Intelligent Methane Monitoring and Management System (IM3S) Project

Final Report

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PROJECT TEAM
Chris Hugenholtz – University of Calgary
Thomas Barchyn – University of Calgary
Mozhou Gao – University of Calgary
Coleman Vollrath – University of Calgary
Tyler Gough – University of Calgary
Keegan Shaw – Highwood Emissions Management
Thomas Fox – Highwood Emissions Management

PREPARED FOR
Marc Godin – Petroleum Technology Alliance Canada
Carolyn Pfau – Alberta Energy Regulator
Bryan Helfenbaum – Alberta Innovates
Richelle Foster – Canadian Natural Resources

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1. Executive Summary

The objective of the Intelligent Methane Monitoring and Management System (IM3S) Project was to develop new knowledge and tools to design, simulate, and evaluate the performance of fugitive emissions management programs (FEMPs). The main technical work focused on improvements to the Leak Detection and Repair Simulator (LDAR-Sim), an open-source modeling system for simulating FEMPs, and increased accessibility so users can run simulations online via standard web browsers.

Outputs from the technical work are LDAR-Sim 2.0 and ldarsim.com. LDAR-Sim 2.0 is the next iteration of the modeling system that includes refactored code to improve structure and implementation, new inputs and modules to increase the scope of FEMP configurations that can be simulated, economic functions to evaluate program costs, and technical documentation. The entire open-source codebase is available for users and developers via GitHub.

ldarsim.com is the web application of LDAR-Sim that was developed to increase accessibility for users who want to learn and explore different FEMP configurations without requiring familiarity with the codebase and Python programming language. Users can sign-up for a free account to use the web application. Once signed-in, users are prompted through a series of steps and drop-down menus to design custom FEMPs using different methods. Results are displayed in graphical form and available for download. The pre-deployment web application was evaluated by a test group and their feedback was incorporated into the final version.

2. Table of Contents

3. Introduction

Mandatory leak detection and repair (LDAR) programs have been introduced across North America. The goal of LDAR programs is to reduce fugitive methane emissions from the oil and gas industry. Alternative LDAR (alt-LDAR) has also been introduced to provide flexibility in how producers manage their fugitive methane emissions. To obtain regulatory approval for a proposed alt-LDAR program, producers must demonstrate emissions equivalence between the proposed alt-LDAR program and the regulatory LDAR standard. Demonstrating equivalence is challenging, but it is generally agreed that some combination of controlled testing, pilot testing, and simulation modeling is needed. While controlled and pilot testing has occurred, there remains no reliable, trusted, versatile, and accessible simulation model for producers or contractors to demonstrate alt-LDAR program equivalence. Importantly, these simulation models also allow producers and regulators to evaluate available alt-LDAR programs and their potential impacts without necessarily requiring expensive field tests. Since 2017, the University of Calgary (UCalgary) has been developing a simulation model, the Leak Detection and Repair Simulator (LDAR-Sim), for evaluating the impacts and equivalence of alt-LDAR programs.

Prior to the Intelligent Methane Monitoring and Management System (IM3S) project, LDAR-Sim was in a mature stage of scientific and performance development. However, additional work was required to improve LDAR-Sim's accessibility and functionality. The University of Calgary IM3S project extends the functionality of the LDAR-Sim modeling system to enable full-scale methane emissions monitoring and management. The project outputs include new information, computer code, research papers, data, and expertise — a knowledge framework — to plan and manage Fugitive Emissions Management Programs (FEMPs) with alternative and conventional LDAR methods. The knowledge framework developed by the IM3S project builds on the technical components and expertise that industry needs to make informed decisions that lead to cost-effective methane emissions reductions.

The primary objective of the IM3S project was to develop new knowledge and tools to design, simulate, and evaluate the performance of FEMPs. A primary motivation in undertaking this project was to help organize existing LDAR data. These data represent a valuable opportunity to develop new insights, tools, and strategies to improve FEMPs and achieve compliance at the lowest cost to industry. Specific milestones of IM3S were to:

1. Develop LDAR data input standards and reporting protocols for use in LDAR-Sim
2. Develop a range of generic LDAR-Sim method modules
3. Integrate geographical data with LDAR-Sim (e.g., public roads, facility locations, airports)
4. Optimize LDAR-Sim program deployment and economic functions
5. Improve LDAR-Sim emissions and economic output features
6. Develop an interactive and accessible LDAR-Sim web app
7. Mobilize LDAR-Sim knowledge through publications and public webinars

The foregoing milestones are captured in LDAR-Sim 2.0 and ldarsim.com. LDAR-Sim 2.0 is the second iteration of the modeling system based on new data, modules, code refactoring, optimizations, and economic functions. ldarsim.com is the web application based on the first iteration, LDAR-Sim 1.0.

4. Input Standards

A broad range of diverse inputs are required to use LDAR-Sim. Previously, these inputs were not well defined or structured. Input standards were developed to ensure input data are consistent among diverse users and of high quality. We developed a set of mandatory and recommended input parameters so that industry, government, and other end users are aware of the data needed to use the model. Formatting requirements and templates were developed.

The input standards developed for the IM3S project were presented in an interim report delivered to the Steering Committee and were finalized in the form of extensive input documentation in a publicly available user manual. We have structured all user inputs into three sets of parameter types: Global Inputs (Section 5 in the user manual), Program Inputs (Section 6), and Method Inputs (Section 7). For each parameter, we systematically describe the data type, the default input value, and a detailed description of the parameter. We then detail notes on acquisition to guide operators and other stakeholders who are responsible for collecting these data to improve modeling outcomes. Finally, for each parameter we describe notes of caution that describe common issues or pitfalls users may face when collecting data or using the parameter.

5. Method Modules

5.1. Modularization

Where possible, LDAR-Sim was segmented into smaller reusable modules to make the application more efficient and supportable. This modularization makes the software easier to troubleshoot, allows multiple programmers to work in parallel, and allows program features to be reused. Method functionality was segmented in the following way:

Sensor type – This determines the sensor’s capabilities to quantify emissions. We developed a *default sensor* type with a simple minimum detection limit (MDL) as a detection threshold. Two *OGI* sensor types were also developed based on MDLs from two separate studies. Users can implement their own sensor type by declaring the *mod_loc* parameter.

Deployment Type – This determines how the sensor is deployed at sites. We implemented *mobile*, *stationary, and orbit* modules. These deployment types differ in site-visit frequency and scheduling, and in how emissions are tagged, flagged, or marked for follow-up.

Measurement Scale – This determines the spatial resolution at which the method operates. The *Component* scale mimics surveys of individual components where detected leaks can be directly tagged for repair. The *Equipment* and *Site* scales screen and flag emissions at larger scales but require a *Component scale* method in order for there to be any follow-up and repair.

