GENERAL MOTORS

Brad Beauchamp

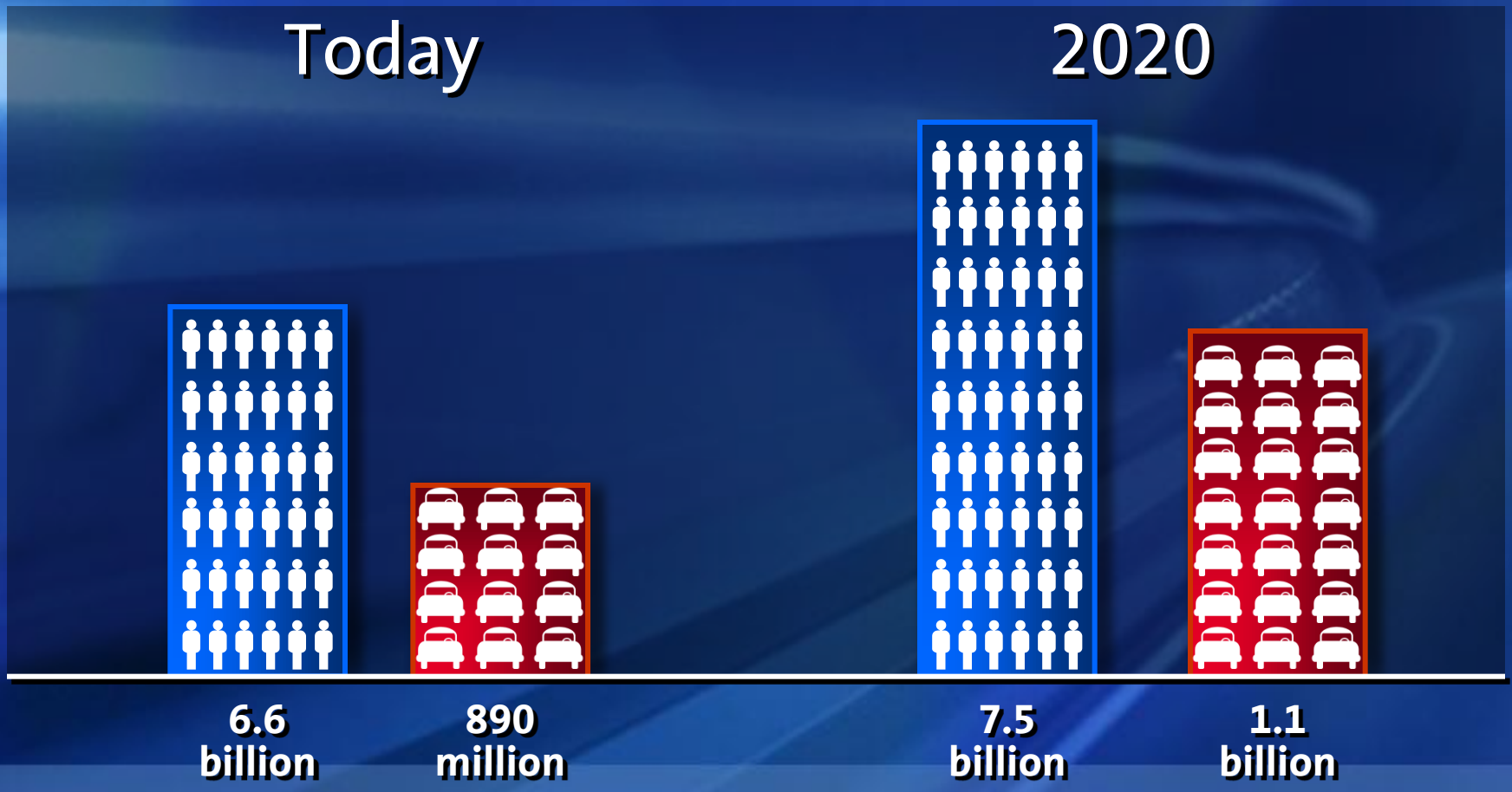
General Motors

Alternative Fuels

The Global Energy Challenge

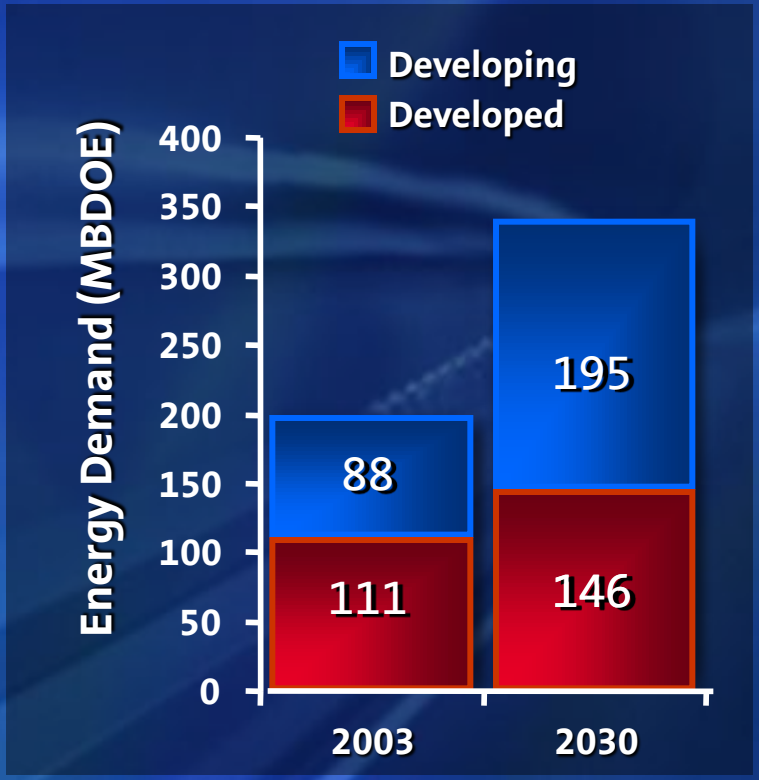
The Global Energy Challenge

Population Growth & World Automobile Ownership



The Global Energy Challenge

- Global energy demand exceeds our current glide path for supply
  - Global energy demand to increase 2% per year
  - We will need 60% more energy in 2030 than in 2003



