Vol. 15, No. 59, 2026
مطالعات اقتصادی کاربردی ایران
Quarterly Journal of Applied Economics Studies, Iran (AESI)
Scientific Association of Regional Development Economics
OPEN ACCESS



Applied Economics Studies, Iran (AESI)
P. ISSN:2322-2530 & E. ISSN: 2322-472X - Journal Homepage: https://aes.basu.ac.ir/
Scientific Journal of Department of Economics, Faculty of Economic and Social Sciences, Bu-Ali Sina University, Hamadan, Iran. Owner & Publisher: Bu-Ali Sina University.
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Electricity Reallocation During Shortages Economic and Legal Constraints on the Value of Lost Load (VoLL)

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Type of Article: Research
https://doi.org/10.22084/aes.2026.33355.3944
Received: 2026/09/04; Revized: 2026/10/25; Accepted: 2026/11/02
Pp: 161-187

Abstract

The growing frequency of power outages resulting from imbalances between electricity supply and demand has heightened the need to allocate scarce electricity efficiently across competing uses. Although the Value of Lost Load (VoLL) is widely used to measure the cost of outages and assess reliability, it remains unclear whether it can also serve as an operational criterion for allocating scarce electricity. This study adopts a descriptive–analytical approach and uses a mathematical optimization model, simulated in GAMS, to examine the adequacy of VoLL from both economic and legal perspectives. From the economic perspective, the study first shows that, under ideal conditions of complete information and no institutional constraints, allocating electricity on the basis of VoLL can yield an efficient allocation. It then assesses the operational feasibility of VoLL as a basis for centralized decision-making by examining information constraints, the dynamic nature of VoLL, and the simulation results. From a legal perspective, this research examines the legal basis for the reallocation of electricity among consumers during periods of shortage, within the framework of regulations governing electricity supply in Iran. The results indicate that, despite its validity as an indicator of outage costs, VoLL lacks the informational and institutional–legal prerequisites to serve as an operational criterion for allocating scarce electricity. Mechanisms based on consumer choice and tradable rights for utilizing existing capacity represent a potential approach for revealing the value of electricity during periods of scarcity, and they warrant further research.

Keywords: Value of Lost Load (VoLL), Electricity Allocation, Electricity Scarcity, Planned Power Outages, Electricity Market.
JEL Classification: L94, D61, D82, K23.

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Citations: Heydari, K., Kiani, P., Saboripour, E., Mousavi Mobarekeh, S. P. & Doudabi Nezhad, A. (2026). Electricity Reallocation During Shortages Economic and Legal Constraints on the Value of Lost Load (VoLL). *Journal of Applied Economics Studies in Iran,* 15(59), 161–187. https://doi.org/10.22084/aes.2026.33355.3944
Homepage of this Article: https://aes.basu.ac.ir/article_6891.html?lang=en

1. Introduction

Electricity is a fundamental input to economic activity and a critical component of modern infrastructure. Disruptions in electricity supply can therefore cause production interruptions, supply-chain disruptions, revenue losses, and broader social and economic damages. These consequences become particularly important when rising electricity demand is accompanied by constraints on the expansion of generation capacity and network infrastructure. Although expanding capacity may provide the main long-term solution, short-term supply shortages may require electricity systems to impose consumption restrictions on some users.

Under such conditions, the challenge is not only the scarcity of electricity but also how the available supply should be allocated among competing users. When electricity supply falls below demand, policymakers and system operators must determine which uses should be prioritized and where the burden of scarcity should be imposed. This creates an economic allocation problem because the consequences of an electricity interruption are not uniform across consumers and economic sectors.

A key economic measure for capturing these differences is the Value of Lost Load (VoLL). VoLL represents the economic value of unserved electricity and has long been used in electricity economics to assess the value of reliability, inform investment decisions in generation and network capacity, and compare the costs of improving reliability with the benefits of reducing outages (Schröder & Kuckshinrichs, 2015). Gorman (2022) shows that VoLL has also been considered in decisions concerning electricity rationing and allocation. However, an important distinction exists between using VoLL for long-term reliability planning and using it to determine supply priorities during an actual electricity shortage. The latter requires VoLL estimates that are sufficiently timely, reliable, and actionable for operational decision-making.

This requirement is challenging because VoLL is inherently heterogeneous and context-dependent. The economic cost of an interruption varies with the type of consumer, the timing and duration of the outage, production conditions, and other characteristics of the interruption. Consequently, a single fixed VoLL cannot necessarily represent the actual cost imposed on consumers under different circumstances (Leahy and Tol, 2011). Recent studies have documented substantial variation in VoLL across sectors, consumer characteristics, outage conditions, and estimation methods (Ovaere *et al.*, 2019; Jin *et al.*, 2024; Matsubara *et al.*, 2025; Jin, 2025a). Evidence based on observed consumer behavior further suggests that the value of reliability may vary with both consumer characteristics and interruption conditions (Brown and Muehlenbachs, 2024).

Despite this extensive literature on the estimation and application of VoLL, an important gap remains between estimating the economic cost of unserved electricity and using that estimate as an operational rule for allocating scarce electricity. An economically valid estimate of VoLL does not necessarily provide sufficient information to establish supply priorities or determine feasible load-shedding allocations. Moreover, technical, temporal, network, institutional, and legal constraints may prevent a simple ranking based on VoLL from being implemented in practice. This gap between the economic valuation of unserved electricity and its operational applicability constitutes the central research problem addressed in this study.

The issue is particularly relevant in Iran, where the growing mismatch between electricity supply and demand, especially during peak-load periods, has increased the need for supply restrictions and load shedding. Figure 1 illustrates the widening gap between electricity generation and consumption during annual peak-load periods in recent years. The economic consequences of electricity interruptions also differ substantially across sectors, and domestic studies have documented significant losses associated with electricity restrictions in different economic activities (Nikzad Hoseini and Sadeghi Shahdani, 2024; Pasandideh *et al.*, 2024).

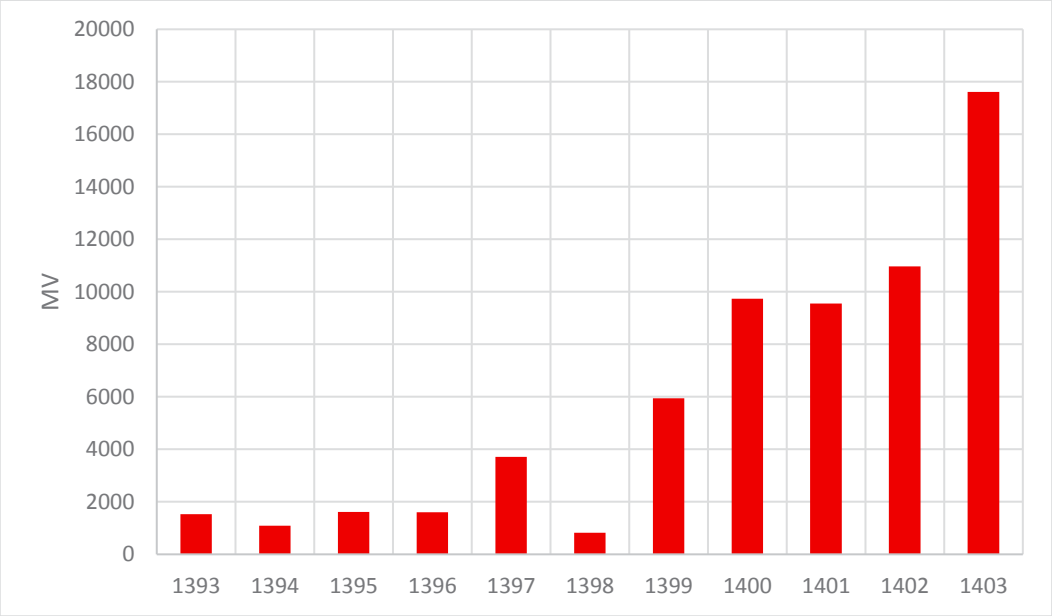


Fig. 1: Increasing gap between electricity generation and consumption during annual peak-load periods in Iran (Source: 57 Years of the Electricity Industry).

