



**Parkland**  
FUEL CORPORATION

## Burnaby Refinery Fuel Composition

November 2018



# Outline

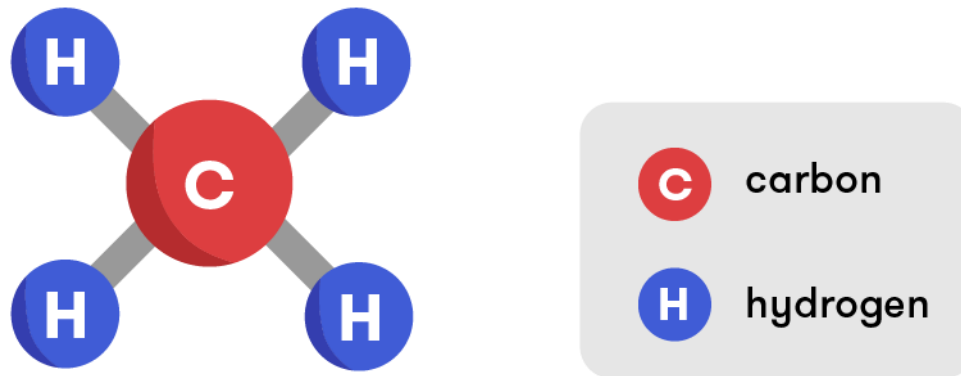
- What are hydrocarbons?
- Current fuels at Burnaby Refinery
- New fuels at Burnaby Refinery





# What are Hydrocarbons?

- Carbon and hydrogen are the primary components of fossil fuels/crude oil
- Hydrocarbons are the simplest forms of organic molecules (e.g. methane). There can be many different hydrocarbon chains within various types of crude oil.



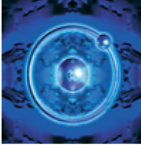
<https://www.science.org.au/curious/earth-environment/methane>



# What are Hydrocarbons?

## Hydrogen

- Hydrogen is the lightest and most abundant element in the universe. On Earth, it is always bonded to other elements or itself

Hydrogen																		Supply risk		High supply risk		Low supply risk		Medium supply risk		Unknown		He																																													
H																	1		1.008		H		Hydrogen		5		6		7		8		9		10																																						
Li	Be											Key isotopes		$^1\text{H}, ^2\text{H}$		Electron configuration		$1s^1$		Density (g cm <sup>-3</sup> )		0.000082		1 <sup>st</sup> ionisation energy		1312.050 kJ mol <sup>-1</sup>		11		12		13		14		15		16		17		18																															
Na	Mg	K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr	Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe	Cs	Ba	La	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn	Fr	Ra	Ac	Rf	Db	Sg	Bh	Hs	Mt	Ds	Rg	Cn	Nh	Fl	Mc	Lv	Ts	Og
58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118													
Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	Lr																																																												

<http://www.rsc.org/periodic-table>



# What are Hydrocarbons?

## Carbon

- Carbon is found in all organic material; it is the fourth most abundant element on Earth

Carbon																		Supply risk		High supply risk		Low supply risk		Medium supply risk		Unknown		He			
H																	C		6		12.011						2				
1																	Carbon														
Li	Be	Key isotopes																12C, 13C, 14C		5		6		7		8		9		10	
3	4	Electron configuration																[He] 2s <sup>2</sup> 2p <sup>2</sup>		13		14		15		16		17		18	
Na	Mg	Density (g cm <sup>-3</sup> )																3.513 (diamond); 2.2 (graphite)		Al		Si		P		S		Cl		Ar	
11	12	1 <sup>st</sup> ionisation energy																1086.454 kJ mol <sup>-1</sup>		13		14		15		16		17		18	
K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr														
19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36														
Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe														
37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54														
Cs	Ba	La	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn														
55	56	57	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86														
Fr	Ra	Ac	Rf	Db	Sg	Bh	Hs	Mt	Ds	Rg	Cn	Nh	Fl	Mc	Lv	Ts	Og														
87	88	89	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118														
Ce		Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu																	
58		59	60	61	62	63	64	65	66	67	68	69	70	71																	
Th		Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	Lr																	
90		91	92	93	94	95	96	97	98	99	100	101	102	103																	

