Welcome

Mid-Level Blend Ethanol: Challenges, Opportunities & Testing Follow Through

Power Point Presentation on Renewable Fuel Terminal Infrastructure

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Senior Specialis & Energy Affairs
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DOCKET
09-IEP-1K
DATE April 14 2009
RECD. April 14 2009

Joint IEPR and Transportation Committee Workshop
on Transportation Fuel Infrastructure Issues
California Energy Commission
Sacramento, CA
April 14-15, 2009

Mid-level Blend Ethanol Drivers and Concerns

- EISA 2007 mandate for “clean, renewable and alternative energy *(liquid fuels)”*
  - Underlying objectives – America’s energy security and GHG reduction
  - Accomplished through home grown fuels and greater efficiency
- Immediate EISA focus – ethanol
- Alternative fuels to evolve from food feedstock to advanced biofuels
- Various studies (by EPA & others) have shown mid-level ethanol is a temporary conduit and won’t achieve EISA RFS mandates
- Call to auto manufacturers – make more vehicles capable to use the over-supply of ethanol
- Capability/compatibility of vehicle legacy fleet to use mid-level blends – requires follow through on comprehensive independent testing
- E15 Waiver Application has been submitted to EPA by Growth Energy

Mid-Level Ethanol Blend - Outline

- Levers to reduce GHG emissions & energy usage (underlying EISA objectives)
- FFV/E85 utilization and challenges
- Mid-level ethanol blends effects analysis

Vehicle & Fuel Levers to Reduce GHG Emissions & Energy Usage

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The Vehicle and Challenge to Automakers

- Congress, the Administration and California understand the significance of transportation in nation's GHG inventory.
- Vehicle component well-handled in EISA for maximum feasible technology going forward.
- EISA also called for 36B gallons/year of alternative fuels by 2022. However, a shortcoming is that a commercial viability determination in the future can allow for an adjustment of the goal.

Vehicle & Fuel Levers to Reduce GHG Emissions & Energy Usage

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The Fuel Opportunity – Challenge Fuel Providers in Similar Way

- Better mechanism needed for production and distribution of alternative fuels so that they can be sold at a price less than gasoline or diesel (when compared on an energy basis)
- Application of maximum feasible technology on the vehicle will assure minimum use of energy. However, any carbon into the tank will go out the tailpipe.
- Therefore, to phase down carbon emissions at maximum rate, the target must be to take the carbon out of the liquid fuel pool.
- Congress should direct EPA to create a rule to limit the carbon content in fuel (in form of a national LCFS). This standard could be modeled after EISA 2007 vehicle fuel provisions.

Vehicle & Fuel Levers to Reduce GHG & Minimize Energy Usage

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Fundamentally, a carbon cap on the liquid fuel pool:

- Attacks the key chemical element (carbon) for GHG reduction and climate improvement
- Compliments: EISA 2007 RFS & associated vehicle actions, DOT's recently released 2011 fuel economy standard and President Obama's goals for national CO_2/GHG reduction.
- Addresses energy security concerns
- Encourages or enables the fuel industry to develop new fuels, processes and market strategies to achieve required carbon limits.
- Fortifies a growing alternative fuel industry and American jobs for the development, production and sale of home grown fuels or energy crops.
- Serves as a step towards a long-term vision and 2050 GHG reduction goals.

Vehicle & Fuel Levers to Reduce GHG & Minimize Energy Usage - Summary

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Actions to-date

- Some federal & state actions have been taken or are underway for achieving a low carbon fuel or contributing to desired GHG reductions.
  - However, a national program is needed to maximize the ability of using the scale of the transportation fuel distribution system to minimize the costs to consumers.
  - Some of these federal & state actions have been diluted by including the vehicle or other factors & thus diminish maximum feasible technology towards a low carbon fuel.

In summary, to secure its energy, America needs to:

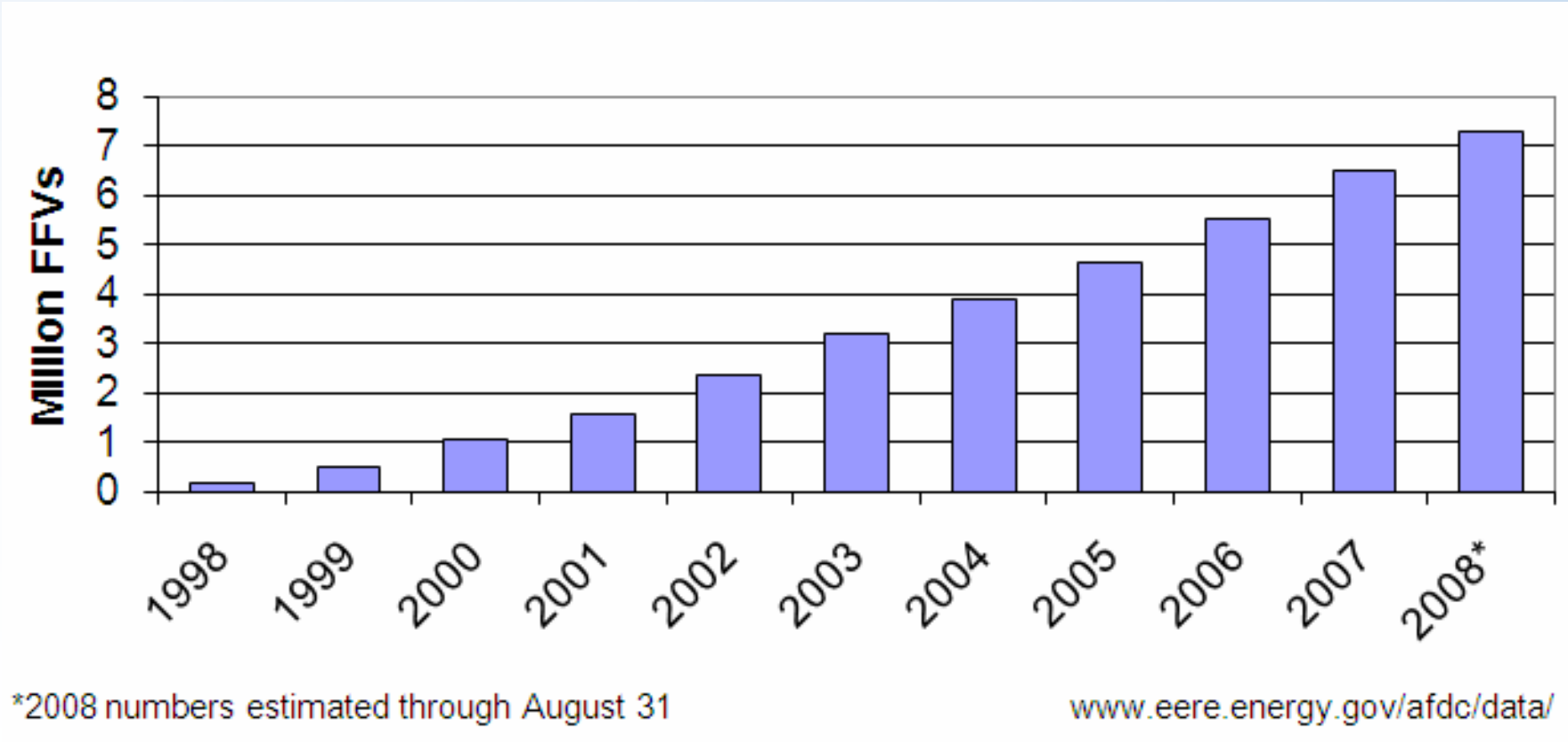
- Attack the carbon in fuel
- Actively promote the development and technology for home grown energy
- Stay focused on a long-term vision for carbon-free energy and transportation

