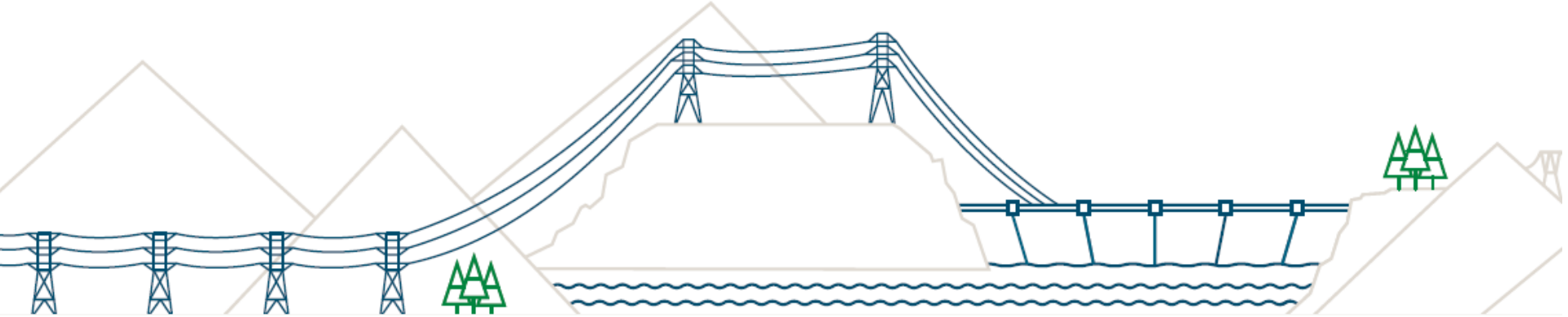
Load Research at BC Hydro

WLRA Spring 2021

BC Hydro Customer & Energy Analytics

Cathy Rupp



April 15, 2021

BC Hydro
Power smart

Contents

- ✓ Background
- ✓ Desired Accuracy
- ✓ Load Profile Process/VEE
- ✓ Sample Design in SMI world
- ✓ Load Research Applications
- ✓ Future Work

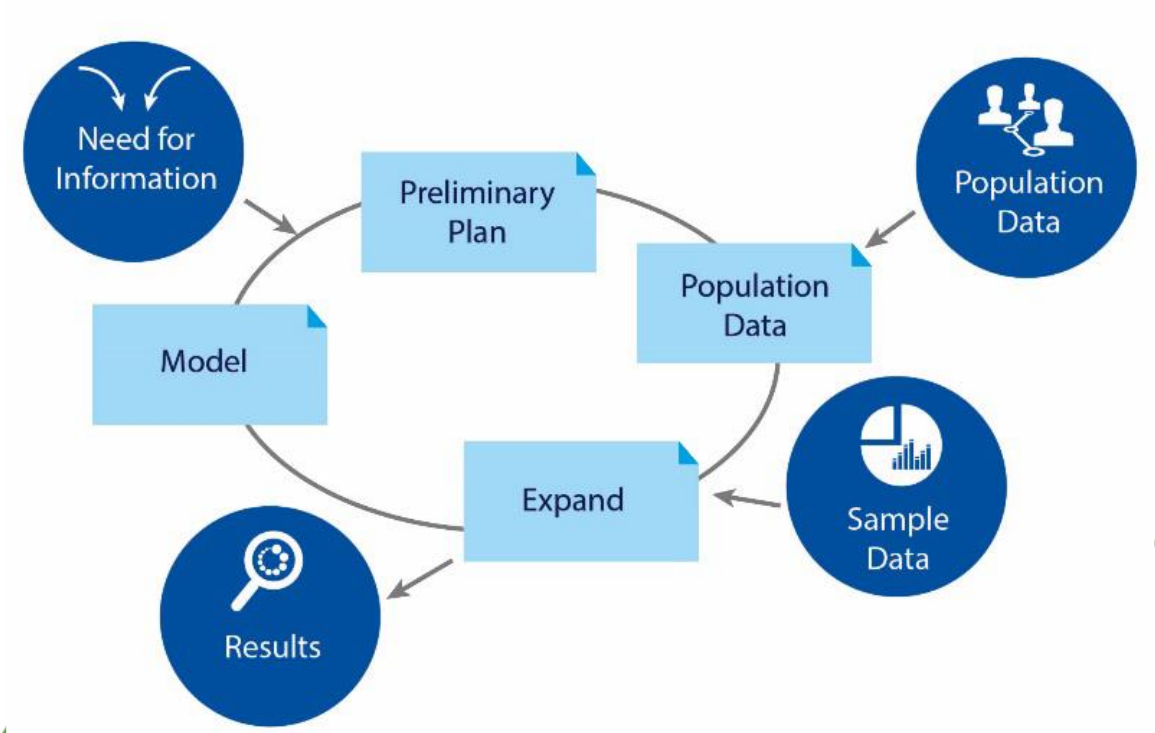
BC Hydro
Power smart

Background

- In 1978, Public Utilities Regulatory Policies Act (PURPA) required the utility industry to develop **statistically valid** load research programs as a basis for cost-of-service filings.
- BCH introduced PURPA based **Load Research** in 1992 as a result of 1991 Rate Design Application from BCUC.
- Load research progressed from its primary role in class cost allocation and rate design to other purposes such as supporting distribution planning, conservation potential, load forecasting etc.

Develop Load Profile

Load Research Life Cycle



Source: Load Research Manual (AEIC)

BC Hydro
Power smart

Desired Accuracy

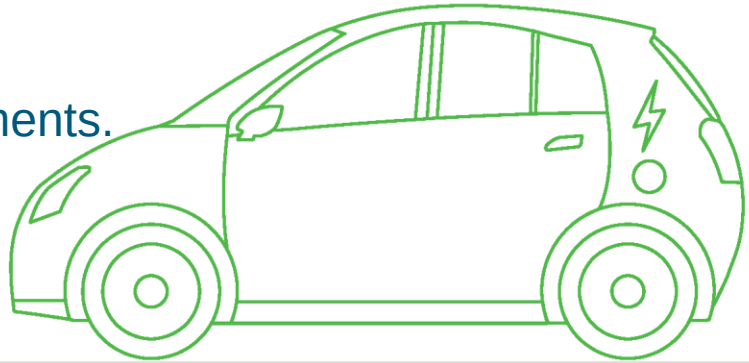
Information: Hourly load profiles for certain class/sector to support variety of business functions or program developments.

