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Dr Denis J. Gendron, Physics PhD

QUANTUM OIL REFINERY (QOR):

A VIABLE PATH TO MEET THE PARIS TARGET

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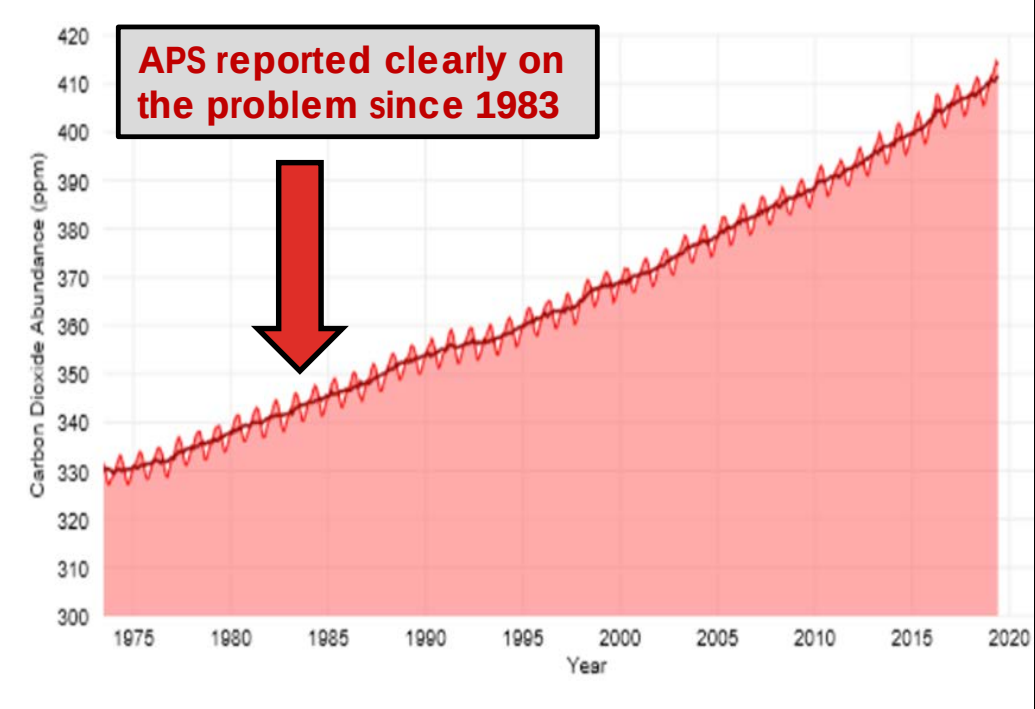
WHY QOR?

CARING FOR LOOMING CRISIS IN PROGRESS

Current rising CO2 level



Methane GHG

As GHG affecting climate, Methane:

=> 25X - 50X more damage than CO_2

Atmospheric distillation releases methane.

Environmental Concerns Of Climate Change

OUTLINE

INTRODUCTION: CONTEXT OF DISCOVERY

A) QOR: A Surprising discovery

B) QOR: Feasibility to implement within a Decade

C) QOR: Best Path to Meet Paris Target

INTRODUCTION: CONTEXT

(i) Who Am I?

Childhood

INTRODUCTION: CONTEXT

(i) Who Am I?

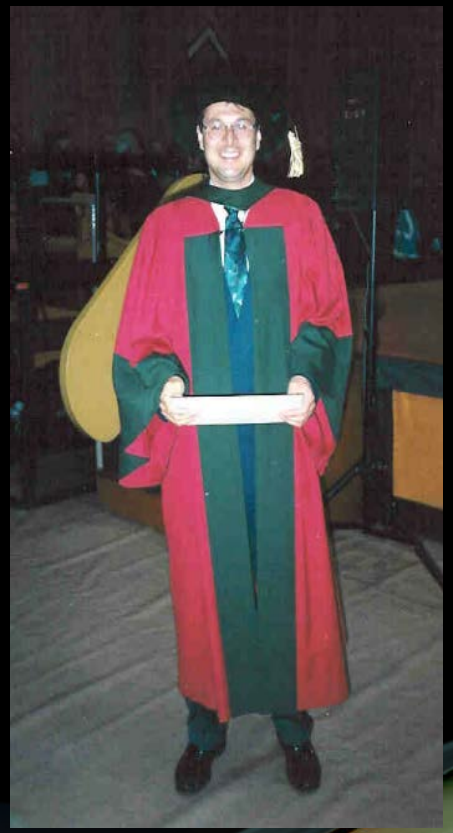
Childhood

Growing up in the spirit of the 60's

INTRODUCTION: CONTEXT

(i) Who Am I?

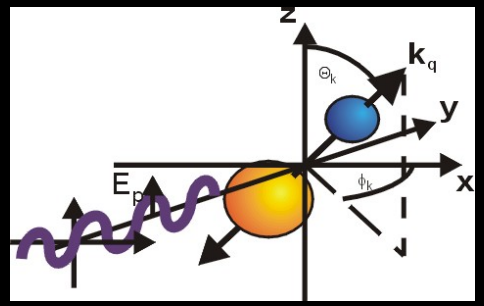
Academic Education

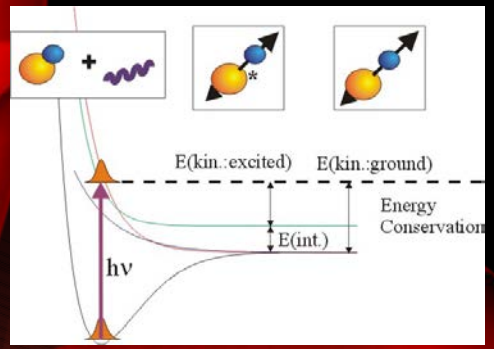


INTRODUCTION: CONTEXT

(i) Who Am I?

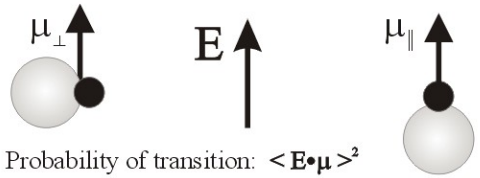
Academic Education





2. Physical observables

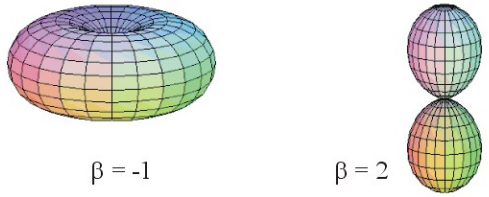
A) Symmetry of electronic transition:



Probability of transition: $<E \bullet \mu>^2$

B) Angular distribution of the photofragment velocities:

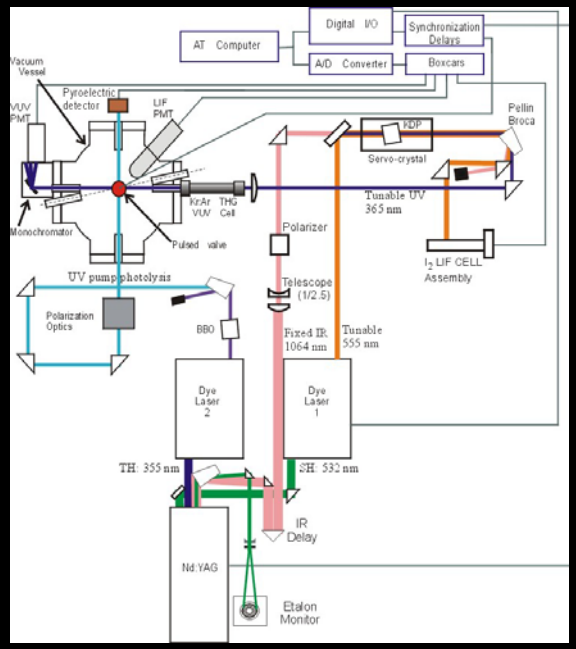
$I(\theta) = (\sigma/4\pi)\,[\,1 + \beta\, P_2(\cos\theta)\,]$, where $\sigma \propto |\mu|^2$

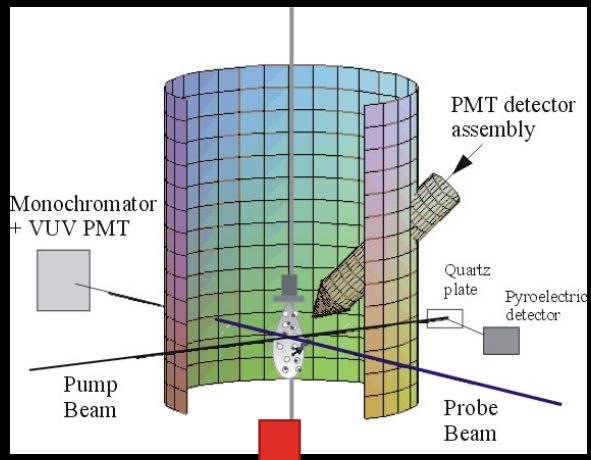


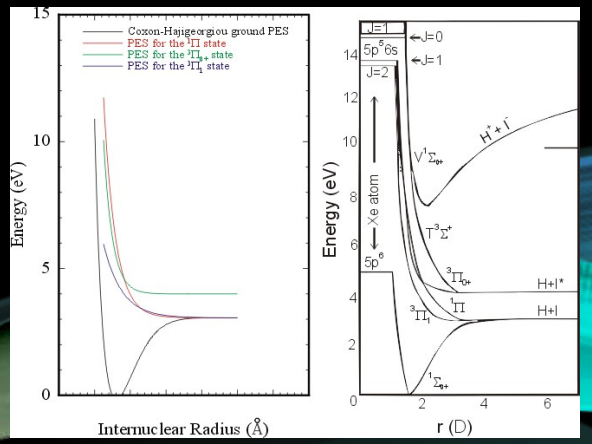
C) Characteristic observables:

