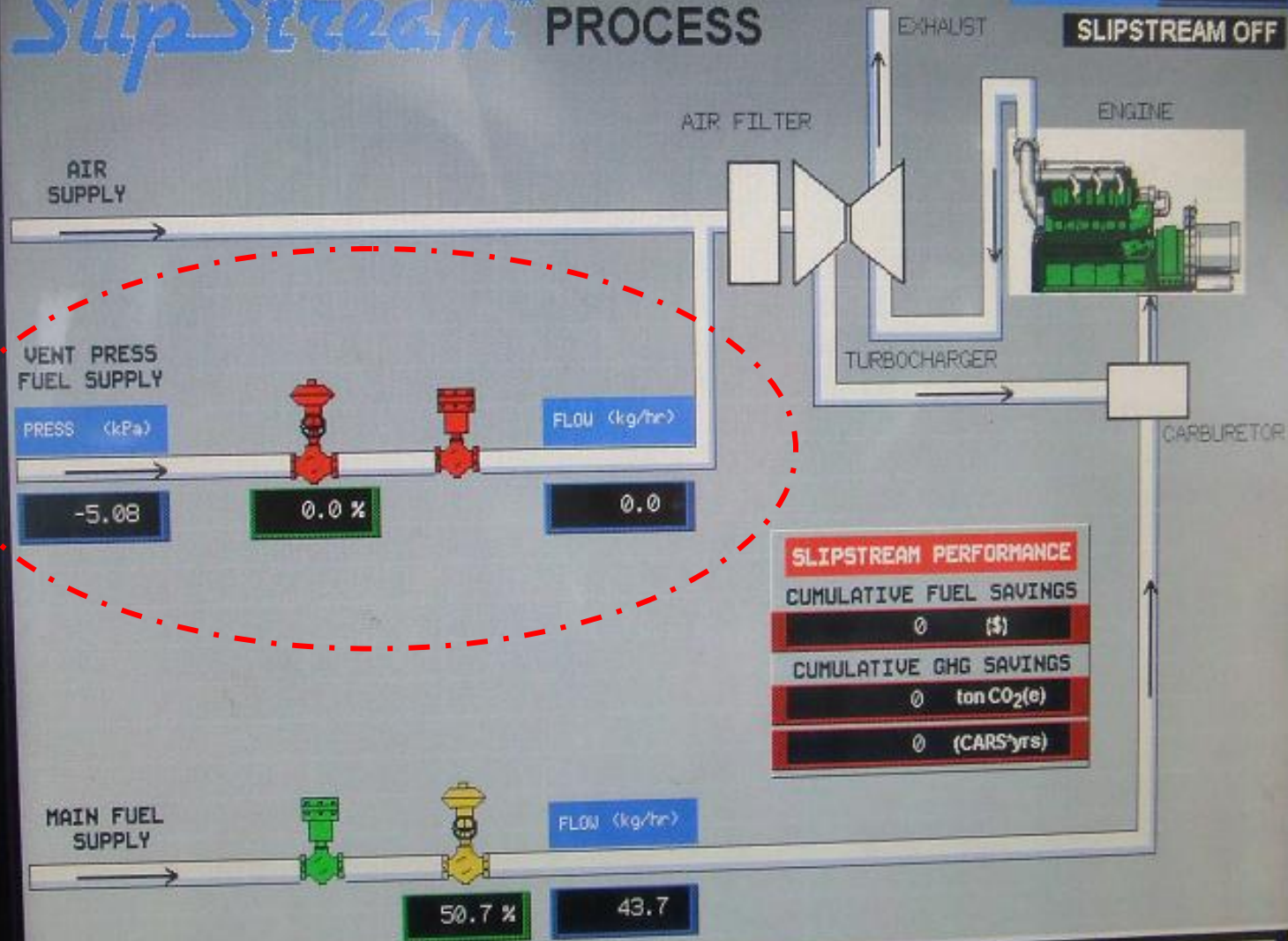


SlipStream™ at PETRO-CANADA

**Natural Gas STAR Program
— October 23, 2007**

***Philip Croteau, P.Eng
Energy Efficiency Engineer
Petro-Canada Oil and Gas***

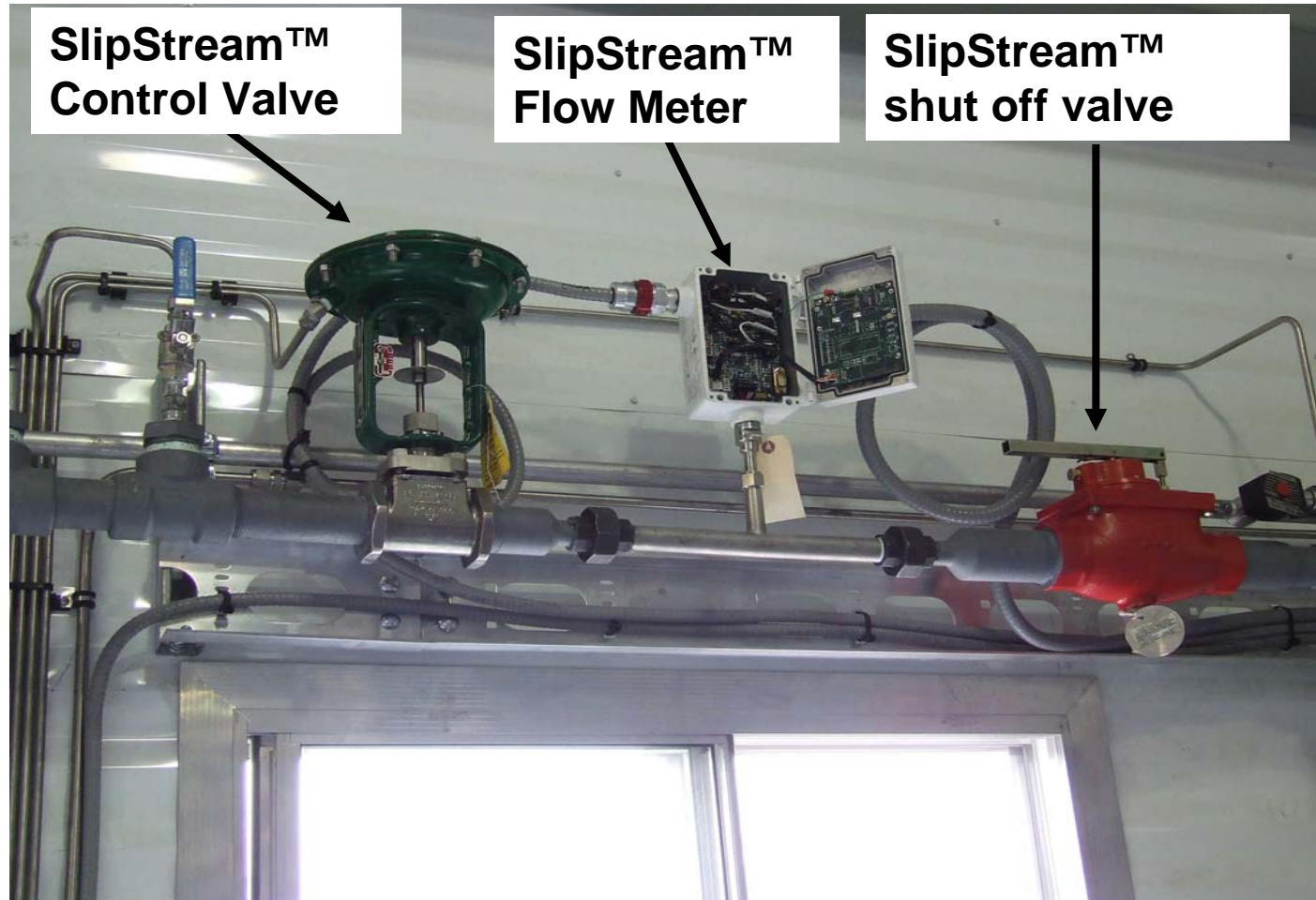
SlipStream[®] PROCESS

SlipStream[®]AIR
CONTROLGOV
CONTROLSLIPSTREAM
CONTROL

SYSTEM

SD/ALARM

Installation



Installation

- 2" pipe for vent gas from Unit 1 to Unit 2
- Manual bypass and block & bleed valves for vent gases
- Pipe, control valve, and flow measurement sensor for SlipStream™ gas
- Connection to intake air duct
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**SlipStream™ gas addition,
installation to intake air**



