


# FINAL OUTCOMES REPORT (NON-CONFIDENTIAL)

## 1.0 PROJECT INFORMATION

<b>1. ERA PROJECT ID #</b>	EE0162576
<b>2. CALL / ROUND</b>	Call #11 Reshaping Energy Systems
<b>3. PROJECT TITLE</b>	Condition Recognition Wireless Network
<b>4. COMPANY NAME</b>	CRWN.ai
<b>5. PROJECT TYPE</b> (R&D, Development, Demonstration, Implementation)	Demonstration
<b>6. LOCATION</b> (primary location the project took place by address, land description, or GPS coordinates)	Alberta
<b>7. PROJECT START DATE</b>	Mar 1 2024
<b>8. PROJECT COMPLETION DATE</b>	Feb 29 2025
<b>9. TECHNOLOGY READINESS LEVEL (TRL) AT PROJECT INITIATION</b>	TRL 7
<b>10. <a href="#">TRL AT PROJECT COMPLETION</a></b>	TRL 7
<b>11. JOBS CREATED</b>	Net New 3
<b>12. GHG EMISSIONS REDUCED</b> (Project-level: annual, cumulatively by 2030 and by 2050)	
<b>13. TOTAL ERA FUNDING</b>	\$785,000
<b>14. TOTAL PROJECT VALUE</b>	\$1,647,140.17
<b>15. ERA PROJECT ADVISOR</b>	Danielle Parent
<b>16. SUBMISSION DATE</b>	March 30
<b>17. KEY PROJECT CONTACT NAME AND EMAIL</b>	Brittany Courvoisier-Nicol Brittany.nicol@crwn.ai

<p><b>18. QUOTE</b> (why was ERA a pivotal funder for this project? How did ERA funding help advance on the TRL scale? Etc.)</p>	<p>Utilities are typically extremely risk adverse.</p>
<p><b>19. NOTABLE COMMUNICATIONS</b></p>	<p><a href="https://www.youtube.com/watch?v=sXSG08R0rk&amp;t=2s">https://www.youtube.com/watch?v=sXSG08R0rk&amp;t=2s</a></p>
<p><b>20. IMAGE</b> (please insert or link a photo capturing the technology for ERA publications)</p>	

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## 5.0 EXECUTIVE SUMMARY

The CRWN project, supported through the ERA initiative, set out to revolutionize how utilities monitor and manage electrical leakage on transmission lines — a largely invisible issue that results in product loss, equipment failure, wildfire risk, and unnecessary GHG emissions. Over a 1+ year pilot, with \$1.5M in funding and deployment of 100 devices, CRWN developed and deployed an innovative pre-commercial system ("Cricket") that uses real-time sensing technologies to detect unwanted electrical discharge at the power pole level.

The CRWN system leverages a combination of radio frequency and ultrasound sensors to detect different types of electrical discharges, including corona, surface tracking, and arcing. These are critical indicators of compromised insulators and deteriorating line conditions, which historically have been difficult for utilities to quantify or locate accurately. By applying machine learning to the sensor data, CRWN enables utilities to make proactive, data-driven maintenance decisions, reducing outages and improving the reliability of the grid.

This technology is a game changer because it provides real-time, field-level insights, where traditionally, utilities relied on sparse, weather-dependent estimations over large segments of their networks. CRWN's system closes this data gap, allowing utilities to target interventions (like insulator washing or replacement) and directly quantify both cost and emissions savings — something previously not possible. For example, CRWN found that for a single degraded structure, approximately 50 watts of power are lost annually, equating to \$93.78 in lost energy and 0.714 t of CO<sub>2</sub>e. Extrapolated, a small utility with 5% degraded insulators could save nearly **7,130 tonnes of CO<sub>2</sub>e over 20 years**, alongside significant cost recovery (~\$937,800).

In real world conditions over cold, mild, and hot weather seasons, the worst 9% of structures were seen to have 3.04 watts of preventable leakage, equating to \$15 of lost product and 0.113 tonnes of CO<sub>2</sub>e each year. While actual savings were lower than projections due to limited data capture (partly from extreme winter conditions impacting hardware, partly also due to monitoring relatively healthy insulators), the system demonstrated strong survivability and high customer value, with 94 of 100 devices still operational. Utilities expressed enthusiasm, noting CRWN's ability to define new engineering standards and justify maintenance investments with quantitative data.

Beyond GHG reduction, the project addresses wildfire prevention — a critical issue, as line faults have been linked to major fires such as the Camp Fire (California) and recent events in Maui. By detecting and predicting defect conditions that lead to fires, CRWN supports utilities in reducing environmental risks and improving public safety.

Looking forward, CRWN is refining its system for commercial readiness by enhancing sampling rates, improving hardware ruggedness, and expanding deployments with major utilities like AltaLink, National Grid, and BC Hydro. With its future commercial product, *PULSE*, CRWN aims to scale this solution, delivering a powerful tool for grid modernization, operational efficiency, and substantial GHG emissions reductions.

## 6.0 PROJECT DESCRIPTION

### 6.1 INTRODUCTION

The focus of the project is the implementation of CRWN (Condition Recognition Wireless Network), a technology that provides continuous, real-time monitoring of transmission line defects using IoT (Internet of Things) devices. The CRWN system utilizes AI-driven ultrasonic sensors mounted on transmission line structures to detect and classify defects related to electrical discharge, which contribute to power transmission inefficiencies and wildfire risks. Unlike traditional inspection methods, which are infrequent and costly, CRWN operates autonomously, offering utilities improved situational awareness of critical infrastructure. By identifying areas of excessive electrical leakage, CRWN enables proactive maintenance, reducing power losses, minimizing emissions, and mitigating wildfire risks, ultimately enhancing the reliability and efficiency of Alberta’s power transmission system.

The core of the CRWN system is the monitoring device, a ruggedized, self-contained unit designed for long-term deployment on electrical infrastructure. As detailed in the following figure,

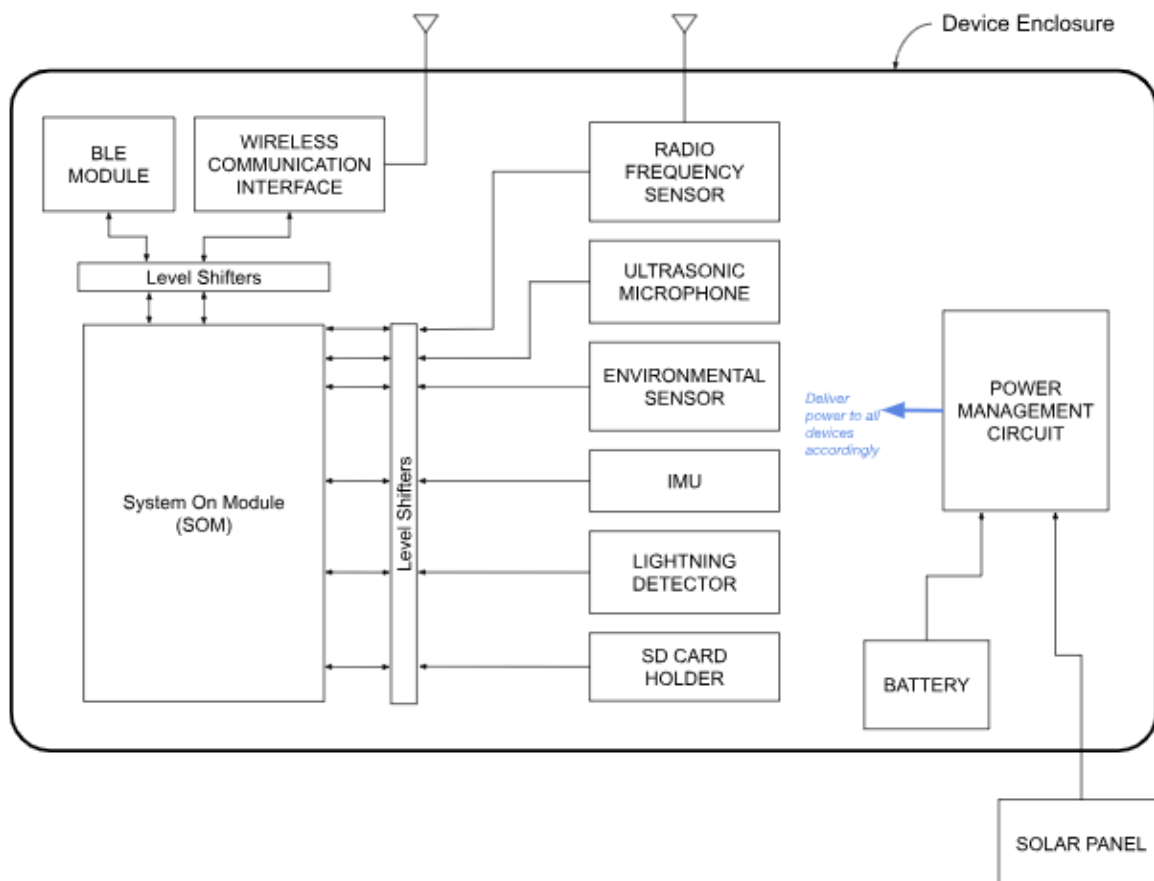


Figure 1. Overview of embedded system of Cricket 1.0 & 1.2 (patent pending)

Each device integrates a primary sensor suite consisting of two key sensors: an ultrasonic microphone and a radiofrequency (RF) sensor. This dual-sensor, or "sensor fusion," design allows the system to cross-validate signals and reduce false positives. The primary suite is augmented by an array of secondary sensors, including an environmental sensor (for temperature, humidity, and pressure), an inertial measurement unit (IMU) sensor to monitor structural integrity, and a low-power, always-on lightning detection sensor for capturing critical transient arc/flashover events. All data acquisition and on-board processing are handled by an integrated system-on-module (SoM).

The system's operational process follows a clear architectural flow, which enables efficient data analysis from the edge to a central dashboard. See the following figure,

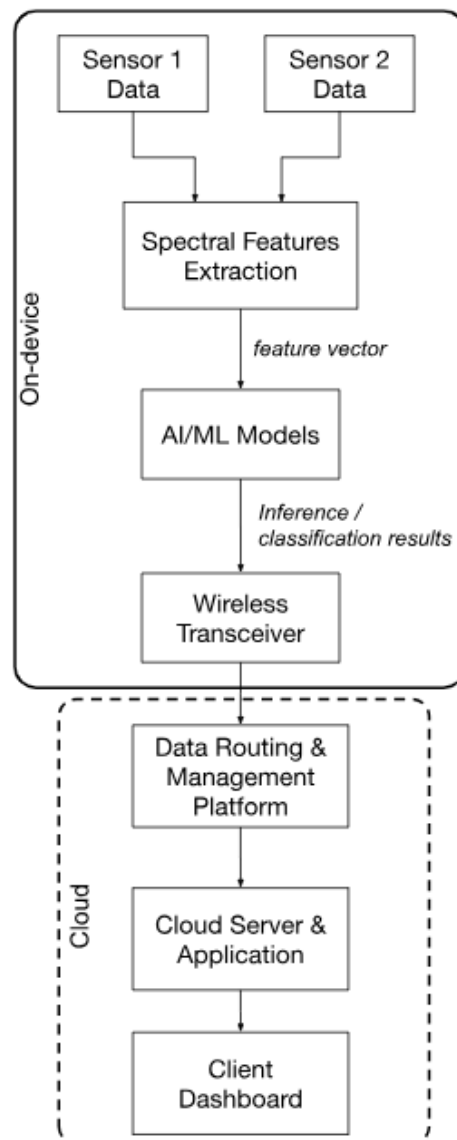


Figure 2. Overview of the systems operational process from on-device to cloud (patent pending)

The process is as follows,

1. The device simultaneously captures data streams from the ultrasonic and RF sensors, creating a correlated, multi-modal snapshot of any potential discharge event.
2. The device's application processor immediately performs pre-processing on the raw sensor data. It uses Digital Signal Processing (DSP) algorithms to filter noise and extract the most relevant characteristics, or "features," from the signals, creating compact feature vectors.
3. These feature vectors are analyzed by a trained Machine Learning (ML) model to classify the condition of the asset (e.g., 'normal operation,' 'corona,' 'partial discharge'). This classification can happen directly on the device for immediate alerts, or the feature vectors can be transmitted to a central cloud server for more computationally intensive analysis.
4. Data and classifications from the entire network of deployed devices are aggregated on a central server. This powers a dashboard that provides a system-wide overview of infrastructure health, identifies long-term trends, enabling proactive and data-driven asset management.