FFV/E85 Utilization and Challenges

- Availability of Flexible Fuel Vehicles
- E85 FFV Portfolio Expansion
- Availability of E85 Fuel
- E85 Utilization Potential
- Technical and Policy Challenges
- E85 Growth Initiatives

Availability of Flexible Fuel Vehicles

- There are over 7 million E85 flexible fuel vehicles (FFV) on the road in the U.S. today
- With almost 2 million flexible fuel vehicles on the road in the US, Chrysler is a major producer of E85 vehicles.



*2008 numbers estimated through August 31

www.eere.energy.gov/afdc/data/

2009 Flex-Fuel Vehicles

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Dodge Ram

Chrysler Town and Country

Chrysler Aspen

Chrysler Sebring

Dodge Avenger

Jeep Commander

Dodge Dakota

Dodge Grand Caravan

Jeep Grand Cherokee

Dodge Durango

E85 FFV Portfolio Expansion

- Domestic automakers have committed that by 2012, 50% of new light-duty vehicles produced will be capable of using alternative fuels. Contingent upon continued infrastructure development.

- Automakers have already invested over $1 Billion in developing and producing FFVs and will continue significant annual investment to meet the 50% commitment.

- In 2009 Chrysler has 10 models with flexible fuel capability

Availability of E85 Fuel

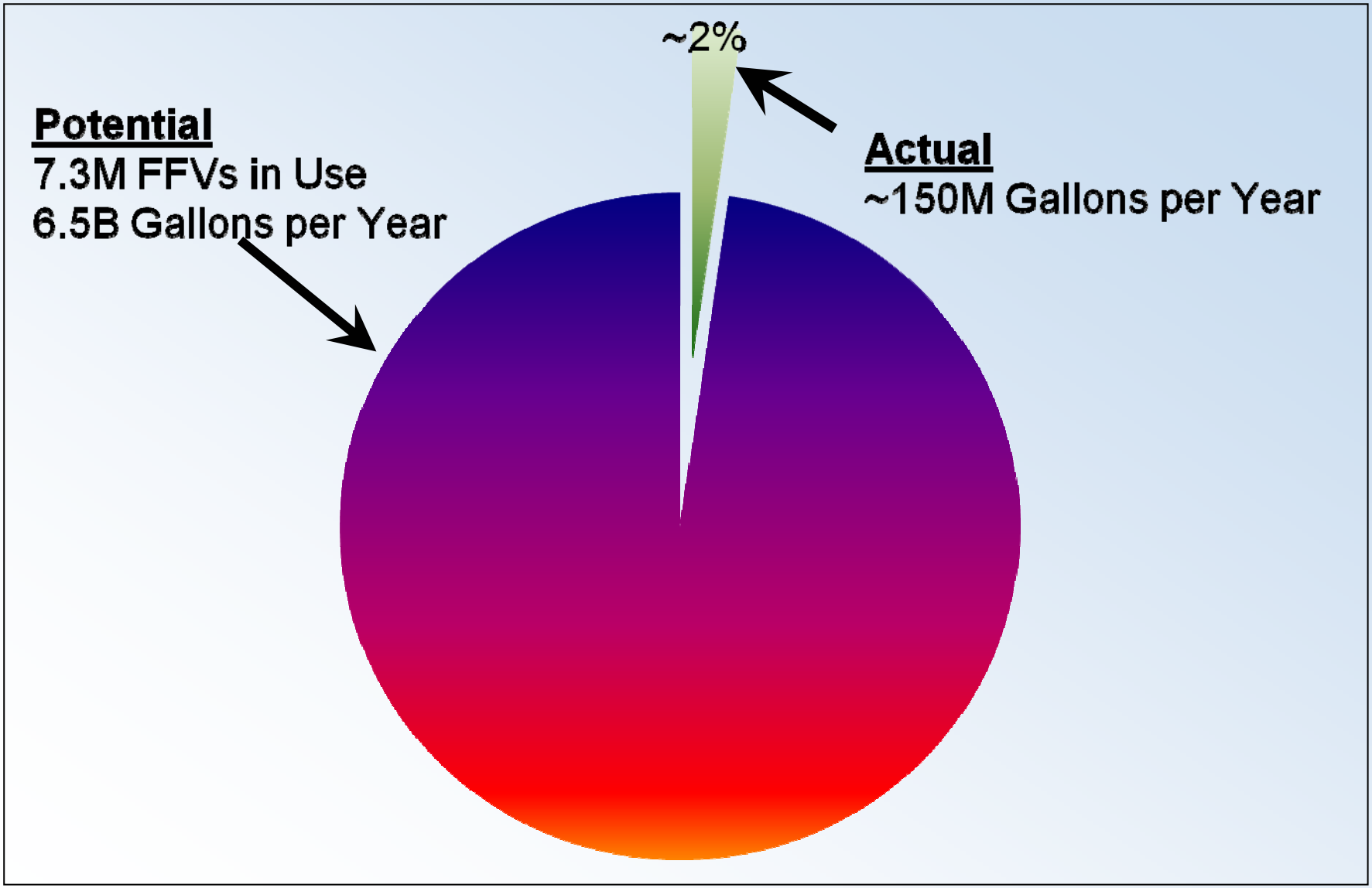
The vast majority of ethanol sold in the U.S. is with an E10 blend

- E10 is at or nearing 80% utilization (for regular gasoline, non-FFVs)
- E85 is at approximately 2% utilization (in FFVs)

There are 1,800 public E85 stations in the U.S. (vs. approximately 121,000 gasoline stations)

- 90% of FFVs do not have an E85 station in the same zip code
- Nearly half do not have an E85 station in their county