Air / Fuel Gas to Air Filter

Warning sign added due to vent gas in air pipe not being “normal”

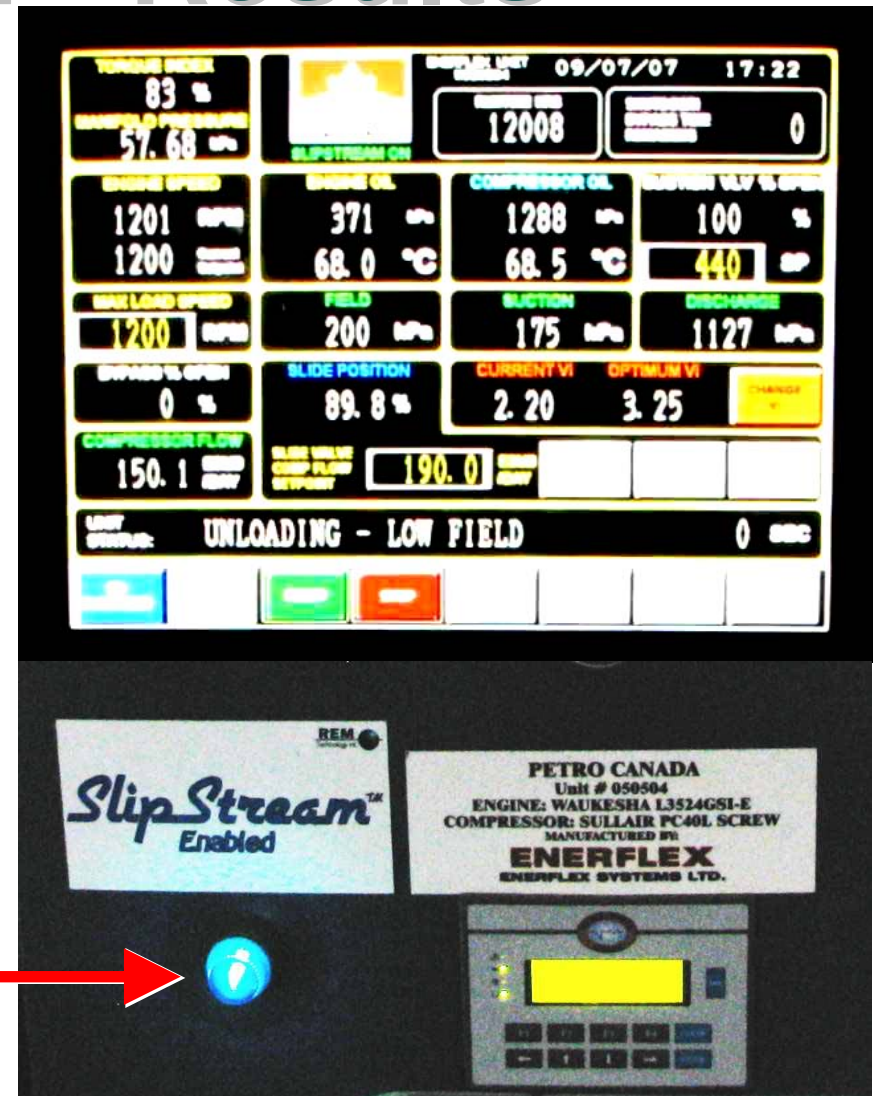


Unit 2 — Waukesha 3524GSI with REMVue® Rich-to- Lean Conversion and SlipStream™



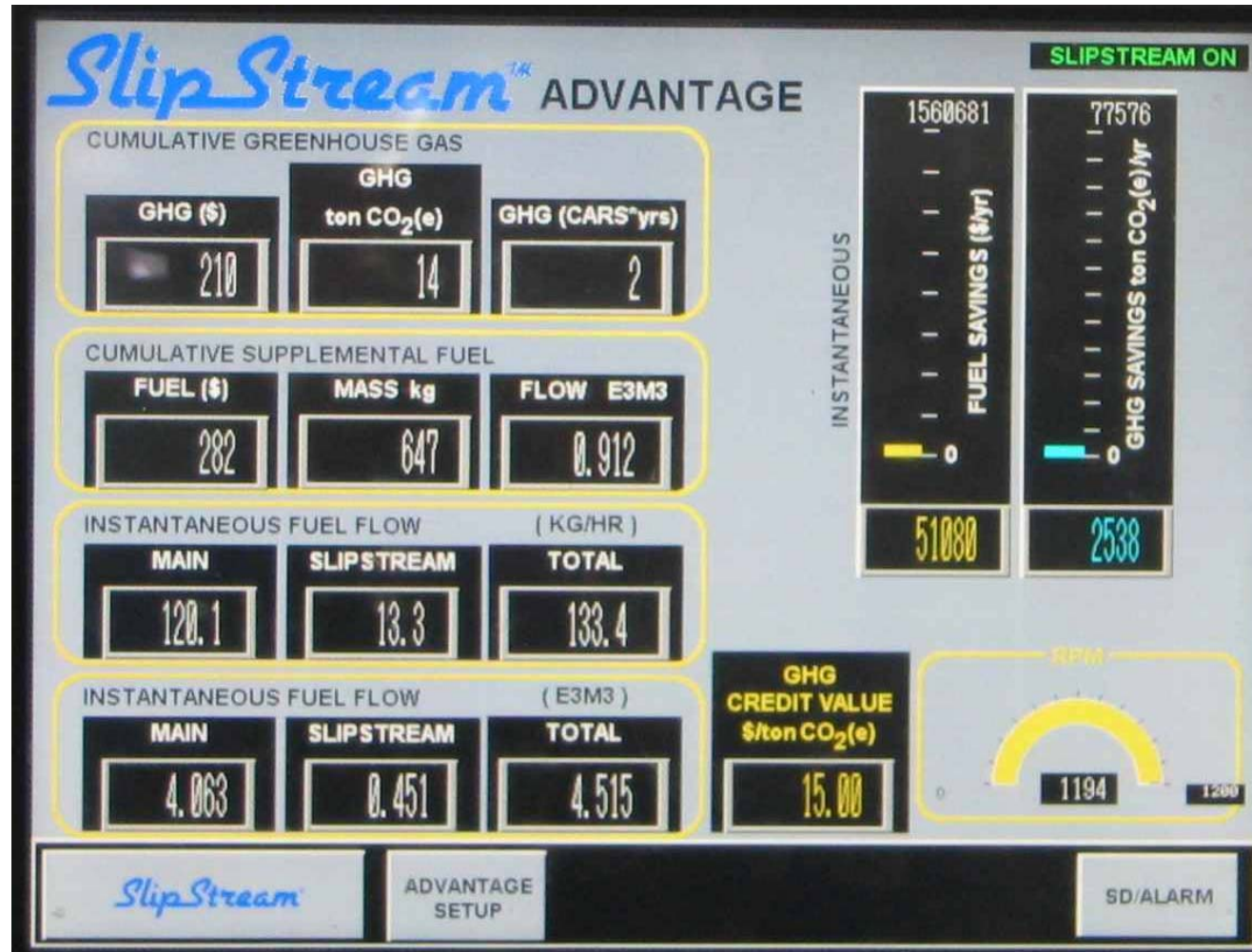
SlipStream™ Results

- Enabled Sept. 6, 2007
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- Production increased by 0.45 e3m3/day \approx 16 mscf/d
- Increased gas sales revenue > \$40,000 per year

