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ALBERTA renewable DIESEL DEMONSTRATION

Alberta Renewable Diesel Demonstration

An Assessment of Winter Operability & Infrastructure Integration

Alberta Renewable Diesel Demonstration

Significance:

- **First Canadian on-road demonstration of cloud point adjusted renewable diesel blends using ultra low sulphur kerosene for cloud point adjustment.**
- **First demonstration of both biodiesel (fatty acid methyl ester, or FAME) and hydrogenation derived renewable diesel (HDRD) in range of Canadian climatic conditions**
- **First on-road demonstration involving participation of CPPI member petroleum refiner, Shell Canada, to blend and retail cloud point adjusted renewable diesel blends in business as usual model.**

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Project Overview

Background and Project Scope

Background

- Environment Canada issued Notice of Intent to Regulate a Renewable Fuel Standard for Canada contingent upon ‘successful demonstrations’ (December, 2006)
- Stakeholders proposed a one-year cold weather operability study to address industry concerns over commercial renewable diesel use in winter
- Partnership struck between fuel industry, trucking industry, federal and provincial governments, and managed by Climate Change Central (late 2006, Contribution Agreements signed April, 2007)

Sponsors

Major Sponsors

Supporting Sponsors

Participants

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Purpose & Scope

- Demonstrate cold weather operability of cloud point adjusted 2% winter blends of biodiesel (FAME) and hydrogenation derived renewable diesel (HDRD) with ULSD after cloud point correction with ultra low sulphur kerosene (ULSK)
- Transition to 5% blends in spring/summer, and incorporation of mixed-feedstock FAME (75% canola methyl ester / 25% tallow methyl ester)
- Demonstrate viability of terminal-level injection blending and workable blend formulation to meet CGSB cloud point specs
- Deploy blended fuel in ‘business as usual’ application for commercial carriers

Focus: Operability

Evaluate Fuels

- Cold weather physical characteristics: cloud point, low-temperature filtration etc.
- Create suitable blend to meet CGSB cloud point targets
- Observe fuel through distribution chain and end use

Evaluate Operability

- Performance in cold Alberta winter
- Collect observations and hands-on experience for stakeholders

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Testing Protocols

Fuels

- Third party lab analysis by Alberta Research Council on retains throughout supply chain (clear & bright, density, ASTM and CGSB)
- Suppliers selected based on quality, reliable supply and environmental characteristics

Vehicles

- Commercial fleets recruited – consistent routes, fuel at designated locations
- Tracked for fuel efficiency and maintenance (failures, filter plugging, loss of service)
- Regular contact with fleets to identify areas of concern – otherwise business as usual

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Desired Outcomes

Successful Demonstration in Range of Climatic Conditions

Value for Stakeholders

Desired Outcomes – Fuel Industry:

- Increase knowledge of blend formulation to meet cloud point specification in northern climates – both for FAME and HDRD
- Understand how renewable diesel fuels will fit into the Canadian Fuel Supply
    - •Confirm that project-specific blends can work in Canada
    - •Confirm fuel quality and performance can be maintained throughout supply chain
- Generate impartial, credible, multi-party observations for policy-makers to use in creating renewable fuel policy for Canada

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Value for Stakeholders

Desired Outcomes - Fleets:

- Address concerns of commercial carriers regarding cold weather operability, fuel quality, blending and handling (distribution)
- Provide hands-on experience among commercial fleet operators
- No breakdowns or non-starts attributed to biofuels
- Knowledge and experience gained by fleets and fuel industry

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Summary Report:

Successful Demonstration

Industrial Scale Blending Facility

Temporary Blending Facility

- Shell's Sherwood Marketing Terminal

Cardlocks

- Three commercial Shell/Flying J sites
- One yard tank

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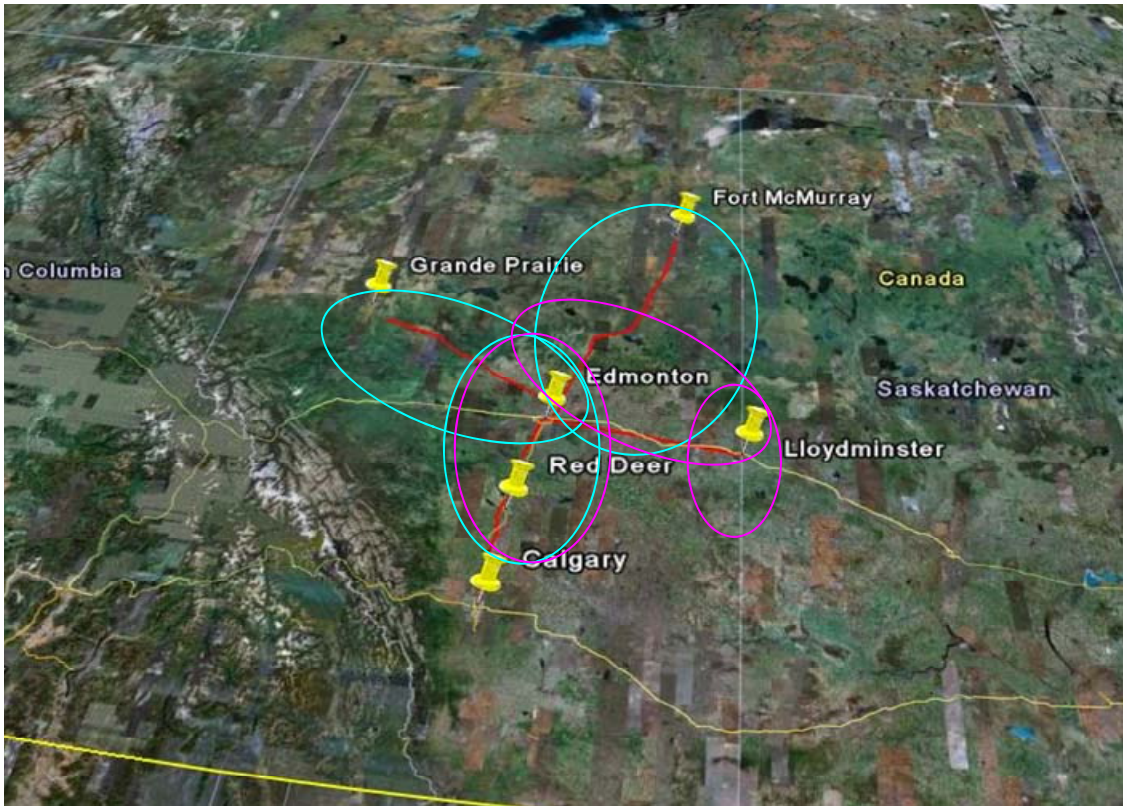
Key Points

- Five fleets recruited – 75 trucks: 16 control, 29 on FAME, 30 on HDRD
- Monitoring and testing protocols signed off by multi-stakeholder group
- Over 1.6 million litres of blended product dispensed
- Over 5.5 million km driven by fleet vehicles

Study Parameters

Operating Area

FAME Operating Area	◯
HT Operating Area	◯



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Monitoring & Reporting

Protocols, Observations and Project Conclusions

Protocols for Data Gathering

Project Monitoring

- Overall fuel efficiency
- Fleet monitoring – budget for analyzing filters, parts, engine oil
- Neat biofuel quality testing
- Blended fuel quality testing
- Cloud point, blend level, density and lubricity on blended fuel

Protocols for Data Gathering

Fuel Quality

Tests Required Along Supply Chain	Full ASTM 6751 or CAN/CGSB 3.517	Clear & Bright and Density	Density, Cloud Point, Blend Level and Lubricity*	Additional testing
Neat Fuel – Producer	Each batch			Only if trouble
Neat Fuel – Delivery	Each batch	Upon delivery		Only if trouble
Blended Fuel – Delivery			Each batch	Only if trouble