Source: DOE Energy Information Agency

MBDOE: Millions of barrels per day oil equivalent

The Global Energy Challenge

Risks in future petroleum availability:

Availability = reserves + pumping out of ground to above-ground infrastructure

- Not enough refineries
- Not enough increase in capacity
- Geopolitical issues
- Unpredictables:
  - Natural disasters
  - Wars
  - Hostile regimes

The Global Energy Challenge

35% of World's Energy

96% of Transportation Energy

comes from PETROLEUM

The Global Energy Challenge

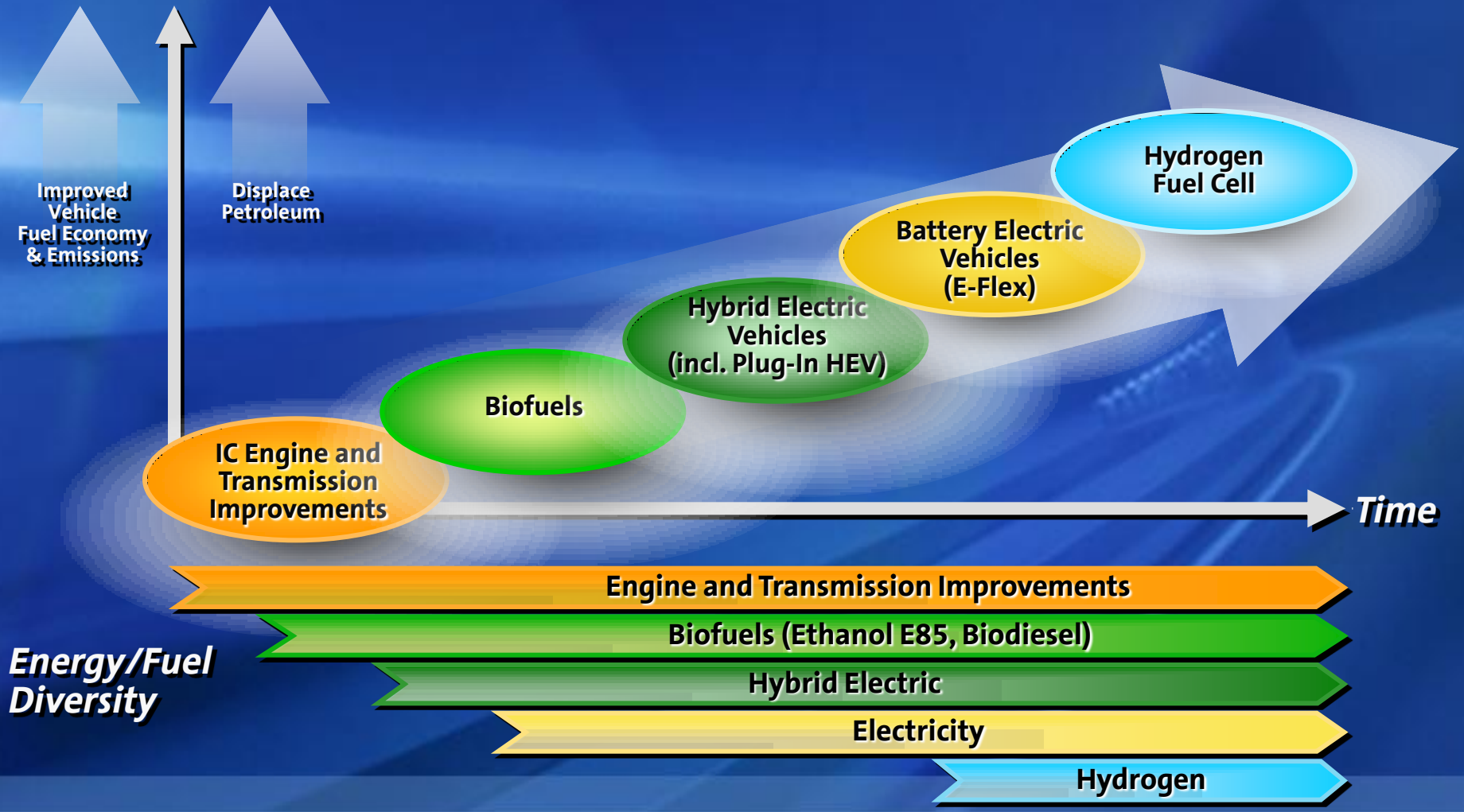
- Growing concern about Global Warming due to CO_2
- Push for legislation that:
  - Reduces emissions
  - Ultimately reduces the use of petroleum

Meeting the Energy Challenge

GM's Advanced Propulsion Technology Strategy

- Broad range of clean, efficient vehicles
- Powered by different sources of energy
- Meet local consumer needs around the world

Advanced Propulsion Technology Strategy



Why Biofuel?

