ADAPTATION OF AUTOMATED DEMAND RESPONSE (ADR) TECHNOLOGY TO REDUCE PEAK ENERGY DEMAND IN SRI LANKAN COMMERCIAL BUILDINGS

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Abstract. Automated Demand Response (ADR) technology could potentially be used to lower peak energy use in commercial buildings in Sri Lanka. By assessing the feasibility, benefits, and challenges of ADR in the local context, the study aims to fill the implementation gap. Using a mixed-method approach, surveys and expert interviews with stakeholders, utility providers, regulatory bodies, and energy market experts were used to acquire quantitative and qualitative data. The results show that Sri Lanka's commercial buildings increase operational expenses and increase grid instability by contributing significantly to peak energy consumption. By allowing dynamic energy consumption changes during peak hours, ADR technology offers an acceptable approach that enhances grid stability and lowers energy costs. The study found several barriers to the ADR, such as the high initial setup costs, the lack of standardized protocols, incentives, and supportive legislation. Despite these barriers, the study emphasizes how ADR might improve sustainability and energy efficiency in Sri Lanka's commercial sector. The surveys showed a mixed state of current readiness for ADR adaptation, while expert interviews offered deeper insights into the feasibility of ADR adaptation. Stakeholders are generally aware of and interested in ADR technology; however, there are still significant gaps in technical capability, financing, and regulatory support. The study concludes with a three-year roadmap for implementing ADR, highlighting the significance of regulatory support, stakeholder involvement, and tech-infrastructure investment.

Keywords. Demand Response, Demand Side Management, Automated Demand Response, Feasibility, Readiness

1. Introduction

In recent years, global energy consumption has been on the rise, which is driven by factors like urbanization, industrialization, technological progress, a growing population, expanding economies, and the widespread adoption of energy-intensive technologies in daily life (Avtar et al., 2019). This global phenomenon is mirrored in Sri Lanka, where urbanization and economic growth have resulted in a simultaneous increase in energy demand, particularly in the commercial sector (Morimoto & Hope, 2004). When it comes to the Sri Lankan context, the load profile of Sri Lanka's electricity system has a high peak in the evening and a poor load factor as a result. (Study report on electrical demand curve and system peak reduction, 2017. According to the Generation summary (2023) load curve, there are two peaks as a day peak and a night peak. The day peak occurs at 16.00 while the night peak occurs at 19.15, with respective values of 1984.9MW and 2324.5MW. To handle peak loads, utility companies were encouraged to look for load management programs (Cappers et al., 2010).
At the forefront of modern energy management technologies, Automated Demand Response (ADR) provides a methodical and automated approach to demand response in commercial buildings. The foundation of ADR is the concept of facilitating communication and control to regulate power usage dynamically between utilities and end customers (Abate et al., 2013). The basic idea is that signals are exchanged, usually in the form of price or dependability data, to initiate

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automated changes in energy consumption and this demand response system gives end users the freedom to adjust to shifting grid conditions while improving grid efficiency and stability (Institute of Electrical and Electronics Engineers, 2014). An Automated Demand Response (ADR) solution that enables the utility to quickly and efficiently manage its customers to enhance the DR capability for wider implementation is presented in (Daisuke et al., 2016). ADR uses technology advancements and automated mechanisms to automatically reduce energy use during times of high demand, doing so without the need for human intervention (Piette et al., 2004).

Globally, power systems are increasingly challenged by growing peak electricity demand, aging infrastructure, and the integration of intermittent renewable energy sources. As a result, Automated Demand Response (ADR) has emerged as a crucial tool for demand-side management, offering a dynamic and intelligent approach to energy reduction during peak periods (Wang et al., 2022; IEA, 2021). ADR systems utilize communication and control technologies to automatically adjust building loads in response to grid signals, providing grid flexibility and reducing operational costs.

While developed countries have seen widespread deployment of ADR technologies, their adaptation in developing nations like Sri Lanka remains limited. According to Fernando (2018), the concept of demand response is still in its early stages in Sri Lanka, highlighting the need for strategic exploration and implementation. Recent analyses by the Public Utilities Commission of Sri Lanka (PUCSL, 2022) emphasize that DR programs, especially when automated, could significantly defer infrastructure investments and optimize grid stability.