Here is a look at our client dashboard, which uses representative data for demonstration purposes to protect customer privacy.

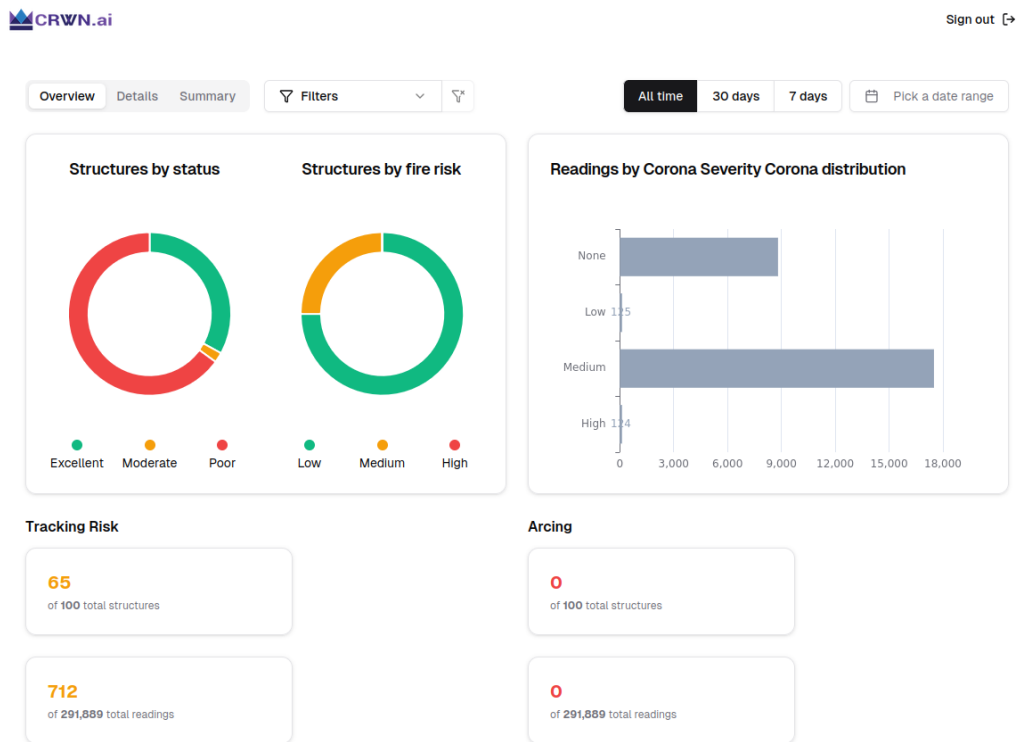


Figure 3. The client dashboard displays simulated representative data to maintain customer data privacy and compliance

## 6.2 BACKGROUND OF THE PROJECT

Utilities are facing a number of challenges with the push to move away from fossil fuels for power generation, to mitigate wildfire risk, to maintain line uptime for their customers and to keep these costs within budget.

Extreme Electrical Discharge is a phenomenon that causes product loss, contributes to wildfire risk and can cost utilities an extraordinary amount of money as they deploy various mitigation measures to increase customer uptime, and maintain transmission line assets.

The industry currently has no cost-effective way to monitor transmission lines in real time, so detailed inspections are limited to once every 8 years. Because inspections are so infrequent, efficiency losses and deteriorating equipment that is at high risk of causing a wildfire may go undetected and unmitigated for years.

[CRWN](#) was conceptualized in TerraSense Analytics, who at the time, monitored forestry in remote areas using computer vision. After discovering that funding was scarce in forestry, TerraSense pivoted quickly to look at opportunities to monitor additional remote assets, including Transmission lines. The product was conceptualized by Jozsef Hamari whose brother worked as a linesman on transmission lines. Since then, CRWN has worked with Utilities in 7 different deployments. Eventually, CRWN spun out as its own company, [CRWN.ai](#) to maintain velocity as TerraSense Analytics focuses heavily in defense. TerraSense Analytics and [CRWN.ai](#) are sister companies and work together closely in an advisory sense but for all intent and purpose are separate on paper. Since the split, CRWN has been a part of the EPRI (Electric Power Research Institute) Innovate program, whose focus was bringing quick pilots into the Utility space. Additionally, CRWN was recently accepted into the Joules Accelerator program, with a focus on providing warm introductions into Utilities in the Southern states. At the end of the ERA project, CRWN was also awarded a \$1.5M project in partnership with NorthX (formerly CICE) and Powertech to study the patterns and trends that lead to degradation of assets in a lab setting, effectively advancing CRWN's capabilities from situational awareness to prediction.

The CRWN team consisted of 6 employees from TerraSense, all of whom had worked together for approximately 3 years prior in TerraSense. Before the ERA project kicked off Jordan Edwards, a software and ML lead was hired to manage the team. As well, Henry Kroker, a hardware engineer, was hired to design proof of concept (POC) devices. During the project Neutron Her, a former employee from Lomi, was hired as a hardware lead. Neutron's role at Lomi was to go from design to product launch with a countertop kitchen composter. Lomi is now in over 200,000 homes globally. Neutron has successfully supported the ERA project to make incremental improvements on the pre-commercial devices, which we see out in the field now, as well as use that information and feedback from the field deployments to design the commercial device, PULSE.

After project completion the decision was made to continue the project outside of ERA's timeline to continue monitoring degrading insulators. This project is expected to complete one year after the first deployment in September 2025.

The project with ERA was meant to focus on electrical leakage, which is caused by dirty or damaged insulators. This can be only discovered with visual inspection. However, upon working with the Utility it was understood that electrical leakage ranked low on their list of priorities as insulators were causing pole fires and the only mitigation solution was walking the lines to discover burn marks on the pole. CRWN worked with the Utility to focus heavily on tracking insulators to understand and identify tracking insulator risks to prevent wildfires. Although leakage models were still deployed, the emphasis from the Utility was that it was not electrical leakage that mattered, but instead the wildfire risk associated with tracking insulators and the ability to identify those remotely.

### 6.3 PROJECT OBJECTIVES

The following were the goals and objectives of the project:

1. *Showing that CRWN can detect, categorize and localize different types of electrical discharge in real time.*

CRWN achieved this through identifying different types of corona, surface discharge (indicative of tracking) and arcing. Both corona and surface discharge were detected in the field, but arcing was not. Arcing is a rare occurrence and a high alert situation, so it is not surprising that it was not detected in the field.

2. *Showing that CRWN can work without an operator for a significant amount of time through different seasonalities, temperatures and humidity*

CRWN devices were deployed through all seasonality, starting in September. All devices were equipped with their own environmental sensors to understand trends and patterns that affect electrical discharge.

3. *Showing that CRWN can be commercially viable by deploying it on a significant section of transmission line (~50 km or greater) with limited access to LTE or Satellite.*

CRWN worked to deploy 100 devices monitoring approximately 10 km in line in total. This did not meet 50km but this was due to the poles being closer together than originally anticipated (6/km vs 2/km). These sites were identified as problematic by the Utility due to their age and the fact that they were on wooden poles

4. *Discovering data trends so that CRWN can start to predict high risk events such as arcing or tracking, reducing wildfires*

CRWN has discovered that different seasonality, temperature and pressure affect surface discharge events which indicate tracking. This matches the research, but as there is no device out there like CRWN, detecting electrical discharge in real time, this is the first data set of its kind. The trends also match what the Utility is experiencing with most pole fires occurring in the

spring. Although CRWN has not yet seen an insulator fail, the data that CRWN found with more electrical discharge activity in the spring, matched the experience of the Utility,

5. *Understanding the real life impact of electrical discharge and line inefficiencies.*

Upon working with the Utility, it was discovered that surface discharge leads to tracking which leads to wildfires. Currently there is no way to detect tracking insulators besides seeing once they fail and catch the pole on fire. This is only discovered either by the public calling it in, or by visual inspection, noticing burn marks. CRWN’s vision is to be able to use the field data collected, corroborate it with research and then use partnerships with Powertech to enable accurate prediction models to ensure that insulators can be changed out before that first spark, both reducing liability for the Utility and decreasing wildfires across the world.

6.4 PERFORMANCE/SUCCESS METRICS IDENTIFIED IN THE CONTRIBUTION AGREEMENT

**Table 1. Performance Metrics Summary Table**

Success Metric	Commercializati on target	Project Target	Project Actual	Achievements to date
<b>Uptime</b>	> 95%	> 80%	<p>“Crickets” &gt;=70%</p> <p>LoRA WAN gateways &gt;=44%</p> <p>The conditions of the two deployments differed significantly from previous deployments. Devices were deployed in the winter and were subject to night time low temperatures of up to -30 degrees Celsius. The CRWN designed and assembled “Cricket” devices that house ultrasonic and RF sensors performed better than expected given the impact of these low negative temperatures on battery power systems. The Gateways that CRWN procured from third-party vendors performed much worse than the Crickets in these conditions.</p>	85% at lab scale

			They were expected to outperform CRWN’s hardware due to the robustness of their battery system. Instead, they demonstrated the success of CRWN’s power system design relative to this particular example of commercial grade power systems for edge IoT devices.	
<b>Device failure</b>	< 5%	< 40%	5% Failure modes will be determined when deployed devices are decommissioned.	50%
<b>Successful Deployment on Lower Voltage lines</b>	>=138kV	< 138kV	CRWN successfully deployed on 138kV lines	230kV
<b>Logging into interface to access data</b>	Daily	Quarterly	Bi- weekly. Target was met.	After each pilot, Utilities are presented with results through a slide deck. There is currently no interface for log in.

6.5 PROJECT CHANGES

The actual project and project deliverables to ERA did not change, except for shifts in deployments due to scheduling. With that being said, new discoveries were made with the Utility. Originally the project was focused on corona and electrical leakage, but the Utility indicated early on that they were not concerned about leakage, but instead with tracking insulators, a known fire risk. Although CRWN still delivered leakage values to the project it was clear that customer focus was on detecting degrading (tracking) insulators and associating wildfire risk to those and each Quarterly business review was focused on delivering value to the customer based on field data and insulator degradation and patterns.

