# A Grassroots Renewable Fuels Revolution


**Presenters**

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**Contributors**

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Dave Kalen (Sensors, Inc.). Horace Mast (Mast Motorsports). Jim McFarland (Engineer, Performance Professor). Zehr Racing.


- Project Objectives
- Engine Testing Results
- Track Testing Results: Performance
- Track Testing Results: Emissions
- Race Demonstration
- A Revolution
- Conclusions

# Project objectives

- Demonstrate using renewable fuels and modern technology:
  1) Significant petroleum displacement
  2) Significant well-to-wheel (WTW) greenhouse gas reduction
  3) Significant criteria emission reduction
  4) Increased performance
  5) Greatly reduced operational cost

- Generate significant educational outreach:
  1) Supply a market for sustainable renewable fuels
  2) Reduce apprehension for adopting the use of newer fuels/technologies
  3) Increase the numbers of racers, spectators, and open new business opportunity's



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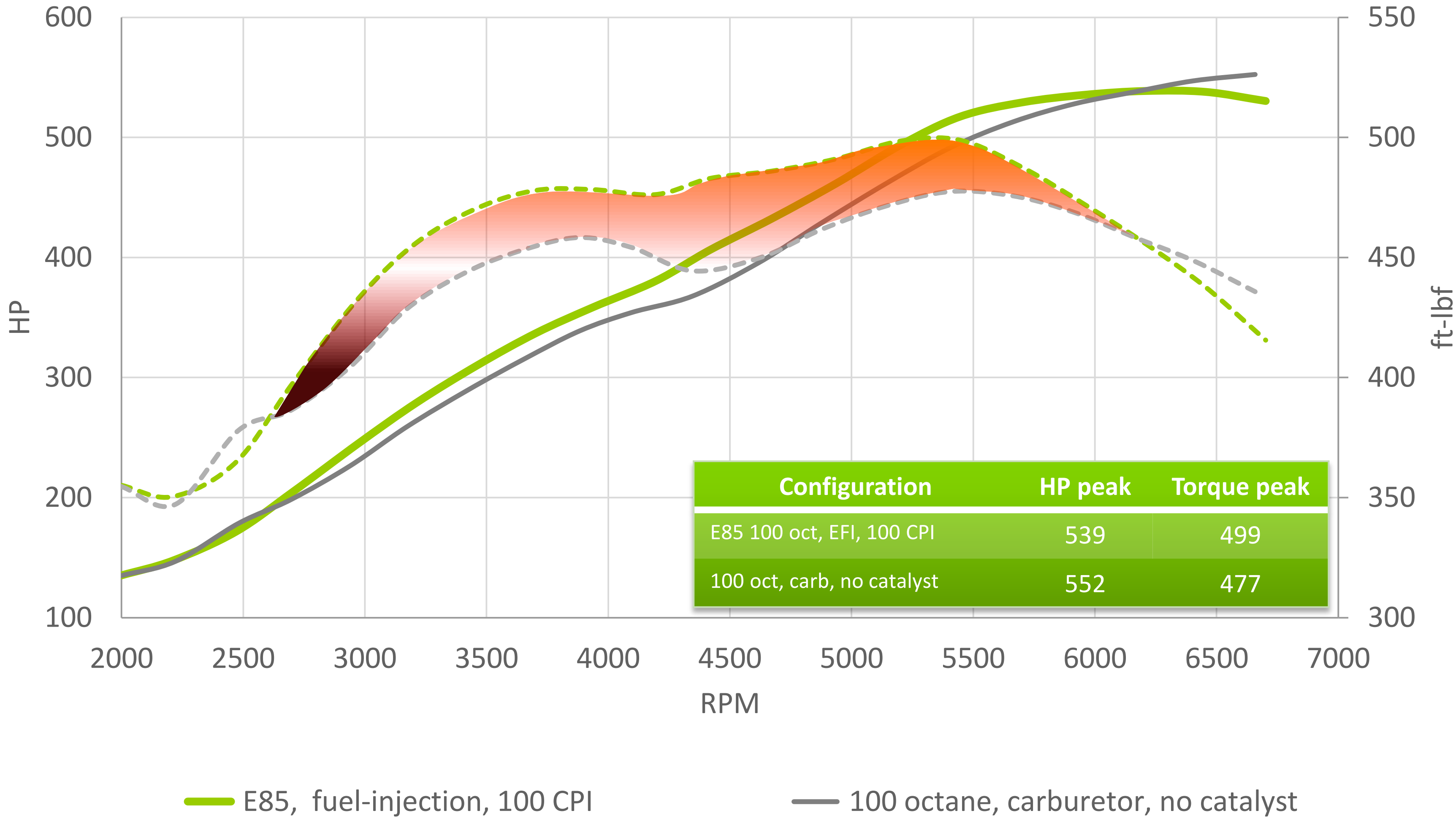
# Engine testing

- LS3 based 6.2L GM CT-525 engine was tested at Mast Motorsports

- Testing benchmarked technologies and fuels:
  1) Fuel injection vs. carburetion
  2) E85 vs. 100 octane race fuel
  3) Catalyst vs. non catalyst