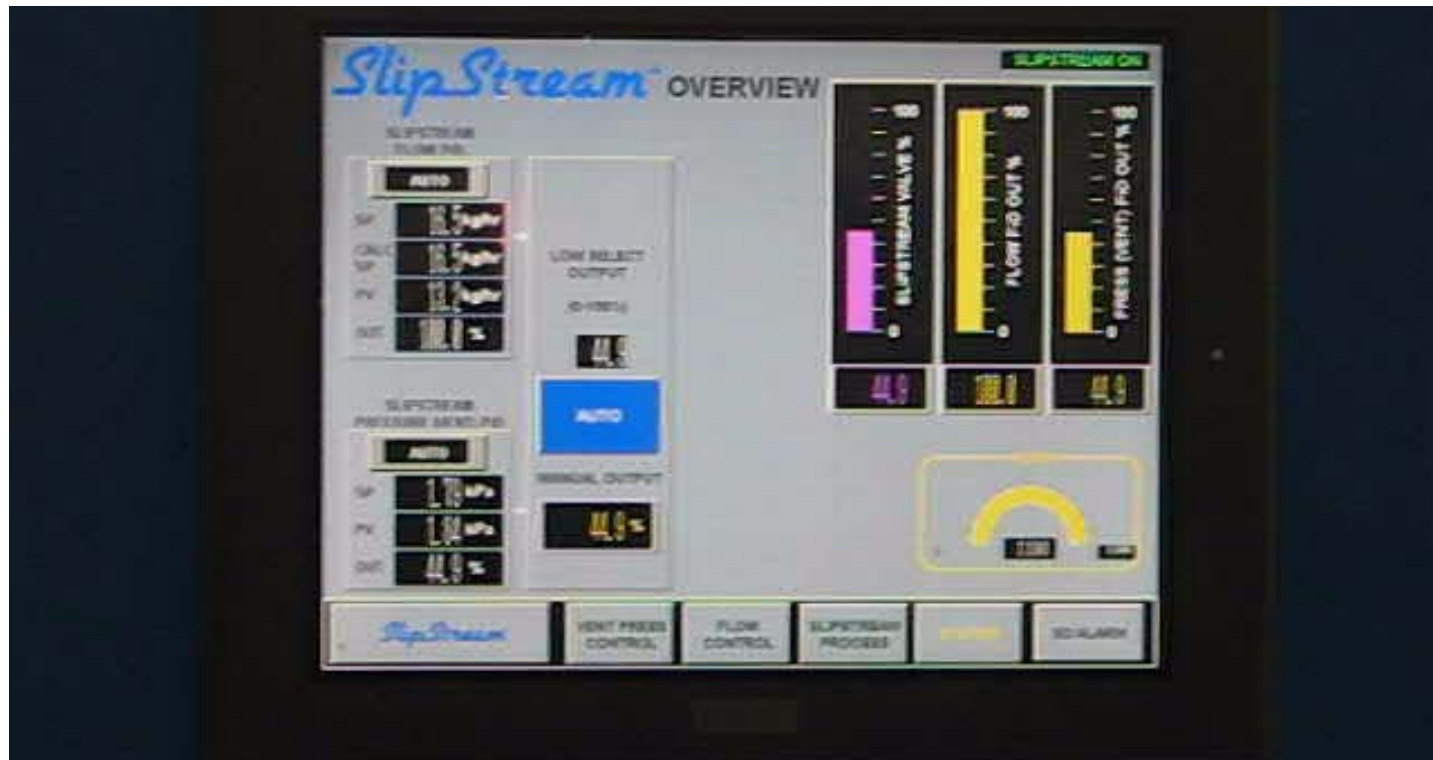


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- Captured vent gases = 10% of total engine fuel
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- Site CO₂(e) reduction rate = 3,000 tonnes (3,360 tons) per year
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SlipStream™ Results



- Gas source abruptly turned on, then off
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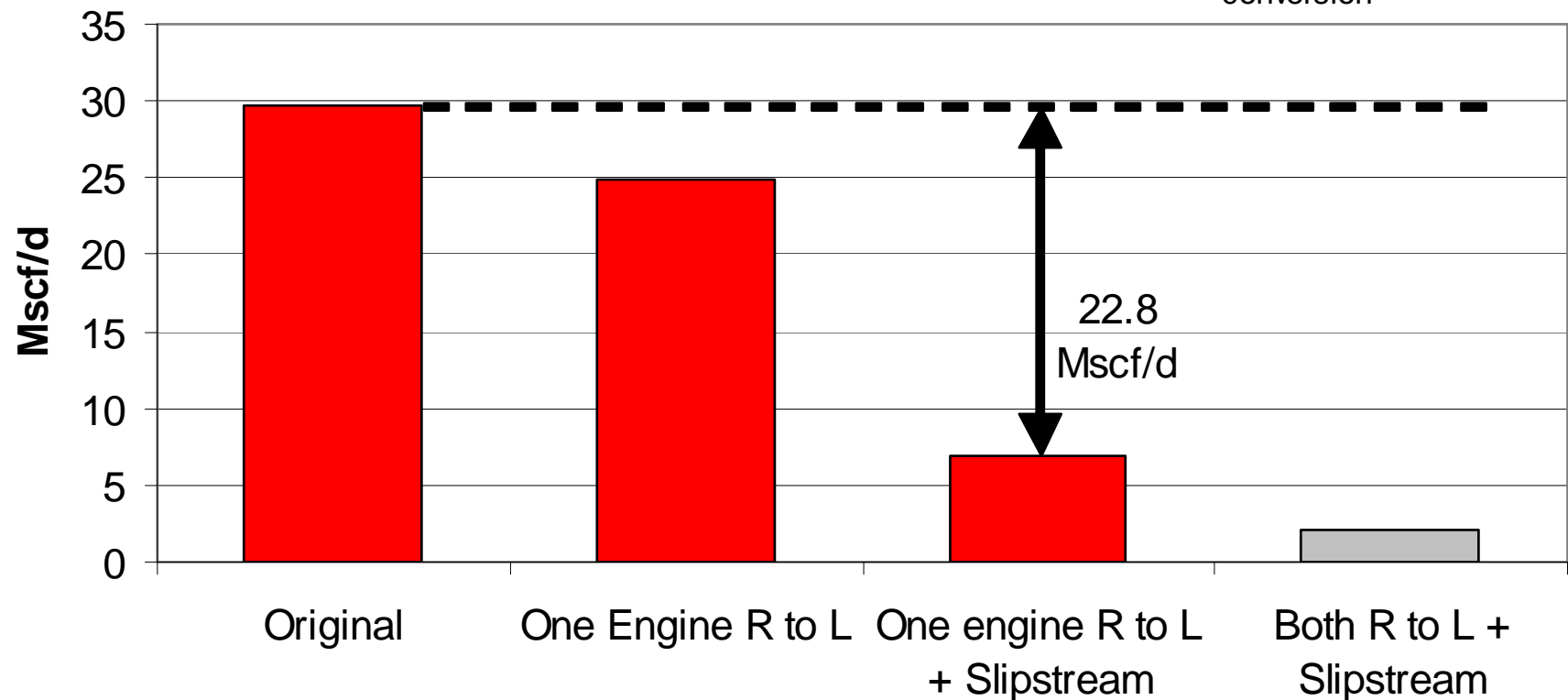
SlipStream™ Results

