

# Chemistry and Emmissions of NExBTL®

Prepared for:

**UC Davis, CARB & CEC  
Meetings**

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California

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On behalf of:  
Neste Oil

**NESTE OIL**

refining the future

# Agenda

- A conventional CARB diesel fuel made from renewable resources
- Neste's non-ester renewable diesel fuel, NExBTL®
  - Its properties
  - Its impact on emissions



# Evolution in Renewable Diesel Fuels

- The Original - vegetable oil or animal fat
  - Proposed early on by Diesel. Its direct use can generate operating problems and failure in modern diesel engines
- First Generation - biodiesel (mono alkyl esters) like FAME
  - Cetane is good by US standards; outstanding lubricity; reduces particulate, hydrocarbon and greenhouse gas emissions
  - Cold weather properties, stability problems, quality control and USEPA's belief it increases NOx may limit use
- Second Generation - renewable hydrocarbon diesels
  - Cetane is outstanding by World standards; cold weather, storage stability and fungibility are excellent; reduces emissions of NOx, greenhouse gases, particulates, hydrocarbons & CO
  - Like most ultra low sulfur diesel fuels it requires a lubricity additive
- Third generation is undefined- It may be gasification/Fischer Tropsch or biotech conversion



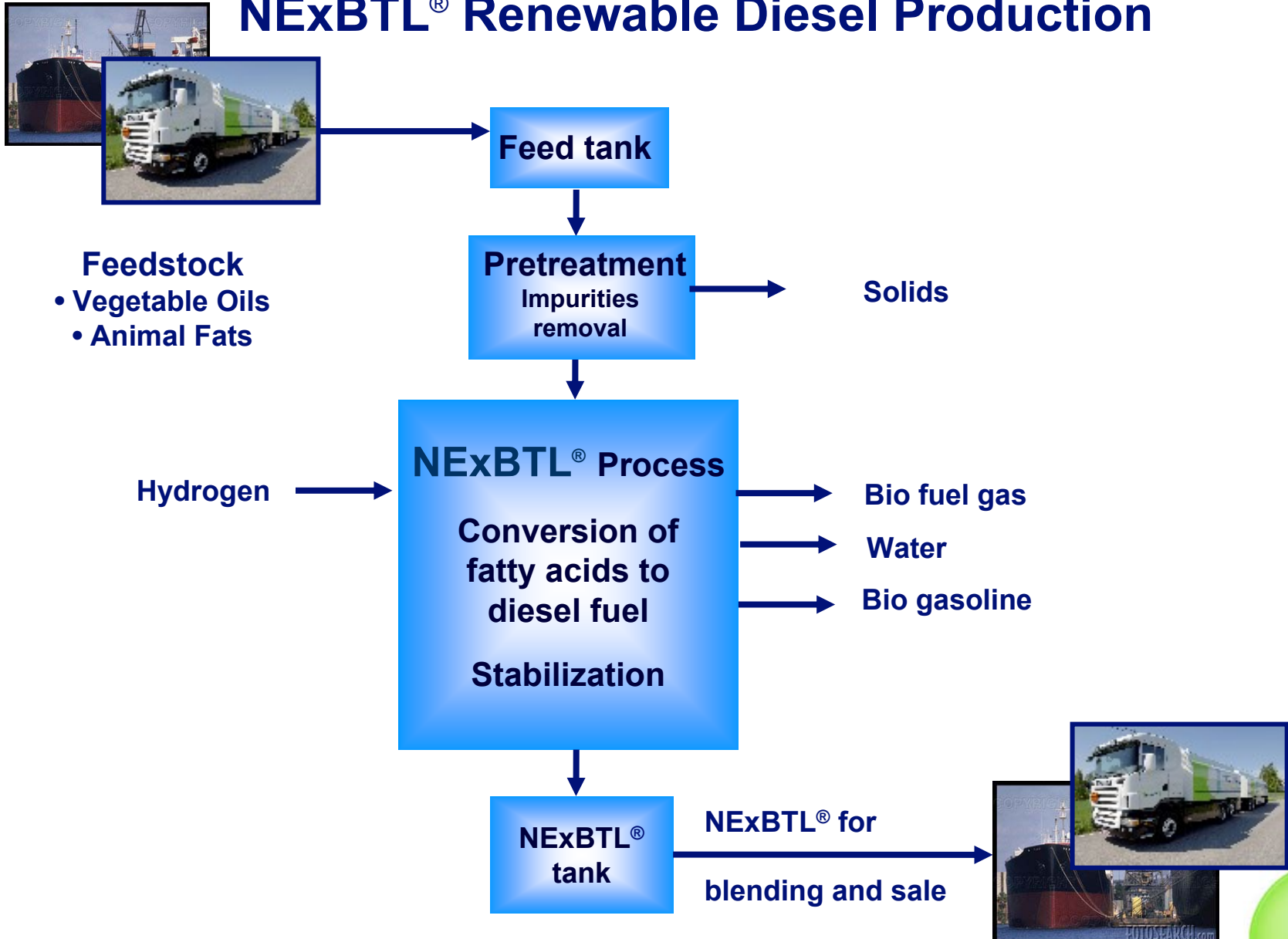
## NExBTL® is a Paraffinic Hydrocarbon That Meets D-975, CARB & TxLED Standards

