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Study Committee C1

Power System Development and Economics

Paper C1-10430_2024

From Resilient and Ready to Used and Useful: Managing Temporal and Locational Uncertainty in Electrification, DER Adoption, and Climate Adaptation

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Motivation

- Grid planning decisions involve weighing risks against benefits.
- The best decisions will facilitate development of electrical infrastructure that minimizes risk and maximizes benefits.
- With the rapidly evolving energy landscape, today's planner must discern new loads and demand cycles; embrace the operational complexity of climate risk; revise settled standards; and anticipate and manage the system impacts of distributed energy resource (DER) adoption.
- Only by managing the combined uncertainty of these dynamic processes can a planner hope to make effective decisions.
- Our analysis focuses on the management of temporal and locational uncertainty, and particularly on the risks presented to customers by the mismanagement of the factors that are the sources of these uncertainties.

Method/Approach

- A review is provided of the various technological, technical, consumer, and policy sources of uncertainty in grid planning due to the energy transition. Practical approaches to manage and mitigate this uncertainty, including new planning tools, are described.

Objects of Investigation

- The first type of uncertainty that we consider is temporal, involving the timing of the rate at which new DERs and electrification loads such as electric vehicles and heat pumps are brought into use.
- The second type of uncertainty that we explore concerns the locations at which adoption occurs.

Discussion

- Depending on the pace at which resource extraction and manufacturing facilities come online, the extent to which a region establishes policies that build markets favourable to the deployment of innovative technologies, and the state of economic growth overall, adoption rates may accelerate or decelerate accordingly.
- Depending on the costs of adoption, the configuration of buildings, variations in household and business economic resources, timing in the replacement of end-of-life equipment, and the regulatory environment within local jurisdictions, adoption decisions are not randomly distributed across a territory. Instead, customer actions often result in clusters of initiative where market "contagion" leads to block- and neighbourhood-level patterns in adoption.

Conclusion

- Investment must be appropriate and timely, enabling capacity where and when it is needed and supporting adequate grid reliability and resiliency.
- Historically, the prediction of peak loads around the system has been focal.
- The risk of error in over-predicting has the potential to manifest as an investment that was over-built for purpose and/or premature.
- The risk of under-predicting can lead to asset overloads, loss of life, or premature equipment failure, ultimately compromising reliability and increasing the cost of maintaining the system.
- The parameters that require analysis and prediction are defined by new and dynamic elements bringing new challenges to distribution planning.
- As planners and regulators begin to fully appreciate these challenges and to account for the decades of load growth that would result from a persistent decarbonization agenda, planning thresholds will be a key consideration in managing affordable investment and grid readiness.

