FEMP Feasibility Study

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Industry Champion: Richelle Foster, Canadian Natural

Regulatory Champion: Lindsay Campbell, AER

Prepared By

Ryan Liu and Wes Funk
Suite 820, 717 - 7th Avenue SW
Calgary, AB, T2P 0Z3

Prepared For

PTAC Petroleum Technology Alliance Canada
Suite 400, 500-5 Avenue SW
Calgary, AB, T2P 3L5

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Introduction

As of January 1, 2020, oil and gas producers and midstream operators across Canada were required by Environment and Climate Change Canada (ECCC) to implement Fugitive Emissions Management Programs (FEMPs) to reduce fugitive methane emissions by 45% from 2012 levels by 2025[1]. Provinces in turn could match the emissions reduction targets via a different method than that prescribed by ECCC, and therefore use their own regulations instead of ECCC's so long as ECCC approved the equivalence. Alberta achieved equivalency with its Directive 060[2] which allowed oil and gas producers and mid-streamers (referred to as duty holders in Alberta) the potential to pivot from conventional FEMPs to alternative FEMPs (Alt-FEMPs). The purpose of the (Alt)FEMP Feasibility study is to develop an understanding of the supply for-and demand of-methane leak detection efforts in Alberta as a core component of FEMPs and Alt-FEMPs. The objective of the study from a supply perspective is to develop a dataset of methane leak detection technologies and their associated performance measures and, if possible, their cost parameters. From a demand perspective, the objective of the study is twofold. The first objective is to document upstream and mid-stream oil and gas industry duty holders' intentions and current efforts to undertake an Alt-FEMP. The second objective seeks to determine duty holder intentions to use third party leak detection services, self-perform or apply a hybrid third party/self-performance model for either Alt-FEMPs of conventional FEMPs. Ultimately, many of the study's data elements will be considered for inclusion in the Canadian Emissions Reduction Innovation Network (CANERIC)-funded Integrated Methane Measurement and Monitoring System (IM3S).

FEMPs are a significant regulatory tool that both federal and provincial governments have invoked to meet current and future methane reduction targets. With respect to greenhouse gas (GHG) management, methane management as a subset has experienced noteworthy activity with respect to new technology development and commercialization efforts over the past several years. Methane leak detection using optical gas imaging (OGI) features prominently in both provincial and federal regulation[1], [2]. Alternatives to OGI may result in more efficient and cost-effective delivery of detection services and are expected to be commonly cited in Alt-FEMPs. The FEMP Feasibility study addresses the supply and demand of conventional and alternative methane emissions leak detection services (e.g., OGI) and alternative methane leak detection efforts. The study scope from a supply perspective, includes OGI and alternative leak detection performed by third parties or self-performed by duty holders. The demand component of the feasibility study includes both upstream and midstream pipeline operators. Leak repair is not the focus of this study but is likely an important area for future research. The geographic focus of this study is Alberta; however, the study design recognizes the potential for competition for leak detection and repair (LDAR) resources presented by other jurisdictions in Canada including those defaulting to the ECCC 3x/year LDAR protocol.

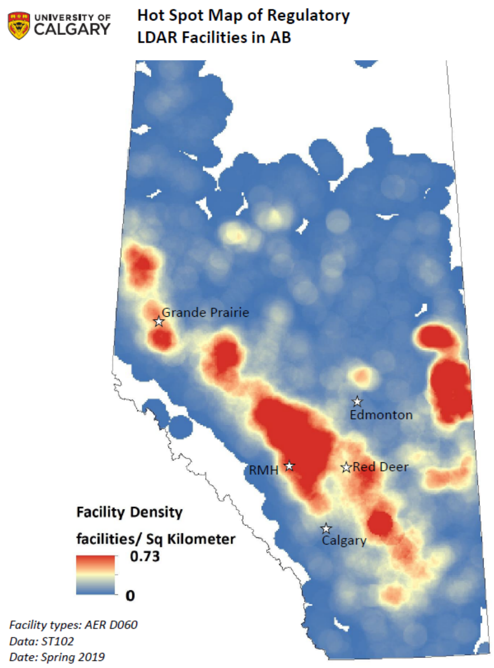
Background: FEMP and Alt-FEMP Demand in Alberta

As of 2019, under the Alberta Energy Regulator's Directive 060 (AER D60) there are a potential 26,000 sites that could require a minimum of once-a-year leak detection operations. Of those, a potential 7,400 sites could require tri-annual leak detection operations. This amounts to approximately 40,800 unique leak detection surveys. These counts were made using Petrinex[3] facility and production data from mid-2018 to mid-2019. A breakdown of the number of facilities per facility subtype that require LDAR operations are presented in Table 1. Using the same dataset there are approximately 17,000 sites that would require tri-annual leak detection operations based on current ECCC federal regulations (if Alberta were to lose its equivalency with the federal regulatory framework). Figure 1a was developed by the University of Calgary (UofC) and presents an LDAR heat map that reflects the number and density of D60 regulated facilities requiring one time (1x) or three times (3x) per year LDAR. This heat map, and the Petrinex derived LDAR demand was corroborated as recently as March 2020 by a Canadian Association of Petroleum Producers (CAPP)[4] estimate which indicated there are approximately 27,000-28,000 sites that require LDAR. Importantly, there are an additional ~13,000 sites cited by Petrinex (and the AER) as unknown status. Should these sites be active, they would require LDAR bringing the total sites in Alberta up to ~41,000. This finding is based on research conducted by the Sundre Petroleum Operators' Group (SPOG) - Methane Emissions Management Program (MEMP)[5] using Petrinex/AER licensing queries using the ArcGIS platform [6]. The "unknown status" sites finding is significant as demand for FEMP and Alt-FEMP activities in Alberta could be up to ~50% higher than previously estimated by this study and CAPP. Notably, a rising driver for LDAR demand is from the switch to exploiting sweet oil and gas formations in fields that have initially been produced and licensed as sour (i.e., containing hydrogen sulfide H_2S). The potential increase in demand for LDAR activities is owing to the D60 stipulated frequencies of 3x/year for sweet (non- H_2S) facilities vs. 1x/year for sour facilities.

