

Valuing Changes in Resilience: A Few Observations

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Valuing Changes in Resilience

Potential steps to quantify and value the effect of a measure on resilience

...where “measure” means investment, policy, etc.

1. Estimate the **effects of the measure on the probability distribution of electricity supply outages** with different durations and geographic areas
2. Estimate the **dollar value of those effects**

To Better Estimate Effects on the Probability Distribution of Outages

...further development of methods for the following would be helpful:

1. Estimating the probabilities and effects of uncommon natural disasters and malicious human actions
2. Predicting durations of outages that result from such disasters and actions
3. Estimating the effects of measures on those probabilities, effects, and durations.

Methods of Estimating the Dollar Value of Changes in Outage Probability Distributions

1. Blackout Case Studies

- Relatively well-known Corwin & Miles USG study of 1977 NYC blackout: \$12/kWh
- Without arson, looting, and a little of other “indirect costs,” ~\$2/kWh
- Without securities and banking industry losses not possible elsewhere in US, ~\$1/kWh
- Emphatically non-comprehensive, and from a time when NYC real incomes 50% lower than today’s US median

2. Surveys about Hypothetical Situations

- Two estimates of direct value of lost load in a US local two-week outage (USDOE, 2017, chap. 4), estimated from two Sullivan et al. reports: **\$20/kWh** and **\$17/kWh** after accounting for customer adaptation

3. Proxy Methods, e.g. gross regional product per day * days of outage

- US GDP / electricity consumption = ~\$5/kWh in 2016
- Rose et al. (2007) estimate of direct value of lost load in Los Angeles two-week outage: **\$1.37/kWh** after accounting for estimated 87% reduction from customer adaptation

4. Revealed Preference Methods

Thank You

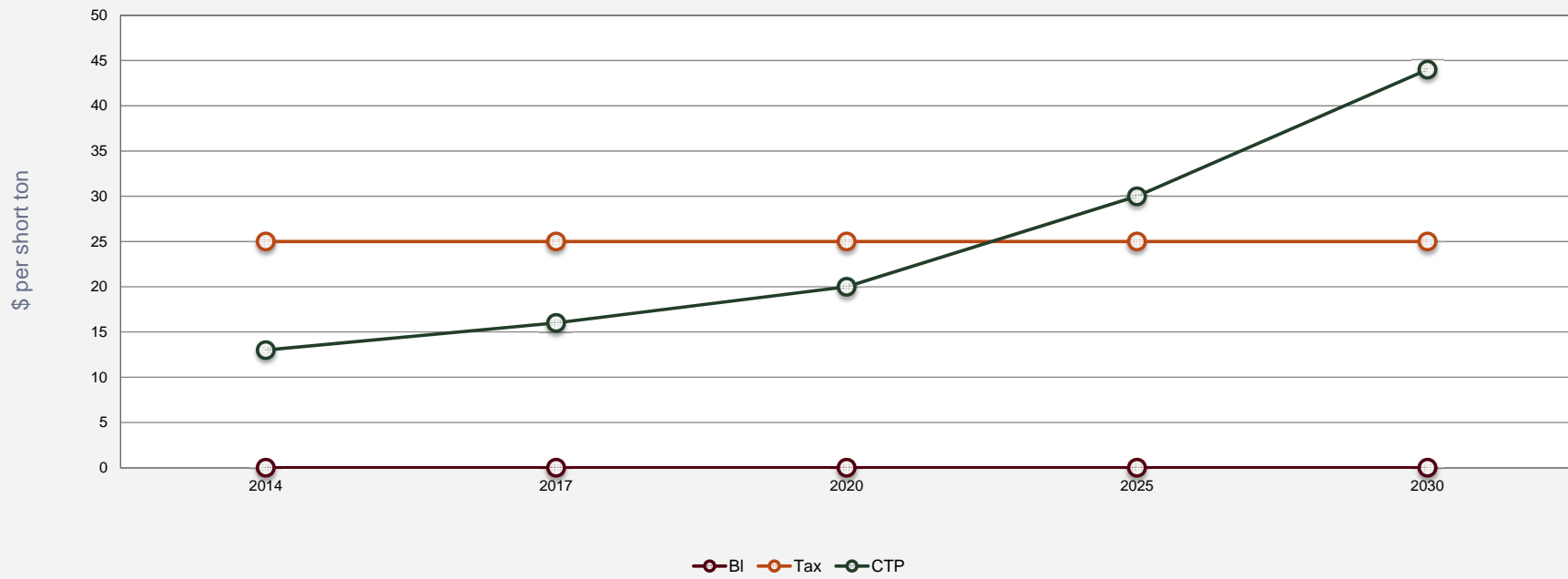
Works Cited

- GE (General Electric) Energy Consulting, 2012. "GE Energy Products/mars." Accessed October 2013.
- Oladosu, Oluwole, and Shu-Yi Liao. 2007. "Business interruption impacts of a total blackout on the electric power system of Los Angeles: customer resilience to a total blackout." *IEEE Transactions on Systems, Man, and Cybernetics - Part A: Systems and Humans* analysis no. 27 (3):513-531.
- Sullivan, Michael and Schellenberg, Josh. Downtown San Francisco Long Power Outage Case Study. March 27, 2013. Freeman, Sullivan, and Company (now part of the GE Energy Group), GE Energy Company.
- U.S. Department of Energy. "Updated Value of Service." Washington, D.C. :: United States. Dept. of Energy. Office of Science.
- U.S. Department of Energy. Report to Congress on the Valuation of Energy Security for the United States. Washington, D.C. :: United States. Dept. of Energy. Office of Science.
- Wang, Yezhou, Chen Chen, Jianhui Wang, and Ross Baldick. "Research on Resilience of Power Systems