Property	ASTM D975-05 Grade 2-D S15	NExBTL® Observed	CARB Diesel Formula	TX-Low Emission
Sulfur, ppm (max)	15	<1	15	15
Cetane , (min)	40	84-99 (Blending)	40	48
Aromatics, (max)	35	<0.1	10	10
Lubricity, HFRR, µm	520 max	Needs ULSD Lubricity Additive	520 max	520 max
T90, °C	282 min 338 max	295	282 min 338 max	282 min 338 max
Oct-Mar: Cloud, °C	14 to -34 max	-5 to -30 max	6 to -7 max	9 to -13 max

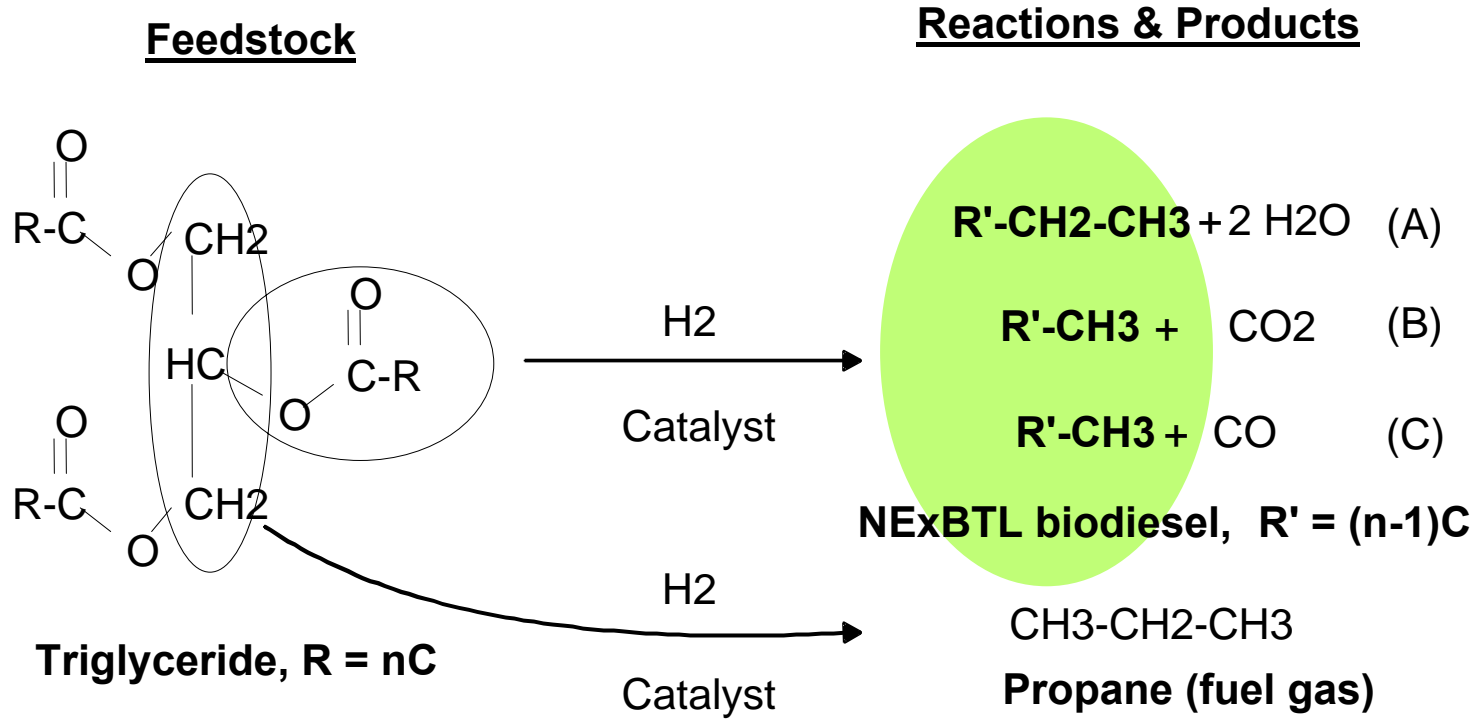
**NExBTL® is a conventional diesel fuel made from renewable resources.**