Table 1: AER D60 Leak Detection Approximate Facility Counts – Petrinex 2018/19 data

	Facility Subtype Code, Alberta																			
	311	321	322	351	361	362	363	401	402	403	405	407	501	502	503	505	507	601	621	671
Facility Count	5976	441	1938	4979	2565	426	381	368	54	28	46	13	726	2	818	23	119	4316	2700	174

	Annually	Tri-annually
Totals	26093	7384



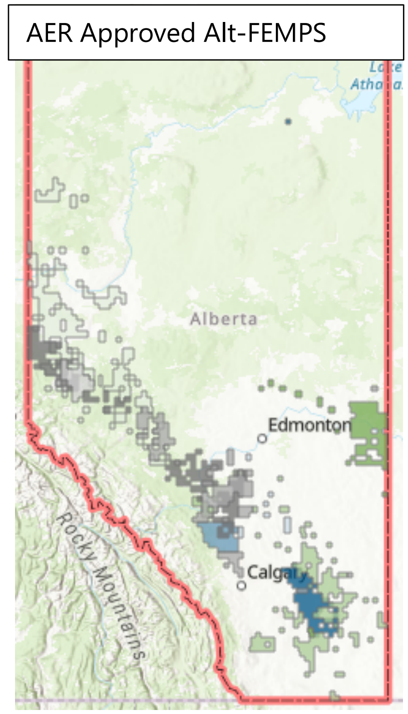


Figure 1a: Facility LDAR Heat Map of Alberta, UofC (2019)

Figure 1b: 2020 AER Approved Alt-FEMPs, AER (2021)

Following the January 2020 update of D60, several Alt-FEMPs were approved by the AER as either 1-or 2-year Pilots or Full Scale. As of April 2021, there were a total of 9 approved pilot and full-scale Alt-FEMPs. These Alt-FEMPs were being conducted by four duty holders including Canadian Natural Resources Limited (CNRL), Seven Generations Energy (now ARC Resources), Torxen, Cenovus, Enhance Energy and Bonavista. Table 2 summarizes the approved Alt-FEMPs which include approximately 5.600 sites across Alberta. Figure 1b depicts the locations of these Alt-FEMPs which not surprisingly align with the heat map presented in Figure 1a. The majority () of Alt-FEMPs are aerial based and truck-based methane sensors with OGI follow up (~5600 sites), with one being continuous monitoring of 16 sites. Additional information on these approved Alt-FEMPs is available on the AER website[7].

Table 2: Approved Alt FEMP programs in Alberta (Source: AER[7]*)*

Submitted By	Proposal Type	Detection Technologies	Approx. # of Sites	Approval Issued & Program Start Date	Program End Date
Torxen1	1 yr Pilot	OGI and truck mounted methane sensors	600	01-May-20	31-Dec-21
Cenovus	2 yr Pilot	Aerial methane sensor with OGI follow-up	400	19-May-20	19-May-22
Seven Generations (now ARC)	3 yr Full Scale	Baseline OGI survey and aerial methane sensor with OGI follow-up	200	08-Jul-20	08-Jul-23
CNRL	2 yr Pilot	Aerial and truck methane sensor with OGI follow-up	1000	01-Jan-21	31-Dec-22
CNRL	2 yr pilot	Aerial and truck methane sensor with OGI follow-up	600	01-Jan-21	31-Dec-22
CNRL	2 yr pilot	Aerial and truck methane sensor with OGI follow-up	900	01-Jan-21	31-Dec-22
SPOG	2 yr Pilot	Aerial and truck methane sensor with OGI follow-up	1200	01-Apr-21	01-Apr-23
Enhance Energy Inc.	2 yr Pilot	Continuous monitoring	16	30-Apr-21	31-Dec-22
Bonavista	2 yr Pilot	Aerial and truck methane sensor with OGI follow-up	700	30-Apr-21	30-Dec-22

Survey Design and Testing

To understand the nature of FEMP-and Alt-FEMP-based service offerings and duty holder demand for them, two questionnaires were developed by DXD in collaboration with the University of Calgary's Thomas Fox. Dr. Fox's familiarity with LDARSim[8] and IM3S contributed significantly to the creation and refinement of the questionnaires. His expertise was essential to ensuring questionnaire elements related to leak detection technologies and methods would service the data/information requirements of IM3S as well as furthering the understanding of the supply and demand relationship related to FEMPs and Alt-FEMPs.

Survey Testing

Once designed both the Service Provider/Vendor and Producer/Duty Holder surveys were shared with the study's industry and regulatory champions (i.e., Richelle Foster – CNRL and Lindsay Campbell – AER). The study champions provided review and advice regarding the accessibility of the surveys re. question intent and structure, the length of the surveys (to maximize likelihood of responses particularly from duty holders) and data and information solicited by the surveys (and its utility to the ARPC, the AER, duty holders and service providers).

Upon finalizing the questionnaires, an online survey platform was selected. Using Survey Monkey[9], the two questionnaires were uploaded and tested internally. A final review of the Producer/Duty Holder Survey was conducted by Don McCrimmon – Manager, Air CAPP.

Appendix A provides the Service Provider/Vendor Questionnaire and Appendix B provides the Producer/Duty Holder Questionnaire.

Respondent Anonymization

The Service Provider/Vendor Questionnaire were provided with the opportunity to have their participation in the study disclosed to PTAC and its members. The vast majority of respondents to this questionnaire elected to have their participation shared. This opportunity was not offered to producers/duty holders. Regardless of the disclosure of a respondent's participation, in all instances questionnaire respondents were anonymized. PTAC and the UofC/IM3C will receive anonymized data sets and completed questionnaires have been redacted to ensure the anonymity of the respondents.

Service Provider/Vendor and Producer/Duty Holder Identification and Participation

Service providers and leak detection vendors were identified using a variety of methods. These methods included online searches, use of contact lists from previous PTAC methane research projects managed by DXD (e.g., Alberta Methane Field Challenge 1.0 and 2.0 and the Fugitive Emissions Management), conferences attendee lists held by various organizations, word of mouth, and producer and regulator-held contact lists. A total of 85 service providers / vendors were identified, contacted, and invited to participate in the Alt-FEMP feasibility study survey starting in February of 2021 and continuing through to April of 2021. Appendix C provides a listing of the service providers and vendors invited to participate in this study. To ensure, maximum response rates, each vendor was approached by email and/or a phone call to introduce the survey and solicit their participations. Subsequently, multiple email reminders and additional invitations were sent out during this period. At the conclusion of outreach efforts, a total of 24 organizations responded to the survey by the end of May 2021.

