REMVue Energy Optimization and Slipstream

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- Efficiency
  - Rich to Lean Engine Conversion
  - Reliability Improvement
  - Compressor Capacity Control
  - Unit Cooling Control
- Diagnostics
  - Unit Efficiency “Gas Mileage”
  - Compressor Leaks
- Use of Fugitive Emissions (Slipstream)
  - Opportunity
  - Status
- Challenges

Why Optimize?

- Money - Save fuel*
- Money - Maximize uptime and throughput
- Money - Use wasted emissions “free fuel”*

- Environment - Reduce Greenhouse gases

* Valid only if engine fuel has a **perceived** cost

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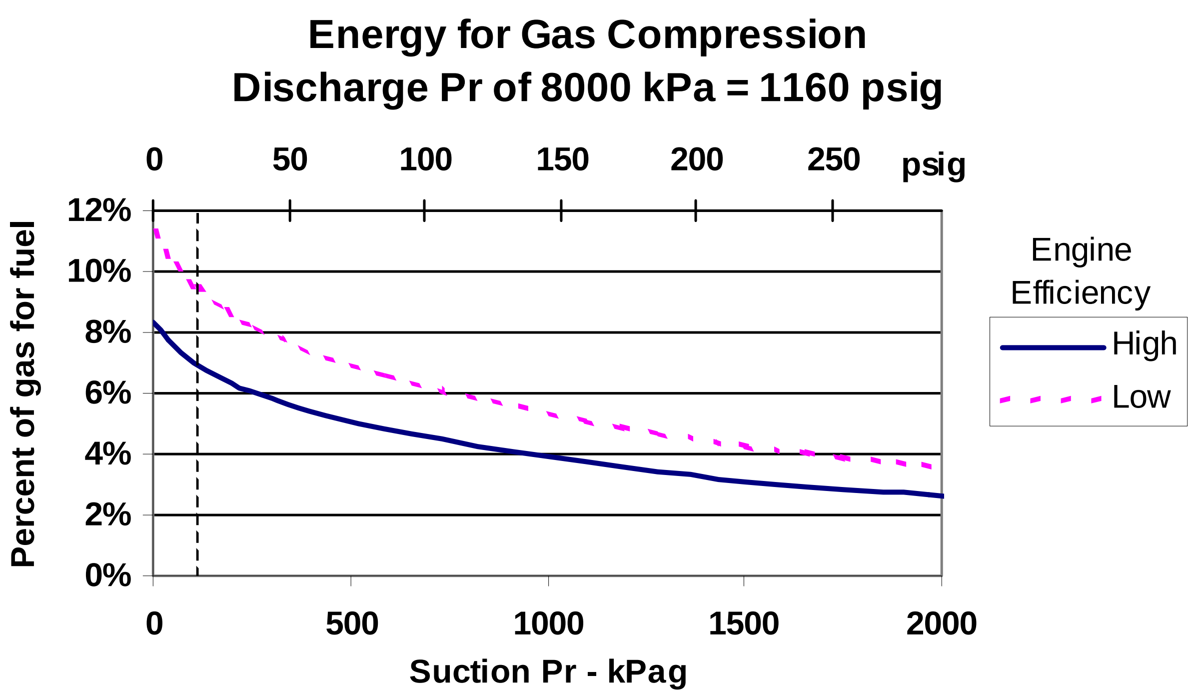
Field Compression

- Lower field pressures require more compression energy
- A big difference to available reserves and potential revenue



As field pressures decline, more compression energy is needed, so efficiency and optimization become <u>even more important.</u>