# NExBTL<sup>®</sup> Renewable Diesel Production



# Simplified NExBTL Process Chemistry



**NExBTL is a stable and pure paraffinic hydrocarbon!**



1st Generation  
In production: Now

NExBTL  
2nd Generation  
2007...

3rd Generation  
After 2015?

In

Vegetable oils \*

Vegetable oils  
Animal fats

Biomass

Esterification

Hydrotreating

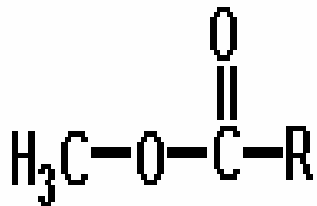
Gasification  
Fischer-Tropsch

FAME

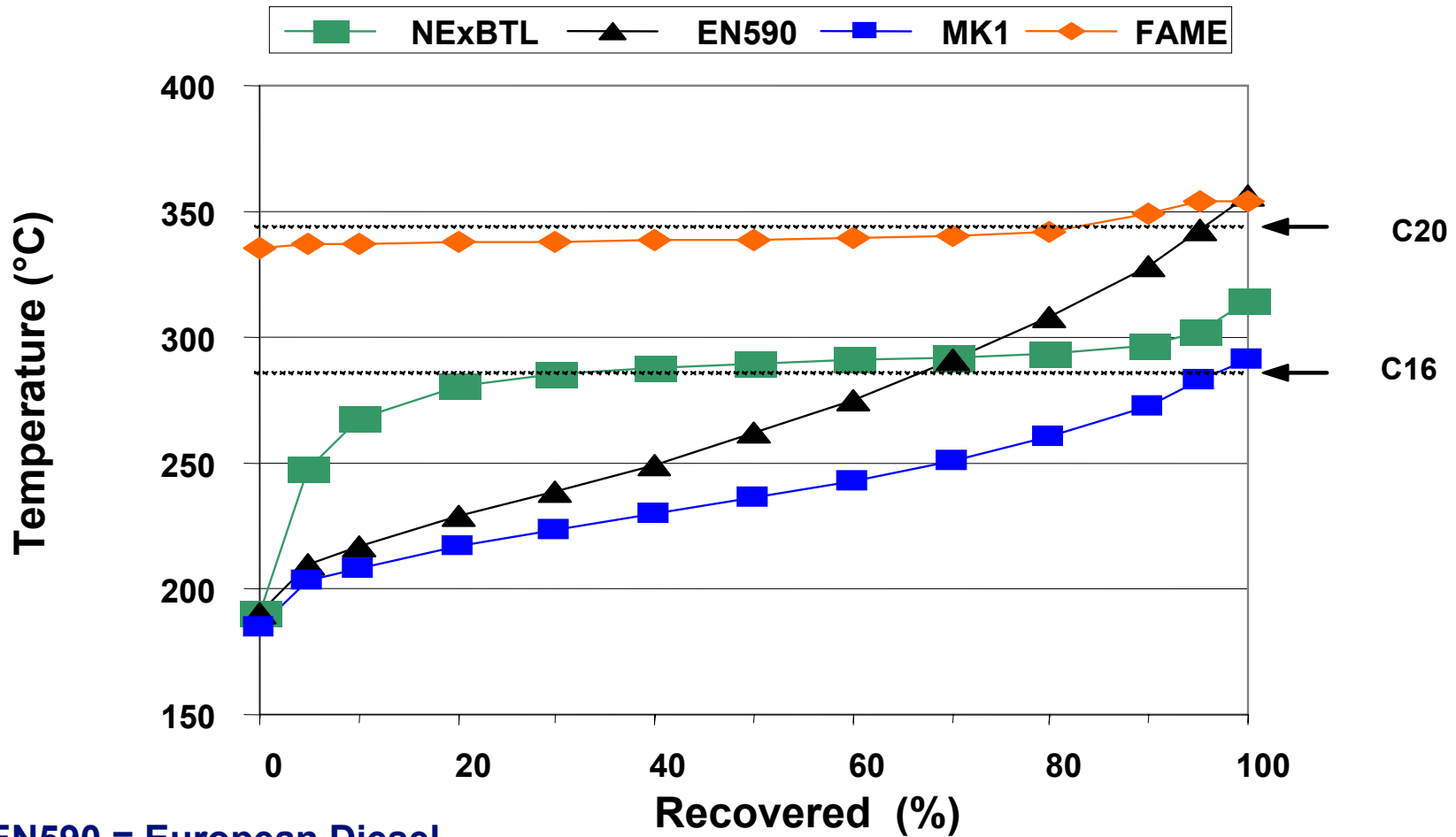
NExBTL

BTL

Out



# Distillation range



EN590 = European Diesel  
MK1 = Swedish Diesel Class 1





