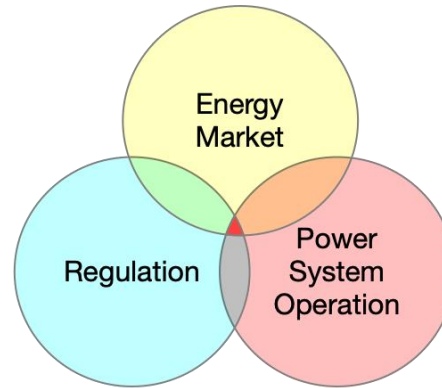


MODELLING SYSTEM-FRIENDLY USE OF INFRASTRUCTURE FOR CARBON REDUCTION

Daniel Schien

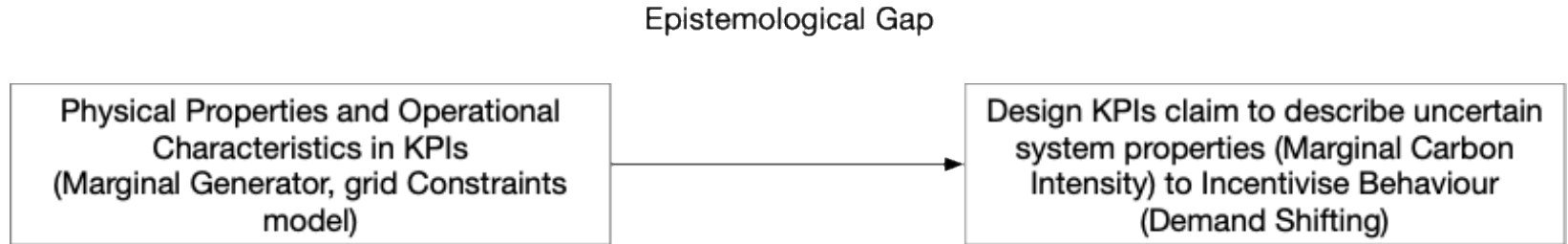
Workshop on Grid AI 9'25

- “evidence-based, **causally-grounded understanding** of how **flexible electricity** demand from data centres can meaningfully **reduce carbon emissions** within the UK energy system. The framing will include the physical and operational nature of the **energy system and data centres**, carbon emission modelling and accounting practices, and policy on both **short-term operational** adjustments and **longer-term strategic investments**.”



Efficacy of Demand Shifting

- Short-term marginal carbon intensity very uncertain
- Uncertain Flexibility, Uncertain Incentives



Grid Carbon Intensity

- Lack of agreement on carbon intensity values for 'positive' demand management
 - e.g. '24/7 matching', 'Emission First', ...
- Modeling future difficult & highly uncertain, e.g. RMI Report
- Current decisions = \$B investment and high impact strategic & policy directions



Assessing the Impact of Voluntary Actions on the Grid

A Consensus Paper from ZEROgrid's Impact Advisory Initiative

Direct Effects - Infrastructure Dynamics

- Infrastructure is inelastic and built for peaks (> avoid)
- Demand shapes the *future* capacity > long-term effect chains
- Problem: System is highly unstable
 - > Carbon Footprints are highly uncertain, at best directional

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Monthly spending on data center construction in the United States

Cost of on-site work to build data centers each month, including materials and construction labor. It excludes the cost of IT hardware like servers and storage, which can account for a large share of total investment. This data is expressed in US dollars, adjusted for inflation.

