Hawaii’s Clean Energy Challenges

HEPF
May 27, 2016
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The RPS Challenge

- "Near" future Oahu renewables estimate
  - 125 MW Wind  ~383 GWh  (4.9%)
  - 375 MW DPV  ~591 GWh  (7.6%)
  - 152 MW CPV  ~293 GWh  (3.8%)
  - 69 MW Waste  ~ 390 GWh  (5.2%)
  - 120 MW Biofuel  ~ 36 GWh  (0.5%)
  - Total Renewable  ~1693 GWh  (~21.8%)

- Oahu (72% of state total) currently gets ~ 11% from wind and solar. Optimistic penetration by 2017 around 15% from wind and solar.

- Options to 100% include
  - Significant growth of wind and solar (Oahu or “offshore”)
  - Biomass and biofuels
  - Geothermal with cable
  - Still emerging technology (wave, OTEC, ?)

- Potential pathway to 100% renewable:
  - Assume we find 30% firm, “dispatchable renewables” e.g biomass, biofuel, geothermal, OTEC
  - Grow balance from solar and wind (numbers below based on available energy)
    - High solar:  2,800 MW additional solar (10 -50 sqmi)
    - High wind:  1,600 MW additional wind: 800 – 2MW turbines, (~60 sqmi )
    - Mixed W&S:  1,540 MW additional solar, 960 MW additional wind
Curtailment at High Penetrations (Oahu)

- Incremental (marginal) curtailment increases significantly at high penetration
- Complex curtailment (hourly and daily) requires flexible mitigation measures
Integration with Electric Transportation

• Potential pathway to 100% renewable electricity plus 40% ground transportation:
  • Assume 30% electric from firm, “dispatchable renewables”

• EV (@ 100 miles/24kwh)
  • High solar: 3760 MW additional solar
  • High wind: 2100 MW additional wind: 1000 – 2MW turbines

• H2 by electrolysis (@2.5x efficiency of current vehicle fleet)
  • High solar: 5530MW additional solar
  • High wind: 3160 MW additional wind (1500 – 2MW turbines)
Closing Comments

- Moving beyond 30-40% will require very creative system integration and new innovations (curtailment, reliability, stability)

- Required renewable energy development is immense and generally underestimated: land use/siting; community impact; community acceptance, multibillion dollar investment

- Optimal path forward is dependent on future costs of renewables and mitigation measures – many rosy predictions, lots of uncertainty.

- Current obsession with low-cost pathway to 100% is distracting from work needed to increase renewables usage using ‘real’ costs.

  - Can the community come together with a definitive plan to double what we have today
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- Quantify impact of new energy systems on production cost and curtailment
  - Different resource mixes (wind, central and distr PV, other)
  - Alternative fuels (LNG, hydrogen, biofuels)
  - Grid configuration (independent or connected)
  - Changes due to load and load-profiles (end-use efficiency, alt transportation)
- Analyze reliability and stability – quantify additional mitigations
- Identify and quantify mitigation methods to address curtailment, reliability and stability
  - Advanced controls, unit cycling, reduced minimum run, improved forecasting
  - Energy storage, smart grids, advanced inverter technology, microgrids, demand response, integration with transportation
- Evaluate cost - grid changes, mitigations, transmission and distribution upgrades