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Energy Use in Buildings Enabling Technologies

Title

Power Delivery System Overview

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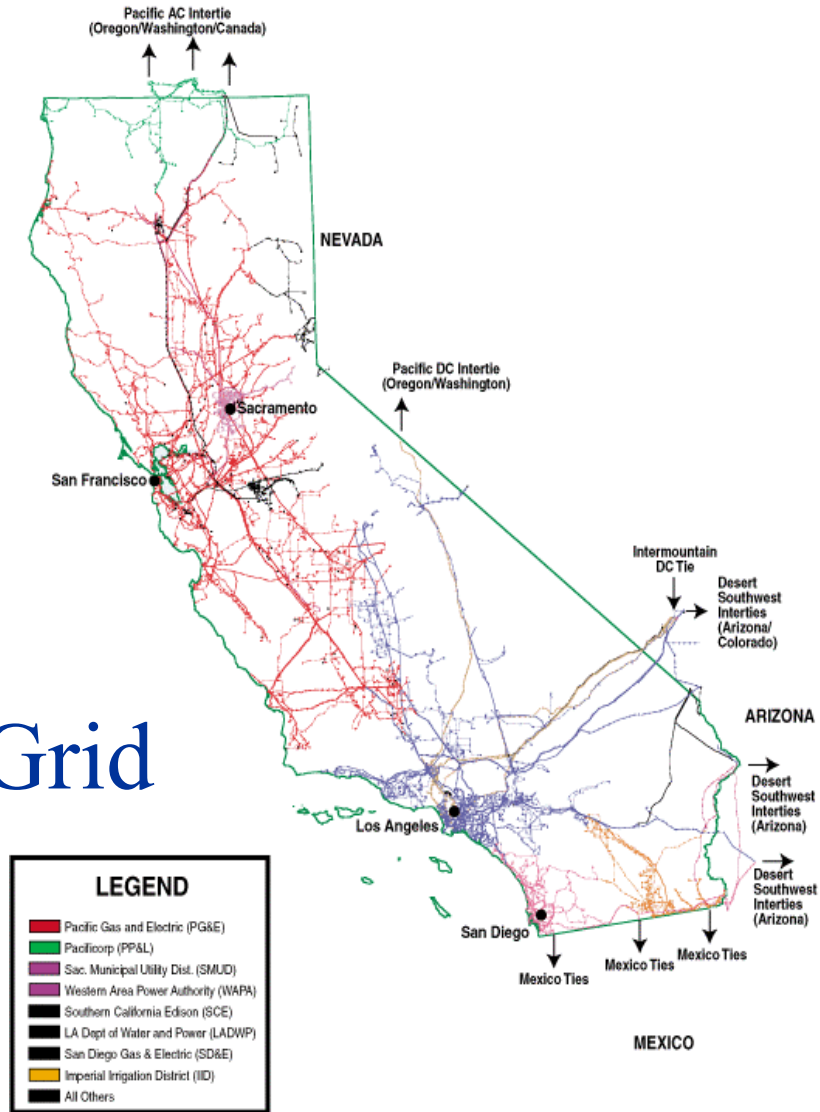