Biofuels, like ethanol, offer the best near-term solution to reducing our dependence on petroleum

- By 2030, Ethanol will reduce oil demand 30%
- Ethanol will also reduce greenhouse gas emissions

Benefits of E85 Ethanol

- Renewable energy source
- Domestically produced
  - Supports rural communities and the domestic agriculture industry
  - U.S. jobs creation
- Infrastructure issues simpler and less costly than gaseous alternative fuels (CNG, LPG, Hydrogen)
- High octane consumer alternative to gasoline

Biofuels Leader

- GM is the world leader in providing customer choice through Biofuel and FlexFuel availability
  - More than 4 million ethanol-capable vehicles on the road worldwide
- GM is committed to have 50% of annual volume E85-capable by 2012

E85 FlexFuel Models in 2009MY

Chevrolet
Avalanche
Express
HHR
HHR Panel
Impala
Malibu*
Silverado
Suburban
Tahoe

GMC
Sierra / Denali
Savana
Yukon / Denali
Yukon XL / XL Denali

HUMMER
H2
H2 SUT

Cadillac
Escalade
Escalade ESV
Escalade EXT

Buick
Lucerne

Pontiac
G6 Coupe/Sedan
G6 Convertible

FLEXFUEL
E85 ETHANOL

Biofuels Leader

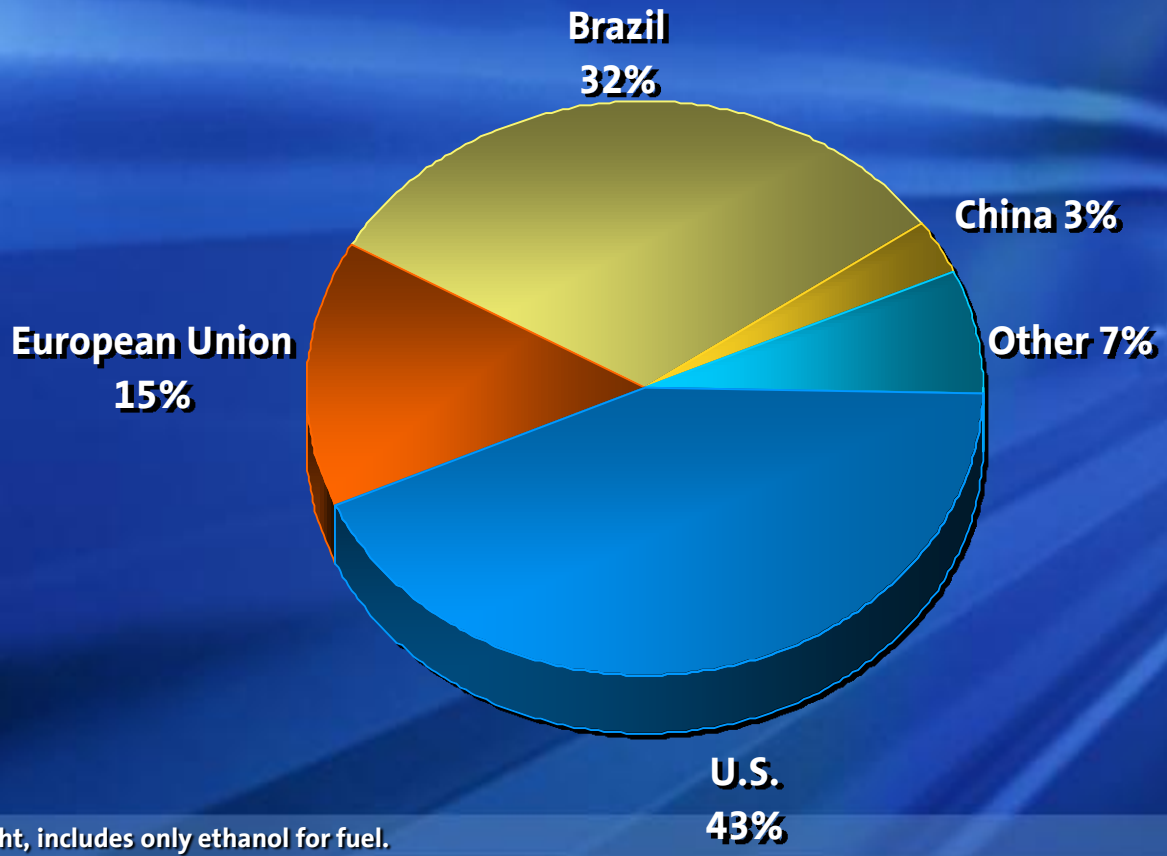
- In Brazil, more than 95% of our fleet is available with FlexPower
- Accounts for 90% of sales

Biofuels Leader

- Saab's 9-5 BioPower is Europe's best selling FlexFuel vehicle
- Saab offers BioPower in its core product lineup

Biofuel Global Production

About **90 Percent*** of Global Biofuel Production is Concentrated in U.S., Brazil and Europe, 2007



*Source: FO Licht, includes only ethanol for fuel.