- Site Vented Methane Escape Reduction

Petro-Canada 06-28 Results

Site Methane Escape

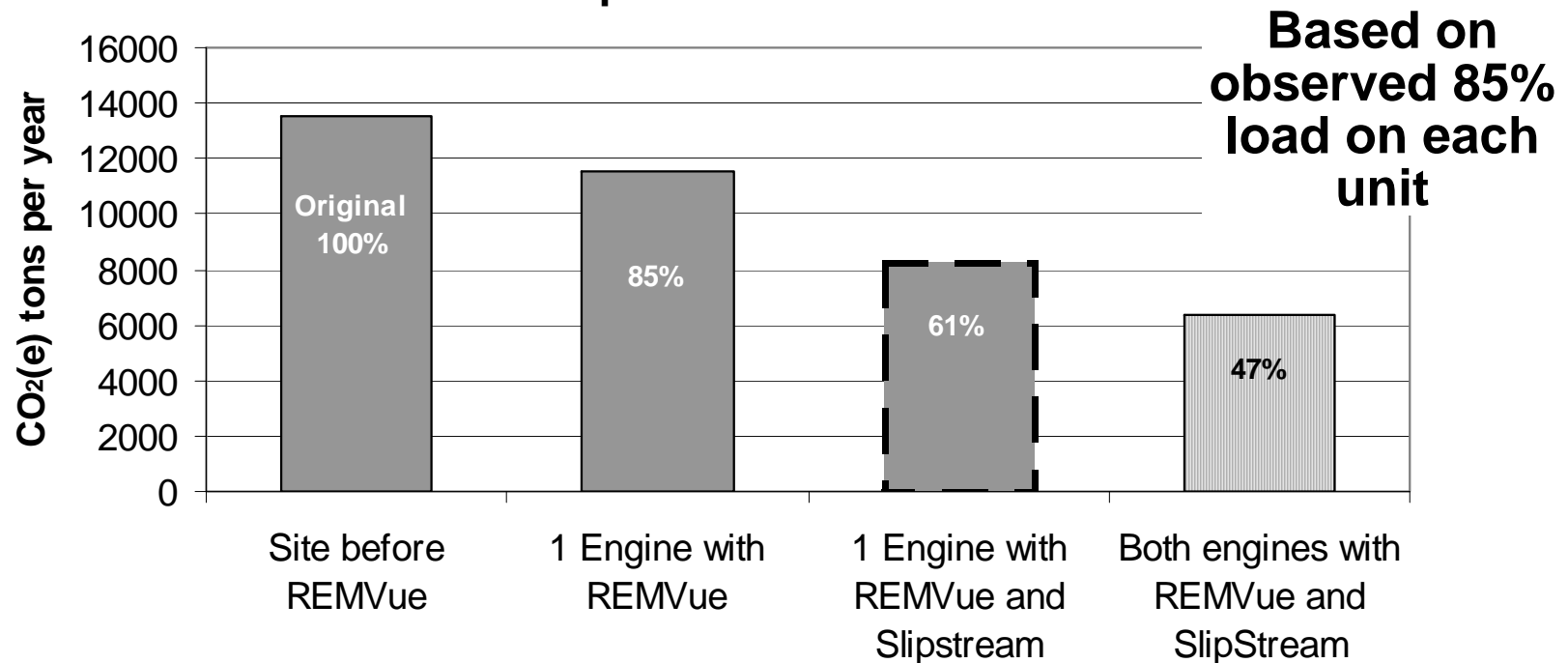
R to L is a Rich to Lean conversion



SlipStream™ Results

- GHG REDUCTION

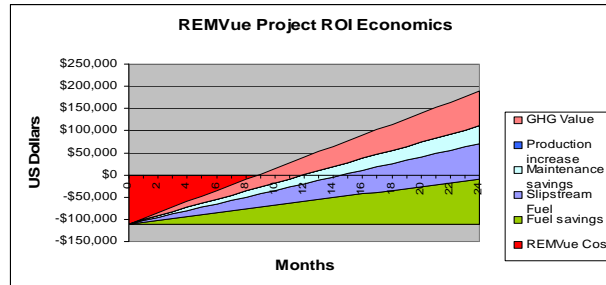
Petro-Canada 06-28 Results
September 2007



A comparison of the original compared to the present.

There is a potential further improvement with the rich-to-lean conversion of the second engine.

SlipStream™ Results — Economics



Unit HP

REMVue® R to L Fuel savings

Annual Maint Savings

Gas Price

SlipStream™ Amount

GHG Credit

Daily Production

Heating Value

Production Increase

REMVue® AFR Cost

REMVue® SlipStream™ Increment

840 BHP

15% (8-18%, 35%)

\$20,000

\$6.64/Mscf

12%

\$13/ton

6.4 MMscfd

1,000 BTU/scf

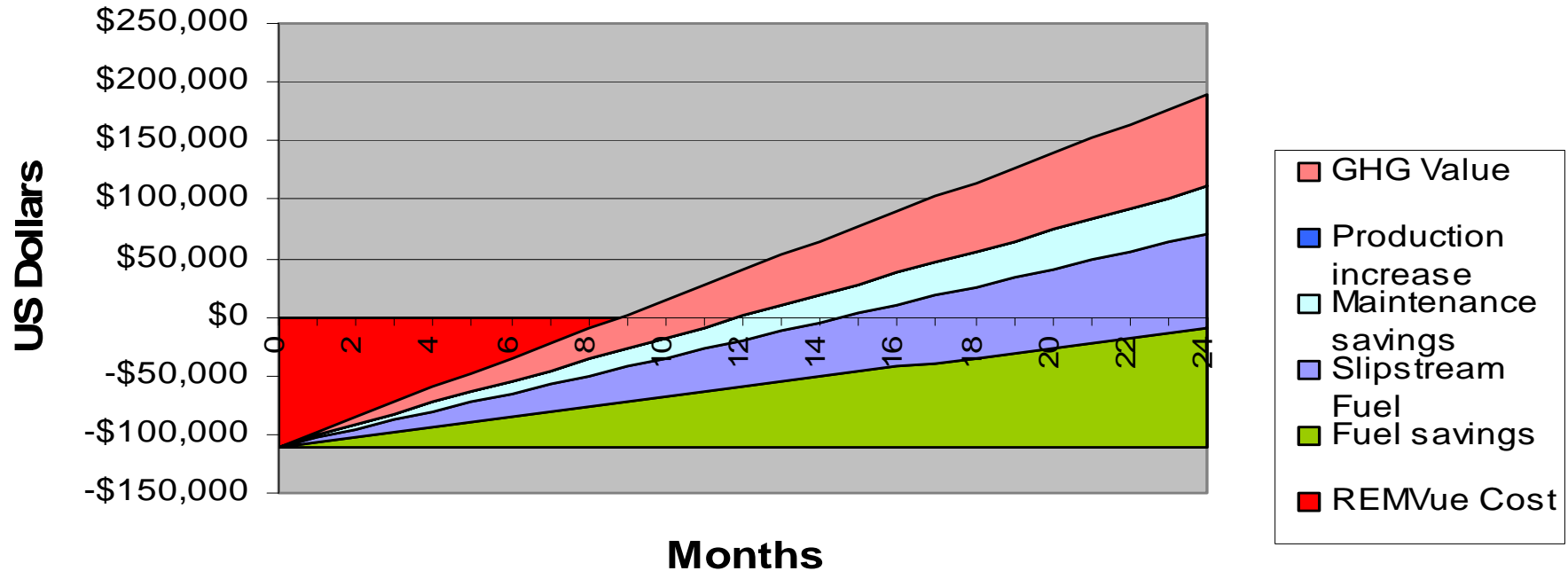
0%

\$80,000

\$30,000

SlipStream™ Results — Economics

REMVue Project ROI Economics



Impact for Petro-Canada

- 164 compressors, 184,000 HP at 71% utilization
- Approximately 50% of the fleet is Sweet Service
- Several units with gas engine drivers have been converted from rich burn combustion to lean burn using **REMVue®** AFR
- Estimate 90% use instrument gas
- Estimate 80% are reciprocating compressors, offering packing vent gas recovery
- Estimate 50% sites with additional sources of vented gas, glycol dehy reboilers, tanks

Potential for Petro-Canada

- Petro-Canada Oil and Gas is clearly in a developmental role of evaluating this new technology.
- We will continue to monitor the performance and benefits of the project and assess its applicability to other sites (sweet gas applications, packing vents, instrument gas).
- We are pleased to have taken the opportunity to participate in the demonstration project. We will continue to work closely with REM Technology in order that we all continue to develop and share in the benefits.

Summary

■ Petro-Canada Overview

- One of the larger gas producers in Canada

■ SlipStream™ Technology Overview

- Vented gases free; enhances net production

■ SlipStream™ Pilot Details

- Utilizing recovering vent gases from 2 units into one machine
- Pilot successful

■ Results

- Production increased by >\$40,000 per year — independent of site output

■ Petro-Canada Plans

- Implementation of REMVue® and SlipStream™ feeds the bottom line and reduces GHG's

Thank You!



REMVue®
SlipStream™

Getting a free boost!

SlipStream™

- SlipStream™ is the REM Technology product* designed for utilizing **vented hydrocarbons** as a supplementary fuel source for natural gas engines
- The product is currently in use at a Petro-Canada gas compression site.

*Patents Pending

Presentation Outline

- **Petro-Canada Overview**
- **PTAC Top 5 Priorities**
- **SlipStream™ Technology Overview**
- **SlipStream™ Pilot Details**
- **Results**
- **Petro-Canada Plans**

Petro-Canada Overview

- We are a substantially sized integrated oil company with five base business units:
 - Canadian East Coast Oil
 - Alberta Oil Sands
 - Refining and Marketing
 - International
 - **North American Natural Gas**
- Our **North American Natural Gas (NANG) BU** explores for and produces natural gas, crude oil and natural gas liquids (NGL) in Western Canada and the U.S. Rockies. We also market natural gas in North America and have established resources in the Mackenzie Delta/Corridor and land holdings in Alaska.
- In 2006, we produced 616 MMcf/d of natural gas and 14,200 b/d of crude oil and NGL.