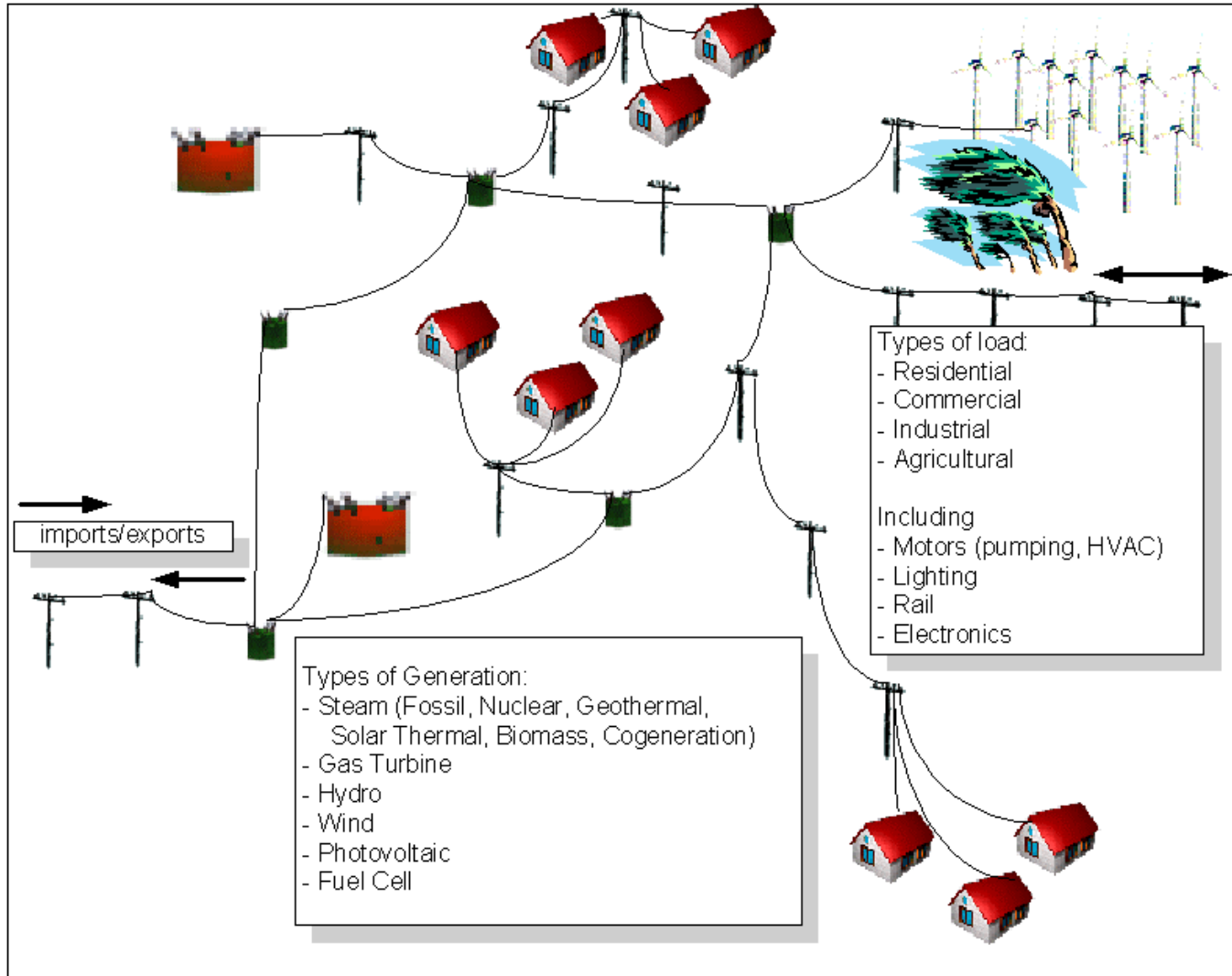
Power Delivery Systems Overview

Alexandra von Meier



California Transmission Grid







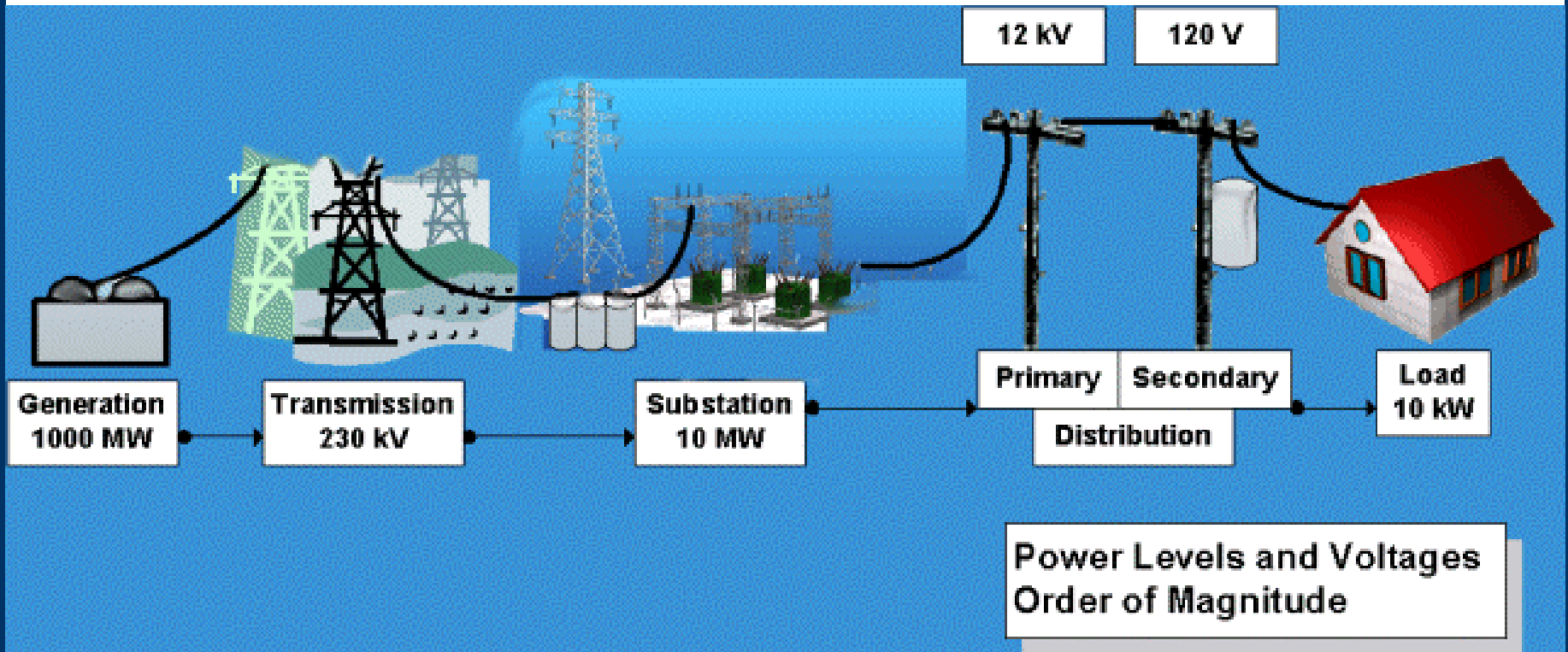
Why are power systems large and interconnected?

- ◆ **Economies of scale in generation**
- ◆ **Load factor (load diversity)**
- ◆ **Pooled resources**
(reliability, access to low-cost resources)



Why do we use alternating current (a.c.)?

- ◆ **Want high voltage transmission (minimize I^2R losses) but low voltage service (safety)**
- ◆ **Transformers are cheap & easy but work only with a.c.**





Why hierarchical structure of T&D system?

- ◆ **Centralized large-scale generation**
- ◆ **Coordination & control**



Why radial structure of distribution system?

- ◆ **Circuit protection**
- ◆ **Cost**



One-way philosophy:

- ◆ **One-way flow of power**
- ◆ **One-way flow of control**
- ◆ **Demand is externally given;
supply is adjusted to meet demand**



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T&D Hardware:

- ◆ **Typical age on the order of decades**
- ◆ **Key technology a century old**
- ◆ **Traditional design and operating philosophies consistent with hardware capabilities**
- ◆ **Existing infrastructure represents large investment; not simply replaced**



Culture clash?

- ◆ **Newer information technologies may be overlaid and integrated with existing power hardware, but may conflict with traditional operating philosophies.**