Sources Of Ethanol Supply

North America

- The United States is the largest producer in the world with an estimated 8 billion gallons for 2008
- Forecasting 12 billion annual gallons in 24 months
- 36 billion gallons mandated in US annually beginning in 2022

Sources Of Ethanol Supply

Latin America

- Brazil is the second-largest ethanol producer in the world
- Brazilian ethanol is forecast to grow from 4 billion to more than 7 billion gallons annually by 2010

Sources Of Ethanol Supply

Asia

- China is the third largest producer of ethanol in the world
- An estimated 1 Billion gallons annually and is focused on biomass for future expansion

Sources Of Ethanol Supply

Europe

- The European nations are producing ethanol from a variety of sources
- Biomass is the current focus

Cellulosic Ethanol Alliances

coskata

MASCOMA

Agricultural / Municipal Waste

Plastic

Tires

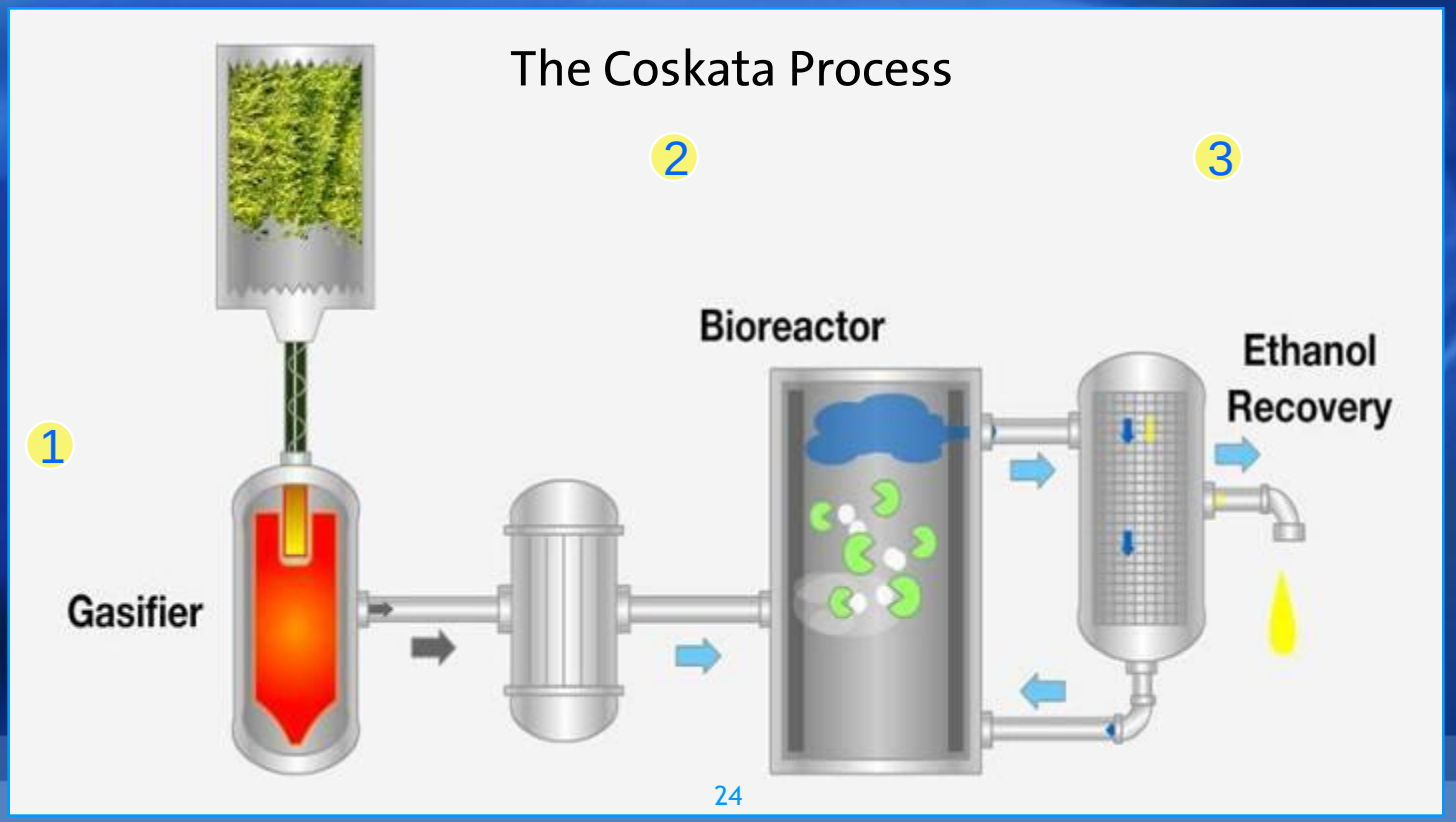
Cellulosic Ethanol Alliances

- GM alliances are aggressively working to make ethanol readily accessible at affordable prices
  - Thermo-chemical to bio-chemical processes
  - Garbage to non-food energy crops

Cellulosic Ethanol Alliances

The 3 Step Process

- Using proprietary microorganisms and bioreactor designs, Coskata can produce ethanol anywhere in the world, from almost any carbon containing feedstock.