REMVue Engine Rich to Lean Conversion*

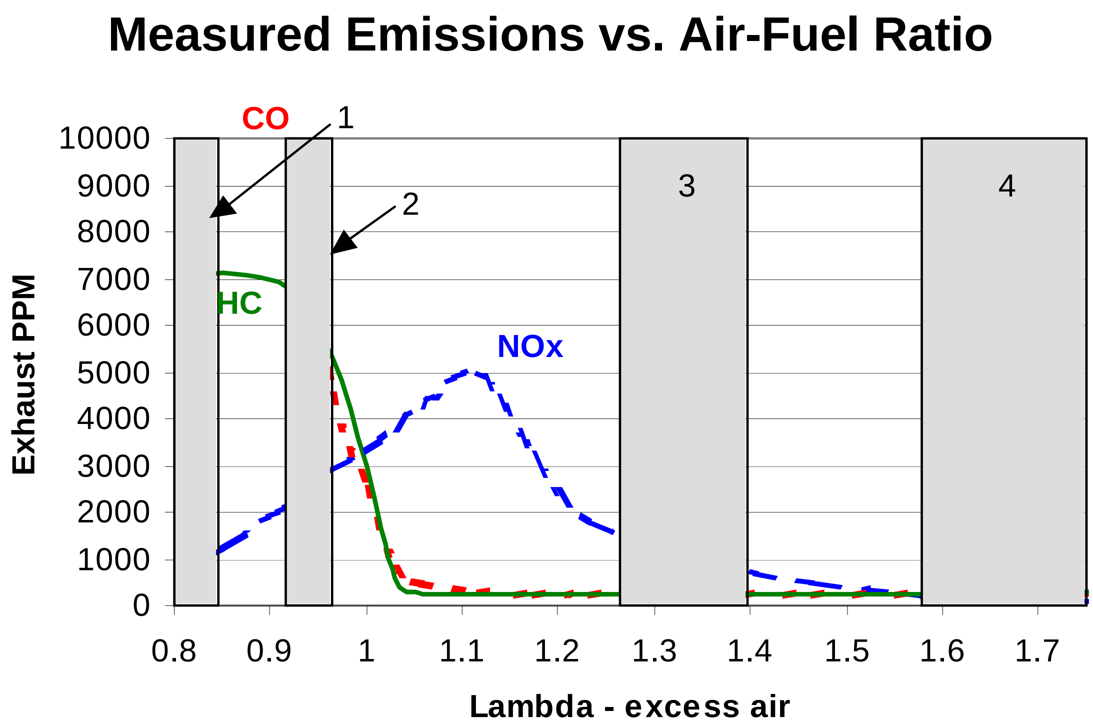
- Provides improved energy efficiency
  - Less unburned fuel, less CO emissions
  - Less heat loss from burned gases
  - No 3-way exhaust catalyst requiring energy
- Improves reliability by lower temperature operation
- Reduces greenhouse gases
  - Less fuel used
  - Less methane in exhaust gases
- Verified by third party study – Accurata/PTAC
  - http://www.ptac.org/eet/dl/eetf0501p06.pdf

* A high fraction of existing NG engines in the oil and gas industry are “rich burn”.

REMVue Rich to Lean Conversion

- Operational Regimes

1. Rich
2. Stoichiometric
3. Lean – Best fuel
4. Lean – Low NO_x



In stoichiometric or rich burn engines, much of the energy goes "up the stack" or to the catalytic converter in the form of CO and unburned methane

