Consensus-Based Power System Planning Using Open Assumptions and Models

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The Question

What kind of power system should we build over the next 30 years?

The Process We've Been Using

- HECO makes investment plans inside a "black box"
- Community and PUC try to judge their merit
- Does not lead to consensus(!)
  - Plans are monolithic, and different options are hard to compare

A Consensus-Based Approach

- HECO and stakeholders **agree on assumptions about the future**
  - Cost of renewable energy projects, fossil fuels and biofuels; screening rules for renewable energy projects; future renewable energy targets; possible range for these values; willingness to pay higher near-term costs to lower long-term risks
  - If stakeholders disagree on some assumptions, they can be used as sensitivity cases
- HECO and stakeholders **agree on optimization techniques** to choose the least-cost investment plan
- If we can agree on these smaller, more concrete questions, then **we get an overall plan we can agree on**

Proposal

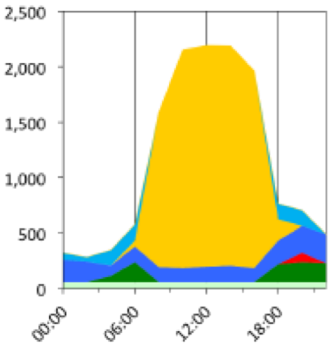
- HECO works with stakeholders to agree on assumptions and questions *before* producing a plan
  - Have already made amazing progress with PSIPs
- HECO works with stakeholders to agree on modeling methods
  - E3 RESOLVE is a great step in this direction
- HECO produces optimal plans using these assumptions and methods
- Iterative process
  - Start with early data and preliminary results, then improve
  - If an "optimal" plan is implausible or unattractive, it's a starting point for constructive discussion and further analysis
    - Do we really want 30% biofuels? What would we build instead if we could only use 5%? How much would that cost?
  - Eventually, this framework can also be used for selecting RFP bids, judging prudency of investments, or even running a full-fledged capacity market

Data Recommendations

- More realistic screens for solar projects
  - No existing or proposed Oahu projects would meet the screens from 4/1/16 PSIP
  - 20%+ slope is possible at reasonable cost
  - Small parcels can be used and can be joined together (maybe 500 kW for smallest flat sub-parcel?)
- Consider using bulk electricity storage
  - Batteries, pumped storage hydro, hydrogen could all be cost-effective, depending on cost of other resources
  - Solar+storage option is especially important with high biodiesel prices

Use a State-of-the-Art Optimization Model as the Heart of Portfolio Selection

- SWITCH power system planning model
  - Written by Matthias Fripp in 2008
  - Now open-source, used and maintained by multiple contributors
  - Oahu version is now running with resource data based on PSIP, OWITS, HSIS, NREL NSRDB
  - All data and code are available from http://github.com/switch-hawaii
- Energy+Environmental Economics (E3) RESOLVE
  - Developed by E3 based on SWITCH
  - Strong team for framing analysis, preparing datasets and running the model
- No other capacity planning models can do this job
  - optimize multi-decade power system investments based on chronological, hourly behavior of renewables, storage and demand response



SWITCH Model Design

Objective

- minimize total cost of electricity production in 2021–2052 (net present value)

Constraints

- policy constraints (RPS, MATS)
- provide enough electricity and reserves every hour
- physical limits of equipment and project sites

Decision variables (co-optimized)

- **Investments**: How much capacity to add of each technology
  - Wind, solar, fossil-fueled and hydro power plants; batteries and hydrogen storage; transmission
  - Investments occur in 2021, 2029, 2037 and 2045
- **Operation:** Power production or consumption by each project and responsive demand, each hour
  - 12-24 days of hourly behavior are modeled during each investment period
  - Follow-up production-cost model can test and plans using 8760+ hours

Open-source model and data available at http://www.switch-model.org