Cellulosic Ethanol Alliances

Cellulosic Ethanol through Biochemical Processing

- In nature, no organism is capable of quickly and cost-effectively producing and fermenting sugars from cellulosic biomass
- Mascoma's research laboratories are now developing a new generation of microbes and processes for economical conversion of cellulosic feedstocks into ethanol

Mascoma's organisms and processes are designed to:

- Rapidly break down the components of biomass
- Convert sugars and polymers of sugars to ethanol
- Thrive in a manufacturing environment

Biofuels Infrastructure

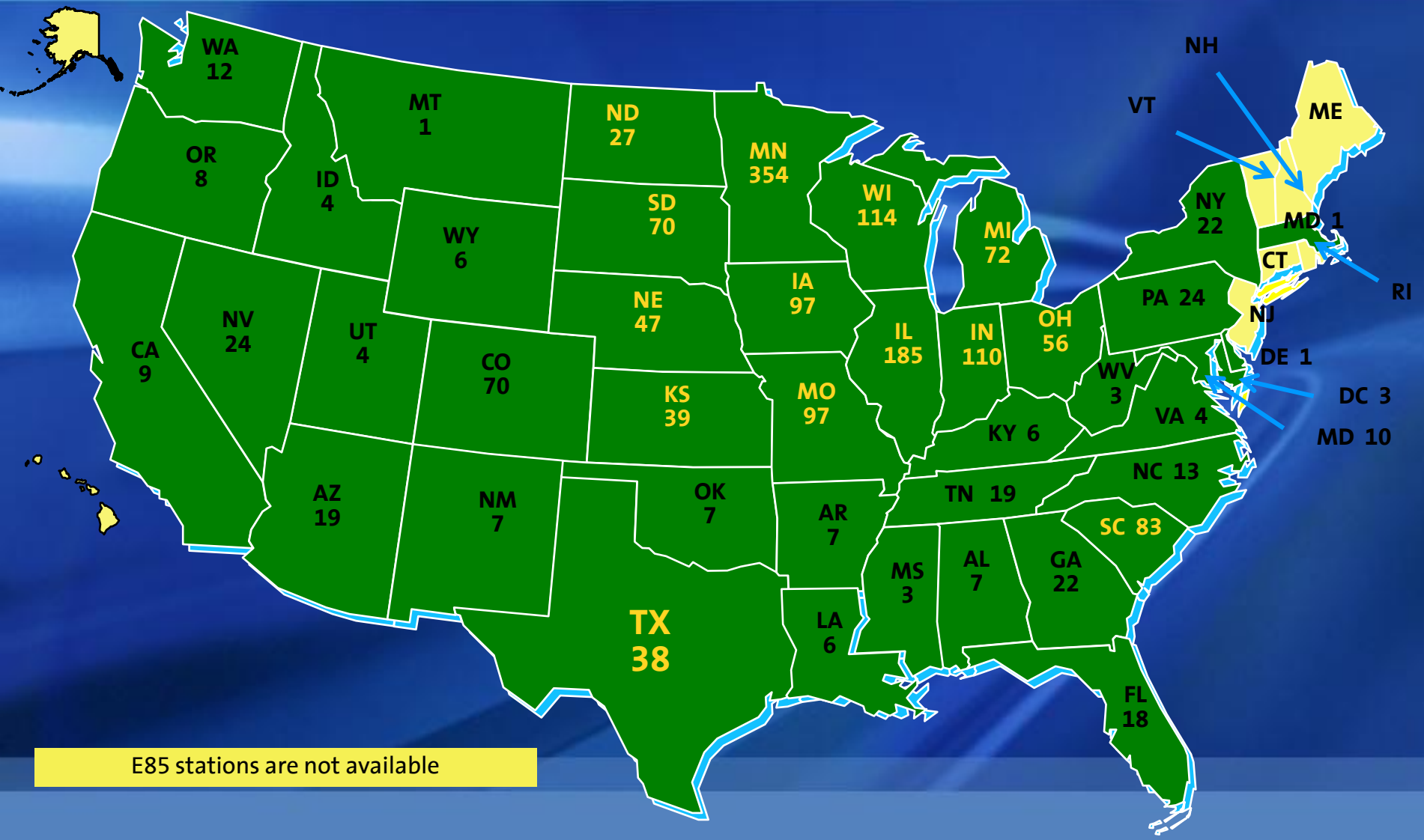
- Working with others to help expand infrastructure

E85 Station and General Motors FlexFuel Vehicle Ownership

	FFV Owners*	E85 Stations**
Arkansas	37,719	7
Kansas	26,019	39
Louisiana	66,691	6
Mississippi	24,343	3
Missouri	52,949	97
Nebraska	21,375	47
Oklahoma	39,635	7
Texas	281,316	38

*5/2/08: GM Vehicles In Operation (New & Used). VIN Year List 2000-2009
**7/24/08: e85refueling.com

E85 Fueling Stations



General Motors & National Governors Association E85 Collaboration

A state-industry partnership through NGA where GM will work with (8) states to expand E85 infrastructure

- Addresses lack of E85 pumps
- Paves the way to support scale-potential of cellulosic ethanol production
- Develops greater relationships with specific states to benefit future fuels and advanced technology efforts
- "Connects the dots" for GM's E85 strategy
  - Supply: Coskata and Mascoma cellulosic alliances
  - Vehicles: 50% volume commitment
  - Consumer availability: Optimizing consumer availability to increase number of stations and enable better pricing

General Motors & National Governors Association E85 Collaboration

The joint NGA & GM selection of the (8) states will be based on factors such as:

- Market size and potential
- Current E85 gaps
- Regional outlook
- Synergies

Selected states will then:

- Develop an E85 task force to analyze E85 status and potential
- Develop an implementation plan with programs to support and fund

Ethanol Myths

Separating facts from fiction

MYTH 1: Ethanol will not reduce U.S. dependence on oil

- **Ethanol is a rapidly growing domestic fuel and every gallon reduces U.S. dependence on oil**
  - In 2007, the production and use of ethanol in the U.S. reduced oil imports by 228.2 million barrels
  - Saving $16.5 billion from being sent to foreign countries
- **By 2030, more than 60 billion gallons of ethanol can be derived from grain-based and biomass sources**
  - Reducing reliance on gasoline as a motor fuel