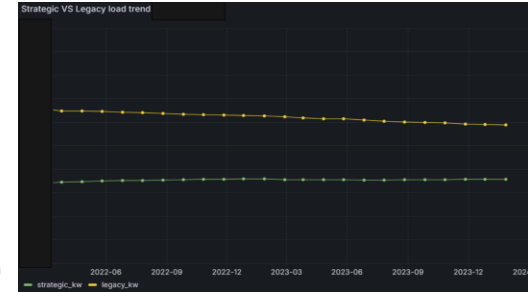
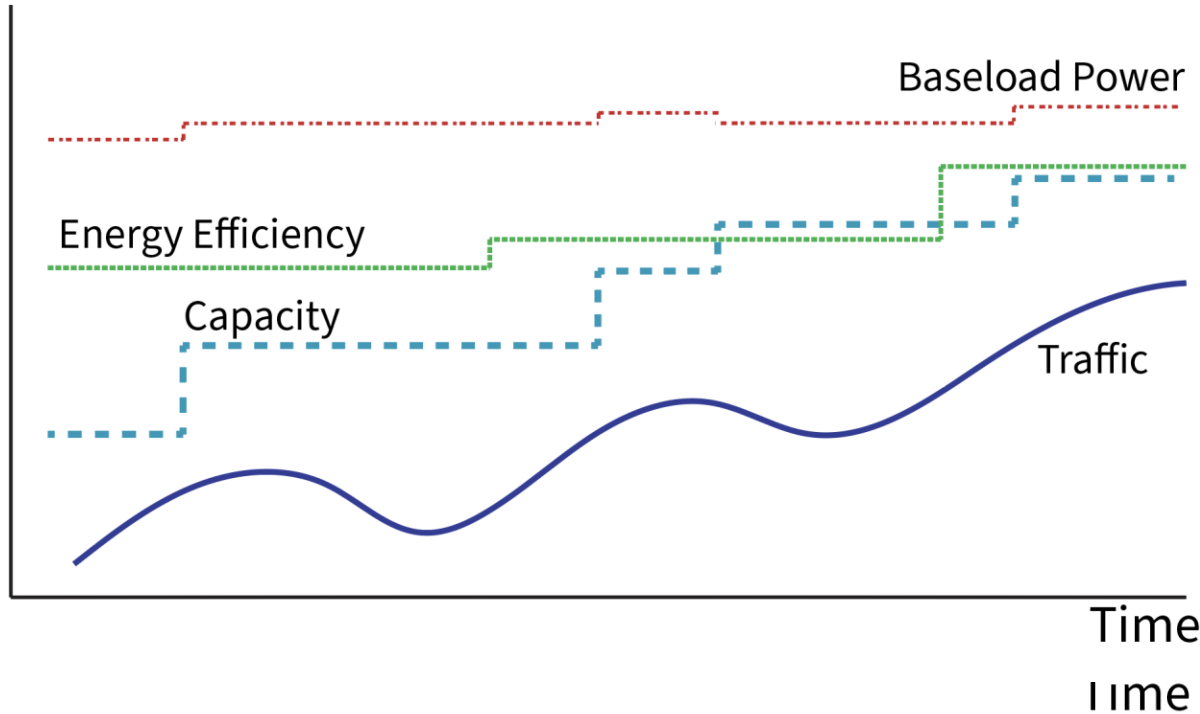


<https://ourworldindata.org/grapher/monthly-spending-data-center-us>

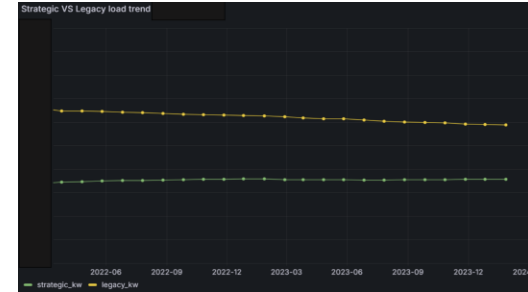
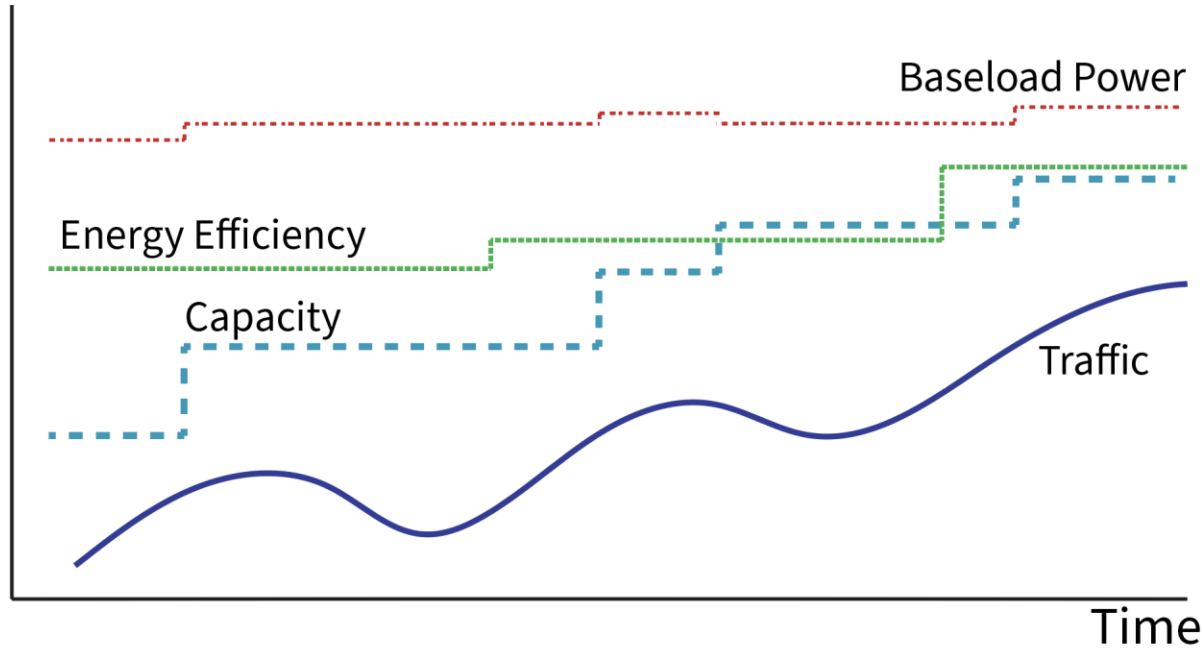