5.2. New Parameters

In parallel with system modularization, the method for parameter input was rebuilt. The model requires many parameters to run. The parameters were separated out so that individual methods and programs have modular parameters that can easily be re-used and modified to perform A/B (split) testing. For example, certain systems can have re-usable, and sharable parameter sets. This enables technology developers to build their own parameter sets that can be distributed and shared without being attached to confidential program or simulation parameters. This modularization increases the ability to 'plug and play' different ideas, methods, and programs.

5.3. Mobile Systems

The mobile module was updated to allow route planning and scheduling. The mobile module now allows a company to preplan their day by allocating work to crews before work is carried out. The benefit of this change is that the code is easier to support, and the program performance was greatly enhanced. Previously, no preplan was done, sites were visited only if there was enough time in the day.

5.4. Stationary Systems

The stationary module was updated to allow users to specify equipment- or site-level monitoring with stationary systems (i.e., fixed sensors or continuous monitors). Whether stationary system modules should operate at the equipment or site level depends on the measurement scale and MDL (§5.1.) of the stationary systems being deployed. This decision should be made in consultations with technology vendors. The model currently allows for only a single stationary system to be assigned to a site; but this may be updated in later model versions. Users are given the option to program the costs of stationary systems in the model as an ongoing daily (i.e., dollars per day) or single upfront (i.e., total estimated dollars for entire modeled period) charge. This reflects the reality that fixed sensors in the field may be leased or purchased. Parameters such as spatial and temporal coverage of the stationary systems can also be customized. Modifying spatial coverage allows the model to account for obstructions at sites that may prevent plume transport towards the sensor or variability in the wind speed and direction that may influence the continuity of observations. Modifying temporal coverage allows the model to account for sensors that operate intermittently. The updated code reflecting these changes can be found here:

https://github.com/LDAR-Sim/LDAR_Sim/blob/master/LDAR_Sim/src/methods/deployment/stationary_company.py.

Stationary system parameters can be customized using the default method parameters file here:

https://github.com/LDAR-Sim/LDAR_Sim/blob/master/LDAR_Sim/src/default_parameters/m_default.yml.

5.5. Orbital Systems (satellites)

LDAR-Sim uses a two-line element set to estimate the orbit of different satellites. The orbital systems consist of two parts: an orbit predictor (https://github.com/LDAR-Sim/LDAR_Sim/blob/master/LDAR_Sim/src/methods/deployment/orbit_crew.py) and a satellite sensor (https://github.com/LDAR-Sim/LDAR_Sim/blob/master/LDAR_Sim/src/methods/sensors/satellite.py). Daylight and cloud cover are two primary variables used to constrain satellite deployment in the simulation. By integrating the time in the simulation and geographical coordinates of sites, the orbit predictor can determine whether a particular site is visible by a satellite. The satellite sensor constrains emission detection. It uses a dynamic minimum detection limit (MDL) and quantification precision to check the emission detection and to estimate the emission rate of the satellite according to the wind speed at the site location (Jacob et al., 2016, 2022).

6. Geographic Data

6.1. Environmental

LDAR-Sim uses the Reanalysis v5 (ERA5) environmental data from the European Centre for Medium-Range Weather Forecasts (ECMWF). ERA5 is the fifth generation ECMWF reanalysis model for the global climate and weather. Weather is used to establish limiting conditions for different LDAR methods. The latest version of LDAR-Sim includes temperature at 2 meters above ground, wind in meters per second at 10 meters above ground, total precipitation in millimetres accumulated per hour, and total cloud cover that shows the percentage of the sky hidden by all visible clouds. More details about the weather data can be found at https://github.com/LDAR-Sim/LDAR_Sim/blob/master/USER_MANUAL.md.

6.2. Scheduling and Optimization

The scheduling and optimization functionality only supports mobile methods (OGI camera, aircraft system, and multi-sensors vehicle system). This functionality enables an LDAR crew to select sites based on the minimum travel time. In the simulation, spatial clustering analysis is performed at the start of each day to partition sites into multiple groups. Instead of searching for the nearest site on the site list, the crew can find the nearest cluster of sites that require follow-up and achieve optimization in travelling. Specified survey times are added for each method. It can be enabled in both screening and follow-up. The travel time is calculated by using pre-defined travel speed and Haversine distance between the coordinates of the LDAR crew and target sites. In addition to visiting the nearest site, scheduling also ensures the LDAR crew always chooses the nearest service center (or airport for aircraft methods) for home base.

6.3. Spatial Scales

Previously in LDAR-Sim, only two spatial scales existed: site and component. All handheld methods measured at the component scale, which led to *tagging* of leaks and repair. All other technologies (mobile, continuous) measured at the site scale, which led to *flagging* of sites that then required follow up close-range surveys. We made several improvements to this structure. First, we added the equipment spatial scale as an intermediate option between component and site. Many screening technologies are able to flag equipment scale emissions, which is more efficient than the site scale. We also created an aggregator that can aggregate emissions from components to equipment and then to site scales. The aggregator allows the same emissions sources to be aggregated to equipment or site scales depending on the technology that's being used to monitor them. When sites are initialized, they are provided with a number of equipment groups. Equipment groups can be a tank farm, a well head, or any process block.

7. Economic Functions

LDAR-Sim 2.0 has added economics functionality. The first version of LDAR-Sim calculated and output the costs of individual methods within simulated programs. The new economic functionality considers the value of the gas captured by LDAR programs to offset these costs. This provides stakeholders with the ability to interrogate the cost-effectiveness of simulated LDAR programs depending on the current market price of natural gas. The economics module now outputs two plots: cost/benefit and cost to emissions mitigation ratio. The codebase for the economics module can be found here: https://github.com/LDAR-Sim/LDAR_Sim/blob/master/LDAR_Sim/src/economics/cost_mitigation.py.

7.1 Cost/Benefit Analysis

The economics module calculates the costs of individual methods within simulated LDAR programs. For example, a program using vehicle-based screenings and OGI follow-up would have costs partitioned between these two methods. Repair and verification costs can also be included depending on how the model is parameterized. Annual site-level averages are taken from total method costs. The Achilles heel of the economics module is the baseline scenario (i.e., no formal LDAR). The module determines the volume of methane each LDAR program mitigates from this scenario and converts it into a mass. It then uses the sale price of natural gas to calculate the value of that methane if it were sold. Users can change the input price of natural gas in the model to account for their location and market fluctuations. This revenue is averaged annually at the site-level. These costs and benefits are all presented in a single plot. The plot also includes the difference between the two (costs – benefits). Negative costs indicate that program benefits completely offset the costs of labour, repair, and verification.

7.2. Cost to Mitigation Ratio

The economics module uses the costs and benefits to calculate program cost to methane emissions mitigation ratios. The module uses the mass of methane mitigated below baseline for each program and multiples it with the global warming potential (GWP) of CH_4 to convert the amount mitigated to carbon dioxide equivalents (CO_2e). The 100-year GWP of 28 for CH_4 is used following the 2013 Intergovernmental Panel on Climate Change report. Users can change the

GWP for CH_4 instead of using the default of 28 (e.g., 20-year GWP of 84). The module then uses total program costs (i.e., the costs of all methods and costs for repair and/or verification) and divides by the amount of mitigation from baseline in tonnes CO_2e. The output is a plot with program cost to emissions mitigation ratio in $/tonne CO_2e. The potency of CH_4 makes most mitigation ratios positive when the units are expressed in CO_2e. Programs with lower ratios are the most cost-effective. Costs for carbon pricing and pure stream carbon capture utilization and storage in $/tonne CO_2e are also included in the plot to compare to program ratios.