Duty holders / producers and midstream organizations were identified via their membership in various organizations which include PTAC, CAPP, EPAC, CEPA, and SPOG among others. A total of 49 producer and midstream organizations were identified and invited to participate in the study. Appendix D provides a listing of the companies invited to participate in the study. Notably, these companies were selected owing to their participation in methane related committees, methane-related conference attendance and status as a duty holder, producer or midstream operator. Using PTAC, EPAC and CAPP as initial distribution channels, invitations to participate in the Producer/Duty Holder/Midstream Operator survey were issued beginning in late January 2021. As of June 2021, 10 producers and one mid-stream organizations had responded to the producer survey. Numerous attempts were made to seek additional participation in the survey. Additional reminders were sent directly to invitees, invitations through partner organizations (CEPA, EPAC, CAPP, and PTAC), and personalized e-mails. These efforts raised participation from approximately 5 respondents in March 2021, to the 11 in June 2021. The total production of the 10 producer-respondents was approximately 60% of Alberta's total BOE production in 2020 (~3.3 MMboe/d of ~5.2 MMboe/d[4]). These respondents represent a significant portion of Alberta's overall production and allow insights into the current market for FEMP and Alt-FEMP technologies, programs, and availability.

There are 9 service providers of the 24 respondents who indicated that they offer 2 to 4 types of detection technologies (e.g., OGI and Truck based). For these service providers, only one technology will be considered to represent the service provider in the results. These will be done based on the screening technology offered in the order of satellite, aircraft, truck, continuous, UAV, and lastly handheld. UAV is considered second to last due to restrictions on drones (particularly the need for line of sight), but still being used as a screening technology before handheld. This order is estimated to be the approximate order of productivity in number of sites visited per day for screening / Alt-FEMP technologies. Service providers are assigned a number from 1 to 24 for anonymization. The service providers with multiple technology offerings are #2, 8, 14, 17, 18, 20, 22 and 23 (Appendix E). Of these service providers, only provider #20 offers their multiple technologies as separate packages, all other service providers offer their multiple technologies together. Please refer to Appendix E and F for their responses and the data analysis for these service providers. Ideally, a survey response for each type of technology offered would be gathered, unfortunately that is not the case as these service providers would be required to spend a significant amount of time filling out multiple surveys. Therefore, the described method is used, with the raw response data and analysis methods disclosed in the appropriate appendices.

Findings

The following section summarizes the survey results. These are divided into Service Provider/Vendor Responses and Producer/ Duty Holder/ Midstream Operator Responses. The former focuses on leak detection services, technologies, and methods while the latter addresses duty holder plans re. use of third party and/or self-performed LDAR. Appendix G provides a detailed summary of the Service Provider/Vendor Responses while Appendix H provides a similar summary of the Duty Holder/Midstreamer Responses. Appendix E provides the redacted questionnaire responses for the Service Provider/Vendor Surveys and Appendix F provides the redacted questionnaire responses for the Producers/Duty Holders/Midstream Operator Responses.

Service Provider/Vendor Survey Results

There was a total of 24 unique responses to the service provider questionnaire, these 24 service providers are assigned a number from 1 to 24 for anonymization purposes, each number corresponding to a service provider. All respondents indicated that they were active in the Alberta market, with 11 service providers also participating in British Columbia, 11 in Saskatchewan, 9 in the United States, and 12 in other regions of Canada and/or around the globe. 20 of the respondents mentioned whether they were AER D60 compliant or part of potential Alt-FEMPs, 10 being AER compliant and 10 for Alt-FEMP programs (e.g., drone or truck monitoring technology). Only 4 service providers indicated that they had successfully applied for Alt-FEMP programs within Alberta, with more service providers are planning to apply in 2021 and/or in the future.