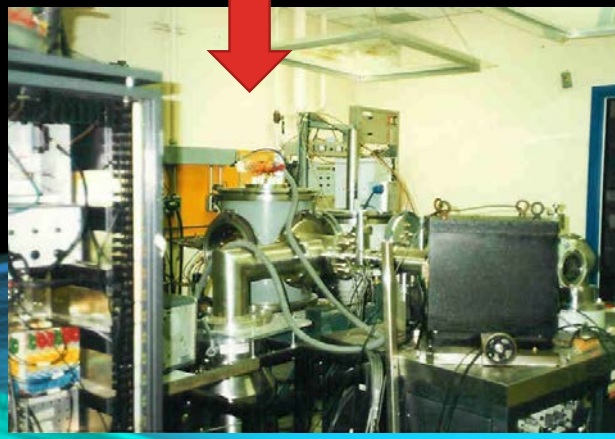
The branching ratio of the electronically excited products:
$R=\sigma(I^*)/[\sigma(I^*)+\sigma(I^*)]$

The anisotropy parameters for each electronic product:
β(I) and β(I*)





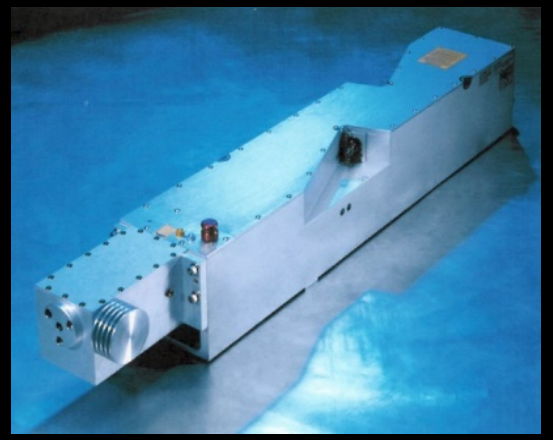


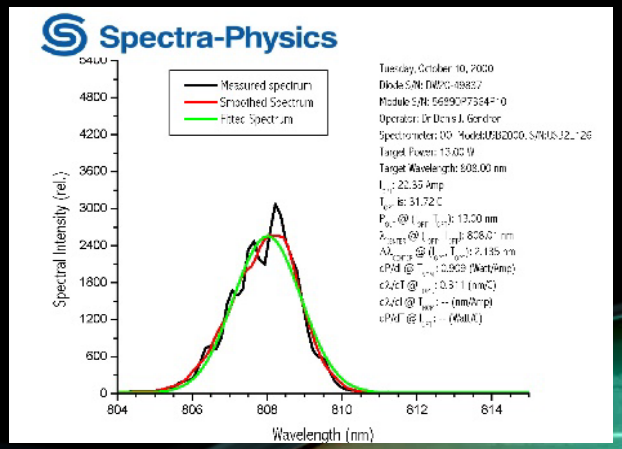


INTRODUCTION: CONTEXT

(i) Who Am I?

Corporate





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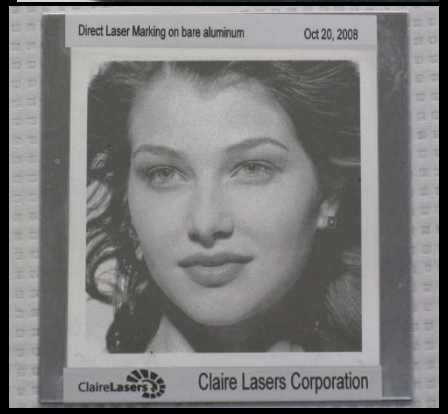
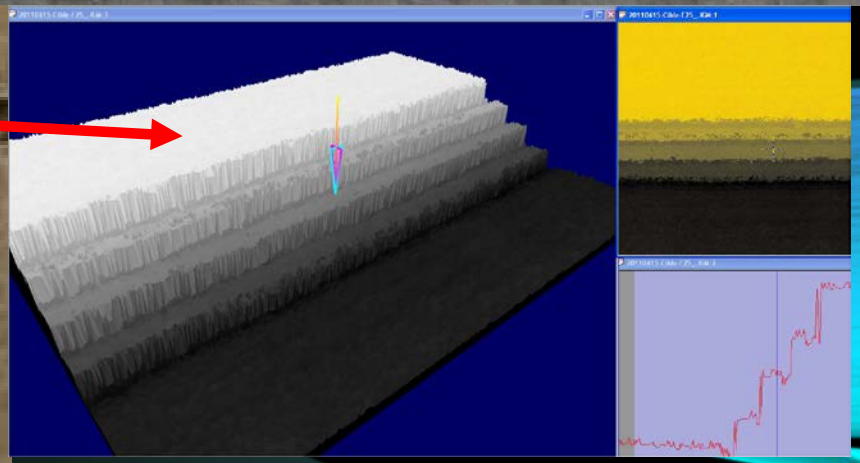
INTRODUCTION: CONTEXT

(i) Who Am I?

Entrepreneurial:





INTRODUCTION: CONTEXT

(i) From Questioning Depletion to Massive Divestment

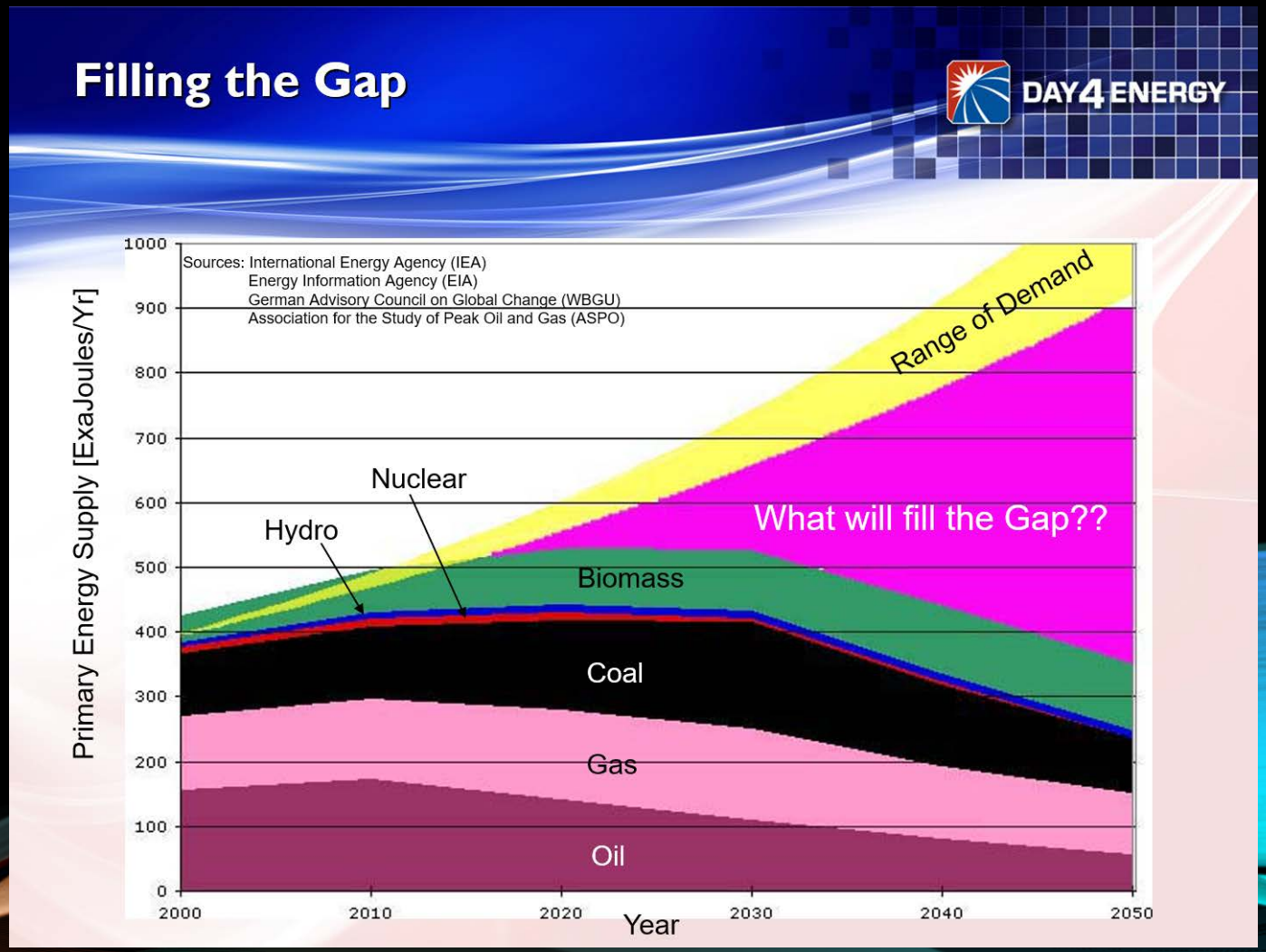
"either we have already entered depletion or we will within 1-2 decades"

John S. MacDonald Da4Energy Inc.
May 4th, 2011

CME Energy Connections Summit
Toronto, Ontario
May 4, 2011

John S. MacDonald**
Day4 Energy Inc.