Schien 2025,
<https://onlinelibrary.wiley.com/doi/10.1111/jiec.70057?af=R>

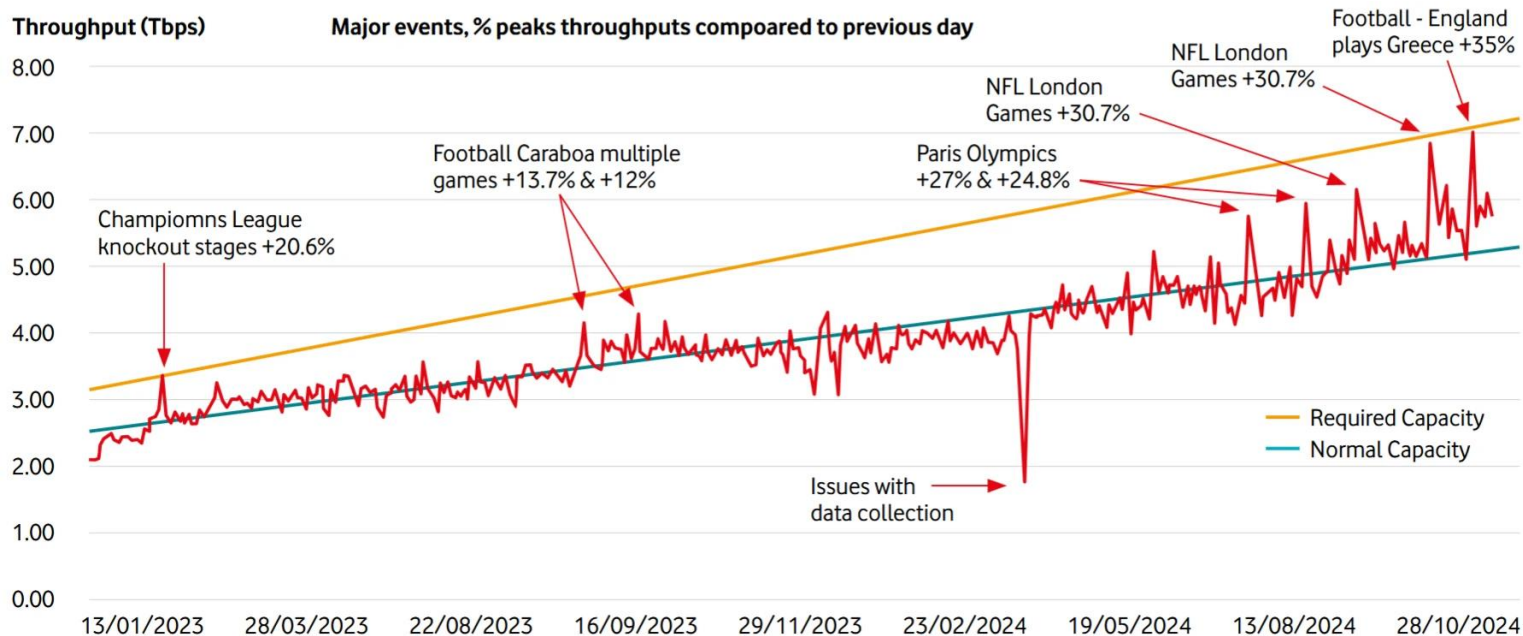
Marginal Factor: Capacity Increments



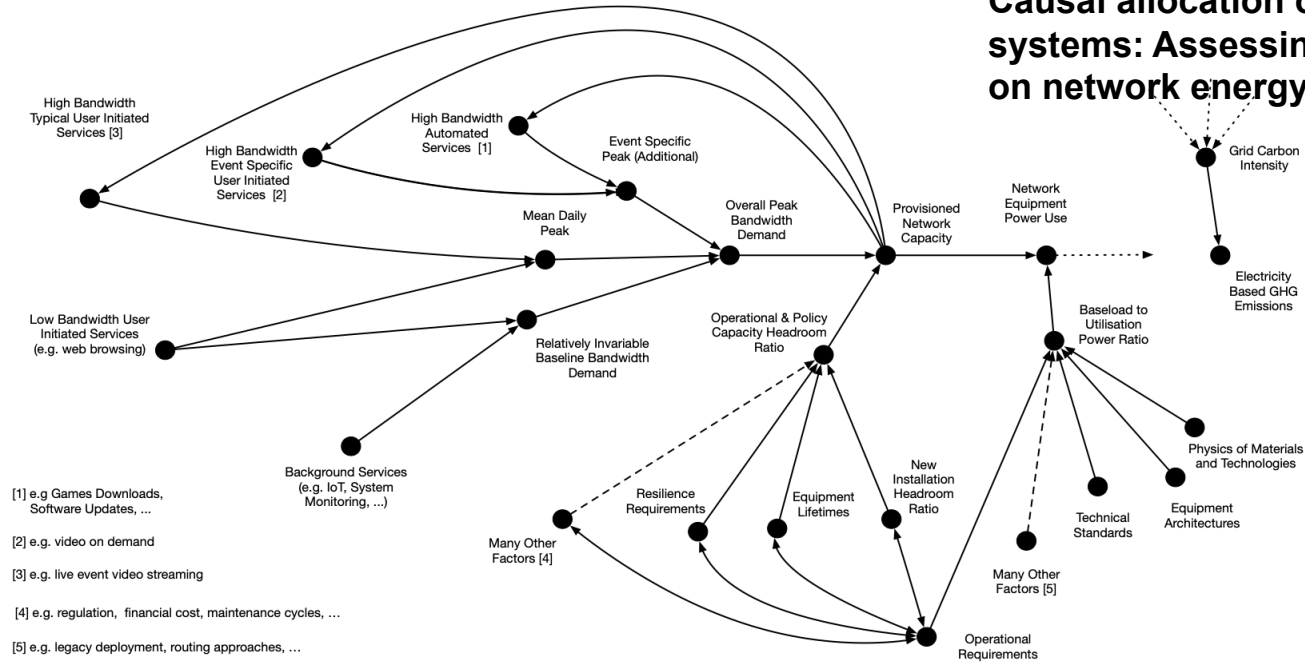
Marginal Factor: Capacity Increments



Peak to Mean Ratio Growing



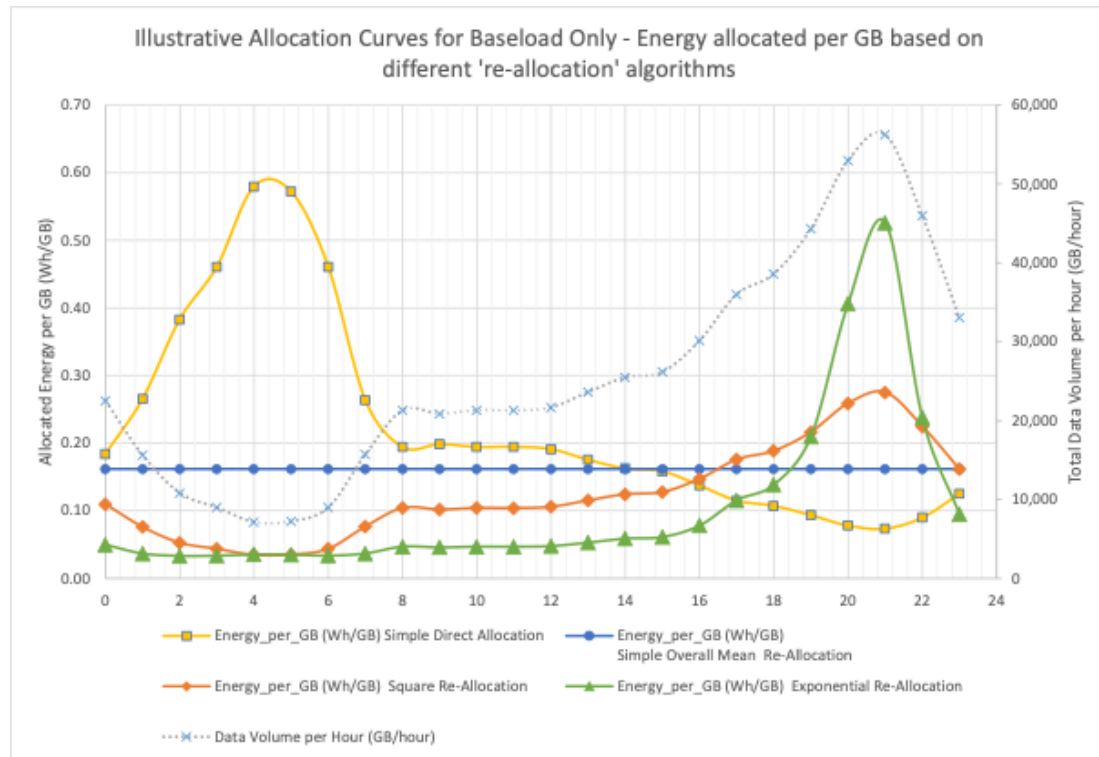
Untangling Marginal Factors



Schien 2025

Causal allocation of fixed impacts in product systems: Assessing the effect of data demand on network energy consumption

Marginal Effect of Diurnal Variability of Demand



Thank you

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