Petro-Canada Overview

■ NANG Inlet Compression Fleet:

- 164 compressors, 184,000 HP at 71% utilization
- Approximately 50% of the fleet is Sweet Service
- Several units with gas engine drivers have been converted from rich burn combustion to lean burn using **REMVue®** AFR

■ Why efficiency is important at Petro-Canada

- Improves facility economics, while reducing emissions
- Can improve facility performance and reliability, through measurement and monitoring of initiatives
- Initiatives please the regulators and environmental groups
- Employees feel pride in the initiatives and successes!

Focus - Energy Efficiency Activities

- **Top 5 EE Targets** set out by PTAC (Clearstone)
- **Venting** – being challenged through measurement, low bleed instruments, installation of instrument air vs. using fuel gas, solar powered chemical injection pumps. REMVue® SlipStream™
- **Reciprocating Engines** – REMVue® Air/Fuel Ratio (AFR) Control, JWC waste heat recovery, compressor re-cylindering and rationalization.
- **Heaters and Boilers** – new O2 Analyzers proposed for fired equipment. Also the PTAC study on Lineheater/Fire Tube Immersion Heaters and purchase of new handheld combustion analyzers. Datalogging and increase servicing of lineheaters.
- **Flaring and Incineration** – being challenged through flare measurement and stack top temp reductions and O2 control in incineration.
- **Fugitive Leaks** – Leak Detection and Repair (LDAR – DI&M) with FLIR GasFinderIR camera, demonstration of Spectrasyne DIAL laser.

- *we're after them all!*

SlipStream™ Technology

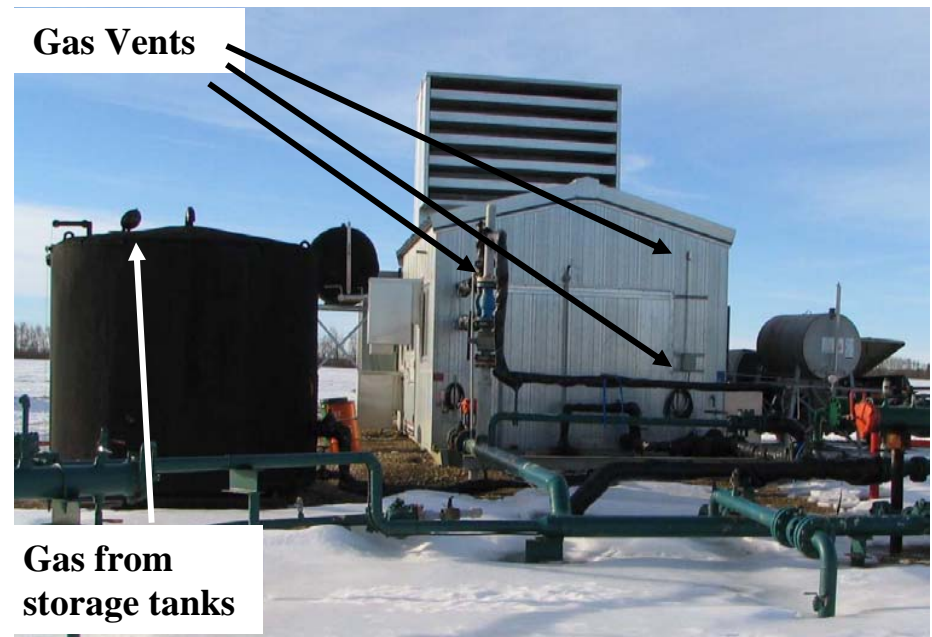
Using Vented Hydrocarbons as Engine Fuel

- Vented HC gas into engine intake
- Can be diluted with air or undiluted
- Suitable for carbureted engines
- Does not require vented gas compression
- Vented fuel that is recovered can be considered “free” (*fuel for a 1200 HP engine at \$6/Mscf costs over \$500,000/y*)
- Using SlipStream™, up to 50% of engine fuel can come from the vented sources

SlipStream™ Technology

SOURCES OF *VENTED GASES*

- Instrument gas vents
- Compressor packing leaks
- I/Ps and pneumatic devices
- Gas driven pumps
- Flash gas from oil facilities
- Flange leaks
- Dehydrators
- Engine starting, purging, blow-downs
- Fuel Gas dryers
- Crankcases

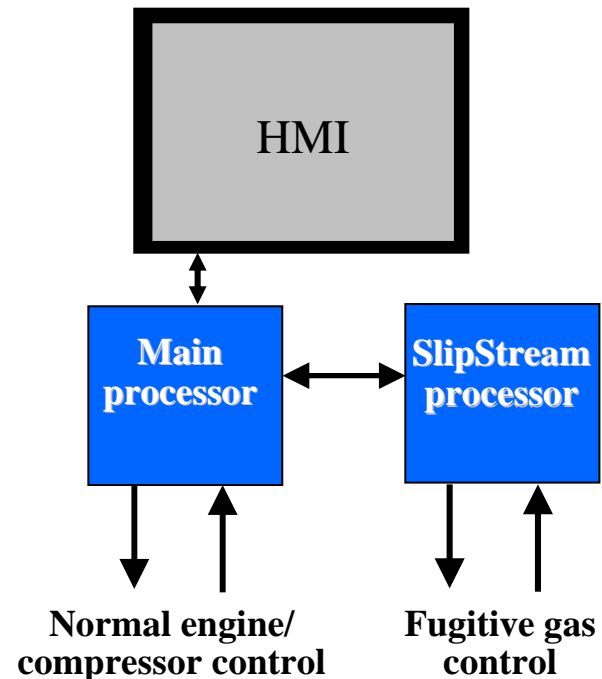


SlipStream™ Technology

- Level 1 < 10% of engine fuel
- **Level 2 < 30% of engine fuel**
- Level 3 < 50% of engine fuel

Site measurements showed a total of ~13 scf/m plus periodic bursts of >100 scf/m.

Engine fuel consumption at 85% load
= 110 scf/m = 160 Mscf/d



Level 2 SlipStream™

SlipStream™ Pyramid

- Up to an additional 10-30-50% more fuel savings
- Substantial GHG savings

SlipStream™

REMVue®
Air-Fuel Ratio
– Stoichiometric
– Lean Burn
– Rich-to-Lean

- Up to 25% fuel savings
- Increased runtime
- Increased throughput
- Reduced maintenance
- Reduced GHG

Natural Gas Engine Efficiency Improvement

REMVue® Rich-to-Lean Conversion

- What is the Rich-to-Lean Conversion?
 - A process in which excess air is added to the air-fuel mixture of a rich burn or stoichiometric engine
- What are the benefits?
 - Reduced engine emissions
 - Improved fuel conversion efficiency
 - Lower operating temperatures
 - More natural gas gets to market instead of burned in the engine



Site Details



- Two Waukesha 3524GSI engines (840 HP at 1200 RPM)
 - each driving a Sullair PC40L screw compressor
- Suction pressure = 140 – 210 kPag (20–30 psig)
- Discharge pressure = 700 – 1200 kPag (100–175 psig)
- Fuel gas used for Instrument drive gas

Site Details

- Instrument gas used on both engines
 - Cost of site air compressor and piping was estimated at **\$150K** and was not installed during original construction.
 - Primary sources of vented gases are the *cactus dryers* and *instrumentation*
 - Units equipped with “low bleed” pneumatic devices
- All vent gases (*except engine starting and blow-down*) previously collected to a single vent per unit
- Unit 1 measured flow = 7.1 scf/m
- Unit 2 measured vent flow = 6.2 scf/m
- Periodic (*1 to 2 minutes*) flows of <100 scf/m from pre/post-lube and compressor lubrication pumps
- Unit 1 and 2 vent gases combined for SlipStream™ on Unit 2



Unit 2 REMVue® Control Panel for the Waukesha 3524GSI

*With integrated Air-Fuel Ratio, Safety Shutdown,
Process Control and SlipStream™*



SlipStream[®] PROCESS

SPEED (rpm) 697

SLIPSTREAM OFF

AIR
SUPPLY

EXHAUST

AIR FILTER

ENGINE

TURBOCHARGER

CARBURETOR

VENT PRESS
FUEL SUPPLY

PRESS (kPa)

FLOW (kg/hr)

-5.08

0.0 %

0.0

SLIPSTREAM PERFORMANCE

CUMULATIVE FUEL SAVINGS

0 (\$)

CUMULATIVE GHG SAVINGS

0 ton CO₂(e)