**Founding Partner at MDA
(purchased SPAR in 2001)



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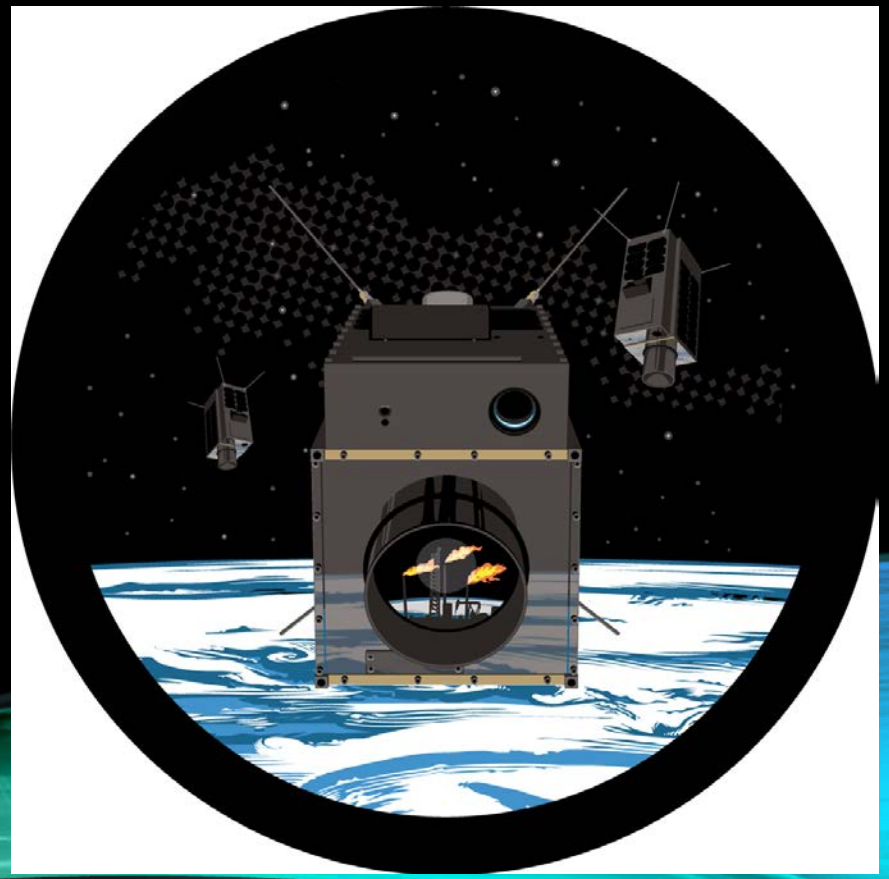
INTRODUCTION: CONTEXT

(i) From Questioning Depletion to Massive Divestment

Shell sells **Canadian oil** sands **assets** for $7.25bn. Royal Dutch **Shell** has agreed to sell most of its **Canadian oil** sands **assets** for $7.25bn in the latest sign of global **energy** groups backing away from some of the world's highest-cost and most greenhouse gas-intensive sources of **crude oil**.

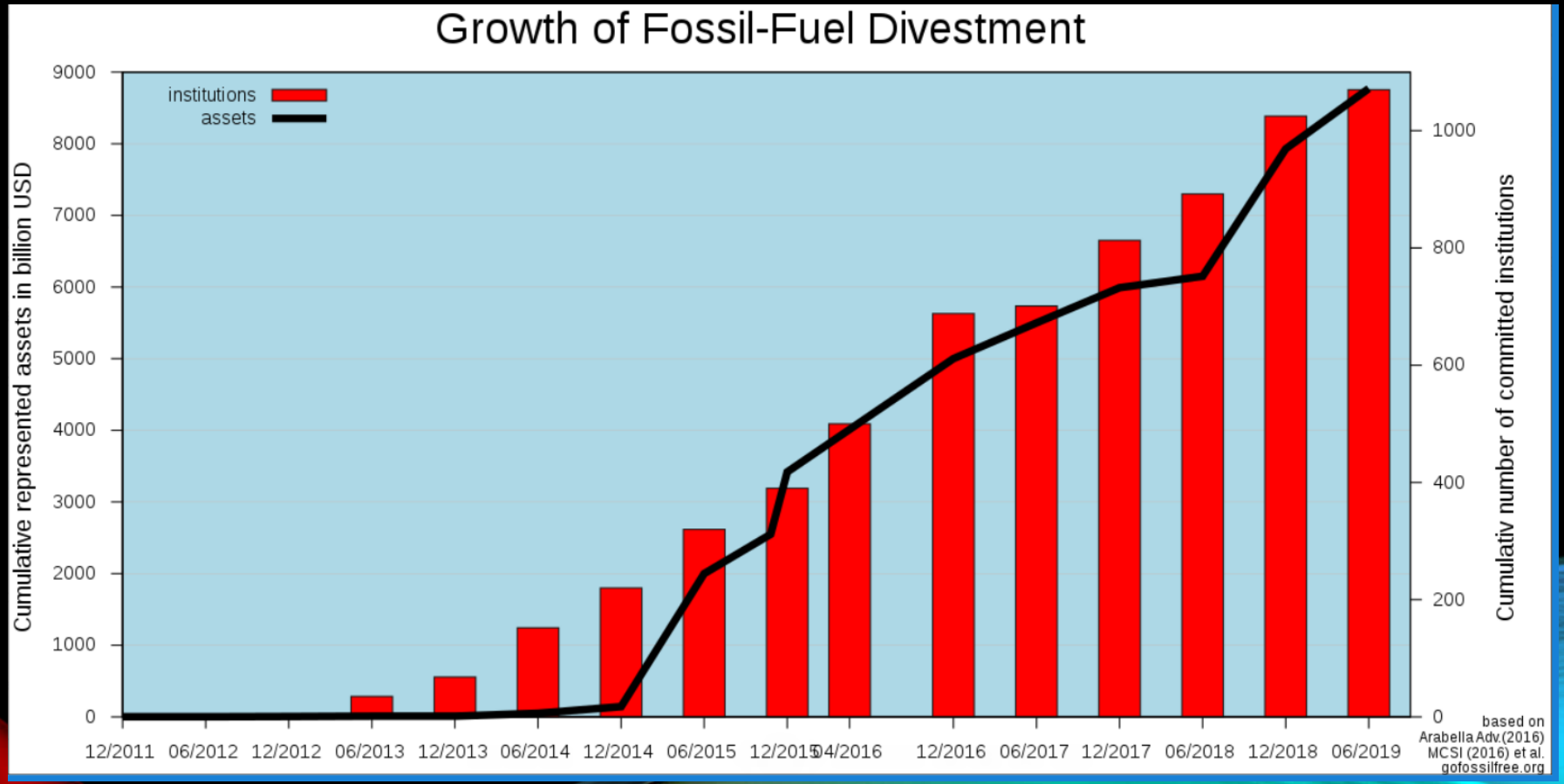
GHGSat and Shell Sign Framework Agreement for Monitoring Services

Newsfile Corp.
Newsfile September 23, 2019



INTRODUCTION: CONTEXT

(i) From Questioning Depletion to Massive Divestment



NEARLY 10 TRILLIONS IN DIVESTISSMENT:
AN IMPORTANT TREND THAT CAN NOT BE IGNORED

INTRODUCTION: CONTEXT

Tesla the solution? Yes and no.
=> The Electrical Power generation problem

Nearly all tier-one automotive are going hybrid or electrical battery

Daimler stops development of internal combustion engines: Complete focus on EVs

Lamborghini Hybrid Uses Supercapacitors in Place of Batteries

The first Lamborghini electrified production car delivers a total of 819 hp (602 kW), enabling it to reach a top speed of over 350 km/h (217.5 mph).

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INTRODUCTION: CONTEXT

Tesla the solution? Yes and no.
=> The Electrical Power generation problem

On May 1, Ottawa began offering rebates of up to $5,000 on the purchase of some electric vehicles. The rebate is intended to bring the price of zero-emission vehicles closer to their gas-powered cousins.

The federal government wants 10 per cent of all cars sold to be zero-emission by 2025, 30 per cent by 2030 and 100 per cent of sales by 2040.
www.tc.gc.ca

Design ENGINEERING

EV sales climb in Canada following new $5,000 federal rebate program

Sales spike despite sharp Ontario decline in wake of province's cancelled rebate.

August 7, 2019 0

THE CANADIAN PRESS
The Canadian Press

100% by 2040. Right… Sure!
No Problem:
Lets just all get Tesla car!

=> Quick Sanity Check:
is the electrical grid ready?

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INTRODUCTION: CONTEXT

Calculated increase in electrical power production to fill car battery for all Canadian

WELL: ALL WE NEED IS $80B TO BUILD 20 NUCLEAR REACTOR

1) Transport needs at least <u>20 GWatt electrical equivalent</u>

Annual gasoline production is equivalent to: 134 GWatt power (Efficiency is only 15%)

2) Converting Canada from combustion to electrical will require: $80B

Doubling our current electrical production capacity, i.e. ***<u>add 40 GWatt at $80B cost</u>****.*

3) The current electrical power production gap

Canada will ***<u>need 20 new nuclear reactors</u>***

Time frame to grow production gap with offer and demand e-car: 30-50 years, at best

<u>Neither Federal nor Ontario can afford the $80B tab to build nuclear capacity</u>!