Common Practice:

Defined in Public Utility Regulatory Policy Act (PURPA) - 1992

+/- 10% error bound at the 90% confidence level (90/10) at the system and class peak for all major rate classes.

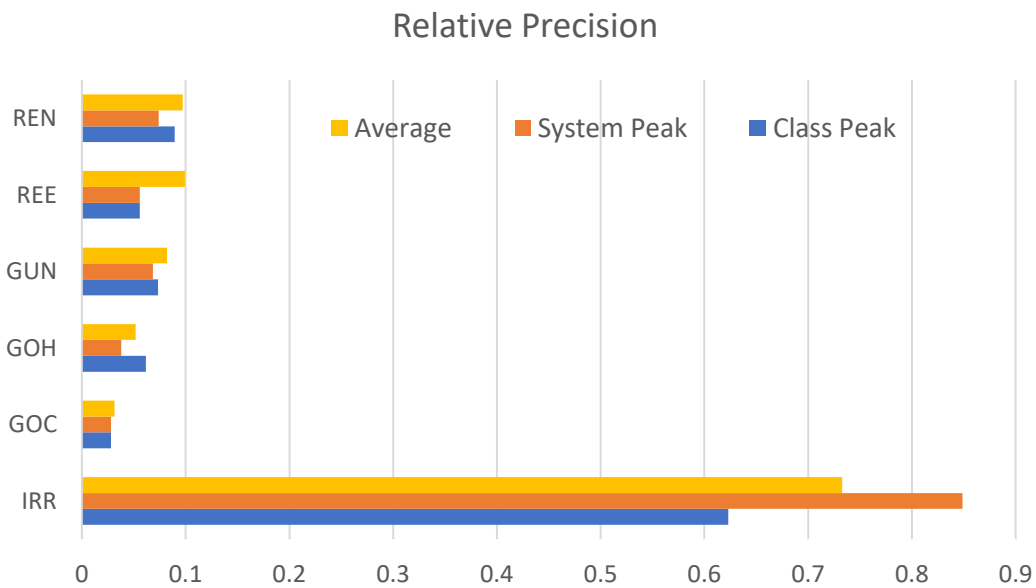
Particularly for regulatory requirements.



Before Smart Meter Infrastructure (SMI)

Small sample size (~1400 samples only). Most met 90/10.

With classes that have large variance, precision can't be met.



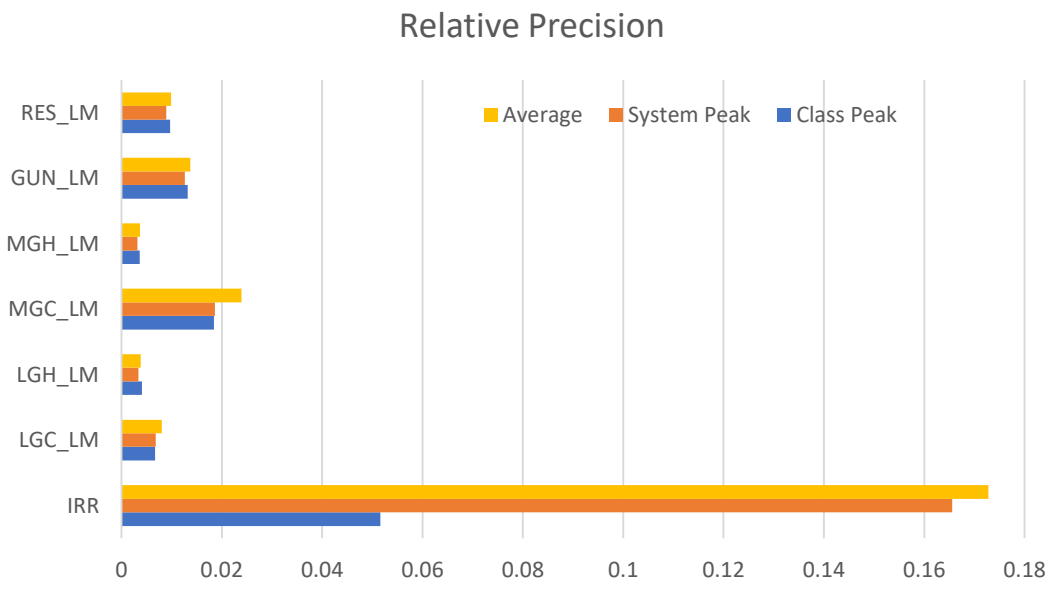
Rate Class	Population	Samples
REN	1,169,665	147
REE	650,255	154
GUN	159,167	153
GOH	22,160	374
GOC	2,817	404
IRR	2,993	20

BC Hydro
Power smart

After Smart Meter Infrastructure (SMI)

Large samples can achieve higher accuracy. Most met 90/2.

100% sampling if the population is small or the variance is large.



Rate Class	Population	Samples
RES_LM	1,105,518	37,766
GUN_LM	95,003	5,745
MGH_LM	9,897	7,899
MGC_LM	191	168
LGH_LM	3,517	3,104
LGC_LM	1,650	1,521
IRR	2,882	2,032

BC Hydro
Power smart

Load Research Revolution with SMI

Customer & Energy Analytics
BC Hydro-Customer Service

A team of utility analytical experts adapting in a changing landscape.

Delivering complex analysis of customer, energy, operational and spatial data

"Small Data"

Interval Data (15-minute):
- ~1,500 Recorders/Meters

Segmentation Data:
- SAS/CCS

Billing Data:
- ~1,873,000 Accounts Annual CCS kWh

Topology Data:
- DAD

"Medium Data"

Interval Data (Hourly):
- 80,000 Accounts (including all LGS/MGS)
- kWh/Voltage

Register Data:
- ~1,873,000 Daily SMI Register Reads

Segmentation Data:
- SAS/CCS

Billing Data:
- ~1,873,000 Accounts Monthly CCS kWh

Topology Data:
- DAD /CIM Topology (Weekly)

Enterprise Analytics "Big Data"

Interval Data (Hourly):
- 1,900,000 Accounts Hourly kWh/Voltage

Register Data:
- 1,900,000 Daily SMI Register Reads

Segmentation Data:
- SAS/CCS

Billing Data:
- 1,900,000 Accounts Monthly CCS kWh

Topology Data:
- DAD/CIM Topology (Daily)