## 6.6 TECHNOLOGY RISKS

- Lack of data currently available for machine learning training on high-risk defects and the cost of acquisition is high. Our efforts have been focused on securing a partnership with a high voltage laboratory testing to expand our dataset and train our machine learning algorithms.
- Significant shortages and lack of availability of hardware components, delaying or requiring redesign of the CRWN infrastructure. CRWN has taken active steps to ensure the hardware design has been around components that are readily available. CRWN's latest hardware designs are integrating the most readily available components for our manufacturing partners.
- CRWN has restricted and infrequent access to power lines as highly trained individuals must be involved for safety reasons which means that testing and iteration is slower and more difficult. An important part of this field test and pilot is the participation and buy-in of the Utility. CRWN was unable to field test without Utility cooperation. However, we have identified diagnostic equipment and implemented tools directly into our own solution that allow us to partially verify that the conditions that CRWN's devices are predicting match the actual conditions on each insulator.
- The CRWN system fails at scale in the field and consequently the devices must be replaced at a high cost. CRWN hired a hardware specialist with 30 years of experience and a specialized focus on testing, and this resulted in devices that survived both the extreme summer and winter conditions. We intended to keep failures to a minimum by having multiple deployments and time in between to redesign any problem subsystems, but ultimately, based on the learnings of previous prototypes in prior deployments, there were zero CRWN-designed device failures.
- One challenge that did emerge that was previously unidentified was the failure of gateway devices used to transmit data back from CRWN-designed devices to the cloud-based database. Specifically, the gateways chosen did not perform as expected according to their specifications, and struggled to stay operational in the cold winter months. CRWN was able to manage the situation by hiring an individual near the deployment sites to inspect the gateways and provide some remote course correction.

## 7.0 PROJECT WORK COMPLETED AND OUTCOMES

### 7.1 METHODOLOGY

#### Data Collection

- Reference data was collected in a laboratory
- A hall sensor was used to measure current drawn from the high potential test energy source and logged for each combination of voltage, insulator material, insulator condition and insulator contamination.
- Radio frequency (RF) and ultrasound signals were captured from the insulator test protocols using the Cricket 1.2 system.

## Test Protocols

- A range of insulator types, conditions of damage and contamination were tested in the laboratory at realistic transmission line voltages using a ramp up from 0 to 100kV over 10 minutes. Since no engineering standards exist for partial discharge on decommissioned transmission line insulators, the methods were adapted from “Radio Interference Voltage” tests.
- Insulator materials tested were glass and ceramic “bell”-type insulators.
- In addition to baseline tests on intact, uncontaminated insulators:
  - One group of Insulators was contaminated using Kaolin clay to simulate the accumulation of contaminants on the bell surface
  - Another group of ceramic insulators were damaged, removing approximately 10, 25 and 50% of insulator material
  - Intact, uncontaminated insulators were also subjected to moisture contamination from a constant water source across the surface of the bells.
  - Combinations of material, damage and contamination were tested at voltages between 0 and 110kV in 10 kv increments to produce a range of partial discharge types and magnitudes
  - ASTM D2303 “inclined plane” test was adapted to produce surface discharge across a ceramic medium.

## Statistics and Modelling

- Statistical features were calculated that described the RF and ultrasound signals
- Statistical features of RF and ultrasound signals were used to group the data from all test protocols into clusters with similar signals.
- A convolutional neural network (CNN) was trained to classify new signals by their similarity to the partial discharge groups determined by the clustering exercise above.

## Groundtruthing

- Ground truthing validation was performed using the ii900 imager and an Ofil Luminar UV camera to precisely diagnose the presence and location of PD on the transmission line infrastructure.
- Stratified random sampling was used to target insulators on the Cricket deployments that showed significant PD in the Cricket telemetry, as well as a random control set.

## 7.2 TECHNOLOGY DEVELOPMENT

CRWN deployed Cricket 1.0 on 30 poles on the first line in September of 2024 and Cricket 1.2 on 70 poles on the second line in December of 2024. These lines were chosen because they are representative of a range of insulator types, manufacturers and ages, and in a range of conditions. This allowed CRWN

to compare data from two different populations and evaluate system design and model improvements iteratively while answering the utilities questions regarding two different pieces of infrastructure. Cricket 1.2 includes several technological improvements that are described below. These included improvements to both the power system and the ML implementation both on-device and in the cloud. The time between deployments allowed significant improvements to be made to the Cricket power system, as well as time for the team to work with the first deployment data, identify trends and posit hypotheses before the second deployment.

### 7.2.1 SOLAR & BATTERY MONITORING

See Fig 4 & 5 for hardware flow diagrams of the power distribution system of both Cricket 1.0 and Cricket 1.2 respectively.

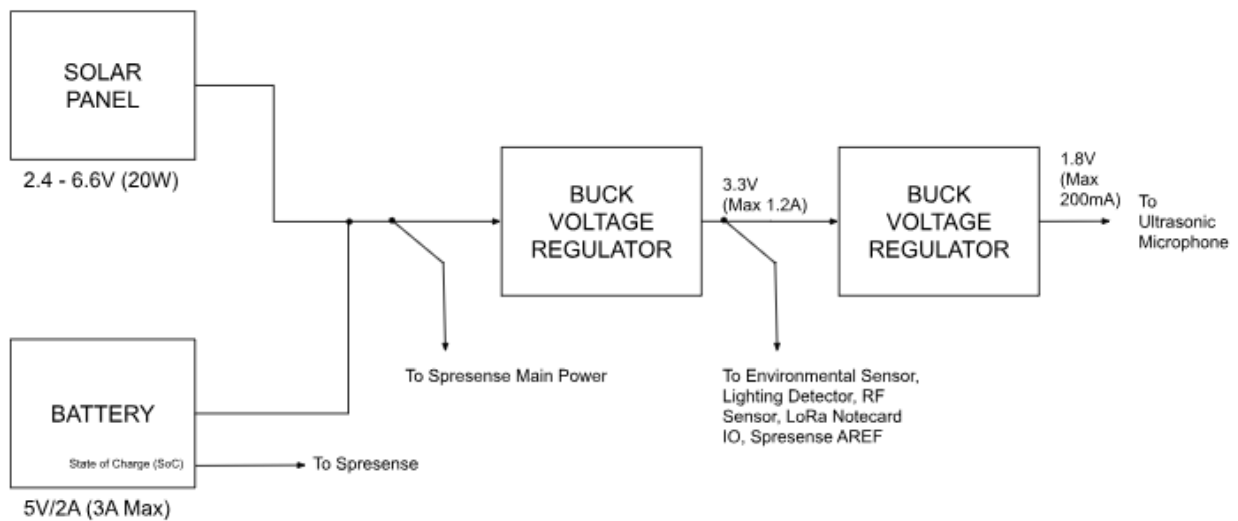


Figure 4. Flow diagram of Cricket 1.0 hardware power distribution system

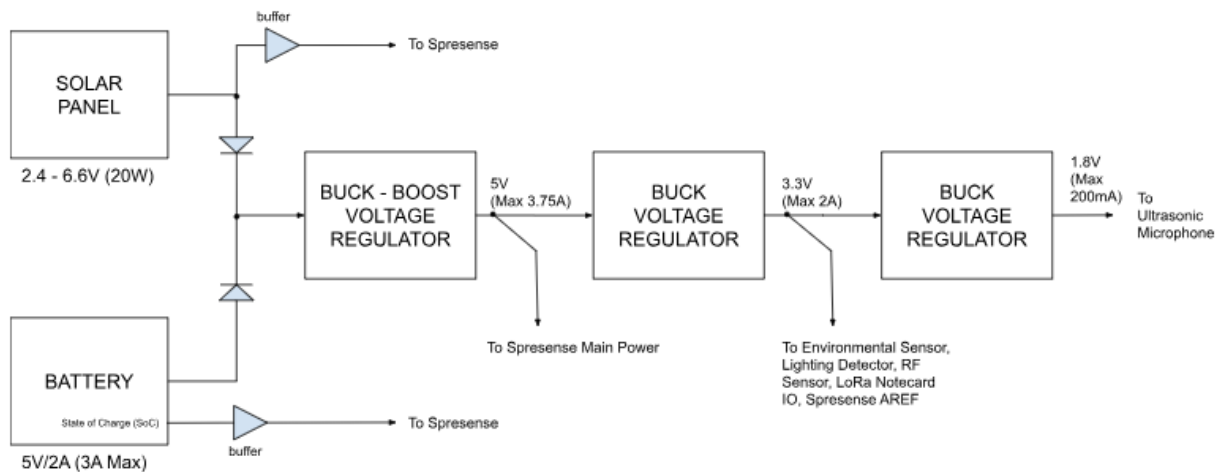


Figure 5. Flow diagram of Cricket 1.2 hardware power distribution system

## 7.2.2 SOLAR MONITORING

These improvements enabled CRWN to reliably monitor voltage at the solar panel output.

1. The solar panel output is fed through a voltage divider, and then through an op amp buffer before feeding it directly into an ADC input pin of the SoM.
2. We added in a diode along the solar output voltage path to the Buck-Boost voltage regulator to ensure the battery output voltage does not affect the solar output voltage reading.

### KEY BENEFIT & USE CASES

The following hardware improvements enable users to reliably monitor the voltage output of the solar panel. This solar panel voltage will be reported back to the centralized server, and can be used in the following ways:

- 1. Seasonal Performance Trends**
  - Analyze how solar voltage output varies across seasons (e.g., summer vs. winter) to understand the effects of weather, day length, and solar angle
  - Detect gradual decreases in solar output that could indicate panel degradation or performance issues.
- 2. Predictive Maintenance**
  - Flag anomalies such as sudden drops in output, which might indicate dirt, damage, or shading issues.
  - Correlate solar output with charging cycles and battery health to optimize replacement schedules.
- 3. Geographic Optimization**
  - If devices are deployed across multiple locations, compare solar performance to select optimal sites for future installations.
  - Identify areas prone to low solar availability, guiding decisions on supplemental power or hardware adjustments.
- 4. Power Budget Optimization**
  - Adjust device features or operating modes based on available solar power, ensuring critical functions (e.g., PD monitoring) always remain active.
  - Use daily trends to determine the best times to run power-intensive features like data transmissions.
- 5. Energy Efficiency Reporting**
  - Provide stakeholders with data demonstrating the efficiency and sustainability of solar-powered devices over a long period.
  - If applicable, use data for environmental reporting or to meet renewable energy usage mandates.
- 6. Impact of Environmental Factors**

- Identify trends caused by temporary or permanent shading (e.g., from vegetation growth, snow, or debris).
  - Correlate solar performance with weather events like heavy snowfall, rain, or overcast days to assess operational resiliency.
- 7. System Design Refinement**
- Evaluate whether the solar panel size is optimal for year-round operation or requires adjustments for specific regions or seasons.
  - Use data to determine if the battery capacity is sufficient or over-engineered for solar input patterns.
- 8. Educational and Marketing Opportunities**
- Share data on solar energy production to highlight sustainability efforts and the impact of renewable energy on grid monitoring technology.
  - Develop case studies showcasing how the devices perform under varying environmental conditions, enhancing credibility and marketability.
- 9. Validation of Simulation Models**
- Develop case studies showcasing how the devices perform under varying environmental conditions, enhancing credibility and marketability.

### 7.2.3 BATTERY MONITORING

An op-amp buffer in a unity gain configuration (voltage follower) was added to the battery's SoC output. This provides a low output impedance, isolating the signal source from the ADC input (on the SoM). By doing so, we prevent variations in the ADC's input impedance or sampling behavior from affecting the original signal source.