- Sensors, Inc. SEMTECH DS was used for emissions/fuel consumption analysis (portable emissions measurement system- PEM

# E85 EFI w/ catalysts vs. 100 octane carburetor




**EFI** = Electronic Fuel Injected **E85** = ethanol fuel (85% ethanol, 15% petroleum) **carb** = carbureted
**nocat** = no catalyst **100CPI** = 100 cell per inch catalyst **300CPI** = 300 cell per inch catalyst **100oct** = 100 octane race fuel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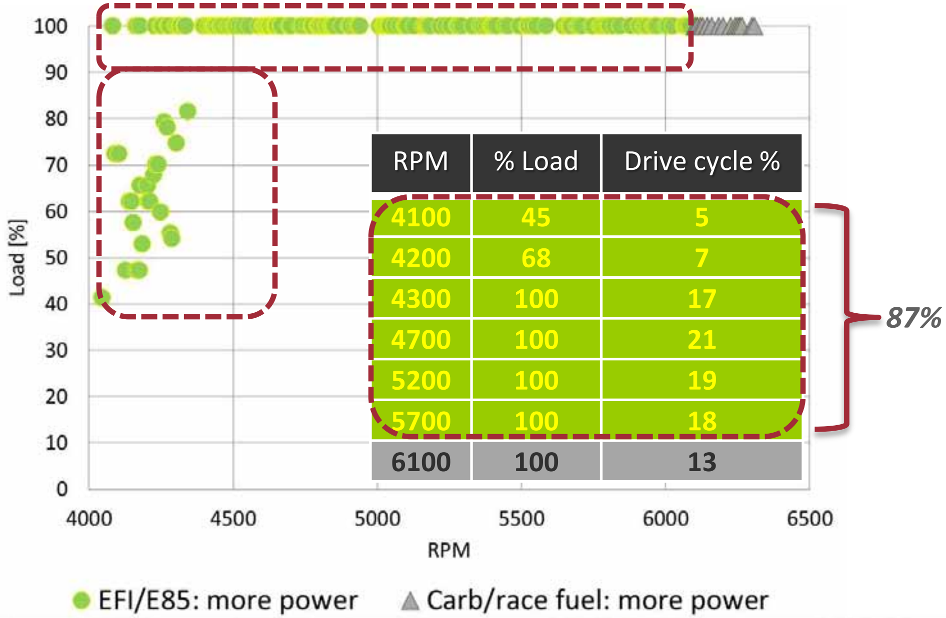
# Track testing

- The same 6.2L GM CT-525 engine was used in a Chevrolet Camaro circle track car and tested at New Smyrna raceway
- Sensors, Inc. SEMTECH DS portable emissions measurements system was used for emissions/fuel consumption analysis
- Testing matrix benchmarked technologies and fuels:
  1) E85 vs. 100 octane race fuel
  2) Fuel injection vs. carburetion
  3) Catalyst vs. non catalyst

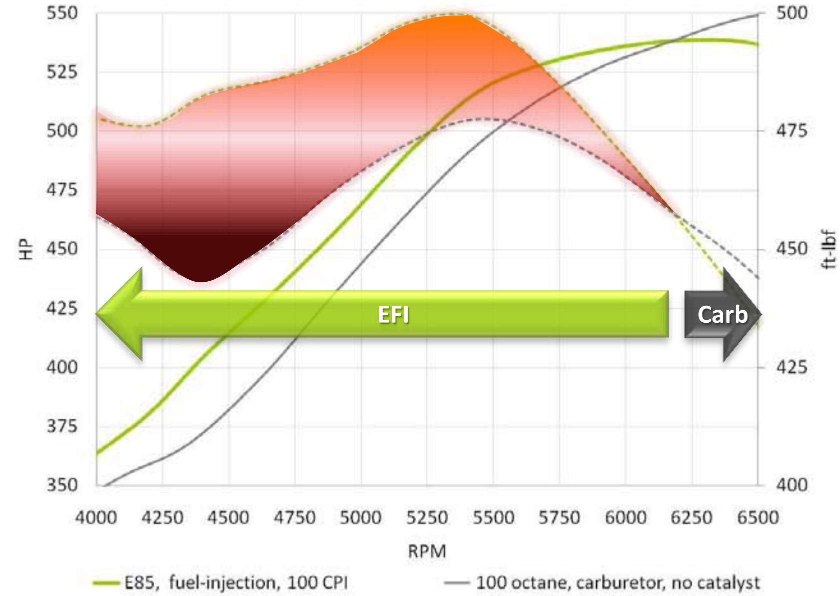
# Dynamometer/track tests detail increased performance

On track recorded engine speed/load points. Data points color coded between EFI/E85 and carburetor. E85 more power for vast majority of drive cycle.




| RPM | % Load | Drive cycle % |
|---|---|---|
| 4100 | 45 | 5 |
| 4200 | 68 | 7 |
| 4300 | 100 | 17 |
| 4700 | 100 | 21 |
| 5200 | 100 | 19 |
| 5700 | 100 | 18 |
| 6100 | 100 | 13 |

E85, EFI configuration with catalysts makes more power and torque 87% of the time weighted engine RPM/load range: Results = faster lap times.