Against this background, this study asks whether VoLL can serve not only as an economic measure of the value of unserved electricity, but also as an operational rule for

determining supply priorities and allocating scarce electricity among consumers. To address this question, the study first examines the logic of VoLL-based allocation under an idealized benchmark of complete information and no technical or institutional constraints. This benchmark clarifies that the problem examined here does not arise from an inherent inconsistency in the economic logic of VoLL-based allocation. The study then relaxes these assumptions and examines the informational, operational, and institutional–legal constraints that may limit the practical application of VoLL. Using an optimization model and alternative valuation and allocation scenarios, the study evaluates the sensitivity of electricity allocation across economic sectors to these assumptions.

The study makes three main contributions. First, it develops a conceptual framework that distinguishes between the economic validity of VoLL as a measure of outage costs and its operational sufficiency as an allocation rule under scarcity. Second, using an optimization model under alternative valuation and allocation scenarios, it examines how the allocation of scarce electricity across economic sectors changes under different assumptions about the measurement and use of VoLL. Third, it identifies the informational, operational, and institutional conditions required for moving from VoLL as an economic indicator to an operational allocation instrument, highlighting why theoretical efficiency under complete information does not necessarily imply feasibility in real-world shortage management. The study further discusses the potential role of alternative allocation mechanisms that reduce reliance on centralized information about consumers' electricity values, while recognizing that their design and evaluation are beyond the scope of this study.

The remainder of the article is organized as follows. Section 2 reviews the relevant literature and identifies the research gap. Section 3 presents the theoretical framework and methodology. Section 4 applies the proposed framework using an optimization model and alternative scenarios and discusses the informational, operational, and institutional–legal constraints of VoLL-based allocation. Finally, Section 5 concludes the study and discusses its implications.

2. Literature Review

2-1. The Emergence and Concept of the Value of Lost Load

The concept of the Value of Lost Load (VoLL) emerged in electricity economics to capture the economic value of unserved electricity and the cost incurred by consumers or society as a result of interruptions in electricity supply. The theoretical foundation of VoLL lies in

the economic valuation of electricity reliability and the comparison between the benefits of reducing outages and the costs of providing additional reliability.

Unlike the price of electricity, VoLL does not represent the cost of supplying electricity. Rather, it reflects the value or cost that consumers and society attribute to the lack of access to electricity. Accordingly, VoLL has assumed an important role in studies of reliability assessment, capacity planning, and network development.

In their review of the VoLL literature, Schröder and Kuckshinrichs (2015) showed that estimates of VoLL depend on the valuation method, consumer type, characteristics of the interruption, and prevailing economic conditions. Gorman (2022) likewise argues, in a critical review of the literature, that VoLL is not a single, fixed concept but encompasses different dimensions of the economic value of electricity and interruptions in its supply.

This feature, on the one hand, explains the importance of VoLL in the economic analysis of electricity reliability and, on the other hand, raises the question of whether it can be used as an operational criterion for ranking consumers.

2-2. Heterogeneity of VoLL across Consumers and Conditions

A robust finding in the literature is that the cost of electricity interruptions is not uniform across consumers. Leahy and Tol (2011) showed that VoLL varies with consumer type and the timing of the interruption. Schröder and Kuckshinrichs (2015) likewise highlighted the role of consumer characteristics, valuation methods, and interruption scenarios in explaining differences in VoLL estimates. Ovaere *et al.* (2019) further showed that using more granular information on VoLL, including differences across consumers and interruption characteristics, can alter decisions concerning reliability.

Recent studies have extended this line of research. Brown and Muehlenbachs (2024), using households' actual investments in solar-plus-battery systems, provided a revealed-preference estimate of the value of reliability and showed that outage experience can affect consumers' investment behavior. In Japan, Matsubara *et al.* (2025) estimated household VoLL separately for predictable and sudden outages and identified differences between the two. Similarly, Jin (2025a), comparing stated-preference and revealed-preference approaches for households in South Korea, found substantial differences between the estimates obtained from the two methods.

Broberg *et al.* (2026) also showed that the actual cost of electricity outages varies across sectors, firms, and production sites, and that relying solely on lost output cannot capture all the consequences of an interruption. Therefore, VoLL estimates depend on factors beyond

the quantity of electricity not supplied, which limits the use of a fixed or average VoLL for ranking consumers.

These findings are particularly relevant to the present study because they demonstrate that the issue is not simply to determine a value for VoLL, but rather to determine which VoLL, for which consumer, at what time, and under what conditions should form the basis of a decision.

2-3. Reliability Planning and Electricity Allocation under Scarcity

The traditional application of VoLL in the literature has been the economic assessment of the appropriate level of electricity reliability. Within this framework, the expected cost of outages is compared with the investment costs required to increase capacity or reliability, thereby determining the economically optimal level of electricity supply.

However, some studies have also used VoLL to analyze electricity allocation under conditions of scarcity. Gorman (2022), in his critical review, draws attention to this distinction and differentiates between the use of VoLL in cost–benefit analyses of reliability investment and its use in electricity rationing.

A separate strand of the literature addresses how scarce electricity can be rationed when consumers differ in the value they place on reliability. Panzar and Sibley (1978) analyze self-rationing, in which consumers' own choices determine who is curtailed, and Chao and Wilson (1987) develop priority service, in which consumers choose among reliability levels at different prices, so that the supplier does not need to know each consumer's valuation in advance. Joskow and Tirole (2007) show that where consumers cannot be curtailed selectively, rationing cannot reflect differences in the value of electricity across users. Interruptible contracts, in which consumers accept curtailment in exchange for compensation, are a related approach (Baldick *et al.*, 2006). These studies indicate that the informational difficulty examined here is not specific to the VoLL, and that the manner in which the value is revealed is as significant as the method used to measure it. This distinction is fundamental to the present study. In long-term planning, knowledge of the average or expected cost of outages may be sufficient to determine the optimal level of capacity. Under scarcity management, however, the decision-maker must make decisions concerning specific consumers, at specific times, based on information that may itself change over time.

Consequently, the question of whether VoLL can be used for short-term electricity allocation cannot be answered merely by establishing the economic value of the indicator.