# Fuel Property Comparison

	<b>NExBTL<sup>®</sup> Renewable Diesel</b>	<b>GTL Synthetic Diesel</b>	<b>FAME RME Esters</b>	<b>S-free Eur. EN590 (summer) Diesel</b>
<b>Viscosity at +40°C (mm<sup>2</sup>/s)</b>	<b>2.9 ... 3.5</b>	3.2 ... 4.5	≈ 4.5	≈ 3.5
<b>Cetane number</b>	≈ 84 ... 99 * <sup>1</sup>	≈ 73 ... 81	≈ 51	≈ 53 * <sup>2</sup>
<b>Cloud point (°C)</b>	≈ - 5 ... - 30 * <sup>3</sup>	≈ 0 ... - 25	≈ - 5	≈ - 5
<b>Heating value (lower) (MJ/kg)</b>	≈ 44	≈ 43	≈ 38	≈ 43
<b>Heating value (MJ/l)</b>	≈ 34	≈ 34	≈ 34	≈ 36
<b>Polyaromatic content (wt-%)</b>	0	0	0	≈ 4
<b>Oxygen content (wt-%)</b>	0	0	≈ 11	0
<b>Sulfur content (mg/kg)</b>	< 1	< 10	< 10	< 10
<b>Carbon / hydrogen</b>	≈ 5.6	≈ 5.6		≈ 6.0