Current E85 Utilization vs. Potential

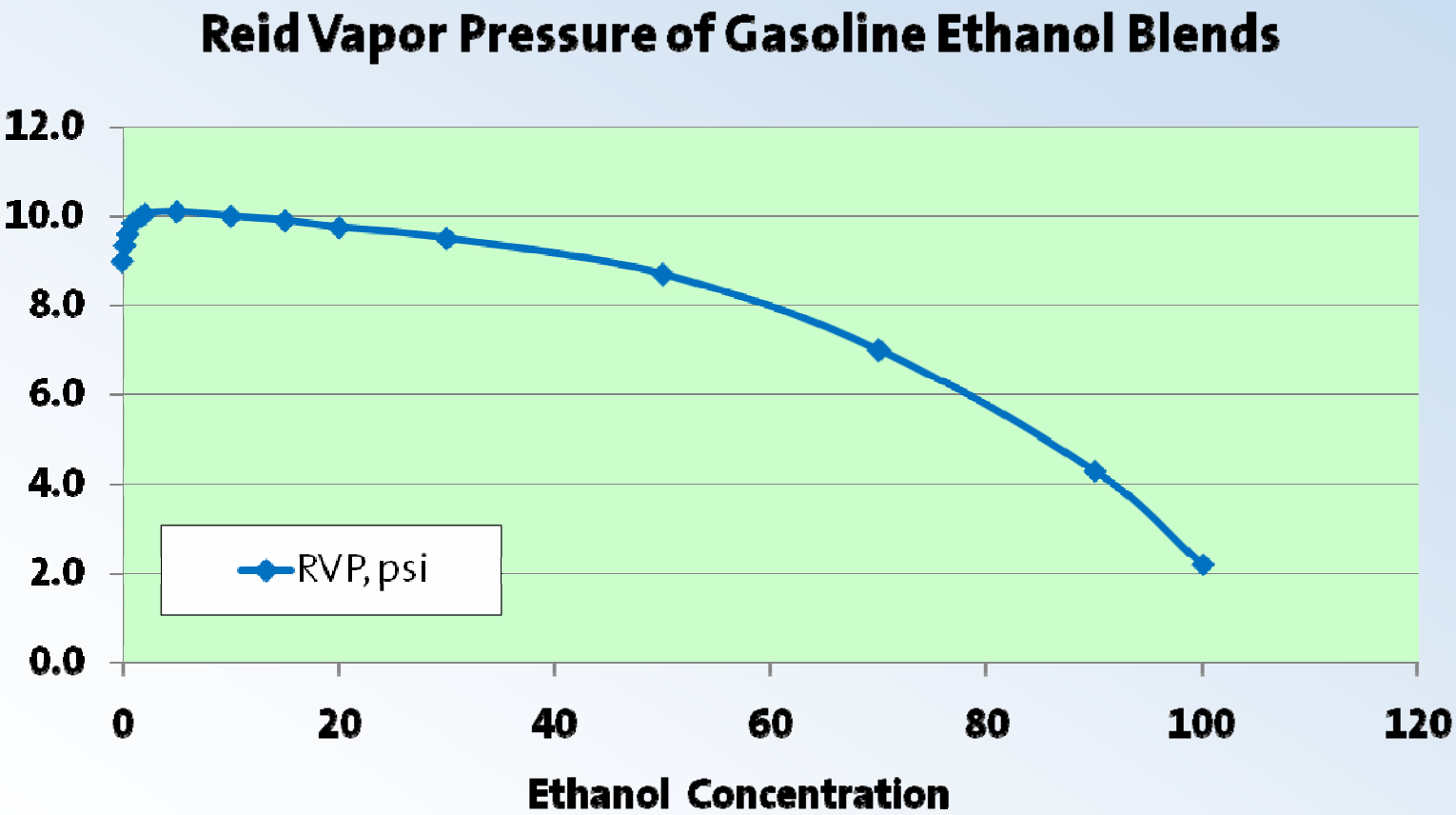


Importance of E85 Utilization

- EISA 2007 set goals that take us far beyond E10 – requiring 36B gallons/year of alternative fuels by 2022
- High concentration ethanol blends play a significant role in enabling EISA-based levels of ethanol supply growth in the U.S. marketplace
- Cellulosic feedstocks could allow biofuel production to reach 90 billion gallons of ethanol by 2030. Source: Sandia National Lab & GM's joint "90-Billion Gallon Biofuel Deployment Study", February 2009.
- Mid-level blends can at best provide only a temporary conduit and cannot satisfy required ethanol utilization mandates