MYTH 1: Ethanol will not reduce U.S. dependence on oil

- **The U.S. is starting to break its "addiction" to foreign oil**
- **Biofuel production and use in the U.S. and Europe during the last three years has cut consumption of crude oil by 1 million barrels a day**
- **According to a Merrill-Lynch study:**
  - Ethanol in the fuel supply kept gasoline prices 15 percent lower than they would be without ethanol

MYTH 2: Ethanol requires more energy to produce than it delivers as a fuel

- **Recent studies from the U.S. Department of Energy conclude that making fuel ethanol from corn yields about one-third more energy than is used to grow the grain**
  - "net energy balance" of 1.34
- **Next generation cellulosic ethanol technologies have an even higher energy balance**
  - A joint study concludes that ethanol from switchgrass produced 540 percent more renewable than non-renewable energy
  - Coskata's process generates up to 7.7 times as much energy as is used - compared to conventional gasoline

MYTH 3: Using corn for ethanol increases food prices and negatively impacts the global food supply

- **Corn prices have minimal impact on consumer food prices**
  - For every dollar spent on food, only 19 cents goes towards raw materials. The balance – 81 cents – goes to:
    - labor (38.5 cents)
    - advertising and packaging (12 cents)
    - transportation and energy (7.5 cents)
    - other non-farm costs (23 cents)

MYTH 3: Using corn for ethanol increases food prices and negatively impacts the global food supply

- **Many parts of the developing world have experienced high economic growth in recent years**
  - Of the world's 34 most food-insecure countries 22 had average annual growth rates ranging from 5 to 16 percent between 2004 and 2006
  - This growth is a central force of change on the demand side of the world food equation
- **High income growth in low-income countries readily translates into increased consumption of food**

MYTH 3: Using corn for ethanol increases food prices and negatively impacts the global food supply.

- **Rising costs in energy and transportation have a more significant impact on food prices than corn**
  - America is growing enough corn for both food and fuel
  - U.S. corn supply is projected to reach nearly 14.5 billion bushels - demand is expected to be 12.7 billion bushels
- **Ethanol production yields co-products that contribute to the food supply**
  - distiller's grain, a high-protein animal feed

MYTH 3: Using corn for ethanol increases food prices and negatively impacts the global food supply.

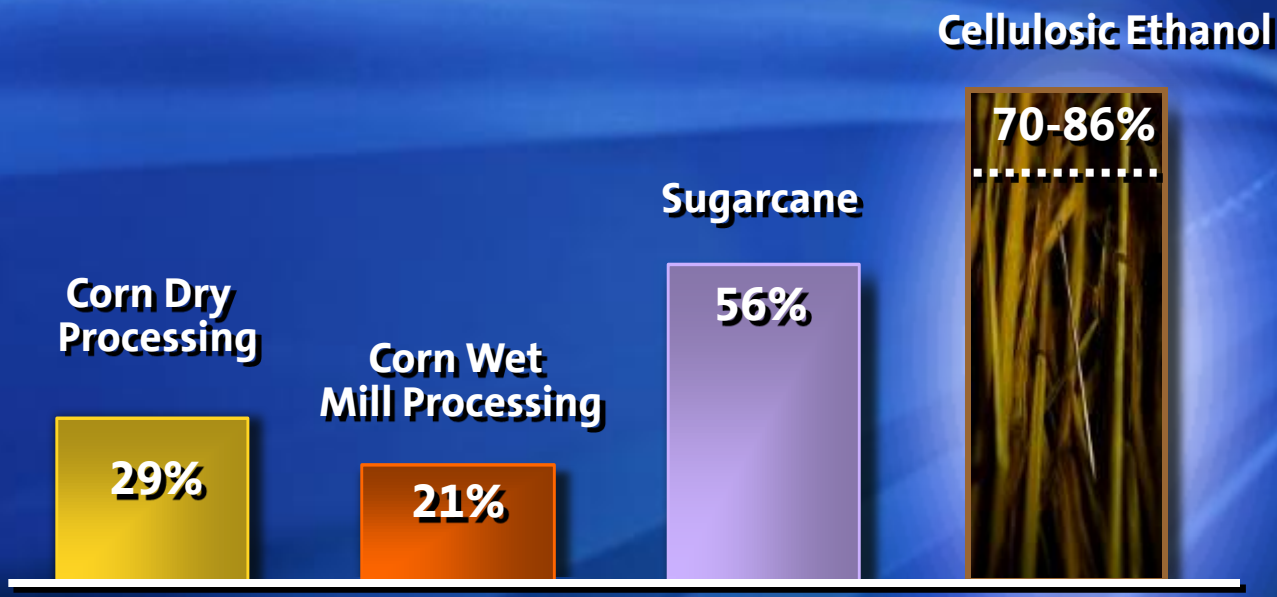
- **World oil prices are the most significant factor driving the price of food across the globe**
- **According to the president of the Renewable Fuels Association:**
  - It requires petroleum to grow, process, package and transport food all around the world
  - With oil prices at record levels it is little wonder that food prices are rising
  - The problems of hunger have existed long before the United States' ethanol industry
  - without structural reform in how aid is delivered will unfortunately persist

MYTH 4: The use of E85 ethanol increases greenhouse gas emissions.