8. LDAR-Sim Outputs

We developed standard graphical outputs to display results from each simulated FEMP as shown in §9. The outputs include the emissions distributions of simulated FEMPs, emissions time series, program cost, and emissions mitigation cost. The graphs can be downloaded as image files.

9. Web Application

Figure 1 shows the architecture of the LDAR-Sim Web Application Programming Interface (API). In this image, the Frontend dashboard uses Next.js, an open-source web development framework built on top of Node.js. It is responsible for sending user requests (e.g., authentication or simulation requests) to the Backend REST API and visualizing the simulation results. The Django web framework has been used to create the Backend REST API and it is primarily responsible for user authentication, database connections, and running user simulation requests. This architecture uses MongoDB as a NoSQL database, Docker as a containerization platform, Celery as an asynchronous task queue, and LDAR-Sim as the LDAR-Sim core. In this architecture, the LDAR-Sim core is the stable release of LDAR-Sim. Finally, Amazon Web Services (AWS) cloud platform hosts the entire architecture.

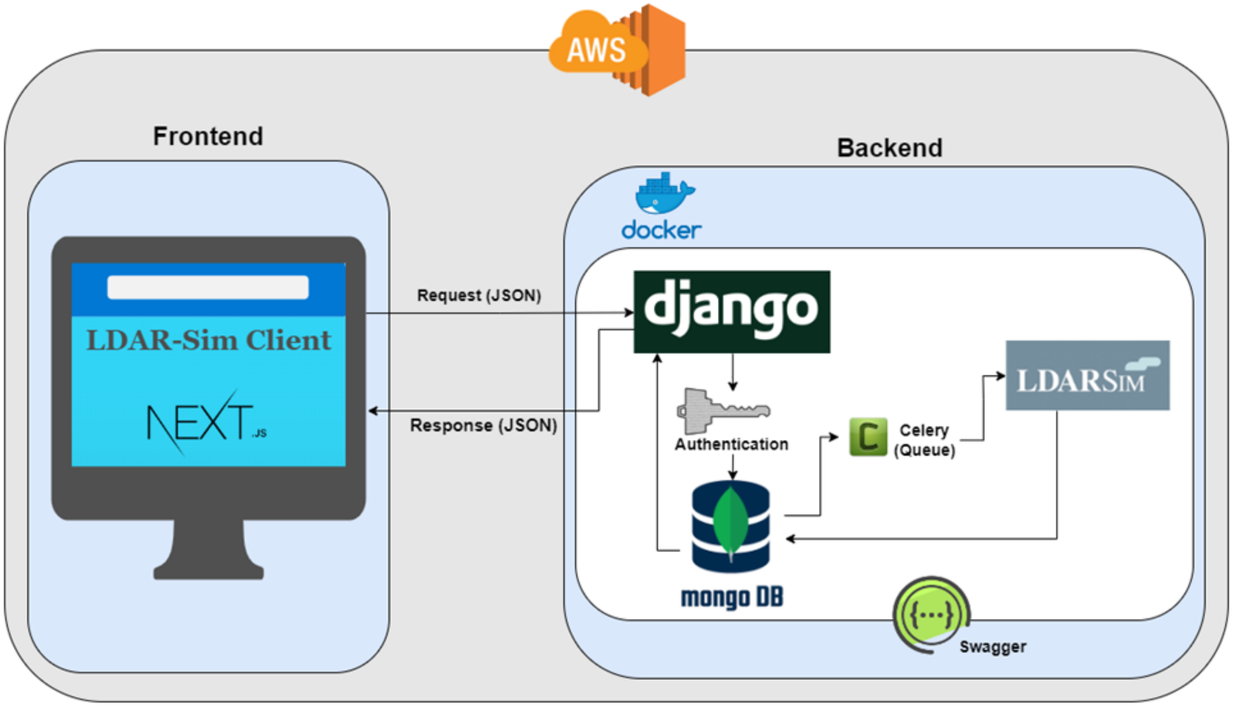
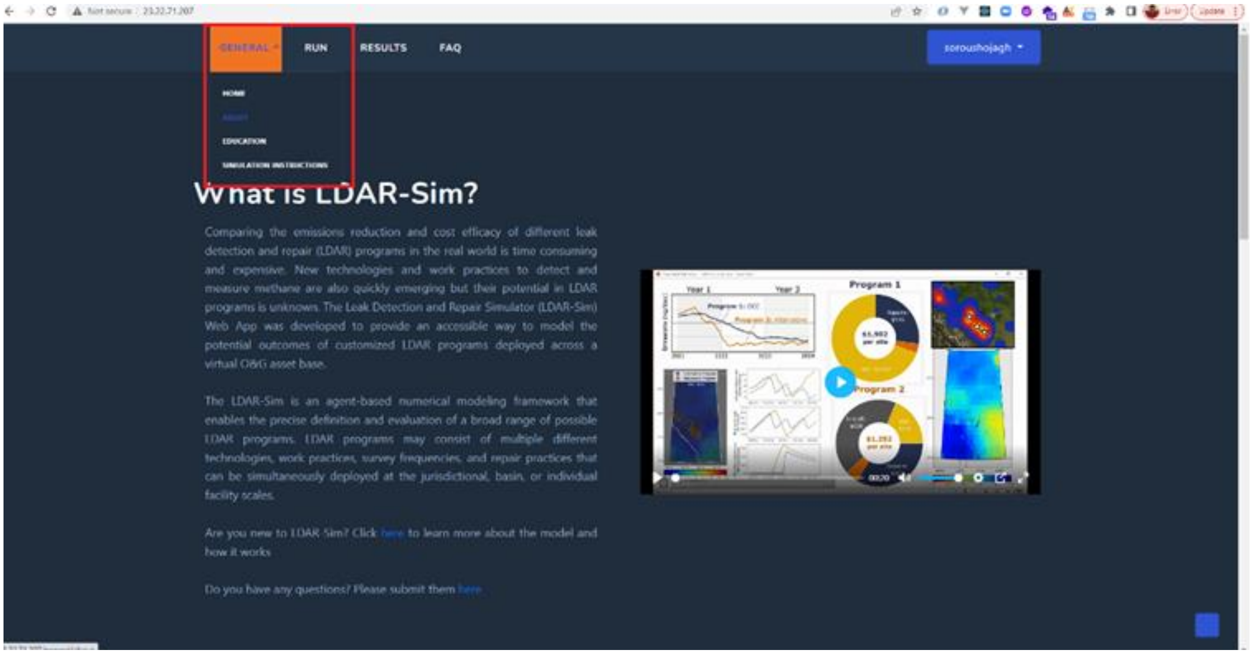


__Figure 1.__ The system architecture of LDAR-Sim Web API.

Different features have been included in the Frontend of the LDAR-Sim Web API to make it easier for users to run LDAR-Sim. As shown in Figure 2, LDAR-Sim users can firstly familiarize themselves with the basic terms and functions of the LDAR-Sim software by visiting the Home, About, Education, and Simulation Instructions pages within the General tab. LDAR-Sim's definition, the different steps for running a simulation, and its key features have been explained briefly on the Home page.

