NSP HIDDEN OUTAGE PREDICTION MODEL

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Nova Scotia POWER
An Emera Company

Introduction

- Nova Scotia Power (NSP) is a regulated electrical utility serving over 525,000 residential, commercial and industrial customers in Nova Scotia, Canada.
- They Provide 95% of the generation, transmission and distribution services for NS.
- An Outage Management System (OMS) is used to track outages across the Province. Various storm types can damage the network and cause outages, but the current OMS cannot determine hidden outages.
- This delays the Estimated Time of Restoration (ETR) for customers and lengthens restoration times.

Objectives

- **Define and Identify Hidden Outages**
- **Build Hidden Outage Prediction Model**
- **Provide Data Visualization Output**

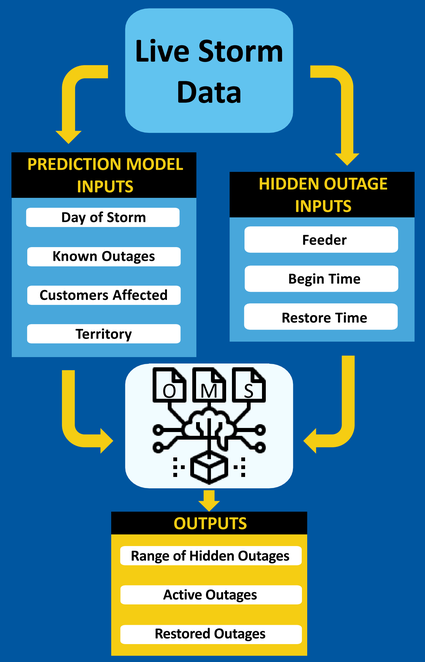
Identifying Hidden Outages

- A **Hidden Outage** is defined as an outage downstream of a recorded outage by the OMS on a power line that is not identified until the initial outage is restored.

1: Shows the Initial Recorded Outage by the OMS.
2: Represents a Hidden Outage downstream not discovered yet.

- Identifying a hidden outage from the raw data received from NSP is calculated by comparing the time when the outage was created in the OMS and the recorded time of this outage being restored for all known outage events.
- A hidden outage is the identified when the difference between the 'Restored Time' and 'Create time' for Events on the same Feeder line is less than 6-8 hours.

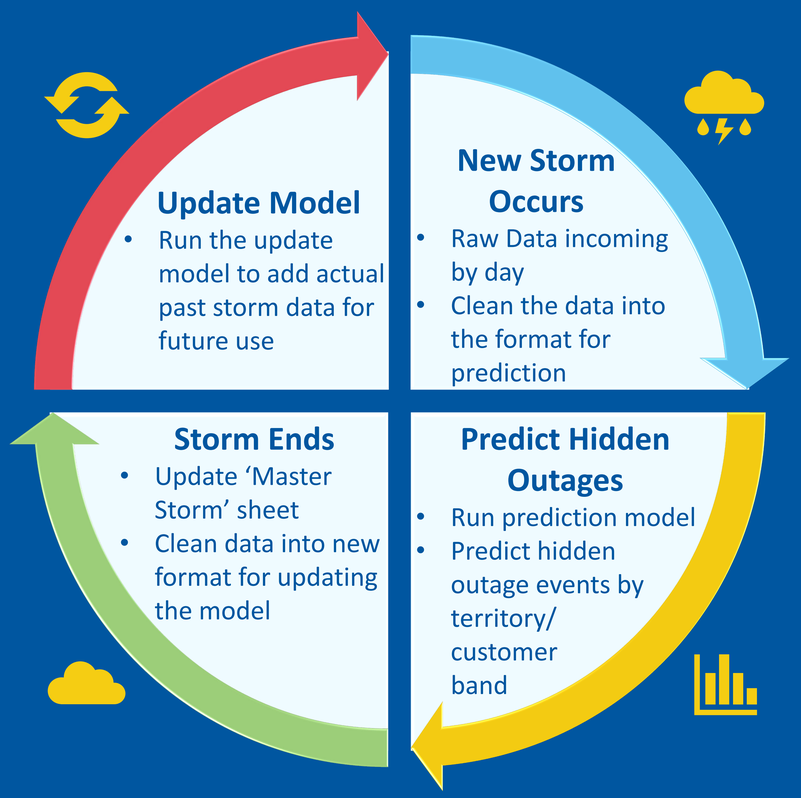
The Prediction Model



Summary of Model Building:

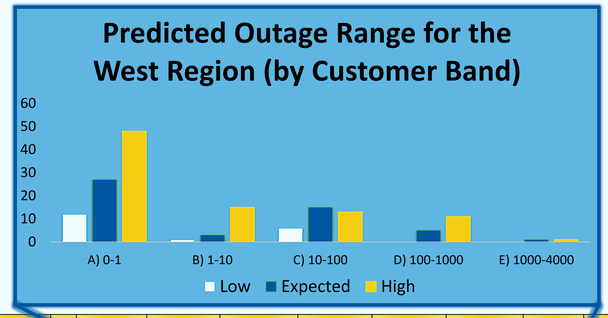
- **Correlation Analysis** → narrowed down the most applicable inputs from the raw storm data to use in the model.
- **Updated Data Format** → restructured the raw storm data to select specific inputs to use in the prediction model.
- **Prediction Code** → created a Python script to run the prediction model built with historical storm data, split into 2 processes.

Code processes:
Predict → runs the prediction algorithm on new storm data and provides a range of expected outages for each territory and respective customer band.
Update → appends new storm data in the updated format to 'Master Storm' sheet, to be used for the following storm.

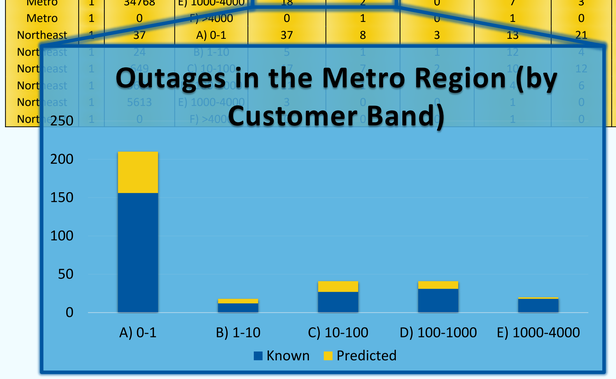


Results & Visualization

- The results include a range of predicted outages, the number of outages currently active, and the number of outages already restored.



Territory	Day	Total Known Customers	Customer Band	Total Known Outages	Predicted Outages	Prediction Range - Low	Prediction Range - High	Remaining Active	Already Restored
Cape Breton	1	32	A) 0-1	32	1	0	11	23	9
Cape Breton	1	21	B) 1-10	3	0	0	12	3	0
Cape Breton	1	118	C) 10-100	4	0	0	3	2	1
Cape Breton	1	2525	D) 100-1000	8	0	0	4	6	2
Cape Breton	1	6801	E) 1000-4000	4	0	0	1	2	2
Cape Breton	1	4628	F) >4000	1	0	0	1	0	1
West	1	86	A) 0-1	86	27	12	48	68	18
West	1	42	B) 1-10	10	3	1	15	9	1
West	1	1538	C) 10-100	36	15	6	13	22	14
West	1	7099	D) 100-1000	21	5	0	11	9	12
West	1	3292	E) 1000-4000	3	1	0	1	0	3
West	1	0	F) >4000	0	0	0	1	0	0
Metro	1	156	A) 0-1	156	54	14	60	124	32
Metro	1	59	B) 1-10	12	6	0	15	8	4
Metro	1	1184	C) 10-100	27	14	3	19	19	8
Metro	1	9907	D) 100-1000	31	10	4	11	17	14
Metro	1	34768	E) 1000-4000	18	2	0	7	3	15
Metro	1	0	F) >4000	0	1	0	1	0	0
Northeast	1	37	A) 0-1	37	8	3	13	21	16
Northeast	1	24	B) 1-10	5	1	0	12	4	1
Northeast	1	1	C) 10-100	1	0	0	1	12	5
Northeast	1	1	D) 100-1000	1	0	0	1	6	5
Northeast	1	5613	E) 1000-4000	3	0	0	1	0	3
Northeast	1	0	F) >4000	0	0	0	1	0	0



- These predictions will help in NSP's current restoration efforts as they can efficiently keep track and plan for expected outage events by day, whilst also keeping tab of total restored and remaining active events after a storm.

Recommendations

- Update data collection process:
  - Create a standard and known definition for a hidden outage, including a defined timeframe for calculation.
  - Begin documenting which events are hidden outages based on the standard definition.
- Adapt model to implement machine learning tools to improve accuracy and further automate the process.

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