Service Provider Results

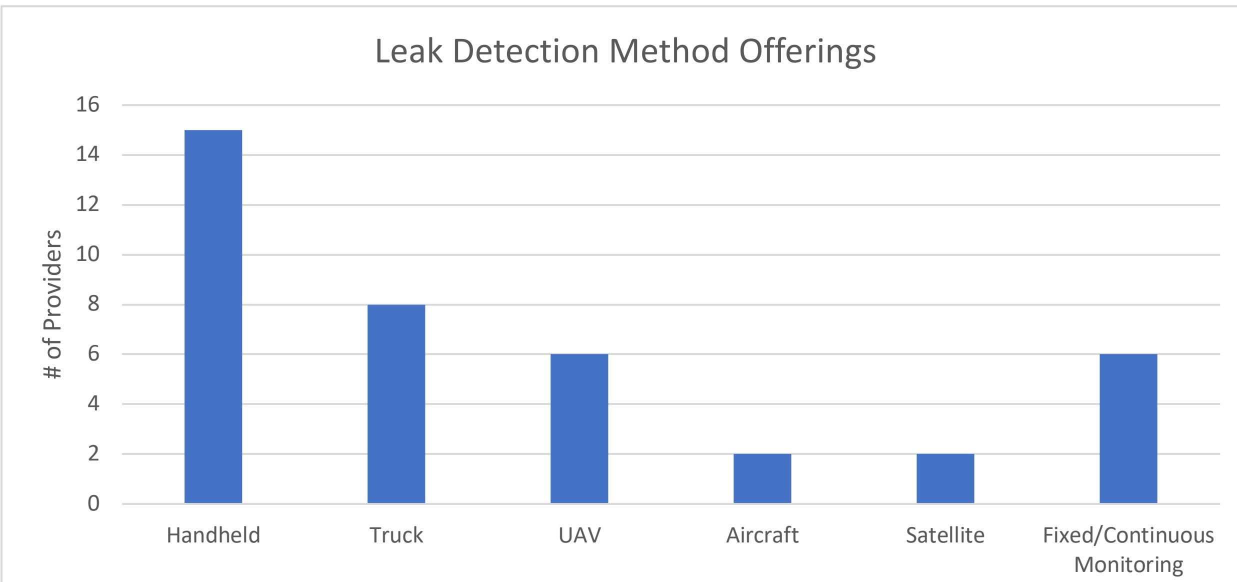


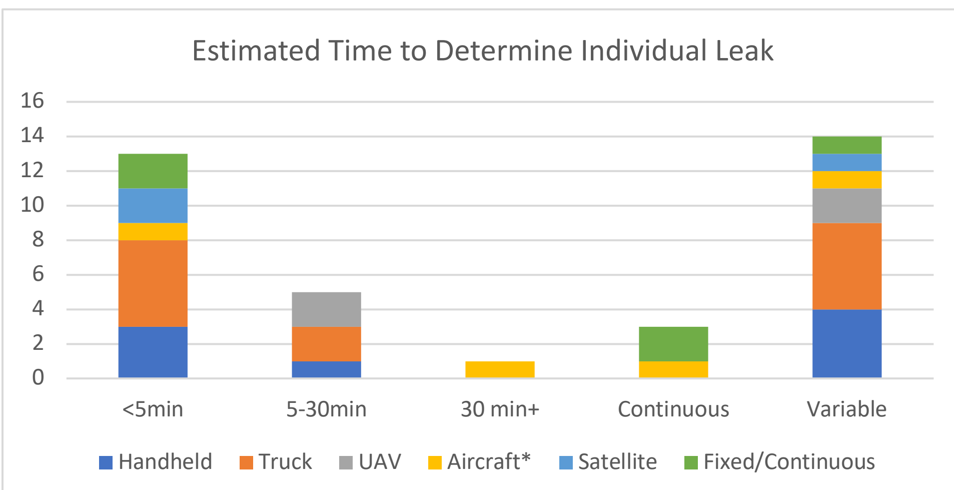
Figure 2: Leak Detection Method Offerings, n=22 offering 39 monitoring methods (8 service providers offer more than just 1 type of monitoring, e.g., handheld and UAV)

Table 3: Technology Offerings by Service Provider

Service Provider	Handheld	Truck	UAV	Aircraft	Sattelite	Fixed/Continuous	If Multiple, Together or Separate
1	1	1					Together
2	1						
3		1					
4		1					
5					1		
6							
7	1	1	1				Together
8							

9						1	
10	1						
11	1						
12	1	1					Together
13				1	1		
14	1						
15	1		1				Together
16	1	1	1	1		1	Together
17						1	
18	1	1	1			1	Separate
19	1						
20	1		1				Together
21	1	1	1			1	Together
22	1						
23	1						
24						1	

Figure 2 shows the different technology offerings available from the 24 service providers. Nine service providers indicated they offered more than 1 method (e.g., UAV and handheld). There are 5, 1, 2 and 1 service providers offering 2,3,4 and 5 technologies respectively. Of the vendors that offer multiple methods, 7 distinctly indicated that their methods could potentially work in unison to provide an Alt-FEMP method, typically starting with Truck/UAV/Satellite for an initial screening survey then moving to handheld OGI if a site's estimated emissions are above a threshold based on the initial survey.



*Aircraft monitoring of 30+ min is likely due to the service provider including OGI follow-up time.

Figure 3: Estimated time to Determine Individual Leaks, multiple answers per service provider were allowed, n=21.

The time it takes to determine an individual leak from the respondents' technologies are shown in Figure 3. 13 of 21 respondents stated their technologies can determine an individual leak under 5 minutes, with some technologies taking potentially longer. 14 of 21 respondents indicated that their leak determination times were variable in addition to an approximate time selection. Variables that affect this timing were stated to include items such as weather conditions, location of component, and type of leak detection technology being used. The one aircraft service provider with 30 minutes or longer potentially includes overall site leak determination and not just a single leak (i.e., OGI follow-up time).

Table 4: Tagged Leaks Specificity of Method, n=21

Technology	Component	Equipment	Facility
Total	17	15	16
Handheld	7	3	3
Truck	4	5	6
UAV	2	1	1
Aircraft	1	1	1
Satellite	1	2	2
Fixed/Continuous	2	3	3

The specificity of leak tagging (facility, equipment, and component) is presented in Table 4. Many service providers offer multiple technologies which can tag leaks at different levels which is why the total is more than 24. Table 5 shows how many vendors disclosed if they could classify a methane source as a fugitive (leak) or vent, ability to tag leaks individually (component/equipment level), and if a flow rate can be calculated. 12 of 21 service providers indicated they can perform all three detection specificities, 5 of 21 only at component level, and 4 of 21 at equipment and/or facility level. 5 of 19 service providers report being unable to determine a leak from a vent while 3 of 20 are unable to calculate a flow rate but can determine whether a site or piece of equipment is leaking.

Table 5: Methane Emission Source Tagging Attributes, n=22

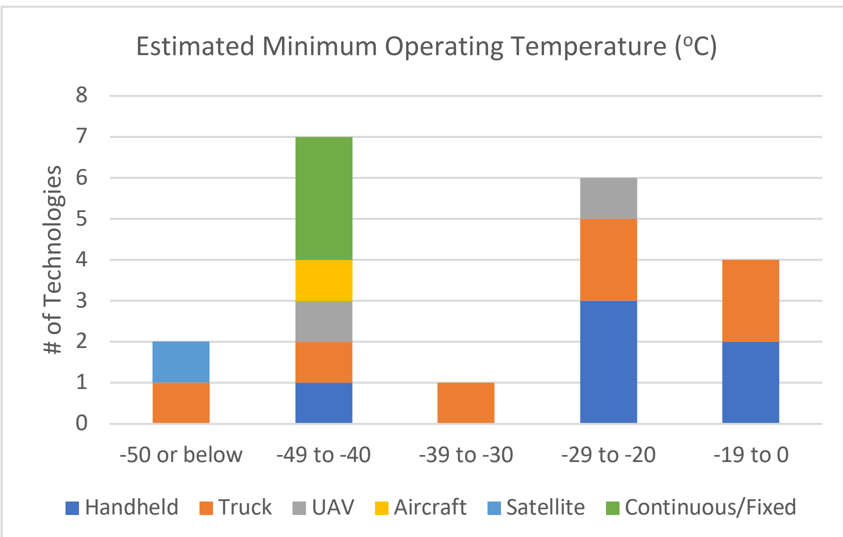
Technology	Y/N	Classification of emissions as Fugitive or Vent	Able to tag individual leaks	Flow Rate Calculated
Total	Yes	15	21	17
	No	5	1	4
Handheld	Yes	6	7	5
	No	1	0	2
Truck	Yes	3	7	6
	No	3	0	1
UAV	Yes	2	2	2
	No	0	0	0
Aircraft	Yes	1	0	1
	No	0	0	0
Satellite	Yes	1	1	1
	No	1	1	0

Fixed/Continuous	Yes	2	3	3
	No	0	0	0

Climate Conditions

The climate conditions that were included in the questionnaire include operating ambient temperatures, humidity, and levels of rain, snow, snow on ground, and wind. Climate conditions can potentially affect the operation of vendor technologies and, consequently, their ability to be reliably deployed in the field and seasonal limitations to their application.