Details about the LDAR-Sim purpose and its contributors can be found on the About page (http://23.22.71.207/general/about). Education (http://23.22.71.207/general/education) and Simulation instructions (http://23.22.71.207/general/simulationinstructions) under the general tab provide a link to research papers related to LDAR-Sim, along with video tutorials for using the API. For example, users can register or log into the Web API using a valid e-mail account and a password, as seen in Figure 3, in the registration form (http://23.22.71.207/login). To guide users step-by-step through the registration and login process, a video tutorial (Figure 4) is available on the Simulation Instructions page (http://23.22.71.207/general/SimulationInstructions).



What is LDAR-Sim?

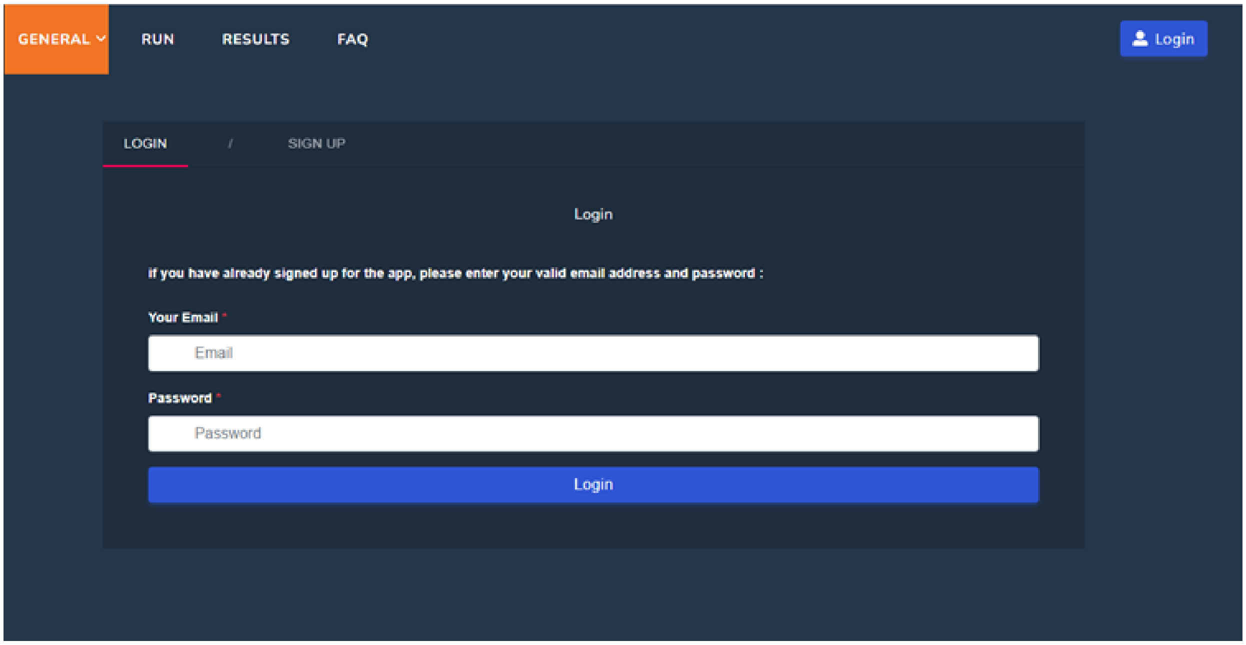
Comparing the emissions reduction and cost efficacy of different leak detection and repair (LDAR) programs in the real world is time consuming and expensive. New technologies and work practices to detect and measure methane are also quickly emerging but their potential in LDAR programs is unknown. The Leak Detection and Repair Simulator (LDAR-Sim) Web App was developed to provide an accessible way to model the potential outcomes of customized LDAR programs deployed across a virtual O&G asset base.

The LDAR-Sim is an agent-based numerical modeling framework that enables the precise definition and evaluation of a broad range of possible LDAR programs. LDAR programs may consist of multiple different technologies, work practices, survey frequencies, and repair practices that can be simultaneously deployed at the jurisdictional, basin, or individual facility scales.

Are you new to LDAR-Sim? Click here to learn more about the model and how it works

Do you have any questions? Please submit them here

Figure 2. *The General tab and its pages in the LDAR-Sim Web API.*



Login

if you have already signed up for the app, please enter your valid email address and password :