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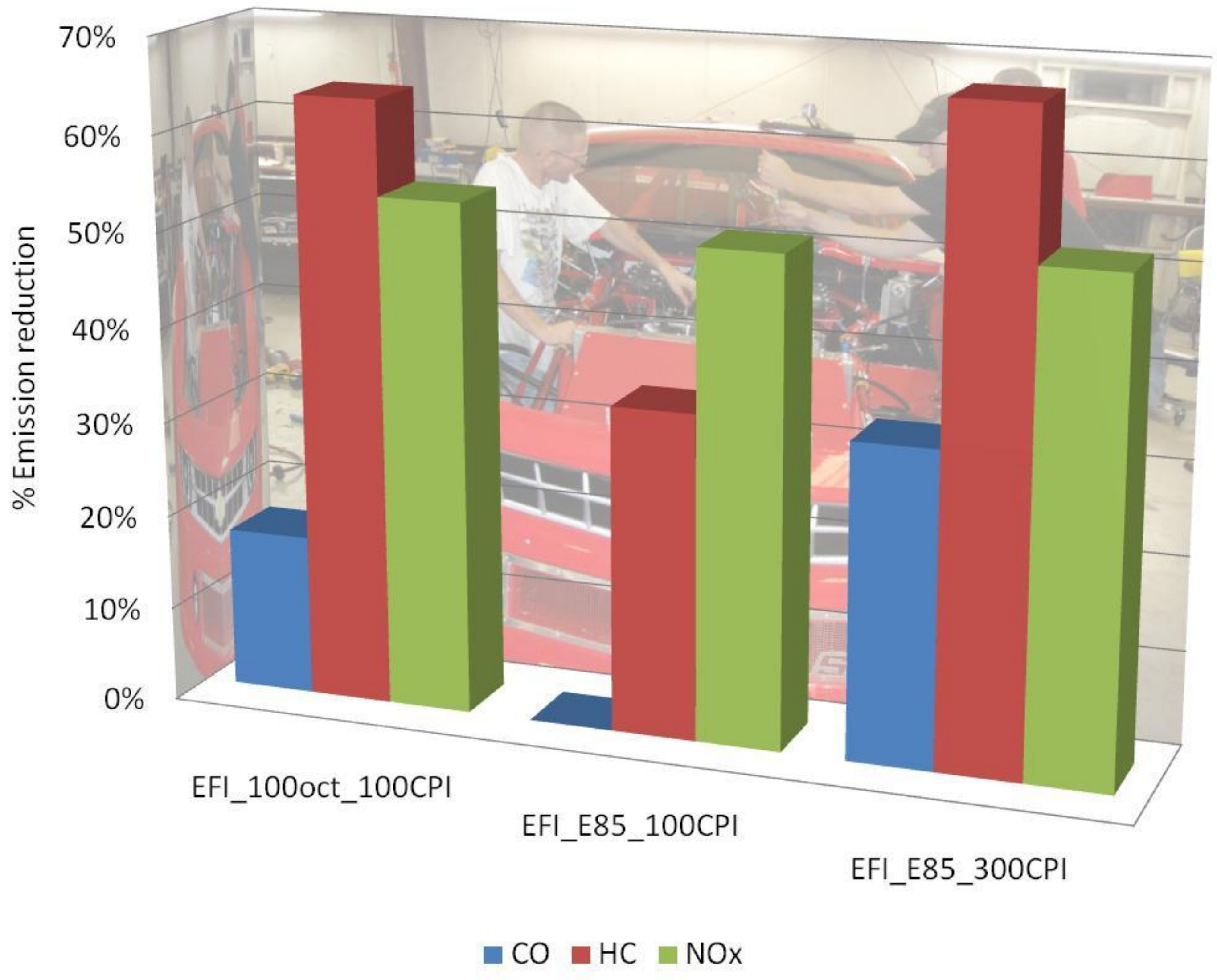
# Catalyst emission reduction - EFI configuration

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nocat = no catalyst 100CPI = 100 cell per inch catalyst 300CPI = 300 cell per inch catalyst 100oct = 100 octane race fuel


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# Race demonstration

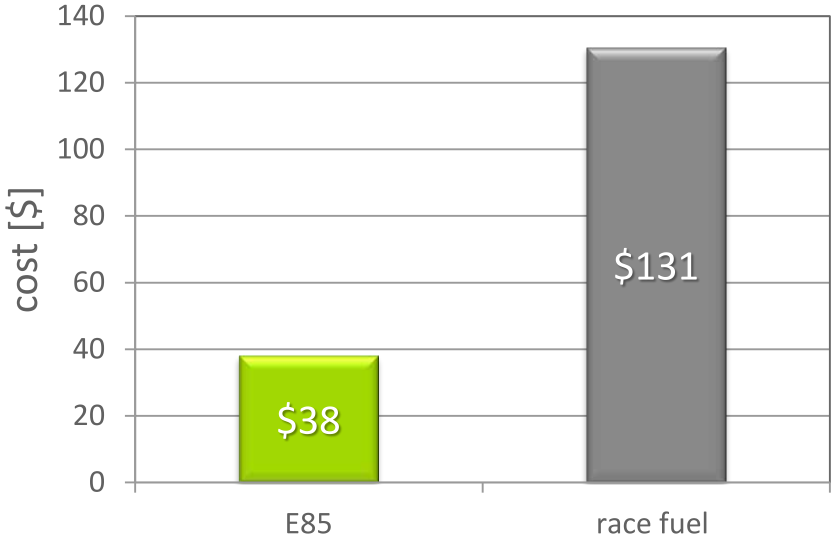
- The Chevrolet Camaro circle track race car using the same 6.2L GM CT-525 engine was raced at the La Crosse-Wisconsin Oktoberfest, 2010
- Data acquisition system measured real time fuel flow, CAN parameters, GPS
- Race car ran exclusively on E85, fuel injection, catalytic convertors (100 CPI)
- Data was analyzed and the petroleum displacement/GHG reduction determined