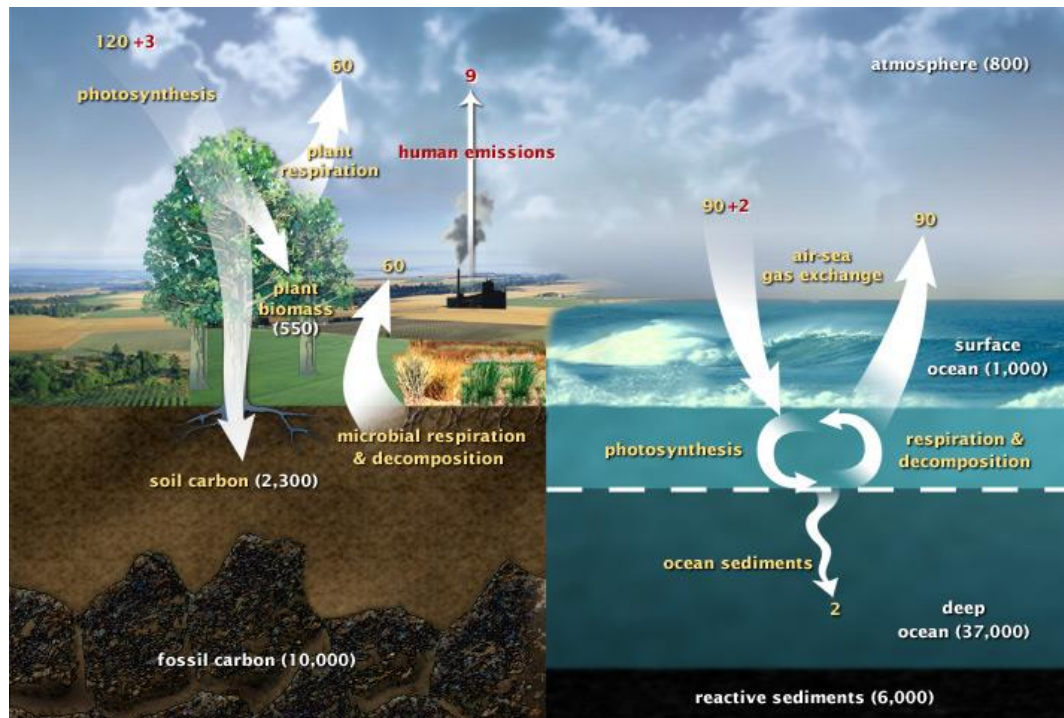
<http://www.rsc.org/periodic-table>



# What are Hydrocarbons?

## The Carbon Cycle

- Carbon cycle is the movement of carbon between reservoirs (atmosphere, oceans, vegetation, soil, rocks)
- 'Retro' crude contains carbon that has been in the carbon cycle the longest
- 'New' crude contains carbon that has been in the carbon cycle for a shorter amount of time



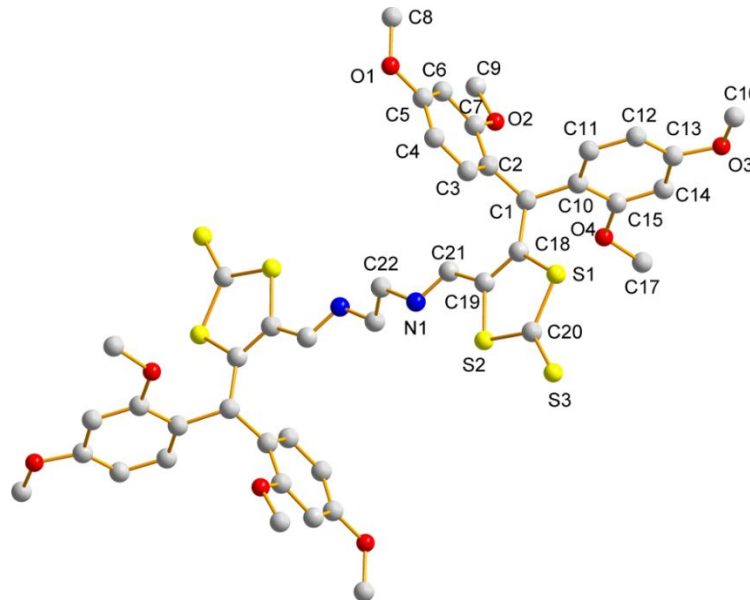
Yellow numbers are natural fluxes, and red are human contributions in gigatons of carbon per year. White numbers indicate stored carbon <https://earthobservatory.nasa.gov/features/CarbonCycle> (2008)



# Current Fuels at Burnaby Refinery

## Material

- Burnaby Refinery processes light sweet crude oil into useful products such as motor gasoline, diesel, jet fuel, asphalt, heating fuels, heavy fuel oils, butane and propane
  - ‘Light’ = low density
  - ‘Sweet’ = low Sulphur
- This current feedstock is considered ‘retro’ crude