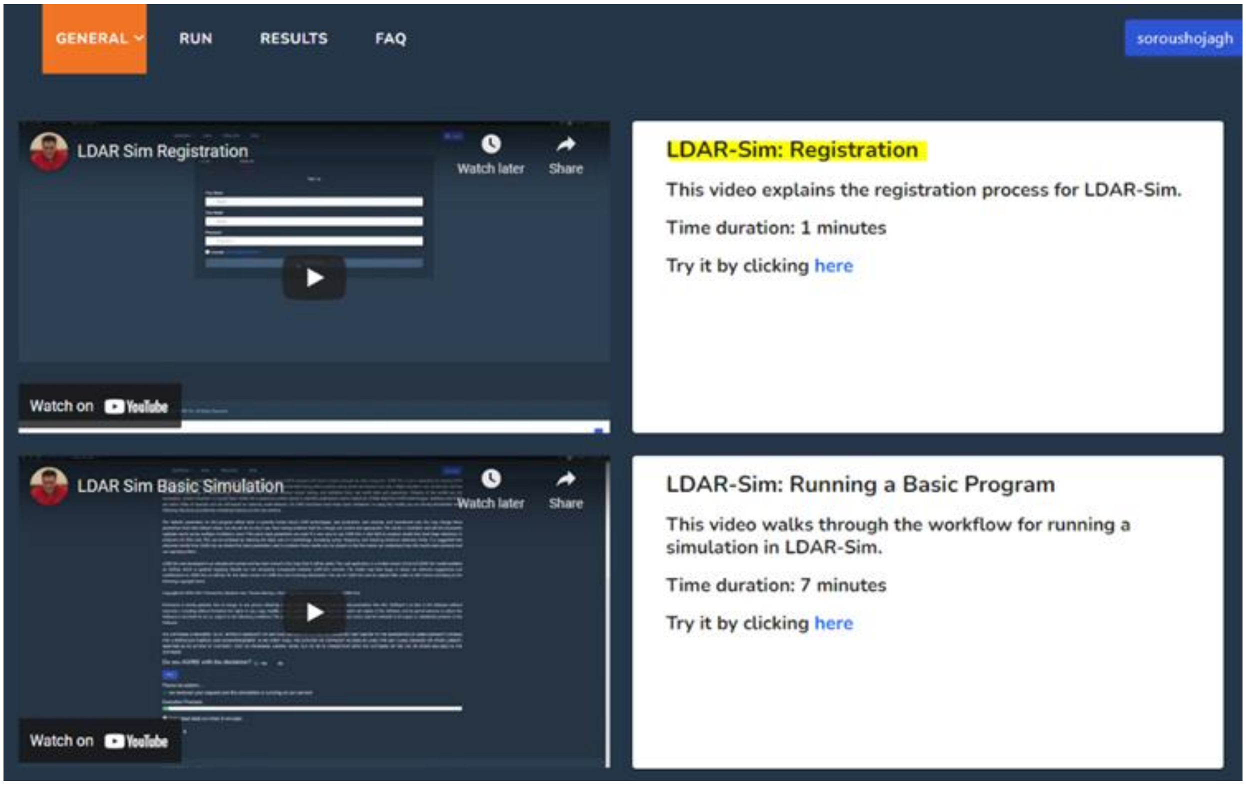
Your Email *

Email

Password *

Password

Figure 3. *Login/Registration page in the LDAR-Sim Web API.*



LDAR-Sim: Registration

This video explains the registration process for LDAR-Sim.

Time duration: 1 minutes

Try it by clicking here

LDAR-Sim: Running a Basic Program

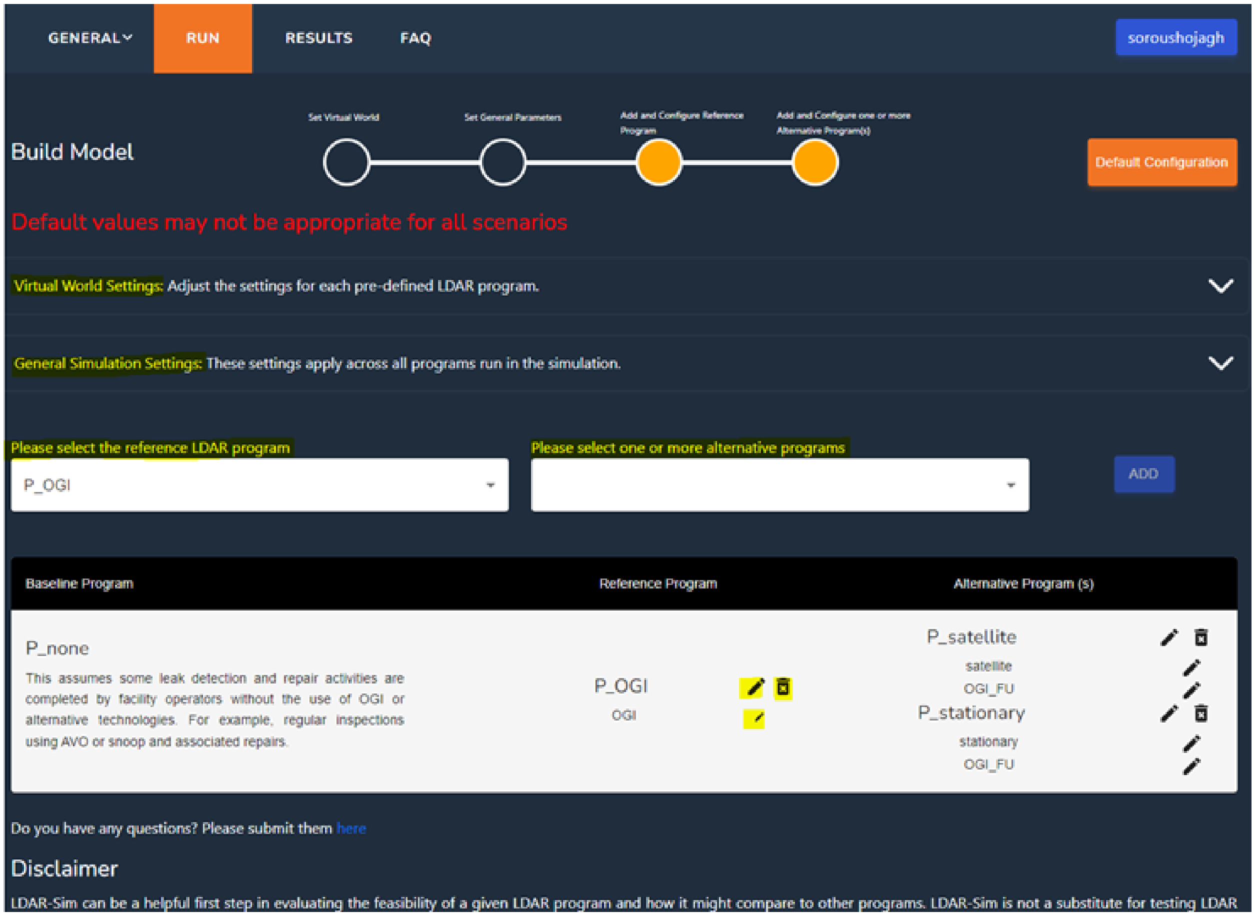
This video walks through the workflow for running a simulation in LDAR-Sim.

Time duration: 7 minutes

Try it by clicking here

Figure 4. *Simulation Instructions page includes video tutorials about the LDAR-Sim Web API.*

The General tab is primarily for introducing users to the LDAR-Sim API, while the Run tab enables users to set up simulation parameters and send simulation requests. In Figure 5, we have highlighted how simulation settings are categorized into four different steps: Virtual World Setting, General Simulation Setting, Reference Program Settings, and Alternative Program Settings. The first expandable category of Virtual World Settings enables users to configure specific virtual world parameters, whereas the second expandable category (i.e., General Simulation Settings) allows them to choose general simulation parameters like the start and end dates. Steps three and four in the simulation setting involve choosing a Reference program and alternative programs. Though the reference program dropdown widget should only include one reference program, users may add one or more alternative programs. Figure 6 shows how users can edit program parameters after adding the program to the table by clicking the Edit icon just beside its name. When the user agrees with the disclaimer and clicks the Run button, a simulation request is sent to the Backend API and simulation results are populated in the Result page as soon as they are prepared.



Build Model

Default values may not be appropriate for all scenarios

Virtual World Settings: Adjust the settings for each pre-defined LDAR program.

General Simulation Settings: These settings apply across all programs run in the simulation.