- **Ethanol is proven to reduce greenhouse gas (GHG) emissions and contributes to eliminating other harmful pollutants**
  - Corn ethanol by 21-29 percent
  - Cellulosic ethanol by 70-86 percent

Benefits of E85 Ethanol

CO_2 Savings from Different Ethanol Processes and Inputs



MYTH 4: The use of E85 ethanol increases greenhouse gas emissions.

- **The efficiency of ethanol production continues to rise**
  - Use of 6.5B gallons of ethanol in the US in 2007 resulted in the reduction of GHG emissions by

    ~10 million tons
- **Nearly 25 percent of ethanol facilities are capturing carbon dioxide emissions for use in making dry ice and bottling carbonated beverages**
  - More than one third of the distillers grain is being sold in wet form - reducing the amount of energy needed to dry and transport the product

MYTH 5: There is insufficient farmland to produce significant amounts of ethanol

- **A Department of Energy (DOE) and USDA study demonstrates that:**
  - By 2030 enough biomass could be produced using existing farmland to reduce oil consumption by 35 percent
  - There are more than 300 million acres of active cropland in the U.S.
  - In 2007 approximately 90 million acres of corn were planted yielding nearly 153 bushels per acre

MYTH 5: There is insufficient farmland to produce significant amounts of ethanol

- **Technology for harvesting corn is improving as evidenced by corn yield increases**
  - Corn yields double every generation through technology
  - Farmers are getting better at growing more on less land
- **Emerging cellulosic ethanol technologies will augment the production of corn-based ethanol**
  - In the U.S. there is more than 1 billion tons of biomass that can be converted into fuel annually
  - Coskata's process predicts that each ton of dry feedstock can be converted into more than 100 gallons of ethanol

MYTH 6: It takes 1,700 gallons of water to produce a gallon of ethanol.

- **Cornell University's David Pimentel gets the number by adding in the water needed to grow corn**
  - As little as 4 percent of the corn used for ethanol production in the United States requires irrigation
  - Ethanol production takes less than 4 gallons of water per gallon of ethanol
  - One acre of corn gives off 4,000 gallons of water per day in evaporation, according to the US EPA

MYTH 6: It takes 1,700 gallons of water to produce a gallon of ethanol.

- The majority of the water used in ethanol production is recycled and reused
- Technology improvements continue to reduce the amount of water required
  - Much of the water used is returned to streams and watersheds
- New technology, such as the Coskata process, uses less than one gallon of water to produce a gallon of ethanol

Driving the Future

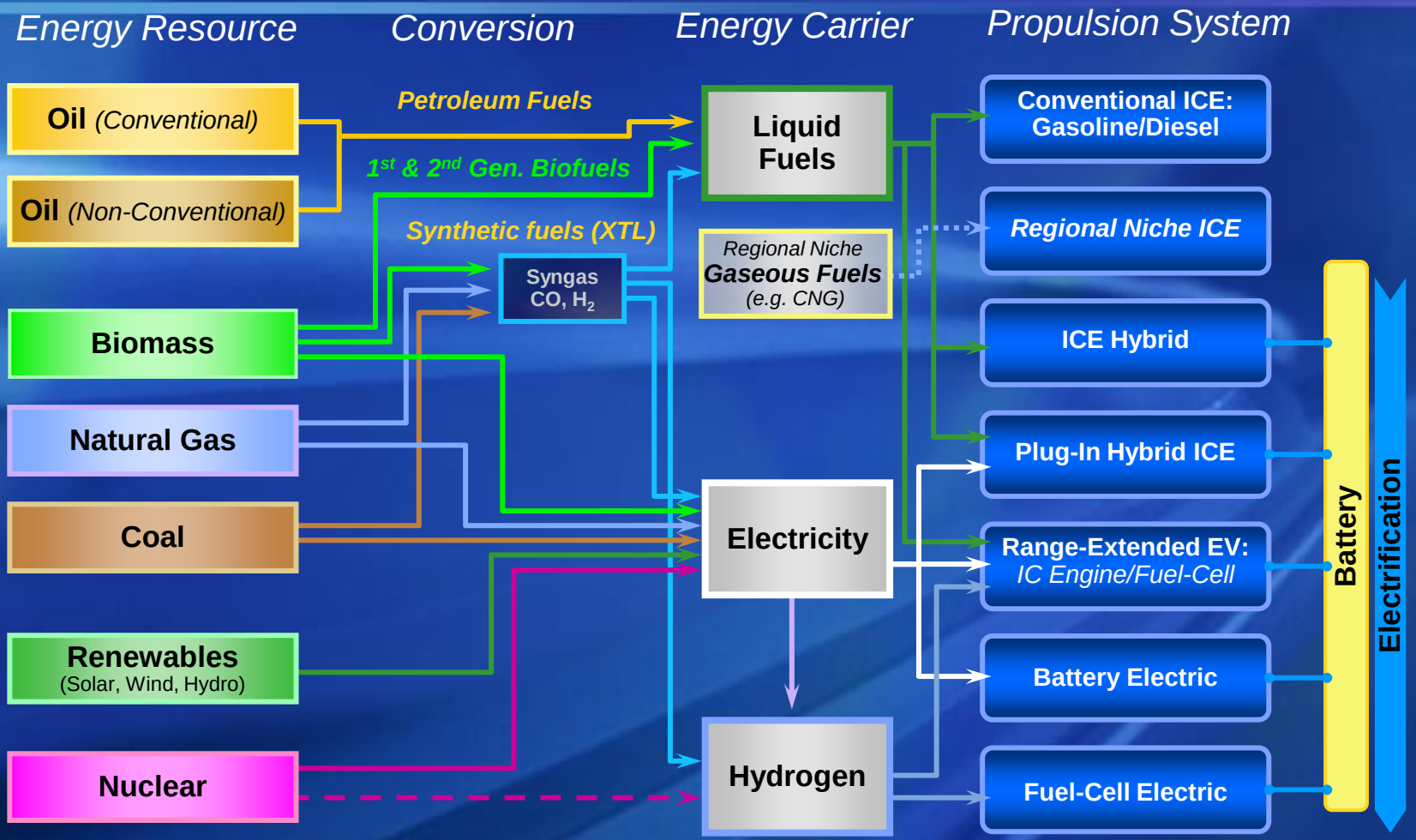
GM's Advanced Propulsion Technology Strategy will...