INTRODUCTION: CONTEXT

Who can pay cost of new electrical generation?

=> Not the nearly bankrupt state (<= exile of manufacturing last 30 years)

=> Not fledging middle-class with dwindling disposable income

How fast can society stop its addiction to crude oil?

Not anytime soon!

INTRODUCTION: CONTEXT

Confusion by misinformation: seeking unifying truth

Mining and Refined Products:

Biggest manufactured export for Canada in 2019.

Crude Oil is crucial for Canadian exports: US$98.8B or 22%

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INTRODUCTION: CONTEXT

Confusion by misinformation: seeking unifying truth

Three applications of transportation: automobile, surface freight and air

Yes for some OEMs

Not for long range Freigth

Not for air travel

Battery availability and prospect

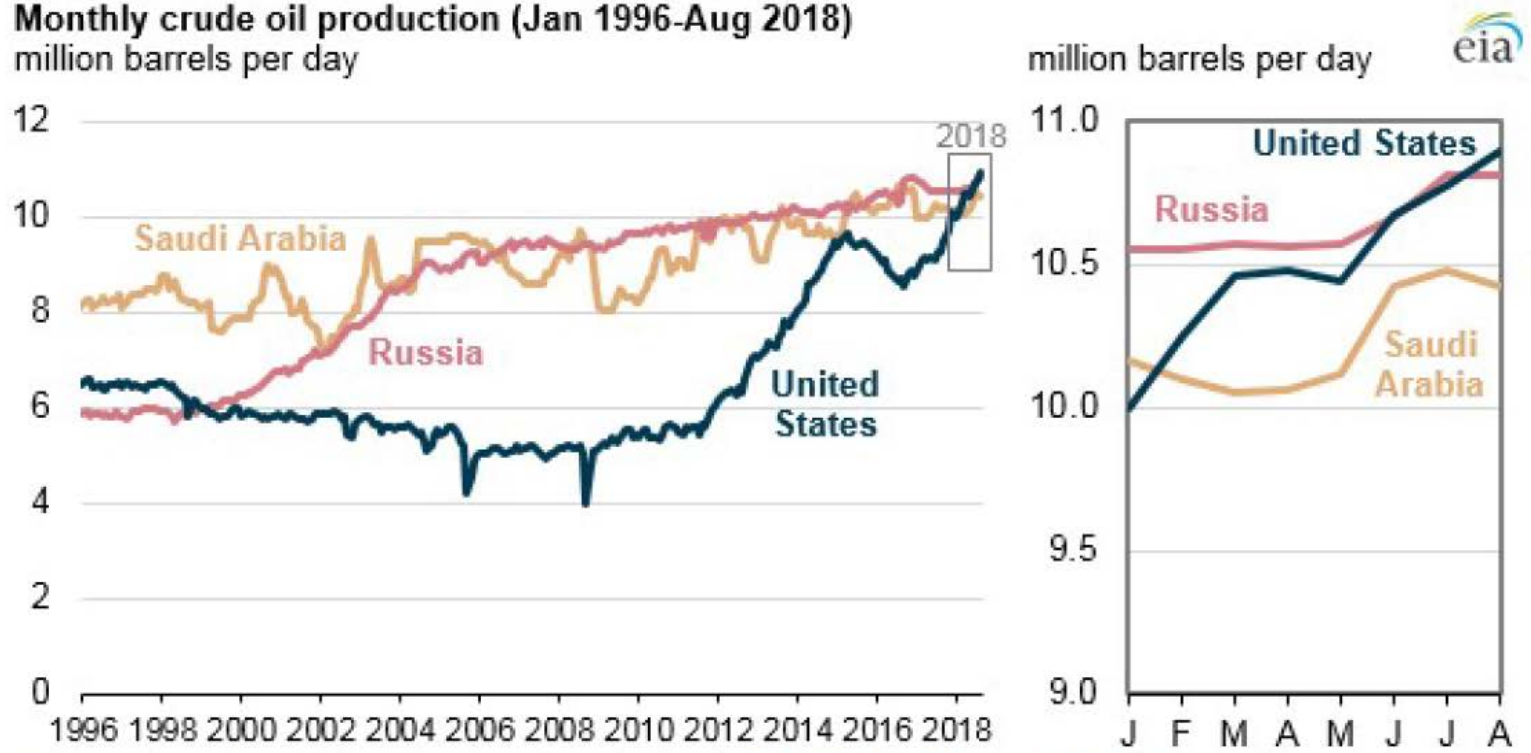
INTRODUCTION: CONTEXT

Confusion by misinformation: seeking unifying truth

Today in Energy

September 12, 2018

The United States is now the largest global crude oil producer



Source: U.S. Energy Information Administration, *Short-Term Energy Outlook*

Note: Production for the United States and Russia includes crude oil and condensate. The total for Saudi Arabia includes only crude oil; EIA estimates that crude oil and condensate production in Saudi Arabia averaged 10.5 million b/d in August 2018.

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INTRODUCTION: CONTEXT

Confusion by misinformation: seeking unifying truth

Transition to electrical transportation: desirable but acceleration needed.

Alternative energy alone can not do it; it is not the answer.

Carbon tax, while politically popular, has not proven to work.

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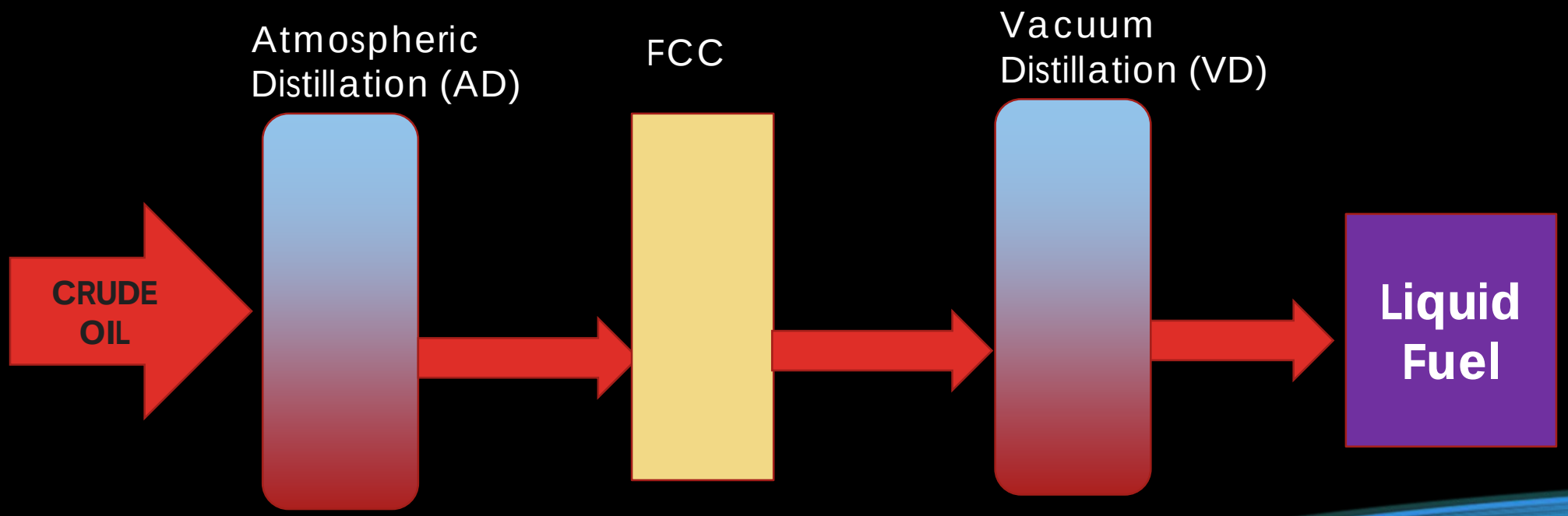
A) SURPRISING DISCOVERY

(i) Traditional refinery



High-Temperature of AD translates into much crude degradation into oxydized heavy ashphaltane