0 (CARs' yrs)

MAIN FUEL
SUPPLY

FLOW (kg/hr)

50.7 %

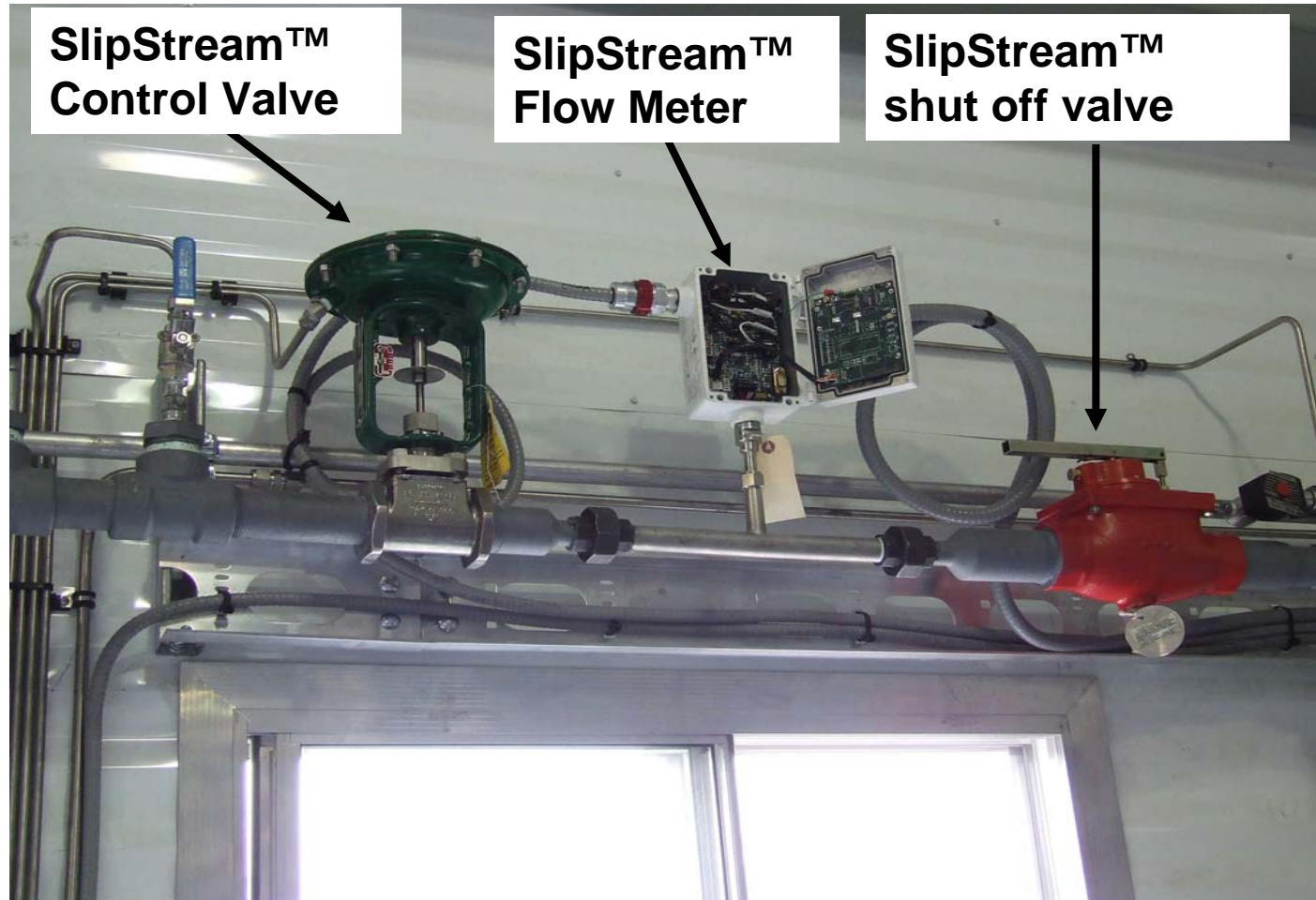
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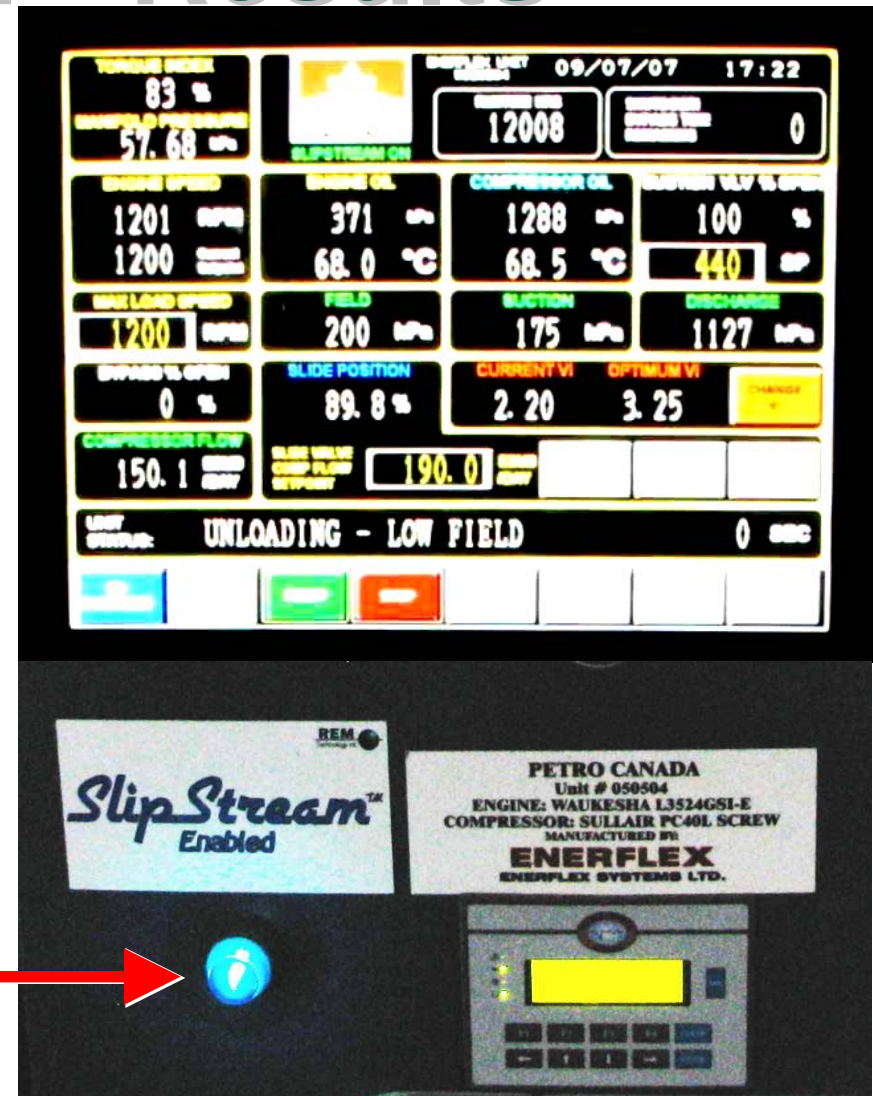