(a)



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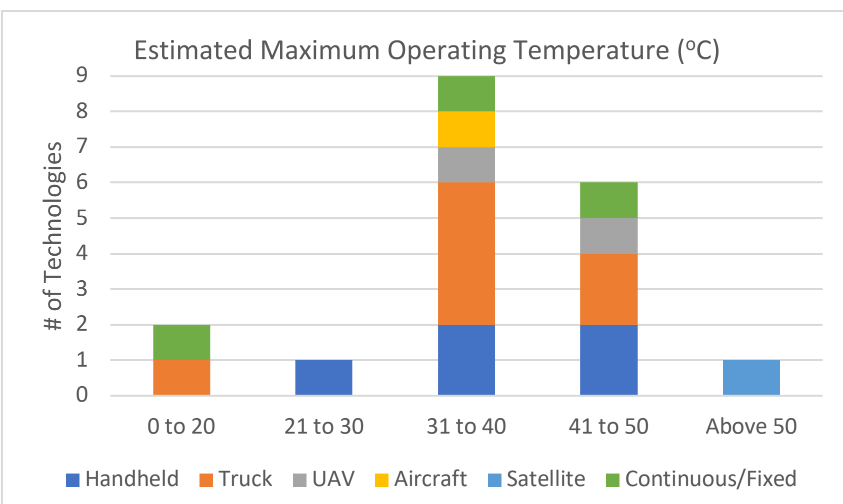


Figure 4 a/b: Minimum and Maximum Operating Temperature of Technologies, (a) n=20 (b) n=19

The operating temperature threshold for technologies varies from -50°C (14 of 20 being from -20°C to -49°C) to above 50°C as shown in Figure 4 a/b. The maximum threshold for most technologies (15 of 19 responses) is between 31°C and 50°C, with only one technology that can operate above 50°C. Minimum operating temperature varies significantly among the technologies. As for humidity, only two service providers indicated a maximum humidity of 80-95%, with 12 responses indicating that humidity would not affect the operation of their leak detection technology or method. With respect to wind speed, all 13 of 13 respondents indicated that they were effective at wind speeds of 20 km/h or less. 6 of 13 respondents indicated their technologies have challenges operating in the range of 20-40 km/h winds. As shown in Figure 5, three respondents indicated that they can operate effectively in winds above 80 km/h.

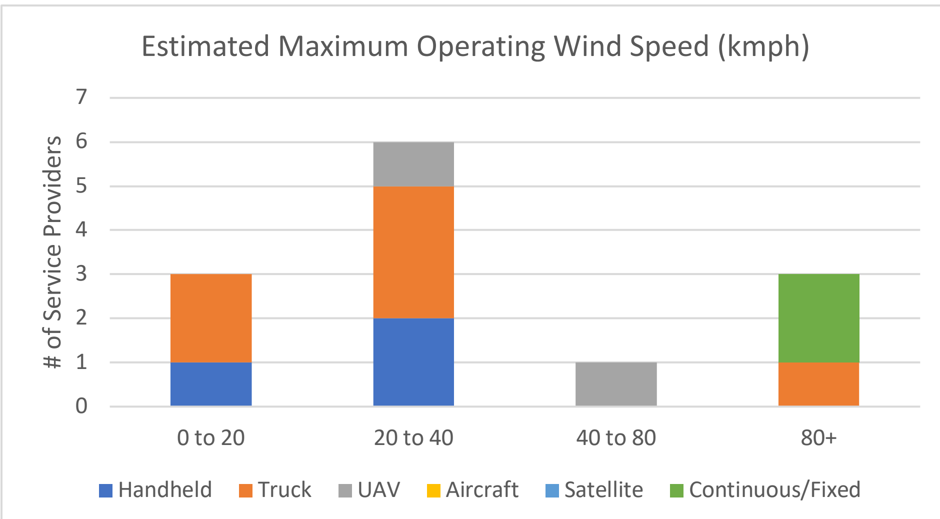


Figure 5: Maximum Operable Wind Speed, n=13

Table 6 to Table 8 indicate the level of rain, snow, and settled snow that service provider technologies were able to operate at. The responses to these questions were quite varied; however, most offered methods that can tolerate light rain and snow levels.

Table 6: Approximate Maximum Rain Level, n=18

Technology	None (no cloud)	Light	Medium	Heavy
Handheld	0	1	3	1
Truck	0	5	2	0
UAV	0	1	0	1
Aircraft	0	1	0	1
Satellite	1	0	0	0
Continuous/Fixed	0	0	1	2

Table 7: Approximate Maximum Snowfall Amount, n=18

Technology	None	Light	Medium	Heavy	N/A
Handheld	1	0	2	1	2
Truck	0	4	2	0	0
UAV	0	1	1	0	0
Aircraft	1	0	0	1	0
Satellite	0	0	0	1	0
Continuous/Fixed	0	0	1	2	0

Table 8: Approximate Maximum Amount of Settled Snow, n=18

Technology	None	Thin	Moderate	Deep	N/A
Handheld	0	1	1	3	1
Truck	0	3	0	4	0
UAV	0	0	0	2	0
Aircraft	0	0	0	0	1
Satellite	0	0	0	1	0
Continuous/Fixed	0	0	0	3	0

