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## How Methodological Choices Shape the Value of Lost Load: A Systematic Review of VoLL Methodologies

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### **Motivation**

Security of electricity supply has re-emerged as a key concern in energy policy and research. The transition of energy systems towards decarbonisation is accompanied by increasing dependence on variable renewable energy sources and declining shares of controllable generation. In parallel, geopolitical uncertainties have increased and refocused attention on how societies value a reliable electricity supply. As electricity systems become structurally more complex and more exposed to supply risks, economically efficient decisions on grid expansion, capacity adequacy, and reliability standards increasingly depend on robust assessments of the costs associated with supply disruptions.

The Value of Lost Load (VoLL) is a central indicator for quantifying the welfare losses associated with unserved electricity demand. VoLL estimates are widely used in academic research, energy system modelling, and regulatory frameworks. At the same time, the VoLL literature exhibits substantial heterogeneity in reported values across studies (Kapeller et al., 2026; Schröder & Kuckshinrichs, 2015). Existing research applies a broad range of methodological approaches, including macroeconomic production-based methods, input-output analyses, survey-based techniques, revealed preference approaches, and case-study-based assessments. While it is well acknowledged that VoLL estimates differ across studies, a systematic and comparative assessment of how methodological choices shape reported VoLL outcomes remains limited.

### **Method**

This paper addresses this gap by providing a systematic methods review of the VoLL literature. We screen existing VoLL studies based on a fixed set of selection criteria, covering a wide range of geographical contexts, sectors, and applications. The reviewed studies are classified according to their underlying valuation approach, sectoral scope, VoLL parameters, and data sources. This structured classification enables a consistent comparison across methodological approaches.

Building on this framework, the paper combines a conceptual comparison of valuation approaches with a systematic assessment of reported VoLL estimates across studies. Rather than aiming to derive a single pooled VoLL, the analysis focuses on identifying patterns and systematic differences associated with different methodological approaches. Particular focus is set on the contrast between aggregate macroeconomic approaches, which infer outage costs from economic output data and typically abstract from behavioural dimensions, and survey-based methods, which explicitly incorporate consumer preferences, budget constraints, and risk attitudes. Within stated preference approaches, differences between willingness-to-pay and willingness-to-accept frameworks are discussed in light of income effects, substitution possibilities, and reference-dependent valuations of electricity supply. The review further considers how different methods address sectoral heterogeneity, indirect effects, and the characteristics of supply shortages.

### **Results**

The review indicates that methodological choices are closely linked to how VoLL is conceptualised and quantified across the literature. Aggregate production-based approaches tend to emphasise average output losses and provide comparatively homogeneous valuations, while survey-based methods allow for greater differentiation across consumers, sectors, and outage characteristics. Differences in behavioural assumptions and valuation frameworks are reflected in systematically different ranges of VoLL estimates reported in existing studies. Figure 1 illustrates how differences in VoLL parameters and methodological implementation influence VoLL estimates in survey-based studies.

Overall, the analysis demonstrates that method choice is a key factor shaping VoLL estimates and their interpretation. The results underline the importance of methodological transparency and of aligning valuation

approaches with their intended application. By clarifying how different methods relate to observed VoLL outcomes, this paper contributes to enhancing comparability and standardisation in future research and provides a structured basis for the informed use of VoLL in energy system modelling and policy analysis.

### **References**

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**Author:** KULAWIK, Jakob (RWTH Aachen, Chair for Energy System Economics)

**Co-author:** Prof. PRAKTIKNJO, Aaron (RWTH Aachen, Chair for Energy System Economics)

**Presenter:** KULAWIK, Jakob (RWTH Aachen, Chair for Energy System Economics)

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