However, Sri Lanka’s commercial sector, a major contributor to national peak demand, has yet to adopt ADR technologies in a scalable and systematic manner. This research therefore seeks to fill that gap by examining the current readiness, feasibility, and adaptation potential of ADR technologies in Sri Lankan commercial buildings. The study aims to provide actionable insights for utilities, policymakers, and building managers, thereby contributing to the modernization of the country’s energy management systems in alignment with global best practices. In order to achieve the research aim, following research objectives were formulated.

- Review the state of demand response programs and their impact on peak energy demand and concept of Automated Demand Response
- Assess the current level of readiness for Automated Demand Response (ADR) adaptation in Sri Lanka
- Develop a roadmap to adapt ADR in next three years in Sri Lanka.

2. Literature Review

This section presents the key literature findings related to two major areas: (i) Current energy market and state of demand response programs and their impact on peak energy demand, and (ii) The concept of ADR and barriers for ADR technology.

2.1 DEMAND SIDE MANAGEMENT AND DEMAND RESPONSE PROGRAMS

Demand response (DR) can be defined as the act whereby consumers who are the end users of electricity modify their consumption levels based on the changes in

the price of power at different times. As stated in the literature analysis by Albadi et al., 2008), it is the process of convincing consumers to shift their consumption of electricity to the periods when there is more availability of electricity or there is less consumption by others in order to balance the load on power systems, which is mainly done through prices or incentive/penalty schemes. (Emi Bertoli, 2023). Based on this definition, the idea is to make DR attractive to consumers, in order to manage their power usage preferences in a way that will benefit not only themselves but also the power grid (Güner et al., 2020).
For many reasons, commercial buildings have a significant potential to engage in DR projects. Commercial buildings account for a large portion of the electricity load in most countries (i) buildings account for more than half of the total electricity load (ii) commercial buildings have many predictable loads operating on repeating schedules, making them good candidates for distributed renewable energy (DR); iii) many commercial buildings have centralized control, which lowers the cost of integrating them in DR programs (Jradi & Veje, 2017).

2.2 EFFECT OF DR APPROACHES ON PEAK ENERGY DEMAND

Supply-side management (SSM) and demand-side management (DSM) are both techniques used in power system management to reduce peak loads, improve network-loading capacity, and mitigate contingencies (Jabir et al., 2018). According to, United Nations Industrial Development Organization, (2007), the study states that supply-side management seeks to improve the operational effectiveness of electricity generation, transmission, and distribution, guaranteeing effective energy production at the lowest possible cost, meeting electricity demand without unnecessary infrastructure investments, and minimizing environmental impacts through the effective use of power system assets.
Programs for demand response (DR) are acknowledged as a crucial subset of demand-side management (DSM) as a whole (Meyabadi & Deihimi, 2017). Demand response is a strategy that aims to optimize electricity usage by intentionally engaging end users to adjust their consumption patterns in response to changing market conditions or grid dynamics (Palensky & Dietrich, 2011).
The study conducted by, Logenthiran et al., (2012), stated that, DSM benefits consumers as well as energy providers as it enables consumers to actively participate in reshaping their load profiles through informed decision-making to achieve optimal energy consumption which leads to reduced peak load demand and, as a result, contributes to the stability of the power system network as a whole.

Optimization of utility system performance is largely dependent on load management, which is an essential component of demand-side management (Gellings, 1985). Currently, utility operations are focused on achieving specific load shape objectives through various types of demand response initiatives that fall into six main categories: flexible load shape, strategic load growth, peak clipping, valley filling, load shifting, and strategic conservation (Logenthiran et al., 2012).

Peak clipping is the process of lowering utility loads during periods of peak demand, whereas valley filling is the process of constructing off-peak loads. Their common objective is to close the gap between peak and valley load levels (Esther & Kumar, 2016) Load shifting is transferring the load from periods of peak demand to periods of off-peak demand while maintaining constant overall energy consumption. This makes it one of the DSM's most successful load control techniques (Javor & Janjic, 2016). The goal of strategic conservation is to lower both peak demand and overall energy consumption by modifying the load-shape at the customer premises. Strategic load growth refers to an increase in electricity sales based on competitive fuel pricing (Sharda et al., 2021). The foundation of flexible load shape is those adaptable clients who are prepared to accept changes in service quality in return for monetary incentives (Javor & Janjic, 2016).