2-4. Methods for Estimating VoLL and Information Constraints

VoLL has been estimated using a variety of approaches, including stated-preference methods, revealed-preference methods, direct cost approaches, value-added approaches, economic models, and combinations thereof. Each approach has its own advantages and limitations.

Recent studies also indicate that the choice of estimation method can have a substantial effect on the resulting VoLL. For example, Jin (2025a), in a study of households in South Korea, showed that VoLL estimates based on willingness to pay differ considerably from estimates derived from the opportunity cost of time. Similarly, Jin (2025b), in a meta-analysis, showed that VoLL estimates depend on the estimation method, economic sector, and macroeconomic variables.

Along the same lines, Matsubara *et al.* (2025) showed that household characteristics, such as income and electricity expenditure, affect willingness to pay to avoid power outages. These findings indicate that VoLL is not a fully observable characteristic; rather, in many cases, it must be inferred from behavioral or economic information.

From the perspective of the present study, this issue becomes particularly important when VoLL is intended not merely to evaluate a general policy, but to rank consumers and determine outage priorities. Under such circumstances, estimation error, methodological differences, and the absence of private information may directly alter the ordering of consumer priorities.

2-5. The Dynamic Nature of VoLL and the Importance of Temporal Granularity

Another important issue is the dynamic and time-dependent nature of VoLL. The economic value of unserved electricity may vary according to the time of day, season, duration of the outage, production conditions, market conditions, and the specific characteristics of the consumer.

Ovaere *et al.* (2019) showed that using more granular VoLL information can alter reliability decisions. Recent studies have reinforced this point. For example, Kachirayil *et al.* (2025) estimated household VoLL at an hourly level across different regions of Germany and showed that incorporating temporal heterogeneity can affect decisions regarding curtailment and the level of reliability.

Therefore, if VoLL is to be used for operational decisions concerning power outages, the issue is not merely the estimation of VoLL, but also its continuous updating.

This issue represents an important gap in the literature. Much of the existing research has focused on obtaining more accurate VoLL estimates or improving its use in reliability

planning, whereas the present study asks whether the information required to use this indicator operationally and repeatedly for ranking consumers under scarcity is fundamentally available and sufficiently reliable.

2-6. Evidence from Iran

In Iran, VoLL and outage costs have also been employed in various studies to assess the economic consequences of electricity shortages. For example, Faridzad *et al.* (2022), using a combination of input–output analysis and linear programming, estimated the cost of electricity shortages in Iran and examined the allocation of electricity curtailments across economic sectors. Najafi *et al.* (2021), focusing on an industrial unit in Iran, showed that VoLL estimates may depend not only on consumer characteristics and outage conditions but also on equipment reliability and the probability of component failure within the industrial facility. By incorporating failure probabilities into the estimation process, they developed a probabilistic model of VoLL.

These studies are particularly relevant to the present research because they demonstrate that VoLL and outage costs can be incorporated into quantitative frameworks for analyzing electricity allocation under scarcity. However, they also give rise to a different question:

Are the information and estimates required for such allocation observable, verifiable, and updatable at the consumer level?

In other words, existing studies have largely asked: if the cost of an outage is known, how should scarce electricity be allocated optimally? The present study takes a step back and asks: can the actual cost of an outage be known with sufficient accuracy in practice to implement such an allocation based on it?

2-7. Research Gap

The literature review indicates that research on VoLL has largely developed along four main lines: the development of estimation methods, examination of heterogeneity in VoLL across consumers, application of VoLL to reliability planning, and, more recently, increasing the temporal and behavioral granularity of VoLL estimates.

Despite the importance of these studies, an important issue remains relatively underexplored: can VoLL, even if accepted as a valid economic indicator, provide a reliable basis for decisions regarding electricity supply priorities and the imposition of outages across specific consumers under conditions of scarcity?

This question has two dimensions. The first concerns the informational and economic feasibility of VoLL: can its actual and dynamic value be identified and updated with

sufficient accuracy? The second concerns its institutional and legal feasibility: does a difference in the economic value of electricity consumption, by itself, provide a sufficient basis for reallocating existing access rights to electricity?

By focusing on these two questions, the present study goes beyond the conventional VoLL literature. Rather than developing a new method for calculating VoLL, it critically examines its applicability as a tool for managing electricity scarcity.

3. Research Methodology

3-1. Research Approach

This study is an applied analytical study with an economic and institutional approach that evaluates the applicability of the Value of Lost Load (VoLL) for managing electricity scarcity and determining electricity supply priorities among consumers.

The methodological logic of the study is based on a sequential test. First, it is shown that, under complete information about VoLL, allocating scarce electricity on the basis of this indicator is economically feasible. The assumption of complete information is then progressively relaxed to examine the informational and economic limitations of this approach. Subsequently, the issue is considered at the institutional level by asking whether a higher economic value of electricity consumption, by itself, can provide a basis for reallocating access to electricity among consumers.

In addition, to identify and analyze the likely behavior of selected consumers under different scenarios, a mathematical optimization model is developed and implemented in GAMS. The model examines the optimal allocation of load across different sectors under supply constraints, with the objective of minimizing outage costs and, thereby, maximizing economic efficiency.

It should be emphasized that the methodology is not intended to develop a new allocation algorithm, but rather to assess the adequacy of VoLL as a tool for managing electricity scarcity.

3-2.Data

This study does not directly estimate the outage damages incurred by individual consumers. Instead, for the simulation component, the required data and information are collected primarily through desk research, including a review of published official documents.

The data required to determine the economic value of electricity across different sectors include information on electricity consumption, production or economic activity, and other relevant economic indicators. These data are obtained from official sources and previous

studies and are used to determine the value of electricity in each sector. Data on electricity consumption, tariffs, and production statistics are collected from official reports of the Ministry of Energy (2025), Tavanir (2025), and the Ministry of Agriculture-Jahad.

3-3.Theoretical Framework: Simulation–Optimization

The theoretical foundations of outage management based on the Value of Lost Load can be traced to centralized electricity network expansion planning models. Accordingly, this section first introduces the framework of these models and then presents an outage-management algorithm based on VoLL, which is critically examined in the subsequent sections.

3-3-1. Centralized Generation Capacity Expansion Planning and the Role of VoLL

Electricity generation capacity expansion planning models provide a framework for determining the amount and type of new generation capacity required to meet cost, environmental, and technical criteria over a specified planning horizon. The planning horizon is divided into several periods or years, and the required capacity to meet projected demand is determined while satisfying the relevant cost and operational objectives

In such models, the objective function generally consists of the sum of discounted investment costs, operating costs, and social costs, such as pollution costs. In a multi-objective model, objectives such as the simultaneous minimization of costs and emissions may also be incorporated, using approaches such as weighting or Pareto analysis. A representative general form of the objective function is presented below (Jadidoleslam and Ebrahimi, 2023; Ehsanbakhsh and Ahmadian, 2018).

$$Min\ C = \sum_{t=1}^{T} (I(U_t) + M(X_t) + O(X_t) - S(U_t))$$

where:

- $I(U_t)$: initial investment costs;
- $M(X_t)$: fixed and variable operating costs, including fuel costs;
- $O(X_t)$: including the cost of unserved electricity, represented by the Value of Lost Load (VoLL);
- $S(U_t)$: salvage value of depreciated assets;
- X_t: cumulative system capacity vector;
- T: planning horizon;
- t: planning periods (years within the development-planning horizon).

