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C. G. Corlu, S. R. Hunter, H. Lam, B. S. Onggo, J. Shortle, and B. Biller, eds.

A SIMULATION-BASED DECISION SUPPORT TOOL FOR DIRECT CURRENT FAST CHARGER INSTALLATIONS

Cathy Rupp
Yanan Sun
Parvir Girn

BC Hydro Customer & Energy Analytics
333 Dunsmuir Street
Vancouver, BC V6B 5R3, CANADA

Deep Jariwala
Suellen Ventura
Scott Nason

SAS Institute (Canada) Inc.
280 King Street E.
Toronto, ON M5A 1K7, CANADA

Bahar Biller

SAS Institute Analytics Center of Excellence
100 SAS Campus Drive
Cary, NC 27513, USA

ABSTRACT

We develop a simulation-based tool for supporting direct current fast charger (DCFC) installation decisions. Our simulation captures details of the DCFC network configuration, non-stationary arrival patterns of the electric vehicles to the fast charging DCFC stations, various DCFC attributes, charging time distributions, and customer behavior. The statistical analysis of the simulation generated output data produces various key performance indicators (KPIs) including DCFC utilizations, number of electric vehicles charged and left uncharged, and queueing experience of the customers. One of the key challenges of developing this simulation is its validation: we have validated the simulation with the historical DCFC charging session data and past observations of the DCFC utilizations. The resulting data-driven simulation is used for supporting DCFC planning through its capability to conduct scenario analysis and predict various KPIs.

1 INTRODUCTION

The Province of British Columbia is on a path to greatly reduce emissions by 2030 and meet a net-zero emissions target by 2050. Key to that is the role of BC Hydro as the crown corporation responsible for electric generation, transmission, and delivery. Part of BC Hydro's role in helping the province meet its targets includes reducing the barriers to adopting electric vehicles (EVs). An efficient network of charging infrastructure is a critical component of the strategy to encourage EV adoption. BC Hydro and SAS worked together to develop a digital twin of their Direct Current Fast Charger (DCFC) network to simulate traffic through the charging stations and predict hourly utilization of every DCFC in this network.

2 BENEFITS

The digital twin serves a virtual laboratory where BC Hydro can predict the performance of any number of DCFC installation decisions in the digital world before making any real changes to their existing DCFC network. Thus, the digital twin provides BC Hydro enhanced visibility into the future and enables playing operational what-if games. It is through the availability of this digital twin technology that BC Hydro is ready to enhance customer experience while ensuring high utilization of the capital-intensive DCFCs to recover the cost of their installations. Furthermore, BC Hydro's digital twin supports energy forecasting for DCFCs and operational work planning for planned outages and system maintenance. As a result, BC Hydro is now more equipped than ever to build the right DCFCs at the right time and place to service British Columbia's increasing needs for comprehensive EV charging infrastructure.

3 DEVELOPMENT STEPS

At the foundation of our work lies a discrete-event stochastic simulation model. The goal is to share our experience of using discrete-event simulation to better support DCFC installation decisions with the Winter Simulation Conference community. There are three key development steps (see Figure 1): (1) description of the EV flow logic; (2) representation of EV, DCFC, and site attributes (and capturing their uncertainties) and execution of the stochastic simulation to obtain KPI predictions; (3) design of a scenario analysis to help optimize DCFC installation decisions. These development steps are illustrated in Figure 2 and implemented by using SAS software where we use its simulation and visual data mining and machine learning capabilities in an integrated manner to make good DCFC installation decisions under uncertainty.

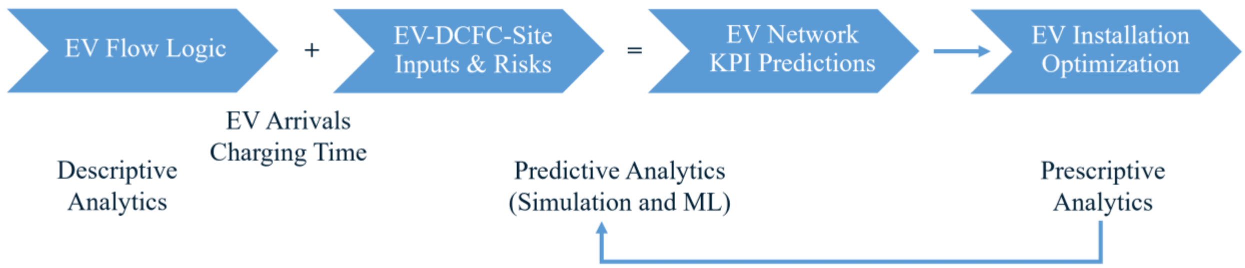

Figure 1: Key Development Steps: Description, Prediction, and Prescription.

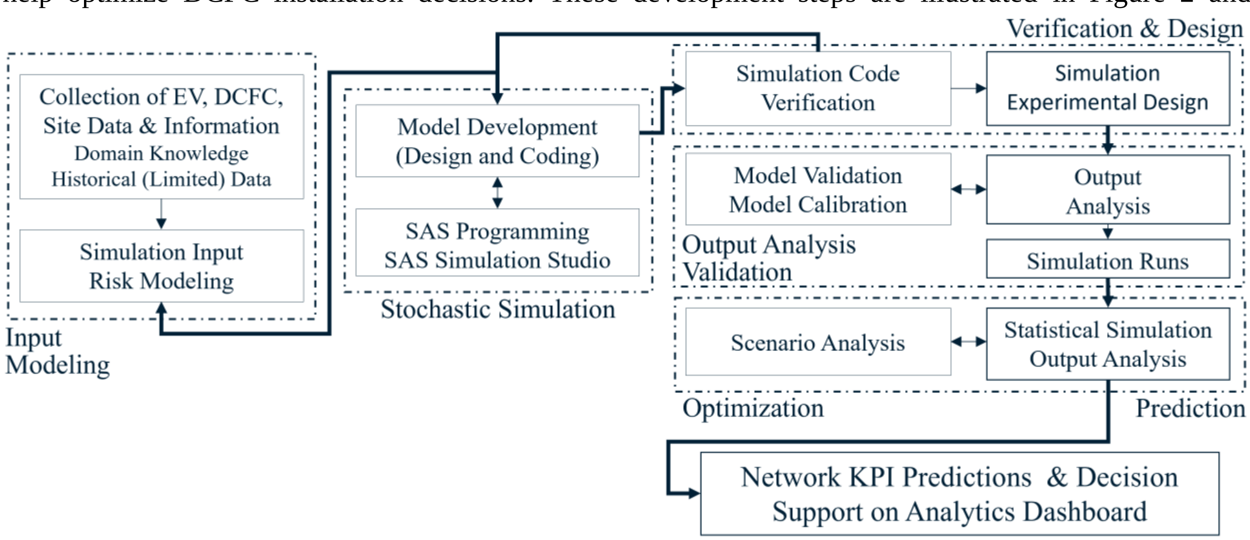

Figure 2: EV – Site – Network Analytics Lifecycle.

4 CONCLUSION

Each of the development steps in Figure 2 will be discussed in detail together with key implementation challenges that we have overcome. Simulation with its capability of representing uncertainty and offering explainable analytics is a key critical component of most digital twin development projects. We utilize these aspects of the simulation technology to the fullest in this work to support DCFC installation decisioning.