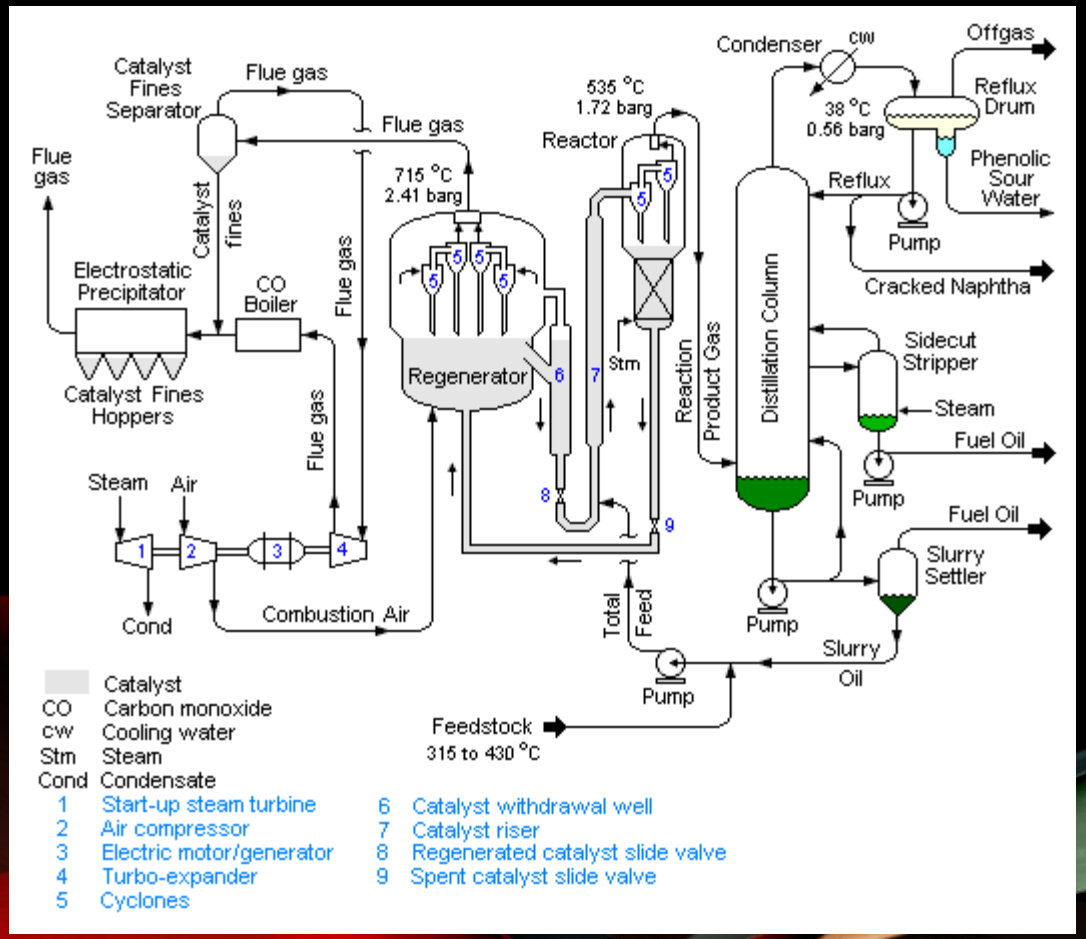
FCC has evolved over the years and relative gasoline production have increased from 1950-1980

Vacuum distillation is more precise and lower material productivity loss due thermal degradation from processing

A) SURPRISING DISCOVERY

(i) Traditional refinery

Complexity of current FCC



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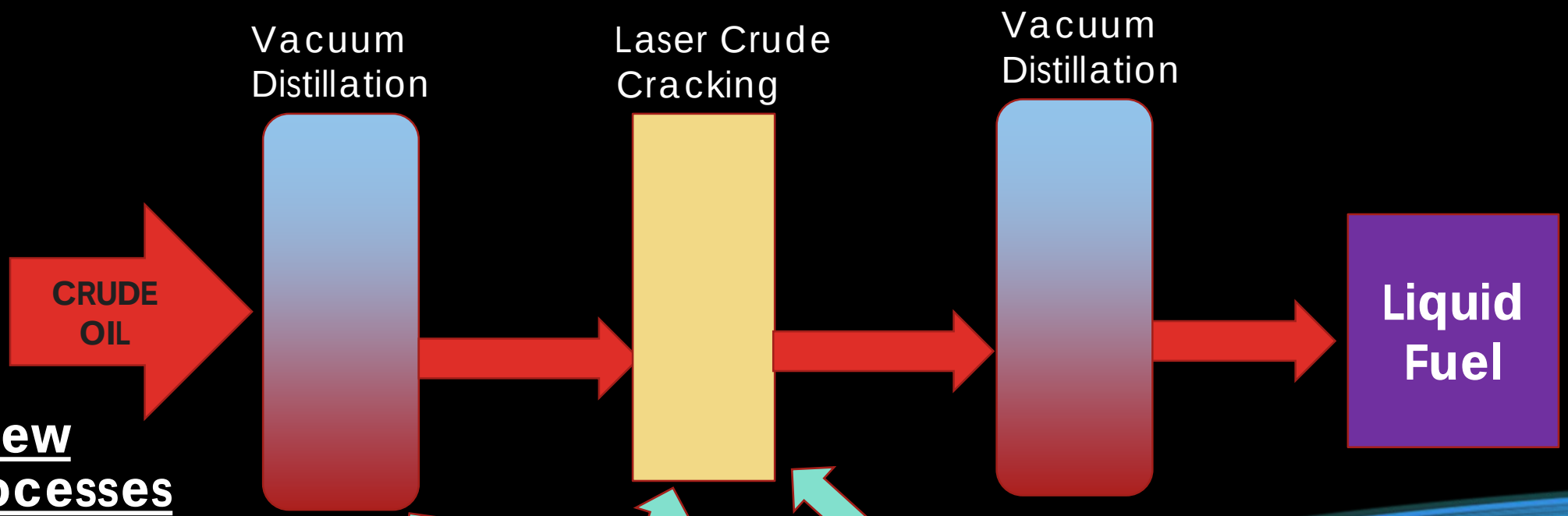
A) SURPRISING DISCOVERY

(ii) Quantum Oil Refinery (QOR)



Three new sub-processes

1. Conformal E-heating

2. High-Precision Vacuum Compressor

3. Laser Heavy Cracking (LHC) Reactor

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A) SURPRISING DISCOVERY

• (ii) Quantum Oil Refinery (QOR)

Petroleum from anywhere

Alternative sources:
Solar and Wind

Electricity as the standard energy currency

Traditional sources:
Hydro-Electric and Nuclear Reactor

Quantum Oil Refinery:

- Thermal BTU from electricity
- Increase Energy Efficiency
- High-Precision Vacuum Distillation
- LHC Replacing FCC process
- Reduce Carbon Footprint

⇒ **Produce a greener gasoline**

Usual Gasoline Diesel and Jet Fuel for Transport

QOR UTILITIES PAVES THE WAY TO ELECTRIC TRANSPORTATION

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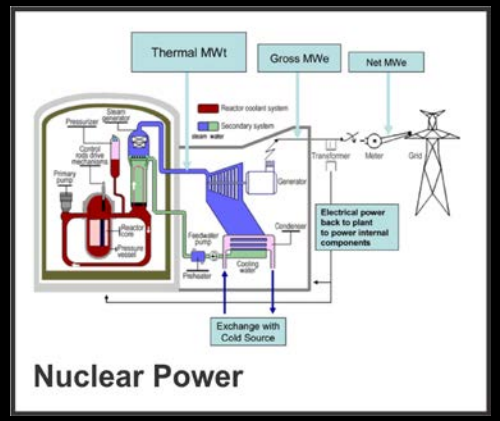
PERSPECTIVE

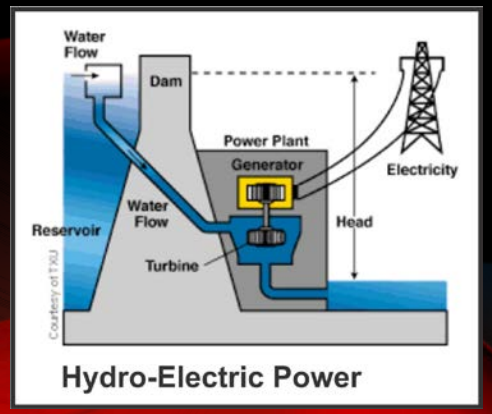
THE REALISTIC GREEN ENERGY FUTURE THAT WE ALL DESIRE

QOR cleantech driving efficiency in transition from oil to electrical transportation

Traditional sources



Nuclear Power



Hydro-Electric Power

Alternative sources


Solar-Electric Power


Wind-Electric Power

Alternative sources: Solar and Wind

Electricity as the standard energy currency

Traditional sources: Hydro-Electric and Nuclear Reactor

Energy Storage: Battery

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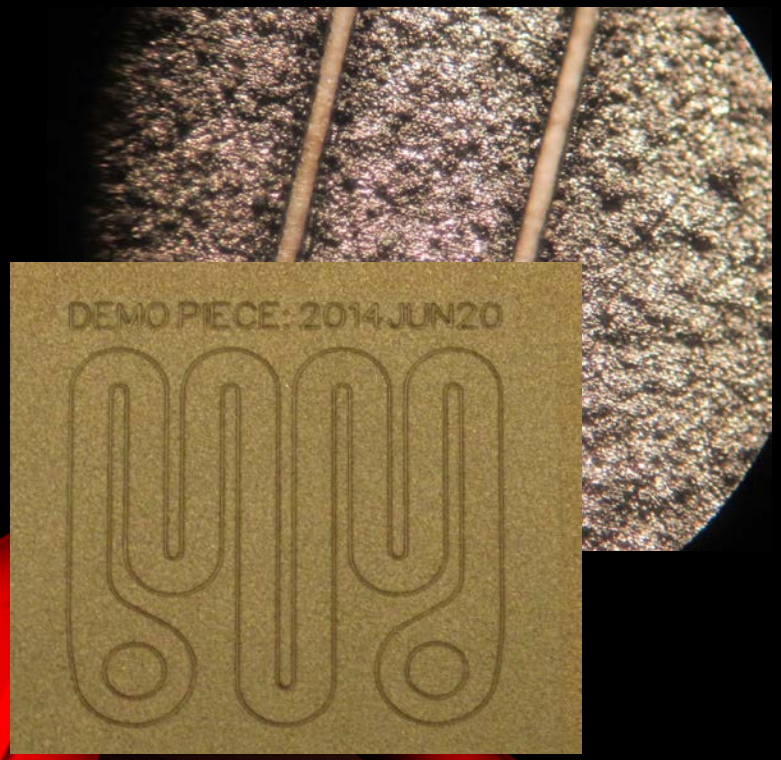
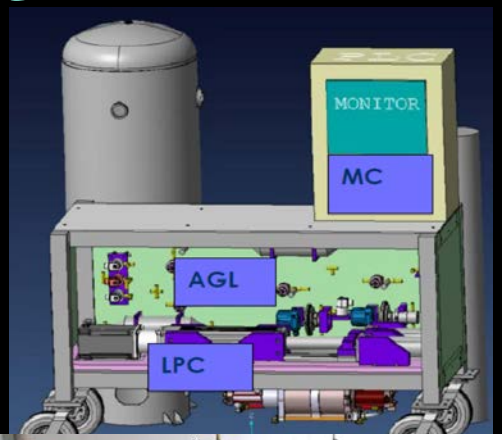
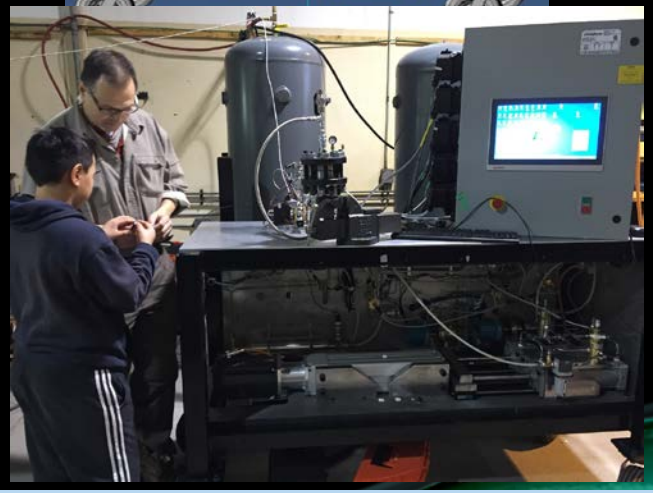
A) SURPRISING DISCOVERY