The minimization of the above objective function is subject to several constraints, the most important of which are:

- Supply–demand balance: total available capacity must be at least equal to peak demand in each period.
- Reserve margin: additional capacity relative to demand to ensure system reliability.
- Technical constraints: maximum capacity of each unit, annual construction and retirement rates, and maintenance or availability constraints.
- Environmental constraints: emission limits or requirements regarding the share of clean energy.
- Investment constraints: annual or total investment ceilings.

Optimization of the development plan generally follows a two-stage structure. In the first stage, the capacity expansion plan, including the type and amount of capacity from different technologies, is determined. At this stage, total investment and operating costs are minimized. In the second stage, short-term operational optimization is conducted primarily on the basis of variable operating costs. Such models are commonly implemented and solved using software such as GAMS and linear or nonlinear programming solvers.

What is the relationship between VoLL and the above modeling framework, and why can this framework be used to allocate outages during periods of electricity scarcity? The answer to these questions is embedded in the objective function presented above. The next section addresses this issue by presenting a simple allocation algorithm.

3-3-2. Allocation of Scarce Electricity Based on VoLL

To examine the applicability of VoLL as an allocation criterion under conditions of electricity scarcity, an idealized case is first considered in which the VoLL of all consumers can be identified completely and without error, and no technical, operational, or institutional constraints exist on reallocating electricity among consumers. Under these conditions, the electricity allocation problem can be formulated as a simple optimization problem.

Suppose that E_i denotes the amount of electricity demanded by consumer i, and x_i denotes the amount of electricity allocated to that consumer. Let V_i represent the Value of Lost Load of consumer i, and let S denote the total amount of electricity that can be supplied under scarcity conditions. The amount of unserved electricity for consumer i is therefore $E_i - x_i$, and the total economic cost of outages can be defined as follows:

$$\min C_{outage} = \min \sum_i V_i(E_i - x_i)$$

subject to:

$$0 \leq x_i \leq E_i$$

and

$$\sum_i x_i \leq S$$

The objective function indicates that, under supply constraints, electricity should be allocated in such a way as to minimize the total economic cost of unserved electricity. Rewriting the objective function yields:

$$\min \left[\sum_i V_i E_i - \sum_i V_i x_i \right]$$

Because, for a given scenario, E_i and V_i are assumed to be known and fixed, the term $\sum_i V_i E_i$is constant. Therefore, minimizing outage costs is equivalent to maximizing the economic value of the electricity allocated:

$$max \sum_i V_i x_i$$

This relationship has an important implication for the allocation problem. Under ideal conditions, each available unit of electricity should first be allocated to the consumer with the highest VoLL. Consequently, under scarcity, consumers with lower VoLL would be subject to supply restrictions first, whereas consumers with higher VoLL would be protected from curtailment to the greatest extent possible.

Thus, under complete information and in the absence of technical, operational, and institutional constraints, VoLL can be transformed from an economic indicator of the value of unserved electricity into a theoretical rule for prioritizing electricity allocation. This result constitutes the theoretical benchmark of the present study.

However, this result depends critically on the assumptions outlined above. In real-world conditions, VoLL is subject to uncertainty and heterogeneity; operational constraints may prevent a simple ranking of consumers; and the reallocation of electricity among consumers is also governed by institutional and legal arrangements. Accordingly, the subsequent sections examine these constraints and assess the robustness of the VoLL-based allocation rule.

4. Application and Critique of VoLL for Electricity Allocation under Scarcity

This section initially assumes that all required information is fully available and continuously updated in real time. It also assumes that the institutional framework imposes no legal restrictions on differential treatment among electricity consumers. Accordingly,

the system operator is assumed to be authorized to impose any necessary degree of additional curtailment on one group of consumers to enhance the security of electricity supply for another group. The objective is to maximize the benefits from allocating limited electricity among consumers with different outage costs.

4-1. Efficiency of VoLL under Complete Information and in the Absence of Legal Constraints

As a first step toward optimal allocation, assume that all required information is complete and that the institutional framework imposes no legal restrictions on differential treatment among electricity consumers. Suppose that the electricity network under consideration has Nconsumers or electricity demanders. The amount of electricity demanded, and the corresponding Value of Lost Load for each consumer are presented in Table 1. For example, consumer 4 demands E_4units of electricity, and if its demand is not supplied, the resulting loss is $VoLL_4$.

Table 1. Characteristics of Consumers in the Selected Electricity Network

Consumer	Electricity Demand	Value of Lost Load
C_1	E_1	$VoLL_1$
C_2	E_2	$VoLL_2$
C_3	E_3	$VoLL_3$
C_4	E_4	$VoLL_4$
C_5	E_5	$VoLL_5$
C_n	E_n	$VoLL_n$

Source: Research findings

If the available electricity is equal to or greater than the total electricity demand of all consumers, that is, if $S \geq \sum_i E_i$, there is no constraint on electricity supply. However, if available electricity is less than total demand, some consumers must inevitably be selected for curtailment and excluded from electricity supply.

As noted above, VoLL is an important criterion in this process. For example, if the VoLL of consumer 2 ($VoLL_2$) is higher than that of consumer 4 ($VoLL_4$), consumer 2 should be given priority over consumer 4 in electricity supply. If, despite this difference, consumer 4 remains supplied while consumer 2 is deprived of access to electricity, the resulting allocation would not maximize economic value and would therefore be considered economically inefficient.

In general, if this criterion is accepted, all consumers can be ranked according to their outage costs or VoLL, and curtailment can then begin with the consumer having the lowest VoLL. Consumers are progressively subjected to curtailment until the total remaining demand is equal to the amount of electricity available to supply the remaining consumers. This process continues until the electricity demand of the remaining consumers can be reliably met. For example, the elimination process would continue up to consumer C^*, as shown in Table 2.

Table 2. Stopping Point of the Consumer-Curtailment Algorithm and Achievement of the Equilibrium Condition and Optimal Allocation

Consumer	Electricity Demand	Value of Lost Load
C_1	E_1	$VoLL_1$
C_2	E_2	$VoLL_2$
C^*	E^*	$VoLL^*$
C_4	E_4	$VoLL_4$
C_5	E_5	$VoLL_5$

Source: Research findings.

Overall, this process indicates that, assuming complete information, the absence of institutional and legal constraints, and the ability of the system control center to impose curtailment on any group of consumers to ensure electricity supply to selected consumers, VoLL-based allocation minimizes the economic costs of electricity outages-that is, minimizes the total value of lost load- and thereby achieves economic efficiency.

4-2.Critique of the Application of VoLL in Electricity Scarcity Management

The previous section showed, under two simplifying assumptions, that allocating available electricity according to the Value of Lost Load (VoLL) can be economically efficient. The first assumption was that the decision-maker has complete access to the true VoLL of all consumers, while the second was the absence of any institutional or legal constraints on reallocating electricity among consumers. Under these assumptions, consumers can be ranked according to the economic cost of unserved electricity, and limited available electricity can be allocated to uses for which interruption would cause the greatest economic loss.