F1996-F2013

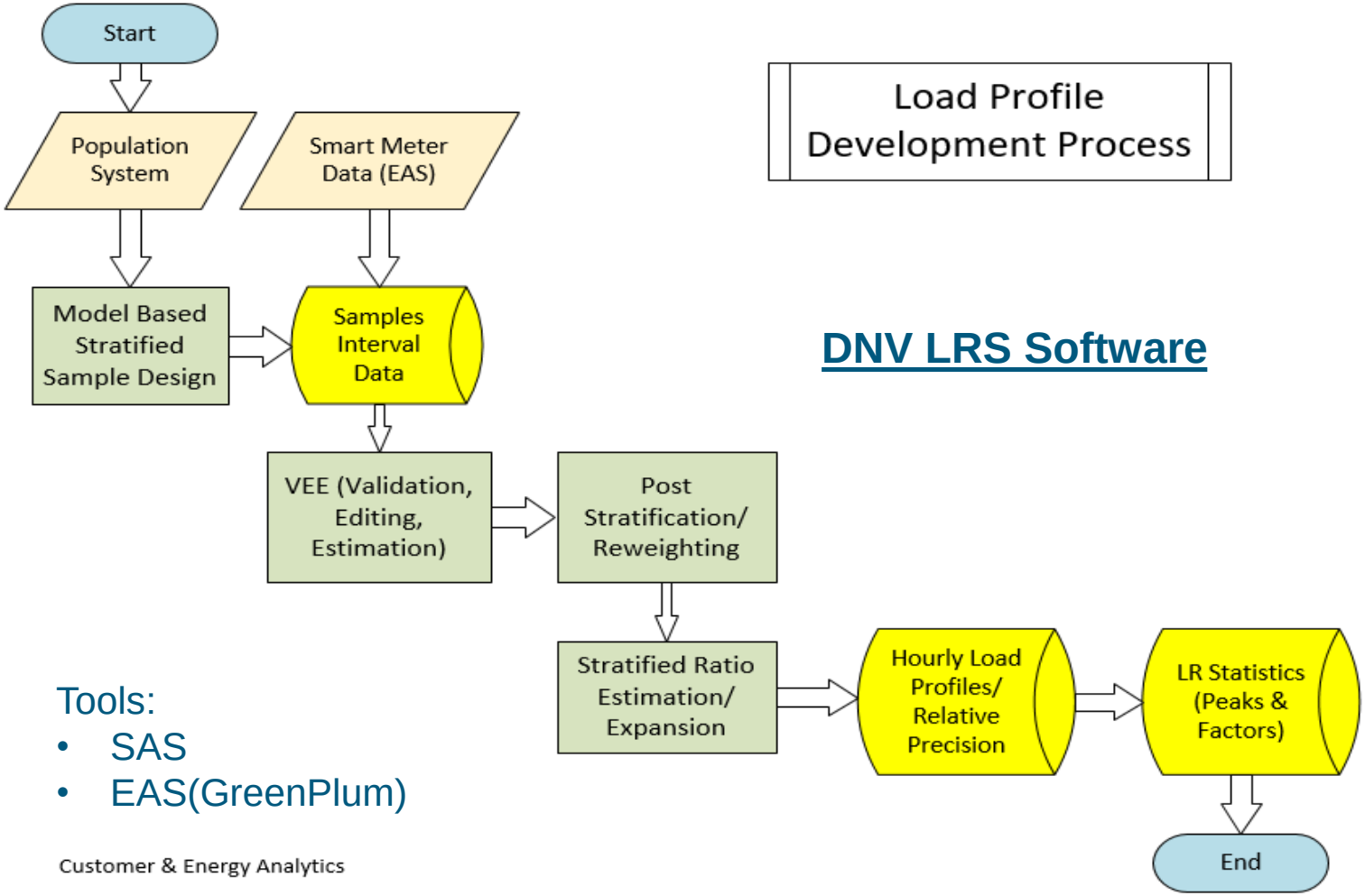
F2014-F2016

F2016 Onwards

Evolution of Major Data Sources and Tools
(for Customer Service, Distribution Planning, Distribution Engineering, Rates, Load Forecast, Regulatory, and Power Smart)

BC Hydro
Power smart

Load Profile Development Process



Load Profile Development Process

DNV LRS Software

Tools:

- SAS
- EAS(GreenPlum)

Customer & Energy Analytics

BC Hydro
Power smart

VEE (Validation/Editing/Estimating)

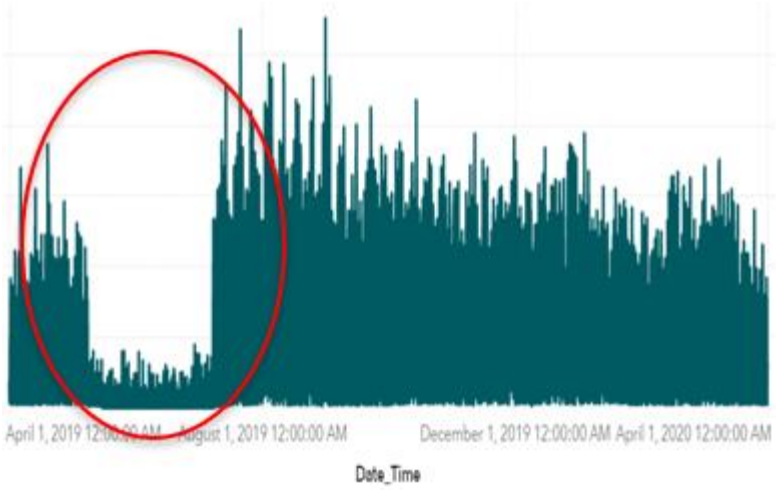
VEE is critical to the success of the load study.

- Causes of the errors
  - Meter exchange
  - Billing multiplier
  - Network communication etc.
- Validation
  - Bill check
  - Spike check, high/low usage check etc.
- Editing/Estimating:
  - Similar day pattern
  - Similar customer pattern etc.