*Lubricity only required on a subset of retained samples

ARDD Fuel Quality Parameters

- FAME met ASTM D6751
- HDRD met CAN/CGSB 3.517
- FAME blends met CAN/CGSB 3.520
- HDRD blends met CAN/CGSB 3.517
- Neat biofuel deliveries accompanied by Certificate of Analysis and pass clear & bright test before offloading
- Additional: 200 second CSFT
- Additional: neat FAME delivered at 15^{o}C above cloud point; neat HDRD at 5^{o}C above cloud point

Product Quality

Fuel Volumes by Type and Location

Total Fuel Lifted	B2 FAME	2% HDRD	B5 FAME	5% HDRD	Total
Lloydminster		177,117		220,816	397,933
Calgary Barlow	100,440		163,941		264,381
Edmonton South		226,161		203,683	429,844
Rosenau Yard	145,132		376,126		521,258
Total	245,572	403,279	540,067	424,498	1,613,416

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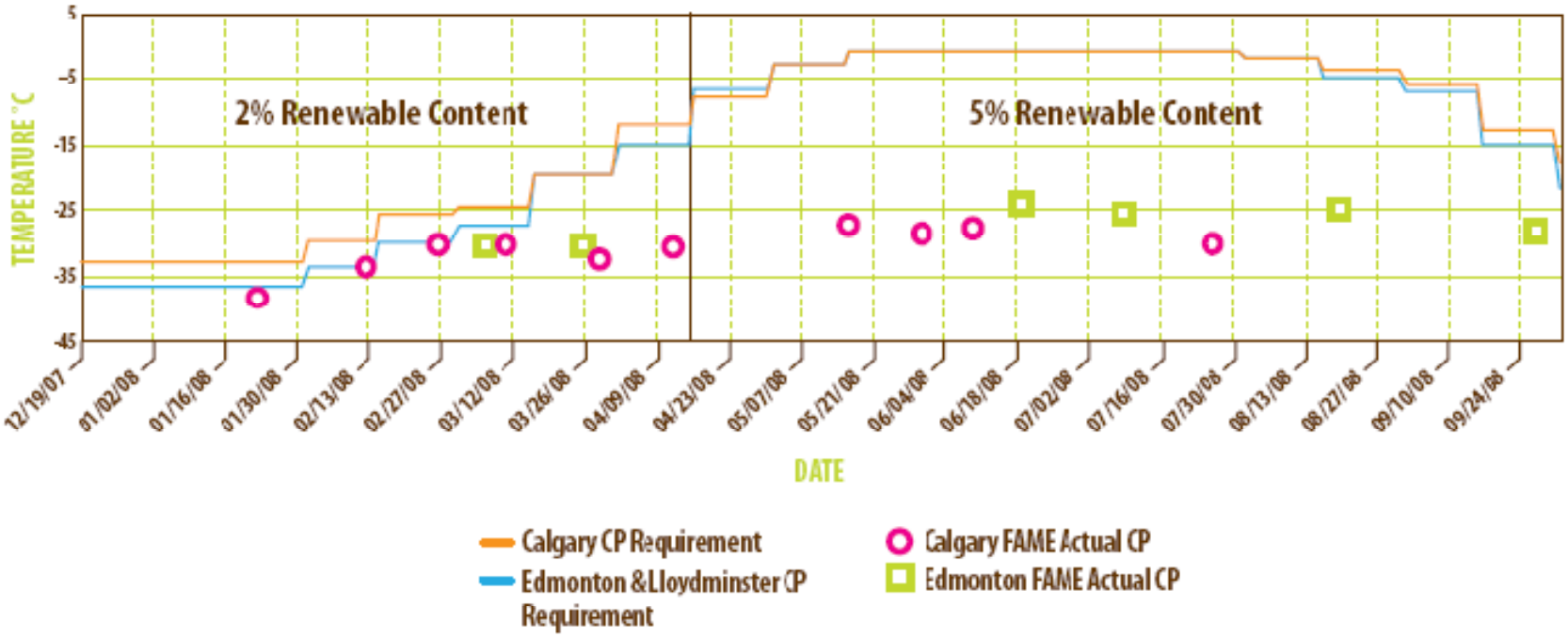
Cold Weather Performance