Accordingly, the critique developed here does not concern the economic logic of VoLL itself, but rather the feasibility of transferring this theoretical efficiency to real-world scarcity management. To this end, the two assumptions are examined sequentially from informational and institutional–legal perspectives.

4-2-1. The Assumption of Complete Access to Information

The assumption of complete access to information is vulnerable to serious limitations through at least two important channels. First, obtaining the true Value of Lost Load as the underlying measure of outage costs involves substantial uncertainty. Second, continuously updating VoLL in real time at the individual-consumer level is highly complex.

A. Difficulty in Identifying the True Value of Lost Load

VoLL is not a directly observable variable; rather, it must be estimated using various economic and behavioral methods. The literature indicates that the estimation method, consumer type, and characteristics of the interruption can significantly affect the estimated value of VoLL (Schröder & Kuckshinrichs, 2015; Gorman, 2022). Recent studies further confirm this uncertainty. For example, Jin (2025a) obtained different VoLL estimates for households in South Korea using stated-preference and revealed-preference methods and showed that the measurement method can significantly affect the estimated value. Her and Jin (2026) likewise documented differences across alternative estimation methods and implicit VoLL values embedded in reliability standards, highlighting the methodological challenges associated with the use of VoLL.

This issue becomes particularly important at the firm level because part of the actual cost of an outage depends on firm-specific characteristics that may not be observable to the decision-maker. These include the structure of the production process, the possibility of recovering lost output, restart costs, delivery delays, and other consequences of production disruptions. Firm-level evidence also indicates that outage costs can vary substantially across firms and industries, and that a single VoLL value may not adequately capture these differences (Broberg *et al.*, 2026). Accordingly, part of VoLL is private and potentially strategic information, and it cannot be assumed that the decision-maker has complete access to it.

This issue becomes even more important when the objective is not to estimate average outage costs at the sectoral or economy-wide level, but rather to rank individual consumers for electricity supply priorities. Under such conditions, estimation error is not merely an error in a parameter; it can alter the ranking of consumers and consequently lead to a

different allocation decision. Empirical evidence also indicates that estimates obtained using different methods can differ substantially (Jin, 2025a; Her & Jin, 2026).

Therefore, applying VoLL to scarcity management requires much more than merely estimating it using an appropriate method. The critical question is whether the true VoLL of all consumers can be identified simultaneously, reliably, and comparably for allocation decisions. The assumption of complete knowledge of consumers' VoLL is therefore a particularly strong assumption.

B. The Dynamic Nature and Updatability of VoLL

Even if the problem of initially identifying VoLL could be partially resolved, assuming that VoLL remains constant would still be inappropriate for scarcity management. The economic cost of an outage depends on the type of consumer, the time at which the interruption occurs, its duration, and prevailing operational and economic conditions. Accordingly, the VoLL required for operational decision-making should be regarded as a state-dependent variable rather than a fixed value.

Ovaere *et al.* (2019) showed that VoLL varies with interruption characteristics and timing, and that the use of more granular data can alter reliability-related decisions. More recent studies reinforce this finding. For example, Kachirayil *et al.* (2025) estimated household VoLL in Germany at regional and hourly levels and showed that incorporating temporal and spatial detail can affect both system costs and curtailment patterns.

This finding has an important implication for the operational use of VoLL. Increasing the detail and accuracy of VoLL may improve decision-making quality, but it simultaneously increases the amount of information required for decision-making. If the value of unserved electricity depends on the time, duration, consumer type, location, and other characteristics of the outage, it is no longer appropriate to assign a single fixed VoLL to each consumer. Instead, the economic value of electricity must be determined for a particular consumer under a particular outage condition.

Consequently, the more precisely and granularly VoLL is defined for allocation decisions, the more complex the collection, processing, and updating of the required information becomes.

From this perspective, the operational use of VoLL requires more than a reliable estimate: the decision-maker must be able to update VoLL in a timely manner. Generation conditions, contracts, inventories, market conditions, expected outage duration, and the possibility of recovering lost production may change over a short period, thereby changing the actual cost of an electricity interruption for a given consumer.

The shorter-term and more granular the allocation decision becomes, the greater the information requirements. Accordingly, the literature's movement toward hourly, sectoral, and regional VoLL estimates, while improving analytical precision, also illustrates the increasing informational complexity involved in using this indicator for operational decisions (Kachirayil *et al.*, 2025).

Thus, two problems arise simultaneously: first, the lack of direct observability and uncertainty in measuring VoLL; and second, the variation of VoLL over time and the difficulty of updating it. Consequently, the informational condition required to transfer the theoretical efficiency of VoLL to real-world scarcity management—namely, accurate, reliable, and timely knowledge of consumers' VoLL—cannot simply be assumed.

C. Testing the Applicability of VoLL to Electricity Allocation under Alternative Scenarios

This section uses the algorithm introduced above and a GAMS-based simulation to examine alternative scenarios for allocating a limited amount of electricity among different consumers under conditions of scarcity, where some degree of curtailment is unavoidable. In addition to VoLL, which may be used as a criterion for curtailment based on either the electricity tariff or the intrinsic value of electricity, other criteria arising from technical and operational constraints of the power system may also affect the allocation decision. The main considerations incorporated into the simulation are as follows:

- Household electricity consumption can be curtailed for a maximum of two hours per day and only during the 09:00–19:00 period.
- Certain industries, such as refineries, cannot be curtailed because of their need to maintain the production of gasoline, diesel, and processed gas products.
- A reduction in exports by dollar-denominated industries increases the exchange rate with a seasonal lag; the estimated effect is an increase of 700 tomans in the exchange rate for every USD 1 billion reduction in exports.

Accordingly, to simulate electricity curtailment and calculate the optimal allocation of outages in Iran, the peak load in 1403 is used as the reference point, representing the highest load observed by the Iranian power sector up to that time. To examine the sensitivity of electricity allocation to the method used to value electricity, as well as to selected allocation constraints and criteria, four scenarios are considered:

Scenario 1: Electricity valuation based on current electricity tariffs.

Scenario 2: Electricity valuation based on the real economic value of electricity.

Scenario 3: Electricity valuation based on network considerations.

Scenario 4: Electricity valuation based on the share of demand.

In these calculations, the analysis is based on the load recorded on 15 Mordad 1403, approximately 79,712 MW, while national power-plant generation at that hour was approximately 61,000 MW. This implies an electricity shortfall of approximately 18,000 MW, for which the model determines the optimal curtailment allocation under each scenario. It is assumed that no sector can be subject to more than 70% load management. The rate for other industries is set equal to the average industrial rate, while the rate for other uses is assumed to be 90% of the household rate.

Table 3. Simulation Results for the Proposed Curtailment Allocation under Different Scenarios (MW)

Consumer group	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Steel	0	0	857	1,944
Petrochemicals	0	0	1,991	648
Refineries	0	0	0	324
Aluminum and copper	0	2,986	2,986	972
Cement	1,593	0	0	518
Other industries	0	0	0	2,074
Residential and commercial	370	7,272	2,765	6,300
Agriculture	8,395	0	8,295	2,700
Other uses	7,742	7,742	1,106	2,520

Source: Authors' calculations.