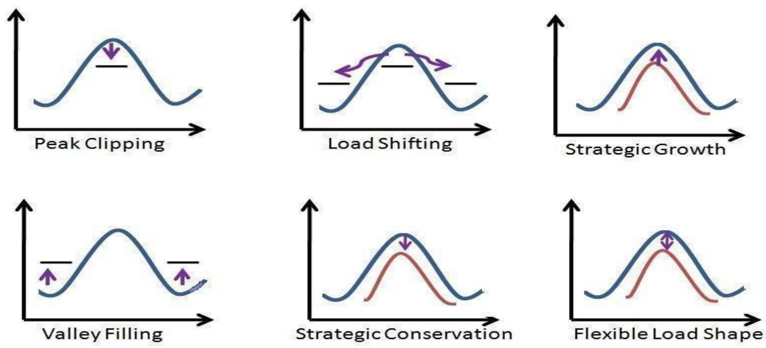

Figure 1: Demand Management

2.3 REVIEW OF ADR TECHNOLOGY

ADR (Automated Demand Response) technology encompasses a range of systems and protocols designed to automate the process of adjusting electricity usage in response to grid signals. Among these technologies, OpenADR (Open Automated Demand Response) stands out as a widely adopted open standard that facilitates seamless communication between utilities and energy management systems.

In its simplest form Open ADR is an open communication standard, which acts as a tool for energy providers, and end users by allowing efficient DR signal exchange. Hoekstra et al., (2016) have postulated that OpenADR provides the facilities to allow this communication to take place efficiently via a standard language that operates over existing Internet Protocol based networks. The OpenADR has been applied in the context of peak load control for quite some time now, but its application has recently been ramped up for the rapid DR programs and auxiliary services. Notably, this change underscores the increasing need to balance variable energy production from renewable sources, emphasizing OpenADR's flexibility and applicability in modern energy environments (Hoekstra et al., 2016)

When OpenADR is incorporated into smart grids, automated demand response (ADR) is created as a result of the systematic transmission of signals. ADR is emphasized by the OpenADR Alliance as fully automated power supply signaling that enables automatic connectivity to end-user control systems (OpenADR Alliance, 2014). This entails a dynamic and predetermined series of steps to successfully balance energy load availability and demand. As stated in the U.S. Department of Energy (2007), ADR is a critical energy management approach, particularly given that an ongoing increase in energy use is placing pressure on available generation capacity.

2.4 BARRIERS FOR ADR TECHNOLOGY

Table 1: Barriers for ADR adaptation

Barriers	Cited From
Integration with existing building management system	(Page et al., 2011)
Lack of standardized protocols	(Heffner, 2009)
Limited incentives	(Electric Power Research Institute, 2011)
High initial setup and installation cost	(California Edison, 2020)
Lack of supportive policies	(Wikler, 2021)
Low awareness	(Bruceri et al., 2017)
Limited knowledge and expertise	(Electric Power Research Institute, 2011)

3. Methodology

The methodical, theoretical examination of the approaches used in a field of study is known as research methodology (Steffe et al., 2012). Consequently, a mixed method was adopted in this research. Experts for interviews and surveys were selected based on the snowball technique. Eight expert interviews were conducted, with the energy industry experts working on utility companies, the sustainable energy authority, and the public utility commission in Sri Lanka, and the questionnaire survey was circulated among 30 people who are involved with the energy market and have knowledge about the Sri Lankan energy sector. Snowball sampling is not a probability technique, and it is a random method. Manual content analysis is used to analyze the data retrieved from expert interviews. To summarize the responses' central tendency, the mean value was calculated when analyzing the questionnaire survey data. The mean value, also called the average, gives a number that sums up the typical answer. The calculation involves adding up each response and dividing the result by the total number of responses, and analyzing the 5-point Likert scale results, for which the SPSS software was used. A comprehensive literature review was conducted on the state of demand response programs and their impact on peak energy demand and the concept of Automated Demand Response concept achieving objective 1. A survey was conducted to assess the current level of readiness for Automated Demand Response (ADR) adaptation in Sri Lanka, achieving objective 2. Findings of the survey and interviews were used to develop the roadmap to adapt ADR in the next three years in Sri Lanka, achieving objective 3.