FAME Cloud Point Results



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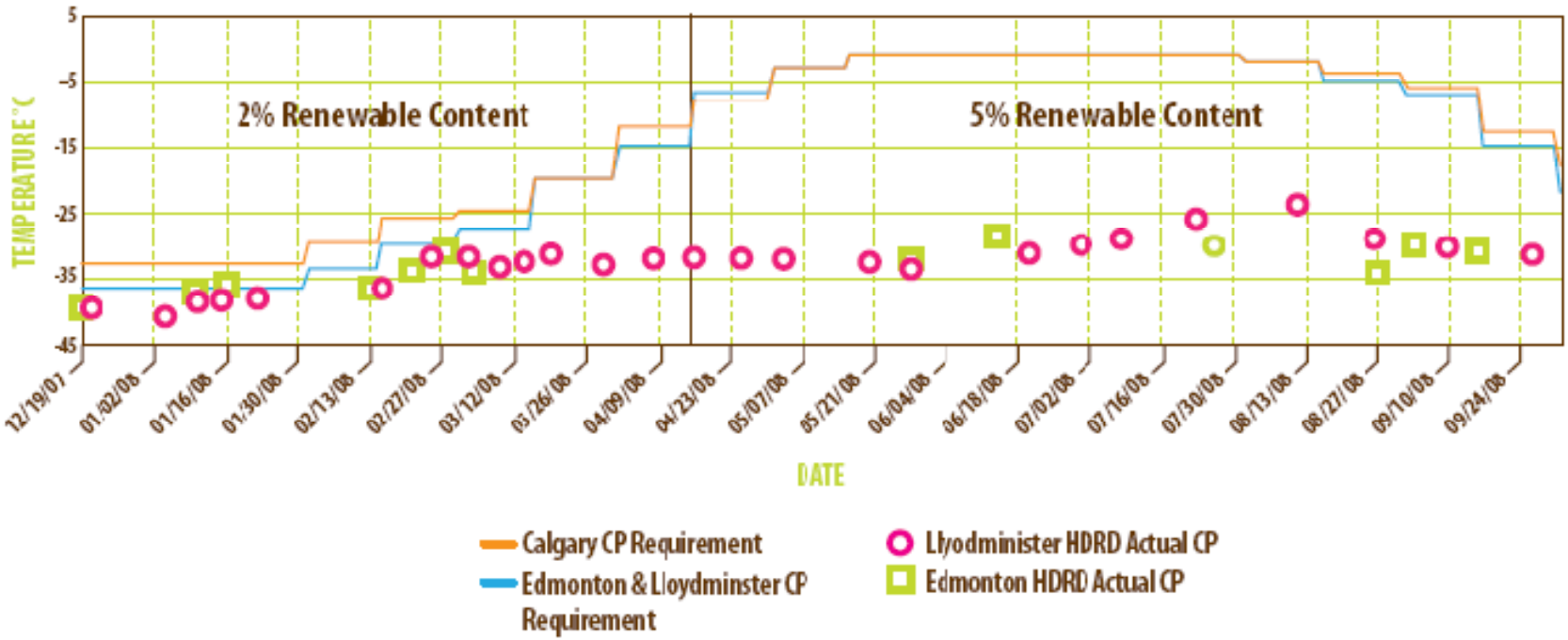
Cold Weather Performance