The results of the four selected scenarios show that the optimal allocation changes significantly as the underlying conditions and assumptions change. The difference between Scenarios 1 and 2 is particularly evident. Given the possibility of shifting agricultural working hours and water-pumping schedules, together with the relatively low electricity tariff for agriculture, this sector is prioritized for curtailment under the first scenario. However, once the estimated economic value of agricultural output and the associated reduction in production are taken into account, agricultural consumers are no longer subject to curtailment.

For residential electricity consumption, even when the estimated economic value of electricity is incorporated, the residential sector remains a major candidate for curtailment. However, when the two-hour restriction is imposed, only approximately 10% of residential load is curtailed. Furthermore, if residential consumers can reveal their preferences—for

example, by accepting the consequences of outages during hot periods in a city such as Bushehr or by paying to avoid curtailment—the resulting allocation could be substantially different.

The simulation results are consistent with the literature in showing that decisions based on outage costs are sensitive to how those costs are measured. Ovaere *et al.* (2019) and Kachirayil *et al.* (2025) found that more detailed VoLL data, including temporal and spatial detail, can change reliability and curtailment decisions. Similarly, Faridzad *et al.* (2022) indicated that sectors with high electricity consumption do not necessarily bear the highest shortage costs. In our results, changing only the valuation criterion shifts agriculture from bearing the largest share of curtailment (Scenario 1) to bearing none (Scenario 2), so allocation outcomes depend on the valuation basis as well as on available supply. Broberg *et al.* (2026) showed that outage costs also vary across firms and production sites, which matters here because our sectoral values are averages that cannot reflect differences within a sector.

Overall, the scenario results indicate that the application of VoLL as an allocation criterion under electricity scarcity depends on the ability to identify the indicator and on its relative stability, as well as on how operational constraints are incorporated. Therefore, even if the informational problem could be resolved, examining institutional and legal constraints remains necessary for transferring the theoretical VoLL rule into operational decision-making.

4-2-2. Institutional and Legal Conditions for the Application of VoLL

Even if the informational problem were assumed to be completely resolved and the true VoLL of all consumers were available to the decision-maker at every moment with complete accuracy, a fundamental question would remain: Does the decision-maker have the authority to reduce one consumer's access to electricity and allocate that electricity to another consumer solely on the basis of their difference in economic value?

In the theoretical model, such authority is assumed. In the actual electricity system, however, the relationship between the electricity company and the consumer is not merely an abstract economic relationship. Rather, it is structured through electricity connections, contracts, supply obligations, and regulations governing the relationship between the utility and its consumers.

Under the *Supplementary Electricity Tariff Regulations*, electricity connection is defined in Clause 4-14 as authorized access to electrical energy, while Clause 4-13 identifies the electricity connection agreement as a contract between the company and the

applicant. Clause 4-15 also defines electricity supply as the provision of the power and energy contractually committed by the company at the delivery point under standard conditions. Accordingly, consumer access to electricity is established within a contractual and regulatory framework and cannot simply be treated as a momentary allocation from a common social resource.

The same logic is reflected in Clause 4-48, which recognizes the company's responsibility for continuity of electricity supply to the consumer, while providing exceptions including events beyond the company's control, cases agreed upon with the consumer, and circumstances specified in the regulations. Thus, continuity of supply is not an absolute and unconditional right. At the same time, however, electricity curtailment cannot simply be justified on the grounds that another consumer derives greater economic value from electricity consumption.

Clause 4-50 specifies the circumstances under which temporary interruption of electricity supply is permitted, including a consumer's request, failure to comply with obligations and regulations, outstanding debts, unauthorized use, judicial orders, and specific cases established by the regulations. The list does not identify a higher VoLL of another consumer, or a higher economic value of another consumer's electricity use, as an independent basis for disconnecting a consumer.

At the same time, Clause 4-57 permits electricity disconnection when necessary to prevent or reduce immediate risks arising from disturbances in the operational system. This provision is fundamentally important for maintaining system security. However, a distinction must be made between disconnection to preserve the technical security of the system and economic reallocation of electricity among consumers. The former is an action intended to preserve system operation, whereas the latter involves choosing one consumer over another based on differences in the economic value of their electricity consumption. The existence of the former authority does not, by itself, establish the latter. In other words, the authorization to disconnect electricity to prevent operational disturbances does not necessarily imply authorization to economically rank consumers and reallocate electricity from a consumer with lower VoLL to one with higher VoLL.

On the other hand, Clause 4-16-2 indicates that the regulations recognize differences in the interruptibility of consumers, but manage these differences through predefined load-management arrangements. For example, under Type A, the consumer reduces consumption during peak periods following prior notification; under Type B, electricity is not disconnected even when the control center must impose planned outages to prevent frequency or voltage declines or overloads; and under Type C, the consumer avoids

consumption during peak hours. Thus, the existing load-management framework recognizes differences in interruptibility, but links these differences to predefined arrangements rather than to real-time calculation and comparison of VoLL across consumers.

Clause 4-58 also recognizes the possibility of declaring the sensitivity of consumers' equipment to electricity interruptions, thereby acknowledging differences in the consequences of outages across consumers. However, such differences do not, by themselves, establish a right to priority in electricity supply.

Overall, the regulation examined indicates that electricity supply relationships have contractual and regulatory foundations, that electricity disconnection is permitted under specified circumstances, and that differences in interruptibility can be defined within predetermined arrangements. However, VoLL is not explicitly provided for in the provisions examined as an independent criterion for withdrawing or reducing one consumer's access to electricity in favor of another.

Therefore, even assuming complete access to VoLL information, implementing a VoLL-based allocation rule would require an institutional and legal basis for reallocating electricity among consumers. Such a basis is not explicitly provided for VoLL in the provisions of the regulation examined.

5. Conclusions

The growing incidence of electricity outages in Iran and the intensifying competition among different electricity uses have increasingly highlighted the need for a sustainable and efficient mechanism for allocating scarce electricity. Under such conditions, the objective of allocation should not be limited to distributing the available electricity among consumers, but rather should be to maximize social welfare and the economic value generated by electricity consumption. This requires a mechanism capable of reflecting differences in the value of electricity consumption in allocation decisions while remaining compatible with the actual economic conditions and institutional arrangements governing the electricity market.

Focusing on the Value of Lost Load (VoLL), which occupies an important position in the literature and in centralized electricity supply planning, this study shows that although VoLL can provide a basis for the efficient allocation of scarce electricity under ideal conditions—assuming complete access to information and the absence of institutional and legal constraints—it is not adequate as an operational tool for determining which consumers should receive electricity and which should be curtailed. The main limitations

are the difficulty of observing the true value of lost load and of estimating it accurately and in a timely manner, substantial differences in this value across consumers and over time, and the lack of a sufficient institutional and legal basis for translating an economic ranking into authority to reallocate electricity among consumers.

