

Characterizing Residential Electrical Panel Constraints and Identifying Affordable Solutions to Accelerate Equitable Electrification and Decarbonization

Affordable and Equitable Residential Electrification Under Electrical Panel and Service Constraints

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Industry Partners:



PROBLEM STATEMENT

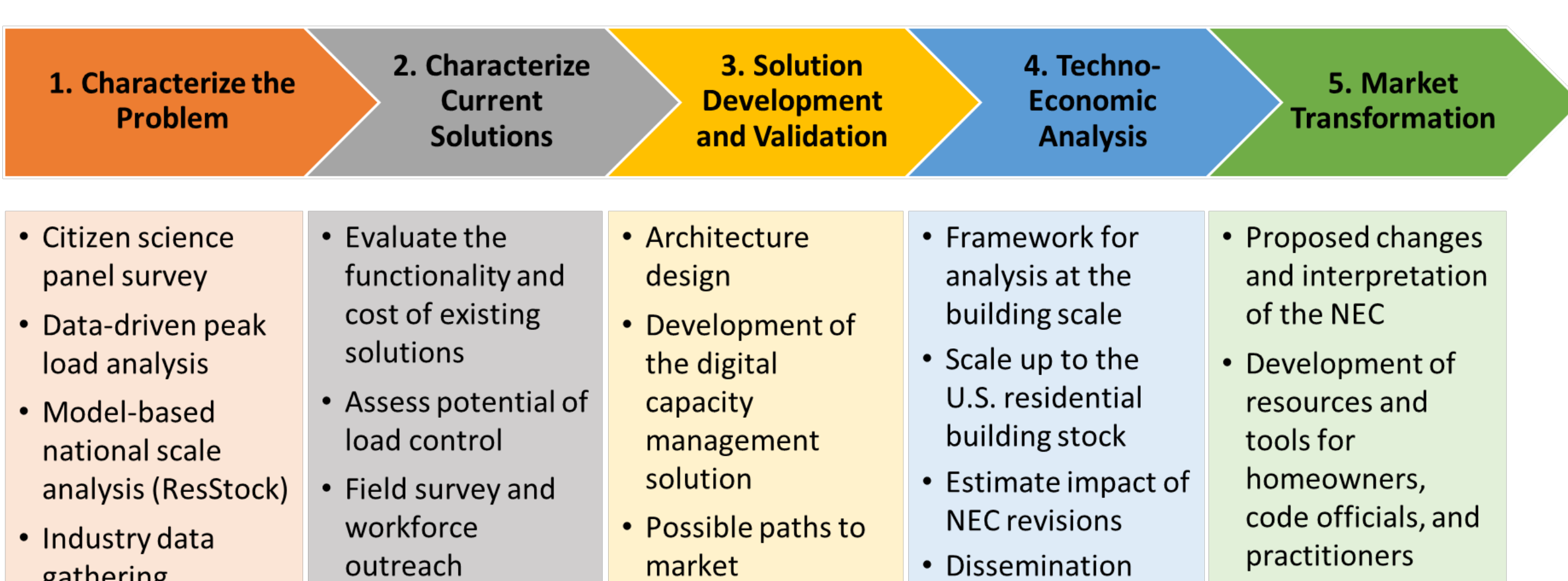
- Decarbonization of homes will require electrification** of currently fuel-fired end uses and introduce new electric end uses such as electric vehicles and heat pumps.
- Low-capacity and space-limited panels in vintage homes **cannot accommodate the new loads**.
- Due to long wait times or high costs, **upgrading electrical panels is not always feasible**—especially for low-income families—and there are upstream impacts on the distribution grid.
- There are **very few existing studies** that characterize the challenge or identify potential solutions.

OBJECTIVES

- Characterize the size of the electrical panel capacity problem.
- Characterize current solutions through engaging stakeholders and laboratory assessment.
- Develop new technology for digital management of panel capacity.
- Understand cost-effectiveness of efficiency and other solutions across diverse housing characteristics and geographies.
- Revise or clarify compliance paths in the National Electric Code (NEC) to support affordable and equitable electrification.