Capacity

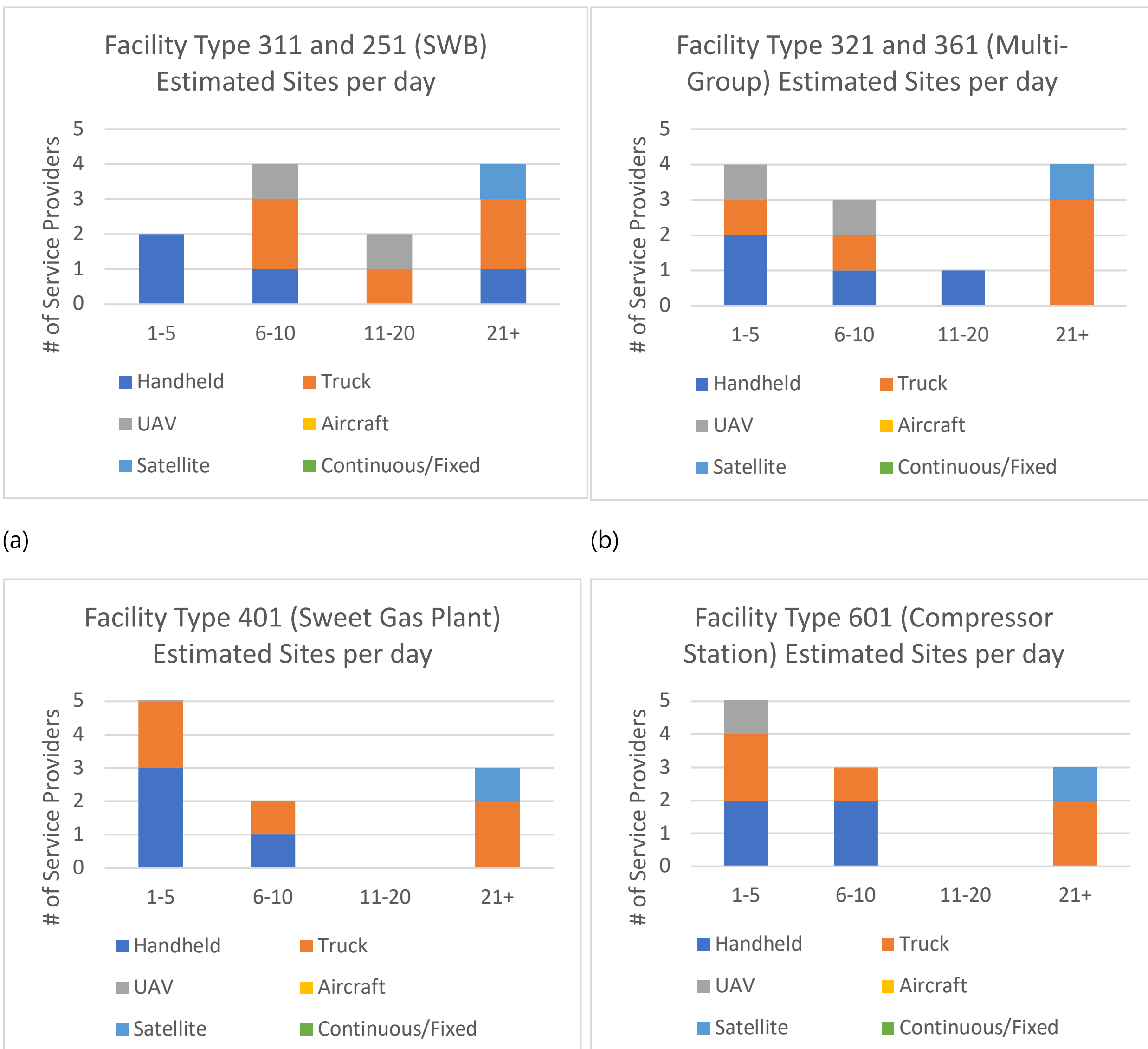
This section of the survey sought to determine pricing for LDAR services as well as their daily productivity.

There were 6 responses which provided some insight into pricing which ranged from $750/day up to $3,500/day for leak detection services. Table 9 summarizes the available cost data from these 6 responses in relation to the reported estimated facilities per day (SWBs) and technology type offered by the service provider.

Table 9: Available Cost Data from Service Provider Surveys

Technology	Cost per day ($/d)	Estimated SWB Facilities per day
Handheld	3,000	20
UAV	3,500	6
UAV	3,200	10
Truck	750	N/A
Handheld	3,500	3
Handheld	2,250	8

Figure 6 a/b/c/d shows the amount of service providers (12 of 24 total) that indicated daily productivity (per site type) of a single leak detection survey crew. 1-10 sites per day range was most frequently cited for larger site types (multi-group, sweet gas plant, and Compressor stations), and more distributed towards more sites per day for single well facilities. The majority of D60 compliant methods are under 20 sites per day, with Alt-FEMP methods reaching 21+ sites per day. There were no D60 compliant methods that were shown to be able to do 21+ facilities per day for a single crew.



(a) (b) (c) (d)

Figure 6 a/b/c/d: Estimated Site visits per day by site and technology type, n=12

With respect to crew capacity, 13 service providers that disclosed their current crew capacity, ranging from 1 field crew to 10 and shown below in Figure 7. Unfortunately, these same providers did not all disclose how many SWB facilities per day they would likely be able to average per crew. The service providers that disclosed this information can be seen in *Figure 8*. The service provider numbers (x-axis) match between Figure 7 and Figure *8*. Figure *8* however does not include the satellite technology sites per day, as they number into 1000's.