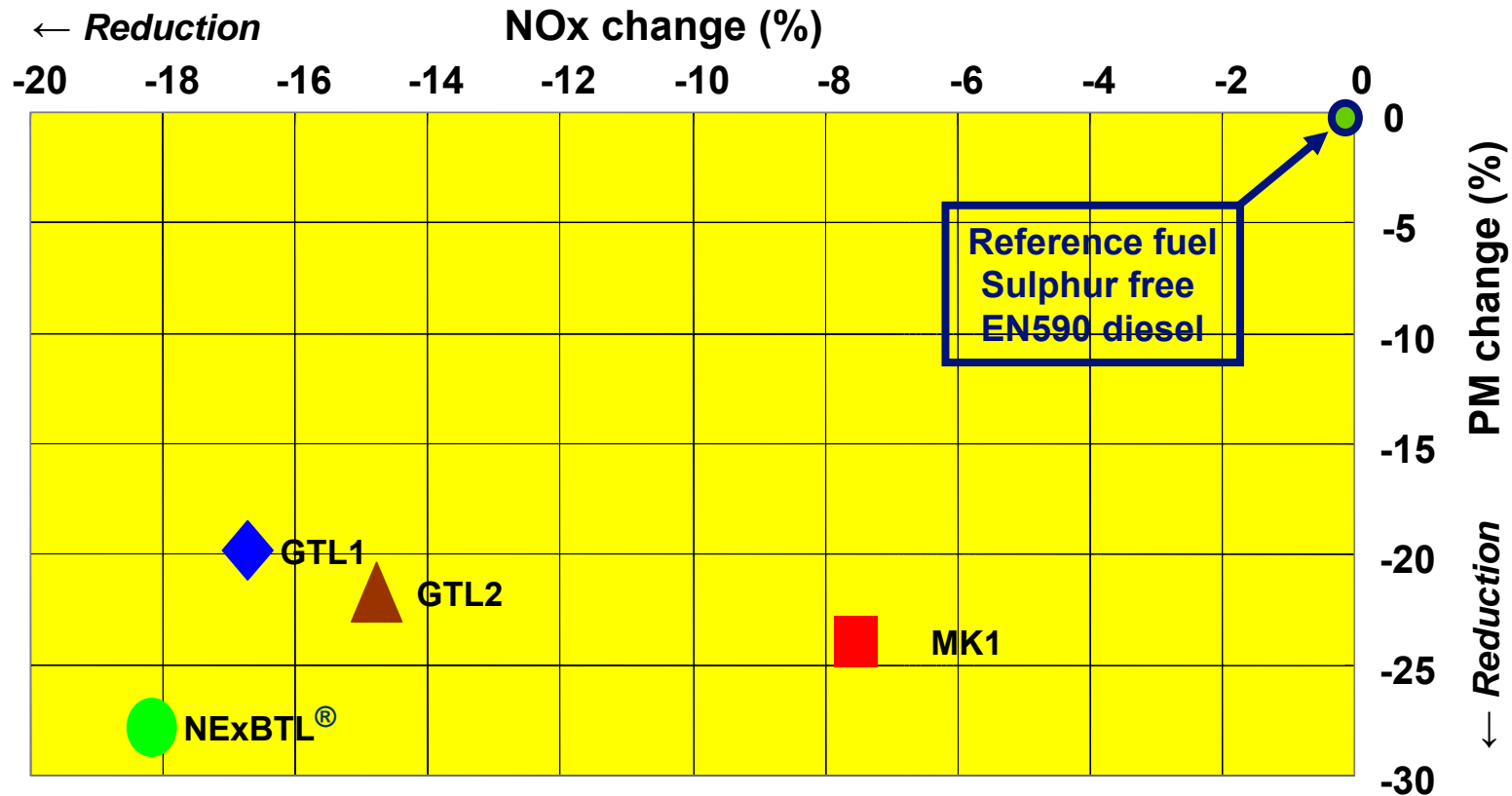
Note \*1: Blending cetane number

Note \*2: ASTM specification > 40

Note \*3: Product can be engineered to specific cloud point within this range by adjusting process conditions



# NOx and PM Emission Changes in Truck Engines - NExBTL<sup>®</sup> and Other Premium Diesels vs. ULSD EN590



► NExBTL<sup>®</sup> results in largest reductions in both NOx and PM emissions.