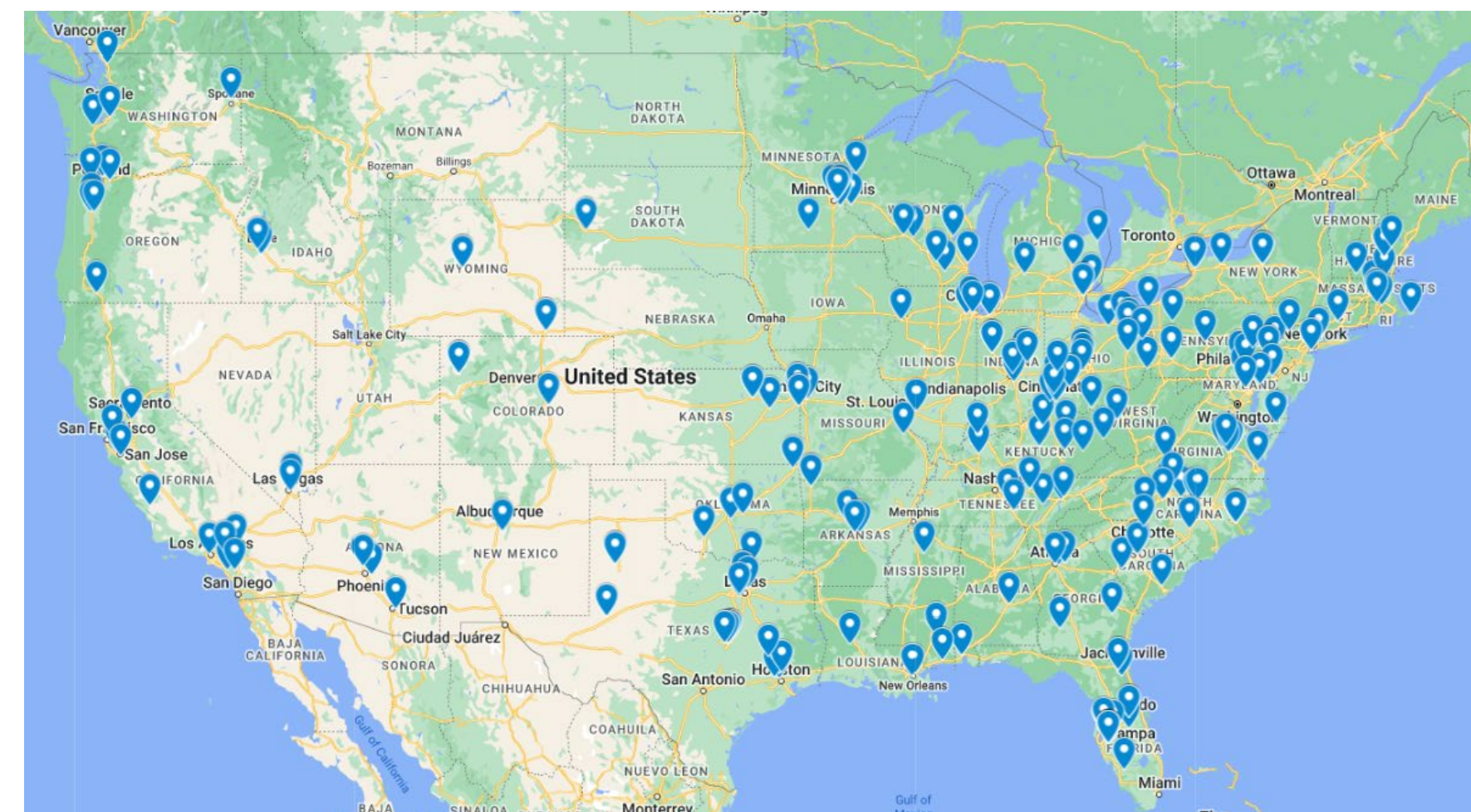
APPROACH

NREL and LBNL, along with industry partners, will characterize the panel capacity problem to inform **future policy and program design**, identify and evaluate **low-cost solutions**, and propose changes to NEC to advance **affordable and equitable electrification**.