HDRD Cloud Point Results



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Cloud Point Adjustment

Winter kerosene requirement for CAN/CGSB 3.520 compliance in ARDD conditions

	Required Cloud Point (°C)	FAME Results %			HDRD Results %		
		FAME	Seasonal ULSD	Kerosene (CP-45)	HDRD	Seasonal ULSD	Kerosene (CP-45)
AB-1 Zone (Calgary)							
Dec 1 – Jan 31*	-33	2	66	32	2	87	11
Feb 1 - 14	-30	2	70	28	2	88	10
Feb 15 - 28	-26	2	74	25	2	89	9**
Mar 1 - 15	-25	2	74	24	2	90	8**
Mar 16 - 31	-20	2	77	21	2	90	8**
AB-2 Zone (Edm & Lloyd)							
Dec 1 - 31	-36	2	55	43	2	84	14
Jan 1 - 31	-37	2	55	43	2	83	15
Feb 1 - 14	-34	2	64	34	2	86	12
Feb 15 - 28	-30	2	70	28	2	88	10
Mar 1 - 15	-28	2	72	26	2	89	9**
Mar 16 - 31	-20	2	77	21	2	90	8**

*Half-month periods have been aggregated where the cloud point is the same.

**Blending model was kept the same despite receipt of the HDRD with a -28oC cloud point.

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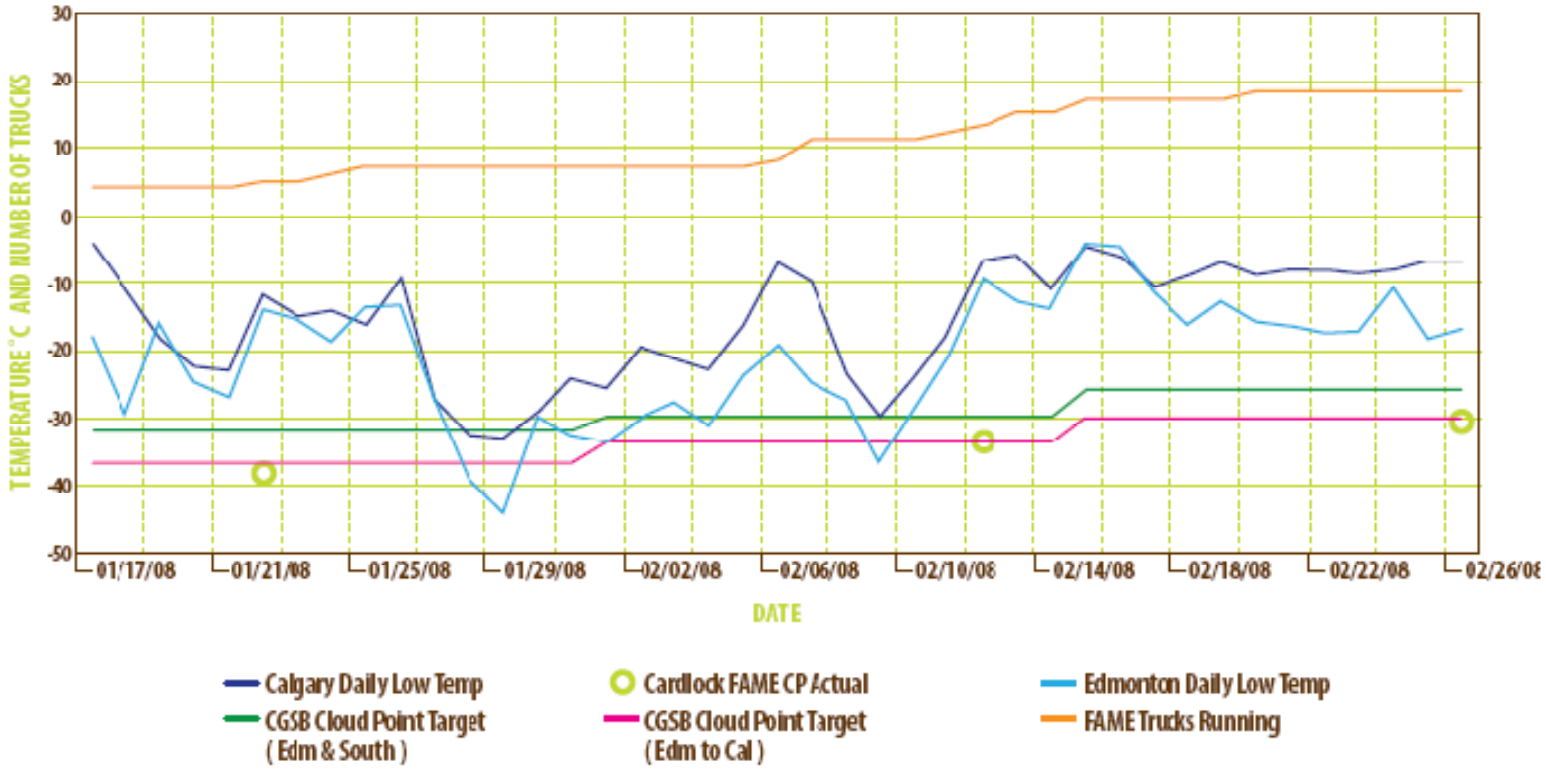
Winter Period Operation