4. Results

4.1 THE CURRENT LEVEL OF READINESS FOR AUTOMATED DEMAND RESPONSE (ADR) ADAPTATION

The current state of readiness for ADR adaptation is examined in this analysis in five major areas: financial, market, regulatory, technological, and knowledge, expertise, and competency readiness. Each component was evaluated by a survey in which 30 participants from the energy market rated their level of readiness using

a Likert scale. The analysis was conducted using the mean of the total responses, and SPSS software was used for these results interpretation.
Readiness levels are categorized based on the mean values from the survey. To summarize the responses' central tendency, the mean value was calculated when analyzing the questionnaire survey data. Given the relatively balanced Likert-type scale used in the survey. Following a structural clarification.
Level 1 0-1 Not ready at all (No or minimal funding, technology and infrastructure, awareness, government and policy support)
Level 2 1-2 Slightly ready (Basic funding, technology and infrastructure, awareness, government and policy support)
Level 3 2-3 Moderately ready (Considerable funding, technology and infrastructure, awareness, government and policy support)
Level 4 3-4 Almost ready (Significant funding, technology and infrastructure, awareness, government and policy support)
Level 5 4-5 Fully ready (Well-developed technology and infrastructure, awareness, adequate funding, as well as government and policy support)

Table 2: Current level of readiness for ADR

Readiness Category	**Question**	**Mean Value**	**Readiness Level**
Technological Readiness	Availability of advanced metering infrastructure	4.31	Level 4
	Availability of network Infrastructure (Wi-fi, Zigbee, cellular)	4.86	Level 5
	Availability of Control devices (Smart thermostats, lighting controls)	3.83	Level 4
	Availability of communication protocols (OpenADR, BACnet)	3.69	Level 4
	Availability of Cybersecurity Measures	3.07	Level 3
	Availability of Demand Response Automation Servers (DRAS)	2.00	Level 2
	Availability of energy management system (EMS, BMS)	4.97	Level 5
Overall Technological Readiness		3.81	Level 4
Financial Readiness	Government funding for smart grid pilot projects	3.79	Level 4
	Has identified as prioritized investment	2.28	Level 3
	Budget allocation for Smart grid concept including ADR technology development and implementation	1.79	Level 2
Overall financial Readiness		2.63	Level 3
Knowledge, Skills, and Competency Readiness	Availability of knowledge, skills, and competencies to adopt the technology	4.38	Level 4
	Research and development efforts to enhance the adaptability of the technology	4.00	Level 4
	Availability of practical cases of the technology	2.24	Level 3
Overall knowledge, skills, and competency Readiness		3.54	Level 4
Market Readiness	Market demand for the Technology	2.34	Level 3

	Sufficient market incentives for participants	3.17	Level 3
Overall market Readiness		2.75	Level 3
Regulatory Readiness	According to your knowledge, rate the regulatory readiness in Sri Lanka for adopting ADR technology	1.93	Level 2
Overall Regulatory Readiness		1.93	Level 2

As illustrated in above table, seven different elements were used to assess the technological readiness for Automated Demand Response (ADR) adaption. The total mean score of 3.81 indicates that while certain factors indicate higher degrees of preparedness, the level of readiness is close to "Almost ready" level. The assessment of financial readiness for the adoption of Automated Demand Response (ADR) was conducted by considering three particular areas, the average score of 2.63 indicates that financial preparedness is somewhere between "Slightly ready" and "Moderately ready." The evaluation of the readiness level for the adoption of Automated Demand Response (ADR) was conducted by assessing the knowledge, expertise, and competencies using four particular areas, the average score of 3.54 indicates a “Moderately high” readiness. The assessment of the market's readiness for the adoption of Automated Demand Response (ADR) has been carried out through the use of two specific questions. A being slightly level to tendency towards a moderate degree of regulatory readiness is indicated by the average score of 2.75. The mean score for this question is 1.93, indicating that the regulatory readiness for ADR technology in Sri Lanka is quite low. This score, which is in the middle of "Not ready at all" and "Slightly ready," indicates significant gaps in the current regulatory frameworks. The low score indicates that the laws that exist are currently insufficient to encourage the effective adoption and use of ADR technology.