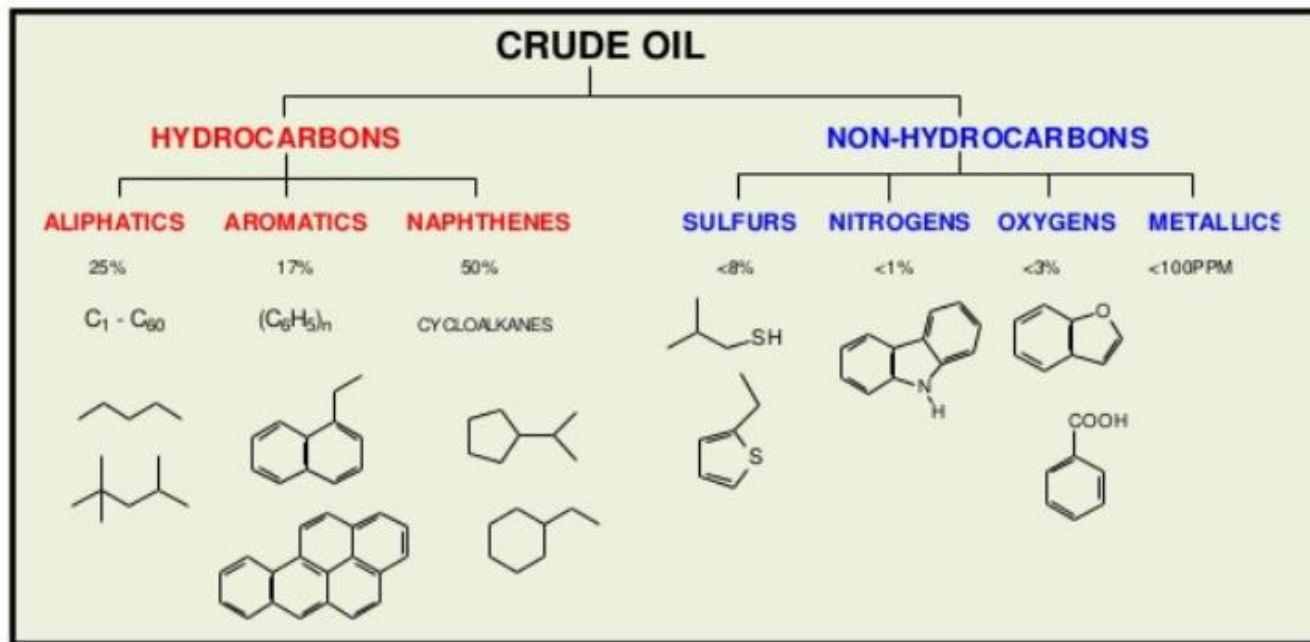




# Current Fuels at Burnaby Refinery

## Material

- Traditional crude oil contains hydrocarbon and non-hydrocarbon components
  - The non-hydrocarbon components are removed through the refining process to ensure the final products meet environmental and performance specifications