Technical & Policy Challenges: Attainment of Emission Standards

- California PZEV/AT-PZEV
- Cold (50ºF and 20ºF) FTP



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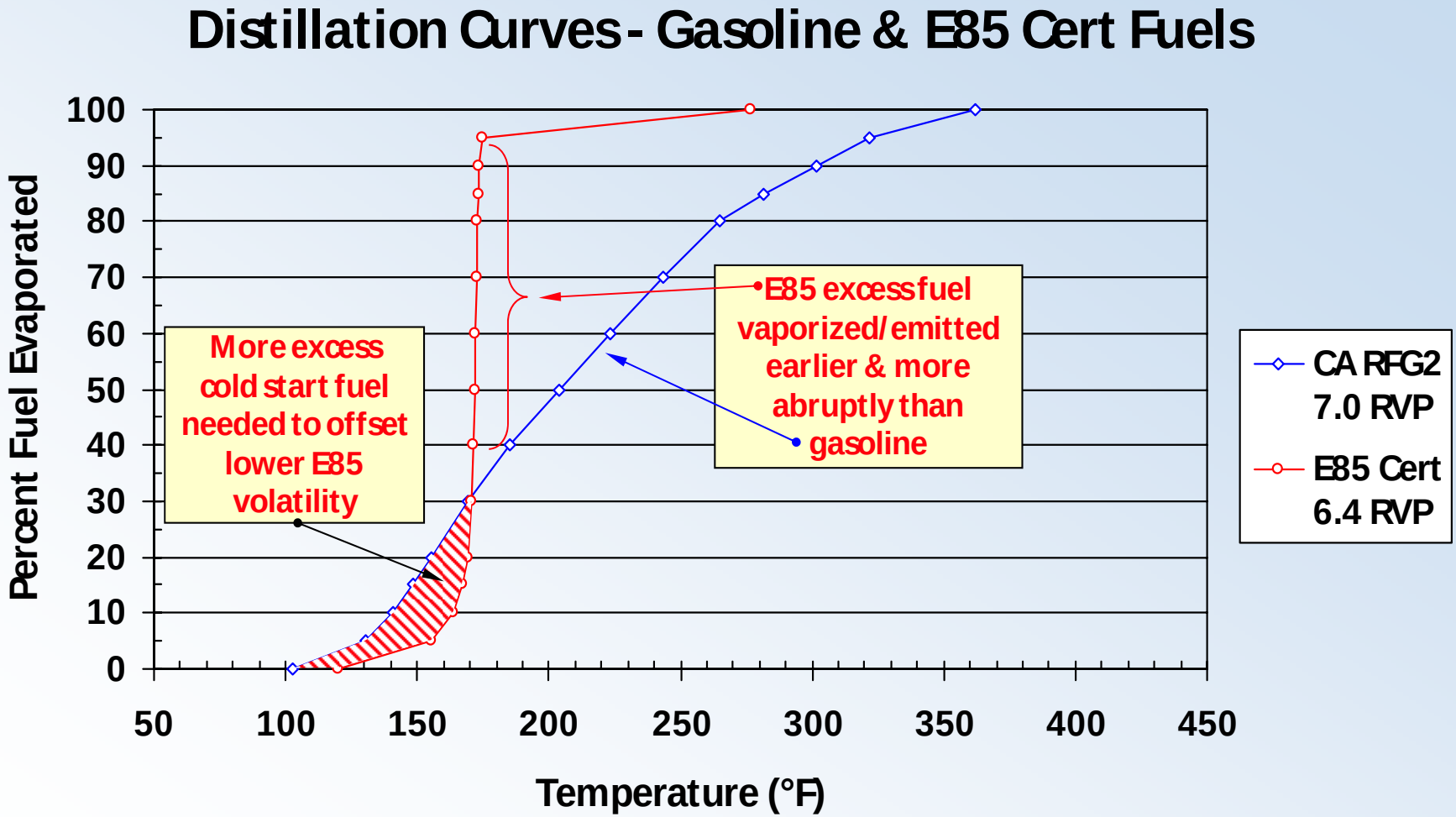
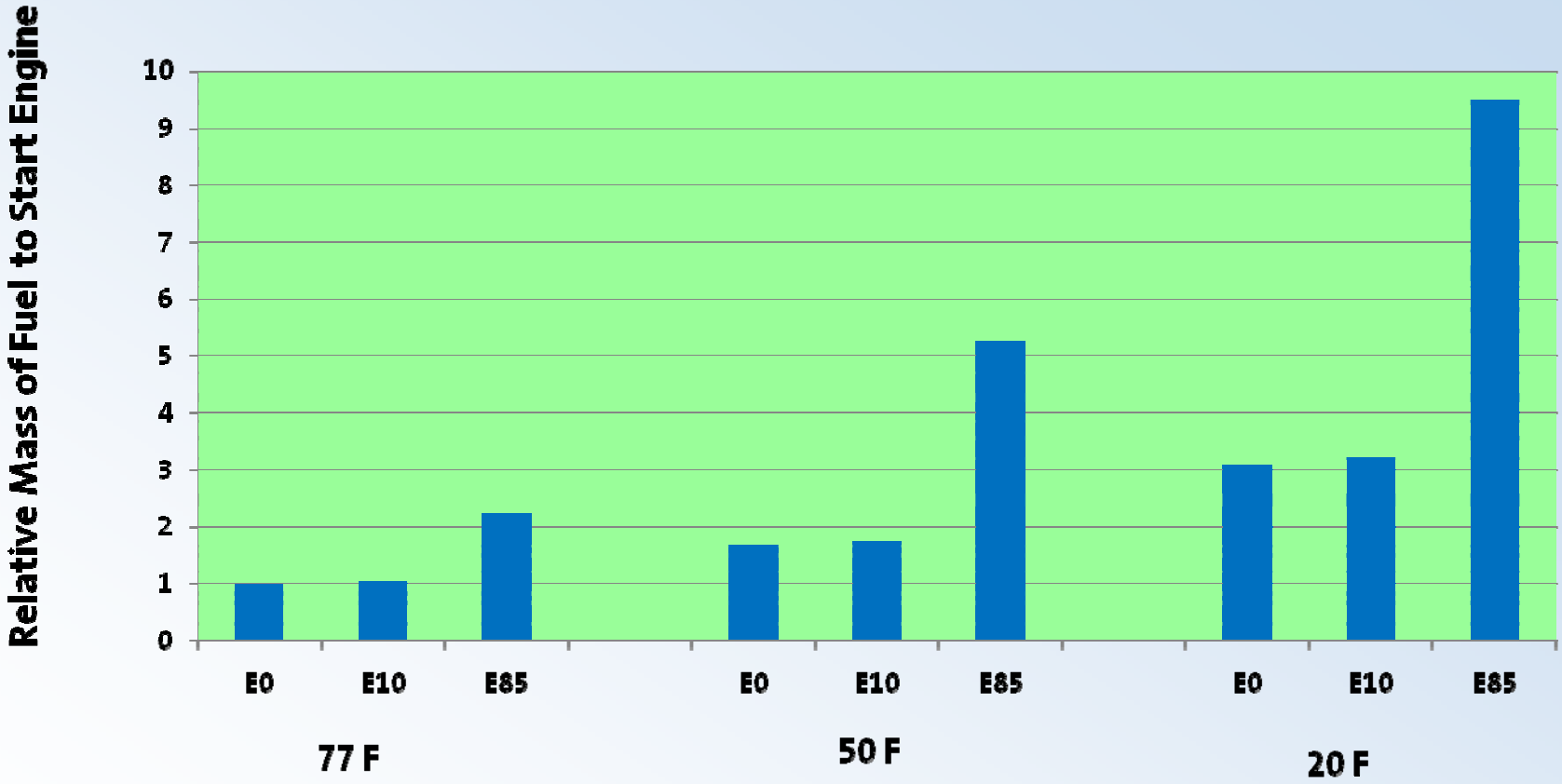
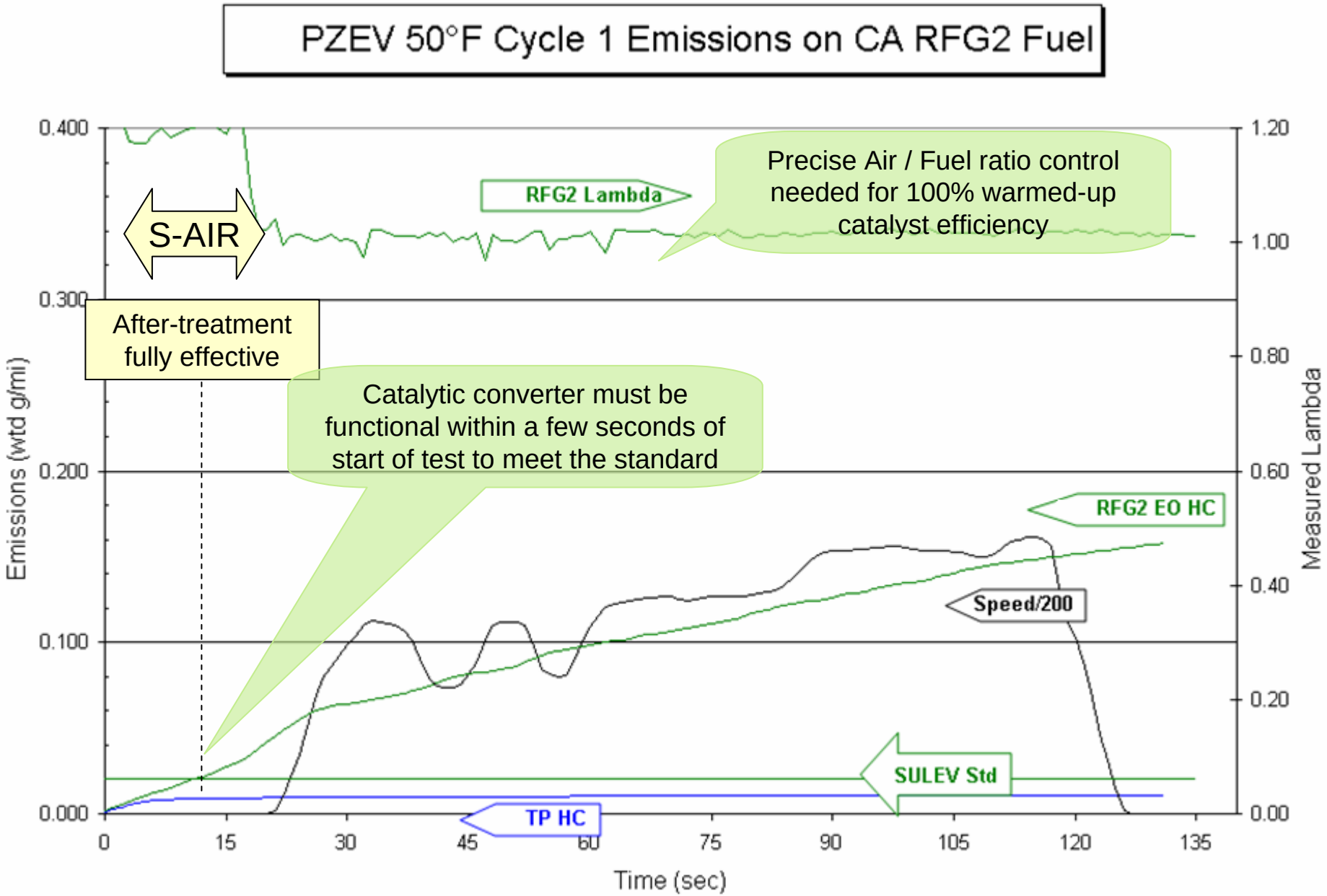
Technical & Policy Challenges: Attainment of Emission Standards