#### KEY BENEFIT & USE CASES

- 1. Enhanced Device Uptime**
- Reliable SoC monitoring ensures timely alerts for low battery levels, preventing unexpected device shutdowns.
  - Enables dynamic adjustment of power-intensive features to extend operational runtime during low charge conditions.
- 2. Improved Maintenance Planning**
- Identify battery degradation trends over time to schedule replacements before failures occur.
  - Provide actionable data on power consumption patterns to optimize maintenance schedules.
- 3. Data-Driven Design Improvements**
- Use SoC data to evaluate whether the battery capacity is suitable for the application's needs.
  - Identify regions or conditions where additional energy storage or solar input may be required.

#### 4. Optimized Power Usage

- Use accurate SoC data to prioritize critical functions when power is limited.
- Adjust data transmission and other energy-consuming activities to times when sufficient charge is available.

##### 7.2.4 RESTART

A restart feature was added to the Cricket 1.2 design. This function performs a complete system shutdown by electrically disconnecting power from the device for 15 seconds. During this time, the device remains completely powered off. After the 15-second interval, power is restored, and the system reboots as if it were freshly powered on, reinitializing all system components and settings.

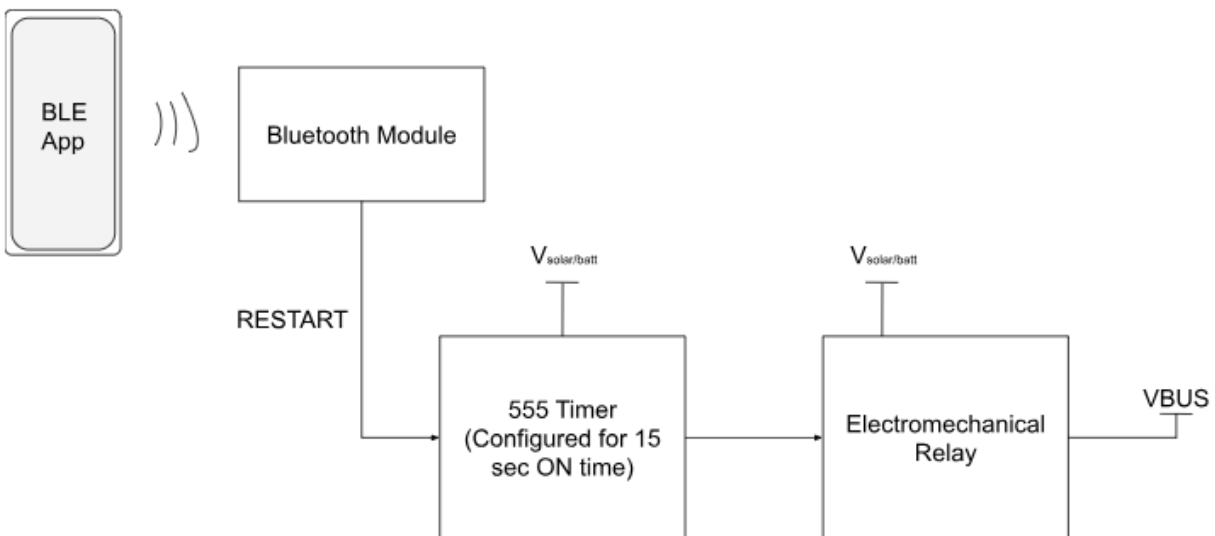


Figure 6. Simplified hardware low diagram of the 'Restart' feature

Key Features of this design are,

1. The 555 Timer and the electromechanical relay are powered directly by the battery and solar voltage outputs, ensuring they remain operational regardless of the system voltage (VBUS)
2. To initiate the '**Restart**' process, a command is sent via a smartphone app to the on-board Bluetooth module over Bluetooth. Upon receiving the command, the Bluetooth module outputs a digital 'Restart' signal, triggering the 555 Timer to activate. During this time, the 555 Timer energizes the electromechanical relay, which temporarily disconnects VBUS power by activating an internal solenoid. This action effectively powers down the system, including the SoM and all onboard modules, for the duration that the 555 Timer is active. In our case, 15 seconds.

## KEY BENEFIT & USE CASES

### 1. System Recovery From Faults

- Provides a reliable method to recover the device from software or hardware lockups by performing a complete power cycle.
- Clears transient errors or misconfigurations by reinitializing all system components.

### 2. Improved Reliability

- Ensures that the system reboots with a clean slate, reloading all firmware and hardware configurations.
- Enhances overall device reliability by addressing potential performance degradation over time without requiring manual resets.

### 3. Remote Troubleshooting

- Allows remote power cycling of the device via Bluetooth, eliminating the need for physical access to perform a manual reset.
- Reduces downtime and maintenance costs, especially in remote or hard-to-reach locations

## 7.2.5 MACHINE LEARNING

- Importantly, Cricket 1.2 has more advanced models for determining both what partial discharge phenomena is expressed at each pole and how much leakage is occurring. Additionally, there were several ruggedization improvements made, and refinements intended to speed up the process of manufacturing the devices.
- The development of these new models was made possible by CRWN's investigation into leakage, which required new features be determined to accurately model the tracking phenomena. After testing dozens of different feature combinations with many different model architectures, CRWN discovered relationships between the relative amount of energy expressed in different acoustic frequency ranges and what kind of partial discharge occurred, as well as how much leakage was expressed. Fascinatingly, how much leakage occurred, on average, was not always cleanly tied to the kind of partial discharge that presented.
- Data collected for training these models occurred prior to device deployment, in acoustic conditions similar to the intended target locations under careful observation. Exactly which partial discharge phenomena occurred during each data collection was determined through the use of a Fluke ii900 Ultrasonic Imager. This device, using an array of its own ultrasonic sensors, is able to show important information about the frequencies present during partial discharge useful in differentiating corona from surface discharge, as well as estimate approximately where target frequencies are being emitted from the hardware under test.
- After deployment, observational data is transmitted from each Cricket back to cloud services under CRWNs control. Observational data includes environmental conditions (temperature, humidity, pressure, solar levels) as well as model predictions for whether corona or surface

discharge was present and how much leakage occurred. Additionally, the features used as model inputs are also sent back and stored for further analysis and verification.

- Several different techniques had to be leveraged to ensure the validity of Cricket’s predictions, each targeting a different aspect of CRWN’s predictive capability. For instance, determining the validity of CRWN’s approach to identifying surface discharge is accomplished by first understanding how partial discharge should present in various environmental conditions, choosing statistically testable hypotheses, and performing the corresponding statistical tests. In particular, there are four key hypotheses CRWN chose to investigate: (a) surface discharge is less likely in very cold and humid condition, (b) surface discharge is more likely near freezing temperatures, (c) surface discharge is less likely when mild, and (d) surface discharge is less likely in low humidity. By taking all of the historical data collected from the Cricket devices, statistical tests verify with a high amount of power hypotheses (b), (c), and (d). There was not enough data collected in cold and humid enough conditions to verify (a).
- CRWN’s corona detection capabilities are verified in multiple ways. Corona, unlike surface discharge, can be visually confirmed through the use of specialized cameras that measure and separate photons emitted in the UV spectrum from those that are visible. This allows accurate localization of emitted corona on high-voltage hardware. Using such a “corona camera”, CRWN was able to check different poles for levels of corona and verify that the predictions made by the models matched this industry recognized tool. More rigorously, CRWN was able to perform similar hypothesis based testing for corona behavior. Specifically, CRWN expects corona to significantly increase with warmer temperatures, due to warmer temperatures causing atmospheric expansion and decreasing air density, resulting in fewer nearby molecules to ionize (and therefore reducing the amount of energy required to do so). Statistically, corona is more likely to occur above 2°C (T statistic 27.841,  $p < 0.001$ ) and we see an increasing trend for corona above -12°C (R-squared 0.536,  $p < 0.001$ ).
- No arcs have been detected for either deployment. Inspection of the insulators in question shows no condition-based reasons to expect arcing.
- Since CRWN is not able to measure leakage on live infrastructure, verifying the leakage estimates produced by CRWN was done during model creation using reserved test data. In particular, the median absolute percentage error was chosen as a robust metric for measuring test data accuracy. CRWN’s models achieved 12% median absolute percentage error.
- Model updates are made possible through the Cortex system, the cloud-based prediction software CRWN has built, which processes the features returned as part of the observational data. Additionally, firmware updates over the air allows for updating of feature sets on already deployed devices.

	Group 1			Group 2		
	Condition	n	Rate	n	Rate	
Surface discharge is less likely when frozen.	$T \leq -20^{\circ}\text{C}, H > 34\%$	140	4.05%	51,871	1.51%	$t = 25.662$ $p = 1.000$
Surface discharge is more likely near freezing.	$-12 \leq T \leq 5^{\circ}\text{C}$	15,149	3.06%	36,862	0.89%	$Z = 18.375$ $p < 0.001$
Surface discharge is less likely when mild.	$10 \leq T \leq 20^{\circ}\text{C}$	18,851	0.58%	33,160	2.06%	$Z = -13.215$ $p < 0.001$
Surface discharge is less likely in low humidity.	$T > 0^{\circ}\text{C}, H < 30\%$	2,440	0.68%	49,571	1.56%	$Z = -3.483$ $p < 0.001$

The enhancements introduced in Cricket 1.2—namely, improved solar monitoring, battery state-of-charge monitoring, and the innovative Restart functionality, and machine learning improvements — mark a significant step forward in the reliability, efficiency, and usability of this transmission line monitoring device. Together, these features ensure that the device remains operational in even the most challenging environmental and power conditions, while providing greater transparency into power availability and system performance.

The solar and battery monitoring capabilities enable Cricketus to capture detailed data about real-world power generation and consumption, allowing us to refine system performance, optimize deployments, and validate simulation models. Meanwhile, the Restart feature ensures the system can recover from faults or interruptions without requiring on-site intervention, reducing maintenance costs and maximizing uptime.

These advancements not only enhance the immediate functionality of Cricket 1.2 but also provide a strong foundation for future developments. By addressing critical needs for remote power management and operational reliability, Cricket 1.2 delivers an effective, field-ready solution for CRWN’s partners, ensuring consistent monitoring and data collection for years to come.

### 7.3 PROJECT ACHIEVEMENTS, RESULTS, AND ANALYSIS

1. CRWN successfully created partial discharge in laboratory conditions and was able to capture ultrasound and RF signals of PD events using appropriate sensors. CRWN was able to characterize these different behaviors using specially developed spectral features, and then used this data to train a variety of machine-learning models.
2. CRWN has achieved a method for estimating the energy lost on any power line insulator, enabling utilities to quickly pinpoint opportunities to reduce emissions. The methodology developed has a median absolute percentage error of approximately 12% using Cricket’s acoustic sensor. The energy lost is estimated as a typical power loss rate in watts. These rates are then totalled and averaged over seasons, weather conditions, and other extended periods of time and presented to key decision makers during business review meetings to elucidate findings and make recommendations.