4.2 STRATEGIES INTRODUCED BY EXPERTS TO OVERCOME THE BARRIERS IDENTIFIED IN LITERATURE FINDINGS

The expert interviews were used to analyze the barriers to ADR adaptation that were found in the literature. A summary of the barriers found in the literature is provided in Table 2.1 along with the experts’ code who have shared their thoughts on the subject matter.

Table 3: Strategies to overcome the Identified Barriers

Barrier	**Strategies**	**Sources**
Integration with existing building management system	Collaborate with BMS and ADR technology providers to build combined solutions.	R1
	Conduct a complete assessment of the current BMS to determine its capabilities, protocols, and limits before ADR adaptation	R2, R4
Lack of standardized protocols	Always promote Open protocols rather than closed protocols to avoid proprietary issues	R7, R5
High initial setup and installation cost	Public and private partnership collaboration to share the cost	R5, R4
	Take loan through government involvement	R3

	Impose tax free regulations on import goods for ADR implementation	R6, R8
	Trying to use local materials for implementation	R2
Limited incentives	Introduce financial incentives scheme for participants	R3, R7
	Introduce non-financial incentives like tax reduction on purchase, for participants	R4
Lack of supportive legislation	Convince government to provide separate legislation for PUCSL	R5, R6
	Include ADR into local building cords	R3, R5
Limited knowledge and expertise	Bring expert knowledge from foreign countries	R3, R4, R8
	Conduct seminars and workshops and special training sessions for the workers who work in energy market	R1, R6
Low awareness	Conduct awareness programs for consumers to make them aware about	R3, R7

4.3 DEVELOPMENT OF THE ROADMAP

The five levels used to determine readiness for ADR (Automated Demand Response) adoption in Sri Lanka were developed based on the findings derived from the survey conducted as part of this study. Participants were asked to rate the level of readiness to adopt ADR technology on a 5-point Likert scale, ranging from 1 (Not ready at all) to 5 (Fully ready). The definitions for each level—Not Ready at All, Slightly Ready, Moderately Ready, Almost Ready, and Fully Ready—were constructed to reflect increasing stages of preparedness in adopting ADR systems. Following the collection of responses, the mean values of readiness criteria were calculated, and the results were categorized into five levels based on the overall mean score distribution: 0–1 for Level 1, 1–2 for Level 2, 2–3 for Level 3, 3–4 for Level 4, and 4–5 for Level 5. This data-driven framework provided a structured basis for the development of the ADR adoption roadmap, offering a clear and quantifiable approach to assess and visualize the country's preparedness from 2025 to 2028.

The roadmap below presents the graphical representation of ADR adaptation within the next three years (from 2025 to 2028). After obtaining the survey results, the calculation of mean value for all the readiness criteria, categorized based on the overall mean value. Categorization is as follow,

0 – 1 Level 01
1 – 2 Level 02
2 – 3 Level 03
3 – 4 Level 04
4 – 5 Level 05

Current level of readiness for ADR in Sri Lanka can be summarized as follows and it was obtained through the mean value of each category.

Financial – level 03
Technological – level 04
Knowledge and skills – level 04
Market – level 03
Regulatory – level 02

Lastly, this roadmap was developed using strategies found through expert interviews. Identified strategies were categorized into long-term and short-term strategies and arrowheads implies the year that the strategy needs to be put into action. Additionally red dotted arrowhead indicates the strategies that need to be prioritized.