Highlights

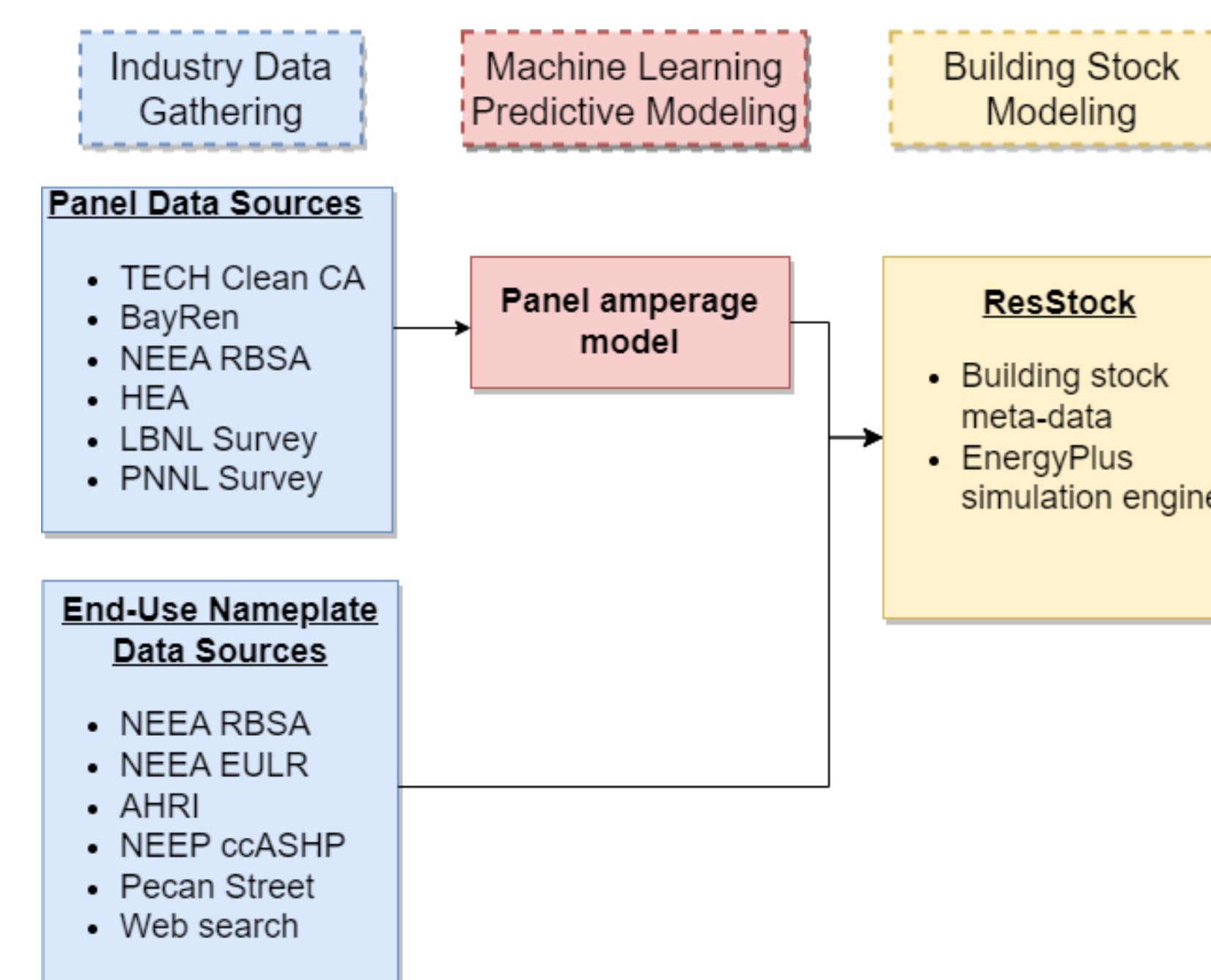
National Survey of Electrical Panel Capacities



Collected ~300 homes with legitimate data, covering most states. Left: Submissions by zip code. Right: Typical photos obtained through survey (whole panel and main).

