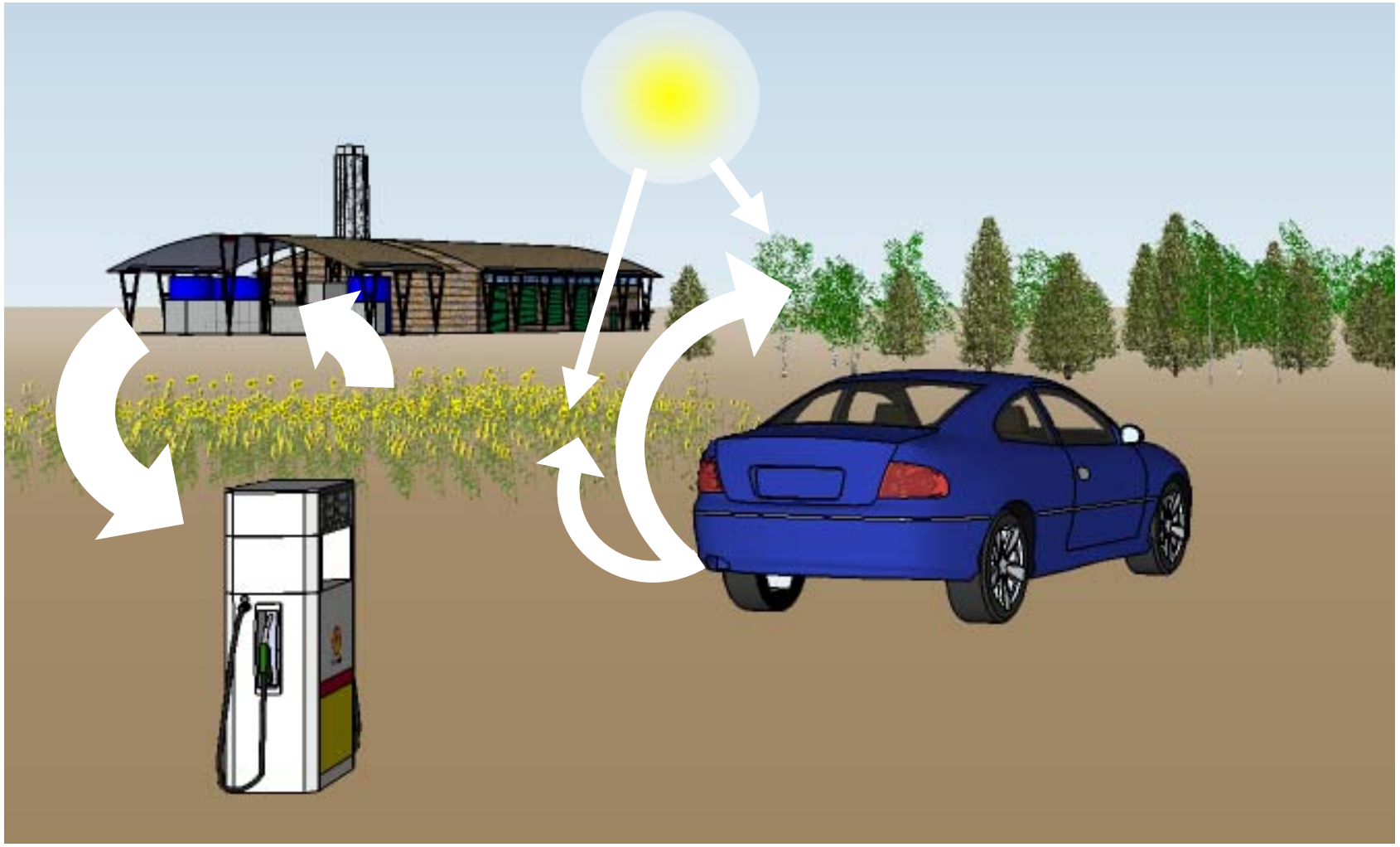