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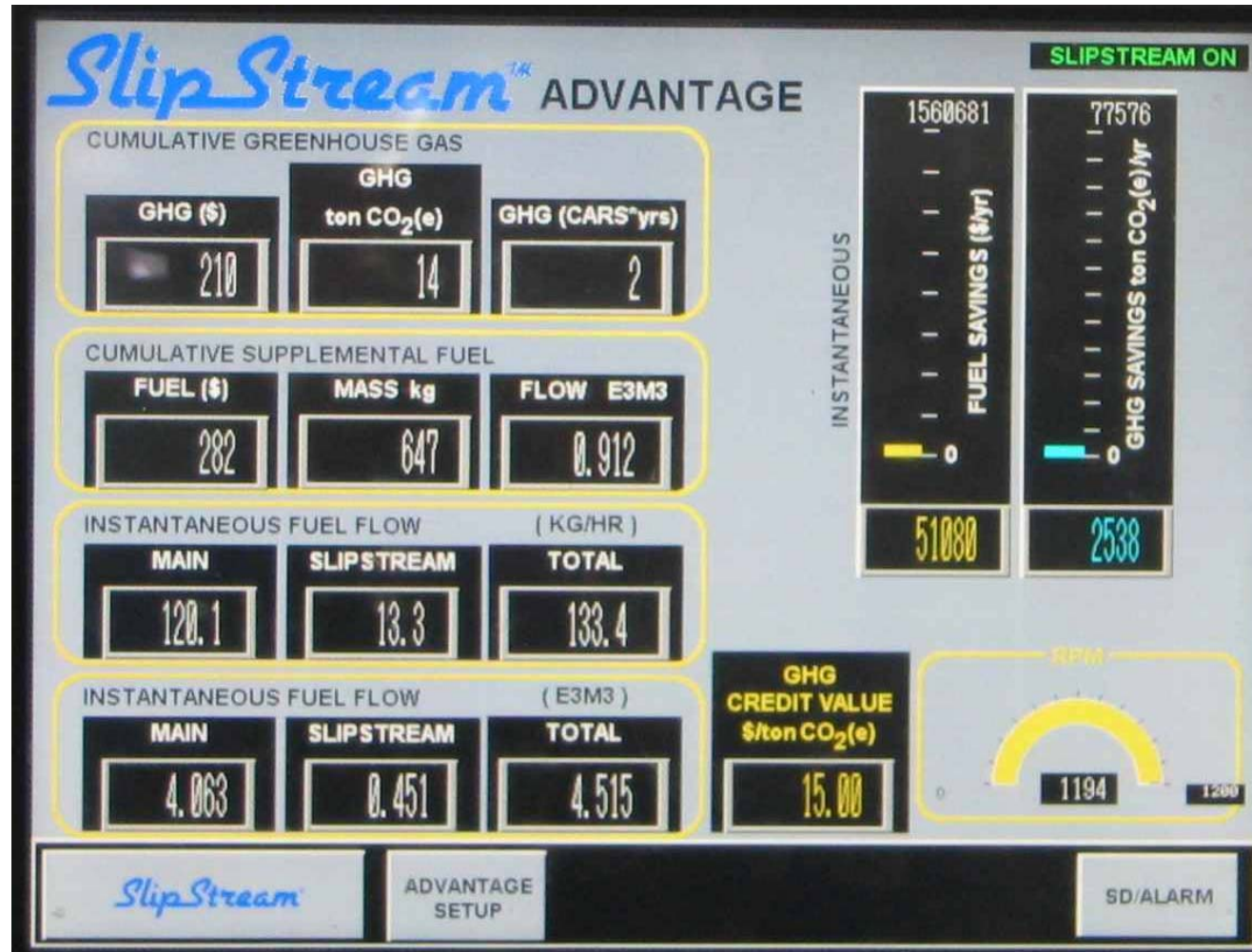
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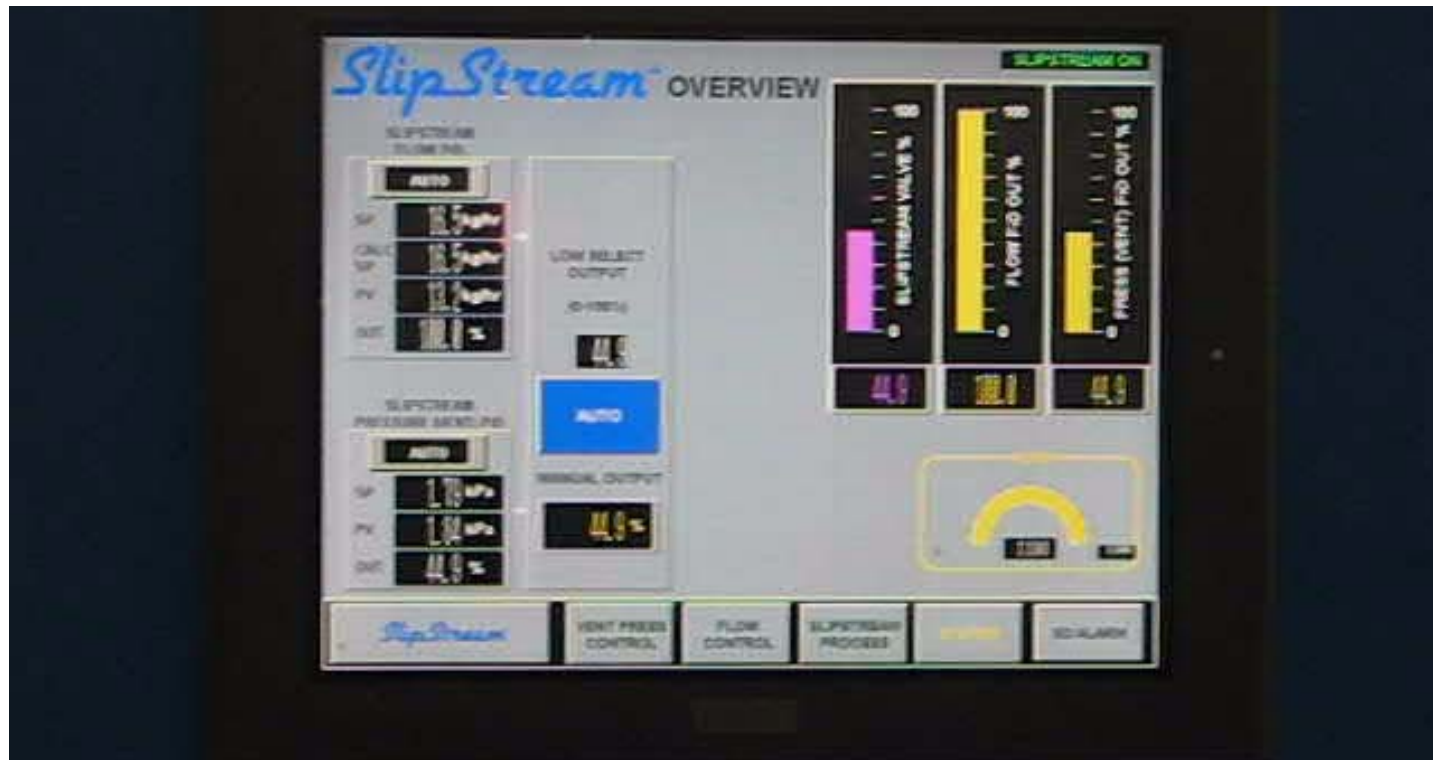


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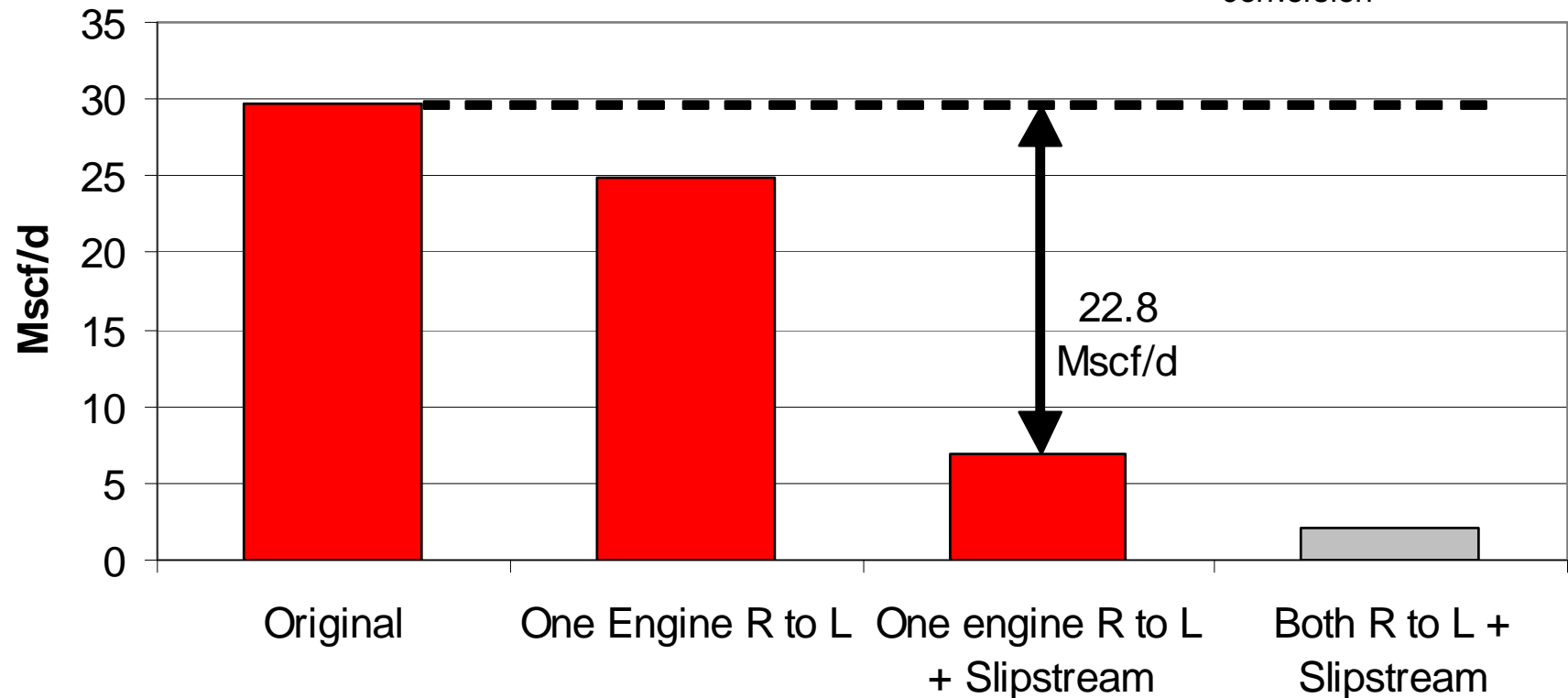
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Petro-Canada 06-28 Results