Please select the reference LDAR program: P_OGI

Please select one or more alternative programs

Baseline Program	Reference Program	Alternative Program (s)
P_none This assumes some leak detection and repair activities are completed by facility operators without the use of OGI or alternative technologies. For example, regular inspections using AVO or snoop and associated repairs.	P_OGI OGI	P_satellite satellite OGI_FU P_stationary stationary OGI_FU

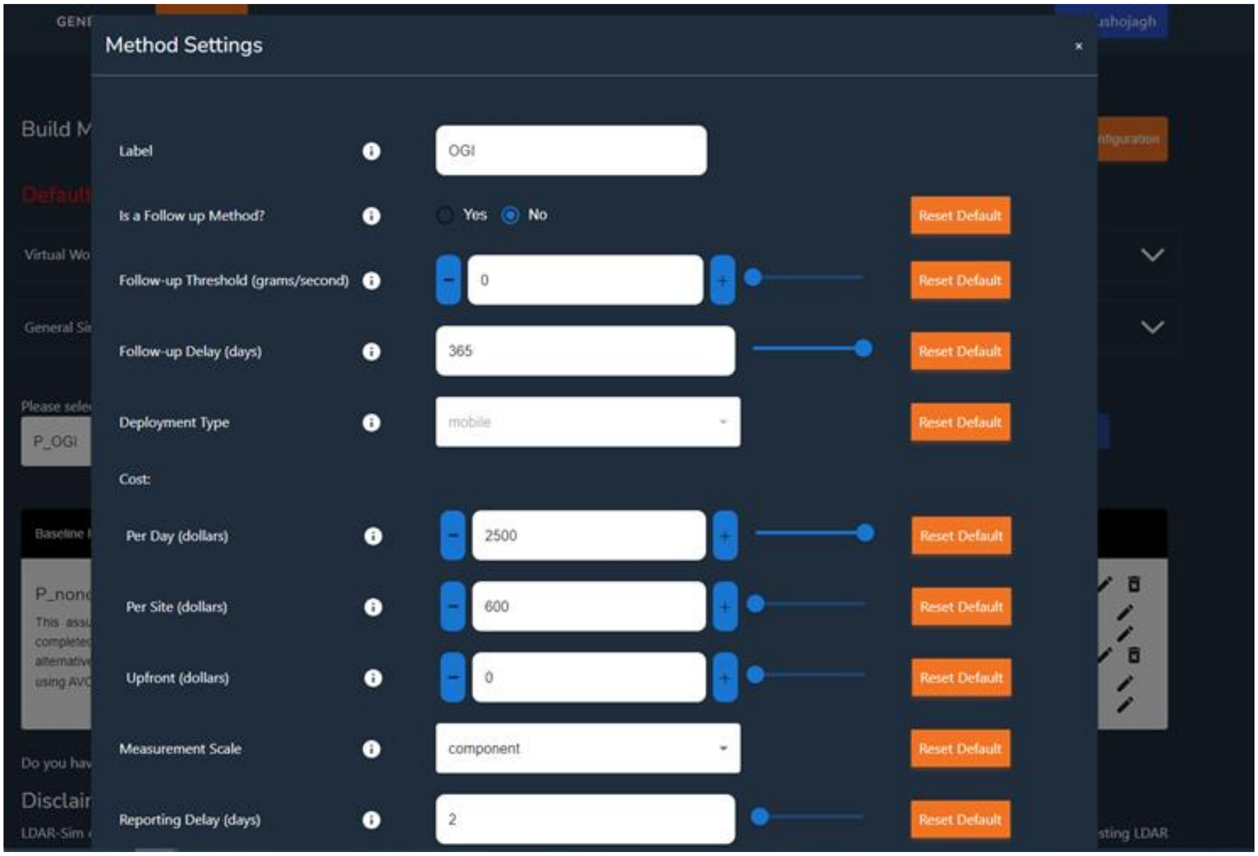
Do you have any questions? Please submit them here

Disclaimer

LDAR-Sim can be a helpful first step in evaluating the feasibility of a given LDAR program and how it might compare to other programs. LDAR-Sim is not a substitute for testing LDAR

Figure 5. *The Run page is the place to set up the simulation parameters and run it.*

On the result page, users can view simulation results and download a report. In Figure 7, the simulation result and all the parameters that have been set for the simulation can be downloaded by clicking the first and second links respectively. Figure 8 shows some of the simulation results on the result page. Finally, the FAQ page (Figure 9) allows users to view frequently asked questions as well as submit questions.



Method Settings

Label: OGI

Is a Follow up Method? ○ Yes ● No

Follow-up Threshold (grams/second): 0

Follow-up Delay (days): 365

Deployment Type: mobile

Cost:

Per Day (dollars): 2500

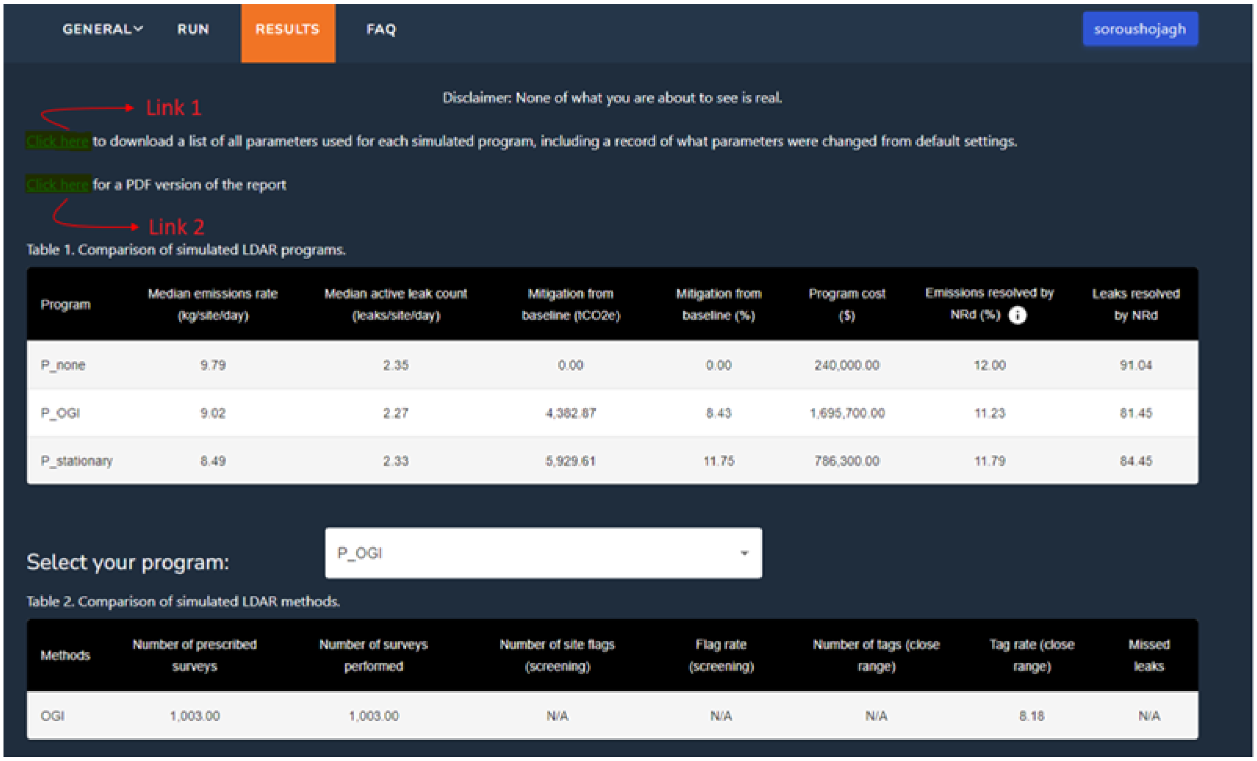
Per Site (dollars): 600

Upfront (dollars): 0

Measurement Scale: component

Reporting Delay (days): 2

__Figure 6.__ Modifying methods' and programs' parameters in the LDAR-Sim simulation request.



Disclaimer: None of what you are about to see is real.