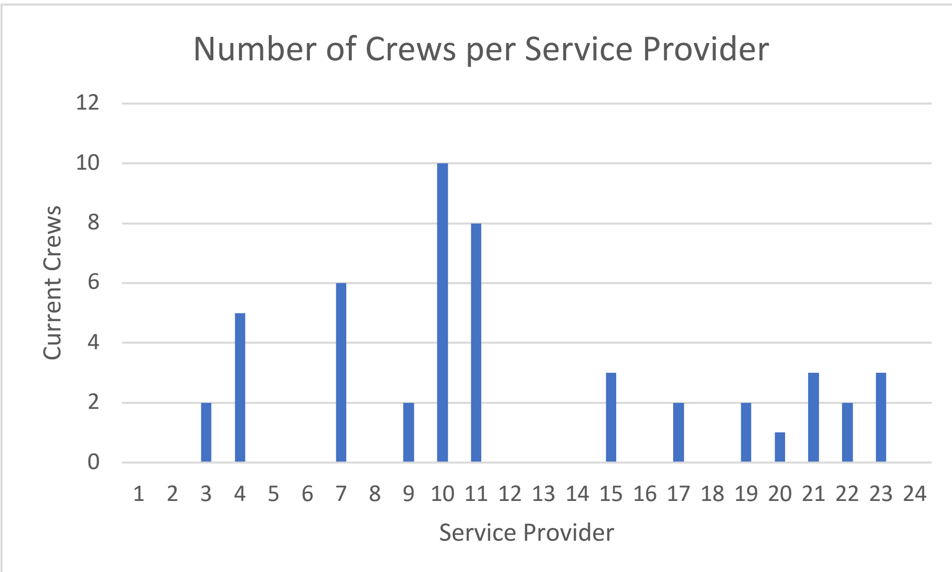


Figure 7: Number of Crews per Service Provider n = 13

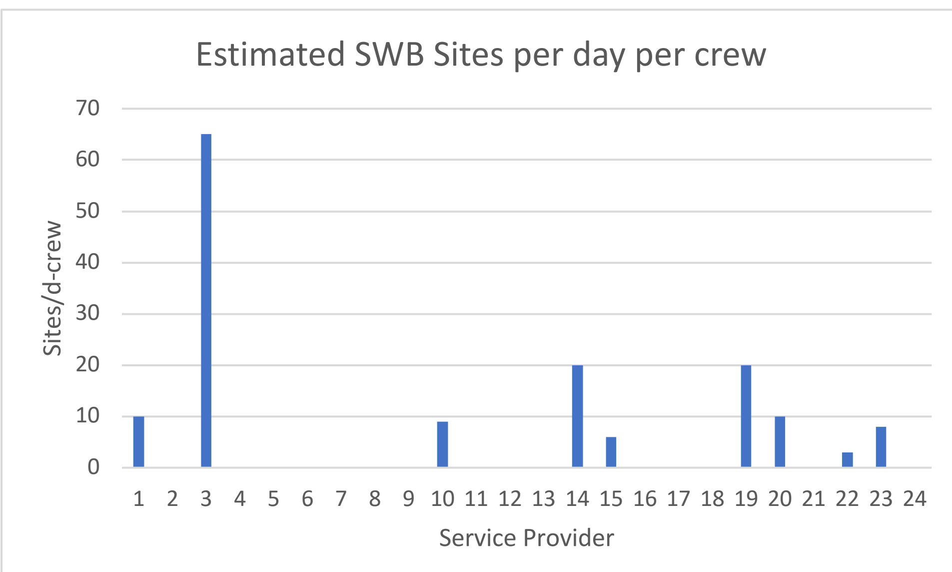


Figure 8: Estimated Sites per day per crew by Service Provider, n=10, satellite provider not shown (1000+ sites/day)

From these responses, we can generate a non-statistically valid estimate of the potential capacity of D60 compliant service providers to meet the LDAR requirements of duty holders. For purposes of this study, we will draw upon the responses of service providers 3, 10, 14, 19, 20, and 22. Multiplying their crews by their estimated sites/day-crew provides a total of 318 sites/d for all 6 service providers that provided responses. Notably, all 6 providers offer AER Directive 60 compliant methods (typically handheld OGI). Recalling from the Background Section that under D60 approximately 40,800 unique LDAR surveys are required every year in Alberta, we see that the combined daily productivity of just 6 D60 compliant service providers can conduct the required surveys in approximately 128 days (i.e., 40,800 sites/318 sites/day = 128 days).

Of the Alt-FEMP methods, there are 3 providers which indicated that they had the capacity to survey 9, 65, and 1000+ (satellite) sites per day per crew. Unfortunately, a similar "capacity" calculation cannot be conducted Alt-FEMP service providers as they cannot be taken on face value as offering equivalent reductions to D60 standard – handheld OGI.

Producer/Duty Holder/Midstream Operator Results

There was a total of 11 unique responses for the producer/duty holder/midstream operator questionnaire, available in Appendix G. All participants indicated that they had a FEMP program budget for 2021 planned with a variation of self-performance and 3rd party combinations. Figure 9 depicts a brief summary of respondents 2020 vs planned 2021 activities. Most activities stayed the same except one respondent who moved from self-performance of leak detection activities to 3rd party. The trend shows that respondents tend to participate in their data analysis and management (mostly in conjunction with a 3rd party) as well as perform most of the repairs, but the majority contract the leak detection portion to a 3rd party.

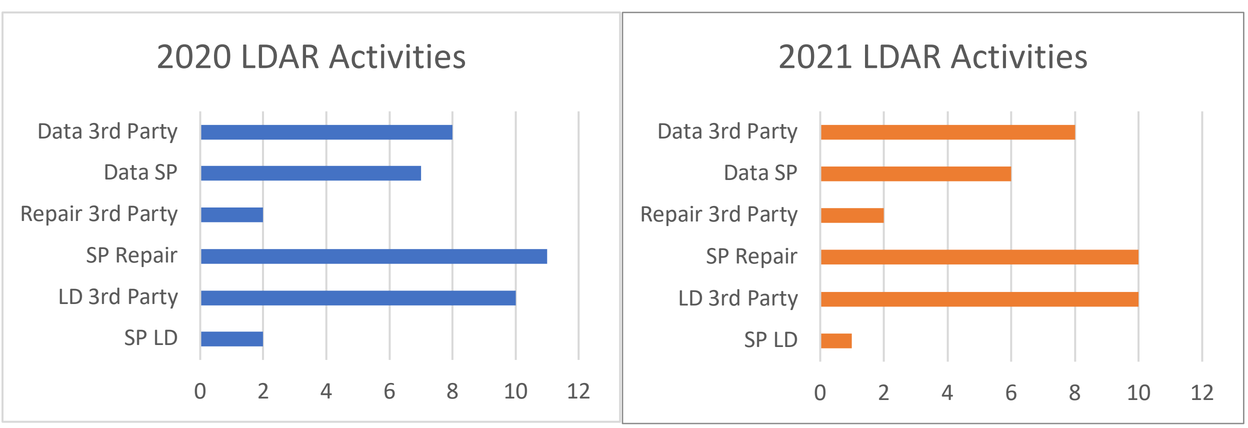


Figure 9: 2020 vs. 2021 LDAR Activity, Self-perform (SP) and/or third party for data analysis (DA), repair, and leak detection (LD). n = 13

For leak detection activities, all participants stated they used optical gas imaging (OGI) as a base, with some using Method 21 approved (other than OGI, 4 participants), and alt FEMP methods (5 participants) for their operations across Alberta. Only one participant disclosed that they owned 12 cameras and had their own personnel to perform leak detection. The majority indicated that they were in the process of applying for an Alt-FEMP pilot with the AER.