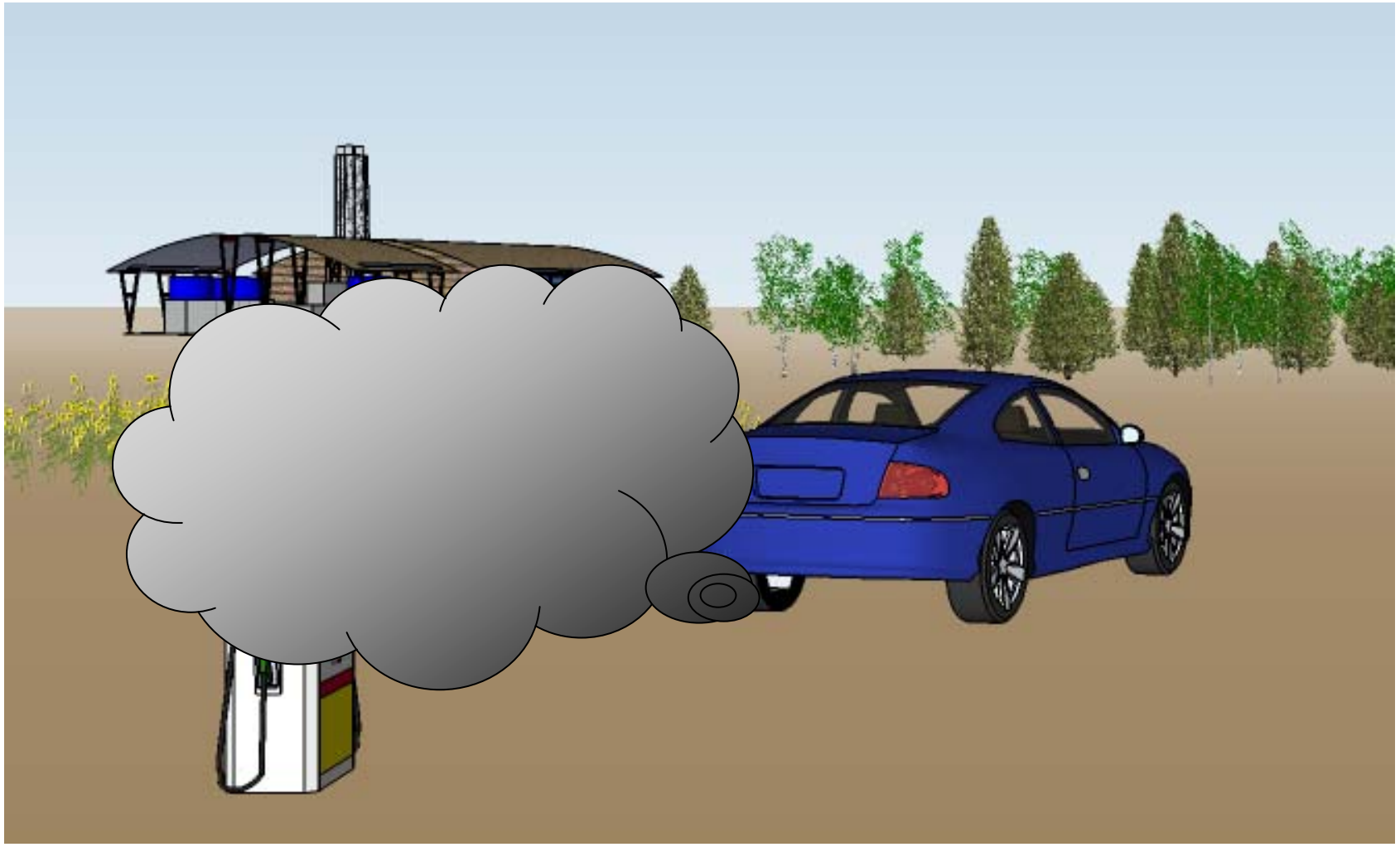
BioDiesel Content
On-board monitoring