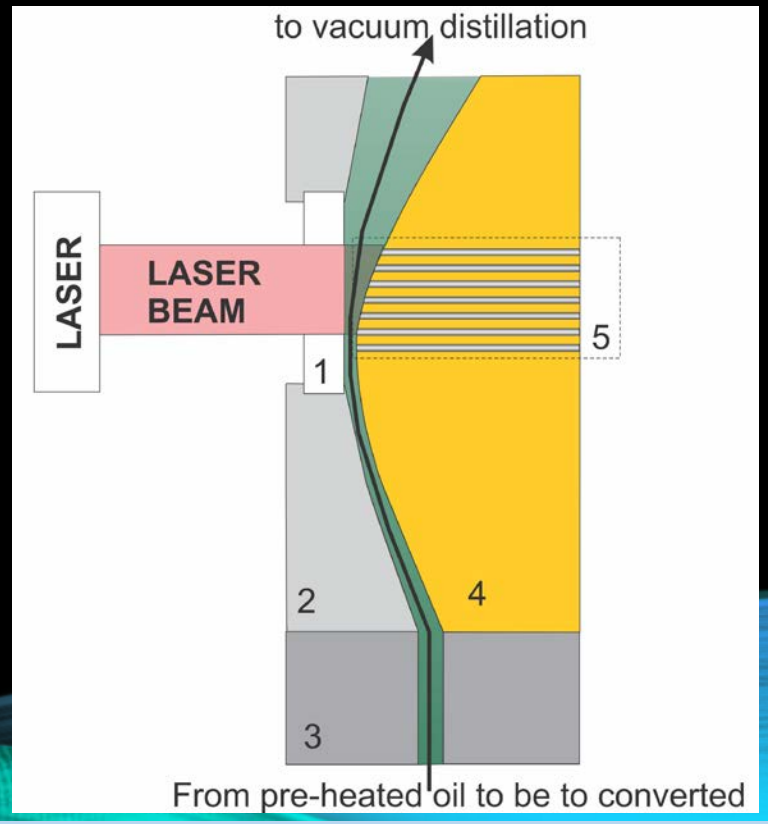
• (ii) Quantum Oil Refinery (QOR)

Three new technologies









Conformal E-heating:

fabrication of heating electrodes by plasma spray deposition

High-Precision Vacuum Compressor:

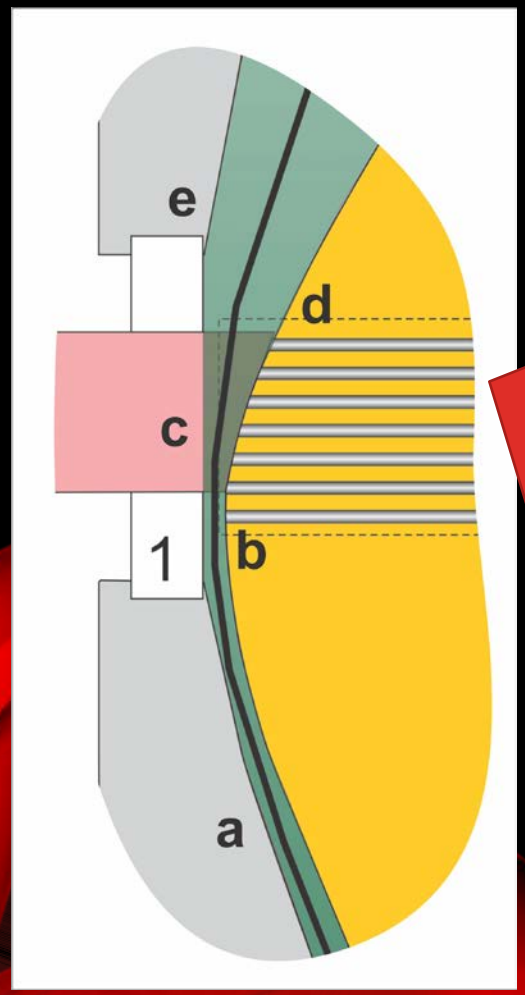
enable smaller and more precise, energy efficient fractionated distillation

Laser Heavy Cracking (LHC) Reactor:

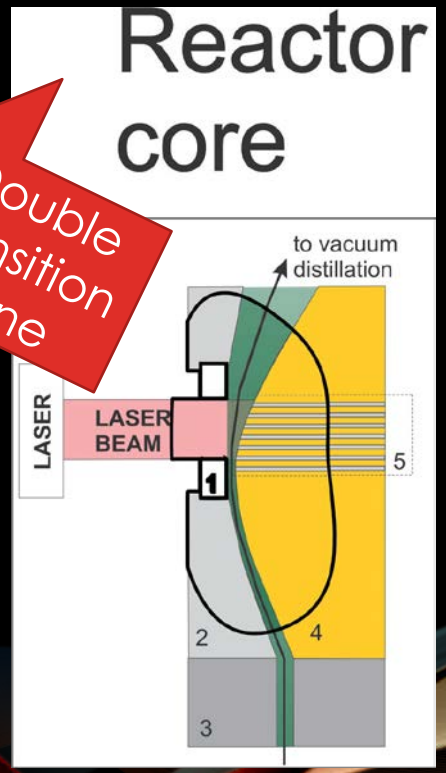
quantum leap in energy and material efficency for hydrocracking

INTRODUCING QOR SOLUTION

Additive Nanomaterial Material Catalytic-injector



In the Double Transition Zone:
State of crude oil changes from viscous liquid from large molecular weight with plasma-catalyzed reaction, into lighter molecules in liquid and vapour states.



LCC: Laser Crude Cracking

Reaction Path:

a. high temperature liquidus

b. steam/hydrogen injection & mixing

c. photocatalytic reactor & hydrogen/steam

d. photocatalytic reactor or hydrogen/steam only

e. high-speed gas expansion

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INTRODUCING QOR SOLUTION

Laser Driven Processes in Compact LCC reactor

- *Fast peak power adjustment of crude heating*
- *Optical saturation of the crude reactant mixture*
- *High pressure reaction in instantaneous laser plasma*
- *Supersaturation pressure from photodissociation breakdown*
- *Threshold control for branching ratio adjustment*

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QOR: A DISRUPTING TECHNOLOGY

Reinventing Petroleum Refinery based on technological advances in S&T
Better Science of last 30 years: Improved fundamental scientific understanding

QOR and Laser Heavy Cracking (LCC) are disruptive technologies:
Replacing established FCC process with LCC can provide breakthrough benefits:

- **Increase Liquid Fuel Production Efficiency (> 20%)**
- **Reduce significantly the capital cost (X 10)**
- **Reduce significantly physical footprint (X 10) of new refinery**
- **Reduce the carbon Footprint (X 10) environmental impact**
- **Reduce Cost of Operation (X 10)**

Better implementation control and automation from last 25 years
Better environmental performance
⇒ **Produce a greener gasoline**

A) SURPRISING DISCOVERY

(iii) Low efficiency of current oil refinery process

10-30% of crude goes to CO2 to provide heat or lower value heavy by-product (tar & ashphalt)

The average barrel (~159 litres) of crude oil to pass through U.S. refineries in 1995* yielded the following products:

a. Gasoline: 44.1% (70.12 litres)
b. Distillate fuel oil: 20.8% (33.07 litres)
c. Kerosene-type jet fuel: 9.3% (14.79 litres)
d. Residual fuel oil: 5.2% (8.27 litres)

Total Yield of liquid fuels: ~100 litres
Other reaction products include: flue gas, tar and ashphalt

**Riegel's Handbook of Industrial Chemistry, 2003 edition (Page 515, Fig.15.6).
Based upon conversion rate of 159 litres per barrel.