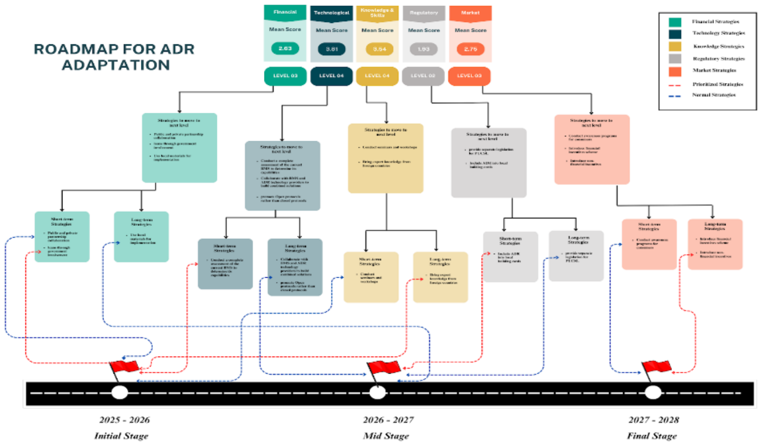

Figure 2: Roadmap for ADR Adaptation

5. Discussion

According to the literature review, Sri Lanka experiences a major imbalance in electricity supply and demand due to infrastructure, economic, and regulatory challenges (Sri Lanka Energy Balance Report, 2007). These data were discussed with experts, who discovered that seasonality and peak hours impose a strain on the system. Drought seasons pose special challenges to energy management, lowering hydropower generation. Furthermore, population increase, urbanization, and economic expansion are likely to increase the gap. Thus, interviewees emphasize the importance of diversifying the energy mix and enhancing infrastructure are critical to addressing this issue. The sources discovered that peak shaving and load shifting in demand side management (DSM) lower the peak demand and calm energy systems (Idrissi et al. , 2022). Experts found that DSM programs decrease the peak demand and grid burden by adopting long-term behavioral modifications and energy efficiency. DSM was a cheaper solution to the conventional construction of physical infrastructure for supporting energy efficiency and sustainability.

The analysis shows that Sri Lanka is almost "Moderately Ready," with a total mean score of 3.81, in terms of technological readiness for Automated Demand Response (ADR) adoption. High degrees of readiness can be seen in important sectors like energy management systems, control devices, and network infrastructure. To guarantee total readiness, however, enhancements to cybersecurity protocols and the accessibility of Demand Response Automation Servers (DRAS) are required. The potential of the current infrastructure is encouraging, but in order for ADR technology to be successfully adopted and implemented, the above key areas must be addressed. Median 2.63, the analysis shows a low level of financial readiness to adopt Automated Demand Response (ADR), which ranges between "slightly ready" and "moderately ready." Though some government funding is available for smart grid pilot projects, it is not enough to support widespread adoption. The funding allocated for ADR and smart grid projects is relatively minimal, and these initiatives receive priority. Obtaining more funding, giving ADR and smart grid initiatives priority, and allocating sufficient funds for their development and implementation are all necessary to increase financial readiness. With an average score of 3.54, the analysis shows that Sri Lanka is somewhat prepared to adopt automated demand response (ADR) technology. Utility providers have a strong foundation in knowledge, abilities, and skills because of significant R&D investments. The lack of practical instances indicates a disconnect between theoretical knowledge and actual application. In order to achieve the maximum potential of ADR technology, it is essential to close this gap by expanding the range of real applications and making use of current knowledge and research and development efforts. With an average score of 2.75, the analysis shows that Sri Lanka is somewhat ready for the deployment of Automated Demand Response (ADR) technology. The relatively low level of market demand for ADR at the moment suggests that potential customers are not entirely aware of its advantages. Even while there are some market incentives, they are insufficient to promote broad involvement. Raising awareness and education about the benefits of ADR is crucial for improving market readiness, as is creating attractive incentive schemes. Resolving these problems will increase demand and facilitate the effective implementation of ADR technology. The results of the study show that Sri Lanka has a very low level of regulatory preparedness (mean score of 1.93) for Automated Demand Response (ADR). This score, which is in the middle of "Not ready at all" and "Slightly Ready," presents attention to important inadequacies in the laws as they are right now. The adoption and application of ADR technology cannot be effectively supported by the laws currently in existence. The creation of comprehensive laws and regulations that support and promote the use of ADR technology is crucial for enhancing regulatory readiness.