FAME Fleet – Cold Snaps



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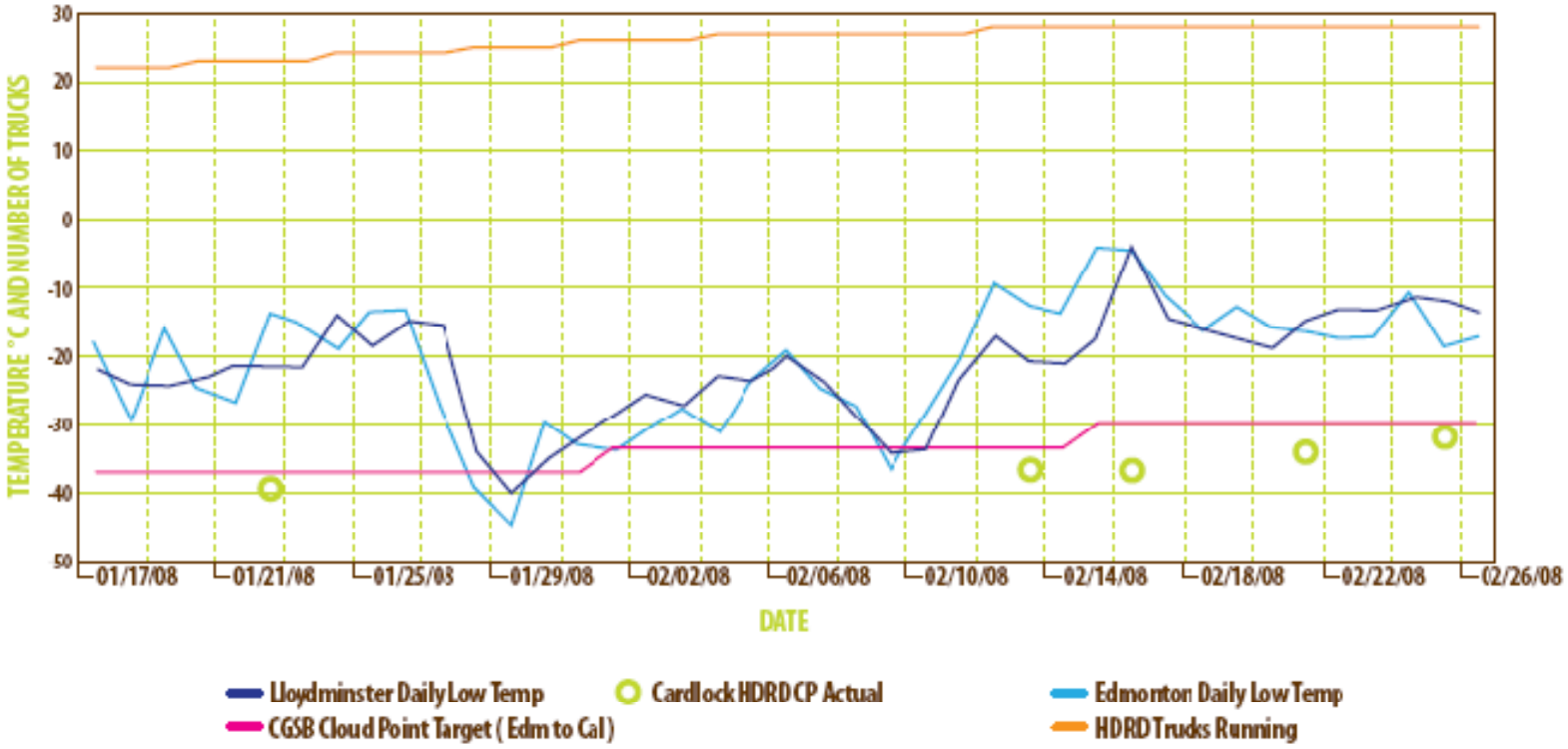
Winter Period Operation