Technical & Policy Challenges: FFV Cold Start Fueling Data



PZEV – Tailpipe Emissions (SULEV)



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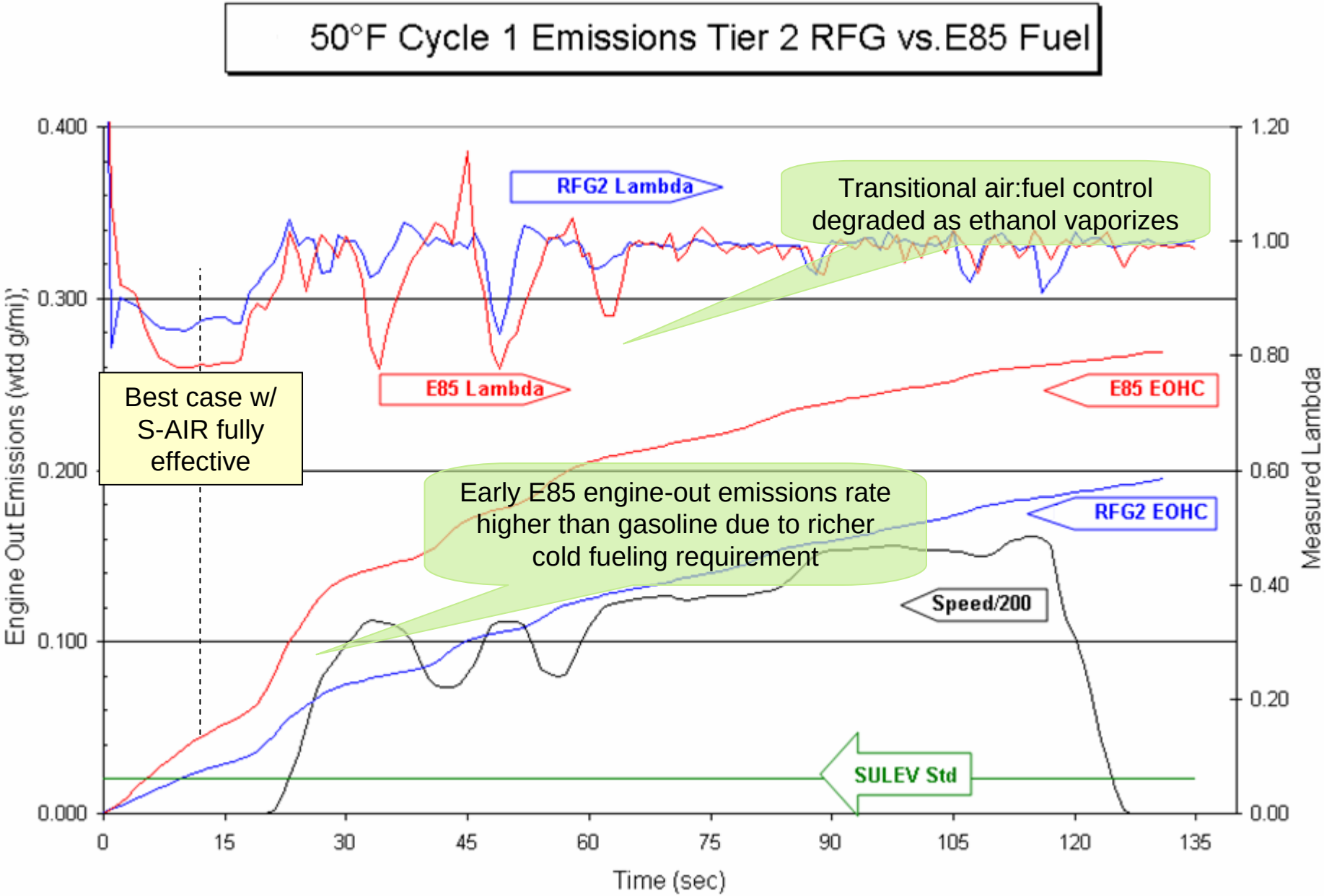

E85 Growth Initiatives for the Industry

- Target E85 distribution growth activities in high FFV concentration markets
  - More pumps
  - Pumps in the right places
- Increase rate of growth of FFV population – resolve regulatory and technology challenges to growth
- Ethanol (and other alternative fuels) prices must be less than the price of gasoline or diesel (when compared on an energy basis)
- Congress should direct EPA to create a rule to limit the carbon content of fuel (in the form of a National LCFS)

Mid-level Blend Ethanol Testing

- Effort started in 2007 as a result of a push for mid-level blends
- Domestic automakers & subsequently other autos joined to:
  - Draw on their global experience with ethanol & identify potential failure modes
  - Focus on areas with known issues based upon experience & literature
  - Design a plan to look at durability effects of mid-level ethanol
  - Engage the Coordinating Research Council (CRC)
- Under CRC's leadership, the test Program has broadened and is now referred to as the Mid-level Ethanol Blends Research Coordination Group and includes members from – Industry (auto, oil, marine, outdoor power equipment, engine manufacturers, motorcycle), Government (DOE, EPA) & RFA
- Test Plans have been developed, initiated or are under development by:
  - CRC (auto/oil) for vehicles
  - NMMA, OPEI, EMA for boats, outdoor power equipment and small engines. CRC committees are reviewing initial test plans.