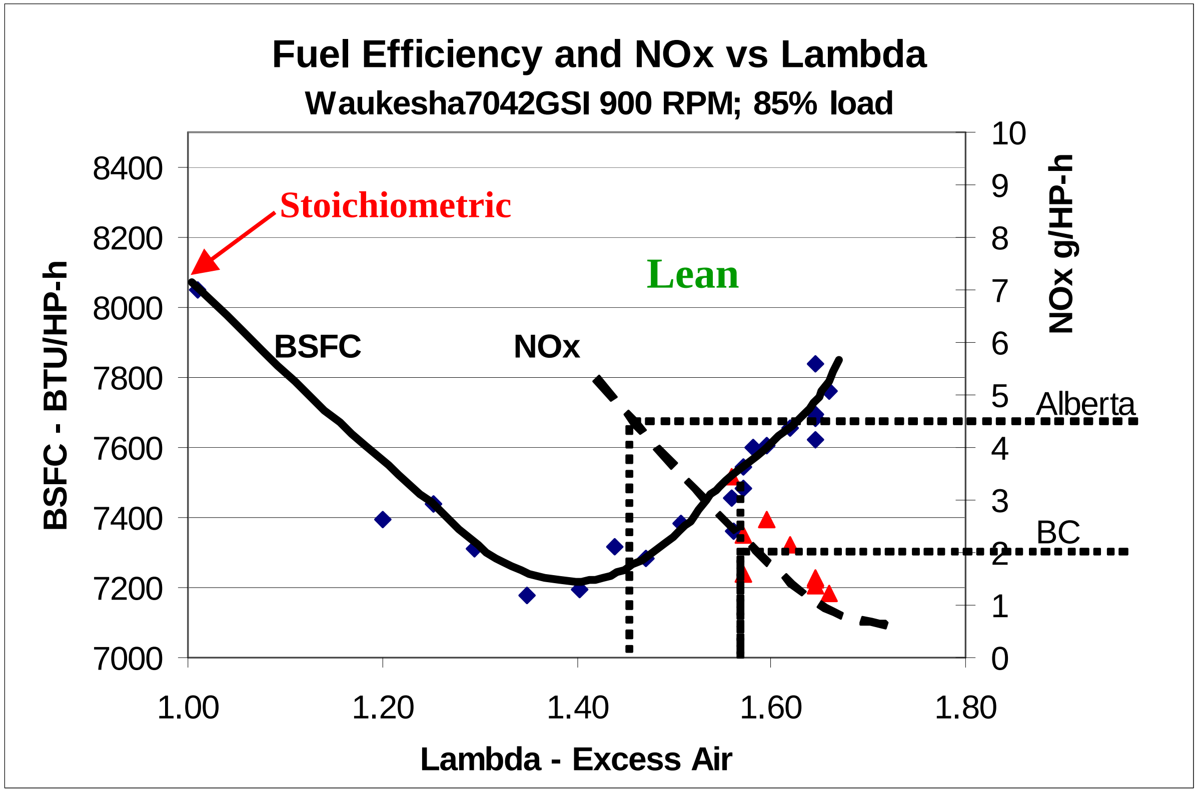
REMVue Rich to Lean Benefits

		Stoich	Lean	Improvement
Load	HP	1233@1000 RPM	1214@1000 RPM	N/A
Fuel	kg/h 1000m^3/d	230 7.69	211 7.05	**8.3% (often more)**
Fuel*	$/y	$613,000	$562,000	**$51,000**
Exhaust Temp	Dec C	690	574	17%
GHG(e)	tonnes/y	7805	5843	**33%**

Savings every year!

* Fuel @ $6.00 / GJ

Effect of Regulations



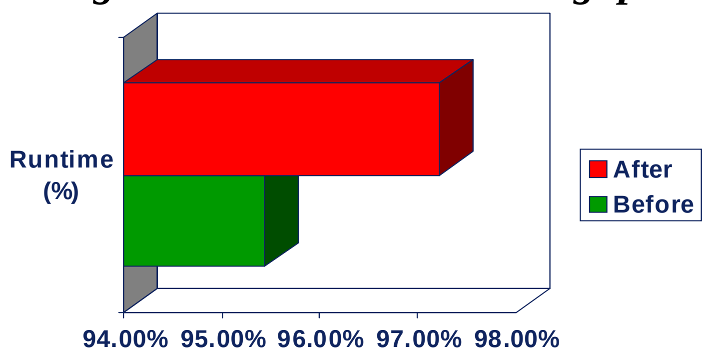
With current Alberta NOx regulations the fuel efficiency is near optimum