# La Crosse Speedway – ½ mile asphalt track

The Project G.R.E.E.N Camaro placed 14/65

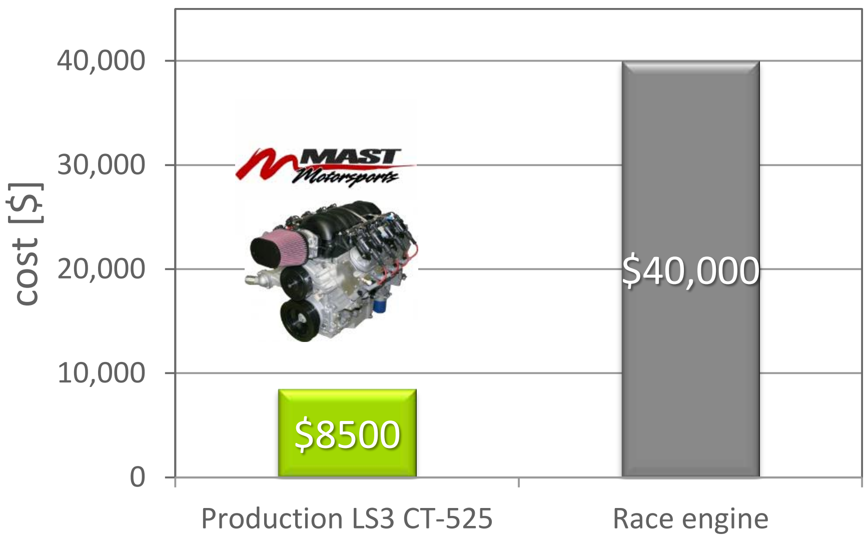
# …and what did it cost us? E85 + tech saved $31,593

## Fuel costs




- Cost of E85 was ~$2.35 per gallon. Race fuel at the track was $10.75.
- Consuming just over 16 gallons of E85, our fuel cost for the weekend was $38.
- Accounting for the per gallon E85 energy deficit, race fuel would have cost $131.

## Engine costs




- The GM production CT-525 engine costs approximately $8500 (our engine).
- Custom built fuel injected LS3 engines cost approximately ~$14,000 (605 HP).
- Race engines at the event cost approximately $40,000.