- Reduce fuel consumption and greenhouse gas emissions
- Be sustainable through energy diversity
- Displace petroleum
- Alleviate the issue of demand outgrowing limited supply
- Reduce our dependence on a supply subject to uncontrollable risks


DRIVING the FUTURE...
GM Advanced TECHNOLOGY
E85 ETHANOL
chevy.com
FUEL CELL

Energy Diversity – Blending Strategy

"Liquid Fuels/Electricity/Hydrogen" as the In-Vehicle Energy Carriers



Biofuels Will Play Increasing Role

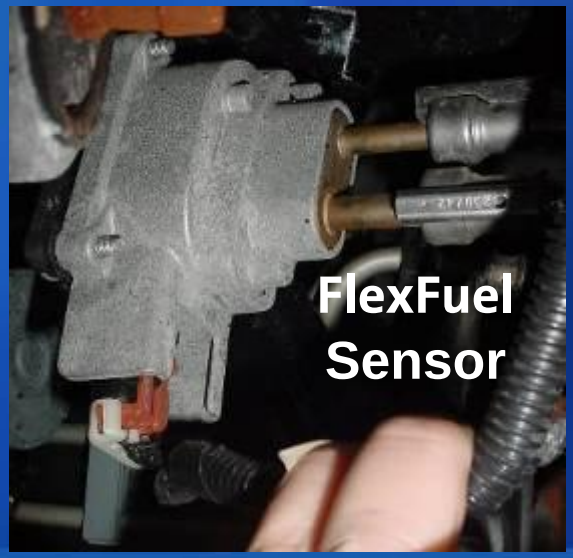
- Forecast
  - 7% annual growth through 2030
  - Greater amounts of traditional fuels to be blended with higher concentrations of renewable fuels
- Our Job:
  - To ensure products are designed for FlexFuel capability with high performance and long life
  - To continue work with business and government on new sustainable biofuels and infrastructure

Summary for E85 Vehicles

- Developing a FlexFuel or a dedicated E85 vehicle is a major undertaking
  - Conversion to an existing flexfuel design requires extensive swapping of parts often deep inside the vehicle
  - Conversion of a vehicle that has never been flexfuel requires extensive engineering of new parts, finding suppliers, and validating the resulting hardware
    - Software and calibration development will be a major undertaking requiring specialists to execute
- Conversions lacking these elements will result in out-of-compliance vehicles with significantly reduced life
  - Consumers will be dissatisfied with the product and, by extension, with ethanol

Typical Content Changes for E85 Vehicles

- Fuel system materials improved for corrosion resistance
  - Pump, level sender, OBD pressure sensor, fuel injectors, seals
  - These changes also needed for E20 compatibility in Thailand
- Higher fuel pump and injector flow capacity compensates for E85 energy density
- Cylinder head and valve materials
  - Software/calibration to detect fuel blend and optimize operVirtual fuel (software algorithm) identifies blend (or FlexFuel sensor)
  - Fueling and spark tailored to fuel characteristic (boost if turbocharged)



In General Motor's View, We Must:

- Increase the fuel efficiency of conventional propulsion vehicles
- Develop alternative sources of propulsion that will displace traditional petroleum-based fuels
- Emphasize energy diversity
  - Alternative sources of energy

Biodiesel Capable Trucks & Vans

- Biodiesel is a renewable alternative to diesel:
  - Made from plant oils, animal fats, recycled cooking oils, and even algae
  - All Biodiesel must be properly processed to meet the current American Society for Testing and Materials (ASTM) specifications
- GM covers under warranty:
  - Certified biodiesel blends of up to 5% for use in all 2008-09 Duramax engines
- To be offered in:
  - Silverado/Sierra Pickups
  - Express/Savana Cutaway Vans

5F4 Option – B20 Biodiesel Capable

- B20 Biodiesel Special Equipment Option is available to Government Fleets
  - Allows biodiesel blends up to 20% (B20 Capability)
- B20 Biodiesel SEO is available on:
  - Silverado/Sierra One Ton & ¾ Ton HD Pickups*
    - Box delete is available on Regular and Extended Cabs
    - SEO is not available on Chassis Cab models (C/K31**3)
  - Express/Savana Cutaway Vans*
    - Models G33*03 (Cutaway only)
    - Not available with K08 Auxiliary Heater or 57 gallon tank

* Special Configurations

MYTH 7 : Ethanol infrastructure can't keep pace with production.

- **Ethanol fueling infrastructure is growing**
  - There are more than 1,600 E85 ethanol fueling stations in the U.S.
  - Companies like GM and others are continuing extensive efforts in partnering with government, fuel providers and fuel retailers

GENERAL MOTORS

Thank You

Have a great day!