With current BC NOx regulations compared to Alberta, there can be a 3 to 4% efficiency penalty and an estimated 15 to 20% GHG(e) penalty

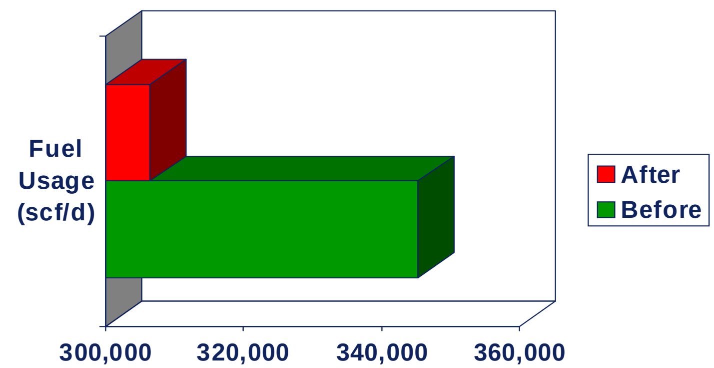
REMVue Reliability

Comparison Data* on Benedum Unit B-2 (Western Gas, Texas) Before/After REMVue installation (7 months before/ 7months after)

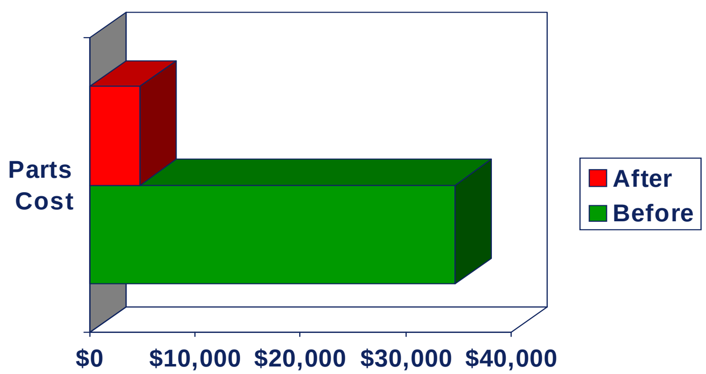
Higher runtime = More throughput



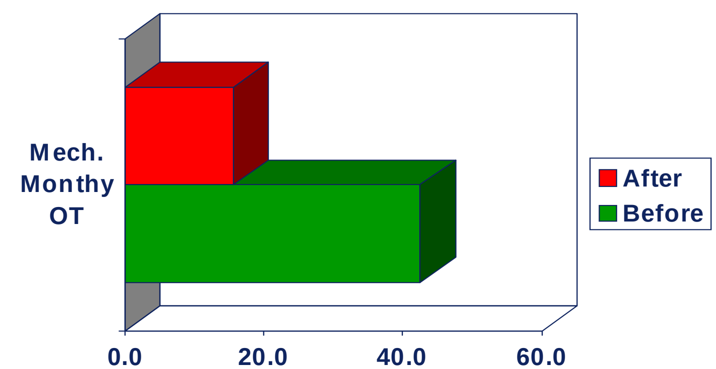
Better AFR = Less consumed fuel



Better control = Fewer damaged parts



Less equipment damage = Less OT



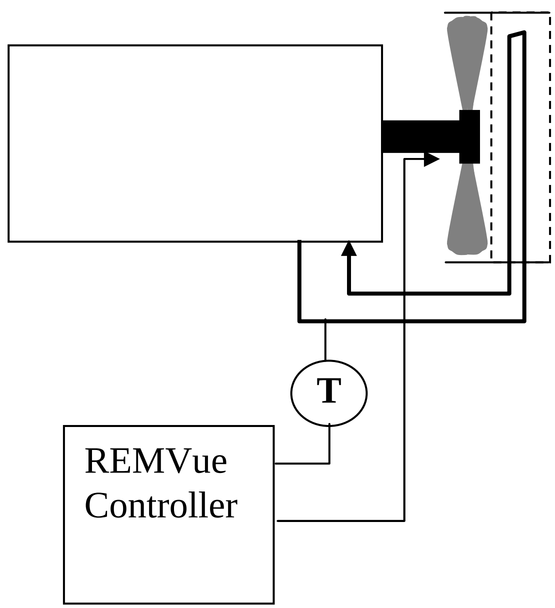
***Data supplied by plant operations**

Compression Optimization

- Control compressor to minimize energy waste
  - Minimize recycling
  - Minimize suction throttling
  - Minimize blow downs
- Engine loading
  - High % load (100% vs. 50%) give up to 18% more efficiency
- Recip Compressor RPM