**These cost savings would grow the market size and support for renewable fuels**

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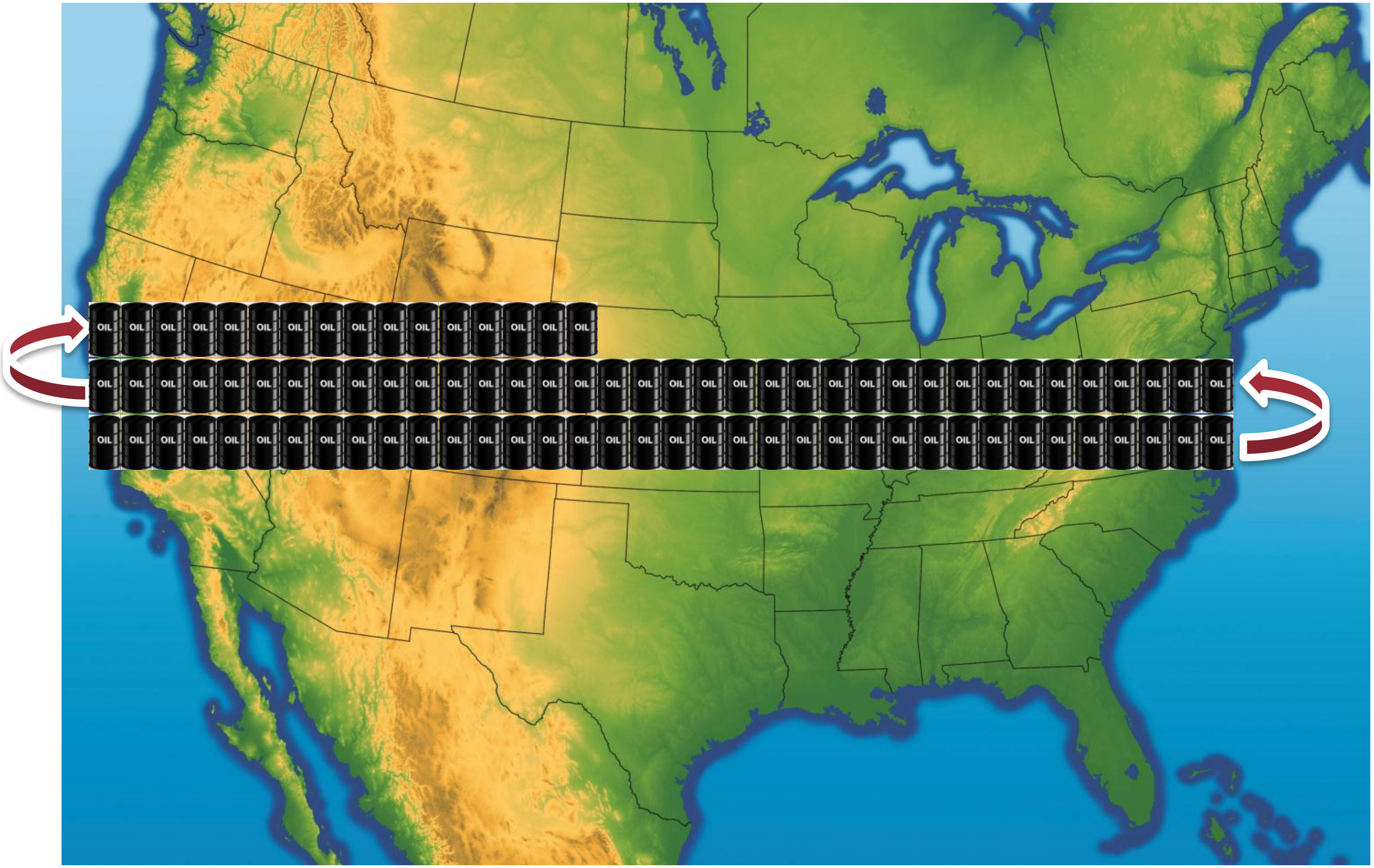
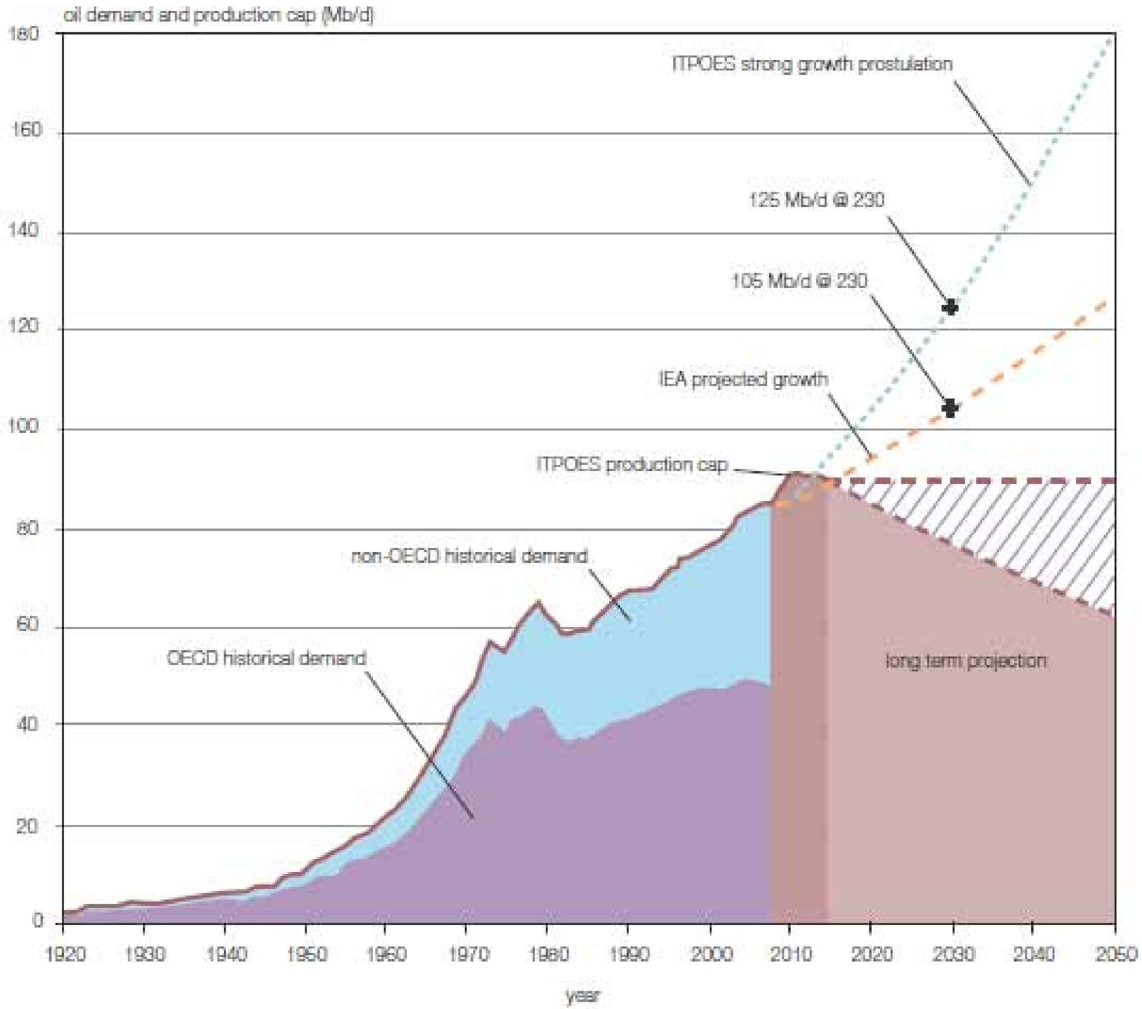
# The U.S. consumes over 20 million barrels of oil per day, ¼ the worlds total. How much is that?