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A) SURPRISING DISCOVERY

(iv) Properties of QOR compared to traditional

More efficient quantum process:

- Increased efficiency of material conversion from crude to liquid fuel: X10% - X30%
- Cheaper X5 – X7 and faster to build : X3 – X5
- More compact: X10 – X20
- Reduced GHG emission by X4 – X8

Global adoption of QOR technology can lower CO2 emission by 3.65 GTon!
=> That is 50% of the Paris Target.

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B) FEASIBILITY TO IMPLEMENT QOR WITHIN A DECADE

(i) Implementation plan: 5-6 years

Core R&D to QOR Pilot to QOR Production:

Phase I (6 - 18 months): Proof-of-concept testing of LHC sub-system & 1st order detailed QOR design

Phase II (12 – 36 months): LHC Optimization and pre-production prototype fab & costed QOR design

Phase III (12 – 18 months): Production prototype of LHC modules, and Integration of LHC in pilot QOR

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B) FEASIBILITY TO IMPLEMENT QOR WITHIN A DECADE

(ii) Large ROI for R&D

BUDGET for three phases: (a) Core R&D to (b) QOR Pilot to © QOR Production:

a – b – c : $2M - $10M - $50M => Program of 5-6 years long

A fair ROI: $100M to create a disruptive market size estimated at $1T

$100M = $1X$10^8$, $1T = $1 X 10^{12} , factor of 10^4

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B) FEASIBILITY TO IMPLEMENT QOR WITHIN A DECADE

(iii) A large technical challenge: inducing global collaboration

Rebuild 700 refineries in 5 years: 50, 100, 150, 200, 200

Peaceful R&D project to rival in size and intensity with “Manahattan project”

So big that there will be shortage of capable well-educated STEM skills

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B) FEASIBILITY TO IMPLEMENT QOR WITHIN A DECADE

(iv) QOR ushers the way to mass electrical transportation

Each refinery requires non-carbon electrical (nuclear) power generation

Each refinery project will create 2000 direct and 18,000 indirect jobs (20,000)

Overall QOR project to create 20M middle-class jobs: kick to global economy

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B) FEASIBILITY TO IMPLEMENT QOR WITHIN A DECADE

(v) Three ingredients for viral transition to e-car

a) Must be affordable for the mass => re-creation of an industrial middle-class

b) Availability of Electrical energy for charging battery

c) Must be self-sustainable (difference with a fad; e.g. solar subsidies)

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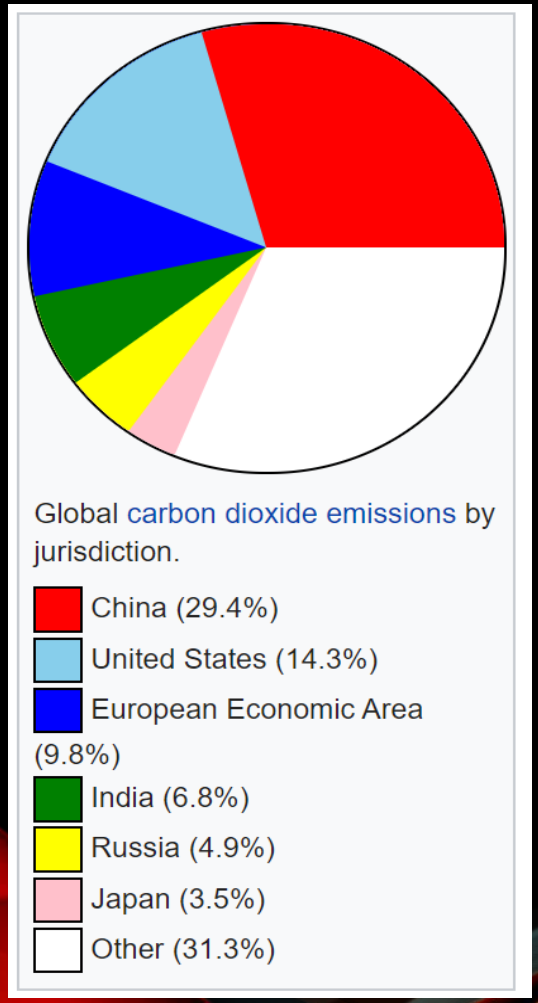
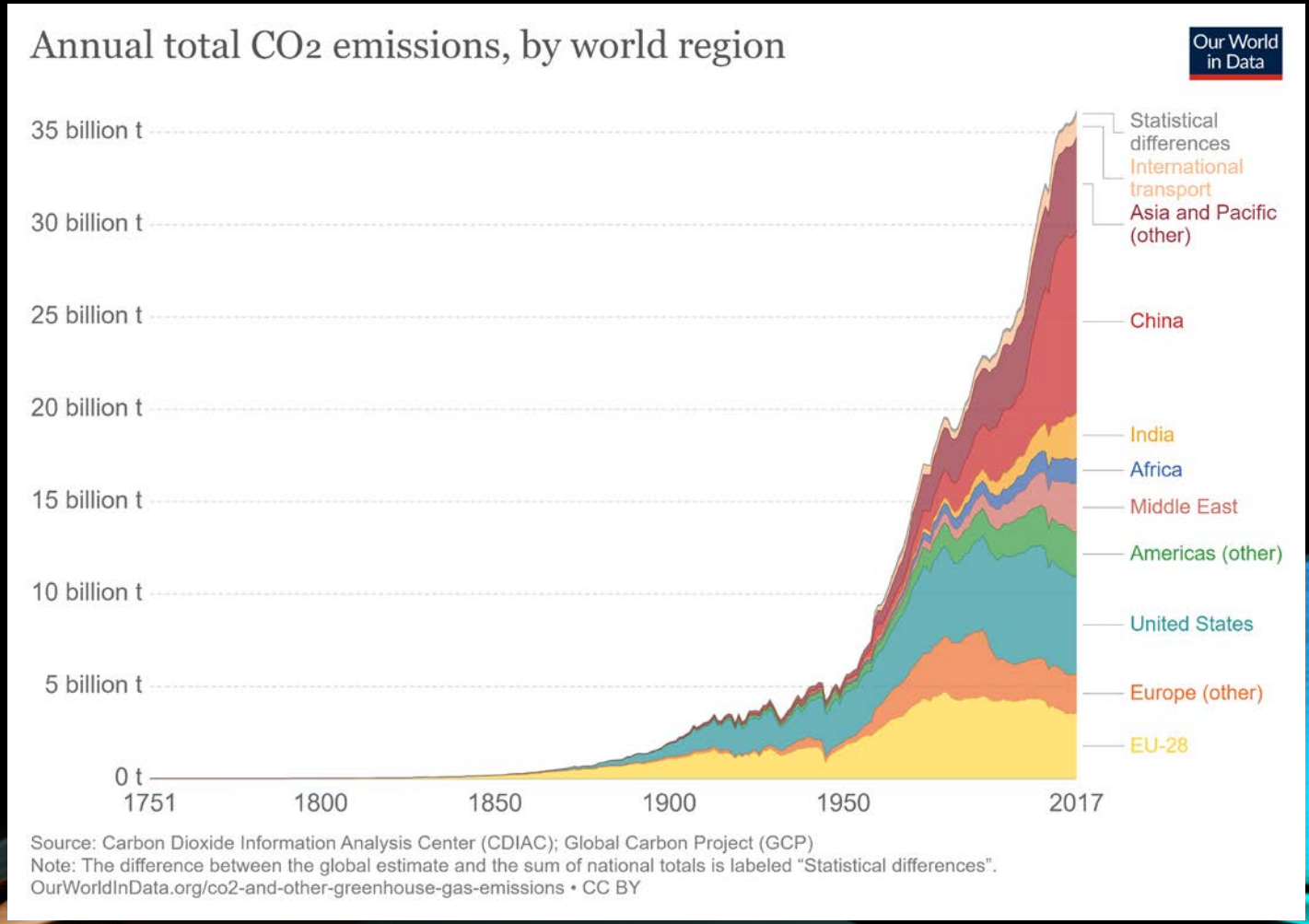
C) BEST PATH FOR PARIS TARGET

(i) Quantify the GHG problem

Globally, we emit over 36 GTon of CO2 per year





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C) BEST PATH FOR PARIS TARGET

(ii) Define the Paris Target: 20/20/20

Meeting the agreements of the Paris 2015: world's first comprehensive climate agreement.