3. As presented fully in section 9.3, CRWN estimates that 3.04 watts of leakage on average can be prevented for each of the worst 9% of observed towers each year via washing or replacing insulators. No action was taken directly by the utility. Selected lines were known to be in relatively healthy condition, and CRWN expects that with dirtier or more degraded insulators, more impactful remediation decisions would present themselves.
4. CRWN has learned valuable lessons with regards to the measurement of electrical leakage. In particular, the amount of loss rapidly changes over very short bursts of time as corona is emitted or surface discharge occurs. Using leakage measuring devices with higher time resolution would practically allow CRWN to reduce the occasions where model confusion occurs, further improving the models accuracy.
5. The leakage modelling developed by CRWN will be portable across future system architectures because the input features used are standard for the other partial discharge models used in the Cricket deployment.
6. In terms of commercial ML product deployment, leakage estimates provide an easily interpretable measure of the “health” of the transmission infrastructure. This data can answer questions about specific poles, groups of poles (of the same age, for instance) or whole transmission lines. This can inform maintenance decision making by optimizing the time and amount of effort by the utility, allowing them to better allocate maintenance budgets and other resources.

## **HARDWARE**

Our plan focuses on enhancing device reliability, scalability, and ease of deployment based on performance data from the field. Key upgrades are as follows,

- Enhanced Durability & Power Systems,
  - We are transitioning to a new enclosure to improve grounding and environmental protection, preventing data loss. To ensure reliable operation in extreme temperatures
  - The power system is being upgraded to a LiFePO4 battery, which offers superior safety, longevity, and cold-weather performance.
- Improved Field Serviceability
  - To streamline maintenance and reduce time on-site, the next device iteration will include an external USB port for diagnostics and updates, along with an LED status indicator for quick operational checks without needing to open the enclosure.
- Scalable and Simplified Design
  - For larger scale production, we are replacing niche components with industry-standard modules to ensure supply chain stability.
  - We are also integrating multiple boards onto a single main PCB to simplify the design, reduce costs, and prepare for future sensor expansion.

## FIRMWARE

For firmware, our commercialization plan is guided by field data to enhance stability, efficiency, and scalability. The strategy is centered on three core areas,

- Optimizing Data Acquisition for Better Insights
  - We are implementing simultaneous capture of ultrasonic and RF data and increasing the sample duration. This provides a richer, correlated dataset that significantly improves the accuracy of our ML models in the cloud. By shifting the processing of this data from the device to the cloud, we also reduce on-device power consumption, extending operational life.
- Improving System Stability and Reliability
  - The core firmware is being refactored into a state machine architecture to prevent system resets and ensure predictable, stable operation. For data integrity, all devices will synchronize their internal clocks via GPS, ensuring every event is timestamped with perfect accuracy across the entire network.
- Enabling Robust Remote Management
  - A key pillar for scalability is the introduction of a comprehensive Over-the-Air (OTA) update system. This allows for secure remote deployment of firmware patches, security updates, and new ML models without physical site visits.
  - We are also enabling the remote download of raw sensor data on-demand, which provides our data science team with the high-fidelity information needed to continuously refine our detection models.

## 8.0 LESSONS LEARNED

### 8.1 CHALLENGES

- No regulator approval was needed for this project as it fell under “pilot”. As CRWN moves to commercialization, it will be up against higher regulatory compliance and stringent requirements such as ISO certifications.
- Basic criteria was provided in that we needed LTE coverage for devices, and that we focused our technology on 138kV to 230kV lines, as that is where the most problems around electrical discharge were seen.
- CRWN focused on proving out the technology and therefore focused on easier areas of deployment - those with LTE access which limited the transmission line selection in remote areas. CRWN is targeting a satellite model in Q1 2026.
- We were able to look at 2 transmission lines. Because of the safety aspect, CRWN was unable to install these without a professional linesman. To get a crew scheduled and co-ordinated takes weeks to months, so there is a long lead time to organize. Changes the day of are difficult.

- Between the first and second install device mounting hardware was improved to make installation faster and easier. With that being said the weather between August and December was much colder, making installation challenging in a different way.
- A dearth of adequate academic research on diagnostic tools for partial discharge and leakage has been a great opportunity for CRWN to rapidly iterate towards a commercializable solution by innovating our own science quickly - but also a great challenge, as CRWN has had to start from scratch on almost everything.
- Even using expensive equipment such as OFIL cameras and audio based PRPD measurement devices, doing diagnostics on live poles is a poorly understood practice. Industry technicians typically diagnose problems after they've become critical, resulting in a fire or downed pole. The boundaries between different types of partial discharge are not always clear. Categorizing the behaviors CRWN observes into low risk and high risk phenomena has required deep analytical work and creative analysis outside any well-documented procedures, but has resulted in practical tools for making best-available classifications, as well as guidelines for comparing relative rates of different partial discharges across specific environmental conditions to validate the performance of our models.
- Environmentally induced events such as hoar frost forming on transmission line cable and insulators may produce intermittent partial discharge that is unrelated to the physical condition of the insulator assembly. Further work is needed to distinguish these events from other, less tolerable sources of corona such as loose hardware on the insulator assembly.
- Available gateway solutions bridging the data collection gap have been unreliable in inclement weather, and are hard to fix when they go offline. Designing our own solution is probably required to withstand the difficult environmental conditions, especially in extreme cold. Without these reliable gateways, the data observed is left uncollected unless devices are taken down from the poles they monitor.

## 8.2 PRACTICAL LEARNINGS

- Utilities impose their own requirements on the placement of CRWN's devices on their power poles. As a result, the predictive models used by CRWN must either be easily calibrated or be free of calibration altogether to be commercializable.
- From field experimentation, we observed that energy lost at an insulator, called leakage, correlated strongly with E-field emitted during partial discharge. However, E-field is itself strongly influenced by practically all environmental conditions, including temperature, sunlight, pressure, humidity, dust levels, insulator defects and contamination, making consistent readings even in the same location on the same insulator impractical. Furthermore, the geometry of the e-field can be highly irregular, meaning positioning an appropriate sensor can be challenging or even impossible.

We believed that RF signals would strongly correlate with our best E-Field measurements and therefore serve as a good substitute for the purposes of modeling and estimating leakage. After a great deal of experimentation with a variety of different derived features from the collected RF signal data, we discovered that, for our sensors, this was not the case. We learned that audio data, ranging from the audible range into the ultrasonic frequencies, contains energy information useful for predicting leakage. Specifically, by binning frequency ranges, measuring the energy content in each bin, and dividing by the sum of all the energies for each frequency bin, and augmenting each normalized energy measurement in each bin with the entropy, a compact set of characteristic values was obtained that could be used by non-parametric predictive models such as ANNs, Decision Tree Regressors, and Ensemble methods to make good estimates of leakage at an insulator.

#### 8.2.1 TRANSFERRABLE LESSONS

- Producing calibration-free prediction requires normalized measurements as inputs. This can be effectively achieved by using suitable measurements (such as energy content) not on the whole of the input signals but on parts instead (for instance, groups of adjacent frequencies in audio), and dividing the measurement of each part by the sum of the measurements over all parts.
- We compared the characteristic values determined for leakage with our previous best predictive features, namely, Mel Frequency Cepstral Coefficients, as well as standardized spectral features, including zero-crossings rate and root-mean-squared energy. A key takeaway from this exercise was that characterizing leakage as described provides a foundation for the identification of partial discharges equivalently or even more capably than any other compared methodology. When CRWN wants to improve predictive performance across the board, addressing the more difficult predictive tasks that are closest to the physical phenomena first is an effective means of doing so.

#### 8.3 ORGANIZATIONAL LEARNINGS

- Categorizing partial discharge phenomena is not enough to determine how much energy is lost on faulty insulators. There may be no partial discharge observed that signals imminent insulator failure, but still significant energy lost to even relatively mild amounts of corona, if continuously present. Detecting corona periodically undersells how much leakage is occurring.
- There are many different subcategories for each type of partial discharge due to different components of the insulator assembly being capable of emitting corona.
- Finding visualizations that expose the underlying physics of the insulator under high-voltage AC loads are a must for accurately identifying the kinds of partial discharge the underlying insulator is experiencing.

- Standardized DSP and spectral analysis are insufficient for the purposes of categorizing partial discharge phenomena from audio - innovative approaches were required.
- Because Utilities have “flown blind” on their infrastructure for so long, they are themselves unsure of what they really want from monitoring solutions beyond broad strokes. CRWN must be a thought leader to demonstrate the commercializable power of its solutions.

#### 8.4 HIGHLIGHTS

1. Using audio recorded through our devices, CRWN is able to estimate the amount of energy lost at any pole, providing utilities an easy tool for finding insulators to replace to reduce their emissions.
2. Additional diagnostic data can be generated directly from the collected audio on single insulators. A magnitude-based PRPD (phase resolved partial discharge) plot can be determined by using optimization techniques to look for the lowest energy points, very reliably. Additionally, CRWN has innovated a new type of plot more closely aligned with the physical phenomena differentiating corona from surface discharge - a phase resolved spectrogram, a promising result towards visualizing the incremental progression from low-risk to high-risk partial discharge. More work is required for multi-phase insulator setups, however.
3. Radio frequency data has been found to be highly effective at detecting surface discharge on inexpensive low-spec, narrow-ranged, antennas. With additional time to incorporate existing designs for broader range RF antennae solutions into CRWN’s sensors, it is likely that the predictive capabilities of CRWN’s models can be further improved.
4. CRWN’s hardware solutions are durable in even the most extreme environments in all seasons.

### 9.0 GHG BENEFITS

#### 9.1 PROJECT BASELINE EMISSIONS

**Table 2. Baseline Sources, Sinks & Reservoirs**

Source, Sinks & Reservoirs	Included / Excluded in Quantification	Justification
B1 - Electrical Losses (Source)	<b>Included (Enabled)</b>	Included in enabled emissions reduction quantification
B2 - Inspection activities (Source)	<b>Included (Enabled)</b>	Negligible; also approximately equivalent to deployment activities in the Project scenario.
B3 - Wildfires (Source)	<b>Excluded</b>	Excluded from baseline quantification due to the inability to reliably attribute, predict, or measure emissions directly linked to faulty infrastructure, making any inclusion speculative and unverifiable

**Table 3. Project Sources, Sinks & Reservoirs**

Source, Sinks & Reservoirs	Included / Excluded in Quantification	Justification
P1 – Manufacturing, installation and maintenance of CRWN devices (Source)	<b>Excluded</b>	Negligible across the lifetime of the project.
P2 - Deployment of CRWN devices (Source)	<b>Excluded</b>	Negligible; also approximately equivalent to inspection activities in the Baseline scenario.
P3 – Operation of CRWN devices (Source)	<b>Excluded</b>	Zero; devices are solar powered.
P4 – Removal and disposal of CRWN devices (Source)	<b>Excluded</b>	Negligible across the lifetime of the project.

Quantification of SSR B1 assumed that the CRWN technology would detect severe electrical losses on transmission lines where the technology is deployed, enabling the utility provider to repair or replace defective components. Deployment of the technology as part of the ERA funded project was carried out primarily for the purpose of testing and data collection and CRWN did not have any guarantee that the utility provider would address equipment in need of replacement. However, the project level emissions quantification assumed that 10% of insulators monitored during the project period would require replacement and that degraded equipment would be replaced by the utility provider.

Quantification was performed using the total annual electricity production in Alberta and the total length of transmission lines, referenced from the Canadian Energy Regulator Provincial and Territorial Energy Profiles website [2], along with an assumption that 3.66% of total electricity generated is lost due to degraded infrastructure and the corona mechanism [3]. These data were used to calculate an estimated quantity of line loss per transmission pole per day which was then used to calculate the emissions associated with implementation of the project, and with the commercial deployment projections.