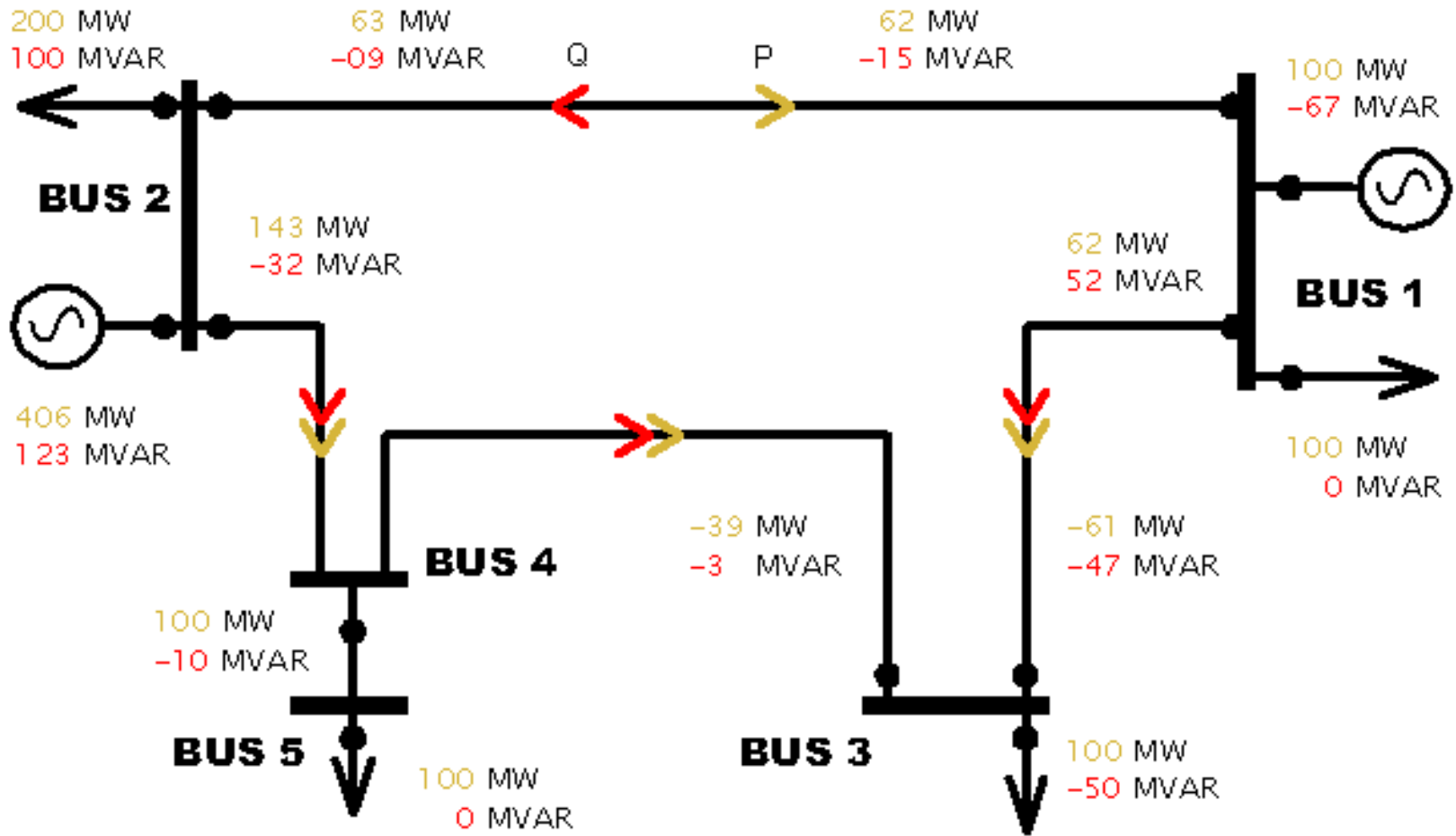


Why is industry attached to traditional philosophies?

- ◆ **Cultivated risk averse attitude**
- ◆ **High stakes; real danger**
- ◆ **Complexity and challenge of operation task calls for minimizing uncertainty (of which there is a lot)**



Power Flow Example





How can such old technology be so complicated?