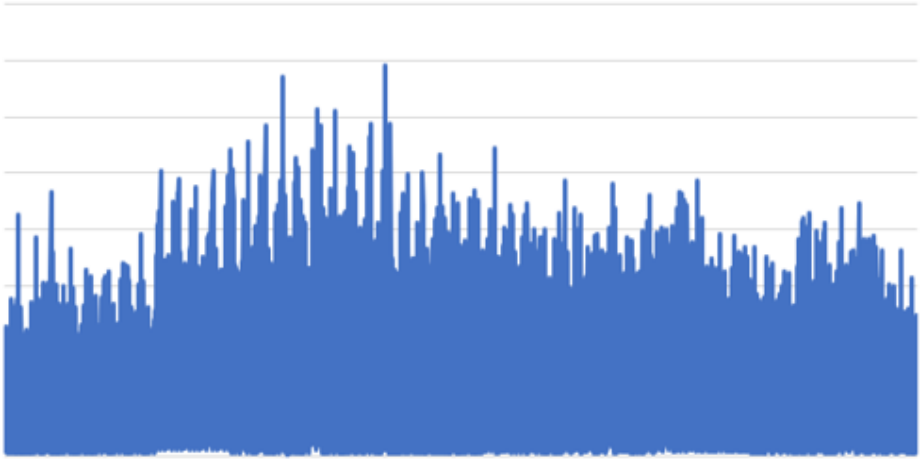
VEE (Validation/Editing/Estimating)

DC Fast Chargers

Using population.

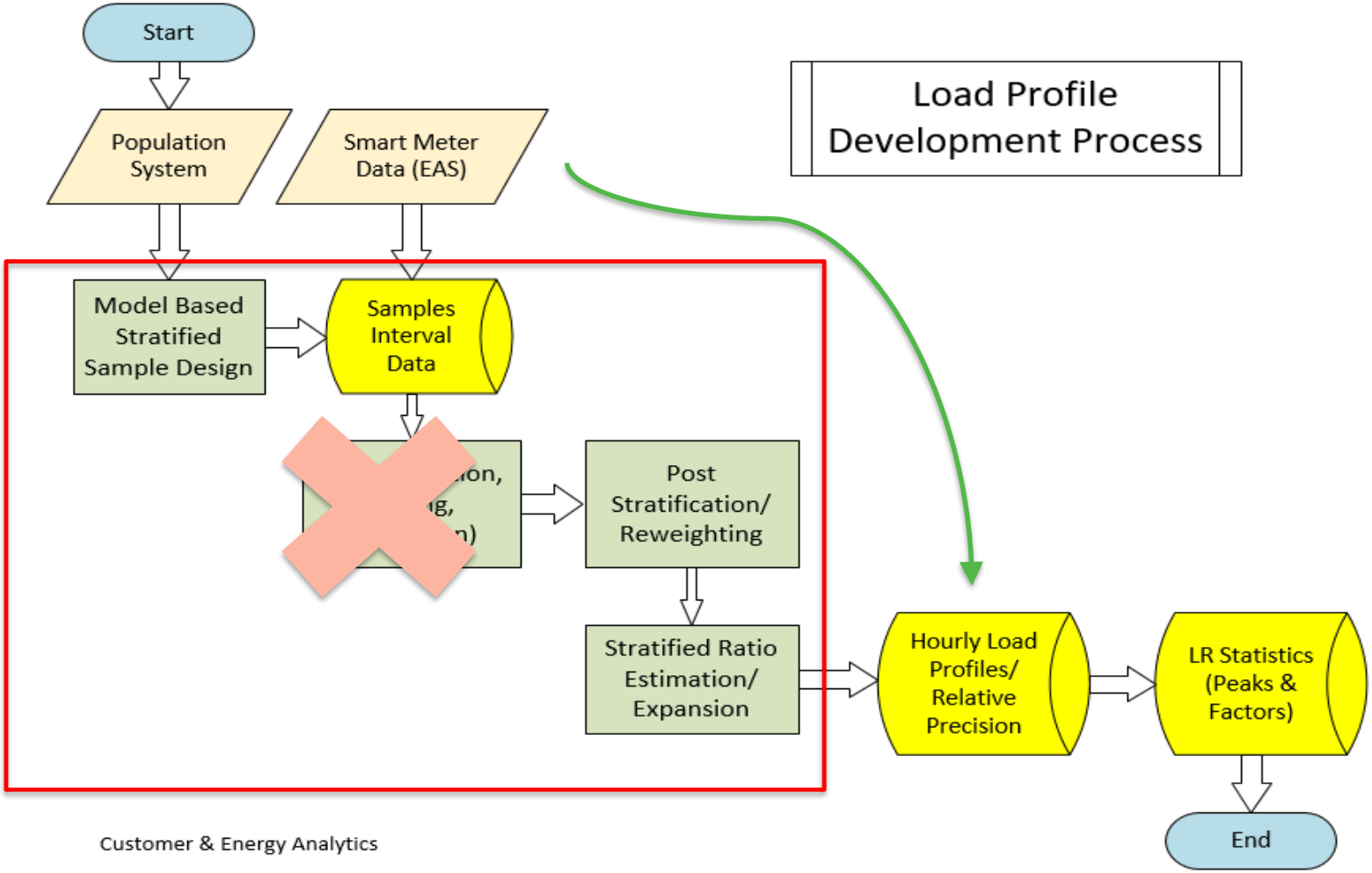


Apply VEE to population.



BC Hydro
Power smart

Load Profile Development Process

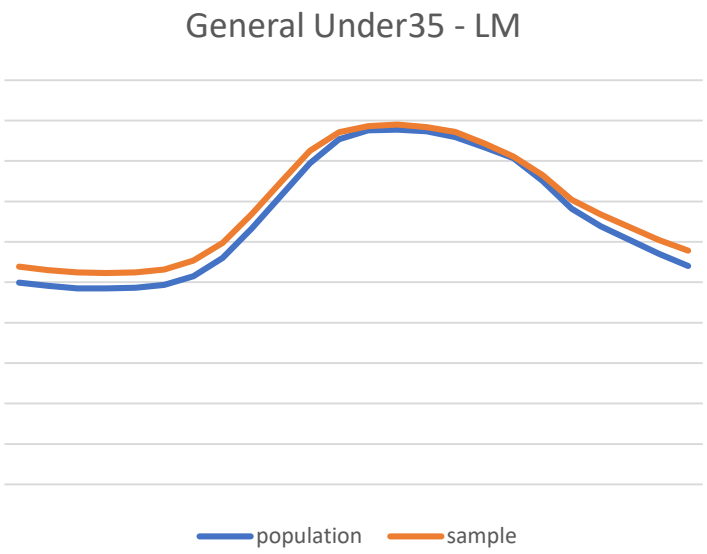


Customer & Energy Analytics

BC Hydro
Power smart

Comparison (Population vs. Samples)

On system peak day (January 14, 2020)



- Difference between both methods are between 1-10%.
- Samples were designed in 2013 and may not represent newer customers.
- Population includes EAS/SMI estimates and may not be 100% clean.