*Composition of Crude Oil*

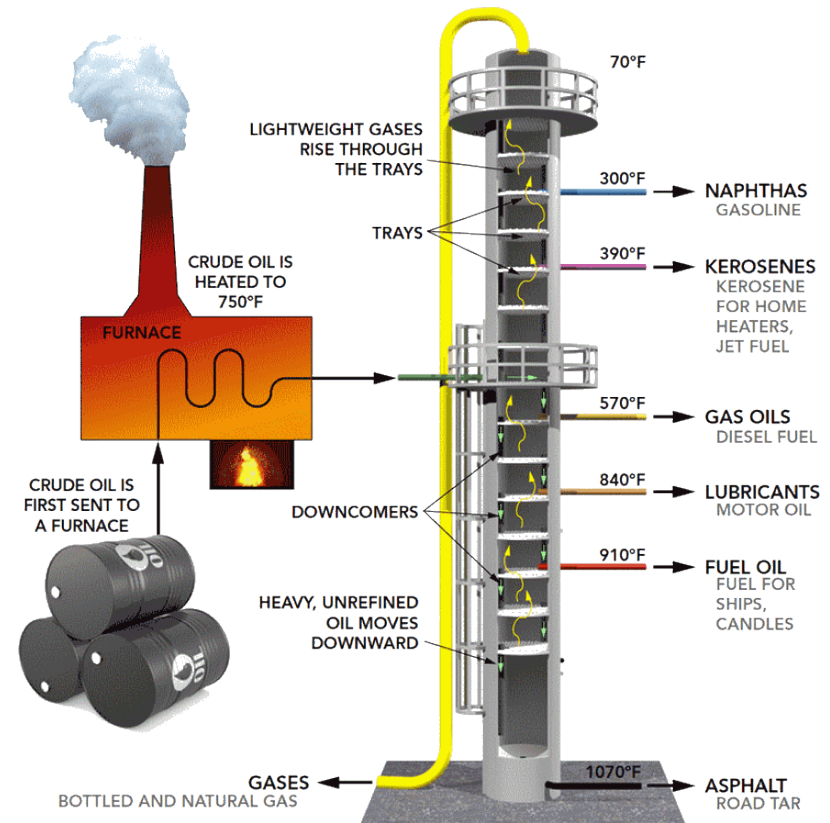




# Current Fuels at Burnaby Refinery

## Process

- Refining has three key processes: distillation, conversion and treatment
  - Distillation** - crude oil is heated and separated into different product streams based on boiling point
  - Conversion** - molecule chains in the product streams are broken up and/or rearranged and/or recombined
  - Treatment** - contaminants are removed from the products (e.g. Sulphur, nitrogen, heavy metals) to make them more environmentally-friendly
- Once these processes are complete, products are blended to specific standards and distributed to customers



Graphic courtesy of Bismarck State College National Energy Center of Excellence  
[http://www.wermac.org/equipment/distillation\\_part1.html](http://www.wermac.org/equipment/distillation_part1.html)



# New Fuels at Burnaby Refinery

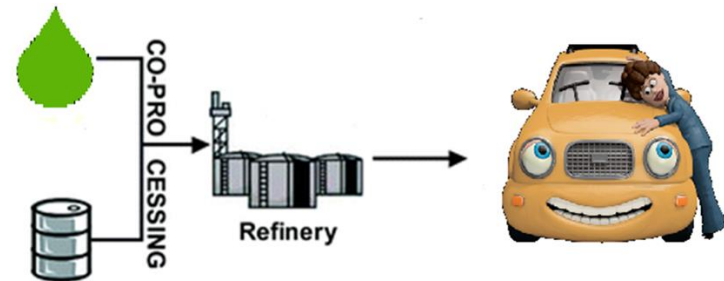
## Background

### Low Carbon Fuel Requirements:

- Provincial and Federal policies are having a significant influence on transportation fuel manufacturing and distribution
- Requirement to lower Carbon Intensity of fuels to lower Greenhouse Gas emissions
- Carbon Intensity (CI) is how much carbon is emitted relative to a given output of energy and is determined using Life Cycle Assessment (LCA) modeling
- Policy has led us to co-processing biocrudes

### Co-Processing, using:

- 1<sup>st</sup> Generation Feedstocks
- 2<sup>nd</sup> Generation Feedstocks





# New Fuels at Burnaby Refinery

## 'New Crude': 1<sup>st</sup> Generation Feedstocks

### What are they?

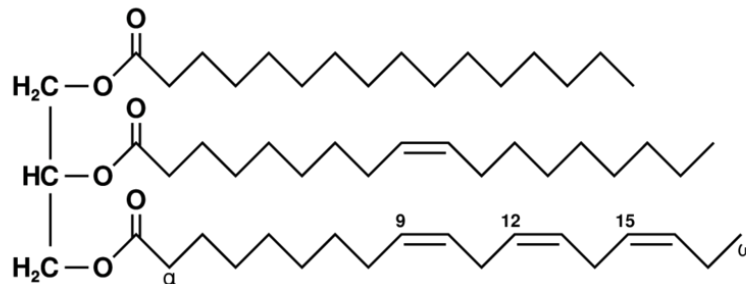
- Source material include animal (tallow) and vegetable (canola) products
- These feedstocks for co-processing are currently available at scale