August 6th, 2008

Biofuel incorporation a sustainable solution



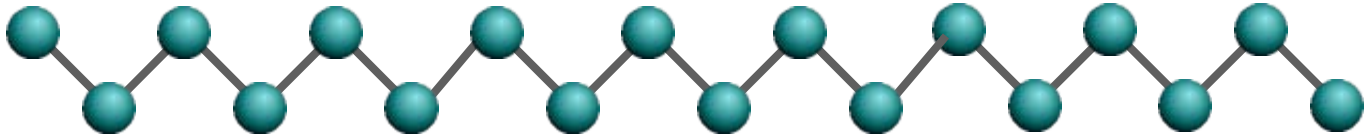
Biofuel incorporation a sustainable solution



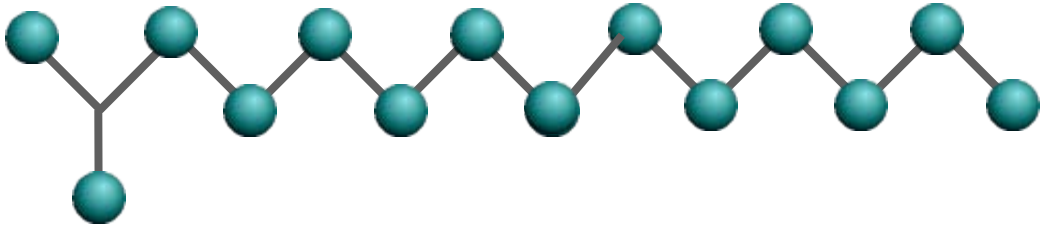
Except if the engine design and parameters are not adjusted accordingly…

Conventional Diesel molecular structure

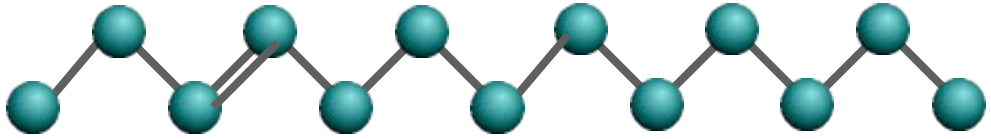
CARBONE / HYDROGEN



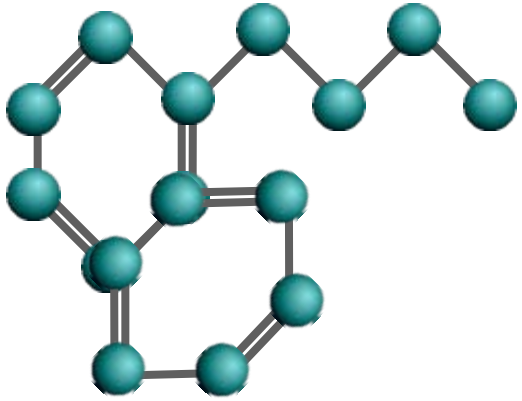
Linear Paraffin



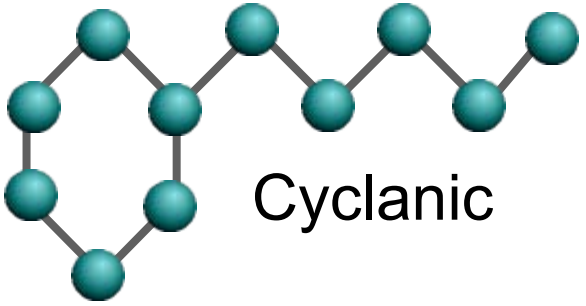
Iso Paraffin



Olefin



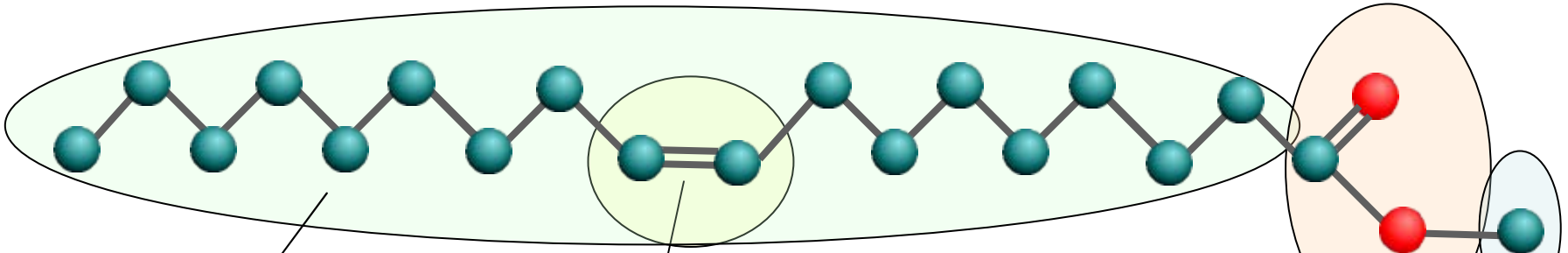
Aromatic



Cyclanic

BioDiesel molecular structure

CARBONE / HYDROGEN / OXYGEN

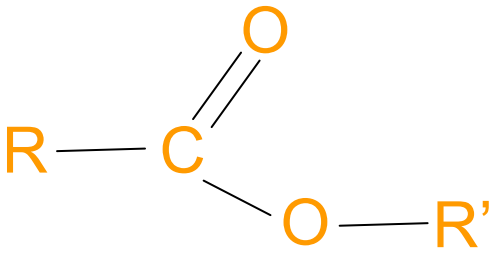


Carbon Chain
(Paraffin)