Auto/Oil Mid-Level Ethanol Blend Test Plan

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CRC Companies

BP	Chevron
Chrysler	ConocoPhillips
ExxonMobil	Ford
GM	Honda
Marathon	Mitsubishi
Nissan	Shell
Toyota	VW

Components of Auto/Oil Test Plan

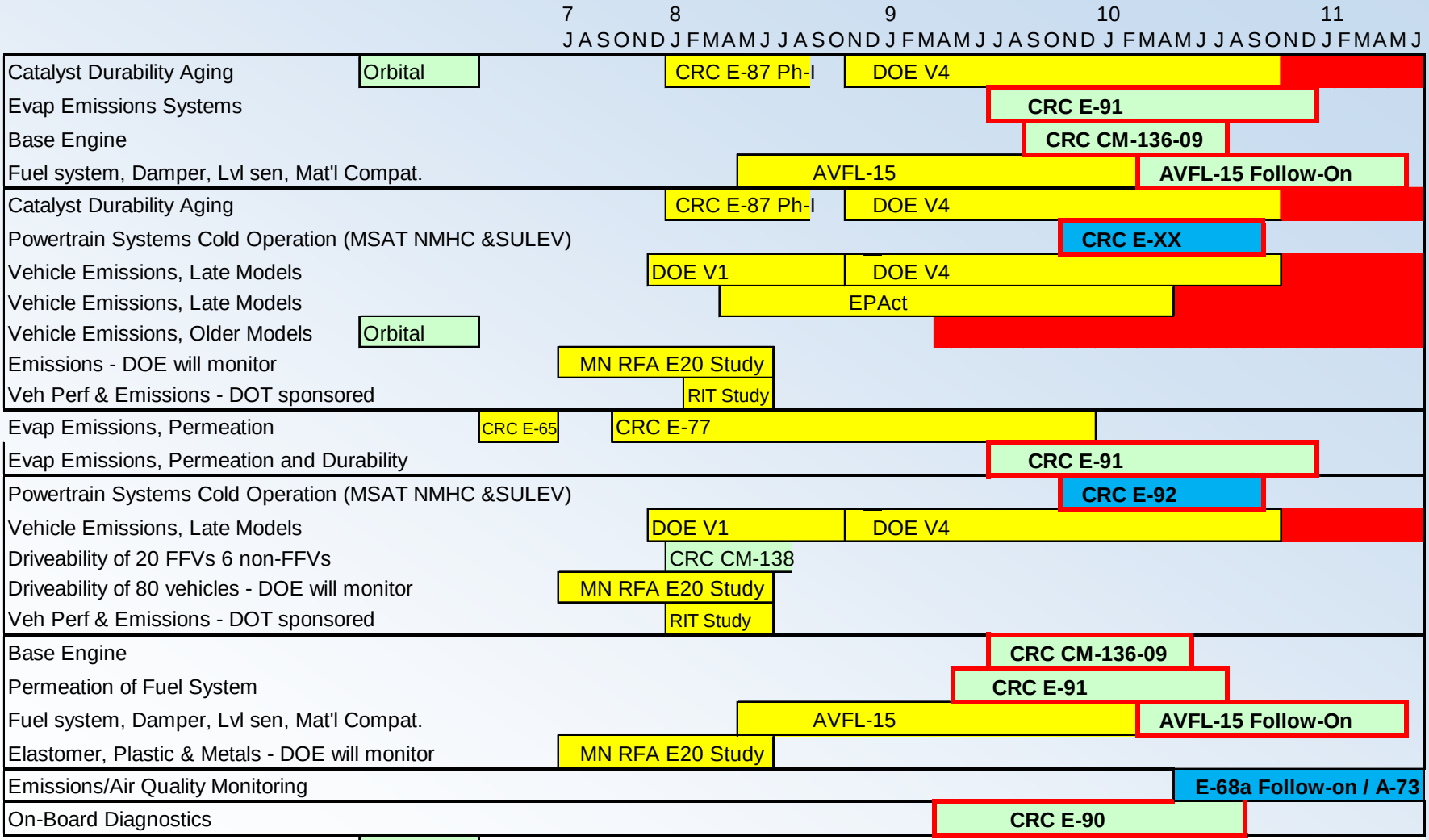
- Fuel Storage and Handling
  - Pump, tank, level sender, fuel line damper, fuel injector & rail
- Base Engine Durability
- On-Board Diagnostics Evaluation
- SULEV and Cold Ambient (20F) Operation
- Catalyst Durability and Degradation
- Evaporative Emissions
  - Long-term permeation
  - Durability of fuel system components
- Emission Inventory and Air Quality Modeling
- Exhaust Emissions on aged vehicles

Note: All test procedures are balloted through CRC and details of above test programs are shown in the back up slides.

Details of Auto/Oil Test Plan – One Sample

- Base Engine Durability - GM/Chrysler Lead
  - This program looks at the effects of mid-level ethanol blends on engine durability, whether directly or through the engine control system
    - Engine deterioration and failure due to ethanol usage will have a significant effect on public support for ethanol
    - As engines fail they become high emitters and will affect air quality
  - The goal is to document the composition threshold and extent of engine damage due to mid-level ethanol blends
    - Automakers upgrade engines for ethanol resistance
    - Many engines have their power protection systems compromised by mid-level ethanol blends
  - CRC CM-136-09 Statement of Work is out for bid

Status of Research on Mid-Level Blends



l Study includes preliminary data for tests & materials compatibility.

Thanks for your attention

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James Frusti
Senior Specialist – Fuels & Energy Affairs
Chrysler LLC

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Backup Slides Follow

- Single page summary of CRC Auto/Oil Test Plan
- Details of each major component of the CRC Auto/Oil Test Plan
- FFV density map by county