This conclusion does not imply that electricity should be allocated under scarcity without regard to the economic value of different uses. On the contrary, differences in the value of electricity consumption should remain at the core of the allocation mechanism. However, this objective cannot necessarily be achieved by centrally determining VoLL and using it to decide which consumers should be disconnected or supplied. What is required is a mechanism that, while avoiding the informational and institutional limitations associated with VoLL, enables the true value of scarce electricity to be discovered through freedom of choice, consumer participation, and the direct involvement of consumers in the allocation process. Such an approach could provide a basis for allocating electricity to uses that generate greater social and economic value, without requiring a centralized decision-maker to determine in advance the true value of electricity consumption for each individual consumer.

From this perspective, the main finding of the study can be summarized in one proposition: the central issue is not to abandon economic value as a criterion for allocating scarce electricity, but to identify a more appropriate mechanism for discovering and realizing that value. Market-based mechanisms that allow greater consumer choice and participation may offer a potential direction for further investigation. However, the feasibility of mechanisms involving the transferability of electricity-use rights depends on the legal status of existing contractual rights, the contractual and regulatory arrangements governing their transfer, and the institutional framework required for implementation and oversight. These issues require further legal and operational assessment before such mechanisms can be recommended for practical adoption.

Accordingly, the policy recommendations of this study are as follows:

1. Avoid relying on VoLL as an independent and operational criterion for determining electricity curtailment priorities. VoLL can continue to be used as an indicator of outage costs and as a tool for economic analysis; however, it is not sufficient for directly reallocating electricity among consumers.
2. Reconsider centralized approaches to electricity allocation under scarcity and move toward mechanisms that enable the value of scarce electricity to be discovered in a decentralized manner.

3. Explore market-based mechanisms as a potential alternative for allocating scarce electricity, subject to further research on their design, feasibility, and consumer protection.
4. Conduct further research on an alternative mechanism to VoLL. The design and evaluation of such a mechanism—one capable of simultaneously incorporating economic efficiency, consumer rights, and the technical requirements of the electricity network—will be pursued as part of a broader research program by the authors.

Acknowledgements

The authors would like to express their gratitude to the Isfahan Regional Electricity Co. and the Niroo Research Institute (NRI) for their support.

Author Contributions

Kioumars Heydari: Conceptualisation, methodology, formal analysis, literature review, writing the original draft, and writing & reviewing the final version. Pouyan Kiani: Literature review, writing and editing the final version. Elahe Sabouripour: Literature review, Data collection, writing the first version. Seyed Peyman Mousavi Mobarekeh: Data collection, simulation, writing the first version. Amir Doudabi Nezhad: Conceptualisation and methodology.

Conflict of Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

No new data were generated or analyzed in support of this research. All data used in this study are publicly available from the cited sources (see References). In addition, the data are available on request.

Declaration of Generative AI and AI-assisted technologies in the manuscript preparation process

During the preparation of this work, the authors used AI-based tools (Claude, Anthropic; ChatGPT, OpenAI) to assist with translation, language editing, and the identification and

correction of grammatical and clarity-related errors. These tools were not used to generate original scientific ideas, arguments, analysis, or conclusions. All conceptual content, theoretical development, and interpretations in this paper are the authors ' own. After using these tools, the authors reviewed and edited all resulting content and take full responsibility for the content of this publication.

References

- Baldick, R., Kolos, S., & Tompaidis, S. (2006). Interruptible electricity contracts from an electricity retailer's point of view: valuation and optimal interruption. *Operations Research*, *54*(4), 627-642. https://doi.org/10.1287/opre.1060.0303

- Broberg, T., Brannlund, R., Lundgren, T., & Persson, L. (2026). Values and metrics of lost load in the Swedish manufacturing industry: A conceptual and empirical analysis. *Heliyon*, 12(12). https://doi.org/10.1016/j.heliyon.2026.e45130

- Brown, D. P., & Muehlenbachs, L. (2024). The value of electricity reliability: Evidence from battery adoption. *Journal of Public Economics,* 239, 105216. https://doi.org/10.1016/j.jpubeco.2024.105216

- Chao, H. P., & Wilson, R. (1987). Priority service: Pricing, investment, and market organization. *The American Economic Review*, 899-916. https://www.jstor.org/stable/1810216

- Ehsanbakhsh M, & Ahmadian M. (2018). Electricity Expansion Planning Under Environmental Constraints. *Quarterly Journal of Energy Policy and Planning Research*, 4(1), 7-39. http://epprjournal.ir/article-1-360-fa.html (in Persian)

- Faridzad, A., Ghasemi, A., Rajabi Nejad, M. & Mohammadian, M. A. (2022). The Electricity Shortage Cost in Iran: An Input-Output Analysis and Linear Programming. *Iranian Economic Review*, *26*(4), 791-807. https://doi.org/10.22059/ier.2022.90656

- Gorman, W. (2022). The quest to quantify the value of lost load: A critical review of the economics of power outages. *The Electricity Journal,* 35(8), 107187. https://doi.org/10.1016/j.tej.2022.107187

- Her, Y., & Jin, T. (2026). Rethinking value of lost load in high-reliability electricity systems: Methodological challenges and policy implications. *Energy Strategy Reviews,* 63, 102061. https://doi.org/10.1016/j.esr.2026.102061

- Jadidoleslam, M., & Ebrahimi, A. (2023). Generation Expansion Planning Considering Demand Side Management Programs Using ABC Algorithm. *Energy Engineering and Management*, *4*(1), 2-15. https://energy.kashanu.ac.ir/article_113332.html?lang=en (in Persian)

- Jin, T. (2025a). Evaluating the value of lost load to South Korea's residential electricity consumers by stated and revealed preference methods. *Utilities Policy,* 97, 102072. https://doi.org/10.1016/j.jup.2025.102072

- Jin, T. (2025b). A meta-analysis of outage cost for value-based reliability planning. *Energy Strategy Reviews,* 62, 101975. https://doi.org/10.1016/j.esr.2025.101975

- Jin, T., Lee, T. E., & Kim, D. (2024). Valuing flexible resources in the Korean electricity market based on stated preference methods. *Utilities Policy,* 88, 101733. https://doi.org/10.1016/j.jup.2024.101733

- Joskow, P., & Tirole, J. (2007). Reliability and competitive electricity markets. *The RAND Journal of Economics*, *38*(1), 60-84. https://doi.org/10.1111/j.1756-2171.2007.tb00044.x

- Kachirayil, F., Huckebrink, D., Bertsch, V., & McKenna, R. (2025). Trade-offs between system cost and supply security in municipal energy system design: An analysis considering spatio-temporal disparities in the Value of Lost Load. *Applied Energy,* 381, 124896. https://doi.org/10.1016/j.apenergy.2024.124896

- Leahy, E., & Tol, R. S. (2011). An estimate of the value of lost load for Ireland. *Energy Policy,* 39(3), 1514-1520. https://doi.org/10.1016/j.enpol.2010.12.025

- Matsubara, M., Mae, M., & Matsuhashi, R. (2025). Investigation of Residential Value of Lost Load and the Importance of Electric Loads During Outages in Japan. *Energies*, *18*(8), 2060. https://doi.org/10.3390/en18082060

- Ministry of Energy of the Islamic Republic of Iran (2025). Supplementary electricity tariff regulations: Regulations governing the relations between electricity companies and applicants for connections and subscribers. https://moe.gov.ir/RulesRegulations/ (in Persian)