Double bond
(Olefin)

Ester function

Carbon Chain



Transposition of existing sensing technology to monitor Bio Diesel content?

- Conductivity based sensor?

Fluid	Dielectric constant
Gasoline	~2
Ethanol	~25
Water	(~88)
Diesel	~2
BioDiesel	~3

Factor 10

Factor 1.5

Dielectric constant of Diesel and BioDiesel very close

Potential complexity and accuracy issues

Transposition of existing sensing technology to monitor Bio Diesel content?

- Oxygen (exhaust) based sensor?

Fluid	%Oxygen brought by Biofuel
Gasoline	0%
Ethanol (E100)	~35%
Water	(~89%)
Diesel	0%
BioDiesel (B100)	11%

3 times less oxygen compared to Ethanol + lean condition

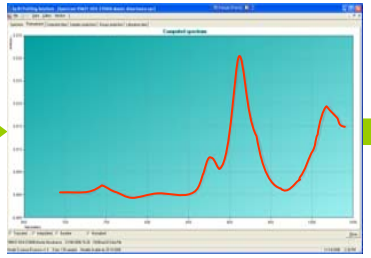
Potential complexity and accuracy issues

SP3H Fuel Quality Sensor process description

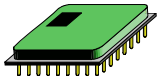
- **Proprietary technologies using dedicated Near Infrared hardware, software and specific algorithms**

NIR sensor

RAW DATA



NIR spectrum

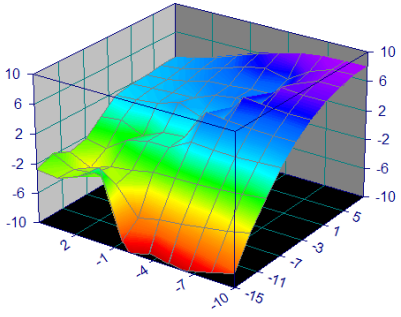


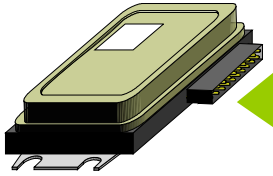
MCU

HCP Aro
HCP Lin
HCP Oxy
.....

HCP™

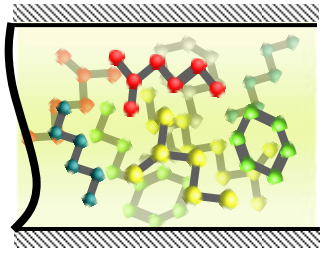
HydroCarbon Profilers





ECU

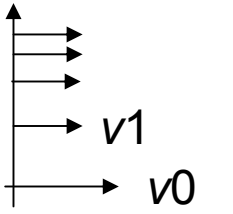
Near Infrared principles

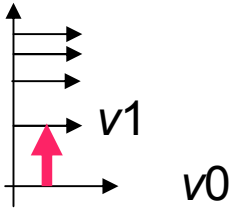


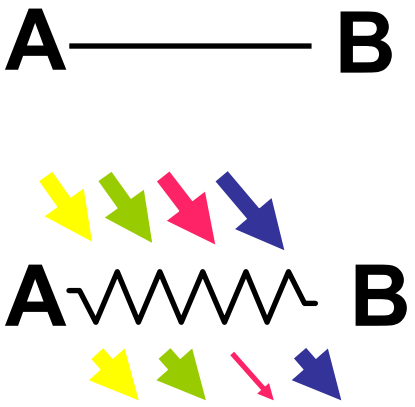
Absorbency = Log(I_0 / I)