Auto/Oil E10+ Test Program for Highway "Non-FFV" Vehicles

Item #	Title	Project #	Status
1	Fuel Storage and Handling	CRC AVFL-15	While AVFL-15 is funded the follow-on program is not
The industries understand system components for E10 and also for E85, but it is unclear at what level of ethanol content above 10% that E10-rated parts fail. The objective of AVFL-15 is to determine the durability of wetted fuel components/systems. Fuel storage and handling is studied in component/systems durability testing. Resource constraints limited the scope of AVFL-15, preventing a definitive program, hence additional testing is required.			
2	Base Engine Durability	CRC CM-136-09	This expensive program awaits outside funding
The industry knows what is required to upgrade engine components for E22, E85 and E100. Some automakers have done internal testing and have found sensitivity to intermediate ethanol blend levels for non-FFV vehicles. The proposed testing for base engine durability (base refers to the actual machinery as opposed to the sensors, controls and the like) is embodied in CRC RFP No. CM-136-09 which will be ready for contracting in mid-2009.			
3	On-Board Diagnostics (OBD) Evaluation	CRC E-90	The first phase of E-90, site selection, is funded by CRC
The automakers have a good understanding of the theoretical effects of ethanol on OBD. The issue is how OBD systems actually work in a fleet of aged production vehicles. The proposed testing for OBD is defined in CRC Project No. E-90.			
4	Tailpipe Emissions for SULEV Vehicles and at Cold Ambient Temperatures	CRC E-92	A final project plan will be prepared by May 2009
Starting with the 2010 model year automakers have to meet Non-Methane Hydrocarbon (NMHC) emissions at a 20F start temperature. Automakers have had to meet stringent SULEV emissions at a 50F start temperature for many years. The enleanment due to oxygen in ethanol and the low volatility of the ethanol portion of the fuel blend at low temperature gives concerns that existing and planned vehicles designed for federal and California emissions test fuels will not meet their required emissions standards when operated on mid-level ethanol blends. Since this program does not envision aging the vehicles it should not be unusually expensive.			
5	Catalyst Durability and Degradation	CRC E-87	The course and fate of this program is currently unclear
The issue of accelerated catalyst aging with intermediate ethanol blends was well-documented in the Orbital research study conducted in Australia. DOE found that 44% of vehicles they tested had the same control architecture as those that had problems with E20 in Australia and their data, when combined with CRC E-87-1 data, indicates that 35-45% of the US fleet will have this sensitive control architecture. Durability testing to identify this phenomenon was planned for CRC program E-87-2. E87-1 was funded by CRC and the report is pending. E-87-2 was funded by DOE with minor funding from CRC.			
6	Evaporative Emissions Durability	CRC E-91	This expensive program awaits outside funding
As reported in previous intermediate ethanol blend research coordination meetings, CRC has conducted research projects under E-65 and E-77 on the effects of ethanol on evaporative emissions. However, these tests have all looked at the effects of short exposures. This project has been defined in CRC RFP No. E-91 which will be ready for contracting in mid 2009.			
7	Emissions Inventory and Air Quality Modeling	A-67 / A-73	A-67 are underway and A-73 is planned for a start in 2009
The CRC Atmospheric Impacts Committee is leading this effort in coordination with others. A program to evaluate ethanol blends requires final release of the EPA MOVES Emission Factor Model, A-67 (Estimating Ozone from Fuel Reformulation) and A-73 (Emissions Modeling and Air Quality Modeling) are the CRC programs that will address this subject. These efforts rely on obtaining emissions data from the other CRC programs above.			
8	Exhaust Emissions on Vehicles Aged On Mid-Level Ethanol Blends	CRC New Project	The details of this project are under development
A good collection of aged vehicle data will be acquired in the above programs. These data will be available for assessing direct emissions impacts from intermediate ethanol blends and for conducting air quality modeling evaluations.			

Details of Auto/Oil Test Plan

- Fuel Storage and Handling (vehicle perspective) – Ford Lead
  - CRC program AVFL-15 - screening to identify sensitive components and vehicles underway
  - The industries understand system components for E10 and also for E85, but it is unclear at what level of ethanol above 10% that rated parts fail.
  - The objective of AVFL-15 is to determine the durability of wetted fuel components/systems. Fuel storage and handling testing is embodied within this program.
  - Resource constraints limited the scope of AVFL-15, preventing a definitive program - additional testing is required.

Details of Auto/Oil Test Plan

- On-Board Diagnostics Evaluation – Honda Lead
  - This program looks at the effect of mid-level ethanol blends on the On-Board Diagnostic (OBD) system.
  - There are several diagnostic tests that are affected by increasing the oxygen in the fuel.
    - Excessive oxygen can cause MILs (malfunction indicator lights) to set when no problem exists
    - Conversely, excessive oxygen can prevent MILs from setting when real problems exist
  - Many states use OBD as part of their in-use monitoring programs
  - The goal is to document the effects of increased fuel oxygen on the OBD system.
  - CRC E-90 is in test site selection phase and a follow-on to this pilot study will likely be needed

Details of Auto/Oil Test Plan

- Tailpipe Emissions for SULEV z& Cold Ambient Operation – Toyota Lead
  - This program looks at the effects of mid-level ethanol blends on tailpipe emissions, both the 20F MSAT NMHC requirement being phased in with 2010 model year vehicles, and the longstanding SULEV (Tier 2 Bin 2) standards
    - Vehicles are certified on federal emissions test fuel (E0).
    - Rigorous emissions standards emphasize minimization of cold start emissions
    - For most manufacturers ethanol levels are not recognized during cold start and emissions compliance is at risk
  - The goal is to document effects of mid-level ethanol blends on emissions relative to these rigorous standards
    - Testing will initially not use appropriately aged catalysts and will thus be only a snap shot or “Quick Look”
    - Follow-on testing using appropriately aged catalyst based on modified parameters developed during the catalyst aging program is possible depending on the results of other programs
  - Statement of Work under development

Details of Auto/Oil Test Plan

- Catalyst Durability & Degradation – GM Lead
  - This program looks at the effects of mid-level ethanol blends, directly and through the engine control system, on catalyst durability
    - Catalyst deterioration will have a significant effect on air quality
  - The goal is to determine the existence and extent of the catalyst deterioration documented by the study done for the Australian Department of the Environment
  - CRC program E87-1, screening to identify sensitive vehicles
    - Complete
    - Report pending
  - CRC program E87-2, durability testing on sensitive vehicles
    - Complete revision of test program has been proposed by DOE
    - The course and fate of this program is currently unclear

