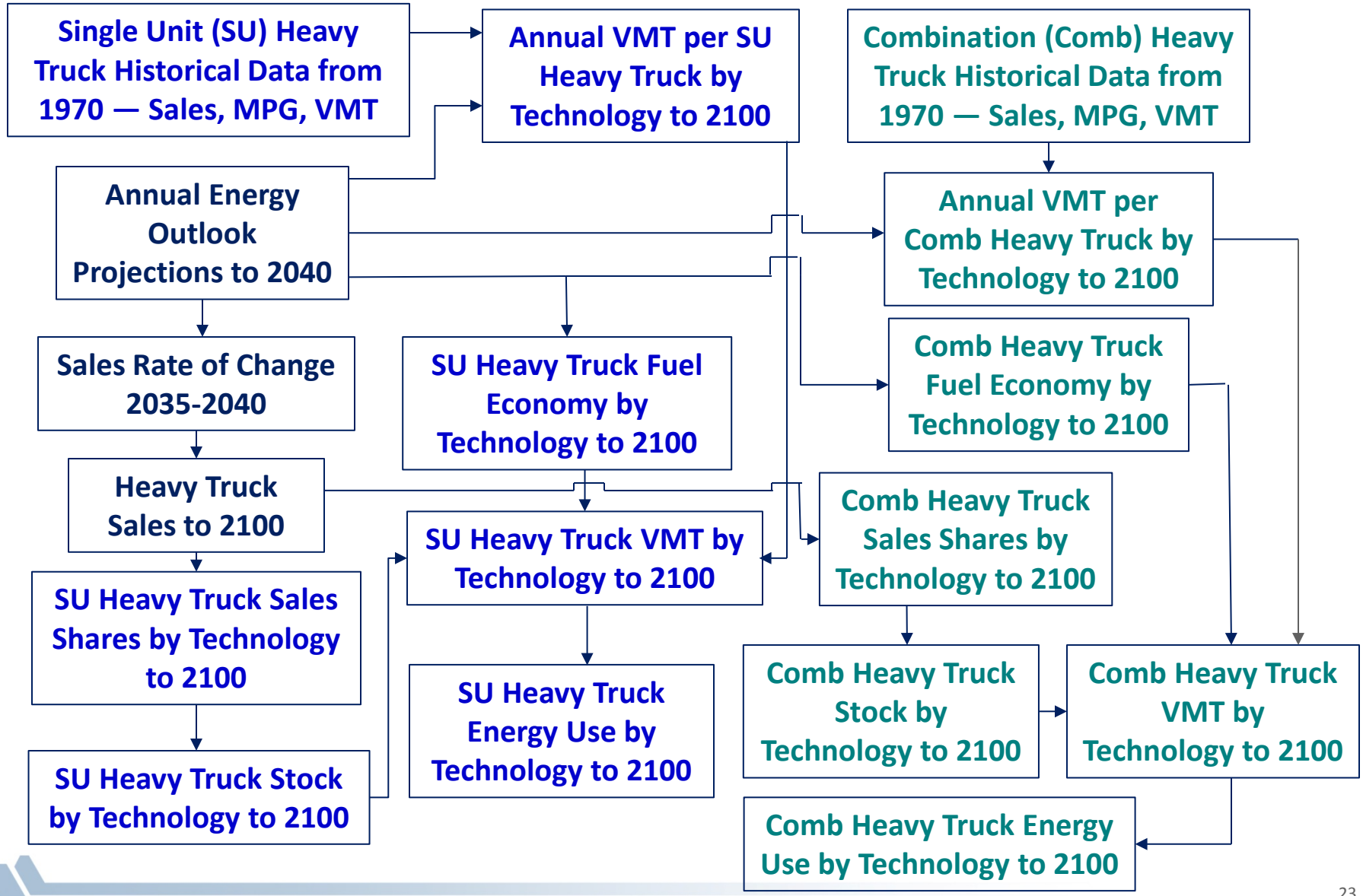
Approach: Create a Medium Truck Long Term Base Case