  - Lower RPM (750 vs. 1200 RPM) can give 19% more efficiency (less valve loss)

REMVue Cooling Control

- Cooling fans use about 4% of delivered power
- Sized for worst case
- Louvers reduce flow but increase fan load
- Pitch adjustment based on water/compressed gas/oil temperature can reduce average fan load to < 2% of delivered power
- Fuel cost savings at1200 HP, $6/GJ ≈ $10,000/y
- Implemented by BP



REMVue Diagnostics

- Provides a well/unhealthy indicator
- On-line 24/7 monitoring
- If well, no action is required;
- If unhealthy, provides an indicator of the problem type;
- If serious, provides alarms or shutdowns;
- Can provide an operating cost of the problem.

Prompt correction of a problem
Can save fuel and avoid lost production

REMVue Diagnostics BSFC

The line shows expected performance;

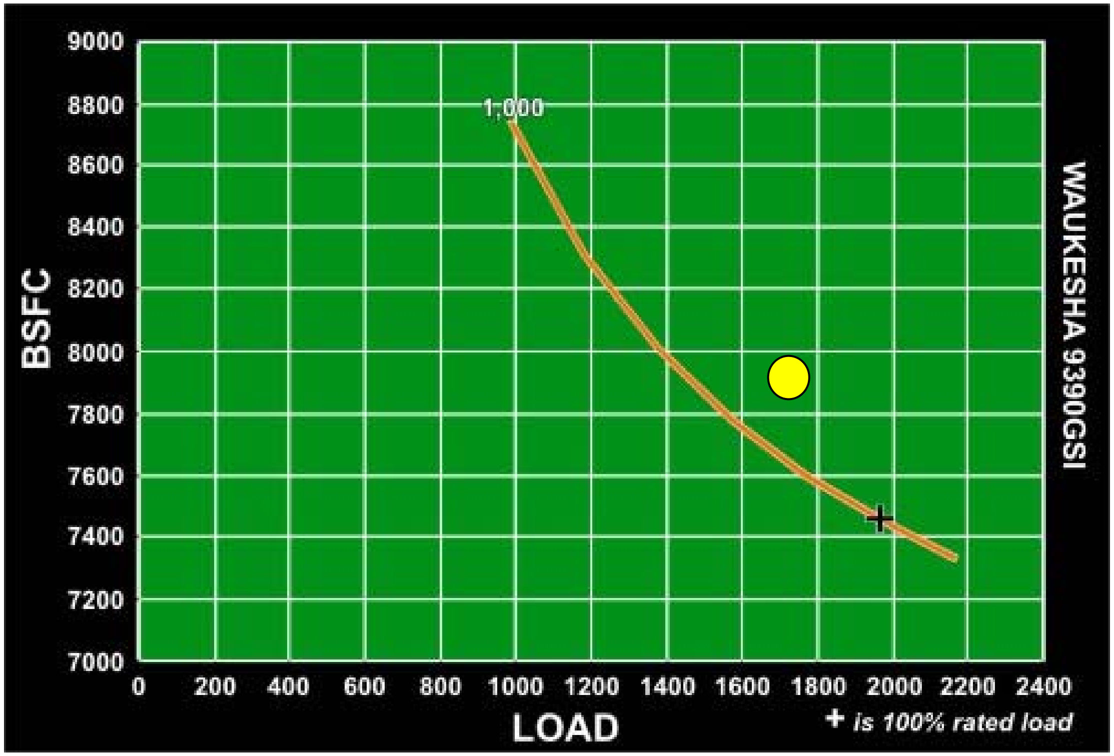
The yellow dot shows current performance