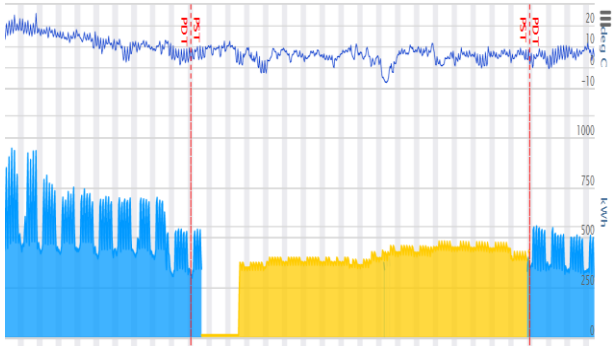
BC Hydro
Power smart

Summarize Population data

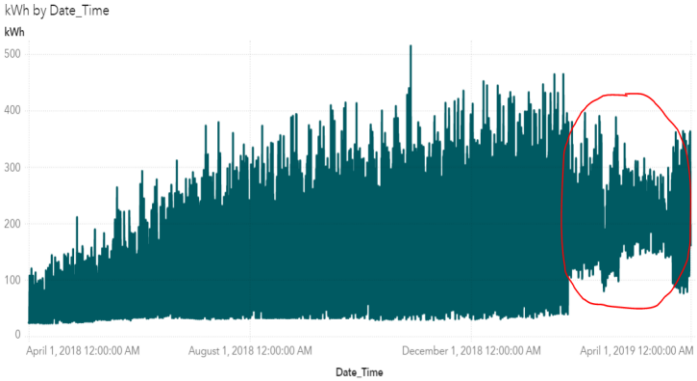
Challenges:

Data Quality:

- Always have missing or invalid data
- Impractical to check data for all population
- Estimates from MDMS/EAS can be inaccurate sometimes



Individual load profiles



Aggregated load profiles

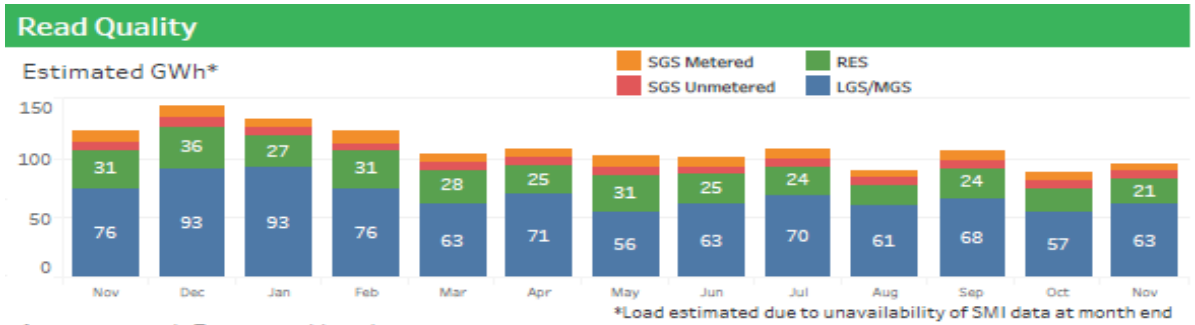
BC Hydro
Power smart

Summarize Population data

Challenges:

Data Availability

- Due to physical constraints or opting out SMI metering
- Use only SMI data can lead to bias in estimating class totals



Accounts with Estimated Load

	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov
LGS/MGS	545	648	655	649	679	661	556	843	837	765	690	690	659
RES	26,669	26,480	23,030	23,447	22,997	24,660	29,163	32,052	29,261	26,744	27,579	23,588	23,155
SGS Metered	3,786	3,809	3,534	3,953	3,772	3,934	4,229	4,484	4,438	4,119	4,305	3,917	3,792
SGS Unmetered	18,115	18,184	18,090	18,262	18,232	17,425	18,571	18,696	18,687	18,640	18,847	18,811	18,826
Grand Total	49,115	49,121	45,309	46,311	45,680	46,680	52,519	56,075	53,223	50,268	51,421	47,006	46,432

BC Hydro
Power smart

Summarize Population data

Challenges:

Cost & Speed

- Cost associated with big data storage and faster processing power
- Processing VEE routines takes longer computing time and analysts' time for population

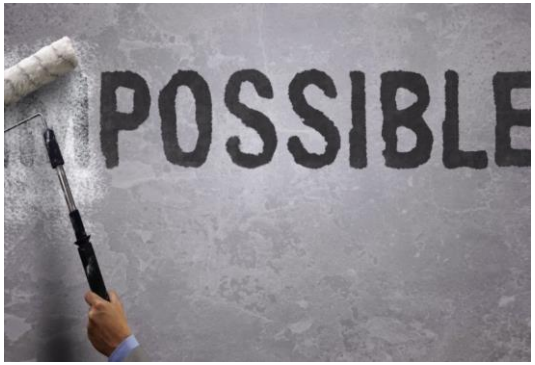
Managing Customer Churn

- Regulatory requirements mostly target general customers in a certain rate class. Frequently move in/out customers can produce misleading analysis. (15% customers move in/out every year.)

BC Hydro
Power smart

Summarize Population data ???

It is possible in the future.



- Data accuracy continue to improve in the source, such as MDMS provides better data.
- Data storage is not an issue.
- Processing power is faster
- Cost is lower
- Data science technique (ML/AI) can be easily implemented in GP

In fact, we used it for real time load monitoring and load tracking tool. It was used for tracking COVID impact last year as well as for variance analysis, load forecasting etc.

BC Hydro
Power smart

Load Profile Summary

In BC Hydro, load profiles development in SMI world

- Design large statistical representative samples
- Apply different VEE process for samples and population
- Use common statistical load research modeling to generate load profiles
- Calculate load research statistics such as peaks, load factors and coincidence factors based on business needs.

Load Research Report Tool

A SAS/VA tool to review the load profiles.

Load Research Report
by Customer & Energy Analytics

This load research report is intended to help the organization study the characteristics of electricity usage of our customers and provide insights on energy usage patterns and trends. The knowledge are used to support various business functions and program developments. For more information, please visit the 'About' page.