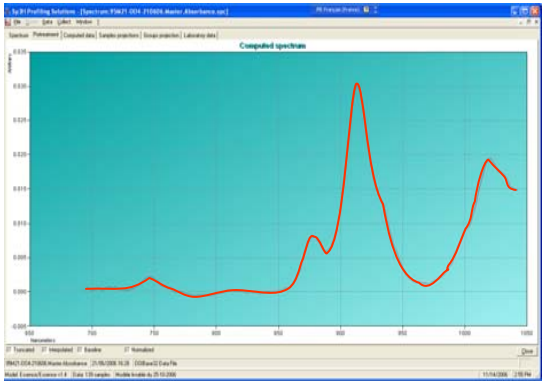
C-H
O-H
N-H
S-H

Fuel sample (> 100 molecules)



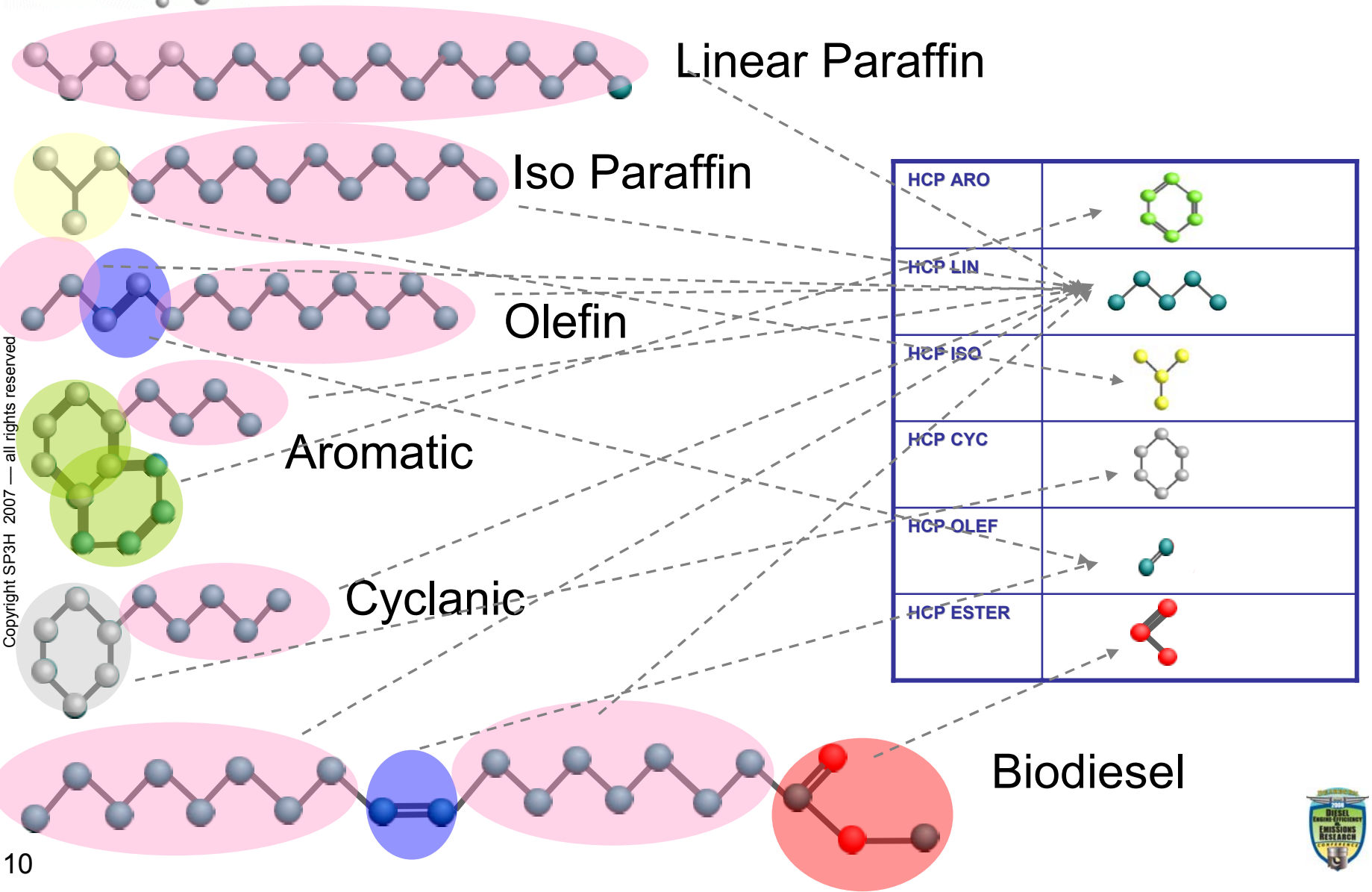






HydroCarbon Profilers : a real fuel "DNA"