In a nutshell, it sets the 20/20/20 targets:

20% reduction: CO_2 emissions

20% increase: renewable market share

20% increase in energy efficiency

REDUCTION BY 20% FROM 36 GTON OF CO2 PER YEAR (2019)
=> REDUCE EMISSION OF CO2 BY 7.2 BILLION TONNES

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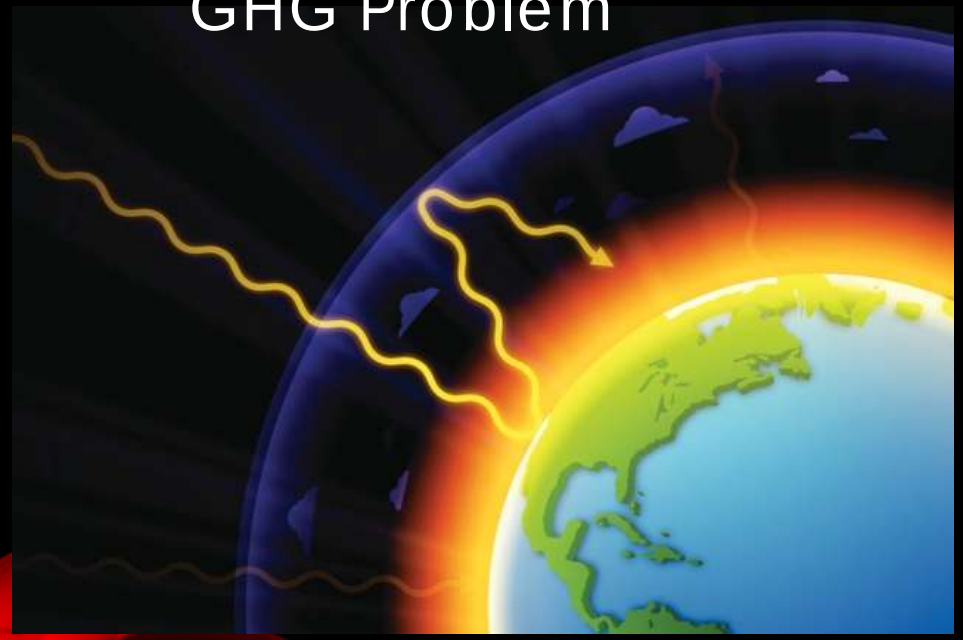
C) BEST PATH FOR PARIS TARGET

(iii) Problem: No clear path to get there

GHG Problem



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QOR

Paris Targets

PARIS2015
UN CLIMATE CHANGE CONFERENCE
COP21·CMP11

C) BEST PATH FOR PARIS TARGET

(iv) QOR: the solution to the problem

QOR paves a path to meet the 20/20/20 Paris Target and to usher a global transition to electrical car transporation with a unifying platform for industry.

Our QOR technology can reduce 3.65 Gton CO2/year:
=> **50% of the way to the Paris Target**

The other 50% comes from reduced gasoline uses, enabled by increased conversion to electrical transportation driven by electrical utilities for QOR.

C) BEST PATH FOR PARIS TARGET

(v) Feasibility to implement QOR

How it is feasible: *Elevates the mutual benefits of potential collaboration*
=> *henceforth entices collaboration between traditional foes (alternative vs conventional)*

Why it is feasible:
Agreeing on existence of problem is conditional to realizing avenue for acceptable solution,
"Problem => Solution" angle that destroys ones established business is never welcome.

Open mind toward a new outlook to **entice collaborative effort for evolving (old => new)**

Respect for the old
Humility to enable support for the new,
And pre-forgive stumbling of new beginnings

ClaireLasers
Dr Denis J. Gendron, Physics PhD

C) BEST PATH FOR PARIS TARGET

VISION FOR COLLABORATION WITH BIG MONIES

I) Interest by Big Oil Company for profitable QOR drive new built of electrical utilities

II) Big Oil will have options between gasoline and electrical power distribution

III) Nuclear energy re-engineering & revival is essential in many places to replace oil

ClaireLasers
Dr Denis J. Gendron, Physics PhD

REINVENTING OIL REFINERY WITH QOR

QOR: It's petrochemistry in the era of depletion:

- Support long-term energy security for Canada
- Improves energy efficiency and lowers emissions
- *Promotes transition from oil to electrical transportation*

Denis J. Gendron, President, Claire Lasers Corporation

ClaireLasers
Dr Denis J. Gendron, Physics PhD

QOR AS A DISRUPTIVE TECHNOLOGY

Disruptive technology triggers a quantum leap for electrification

Drive significant increased revenue benefits for leading oil producers:

(i) More efficient (>30%) crude refinery affords higher crude oil price (competition factor)

(ii) Lower (X10) capital cost of refinery enables previously inaccessible refining production.

(iii) Bi-partisan support: => O&G + government are investing to increase electrical capacity

ClaireLasers
Dr Denis J. Gendron, Physics PhD

Efficiency of Energy Processes

Four factors improving energy efficiency for QOR:

i. reduction of collateral energy losses associated with heating large structures

ii. large reduction of process temperature: heavy crude remains liquid

iii. avoiding the necessity to constantly reprocess (de-coke burn) FCC catalyst

iv. reduction of energy used in High-Flow Compact Vacuum-Distillation (HFCVD)

v. Better control of (electrical) heating processes, both in time and in space

ClaireLasers
Dr Denis J. Gendron, Physics PhD

DRASTIC REDUCTION IN EMISSION

Reductions in emissions result from many factors of QOR process:

i. Replacing hydrocarbon burn with carbon-free electricity, reduces CO_2

ii. Vacuum distillation of incoming crude reduces methane emission

iii. No CO_2 associated with constant reprocessing (burn-off decoking) FCC catalyst

ClaireLasers
Dr Denis J. Gendron, Physics PhD

QOR AS A CLEANTECH

Breakthrough Cleantech

Current refinery uses part of the crude (up to ~30% of material mass) as a burn fuel

QOR implemented as industry standard, is biggest opportunity for CO_2 reduction

Treating precious crude with more respect for its scarce nature *will increase its price*!

QOR AS A CLEANTECH

QOR CLEANTECH Benefits

- ❑ Higher Energy Efficiency for current process
- ❑ Reduced Emission compared to current process
- ❑ “Pave the way” for transition to electrical transportation

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Dr Denis J. Gendron, Physics PhD

LUCRATIVE AND GREAT FOR CANADA

Canada exports mineral fuels & oil: US$98.8B or 22% of total export

Canada has a $10B trade deficit with China

=> Refining 1/3 of Canada crude oil will add $10B in revenues

QOR can accelerates electrification of transportation

Motivate big oil companies to invest in oil-free electrical utilities

=> Potential opportunity to revive our nuclear energy industry (CANDU safest reactor ever)

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Dr Denis J. Gendron, Physics PhD

QOR AS A FINTECH

Avenue to balance international trade deficit of Canada

Crude Oil is crucial for Canadian exports: US$98.8B or 22%

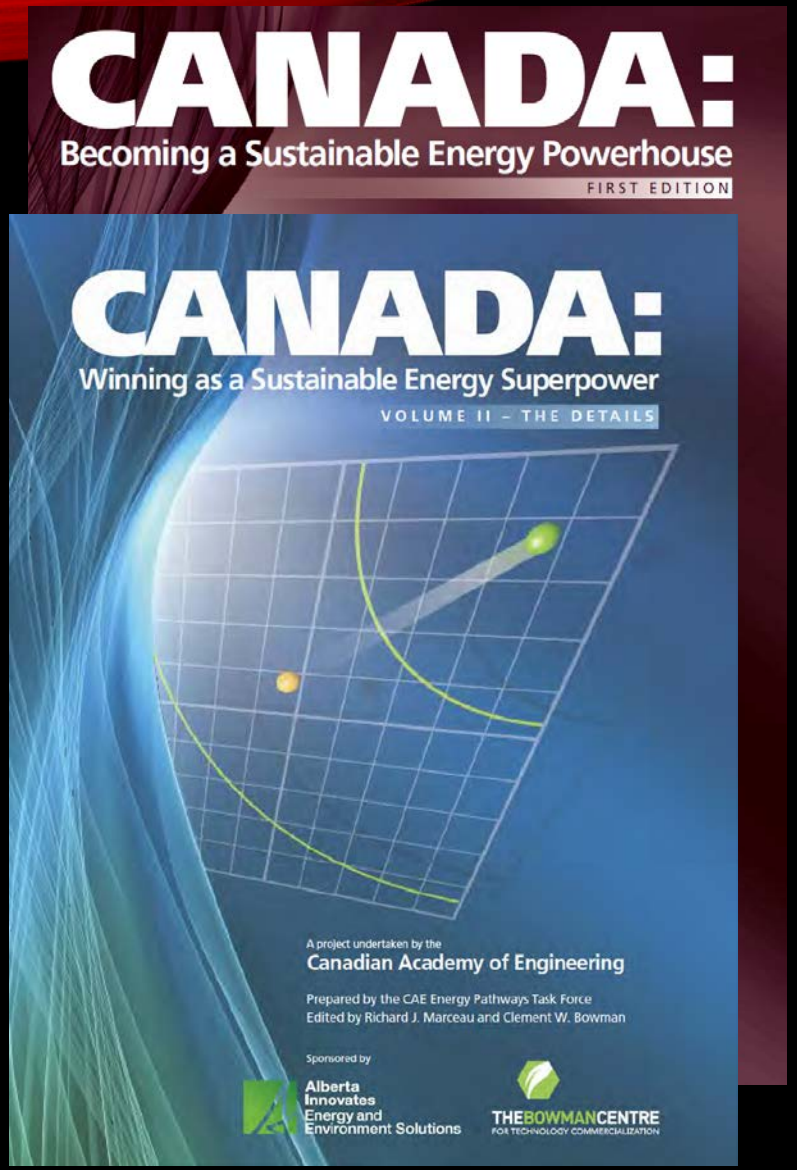
Refining a third of Canadian crude oil for export: $10B - $20B.

Additional annual revenues for Canada

that corresponds to trade deficit with China!

BECAUSE IT IS POSSIBLE !

THANKS FOR INSPIRATION AND PERSONAL ENCOURAGEMENTS



A Tribute to Dr. Richard Marceau

Memorial University lost a great champion and gentleman overnight on Sept. 26, 2016, with the sudden passing of Dr. Richard Marceau, Vice-President (Research).

- Read *Gazette* news story "Gentle giant," from Oct. 3, 2016.