Click here to download a list of all parameters used for each simulated program, including a record of what parameters were changed from default settings.

Click here for a PDF version of the report

Table 1. Comparison of simulated LDAR programs.

Program	Median emissions rate (kg/site/day)	Median active leak count (leaks/site/day)	Mitigation from baseline (tCO2e)	Mitigation from baseline (%)	Program cost ($)	Emissions resolved by NRd (%)	Leaks resolved by NRd
P_none	9.79	2.35	0.00	0.00	240,000.00	12.00	91.04
P_OGI	9.02	2.27	4,382.87	8.43	1,695,700.00	11.23	81.45
P_stationary	8.49	2.33	5,929.61	11.75	786,300.00	11.79	84.45

Select your program: P_OGI

Table 2. Comparison of simulated LDAR methods.

Methods	Number of prescribed surveys	Number of surveys performed	Number of site flags (screening)	Flag rate (screening)	Number of tags (close range)	Tag rate (close range)	Missed leaks
OGI	1,003.00	1,003.00	N/A	N/A	N/A	8.18	N/A

Figure 7. *Download the simulation results and the values that have been set for the simulation.*

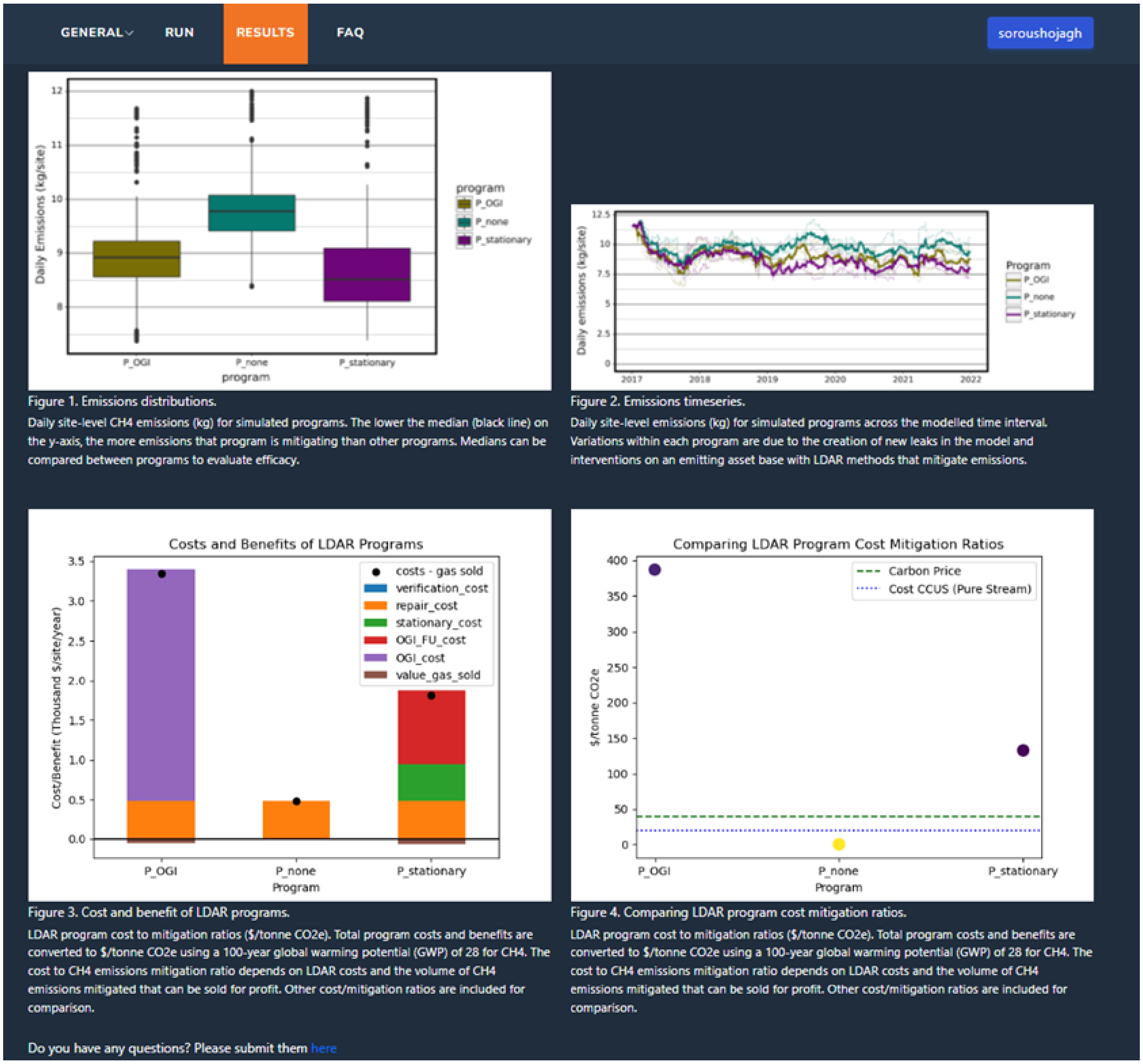


Figure 1. Emissions distributions.

Daily site-level CH4 emissions (kg) for simulated programs. The lower the median (black line) on the y-axis, the more emissions that program is mitigating than other programs. Medians can be compared between programs to evaluate efficacy.

Figure 2. Emissions timeseries.

Daily site-level emissions (kg) for simulated programs across the modelled time interval. Variations within each program are due to the creation of new leaks in the model and interventions on an emitting asset base with LDAR methods that mitigate emissions.

Figure 3. Cost and benefit of LDAR programs.