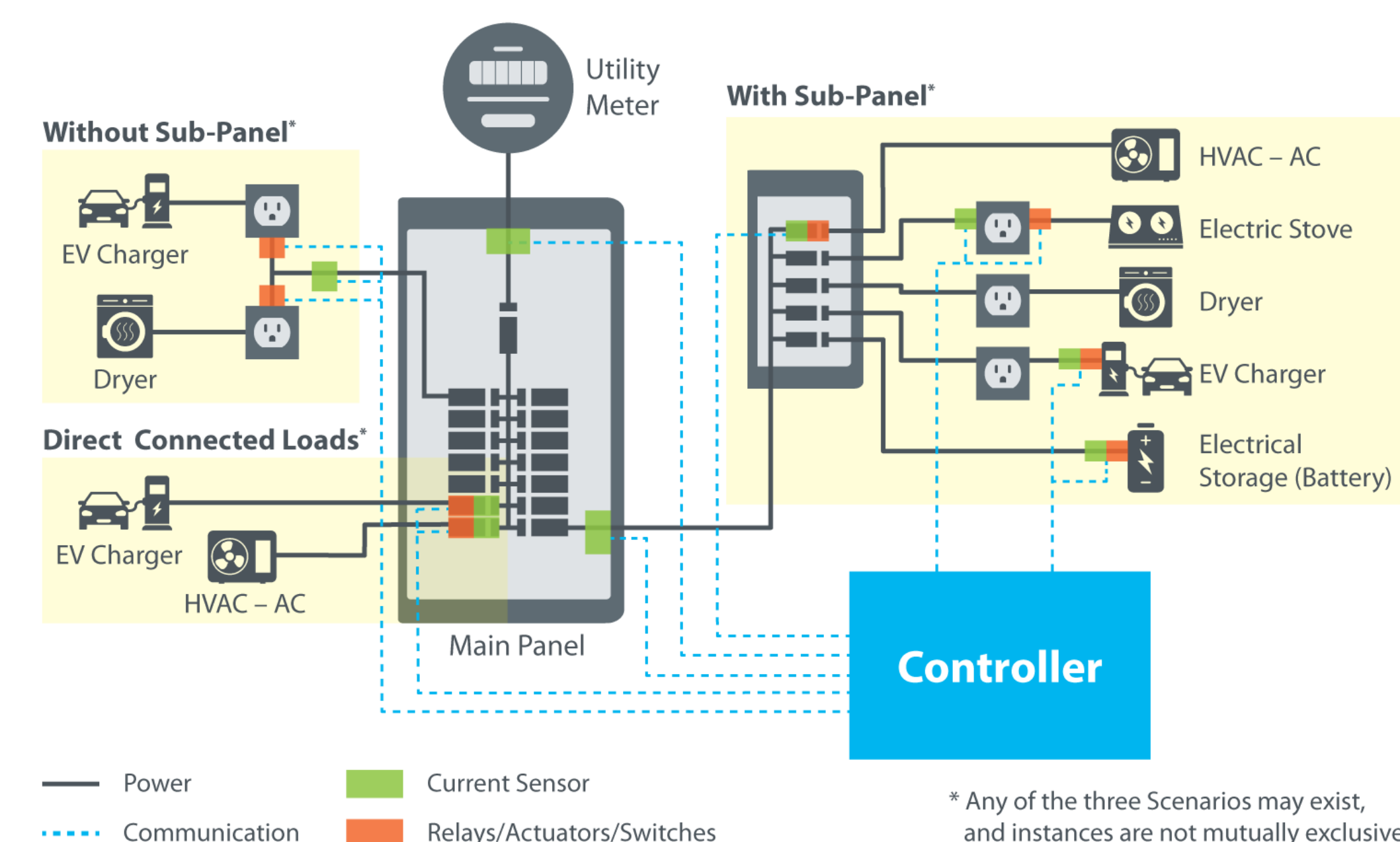


Data-Driven Panel Capacity Estimation



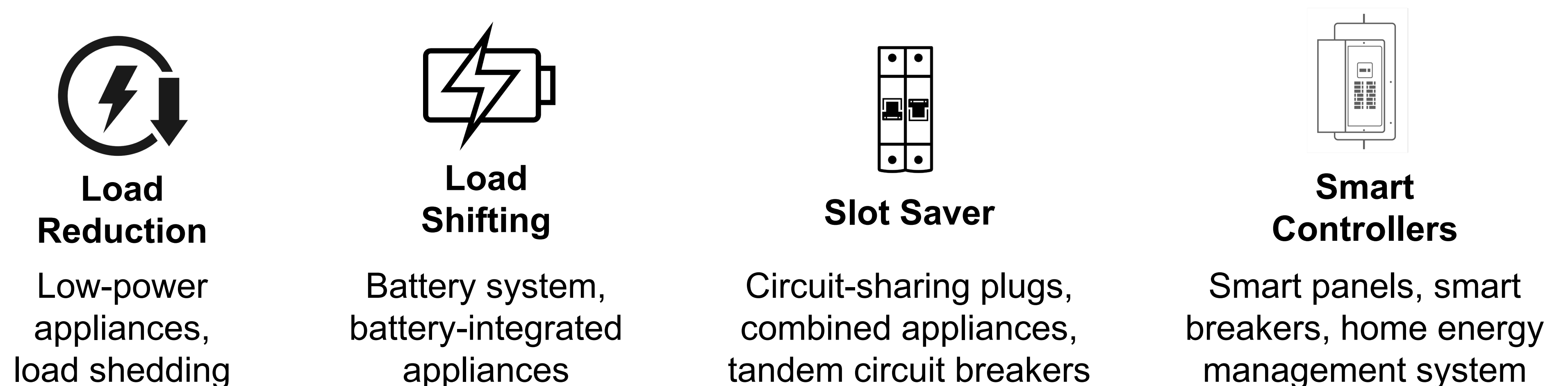
Developed a model that can predict panel capacity based on building characteristics and installed equipment.

Digital Capacity Management



Concept diagram of the digital capacity management solution for powering and controlling large electrical end uses with different configurations.

Alternatives to Panel/Service Upgrades



Impact

- Improved estimates** to better inform electrification policies and program design. Estimates include the number of U.S. homes that may need panel upgrades and the number of homes that could avoid panel upgrades with efficiency or load control solutions.
- Guidance for homeowners, contractors, and other stakeholders** on how to select from the 50+ existing products to electrify homes under the current NEC without panel upgrades and save thousands of dollars per home.
- A system architecture** for digital capacity management to overcome gaps in existing solutions and utilize all rated power capacity. Embody the technology in open industry technology standards.
- Proposed changes** in future NFPA 70 NEC provisions to help facilitate adoption by local authorities and practitioners.
- Identified solutions** to reduce the need for costly utility distribution system capacity expansion.