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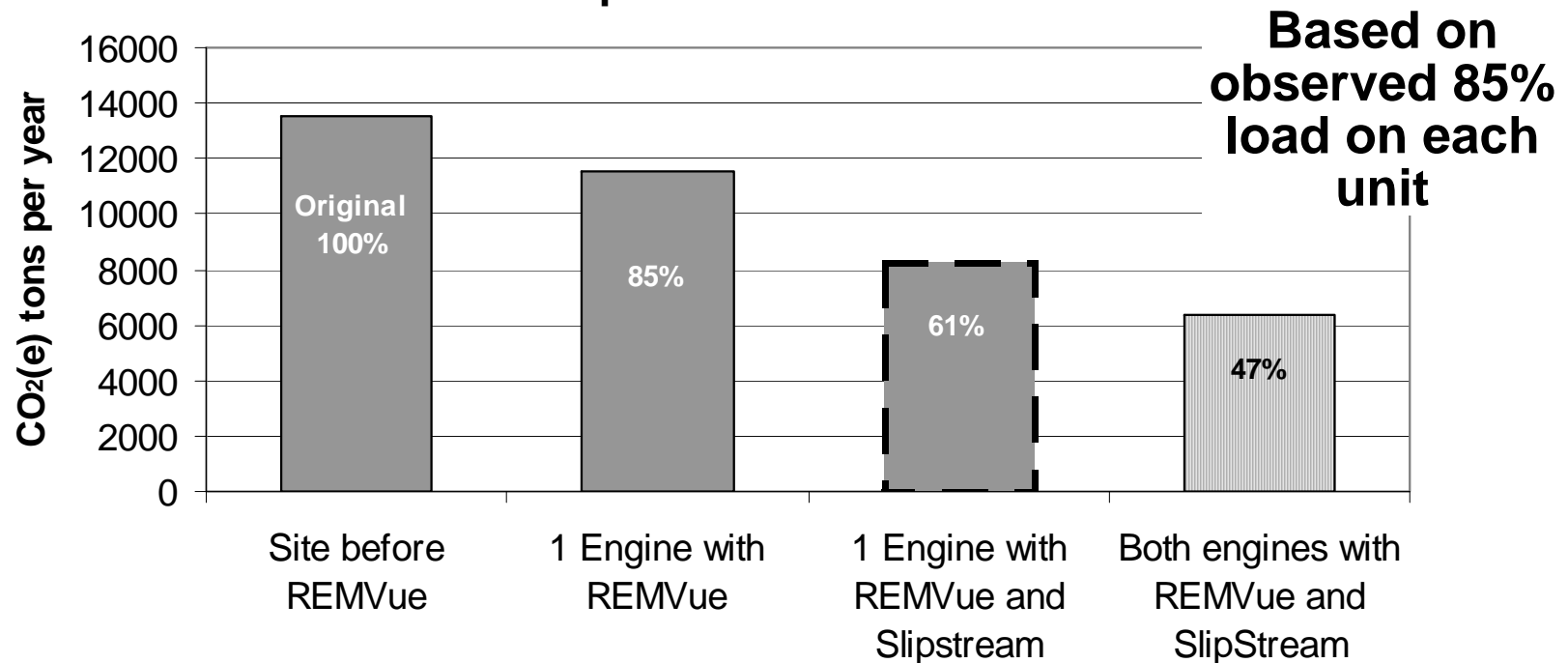
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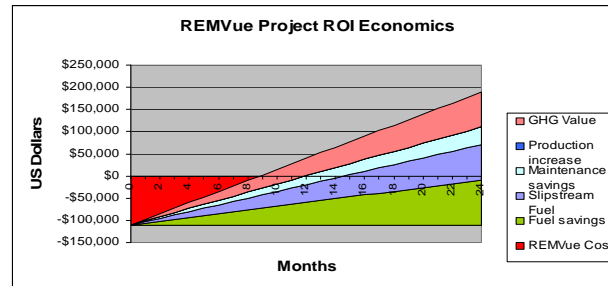
Petro-Canada 06-28 Results
September 2007



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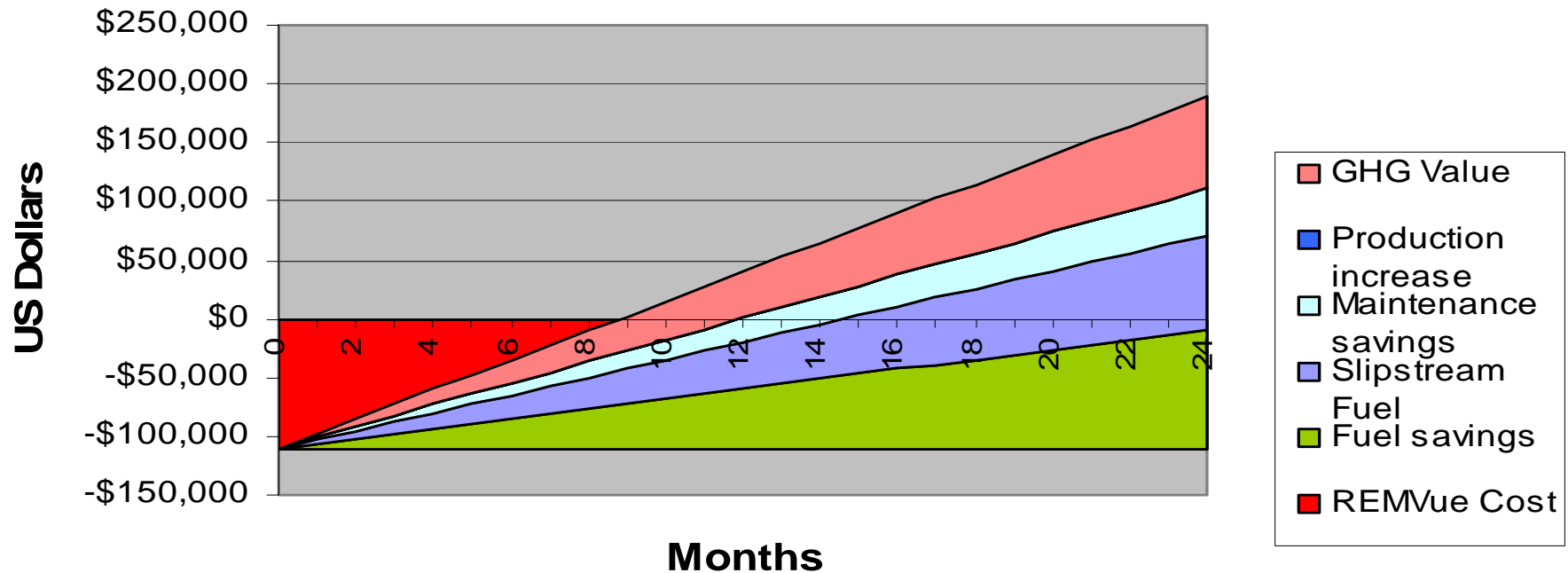
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