BSFC "Gas Mileage"

On the line = OK

Off the line = problem

Engine or compressor not healthy



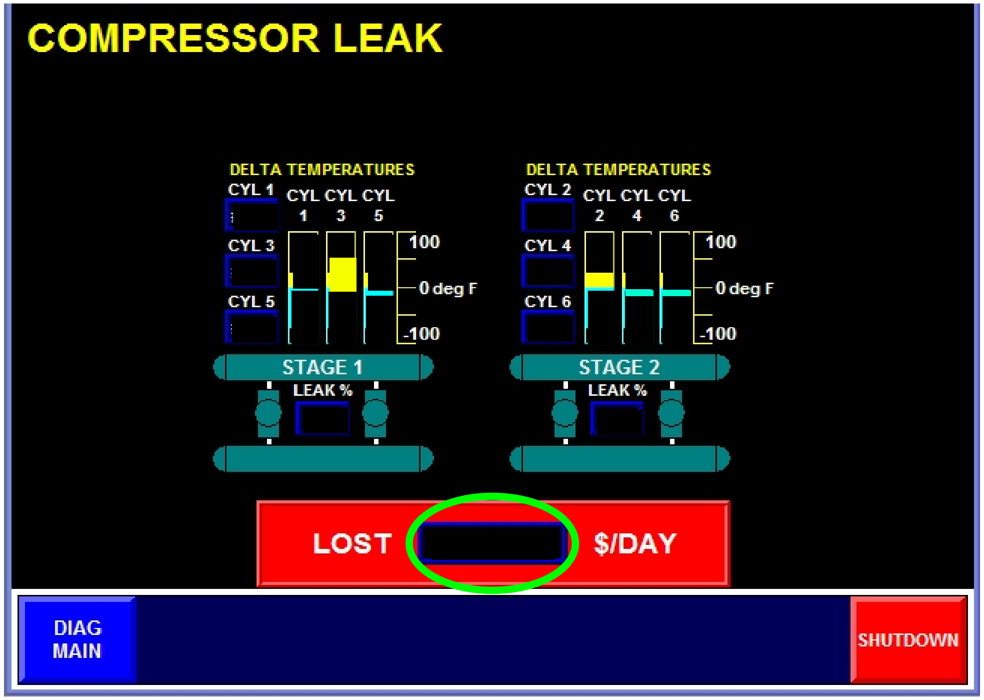
***B**rake **S**pecific **F**uel **C**onsumption (BSFC) is the fuel heat per hour to generate 1 HP of mechanical power; a low BSFC means high fuel efficiency*

REMVue Leak Diagnostics

A compressor leak causes lower compressor through-put and wasted engine fuel

- Compressor leak detection
  - Valve leak
  - Packing leak
  - Ring leak
  - Unloader leak

- Lost production estimate is $2443



REMVue Slipstream

Getting a free boost.