Advanced product classification



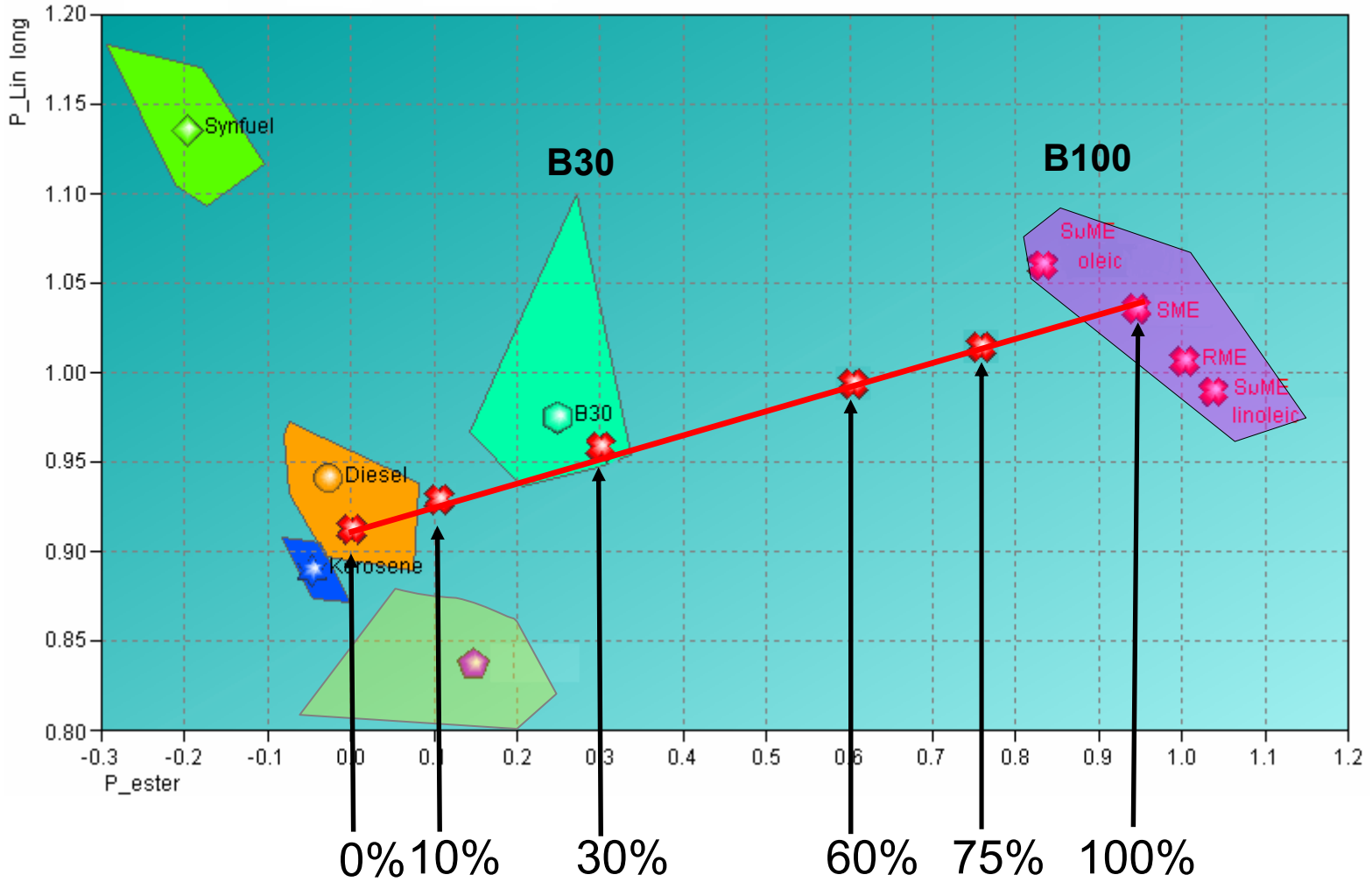
HydroCarbon Profilers : HCP Matrix

- **Advanced product classification**

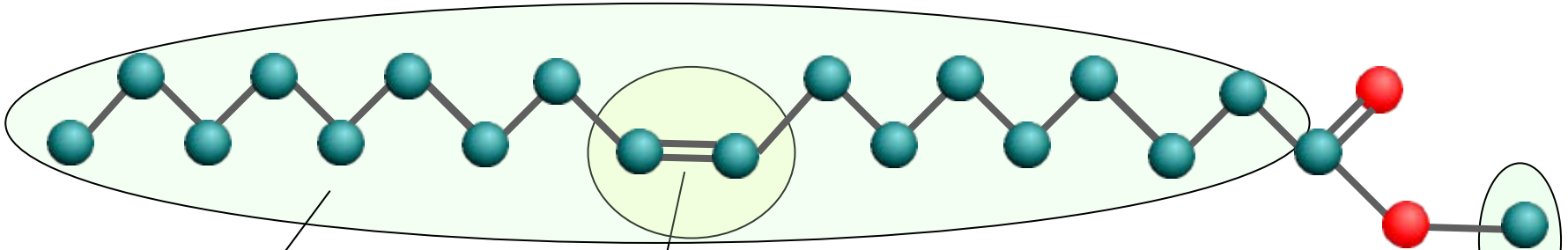
Family	Light	Medium	Heavy
Linear Paraffins	HCP LIN 1	HCP LIN 2	HCP LIN 3
Iso Paraffins	HCP ISO 1	HCP ISO 2	HCP ISO 3
Olefins	HCP OLEF 1	HCP OLEF 2	HCP OLEF 3
Naphtenes	HCP CYCL 1	HCP CYCL 2	HCP CYCL 3
Aromatics	HCP ARO 1	HCP ARO 2	HCP ARO 3
Alcools	HCP OH		
Ethers (MTBE/ ETBE)		HCP Ether	
Esters			HCP Ester
Water	P H2O		