HDRD Fleet – Cold Snaps



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Accomplishments

Observations

- Blended, delivered and operated B2 blends of FAME and HDRD in very cold temperatures
- No reports of non-starts, plugged filters or loss of power with long-haul trucks
- Successful blending, handling and retailing in commercial card locks
- ‘Seamless integration’ from end user point of view

Accomplishments

Conclusions

- No operational difficulties at B2 in cold weather in ARDD (except for one fuel filter for cold start on a school bus– insufficient data to determine cause)
- Fuel quality maintained throughout supply chain and infrastructure
- Handling practices met according to standard practices (with the addition of delivery temperature and 200 second CSFT)

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Conclusions

- It is possible to create CGSB 3.520 compliant blends at 2% in winter with CME or HDRD using ULSK for the cloud point schedules of the regions covered.
- CGSB compliant blends of 5% were made in spring/summer with mixed-feedstock FAME and HDRD without ULSK from April 1 to September 30 due to the cloud point of the seasonal diesel used.
- Effect of renewable content on cloud point was offset by ULSK addition for winter operation. For FAME the 3°C deflection from 2% canola methyl ester required 21 to 43% kerosene with -45°C cloud point. For 2% HDRD the 1°C cloud point deflection required 0-15% ULSK in the same conditions.

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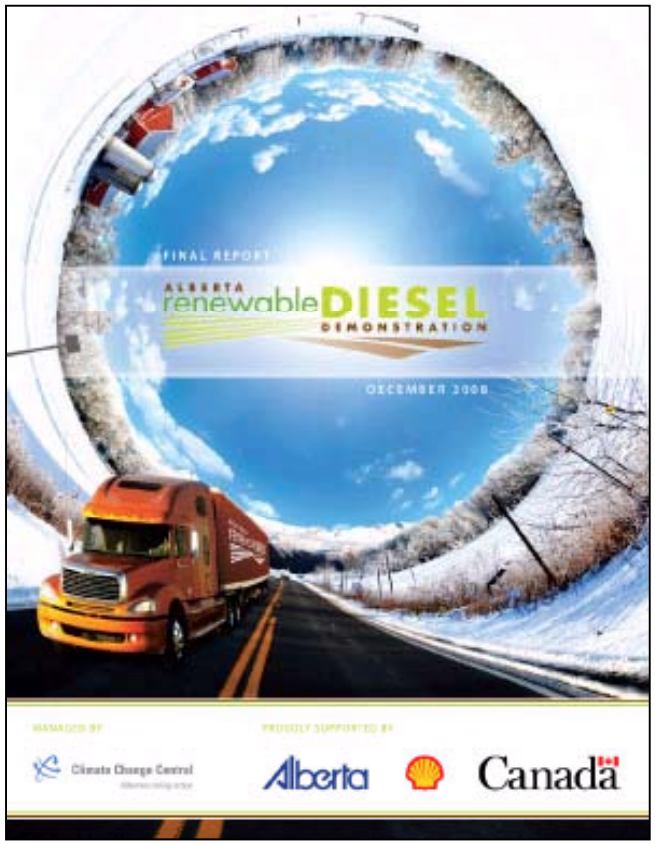
Final Report

www.renewablediesel.ca



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Comments or Questions?

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