Last Modified:

Load Profile by Sitecode

COM | IND | RES | Residential - High-Rise Apt Suites (Elec Heat) | LM | N | SI | VI | F18 | F19 | F20

Hourly Load | Daily Load | Monthly/Annual Load | Hourly Load by Day Type | Hourly Load by Weekday | Peaks & Factors | About

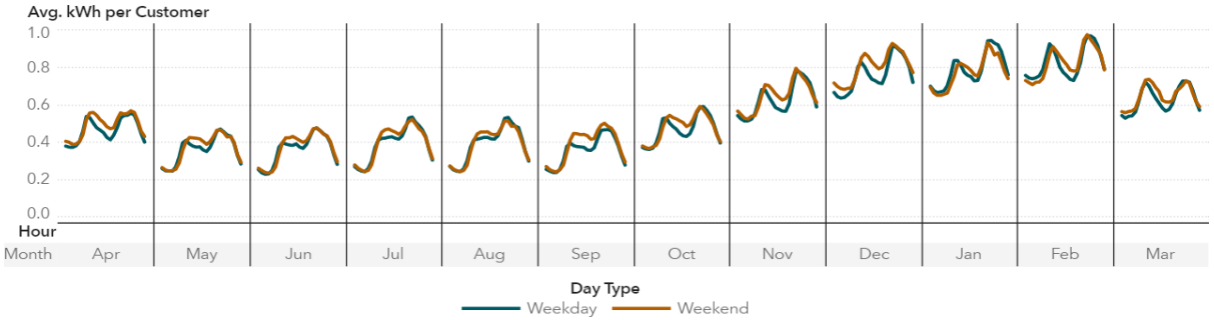
System Load | Rate Class | S

Saturday, April 1, 2017 to Tuesday, March 31, 2020

Saturday, April 1, 2017 — Tuesday, March 31, 2020

- Select Sector, Sitecode, Region, Fiscal Year and Date range from filters above

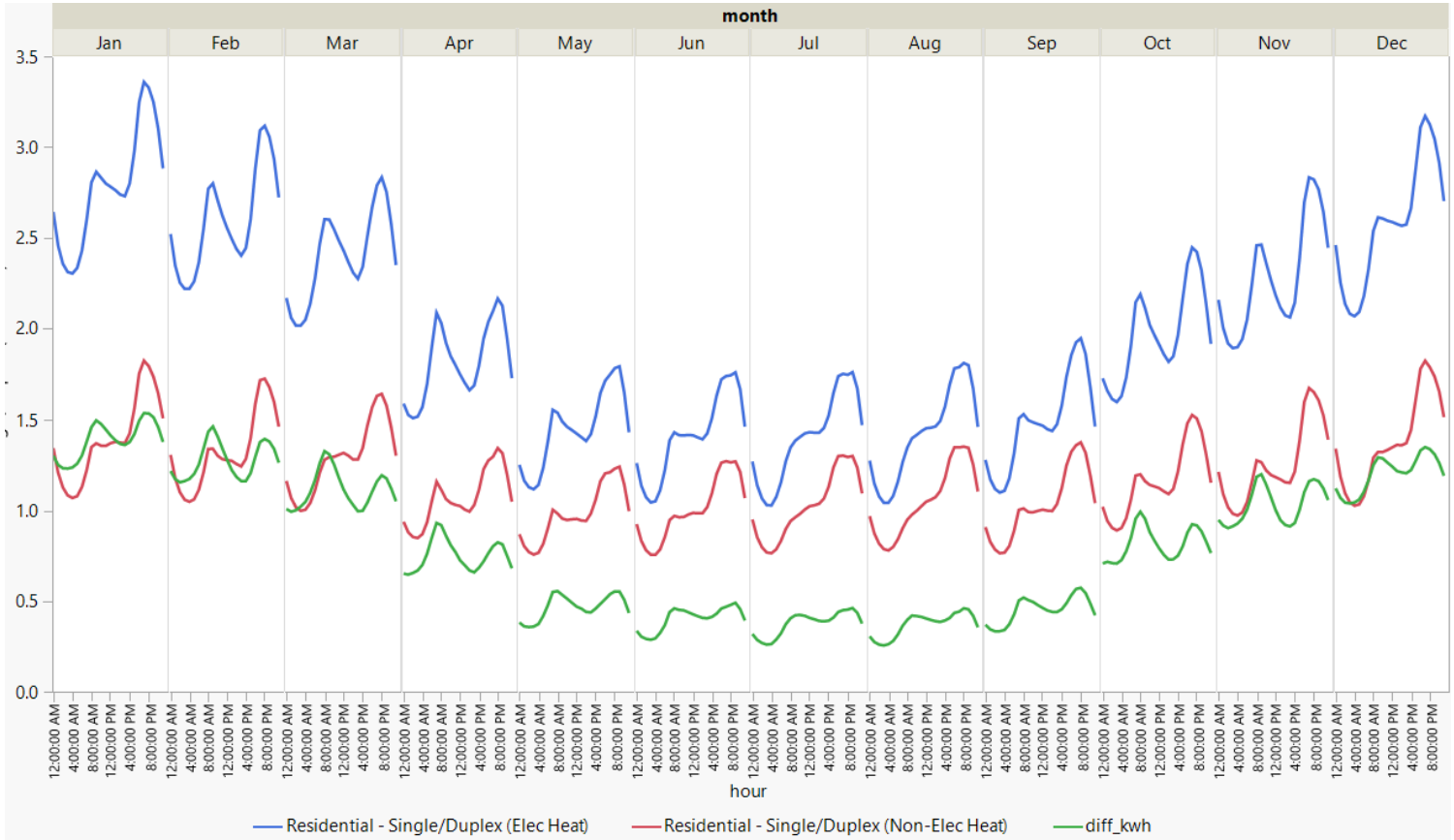
Average Hourly kWh by Weekday/Weekend



BC Hydro
Power smart

End Use Profiles

Identify water heating and space heating load profiles.