6. Conclusion

This study on "Adaptation of Automated Demand Response (ADR) Technology to Reduce Peak Energy Demand in Sri Lankan Commercial Buildings" achieved its objectives through the use of literature reviews, expert interviews, and survey analysis. The study investigated the existing condition and impact of demand response programmers, provided a thorough explanation of ADR, and emphasized the need for demand side management in Sri Lanka. According to feasibility assessments, while ADR is technically possible with infrastructure enhancements, market preparedness needs to be improved. In addition, adaptation is environmentally feasible due to the positive impacts on environment and with awareness programs along with financial incentives; this would be behaviorally feasible too. The readiness level was evaluated using technological, financial, market, knowledge competency, and regulatory factors, showing areas for improvement. Finally, a strategic roadmap was created to guide the adoption of ADR technology over the next three years, providing a clear way to improve energy management. Many commercial buildings in Sri Lanka experience higher electrical energy and cost during the peak demand hours and implementation of ADR helps to optimize energy usage and helps to reduction of electrical cost. Furthermore, ultimately ADR implementation supports Sri Lanka’s sustainable goals by lowering peak demand and use of energy sources. Future research can focus on extend the adaptation of ADR technology to domestic sector, study on integration of ADR technology with on-site renewable energy sources, and development of regulatory framework that support ADR implementation, addressing legal, policy and market barriers to further enhancement of ADR adoption and effectiveness.

7. References

Abate, A., Kim, J. J., Kiliccote, S., & Yin, R. (2013). Automated Demand Response Technologies and Demonstration in New York City using OpenADR.

Albadi, M. H., & El-Saadany, E. F. (2008). A summary of demand response in electricity markets. In Electric Power Systems Research (Vol. 78, Issue 11, pp. 1989–1996). https://doi.org/10.1016/j.epsr.2008.04.002

Avtar, R., Sahu, N., Aggarwal, R., Chakraborty, T., Kharrazi, A., Yunus, A. P., … Kurniawan, T. A. (2019). Exploring renewable energy resources using remote sensing and GIS—A review. Resources, 8(3), 149. https://doi.org/10.3390/resources8030149

Bruceri, M., Alxugaray, M., & Pearson, D. (2017). Automated demand response in Title 24, Part 6: Stakeholder outreach assessment. Pacific Gas and Electric Company. https://title24stakeholders.com/wp-content/uploads/2017/09/T24-2019-CASE-Report-Demand-Response-Cleanup_Final_September-2017.pdf

California Edison. (2021). 2020 demand response program executive summary. https://www.calmac.org/publications/SCE0455.01_PY2020_SCE_DR_Program_Executive_Summary_Public.pdf

Cappers, P., Goldman, C., & Kathan, D. (2010). Demand response in U.S. electricity markets: Empirical evidence. Energy, 35(4), 1526–1535. https://doi.org/10.1016/j.energy.2009.06.029

Electric Power Research Institute. (2014). Demand response-ready end-use technologies. https://restservice.epri.com/publicdownload/000000003002006785/0/Product

Bertoli, E. (2023, July 11). Demand response. International Energy Agency. https://www.iea.org/energy-system/energy-efficiency-and-demand/demand-response

Esther, B. P., & Kumar, K. S. (2016). A survey on residential Demand Side Management architecture, approaches, optimization models and methods. In Renewable and Sustainable Energy Reviews (Vol. 59, pp. 342–351). Elsevier Ltd. https://doi.org/10.1016/j.rser.2015.12.282

Fernando, M. D. V., & Rodrigo, A. S. (2018). Dispatch analysis of variable renewable energy penetration in Sri Lanka with HVDC grid interconnection with India. In 2018 International Conference on Electrical Engineering (EECon) (pp. 1–6). IEEE. https://doi.org/10.1109/EECon.2018.8541015

Gellings, C. W. (1985). The concept of demand-side management for electric utilities. In A. T. Almeida & A. H. Rosenfeld (Eds.), Demand-side management and electricity end-use efficiency (pp. 99–112). Springer. https://doi.org/10.1007/978-94-009-1403-2_5
`

Güner, S., Erenoğlu, A. K., Şengör, İ., Erdinç, O., & Catalão, J. P. S. (2020). Effects of on-site PV generation and residential demand response on distribution system reliability. Applied Sciences (Switzerland), 10(20), 1–13. https://doi.org/10.3390/app10207062

Hoekstra, A., Singh, H., & Voskuilen, P. (2016). Using OpenADR with OCPP Combining these two open protocols can turn electric vehicles from threats to the electricity grid into demand-response assets. http://products.openadr.org/

Heffner, G. (2009, February 1). Demand response valuation frameworks paper. Lawrence Berkeley National Laboratory. https://escholarship.org/uc/item/401781d4

Iioka, D., Watanabe, S., & Yokoyama, R. (2016). Optimal operation scheduling of home energy management system using battery storage system. International Journal of Energy Sector Management, 10(1), 137–154. https://doi.org/10.1108/IJESM-07-2015-0004