A conservative estimate that 10% of damaged components would be replaced by the transmission provider was applied for both project level and market level calculations. However, CRWN’s devices ended up being tested on well-maintained infrastructure showing little partial discharge activity. As a result, no insulators were replaced, and no emissions reductions were realized.

Emission factors for grid electricity are sourced from Environment and Climate Change Canada (ECCC) Canada’s Greenhouse Gas Emissions Projections, Electricity Grid Intensities.

### 9.1.1 QUANTIFICATION PLAN

#### **Mechanism 1: Reduction of Electrical Losses**

This project will enable reduction of electrical losses on transmission lines due to the corona mechanism. Approximately 3.66% of power transmission is lost due to corona [1]. Current industry practice is to conduct physical inspections on transmission lines by an operator which is costly and can be especially challenging in remote locations. For these reasons, the inspection frequencies are quite low; once or twice per year on critical lines and once every eight years on less critical lines. Due to the low frequency of inspections, damaged or degraded equipment often goes unnoticed, continuing to operate while experiencing significant electrical losses. The emissions associated with these losses contribute to baseline emissions.

#### **Mechanism 2: Reduction of Emissions from Prevented Wildfires**

As degraded electrical infrastructure is a known ignition source and cause of wildfires, this technology offers the potential to prevent utility-caused wildfires, thus reducing emissions of biogenic CO<sub>2</sub> from combustion of biomass and avoiding loss of forest trees as a carbon storage source. However, quantification of avoided emissions related to the prevention of wildfires is challenging and speculative; there is no clear way to measure or verify if the technology will actually have prevented any wildfires when commercially deployed. There is also significant uncertainty in the magnitude of emissions that may result from a wildfire and the carbon storage capacity of forest trees; these depend on a multitude of factors including forest tree ages, volume of wood, dominant species, and wildfire size. In light of these challenges, this emission source was not included in the emissions reduction calculation, but estimates are provided for consideration.

CRWN.ai provided an estimate of the average emissions per wildfire in Canada in 2021 derived from the total estimated emissions from wildfires [4] and the total number of wildfires [5]. On this basis, the average wildfire in Canada generated approximately 41,000 tonnes CO<sub>2</sub>e in 2021. CRWN.ai conservatively assumes that commercial deployment of their technology may prevent one utility-caused wildfire by 2030 and a total of two utility-caused wildfires by 2050. Based on these assumptions and using the historical average data described above, CRWN.ai estimates that their technology could facilitate avoidance of approximately 41,000 tonnes CO<sub>2</sub>e by 2030 and 82,000 tonnes CO<sub>2</sub>e by 2050. This is incremental to the emission reduction estimates provided in the Results section below. Note that these estimates comprise biogenic CO<sub>2</sub> and do not account for the loss of carbon storage capacity of forest trees or emissions from firefighting activities. In accordance with the United Nations Framework Convention on Climate Change (UNFCCC) reporting guidelines, CO<sub>2</sub> emissions from the combustion of biomass are generally quantified but are excluded from reporting of direct emissions. Furthermore none of the SSRs associated with this mechanism are possible to measure, quantify or verify after implementation of the project or commercial deployment of the technology as there is no way to know if a wildfire has been prevented, or the magnitude of the fire or the avoided emissions.

### 9.1.2 MONITORING PLAN

**Table 4. Monitoring Plan**

Parameter	Monitoring Specifications
Data parameter	Partial discharge events causing lost energy
Source/sink	B1 – Electrical losses
Monitoring method	Modelling from ultrasound and RF data
Unit of measure	A classification describing the severity of corona events (LOW, MEDIUM, HIGH)
Sources/Origin	Direct monitoring of partial discharge phenomena by CRWN.ai devices
Monitoring frequency	Continuous
Monitoring location	Device located on each powerline pole monitor, aimed at insulator
Description and justification of monitoring method	Ultrasound and RF data emitted from the insulator is directly monitored and immediately processed into spectral features and used to determine partial discharge severity via statistical modelling. Unhealthy insulators can be identified and marked for replacement by the utility.
Data validation methods	Data can be validated by: <ol style="list-style-type: none"> <li>1. Manual inspection of the condition of each insulator monitored, both on initial setup and periodically each year.</li> <li>2. Direct corroboration of corona using specialized cameras.</li> <li>3. Lab-based reproduction of environmental conditions to ensure model performance matches real-world expectations.</li> </ol>
Data storage and retention	Data collected by CRWN.ai devices is automatically uploaded to a centralized database for further analysis and reporting to the utility. Data is stored redundantly outside the centralized database also in object storage and the database is backed up daily.

## 9.2 PROJECT EMISSIONS

CRWN.ai has deployed its devices on two lines and leverages data collected from these devices to estimate the amount of energy lost due to various forms of partial discharge, including corona and surface discharge. By identifying insulators that show a trend towards degradation, that is those with higher rates of corona and surface discharge, CRWN.ai aims to quantify emissions impacts and build a case for early replacement or insulator washing.

The primary source of GHG emissions considered in this project is emissions attributed to lost electric product from corona and surface discharge. No sinks or reservoirs are evaluated - all possible emissions reductions come from emission prevention.

To quantify the amount of preventable emissions, CRWN.ai created a model that estimates the amount of energy lost based on the partial discharge activity observed. This model was developed by measuring the amount of current lost while running various voltages across a collection of insulators in various conditions.

### 9.3 EMISSIONS REDUCTION IMPACT

**Table 5. Emission Reduction Impact**

Year	Baseline Emissions @Year (tCO2e)	Project Emissions @Year (tCO2e)	Estimated Annual Production (if applicable)	Unit of Production	Emissions Reduction @Year (tCO2e)
2023	-	-			0
2024	-	-			0
2025	0.663	0.113	100	devices	0
2026	73.63	12.56	1000	devices	12.56
2027	147.2	25.12	1000	devices	25.12
2028	220.9	37.68	1000	devices	37.68
2029	294.5	50.24	1000	devices	50.24
2030	368.2	62.80	1000	devices	62.80
2031-2040	7731	1318	10000	devices	1318
2041-2050	15094	2574	10000	devices	2574

It is observed that, since surface discharge rates are relatively low compared to corona, most of the leakiest structures are the ones with the most corona. Most of these use polymer insulators, whose chemical condition can degrade with age. A few use ceramic insulators, whose chemical condition typically does not degrade with time, and these are expected to be contaminated.

From the 100 poles monitored, CRWN.ai identified 9 whose leakage rate was at least 15% higher than the median rate observed (14.79 watts, averaged yearly). Of these 9, one structure is showing continuous surface discharge across a variety of temperature and humidity conditions, albeit at a low rate, suggesting that the tower may have insulators showing early but significant degradation.

CRWN.ai’s estimates for baseline GHG are based on these 9 structures. Emissions reductions are enabled through the assessment and assumed consequent washing or replacement of the insulators there contained. CRWN.ai initially believed that remediation would eliminate essentially all leakage caused by an insulator, giving the following straightforward equation for calculating emissions reductions:

$$(\text{emissions prevented}) = (\text{estimated percentage leakage rate}) * (\text{grid emissions factor}) * (\text{duration replaced insulator operates})$$

However, after conducting data collections in both field and controlled lab settings, CRWN.ai now understands that there is some inherent leakage expected in new or otherwise good condition insulators. Leakage on such insulators is expected to be well below the observed median. As a result, CRWN.ai proposes the following more refined calculation process: first, calculate the typical amount of

leakage that can be prevented for each tower at least 15% above the median. From there, a straightforward multiplication can be used to estimate the amount of GHG preventable from insulator remediation:

(emissions prevented) = (typical leakage rate in watts per pole) \* (number of hours replaced for) \* (number of poles remediated) \* (grid emissions factor in tonnes per watt hour) \* (duration replaced insulator operates)

For instance, if all 9 structures identified out of the 100 monitored were remediated into at least median condition, the total of 160.47 watts leaked (averaged over a year) would be reduced by 27.37 watts (about 3.04 watts per tower out of 17.8 watts per tower), or 17% of the total. There being 8760 hours in each year, means that each remediated structure would expect to save a little more than 26630 watt hours each year. With a 470 grams of CO<sub>2</sub>e per kilowatt hour estimated emission rate [1], or  $4.7 \times 10^{-7}$  tonnes per watt hour, this represents approximately 0.113 tonnes of GHG that could be prevented, or 0.01256 tonnes of GHG per tower remediated.

For additional clarity, the equation fully substituted would look like:

(emissions prevented) = (3.04 watts per pole) \* (9 poles) \* ( $4.7 \times 10^{-7}$  tonnes CO<sub>2</sub>e per watt hour) \* (8760 hours) = 0.113 tonnes of CO<sub>2</sub>e over all 9 poles

Extrapolated, if it is assumed that 3.04 watts of leakage on average can be prevented for each of the worst 9% of observed towers each year via washing or replacing insulators, CRWN.ai estimates that, over all of Alberta's (conservatively estimated) 100,000 towers, it could prevent 1130 tonnes of GHGs each year:

(emissions prevented) = (3.04 watts per pole) \* (9,000 poles) \* ( $4.7 \times 10^{-7}$  tonnes CO<sub>2</sub>e per watt hour) \* (8760 hours) = 1130 tonnes of CO<sub>2</sub>e over all 9 poles

If, more conservatively, an additional 1% of Alberta's towers (approximately 1000) come under CRWN.ai's observation each year starting in 2026, and the worst 9% of observed poles are remediated, cumulatively, one can arrive at the estimates given in the table above.

## 10.0 ENVIRONMENTAL, ECONOMIC, AND SOCIAL IMPACTS

### 10.1 OTHER ENVIRONMENTAL IMPACTS

This project provides two significant potential environmental benefits. The first benefit results from the CRWN system's capability to estimate the potential leakage current from a transmission line. This metric represents the amount of energy lost in transmission due to contaminated, faulty, damaged, or worn out insulators. This quantity of current can be converted to a quantity of greenhouse gasses emitted by the generation of power at that line's source. The second benefit results from the CRWN systems capability to identify insulator behaviour and environmental conditions that may indicate a probability of wildfire ignition on the line. Wildfires are significant contributors to both greenhouse gas and particulate emissions into the atmosphere, and in severe cases can affect hydrology and cause long term changes in ecosystems that are not sufficiently resilient to fire.

It should be noted that even though wildfire GHG’s do not count towards emissions, a significant part of pole fires are started through tracking insulators. Surface discharge, which is one of the things that CRWN monitors for causes tracking.

As a CRWN team we are working with additional grant funding agencies such as NorthX who are now funding projects that predict wildfires as part of their climate tech initiatives. Assuming CRWN is deployed over a 2-year project period in wildfire-prone areas of Alberta on aging infrastructure (known for causing fires)—covering sufficient territory to prevent one medium-scale wildfire per year (approximately 10,000 acres or ~4,050 hectares annually)—the project would result in annual GHG reductions of 600,000 to 1.2 million tonnes of CO<sub>2</sub>e. These estimates are based on wildfire emission factors from NRCan and IPCC guidance (150–300 tCO<sub>2</sub>e per hectare), reflecting emissions from both biomass combustion and soil carbon loss in Alberta’s boreal forests.

## 10.2 PROJECTED ECONOMIC IMPACT

The economic impact to Alberta will be cost savings through an investment in our technology. We expect that the predictive maintenance capabilities of our technology will provide 20-40% direct cost reduction (operations and maintenance in the portion of line monitored, productivity increase) further we expect there to be a projected asset life extension of 15-40% which provides a huge deferral of capital expenditures to the utility. For reference, a single structure is estimated to cost 25-97,000 to replace. We anticipate the economic benefits to be a combination of these for the utility. Below is a grid of ROI for predictive maintenance solutions. We expect [CRWN.ai](#) ROI to be aligned with these.