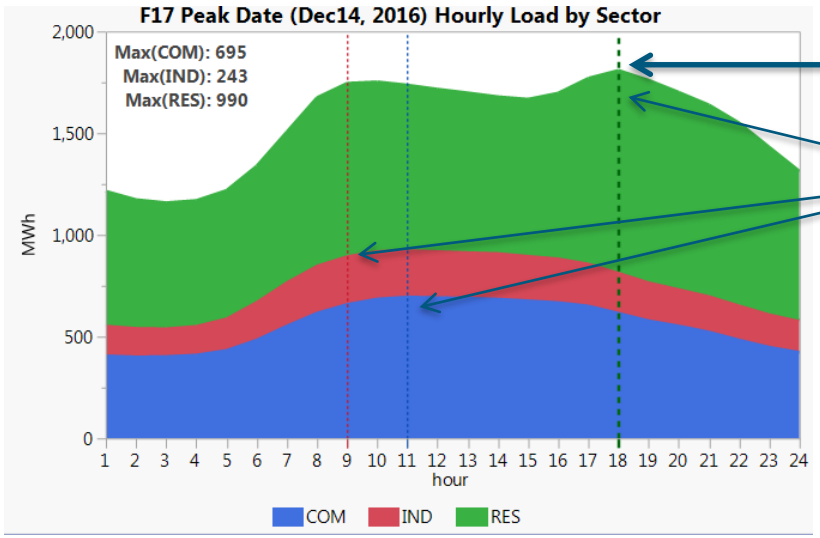


BC Hydro
Power smart

LR Application – Distribution Load Forecasting

Regional and substation/feeder load analysis to support distribution load forecasting

Load Research is able to answer questions to determine how much each sector contribute to the area peak.



Coincident Peak (Hour 18)

Non-Coincident Peak

Coincident Peak (MW)

Sector	F2017
COM	615 (34%)
IND	205 (11%)
RES	990 (55%)
Area Peak	**1810**

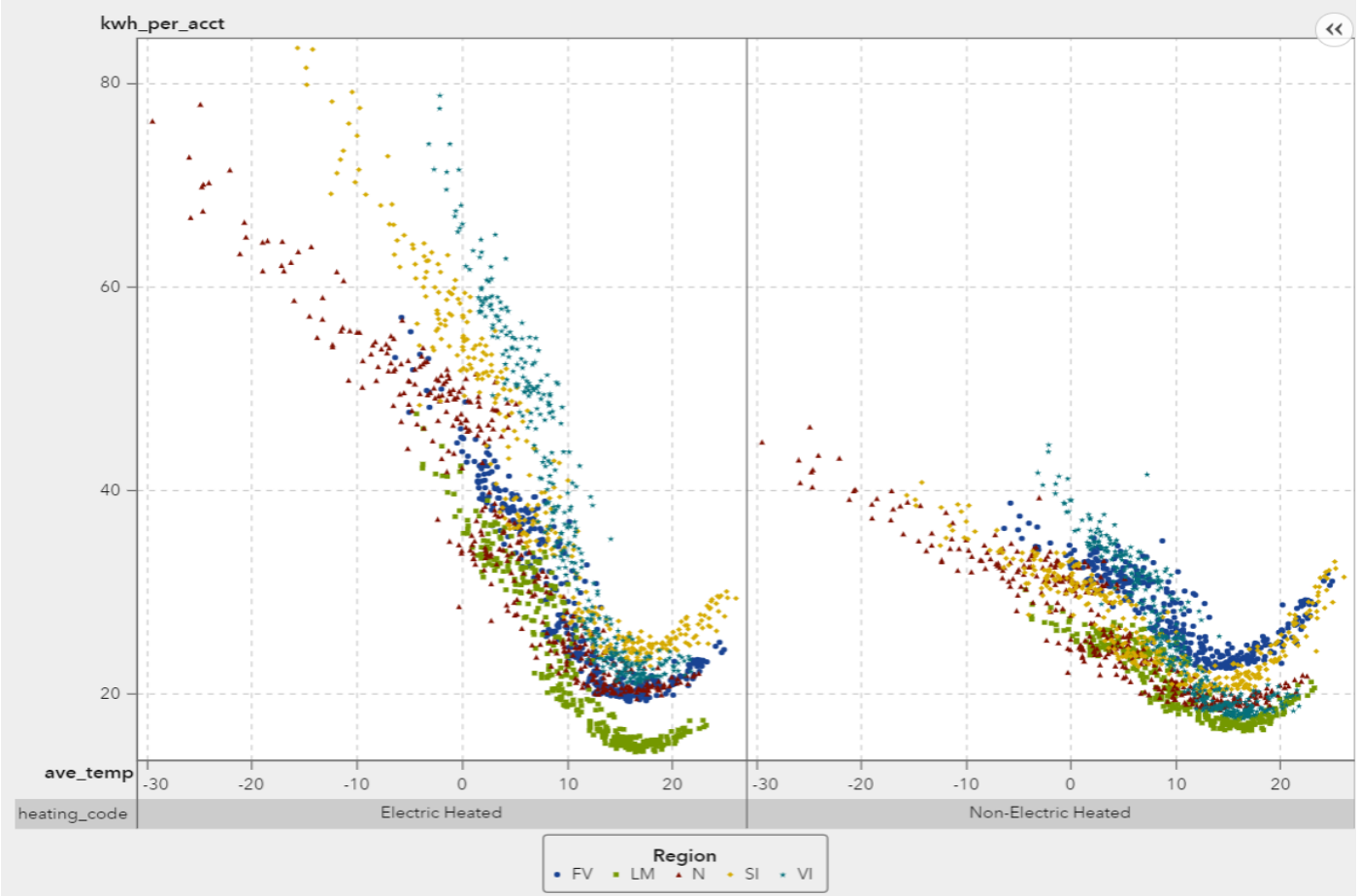
Non- Coincident Peak

Sector	F2017
COM	695 (36%)
IND	243 (13%)
RES	990 (51%)
Area Peak	**1928**

BC Hydro
Power smart

LR Application – Energy Load Forecasting

Understand weather response for energy and peak
- for load forecasting and variance analysis



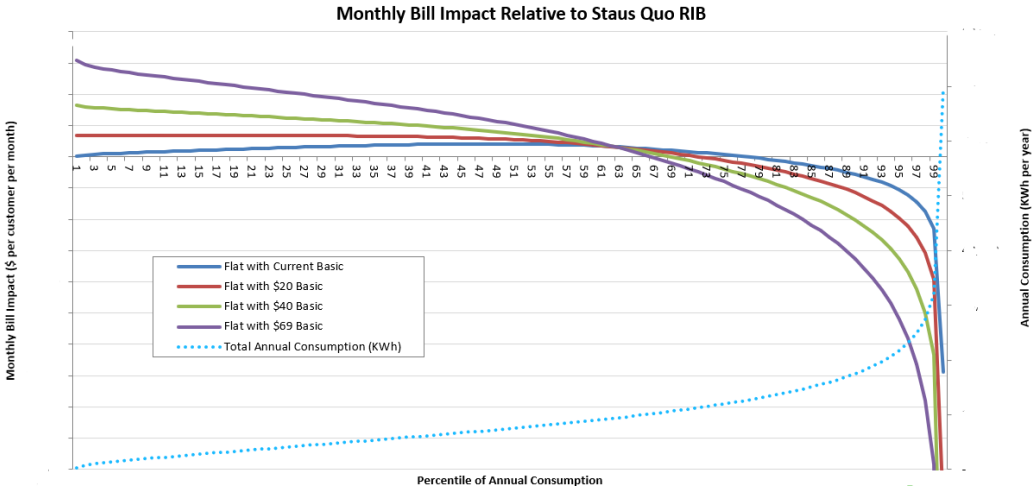
BC Hydro
Power smart

LR Application – Customer Segmentation & Bill Impact Analysis

Support customer service to do some preliminary analysis for special sector.