- **%Bio Diesel =f (HCP)**

BioDiesel content determination



BioDiesel variability



Carbon Chain
(Paraffin)
Chain length variable

Double bond
(Olefin)
One, two to three double bonds

Carbon Chain
Usually 1 to 2
Carbons

Bio Diesel structure is highly variable

BioDiesel Variability impacts on Qualities

- Usual variability among different B100

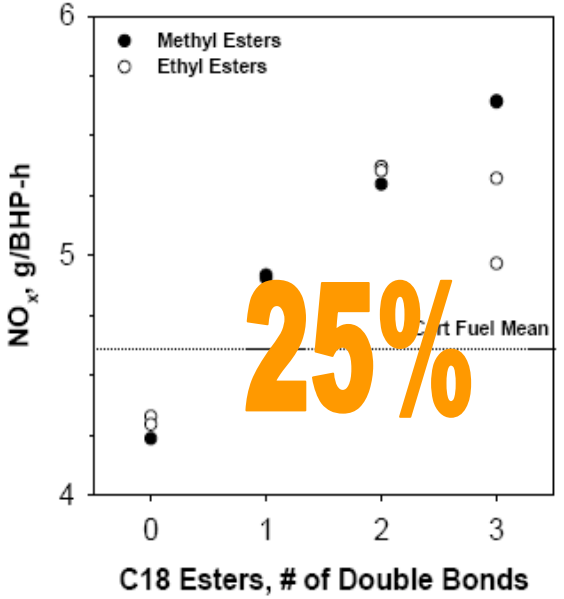
Property	Min	Max	Variability
Density	0.86	0.91	5%
Cetane	45	60	25%
Viscosity	2.5	6	60%
# double bonds	1	3	70%
C Chain length	16	22	30%