Institute of Electrical and Electronics Engineers. (2014). 2014 IEEE International Conference on Smart Grid Communications (SmartGridComm 2014). IEEE. https://ieeexplore.ieee.org/document/7380737

Jabir, H. J., Teh, J., Ishak, D., & Abunima, H. (2018). Impacts of demand-side management on electrical power systems: A review. Energies, 11(5), 1050. https://doi.org/10.3390/en11051050

Javor, D., & Janjić, A. (2016). Application of demand side management techniques in successive optimization procedures. Communications in Dependability and Quality Management: An International Journal, 19(4)

Jradi, M., & Veje, C. T. (2017). Demand response in commercial buildings with an assessable impact on occupant comfort. In 2017 IEEE International Conference on Smart Grid Communications (SmartGridComm) (pp. 410–415). IEEE. https://doi.org/10.1109/SmartGridComm.2017.8340713

Logenthiran, T., Srinivasan, D., & Shun, T. Z. (2012). Demand side management in smart grid using heuristic optimization. IEEE Transactions on Smart Grid, 3(3), 1244–1252. https://doi.org/10.1109/TSG.2012.2195686

Meyabadi, A. F., & Deihimi, M. H. (2017). A review of demand-side management: Reconsidering theoretical framework. Renewable and Sustainable Energy Reviews, 80, 367–379. https://doi.org/10.1016/j.rser.2017.05.207

Morimoto, R., & Hope, C. (2004). The impact of electricity supply on economic growth in Sri Lanka. Energy Economics, 26(1), 77–85. https://doi.org/10.1016/S0140-9883(03)00034-3

Palensky, P., & Dietrich, D. (2011). Demand side management: Demand response, intelligent energy systems, and smart loads. IEEE Transactions on Industrial Informatics, 7(3), 381–388. https://doi.org/10.1109/TII.2011.2158841

Page, J., Kiliccote, S., Piette, M. A., & Parrish, K. (2011). Automated demand response technology demonstration project for small and medium commercial buildings. Lawrence Berkeley National Laboratory. https://www.osti.gov/biblio/1045929

Piette, M. A., Ghatikar, G., Kiliccote, S., Palensky, P., Mcparland, C., Koch, E., & Hennage, D. (2009). Open Automated Demand Response Communications Specification (Version 1.0). http://openadr.lbl.gov/

Public Utilities Commission of Sri Lanka. (2017). Study report on electricity demand curve and system peak reduction. https://www.pucsl.gov.lk/wp-content/uploads/2017/10/STUDY-REPORT-ON-ELECTRICITY-DEMAND-CURVE-AND-SYSTEM-PEAK-REDUCTION.pdf

Public Utilities Commission of Sri Lanka. (2022). Techno-economic feasibility study on demand response opportunities in Sri Lanka. https://www.pucsl.gov.lk

Sharda, S., Singh, M., & Sharma, K. (2021). Demand side management through load shifting in IoT-based HEMS: Overview, challenges, and opportunities. Sustainable Cities and Society, 65, 102517. https://doi.org/10.1016/j.scs.2020.102517

Steffe, L. P., Thompson, P. W., & von Glasersfeld, E. (2012). Teaching experiment methodology underlying principles and essential elements. In Handbook of research design in mathematics and science education (pp. 267-306). Routledge.

United Nations Industrial Development Organization. (2007). Introduction and user manual: Sustainable energy regulation and policymaking for Africa. UN CC:Learn. https://www.uncclearn.org/resources/library/introduction-and-user-manual-sustainable-energy-regulation-and-policymaking-for-africa/

U.S. Department of Energy. (2009). Smart grid system report. https://energy.gov/sites/prod/files/2009%20Smart%20Grid%20System%20Report.pdf

Wang, X., Zhang, R., & Li, F. (2022). Recent advances and challenges of demand response in smart grids: A review. Renewable and Sustainable Energy Reviews, 158, 112121. https://doi.org/10.1016/j.rser.2022.112121

Wikler, G. (2021). Flexible demand resources need new rules. California Efficiency + Demand Management Council. https://cedmc.org/wp-content/uploads/2021/10/2021-CEDMC-Flexible-Demand-Resource-Brief_8-10-21.pdf.