Load Research data is used to:

- Identify special sector's load behavior
- Produce bill impact and revenue impact
- Explore options to mitigate impact



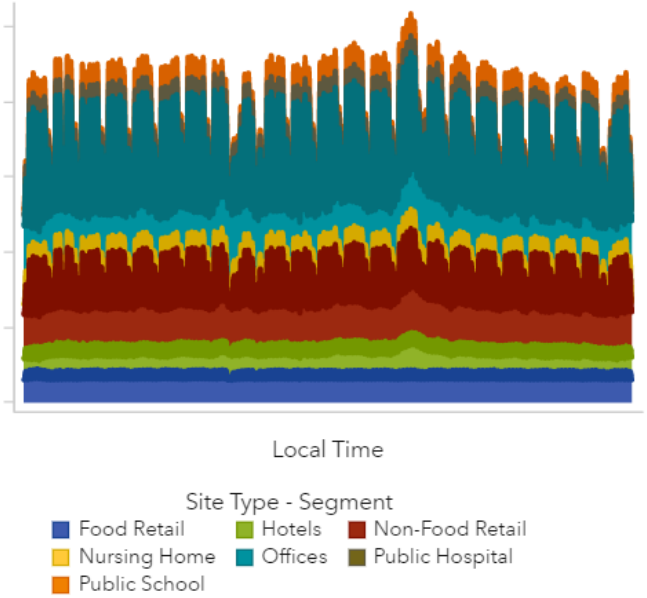
BC Hydro
Power smart

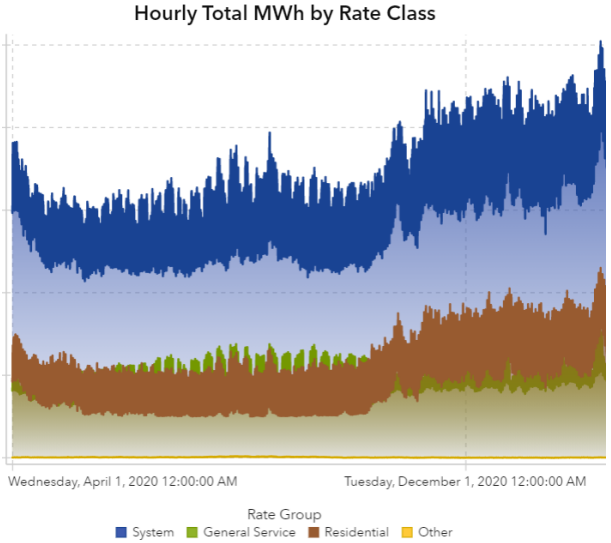
LR Application – Load Monitoring

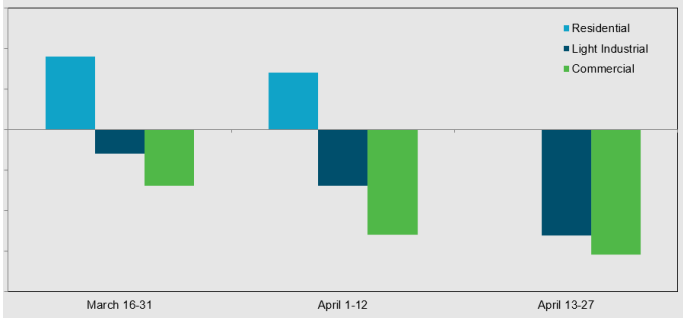
Tracking impacts of COVID on customers' load behavior

Load Research data is used to:

- Load impact on system level and by rate class and business type.







BC Hydro
Power smart

Future Work

- Weather normalized load profiles
- Study the load profiles change over the years
- Large end use load profiles
- Documentation and share with the our stakeholders

Load Research Embedded in Customer & Energy Analytics

Operational Systems & Data Sources → Data Extracts & Reports → BI Tools (Prod) → Self-Serve Tools (Agile) → Analytics Systems (Prod)

BC Hydro Power smart

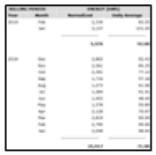
SAP | GIS | MDMS | MV90 | GATEWAY | SCADA | IVR | SSO | Upaknee | PowerOn | xRM | Others

External: Weather | Property | Muni | TGI

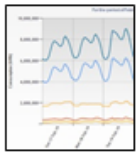
SCHEDULED EXTRACTS
LGS/ MGS Billing
LGS/MGS PF List
Site Code list for DAD
DLSR substation load profile
FACOS Load Profiles
Feeder Daily Peak
Dist. Load Profiles and RCIA%

BI REPORTING
Top 100 Companies
EDX Daily Summary
CTI Report
EC Transaction Log
MyHydro Daily Report
SSO Operations Report
RevStats Report

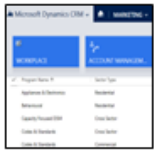
Customer Data Requests (CDR)



AHR
(750 users)

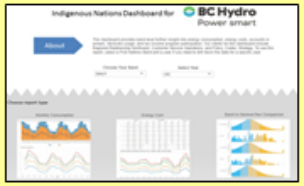


DLSR
(25 users)



xRM
(Used by CEM / KAM)

Res Bill Comp Tool
(As of Nov 152 views)



EAS Revenue Assurance
(40 users)

EAS Non-RA
(160 users)

Customer and Energy Analytics Environment

Static Reports | Dynamic Data Use | Analytic Systems

SAS/R/SQL/Python
(Sampling, Cleansing, Aggregation, Modeling, Research)

GreenPlum | Data Lake (Hadoop)

Business Analysts/ Decision Makers
Data Analysts/ Data Scientists
IT/ Administrators

External Information Requests
Government, Regulator, Customers, Universities

Future Open Data Analysis

Cloud Analytics Solutions
awesense

ydro smart

BC Hydro
Power smart