- Najafi, M., Akhavein, A., Akbari, A., & Dashtdar, M. (2021). Value of the lost load with consideration of the failure probability. *Ain Shams Engineering Journal*, *12*(1), 659-663. https://doi.org/10.1016/j.asej.2020.05.012

- Nikzad Hoseini, S. E. M., & Sadeghi Shahdani, M. (2024). Economic Valuation of Electricity Input in Iranian Energy-Intensive Industries. *Journal of Applied Economics Studies in Iran*, *12*(48), 133-160. https://doi.org/10.22084/aes.2023.28204.3622 (in Persian)

- Ovaere, M., Heylen, E., Proost, S., Deconinck, G., & Van Hertem, D. (2019). How detailed value of lost load data impacts power system reliability decisions. *Energy Policy,* 132, 1064–1075. https://doi.org/10.1016/j.enpol.2019.06.058

- Panzar, J. C., & Sibley, D. S. (1978). Public utility pricing under risk: The case of self-rationing. *The American Economic Review*, *68*(5), 888-895. https://www.jstor.org/stable/1811320

- Pasandideh, A., Keyghobadi, M., & Pourkeivani, I. (2024). Estimation of Outage Losses Due to Dust Phenomenon. Economics Research, 23(89). https://doi.org/10.22054/joer.2024.76516.1162 (in Persian)

- Schröder, T., & Kuckshinrichs, W. (2015). Value of Lost Load: An efficient economic indicator for power supply security? A literature review. *Frontiers in Energy Research,* 3, 55. https://doi.org/10.3389/fenrg.2015.00055

- Tavanir, Specialized Holding Company, Deputy of Research and Human Resources, Office of Information Technology, Statistics and Cyberspace Security. (2025). *57 years of Iran's electricity industry in statistics (1346–1402).* https://amar.tavanir.org.ir/pages/omomi/58saleomomi.pdf

مطالعات اقتصادی کاربردی ایران
Quarterly Journal of Applied Economics Studies, Iran (AESI)
سال پانزدهم، شمارهٔ ۵۹، ۱۴۰۵

فصلنامهٔ علمی مطالعات اقتصادیِ کاربردی ایران
شاپای چاپی: ۲۵۳۰-۲۳۲۲؛ شاپای الکترونیکی: X۴۷۲۲-۲۳۲۲ - وب‌سایت نشریه: https://aes.basu.ac.ir
نشریهٔ گروه اقتصاد، دانشکدهٔ علوم اقتصادی و علوم اجتماعی، دانشگاه بوعلی‌سینا، همدان، ایران.
حق انتشار این مستند، متعلق به نویسنده(گان) آن است. ۱۴۰۵ - ناشر این مقاله، دانشگاه بوعلی‌سینا است.
این مقاله تحت گواهی زیر منتشرشده و هر نوع استفاده غیرتجاری از آن مشروط بر استناد صحیح به مقاله و با رعایت شرایط مندرج در آدرس زیر مجاز است.
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بازتخصیص انرژی الکتریکی در دوره‌های کمبود
محدودیت‌های حقوقی و اقتصادی ارزش بار از دست رفته به‌عنوان معیار بازتخصیص

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نوع مقاله: پژوهشی
شناسهٔ دیجیتال: https://doi.org/10.22084/aes.2026.33355.3944
تاریخ دریافت: ۱۴۰۵/۰۶/۱۳، تاریخ بازنگری: ۱۴۰۵/۰۸/۰۳، تاریخ پذیرش: ۱۴۰۵/۰۸/۱۱
صص: ۱۸۷-۱۶۱

چکیده
افزایش دفعات قطعی برق، ناشی از عدم تعادل میان عرضه و تقاضای انرژی الکتریکی، ضرورت تخصیص بهینه این منبعِ محدود را میان مصارف رقیب دوچندان کرده است. اگرچه شاخص «ارزش بار از دست‌رفته» (VoLL) به‌طور گسترده‌ای برای سنجش هزینهٔ قطعی‌های برق و ارزیابی قابلیت اطمینان شبکه به‌کار می‌رود، اما همچنان مشخص نیست که آیا می‌توان از آن به‌عنوان معیاری قابل‌اتکاء برای تخصیص برقِ محدود نیز استفاده کرد یا خیر. این پژوهش با اتخاذ رویکردی توصیفی-تحلیلی و با بهره‌گیری از یک مدل بهینه‌سازی ریاضی (شبیه‌سازی‌شده در نرم‌افزار GAMS)، کفایت شاخص VoLL را از دو منظر اقتصادی و حقوقی مورد بررسی قرار می‌دهد. از منظر اقتصادی، مطالعهٔ حاضر نخست نشان می‌دهد که در شرایط آرمانی، یعنی وجود اطلاعات کامل و نبودِ محدودیت‌های نهادی، تخصیص برق برمبنای شاخص VoLL می‌تواند به تخصیصی کارآمد منجر شود؛ سپس، با بررسی محدودیت‌های اطلاعاتی، ماهیت پویای شاخص VoLL و نتایج حاصل از شبیه‌سازی، امکان‌پذیری عملیاتیِ استفاده از این شاخص به‌عنوان مبنایی برای تصمیم‌گیری‌های متمرکز ارزیابی می‌شود. از منظر حقوقی، این پژوهش مبانی قانونیِ بازتوزیع برق میان مصرف‌کنندگان در دوره‌های کمبود را در چارچوب مقررات حاکم‌بر تأمین برق در ایران بررسی می‌کند. نتایج نشان می‌دهند که شاخص VoLL، باوجود اعتبارش به‌عنوان معیاری برای سنجش هزینه‌های قطعی برق، فاقد پیش‌نیازهای اطلاعاتی و نهادی-حقوقی لازم برای ایفای نقش به‌عنوان معیاری عملیاتی جهت تخصیص برقِ محدود است. سازوکارهایی که برپایهٔ انتخاب مصرف‌کننده و حقوق قابل‌معامله برای بهره‌برداری از ظرفیت موجود استوارند، رویکردی بالقوه برای آشکارسازی ارزش برق در دوران کمبود محسوب می‌شوند و شایستهٔ پژوهش‌های بیشتر هستند.

کلیدواژگان: ارزش بار از دست رفته (VoLL)، تخصیص انرژی الکتریکی، کمیابی برق، خروج برنامه‌ریزی شده، بازار برق.
طبقه‌بندی JEL: L94, D61, D82, K23.

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ارجاع به مقاله: حیدری، کیومرث؛ کیانی، پویان؛ صبوری‌پور، الهه؛ موسوی‌مبارکه، سید پیمان؛ و دودابی‌نژاد، امیر، (۱۴۰۵). بازتخصیص انرژی الکتریکی در دوره‌های کمبود محدودیت‌های حقوقی و اقتصادی ارزش بار از دست رفته به‌عنوان معیار بازتخصیص. مطالعات اقتصادی کاربردی ایران، ۱۵(۵۹)، ۱۶۱-۱۸۷. https://doi.org/10.22084/aes.2026.33355.3944
صفحهٔ اصلی مقاله در سامانهٔ نشریه: https://aes.basu.ac.ir/article_6891.html