Research funded by Commonwealth Edison
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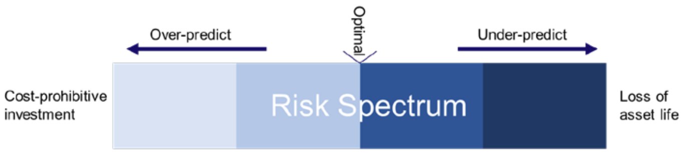
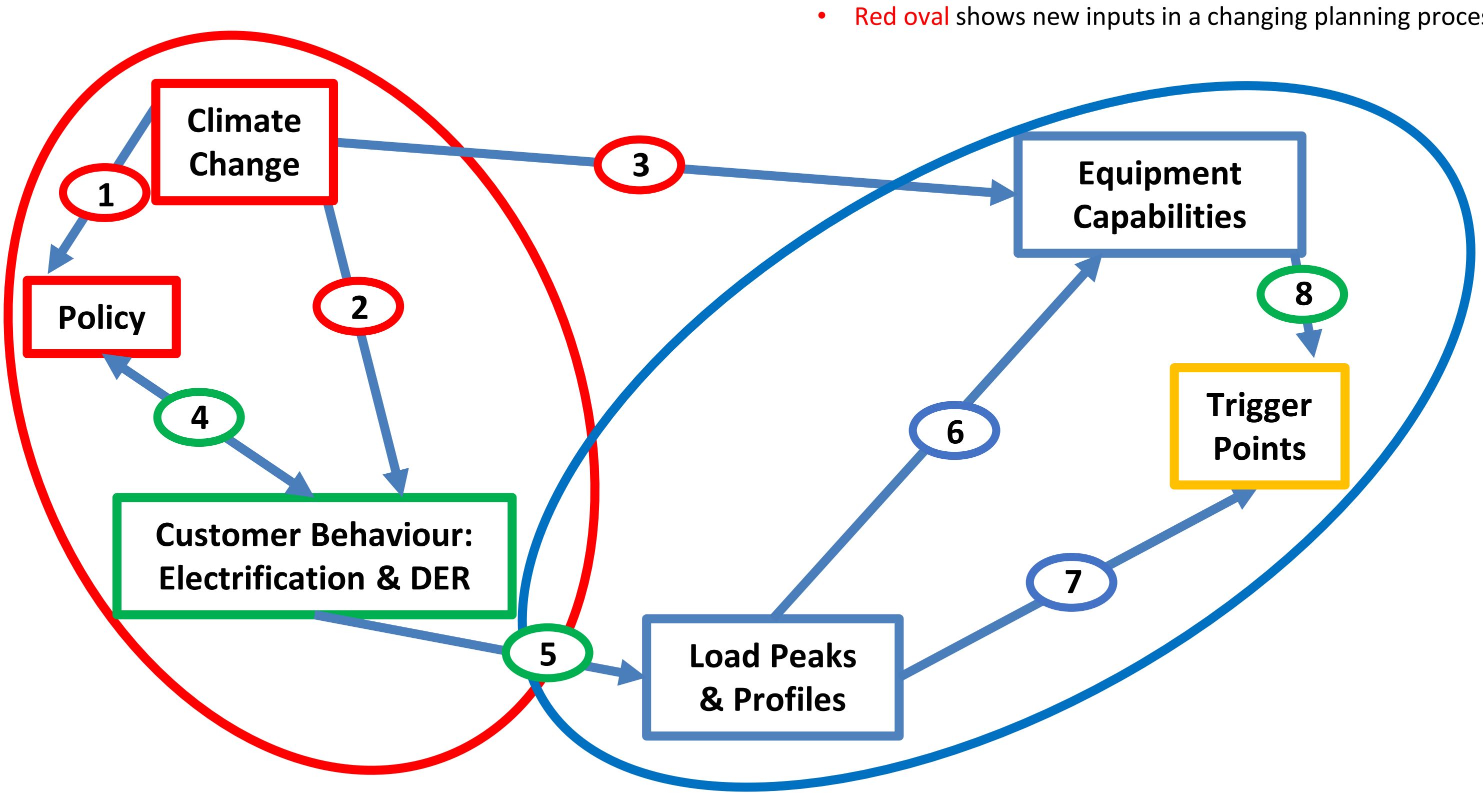
The Growth Projection Risk Spectrum

- Over-predicting can result in unnecessary or premature spending; under-predicting can result in poor system performance, including early loss of asset life.
- By managing sources of uncertainty, planners can more accurately predict system behaviour to achieve a balance in grid development.



Trigger Point Process

- Blue oval is system planners' historical focus.
- Red oval shows new inputs in a changing planning process.

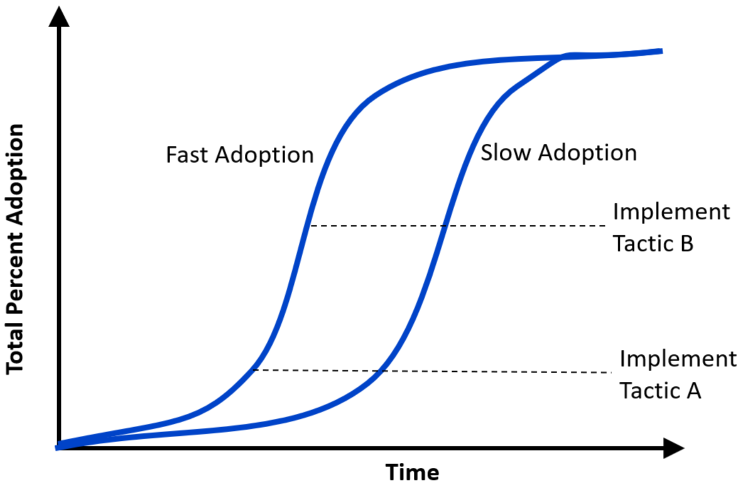


1. Policymakers respond to climate change
2. Customers respond to climate change
3. Equipment affected by climate change
4. Policy impacts behaviour/behaviour impacts policy
5. Behaviour and adoption changes load peaks and profiles
6. Equipment ratings affected by load profiles

7 & 8. Trigger points reached when peaks exceed equipment capabilities

Trigger Points

- ComEd has found it advantageous to begin to identify the relationship between system needs and lead-times for the implementation of various mitigation tactics.
- Parameters such as the local percent adoption of a certain technology like electric vehicles can be used as a trigger point at which defined tactics should begin to be implemented.
- Figure at right illustrates the relationship between the system needs and lead-time and how adoption can be used to identify trigger points.



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