REMVue Slipstream*

Using fugitives as engine fuel

- Fugitive HC gas into engine intake
- Can be diluted with air or undiluted
- Does not require fugitive gas compression
- Fuel is "free" (Fuel for a 1200 HP engine at $6/GJ costs over $500,000/y)
- Site results by using **only** the vented instrument gas (6.6 scf/m) *showed a fuel cost reduction of $24,290 per year*.
- Substantial GHG(e) reduction
- Advanced control allows for variability
- Can burn BTEX+ (> 99.5% reduction)

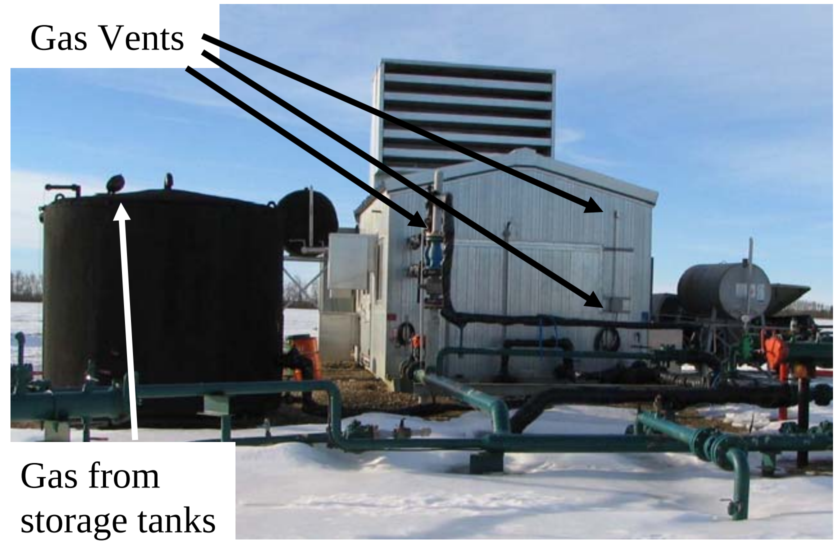
* US Patent Pending

+ BTEX = Benzene, Toluene, Ethyl-benzene, Xylene

REMVue Slipstream

Where Do Fugitives Come From?

- Instrument gas vents
- Compressor packing leaks
- I/Ps and pneumatic devices
- Petroleum liquids tanks
- Flange leaks
- Dehydrators
- Engine starting, purging, blow-downs
- Crankcases



REMVue Slipstream

- Status
  - Proven with instrument gas
  - Pilot for solution gas and packing vent gas being commissioned (Jan/Feb 2007)
  - 1200 HP engine
  - 50% of fuel = $250,000/y
  - GHG(e) ≈ 50,000t/y if methane

Oil Tanks

Gas vents

Compressor Building

Slipstream Value @ $6/GJ

Using fugitives as engine fuel

Venting and Leaks of Methane[1]

Reported Venting	$204 M/y
Unreported Venting	$150 M/y
Storage Venting	$ 32 M/y
Leaks	$157 M/y
Total	$543 M/y

Use some of this for engine fuel

Fuel gas consumed by NG engines (Canada)[2] > 600 HP is $930M/y

1 - "**Upstream Oil and Gas Fact Finding Report on Fugitives**" – March 2006 – PTAC Report by Bruce Peachey, P.Eng.

2 – "**Emissions and Efficiency Enhancements with REM AFR Systems**" – March 2006 – PTAC Report by Bill Gibb, Ken Terrell and Frank Zahner

Challenges

- Fuel cost is perceived as very small
  - "The fuel doesn't appear on my books."
  - Reduces incentive to improve.
- Conflict between low NOx and efficiency (low CO_2)
  - Which is more important?
- Industry adoption of fuel efficiency is sporadic
  - Is legislation needed?

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Summary

- ✓ Rich to lean conversion – Proven
- ✓ Capacity control – Proven
- ✓ Reliability improvement – Proven
- ✓ Diagnostics – Proven
- ✓ Fan optimization – Proven
- • Slipstream – Immense promise
- ? Challenges – Regulatory, technical

Closing thoughts

The average vehicle generates about 5 tonnes of GHG per year.

One rich to lean conversion of a 1200 HP engine reduces GHG(e) emissions by 412 vehicles.

One slipstream application using fugitive emissions of methane for 20% of the fuel reduces GHG(e) emissions by 3600 vehicles.

Thank you

Green = Green