Medium trucks are GVW class 3 through 6

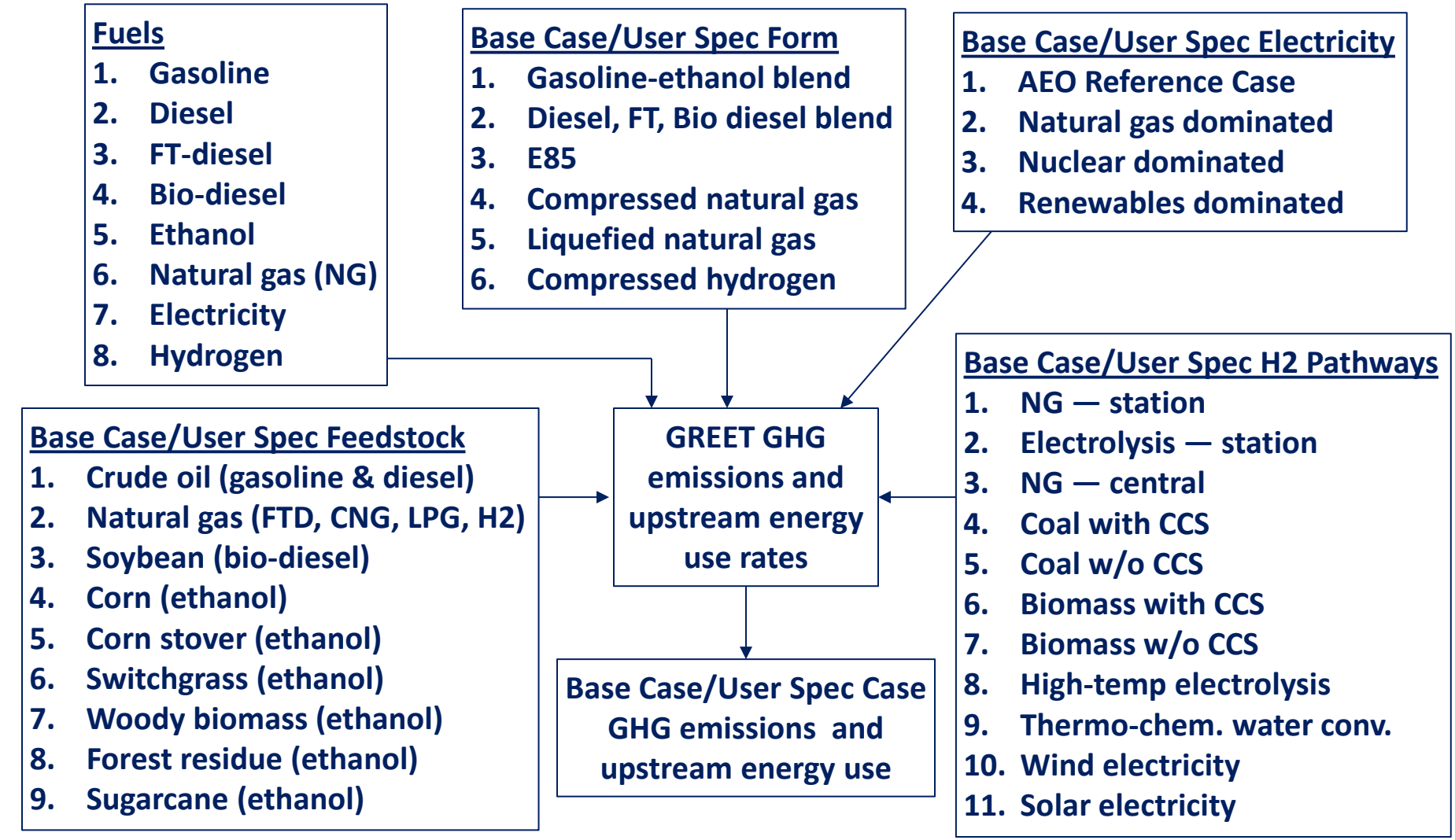


Approach: Create a Heavy Truck Long Term Base Case

Heavy trucks are GVW class 7 and 8



Approach: Incorporate Upstream Energy Use and GHG Emissions Rates from GREET Life Cycle Analysis



NEAT Approach: 36 Commodities Are Included in the Tool

SCTG	COMMODITY	SCTG	COMMODITY	SCTG	COMMODITY
01	Live Animal/Fish	15	Coal	25-26	Logs & Wood Product
02-04	Cereal Grain, Other Ag Product & Animal Feed	16	Crude Petroleum	27-29	News print/Paper, Paper Articles & Printed Matter
02200	Corn for Fuel Ethanol (from 02)	17-18	Gasoline & Fuel Oil	30	Textile & Leather
03602	Cellulosic Biomass (from Other Ag Product)	19	Coal not-elsewhere-classified	31	Nonmetallic Mineral products
05	Meat/ Seafood	19330	Natural Gas	32-33	Base Metals & Their Articles
06-07	Milled Grain Product & Other Food stuff		Biofuels	34	Machinery
08	Alcoholic Beverages (excluding Fuel Ethanol)	20	Basic Chemicals (Excl H2)	35	Electronics
08310	Fuel Ethanol	20242	H2, N2, O2 & Rare Gases	36	Motor Vehicles
09	Tobacco Product	21	Pharmaceuticals	37	Transportation Equipment
10-12	Building Stone, Natural Sand & Gravel	22	Fertilizers	38	Precision Instruments
13	Nonmetallic Minerals	23	Chemical Products	39	Furniture
14	Metallic Ores	24	Plastics & Rubber	40-99	Misc Manufacturing Prod, Waste/Scrap, Mixed Freight, U/K