For 2021, 4 producers indicated that they are moving or have already moved to aerial and/or truck-based survey and ground-based OGI for follow up Alt-FEMP programs instead of the conventional OGI based survey. As far as supply, none of the producers indicated any difficulty in finding 3rd party leak detection and/or data analysis services; however, one producer indicated that they did not have resources to go from 3rd party to in-house leak detection. In addition, only one producer indicated further development for in-house leak detection operations.

Study Limitations

There are a few major potential limitations to this study as it was a voluntary participation questionnaire to industry. Some of the potential limitations are the following:

- Number of questionnaire participants,
- Ability and/or 'want' to disclose potentially sensitive business information,
- Representation of participants to overall market,
- And subjectivity of responses.

The number of questionnaire respondents for the producer / duty holder / midstream operator and service provider surveys were 11 and 24 unique responses, respectively. Although the service provider responses represented 24 out of 85 identified vendors (or 28%), questionnaire responses were incomplete for several questions which further reduces the sample size for individual survey questions and their capacity to represent their peers in a statistically robust fashion. The 10 producers (and one midstream operator) that responded to the questionnaire account for approximately 60% of Alberta's oil and gas production based on 2020 production numbers from year end reports. This represents the majority of the upstream industry by production and can allow for the approximation of the overall industry's demand for FEMP and Alt-FEMP programs either in-house or from service providers. That said, it is important to recognize that the capacity of small and mid-size producers and duty holders to either self-perform their LDAR activities or plan and execute an Alt-FEMP may be limited relative to the 11 survey respondents.

Discussion

The 24 participants in the service provider survey were approximately evenly split in offering FEMP (AER D60 compliant) and Alt-FEMP methods. This potentially shows that although conventional FEMP methods are readily available and likely thriving in the current market, there is large growth potential for Alt-FEMP methods pending successful applications with the AER.

Seeing as some Alt-FEMPs have already been approved or are in a trial phase, the likelihood of more Alt-FEMPs being approved in the future is high as technologies mature and offer savings in time and/or capital for producers.

Alt-FEMP methods typically have the advantage of being able to perform more surveys (sites/day) compared to conventional FEMP methods. This allows producers to potentially save a significant amount of time and capital should their Alt-FEMP method be approved. This may also be a driver for service providers to develop their own Alt-FEMP methods whether they be truck, drone, UAV, or satellite based. The challenge of most Alt-FEMP methods comes to determination of the properties of individual leaks whether that be the component source, flow rate, or fugitive vs. vent. OGI follow-up, consequently, becomes a necessity for the identification and repair fugitive and leaked emissions.

Many Alt-FEMP methods have challenges in more severe/heavy weather conditions which could be any individual or combination of rain, snow (falling and settled), and wind. These conditions can affect either the visibility of the gas, or the patterns of the emissions themselves which current technology has a difficult time circumventing. Additionally, road bans and winter-only access can be limiting factors for technologies requiring site access. Therefore, a significant portion of the year in Alberta is affected, winter months (~November to March), rainy season (portions of April - July), along with windy days throughout the year could make meeting regulatory requirements challenging as supply of FEMP and Alt-FEMP programs to all producers may be constrained at certain times of the year.

This study examined the supply of 6 providers for conventional FEMP methods, which roughly can equate to ~300 single well battery sites a day. If 6 providers can perform up to 300 sites per day and represent an approximate industry average, then it potentially stands to reason that the up to 30+ providers of FEMP services identified in the initial outreach phase could potentially survey 1500+ sites per day. This would cover all of Alberta's conventional LDAR needs (barring transportation to remote area time) in 1-2 months (accounting for m ore time-consuming site/facility types) to fully survey the province. This simplified analysis, however, does not address factors such as difficulty of access, distance between sites, size of sites (e.g., SWB vs Gas processing facility) among other logistical challenges. It is this study's finding that the current supply of FEMP and Alt-FEMP providers is likely to satisfy current demand (based on ~26,000 potential sites requiring at least 1 time leak detection per year). Four of the service providers who indicated their projected growth over the next few years all responded that they were planning for significant expansion to 400, 3,000, 1,000, and 1,000 sites per day, totaling 5,400 sites/yr for 4 providers.

With respect to producers/duty holders, most producers plan to utilize 3rd party service providers to perform the leak detection portion of their FEMP/Alt FEMP programs. With a combined approach (for most) for data management and analysis, and mostly self-performing repairs. Only one producer of those surveyed plans to perform their leak detection activities in-house. These findings infer that the industry overall is likely to rely on service providers, and therefore it is likely that most Alberta sites which will require LDAR will contract a service provider for leak detection services. This causes a potential challenge with supply, as the service sector capacity to supply experienced, reliably performing FEMP and Alt-FEMP services will be limited in the first few years following the release of D60.

Currently, all approved, or Trial Alt-FEMP programs use the approach of a screening survey, followed by a handheld OGI follow-up on sites that trigger a certain emissions threshold. The screening survey is completed via a truck/drone/UAV technology, which can survey sites at a faster rate compared to conventional FEMP methods. These technologies and methods, following successful applications and trials with the AER, can expand the capacity of the market to perform FEMP and Alt FEMP programs. As more Alt-FEMP methods become approved, the potential strain on supply of service providers diminishes. Another potential benefit to Alt-FEMP programs is the ability to target high emission sites at a faster rate, thus reducing emissions at a faster rate compared to conventional FEMP programs.

Conclusions

The current capacity of service sector to meet needs of duty holders' FEMP programs is likely sufficient to satisfy the oil and gas industry's requirements in Alberta. We identified potentially 80+ service providers and have based this conclusion on the responses of only 24 service providers. Based on our service provider outreach and the survey results, it is evident that there is a wealth of competition in the FEMP/Alt-FEMP market. This is likely to bode well for duty holders regarding future access to and costs of LDAR services resulting in an greater ability to identify and mitigate methane emissions.

The producer/duty holder survey indicated that just less than half are in the process of-or are planning to move towards Alt-FEMP programs as they offer the promise of cost and time savings compared to conventional FEMP programs. This sends a strong signal to the AER, that compliance and cost-effectiveness are both desired ends for its duty holders.

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