One day of U.S. consumption, 20 million barrels side-by-side, would stretch from California to the east coast, back to the west coast, then back to Nebraska.



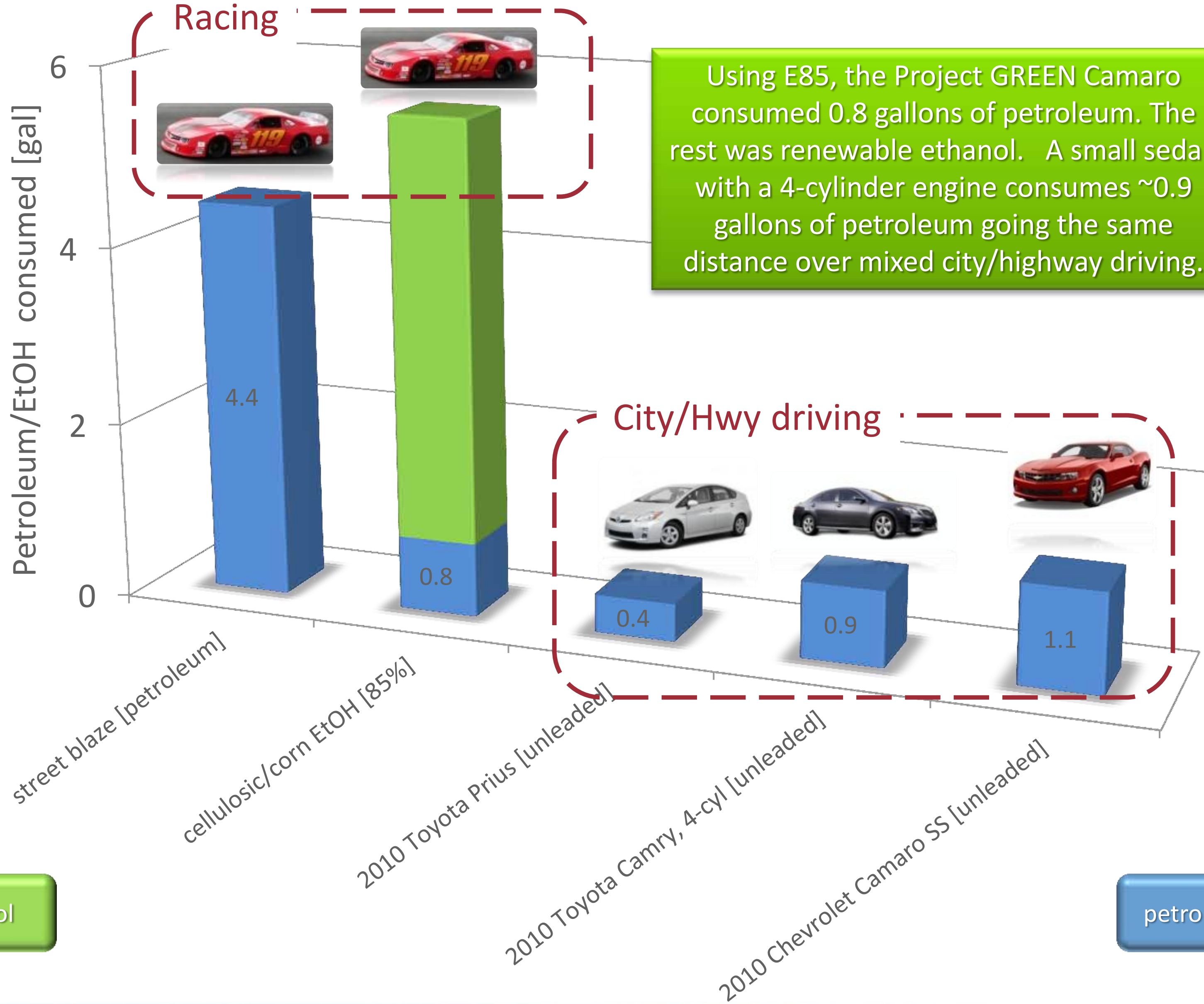
# The upcoming global oil gap[1]




1. The Oil Crunch- A wake-up call for the UK economy, Industry Taskforce on Peak Oil & Energy Security Second report of the UK Industry Taskforce on Peak Oil & Energy Security (ITPOES). February 2010.