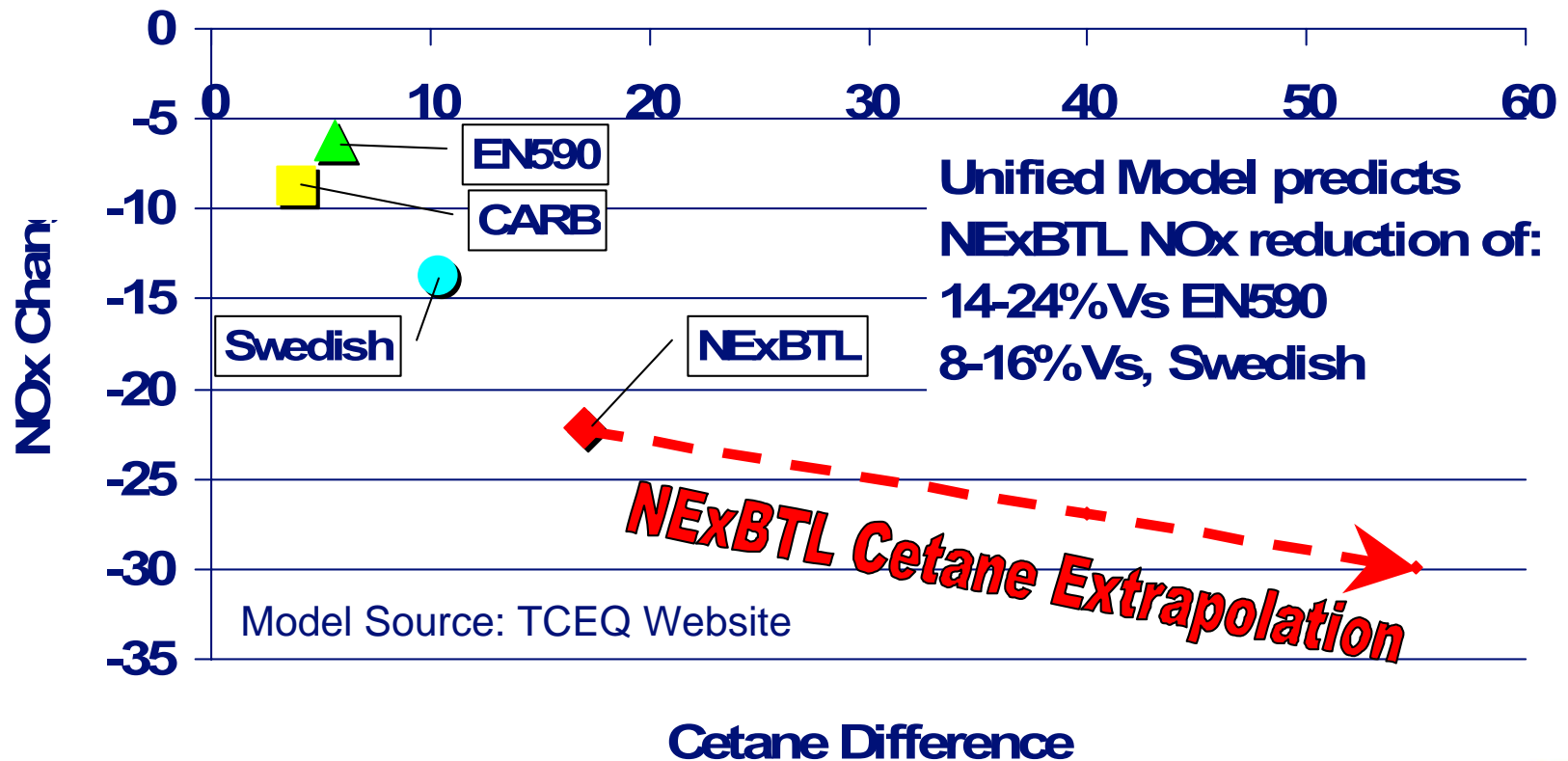
GTL1,2 = Gas-to-Liquid diesels; MK1 = Swedish Envir. Class 1 diesel