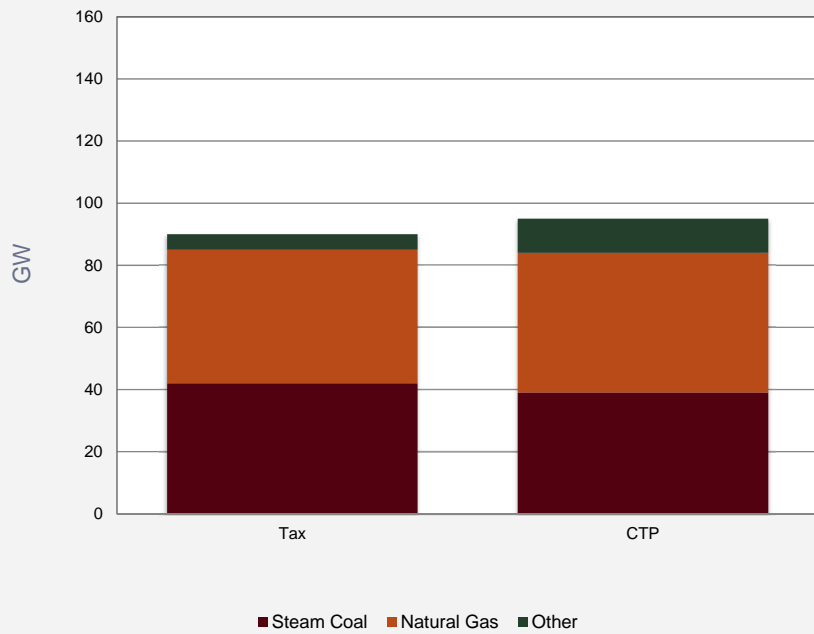




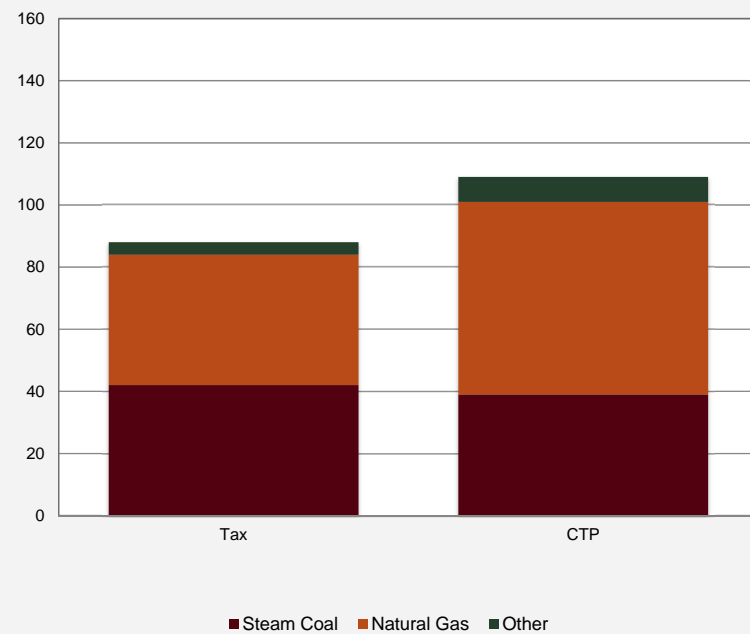
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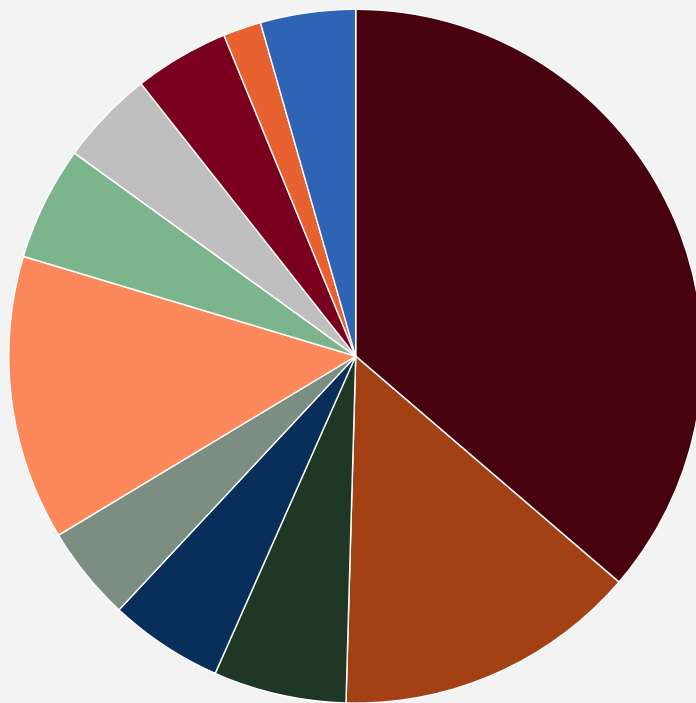


2020



2030





Sales

- Developed
- Cultivated/Pasture
- Grassland/Herbaceous
- Forests
- Scrub/shrub
- Palustrine Forested Wetlands
- Palustrine Nonforested Wetlands
- Estuarine Wetlands
- Unconsolidated Shore
- Bare Land
- Open Water