Fig 6.6 Oil demand for the historical period 1920-2008, with extrapolations to 2050 for the IEA 'Reference Case' (1% growth rate) and the ITPOES 'strong growth' case. Also shown are two projections for production: a plateau (based on Shell's paper in the first ITPOES Oil Crunch Report, 2008), and the ITPOES production cap (Section 3) followed by a 1 percent per annum net depletion rate. (Sources: BP Statistical Review of World Energy and the IEA's World Energy Outlook 2009).

# Petroleum displacement - 33 laps of racing (~21 mi)



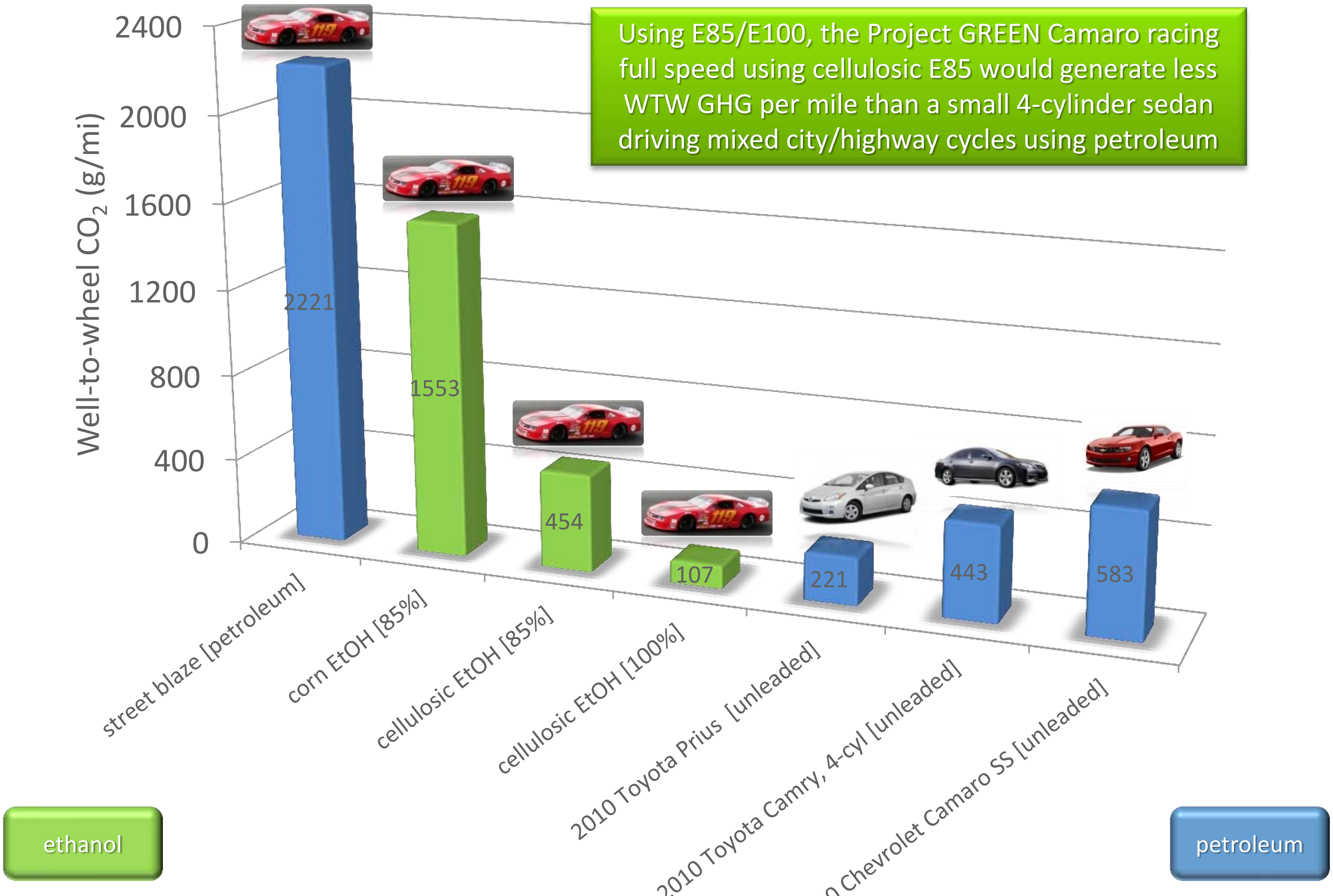

Using E85, the Project GREEN Camaro consumed 0.8 gallons of petroleum. The rest was renewable ethanol. A small sedan with a 4-cylinder engine consumes ~0.9 gallons of petroleum going the same distance over mixed city/highway driving.