- ◆ **Complexity = no single individual can comprehend entire system at once**
- ◆ **Large number of buses, all interdependent**
- ◆ **Strict real-time operating constraints
(power in = power out; capacities)**
- ◆ **Power flow problem has no closed-form solution;
solved approximately by iteration**
- ◆ **Predicting effects of change in one variable requires
simulating entire system**
- ◆ **Disturbances propagate (e.g. the Oregon tree)**

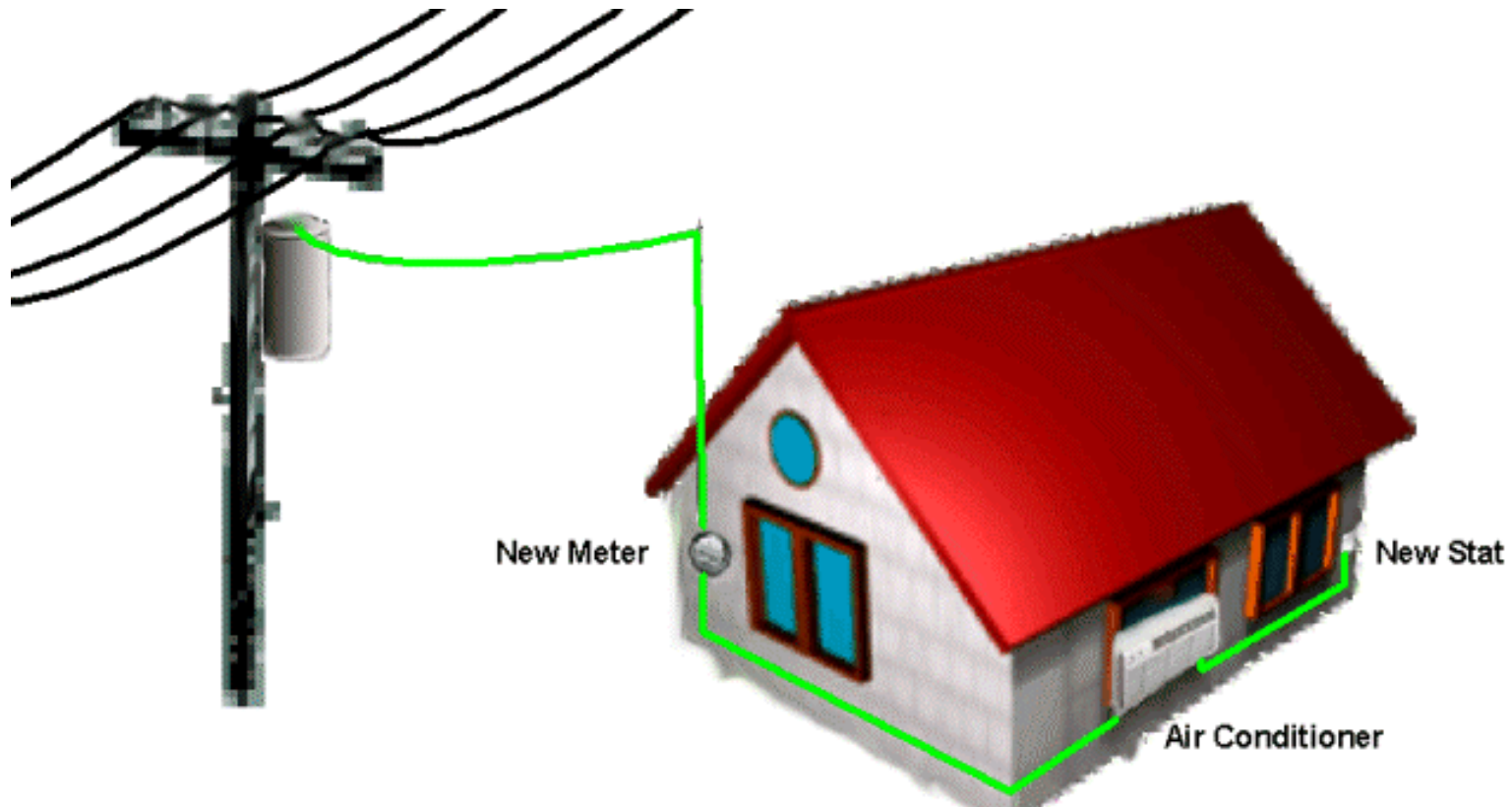


How does this research fit in?

- ◆ **Proposing to turn traditional one-way philosophy upside down by considering demand as controllable**
- ◆ **Small change in hardware may represent major conceptual change**
- ◆ **Location & function of prospective DR technology within system (e.g. meters, thermostats)**



New Technologies in Context



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