### What do they produce?

- Renewable gasoline and diesel

### Considerations:

- More oxygen than 'retro' crude but also a much higher hydrogen content





# New Fuels at Burnaby Refinery

## 'New Crude': 2<sup>nd</sup> Generation Feedstocks

### What are they?

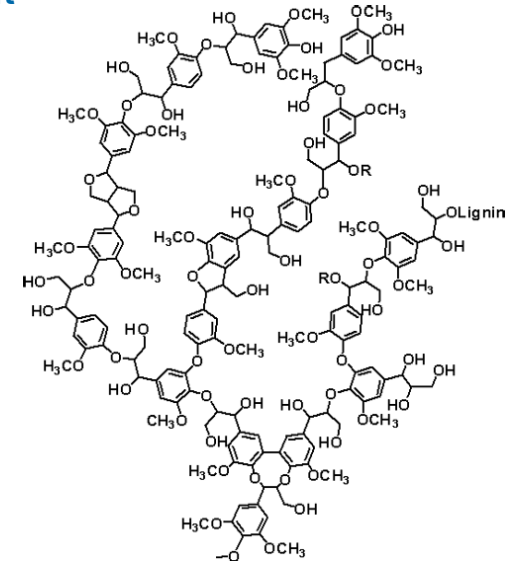
- '2<sup>nd</sup> Gen' is general term for biological feedstocks in development
- Source material varies between wood waste, municipal solid waste, municipal sewage sludge

### What do they produce?

- Feedstock in development for renewable gas, jet and diesel production
- Four methods of production:
  1. Thermal Pyrolysis
  2. Catalytic Pyrolysis
  3. Hydro Thermal Liquefaction (HTL)
  4. Gasification and Recombination (Fischer-Tropsch)

### Considerations:

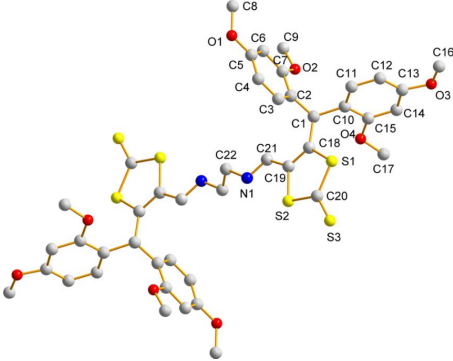
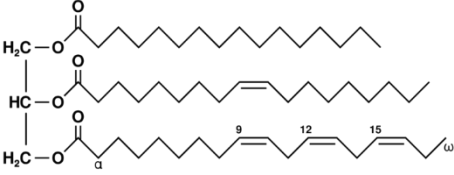
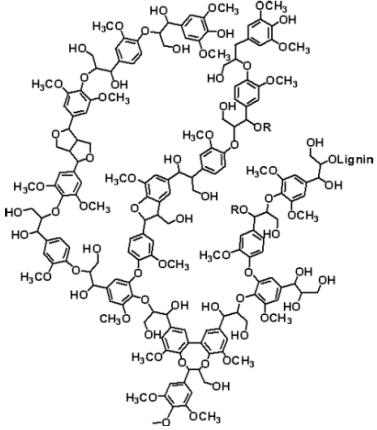
- Significantly more challenges for co-processing:
  - Oil miscibility
  - Unstable – polymerizing
  - High in oxygen and other contaminants
- Parkland is working with several technology partners on solving problems and scaling from R&D to commercial scale





# New Fuels at Burnaby Refinery

## Feedstock Comparison

Current feedstock (light sweet crude oil)	1 <sup>st</sup> Generation Feedstocks	2 <sup>nd</sup> Generation Feedstocks
		
<ul style="list-style-type: none"><li>• More carbon</li><li>• Less oxygen</li><li>• Less hydrogen</li><li>• Less contaminants to remove</li></ul>	<ul style="list-style-type: none"><li>• Less carbon</li><li>• More oxygen</li><li>• More hydrogen</li><li>• Different contaminants to remove</li></ul>	<ul style="list-style-type: none"><li>• Less carbon</li><li>• More oxygen</li><li>• More hydrogen</li><li>• Different and more contaminants to remove</li></ul>



# New Fuels at Burnaby Refinery

## Environmental Benefits of 'New' Crude

- Contains lower carbon intensity of liquid fuels (gasoline, diesel, jet fuel) resulting in lower GHG and fewer emissions
- Increases value of waste residuals (tallow, forest residue, municipal wastes)
- Repurposes existing refinery infrastructure for at-scale commercial production of renewable fuels
- Leverages existing technical expertise to create the 'Fuels of the Future'





# New Fuels at Burnaby Refinery

## Looking Ahead

- Burnaby Refinery is a proud leader in new fuel initiatives
- We are evolving our current refining processes to create 'greener' fuels, but this takes time





## References

<http://www.chfca.ca/education-centre/what-is-hydrogen/>  
<https://www.visionlearning.com/en/library/Earth-Science/6/The-Carbon-Cycle/95>