ethanol

petroleum

# GREET modeled greenhouse gas results[5]

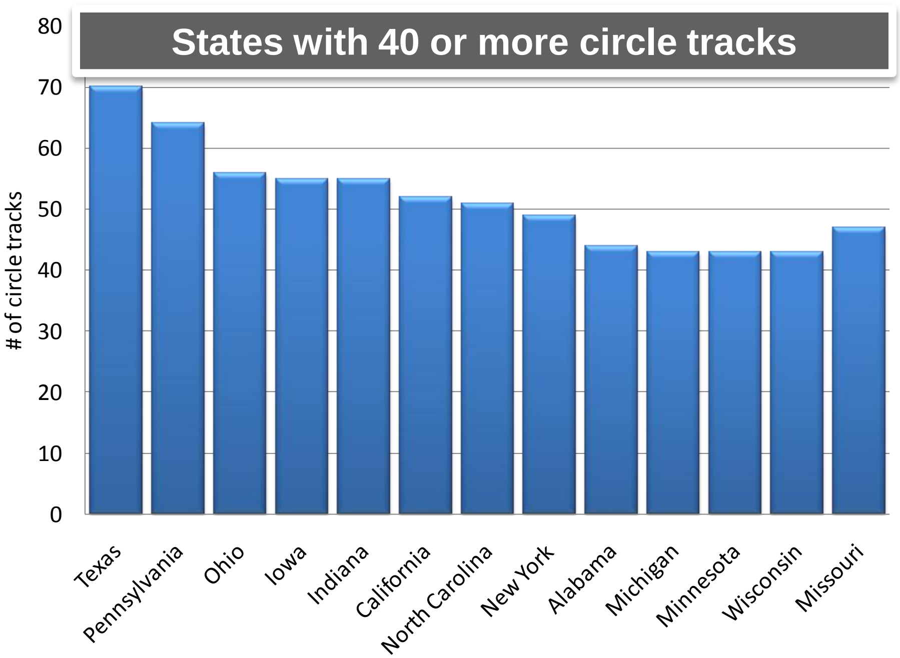
Using E85/E100, the Project GREEN Camaro racing full speed using cellulosic E85 would generate less WTW GHG per mile than a small 4-cylinder sedan driving mixed city/highway cycles using petroleum

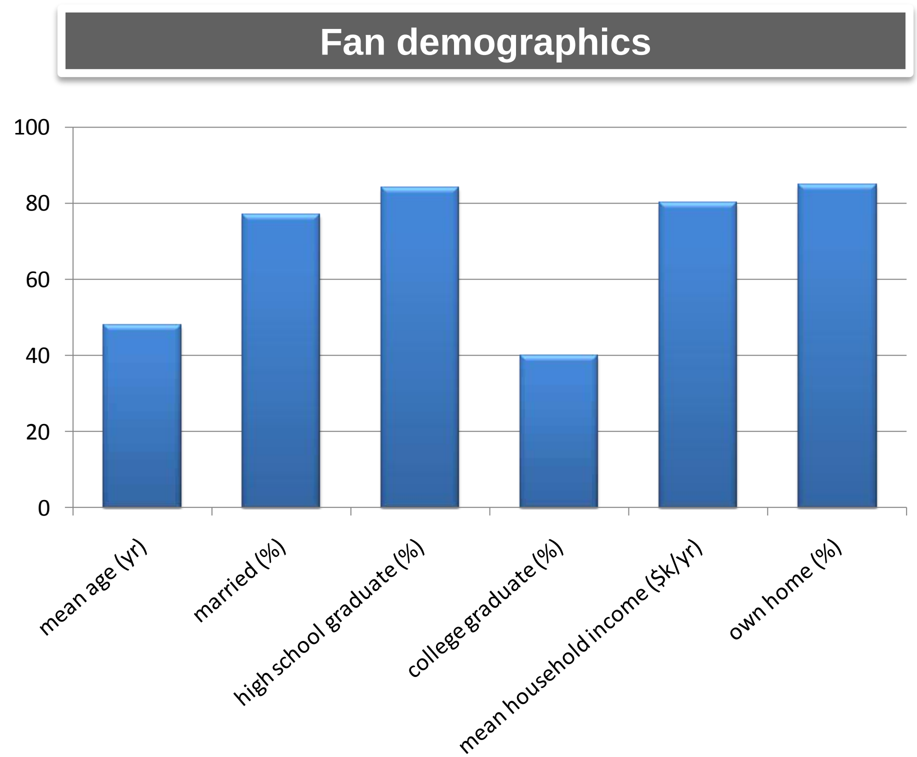



5. http://www.transportation.anl.gov/modeling_simulation/GREET/index.html

# Circle track racing has tremendous renewable fuels and advanced technology outreach potential!

- 20+ million people attend grassroots oval track races (annually)
- Auto racing is the #2 television audience sport in the U.S. (second to the NFL)
- There are approximately 443,000 participants (teams/drivers) in the United States [6]
- There are over 1,100 oval tracks in the U.S.- every state has an oval race track




6. According to 2004 data, Circle Track Magazine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# Faster. Cheaper. Cleaner. Sustainable.
# There are no Compromises

- Going green and going faster are synonymous
  - increased performance at a ~75% cost reduction
  - reduced petroleum consumption ~ 80% with domestically generated renewable fuels
  - reduced GHGs by ~75%
  - criteria emissions by ~60%
- Circle track racing offers tremendous audience for renewable fuels and sustainability
- Tremendously powerful message if cellulosic E85/advanced technology used:
  - In a 100 lap race, E85 would consume roughly 2.0 gallons of petroleum, less than a 4-cylinder small sedan, using petroleum, covering the same distance in mixed city/highway driving
  - GREET analysis shows that less WTW GHG would be emitted, per mile, using cellulosic E85 than a 4-cylinder small sedan using petroleum

# Environmentalists?


# Environmentalists!