

What is Demand Response?

- One definition: "...the ability of customers to respond to either a reliability trigger or a price trigger... by lowering their power consumption." [A]

Why Demand Response?

- Current/upcoming changes to the grid:

Demand side: New loads to support



Supply side: Influx of renewable energy



- How can we make the grid more reliable in the face of these changes?

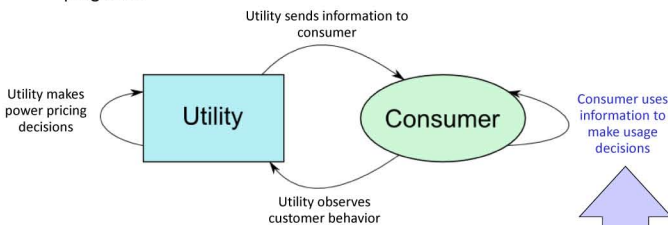
- One possibility: Use demand response programs to motivate users to reduce or redistribute electric loads.

- Customers can save money by shifting loads to cheaper time periods [B].
- Grid operators can reduce stress on the grid by encouraging and/or coercing customers to shift loads [C].

- **Everybody wins!** 🧐

So What's the Problem?

- Consumer behavior is critical to the success of demand response programs!



If we don't understand how the consumer makes decisions, how can we optimize the system, or make it work at all?

Prior Work on Demand Response

- Most researchers assume that consumers will always make the rational choice to maximize their utility!

"Consumer rationality assumptions indicating real world scenarios have been utilized." [E]

"We show that... when users selfishly maximize their own surplus under the optimal prices, their consumption decisions... maximize the social welfare." [D]

"The objective function... to be minimized is the minus utility of the consumer..." [F]

"Participation of customers... is mathematically modeled based on the customer's obtained benefit... as well as the offered incentives and the specified penalties." [G]

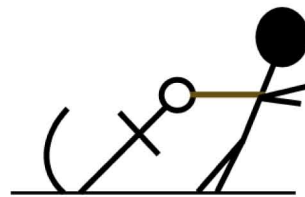
- **Problem: Humans don't always make the rational choice!**



How Could Someone Get It Wrong?

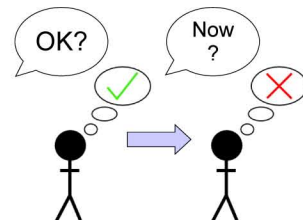
- **Anchoring [H]:** Humans make estimates based on an initial point, and different starting points yield different estimates.

- If consumers fixate on a price they consider "high," it could adversely affect their price tolerances.
- Consumers could also be primed to incorrectly assume when peak pricing blocks begin and end.



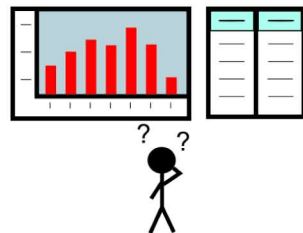
- **Preview-Based Forecasting [I]:** Humans are bad at predicting their future preferences.

- If a consumer declares that he or she can reduce energy load on demand, but is actually unable or unwilling to reduce load when asked, neither the consumer nor the utility gains any benefit from the demand response program.



- **Duration Neglect [J]:** Humans do not take an entire event into account when evaluating it, but use only certain portions, such as the ending.

- If consumers misinterpret the information provided by the utility, they may think that they have used more or less energy than they have, which may influence future usage decisions.



How Could This Affect Cybersecurity?

- Demand response programs aim to maintain the reliability of the power grid during peak-load periods.
- **An attacker could use these biases to reduce the grid's reliability.**
 - By manipulating consumers' price tolerance, or altering their view of their electricity usage, an attacker could reduce the load-cutting capacity of the program.
 - By convincing consumers to participate in load reduction programs despite not being able to drop enough load in reality, an attacker could induce an overestimate of a program's effectiveness, putting the grid in a precarious situation during a peak load event.

Fundamental Questions

- What biases come into play in a typical demand response scenario?
- Is there a way to counteract the effects of those biases, or even use them to improve grid performance?
- By taking the biases into account, can we better understand how consumers operate within the smart grid, and ensure that the grid still functions correctly and reliably?

References

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NOTE: All clipart from Microsoft Corporation.