The substantial ROI metrics driving this growth include:

<b>Metric</b>	<b>Typical Improvement Range</b>
Downtime Reduction	30-70%
Asset Life Extension	15-40%
Maintenance Cost Reduction	25-40% (vs. Reactive)
Breakdown Reduction	70-75%
Productivity/Efficiency Increase	20-25%

Job Creation - Dual, from [CRWN.ai](#) as well as partners as the pre-deployment and post-deployment maintenance and support will require [CRWN.ai](#) resources and local representatives.

Throughout the project CRWN made 4 FTE Hires - Neutron Her, Graeme Douglas, Brad Hicks and Brandon Jones. Additionally, CRWN contracted a part time employee in Alberta, Callahan New, to do data collections. Brad Hicks has left during the project, and we are currently looking for a replacement.

At the end of the project, CRWN hired a CTO, Jozsef Hamari, out of Calgary Alberta and has subsequently opened an office space in Calgary.

Additionally, CRWN has engaged with Toast to help in additional scaling and recruitment efforts focused in Alberta and with a particular focus on hiring more women in tech.

### 10.3 RESULTED INNOVATION CAPACITY

During this project, CRWN collaborated with Utilities and labs to advance their knowledge of partial discharge events on their transmission lines. In addition, during the course of this project CRWN has initiated collaboration with Powertech Inc. which is one of the world's leading high voltage testing and research organizations.

### 10.4 SOCIAL IMPACT AND EDI OUTCOMES

[CRWN.ai](#) deployments will be in local communities in Alberta, serving benefits to those communities as well as hiring local citizens. Throughout this project CRWN has understood that no new transmission lines may be installed without the consultation of Indigenous communities and land surveys. CRWN is in talks with bands across Western Canada to educate on the CRWN benefits and engage them to support

Additionally, CRWN is signed with Toast. Toast is a high tech recruiting agency that focuses on equal representation of candidates across all genders.

## 11.0 SCIENTIFIC ACHIEVEMENTS

The following scientific contributions have been made based on work conducted during the project,

### 1. Patent Applications

- **Title:** *Method and System for Detecting Defects on Remote Infrastructure*
  - **PCT Application No.:** PCT/CA2023/050790
  - **International Publication No.:** WO 2023/235981 A1
  - **National Phase Entries (in Dec 2024):** United Kingdom, Canada, United States
- **Title:** *Sensor Fusion with Machine Learning for Detection of Partial Discharge on Electrical Transmission Infrastructure*
  - **US Provisional Application No.:** 63/755,678
  - **Filing Date:** February 7, 2025

## ■ Status: Provisional Patent Application Filed

At this time, there are no published books, journal articles, conference presentations, or student theses associated with this project. However, we anticipate future contributions as the project progresses. CRWN was invited to speak at a global insulator conference, INMR, to talk through the results of ERA and how we use machine learning to detect and highlight the risk of tracking in the field.

## 12.0 POST-PROJECT STEPS

### 12.1 NEXT STEPS AND FOLLOW-UP PROJECTS

In the immediate short term CRWN is looking to take the pre-commercial learnings and the device developed under ERA and immediately expand pilots across North America to understand more real life trends and patterns leading to failed insulators. CRWN is currently in talks with 4 other Utilites. Additionally, CRWN is currently engaged with Powertech and NorthX under a project to advance its prediction capabilities.

In the medium term (~6 months) CRWN is looking to move from TRL 7 - 9, which would be a potential follow-up project with ERA. This scope of work would build the operational, technical, and compliance infrastructure needed for scaled commercial success. Core workstreams include:

- **Deployment Readiness:** Secure utility partnerships and sites, finalize field protocols, and improve CRWN device hardware for rugged environments.
- **Hardware & Software Development:** Enhance device capabilities including dynamic data sampling, edge ML predictions, remote firmware updates, and provisioning tools.
- **Manufacturing Scale-Up:** Move from manual production to a certified, high-volume manufacturing line with standardized QA/QC (Quality Assurance/Quality Control) and sourcing agreements.
- **Fleet Infrastructure:** Build out backend monitoring tools, over the air (OTA) update pipelines, and device health dashboards to manage a growing sensor fleet.
- **Compliance & Certification:** Achieve full regulatory compliance and conduct cybersecurity audits for infrastructure-level integrations.
- **Utility System Integration:** Integrate sensor outputs into utility software such as SCADA (Supervisory Control and Data Acquisition) and asset management platforms.
- **Customer Success Systems:** Establish installer certification programs, technical support teams, and logistics processes.
- **Commercial Readiness:** Finalize go-to-market systems including sales ops, ordering portals, commercial contracts, and SLA (Service Level Agreement) commitments.

## 12.2 PARTNERSHIPS

Preliminary discussions with sponsoring bodies (e.g. accreditation of data insights), utility partners (adopters) and ecosystem partners (e.g. labs, hardware manufacturers, radio/gateway). We don't anticipate partnerships with SIs (system integrators) as it's expected the development and fulfillment of service offering will be a joint effort between the utility and [CRWN.ai](#).

## 13.0 OVERALL CONCLUSIONS

Requirements were developed outside of project scope based on feedback from the Utility.

## 14.0 COMMERCIALIZATION AND TECHNOLOGY TRANSFER PLAN

### 14.1 PROJECT COMMERCIALIZATION ADVANCEMENTS

Working closely with Utilities has afforded us deeper knowledge of pain points for utilities and specifically those with power lines that suffer through extreme and variable weather conditions. This has provided knowledge for improvements of the device but also how to communicate [CRWN.ai](#)'s unique capabilities. Further, the ease of deployment of [CRWN.ai](#) devices - information fed from the field to [CRWN.ai](#) - has enabled a closed-feedback-loop that can be implemented with future clients enabling easier commercial deployment and market adoption.

The market for CRWN's technology is ready and urgent. Utilities, infrastructure operators, and resource industries are facing mounting pressure from wildfires, aging assets, and reliability challenges. The pain is acute, and the need is immediate, yet the industry lacks sufficient data or precedent datasets to guide predictive maintenance and wildfire-risk modeling at scale. This absence of empirical field data represents a key awareness and education gap. Utilities understand the problem, but they need verified data to confidently act on it.

Based on funding through ERA, CRWN's Cricket device is fully developed and ready to deploy at a pilot scale of up to 500 units. These pre-commercial devices (priced ~\$1,500 each) are now being used for rapid validation and data capture in active projects with partners, focused on predicting wildfire risk from tracking insulators. In parallel, CRWN is developing PULSE, its commercial-grade product (target ~\$350; 5–8-year field life), designed for mass deployment and long-term reliability.

To address the market's education gap, CRWN is pursuing a multi-channel awareness strategy. Through the Joules Accelerator and EarthTech Accelerator, CRWN is working with experienced utility executives to refine positioning, build credibility, and communicate the impact of predictive IoT sensing. Speaking at the INMR World Congress in Panama and engaging trusted engineering firms enables CRWN to educate the market through recognized, industry-credible partners. These firms act as both advocates and integrators—translating CRWN's innovation into frameworks utilities already trust.

As deployments scale, each dataset strengthens CRWN’s ability to quantify risk, predict failure, and demonstrate measurable return on investment. In turn, this data becomes the foundation of market education, building the trust, validation, and awareness necessary for broad commercialization.

**Table 6. Commercialization Performance Metrics Summary Table**

Success Metric	Commercialization targets from CA	Commercialization targets after project completion	Explanation
Uptime	>80%	> 95%	<a href="#">CRWN.ai</a> devices performed extremely well, and were up for almost the entire duration of the project
Device Failure	< 40%	< 5%	Of the 100 devices, only four failed, a negligible 4% failure rate, 1/10 of the projected failure rate for the project
Successful Deployment on Lower Voltage Lines	<138k	V>= 138kV	We deployed as intended
Ability to login to interface to access data	Quarterly	Daily	We created a robust interface showing dynamic charting and tabular data across multiple variables.

#### 14.1.1 PROJECT TECHNOLOGY ADVANCEMENTS

Over the course of this project, CRWNs technology has advanced in a few significant ways. First, as a result of the opportunities the two deployments have afforded, CRWN’s hardware designs have been refined to allow for far greater production agility. The speed at which devices could be produced has more than doubled, with significant additional multipliers being unlocked. Ultimately, these hardware design and implementation improvements enable on-demand production.

Second, the statistical models have been iteratively improved, providing more accurate detection and diagnosis of partial discharge. New statistical models have been developed to estimate the loss of energy at each insulator due to various defects. While there is still much room for improvement, further

analysis on the trends present during specific weather conditions such as extreme cold with high humidity as well as analysis on raw data coming back demonstrates that our models are a great start towards providing the accurate results utilities will need. For each future deployment, CRWN can provide utilities with accurate geo-located insights into where their leakiest insulators are - especially in areas with highly degraded infrastructure experiencing far more deleterious partial discharge. This makes CRWN an excellent tool for utilities both looking to prevent at-fault forest fires as well as reduce emissions due to inefficiencies in transmission.

#### 14.1.2 PROJECT TRL ADVANCEMENTS

CRWN started the project at TRL 7 and finished the project at TRL 7 using the learnings of the project to create a clear path to TRL 8 and 9.

#### 14.2 TECHNOLOGY PROVISION AND THIRD-PARTY VENDORS

Our transmission line monitoring device will be manufactured through a hybrid supply chain model that prioritizes IP security, quality, and cost efficiency.

- Electronics manufacturing, firmware flashing, testing and final assembly will take place in North America, ensuring secure firmware deployment and rigorous quality control.
- Mechanical housings, enclosures, and non-sensitive components may be sourced from overseas suppliers, leveraging specialized manufacturing capabilities while maintaining strict oversight.

This approach balances supply chain resilience, cost efficiency, and security, ensuring a high-reliability product designed for utility infrastructure.

To ensure seamless adoption, we will provide complimentary on-site commissioning in coordination with the utility's certified power line technicians. Our team will:

- Oversee installation to ensure proper integration with infrastructure.
- Validate connectivity, calibration, and system performance.
- Confirm operational readiness of the CRWN system.

This ensures a smooth transition to full deployment, minimizing technical barriers for the customer.

While vendor selection is ongoing, we are engaging partners in:

- Electronics Manufacturing & PCB Assembly – North American-based, specializing in high-reliability industrial electronics.
- Mechanical Components & Enclosures – High-quality overseas suppliers for injection molding and protective housings.

- Testing & Compliance – North American certification partners to ensure regulatory adherence.
- Supply Chain & Logistics – Strategically selected fulfillment partners for large-scale distribution.

Our focus is on high-reliability, scalable manufacturing with secure integration and seamless deployment, ensuring a robust, field-ready solution for the utility sector.

### 14.3 COMPETITIVE SCAN

The competitive landscape for CRWN.ai's technology is characterized by a mix of traditional and emerging solutions aimed at monitoring transmission line health and mitigating wildfire risks. The industry currently lacks a comprehensive, cost-effective, and real-time monitoring solution, creating an opportunity for CRWN to differentiate itself. Ultraviolet corona cameras (eg. OFIL's DayCor and Sonel's UV-260), require manual operation and on-site interpretation. Other solutions, such as LineVision and IND Technologies, rely on LiDAR and visual detection, limiting their ability to detect non-visible defects like electrical discharge.