Source: Scania NMEC / 5th International Colloquium Fuels / Jan 12, 2005



# Unified Model Validates NExBTL NOx Reduction

## NOx Change Vs Cetane

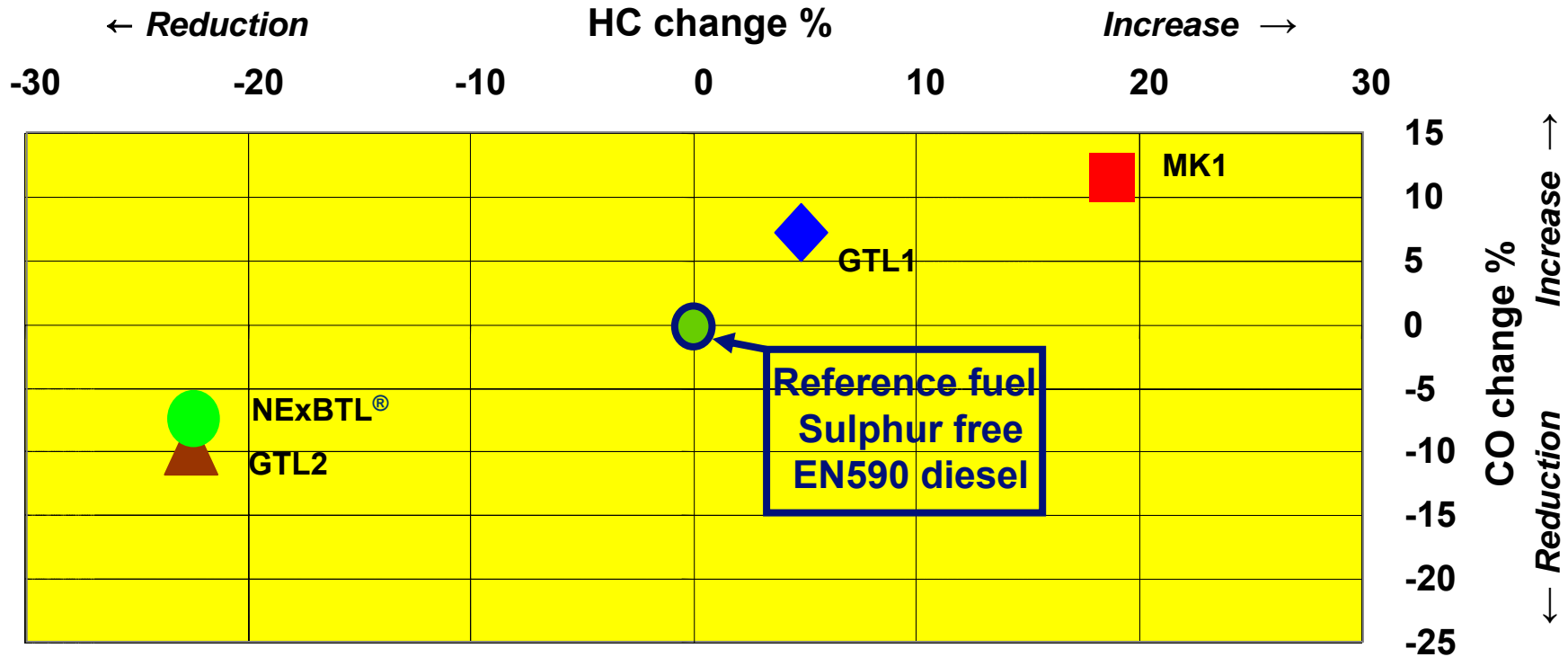


# No Surprise because Diesel engines like Paraffins

- I have wanted more paraffins for diesel fuel since I was a freshman economics engineer making 50+ cetane Amoco Premier Diesel
- The Unified Model indicates:
  - Reducing specific gravity (a characteristic of increasing paraffin content) lowers NOx emissions
  - Reducing diesel aromatics content (probably increasing paraffin content) lowers NOx emissions
  - Increasing cetane (another characteristic of paraffinic hydrocarbons) lowers NOx emissions
- The NExBTL® process makes the paraffinic hydrocarbons that diesel engines love from renewable resources at a time when crude oil quality and refining processing trends tend to increase yields of less desirable naphthenic and aromatic diesel molecules
- It provides engine enabling quality today while we watch for third generation developments



# HC and CO Emission Changes in Truck Engines - NExBTL<sup>®</sup> and Other Premium Diesels vs. ULSD EN590



► NExBTL<sup>®</sup> and GTL2 result in reductions in both HC and CO emissions, while GTL1 and MK1 are increasing the emissions.

GTL1,2 = Gas-to-Liquid diesels; MK1 = Swedish Envir. Class 1 diesel

Source: Scania NMEC / 5th International Colloquium Fuels / Jan 12, 2005  
Averages of all tests with Scania Euro 4 engine



# CONCLUSIONS

**NexBTL<sup>®</sup> Renewable Diesel is a 2<sup>nd</sup> generation fuel that delivers the combined benefits of GTL synthetic diesel and biodiesel esters**

**The paraffinic hydrocarbons produced from diverse renewable feedstocks are old friends that provide:**

- **Premium fuel properties**
  - **Very high cetane**
  - **Superior cold temperature performance**
  - **Stability for emergency, tactical and standby applications**
- **Reduced exhaust NOx, PM, HC,CO and toxic emissions**
- **Easy integration into existing infrastructure and engines**
- **CO<sub>2</sub> savings over life-cycle**
- **Reduced petroleum dependence and**
- **A cleaner more energy efficient future**