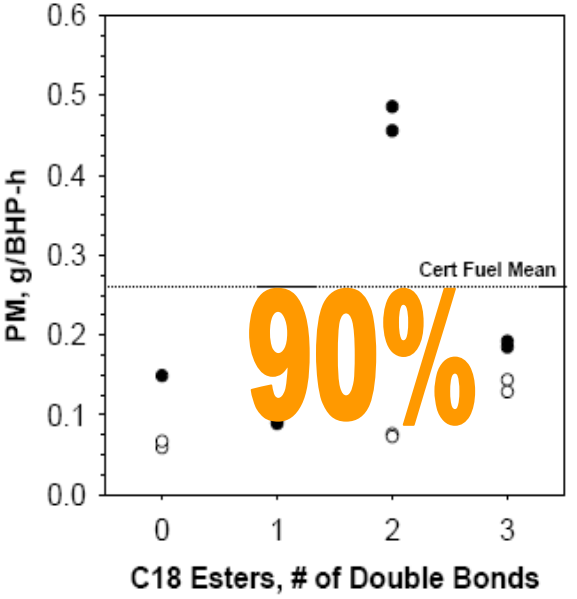
BioDiesel Variability impacts on Emissions

Source: NREL National Renewable Energy Laboratory

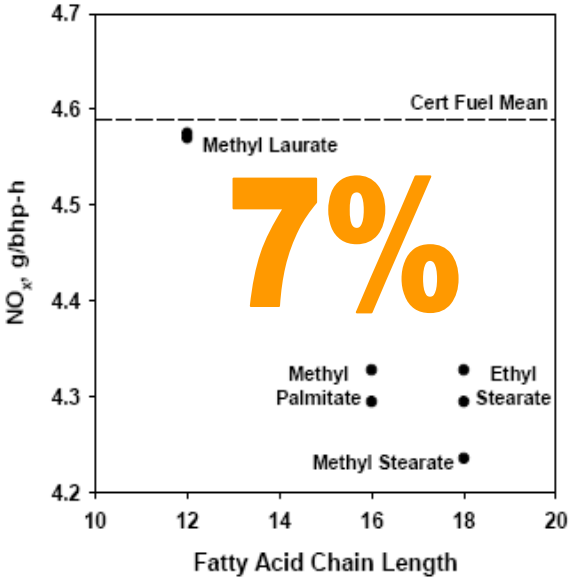
The Effect of Biodiesel Composition on Engine Emissions from a DDC Series 60 Diesel Engine

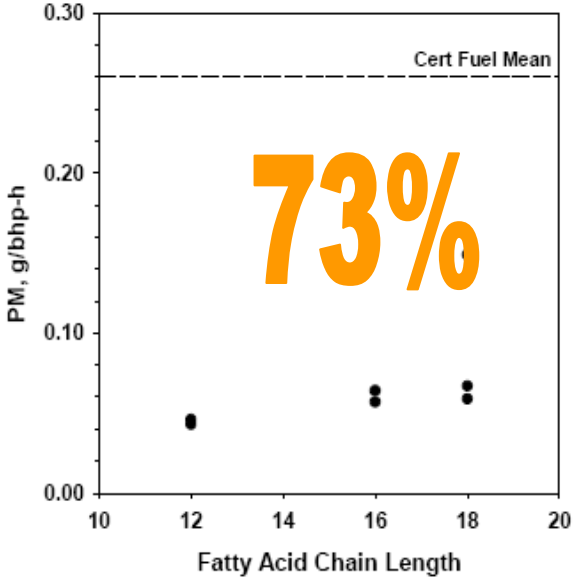
- # Double bonds





- C Chain Length





Full quality vector consideration

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Alcools	HCP OH		
Esters			HCP Ester
Water	P H2O		

- HC, PM, NOx = $f_{engine,conditions}$ (HCP)
- Ignition delay, Heat Value = $f_{engine,conditions}$(HCP)
- %BioDiesel = f(HCP)
- Density, Viscosity… = f(HCP)

Full quality vector consideration

- Advanced product classification

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Alcools	HCP OH		
Esters			HCP Ester
Water	P H2O		

- Viscosity, Density… = f (HCP)
- Cetane, …. = f (HCP)
- %Bio Diesel, … = f (HCP)

Sensor output

Property / Quality	Status
HCP matrix	Available
% BioDiesel (FAME)	Available
Cetane Index; Density; Distillation; %HAP; %C, %H, %O	Available
Water content >150ppm	Available (segregation)
Fuel mishandling	Available (segregation)
Viscosity, Ethanol in Diesel, Heat Value	On going
S%	Feasibiltiy study On going
BioDiesel Aging & BioDiesel type (SME, RME…)	Feasibiltiy studies On going

Thank you

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