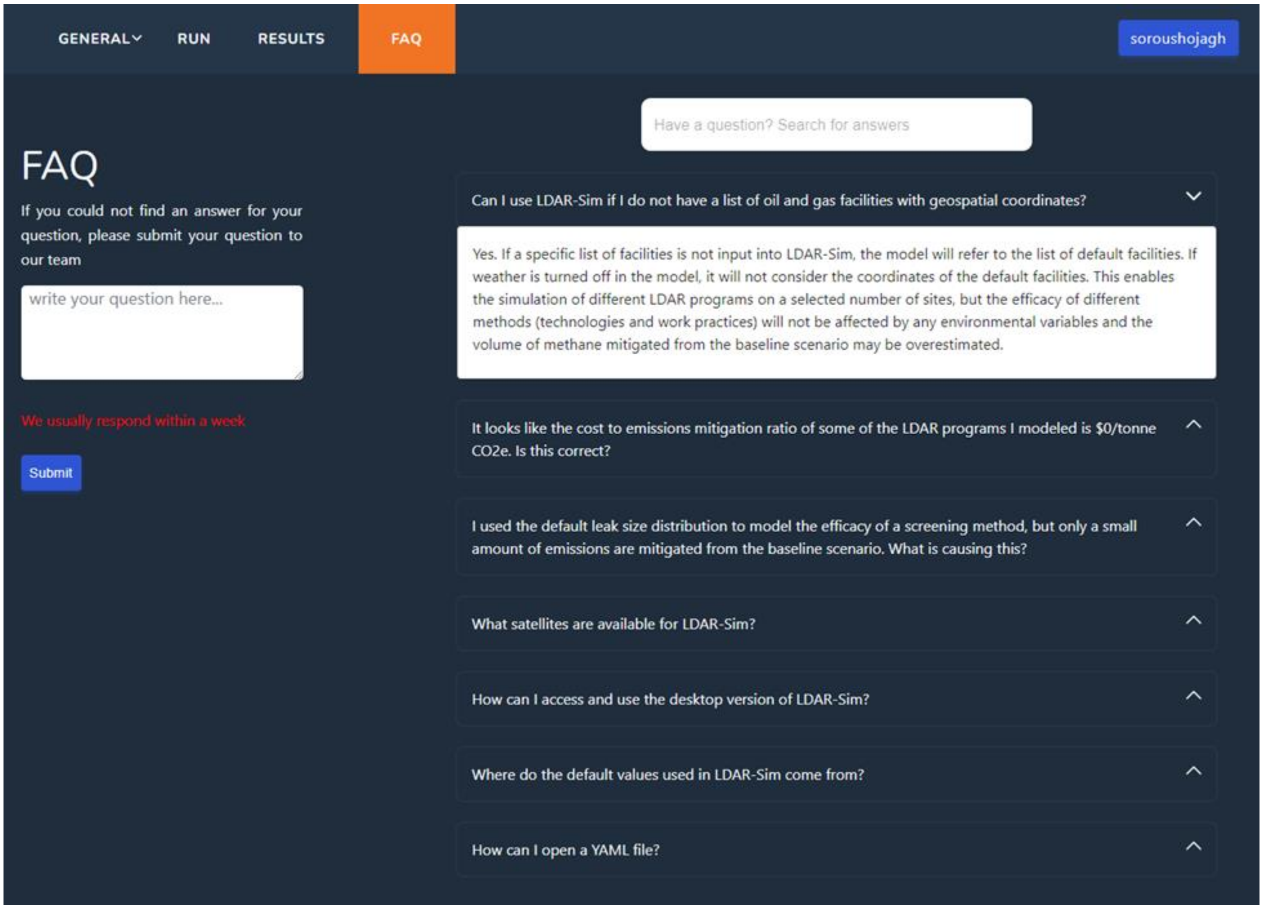
LDAR program cost to mitigation ratios ($/tonne CO2e). Total program costs and benefits are converted to $/tonne CO2e using a 100-year global warming potential (GWP) of 28 for CH4. The cost to CH4 emissions mitigation ratio depends on LDAR costs and the volume of CH4 emissions mitigated that can be sold for profit. Other cost/mitigation ratios are included for comparison.

Figure 4. Comparing LDAR program cost mitigation ratios.

LDAR program cost to mitigation ratios ($/tonne CO2e). Total program costs and benefits are converted to $/tonne CO2e using a 100-year global warming potential (GWP) of 28 for CH4. The cost to CH4 emissions mitigation ratio depends on LDAR costs and the volume of CH4 emissions mitigated that can be sold for profit. Other cost/mitigation ratios are included for comparison.

Do you have any questions? Please submit them here

Figure 8. *A visual representation of the simulation results.*


GENERAL
RUN
RESULTS
FAQ
soroushojagh
Have a question? Search for answers
write your question here...
Submit

FAQ

If you could not find an answer for your question, please submit your question to our team

We usually respond within a week

Can I use LDAR-Sim if I do not have a list of oil and gas facilities with geospatial coordinates?

Yes. If a specific list of facilities is not input into LDAR-Sim, the model will refer to the list of default facilities. If weather is turned off in the model, it will not consider the coordinates of the default facilities. This enables the simulation of different LDAR programs on a selected number of sites, but the efficacy of different methods (technologies and work practices) will not be affected by any environmental variables and the volume of methane mitigated from the baseline scenario may be overestimated.

It looks like the cost to emissions mitigation ratio of some of the LDAR programs I modeled is $0/tonne CO2e. Is this correct?

I used the default leak size distribution to model the efficacy of a screening method, but only a small amount of emissions are mitigated from the baseline scenario. What is causing this?

What satellites are available for LDAR-Sim?

How can I access and use the desktop version of LDAR-Sim?

Where do the default values used in LDAR-Sim come from?

How can I open a YAML file?

Figure 9. *Displaying the FAQ page, which provides answers to frequently asked questions and allows users to submit their own questions*

10. Knowledge Mobilization

10.1. Academic Articles

Vollrath C, Hugenholtz CH, Gao M, Gough T, Fox TA, Barchyn TE. 2022. Comment on the US EPA proposed new source performance standards: Emissions guidelines to reduce methane and other harmful pollution from the oil and natural gas industry (Docket ID No. EPA-HQ-OAR-2021-0317), 20p. https://www.regulations.gov/comment/EPA-HQ-OAR-2021-0317-0747

Shaw K, Fox TA, 2022. Optimizing Deployment of Methane Leak Detection Technologies Using an Open-Source Tool. *Global Energy Show*, Calgary, Alberta.

Fox TA, Hugenholtz CH, Barchyn TE, Gough TR, Gao M, Staples, M, Can new mobile technologies enable fugitive methane reductions from the oil and gas industry? *Environmental Research Letters* 16(6): 064077. https://iopscience.iop.org/article/10.1088/1748-9326/ac0565/pdf

Fox TA, Barchyn TE, Gao M, Jamin Y, Hugenholtz CH. 2021. An agent-based model for estimating emissions reduction equivalence among leak detection and repair programs. *Journal*

of Cleaner Production 282(1): 125237. https://www.sciencedirect.com/science/article/pii/S0959652620352811

Fox TA, Hugenholtz CH, Shaw K, Barchyn TE, Vollrath C, Gao M, Gough T, 2021. LDAR-Sim Version 2: Progress Update on the Intelligent Methane Monitoring and Mitigation System (IM3S). Petroleum Technology Alliance Canada Net Zero & Methane Emissions Reduction Conference, Calgary, Alberta.

10.2. User Manual

IM3S took the documentation from the inputs standard section and expanded it into a user manual. The document lives on the publicly available GitHub page as a Markdown document allowing all versions and revisions of the document to be tracked with each incremental version of LDAR-Sim. The document can be found here and features:

- Project background
- File structure and software setup
- Instructions for running models
- Notes for developers
- Detailed input documentation

12. References

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