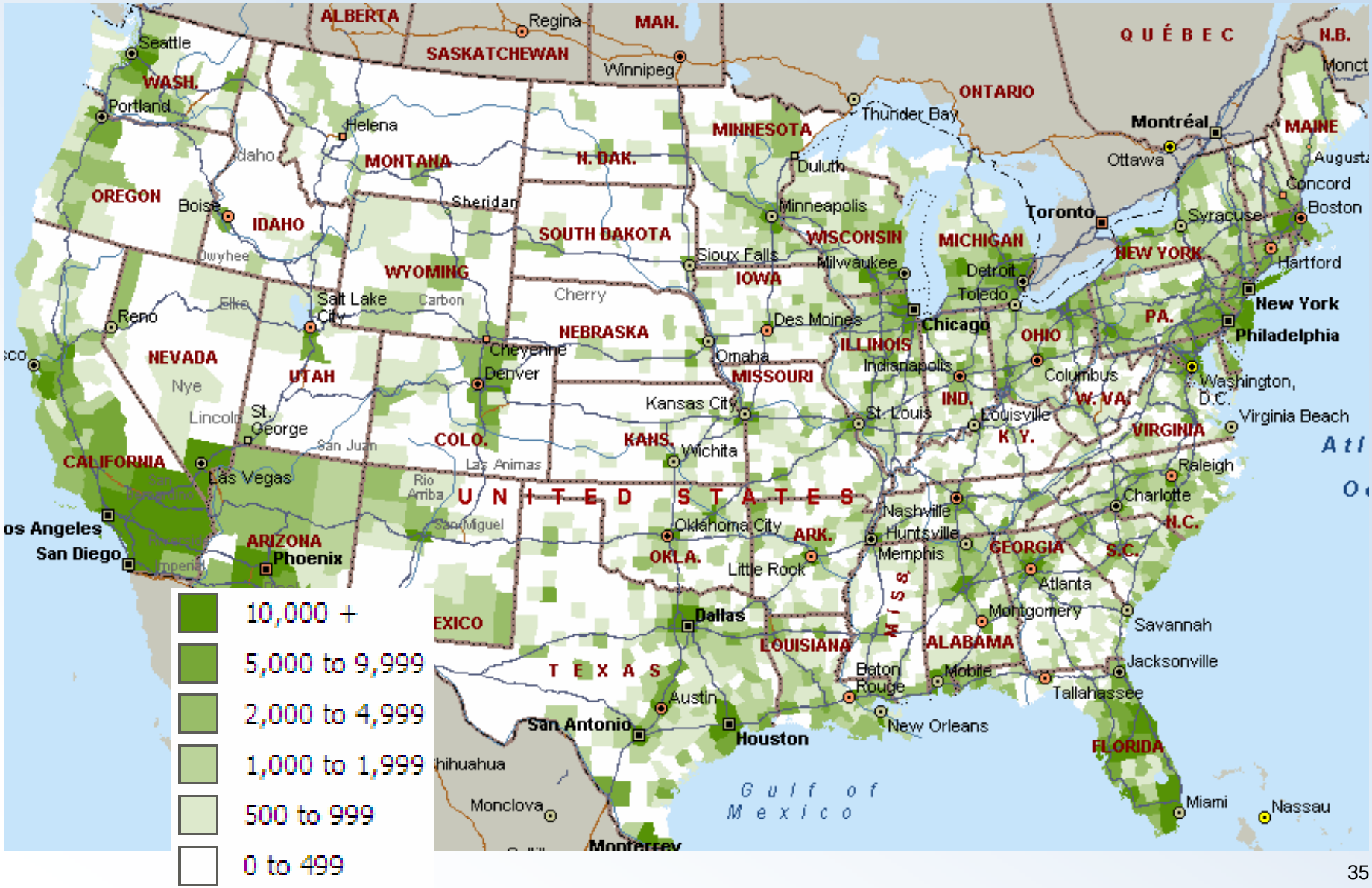
Details of Auto/Oil Test Plan

- Evaporative Emissions – Useful Life – Chrysler/GM Lead
  - This program looks at the effects of mid-level ethanol blends on evaporative emissions durability
    - Deterioration of the evaporative emissions system will have a significant effect on air quality
  - The goal is to build on CRC programs E-65 that documented ethanol's evaporative emissions effects. The test plan is built using the California regulations regarding evaporative emissions durability testing
    - California data is used for EPA certification
  - CRC program E-91 Statement of Work is out for bid

Details of Auto/Oil Test Plan

- Exhaust Emissions
  - The effects of long term exposure need to be determined for vehicles likely to be exposed to mid-level ethanol blends
  - This will be done as part of the other portions of the CRC program
- Emission Inventory and Air Quality Modeling – Chevron/Ford Lead
  - CRC E-68a Follow-on (MOVES Emission Factor Model Evaluation)
  - A-67 (Estimating Ozone from Fuel Reformulation)
  - A-73 (Emissions Modeling and Air Quality Modeling)
  - Projects to incorporate mid-level ethanol exhaust and emission impacts into MOVES and ultimately provide an emission inventory analysis
  - These projects can begin once EPA validates their MOVES model and the data from the other portions of the CRC program

FFV Density Map by County



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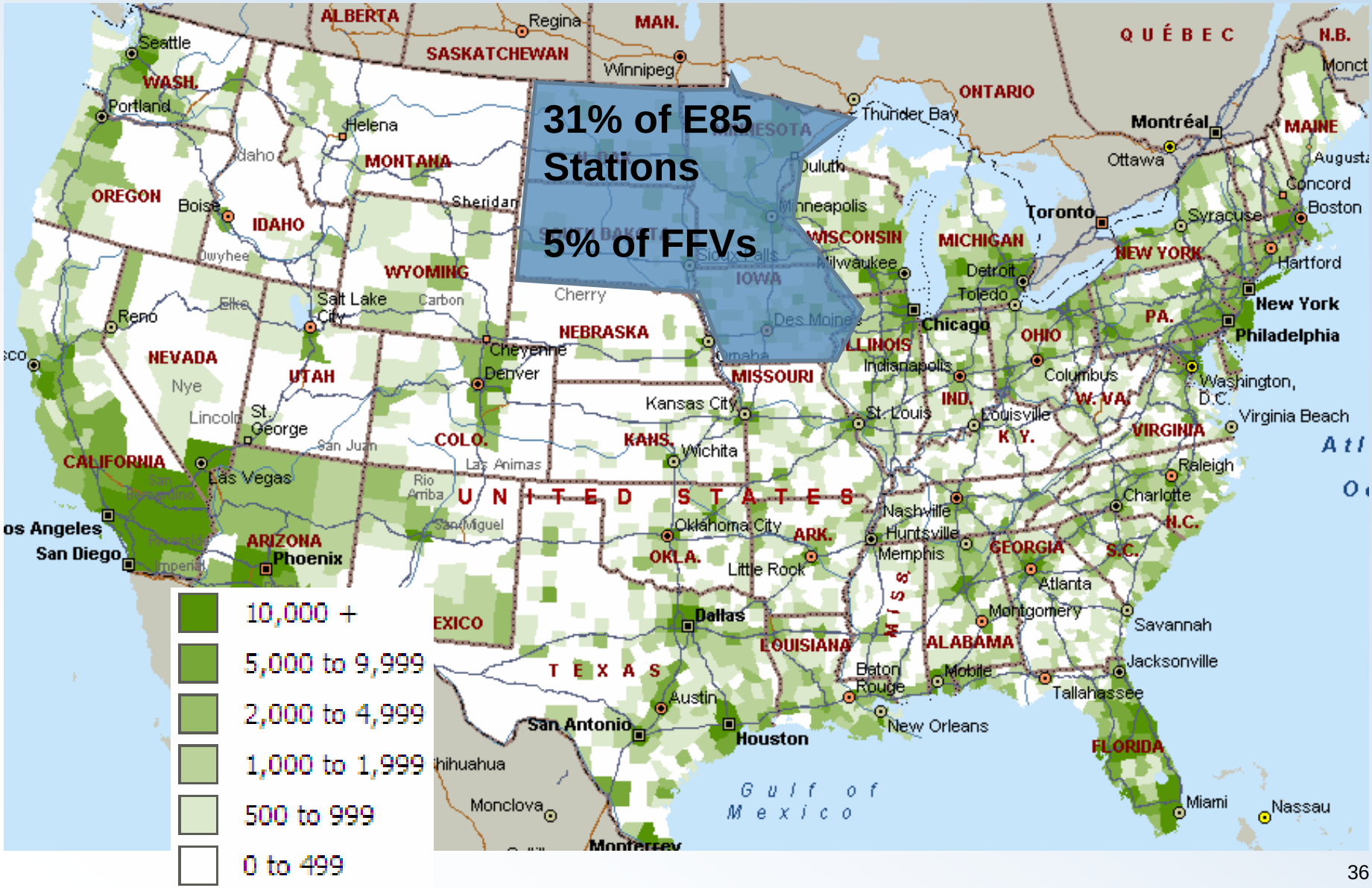

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