The implications of this competitive landscape on CRWN's technology transfer plan highlight the need for industry validation, strategic partnerships, and regulatory engagement. Since utilities traditionally adopt new technologies at a slow pace due to long evaluation cycles, CRWN must demonstrate the reliability and cost-effectiveness of its solution through pilot projects and collaboration with key industry players such as the Electrical Power Research Institute (EPRI). The ERA-funded project will serve as a crucial stepping stone for securing reference customers and proving the technology's scalability. Additionally, CRWN's ability to offer a proactive, autonomous monitoring system, requiring targeted education and adoption strategies to drive market penetration.

The main competitors in CRWN.ai's market include a range of sensor-based and AI-driven monitoring technologies:

**Ultraviolet Corona Cameras (eg. OFIL's DayCor, Sonel's UV-260):** These cameras detect corona emissions but require an operator to manually assess data.

**AI-Based Aerial Inspection (Labellec):** Uses drones and helicopters for automated image-based defect detection but is limited to visible defect

**LiDAR-Based Systems (LineVision, IND Technologies):** Focus on detecting visual anomalies but cannot identify electrical discharge, a key contributor to inefficiencies and wildfire risks.

**Wildfire Monitoring Solutions (Ororatech, SenseNet):** Reactive solutions that focus on predicting fire spread or detecting smoke but do not provide preventative monitoring to reduce the risk of wildfires starting.

**Gridware:** Focusing on arcing and pole sway detection.

CRWN's key advantages over its competitors include:

**Continuous, real-time monitoring** using IoT sensors, eliminating the need for manual operation.

**Ability to detect non-visible defects** such as electrical leakage and surface discharge, whereas competitors mainly focus on visual anomalies.

**Autonomous operation in remote locations** without reliance on WiFi or cellular networks.

**Provisional patents in the U.S. and Canada**, ensuring intellectual property protection and a pathway to commercialization.

CRWN's innovative approach places it at the forefront of proactive transmission line monitoring, providing utilities with a cost-effective solution that enhances grid efficiency, minimizes wildfire risks, and reduces greenhouse gas emissions.

#### 14.4 MARKET AND END-USERS

CRWN.ai's primary target market consists of utility companies and grid operators responsible for high-voltage transmission infrastructure. These organizations face increasing pressures to modernize aging infrastructure, reduce greenhouse gas (GHG) emissions, and mitigate wildfire risks.

Industry Segments:

- Utilities with Transmission Infrastructure – Companies managing large-scale transmission networks (>60kV).
- Independent Power Producers (IPPs) & Renewable Energy Operators – Organizations integrating wind, solar, and hydroelectric power, requiring real-time monitoring of transmission assets.
- Government Agencies & Regulatory Bodies – Entities responsible for grid reliability, emissions compliance, and wildfire prevention.

Geographical Focus:

Primary Markets: North America

United States: States with high wildfire risk and aging infrastructure (e.g., California, Arizona, Texas).

Canada: Provinces with significant transmission assets (e.g., Alberta, British Columbia, Ontario).

● Expansion Markets:

South America & Australia: High wildfire risk and large-scale power grids.

Europe: Markets with strong grid modernization policies and GHG reduction mandates.

Key Decision Makers in Target Market

Grid Operations & Asset Managers: Responsible for infrastructure maintenance and reliability.

Transmission Engineers: Focused on system efficiency and predictive maintenance.  
Utility Executives & Procurement Teams: Decision-makers for new technology investments.  
Regulatory Compliance Officers: Ensuring adherence to emissions and safety mandates.

End-users of CRWN.ai’s technology are the personnel within utility companies and grid operators who interact with the data and insights generated by CRWN’s IoT monitoring system.

#### Key End-User Groups:

- Operations Teams: Use CRWN data to schedule repairs and manage grid health.
- Transmission Line Engineers: Analyze real-time insights to improve system efficiency.
- Field Maintenance Crews: Receive targeted alerts to address specific defects in the infrastructure.
- Wildfire Mitigation Specialists: Utilize CRWN’s detection capabilities to identify high-risk assets.

#### Length of Time to Reach End-Users:

The utility industry has long technology adoption cycles, typically ranging from 12 to 36 months per customer. Key factors influencing adoption include:

- Pilot Testing (6-12 months): Initial small-scale deployments to validate performance.
- Regulatory & Procurement Approvals (12-24 months): Securing long-term adoption within a utility.
- Full-Scale Deployment (24-36 months): Expansion across multiple transmission lines and regions.

CRWN.ai’s ERA-funded project accelerates this timeline by establishing a reference deployment in Alberta, providing a strong foundation for further adoption and scaling across North America.

## 14.5 MARKETING

Primary mediums (channels) will be Website, LinkedIn, email and virtual. This is for two reasons: i) digital transformation that provides a much lower acquisition cost than print or in-person; ii) buying committees and their decision-makers are making over 70% of the buying decision through their own efforts, and online. [CRWN.ai](#) will ensure its content, messaging and brand is visible in the related channels and reduce friction for those interested. Mechanics to achieve this will be both organic and paid, with a greater focus on ABM (account based marketing) because of the very specific nature of the target customer.

Marketing activities will be geotargeting North American audiences in 2026 through to 2030, and as market penetration increases geotargeting will move to those countries where there is greatest need

and demand. However, due to the ubiquitous nature of website content, and even more pronounced with generative engine optimization, [CRWN.ai](#)'s message will be shared globally though our own - and paid - targeting may be more strategic. Marketing activities are currently underway with customer discovery - better understanding of the opportunities and pain points - and this will evolve into content and virtual events late in 2025 in preparation for larger scale deployments in 2026.

#### 14.6 DISTRIBUTION

In the short-term, hardware will be shipped to customers with a joint scheduled training and subsequent deployment effort between the utility customer and [CRWN.ai](#). This will be followed by an onboarding session with the customer to illustrate the platform (SaaS interface) capabilities and subsequent activation of users through the client's admin user account.

Due to the nature of the customer buying process and the mechanics of implementation, CRWN.ai will adopt a B2B sales model, selling directly to utilities. Currently relationships are being established with Canadian utilities and we are working towards expanding our footprint into the US to build these same relationships in the interim of weightier marketing activities. Very targeted outreach amplified through paid activities and organic efforts (e.g. list building, referrals, etc.).

#### 14.7 TECHNOLOGY PROTECTION

Our technology is protected through a multi-layered approach, including patent protection, proprietary methodologies, and regulatory compliance. We will elaborate more below,

##### Patent Protection

- We have filed multiple patent applications to secure our core innovations
  - PCT Application No.: PCT/CA2023/050790 (*Method and System for Detecting Defects on Remote Infrastructure*). National Phase Entries in Dec 2024: UK, CA & US
  - US Provisional Application No.: 63/755,678 (*Sensor Fusion with Machine Learning for Detection of Partial Discharge on Electrical Transmission Infrastructure*), filed Feb 7, 2025.

##### Proprietary Development & IP Ownership

- Strict IP Assignment & Protection
  - All team members assign full rights to technologies developed for CRWN.AI, ensuring company ownership of all innovations
  - All team members are trained to identify novel and technological innovations with IP protection potential

- Standardized IP clauses, non-compete agreements, and NDAs are enforced when working with external partners to retain control over all deliverables and technological breakthroughs to help ensure clear IP ownership and exclusivity
- Secure & Trusted Manufacturing
  - All key electronic components are manufactured exclusively through trusted North American partners to ensure security and quality control.
  - Firmware is flashed in-house under strict security protocols, ensuring no unauthorized access.
  - Extensive system lifecycle and reliability testing is conducted at trusted CM facilities under tight control, guaranteeing field-ready reliability.
- Security & Cyber Resilience – Secure by Design:
  - Our device is secure by design, integrating strict data protection and cybersecurity measures across all layers
    - Hardware security - Manufactured with tamper-resistant design to prevent unauthorized access.
    - Firmware security -Protected against reverse engineering, unauthorized modifications, and malicious tampering.
    - Wireless communication security - End-to-end encryption and authentication prevent interception or manipulation.
    - Cloud security -Data integrity is enforced through secure storage, access controls, and monitoring to protect against cyber threats.
  - These security measures prevent malicious actors or adversarial nations from compromising our system, stealing data, or interfering with operations.

To the best of our knowledge, there are no competing patents or proprietary processes that would challenge our claims. A comprehensive prior art review was conducted to confirm the novelty of our technology, ensuring strong IP positioning and freedom to operate.

There are no legal or contractual risks that would impact commercialization. All manufacturing, supplier, and development agreements are structured to,

- Maintain full IP control over all technological innovations.
- Enforce strict confidentiality and IP protection with external partners.
- Ensure long-term exclusivity and competitive advantage in utility infrastructure monitoring.

#### 14.8 COST OF COMMERCIALIZATION

Estimated cost of development to date is \$3M, though this cost is lower than market-rate offset by salary and technical choices to stretch the related capital investment. The primary characteristics that will positively impact the investment return are the decreasing risk for the utility customer (subsidized deployment) and high benefit/revenue potential with minimal initial investment. This in turn will

accelerate market adoption by providing a strong referenceable customer and project results. Projected cost to implement the transfer plan is \$25M, i.e. achieve profitability, this does not reflect the expected.

#### 14.9 SHORT-TERM ACTIONS.

[CRWN.ai](#) will have over a dozen pilots and fuller trials within two years of Project completion, specifically it will have achieved the following:

- expanded transmission line coverage on additional lines
- achieved significant market penetration in Canada
- entered the US market

#### 14.10 LONG-TERM COMMERCIALIZATION

Long-term plans are to capture \$80M in revenue from North American utilities, focusing on higher risk transmission lines (based on age, environmental factors) and begin to enter other geographies based on: rate of market adoption, need, regulatory factors. The horizon for this is 5-7 years.

### 15.0 COMMUNICATIONS PLAN

#### 15.1 KNOWLEDGE SHARING DURING PROJECT

- During the project the primary audience were stakeholders from executives through to line crew.
- CRWN successfully expanded the project beyond the ERA timeline and built relationships with executives to line crews. We ran bi-weekly meetings as well as more intensive quarterly meetings to discuss learnings, show progress and speak to expanding the client relationship.
- There was also educational content developed in document format as to both the aspects of CRWN's proprietary technology as well as the foundational technical aspects of machine learning, data capture and proving confidence in the data analysis.
- CRWN also provided educational information in the form of training to line crew and line maintenance staff for deploying and installing devices.

#### 15.2 KNOWLEDGE SHARING POST PROJECT

- CRWN's market entry rests on accelerating adoption and mitigating risk, so it will work with industry and public sector partners to phase the deployment sizes and use educational content to build awareness and generate demand for its solutions.
- The timing of significant marketing activities will be aligned with commercialization readiness of CRWN.ai's solution to generate awareness and demand. It will be heavy in content and ABM

tactics. The longer sales cycle and phasing of deployment size for the utility will also be supported with materials for the various stakeholders in the sales cycle, to educate and anticipate related objections and/or selection vetting.

- The geographic location of marketing activities will be primarily focused on North America, with emphasis in areas that have extreme weather conditions (temperature, precipitation, wind, storms, variations) as these are factors that most influence the health of the asset.
- Communication tools will be as follows: case study, long-form content (eg blogs), media interviews (driven by outreach and media release). Channels will be web, email, social and industry partners.

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