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Review on Advances in MPC-Based EMS for EV and V2G Systems

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ABSTRACT

Grid stability, energy efficiency, and coordinated power exchange face additional difficulties as a result of the EV industry's explosive growth. The current uses of MPC in EV integration and V2G operation are examined in this review. Out of more than 5,140 records from Scopus and WoS, more than 100 pertinent papers were shortlisted using the PRISMA approach. The findings demonstrate that MPC-based techniques significantly enhance system performance, with up to 35% fewer frequency fluctuations, 20–30% lower harmonic levels, and 15-20% longer battery life. Under uncertainty, hybrid MPC techniques that include adaptive or learning-based components also improve dynamic response by roughly 25%. Nevertheless, computational complexity, restricted scalability for dense EV fleets, and the absence of consistent communication protocols continue to limit wider adoption. To promote large-scale, resilient EV-grid interaction, future research should focus on real-time digital modeling, machine learning-enhanced prediction, and regulatory frameworks.

1. Introduction

The transition to EVs and RESs has hastened because of mounting pressure to reduce greenhouse gas emissions [1]. EVs act as on-board ES resources and at the same time support environmentally friendly transport solutions [2]. Nonetheless, their adoption faces various challenges, such as F oscillations, stability within the power system, and complex EM operations due to the unpredictable charging behavior and varying RES resources' output rate [3]. As such, advanced methods for controlling PF and other operations within the system seem necessary for improved efficiency and system stability. The ability to predict system performance and accurately adapt operations within the time rate is responsible for the fascinating prospect laid out for the PCs. More specifically, MPC offers constraint-based optimization solutions, thus allowing EV-supporting power grids to manage F and V support efficiently and facilitate effective scheduling operations while offering improved PQ conditions on the interface between generation and consumption within various power smart grids and for smart cities scenarios [4]. Despite all the pros listed above, substantial computational requirements and other inter-operation drawbacks seem to exist for feasible interventions and application at this stage. This research investigates MPC application within EV-EM circuits at this stage and focuses on various technological updates achieved thus far and

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current demands for urgently needed additional research on this subject for broader application prospects [5], [6].

EV charging is a two-step process (Fig. 1): First, PFT compensation is employed to generate DC power from the AC supply from the grid, and then this DC power is conditioned to meet the battery needs [7], [8]. EV charging can affect the V, F, and stability of the power grid due to nonlinearities from EV chargers. As more EV charging demands rise on the power grid, stability tends to further decline. Simultaneously running chargers can be limited by substantial V drops (as much as 40%), inadequate PFT compensation, losses, and phase unbalance. Additionally, power-electronic converters increase transformer burden by introducing voltage and current harmonics. Hybrid filters and sophisticated PWM techniques like SPWM, SVPWM, and carrier-based PWM help reduce harmonic problems. Furthermore, V2G operation can provide economic and sustainability benefits while improving grid flexibility and stability. Fig. 2 depicts a general G2V and V2G operation arrangement [7]. Fig. 3 illustrates various DC–DC converter configurations commonly applied in EV systems [7], [9].

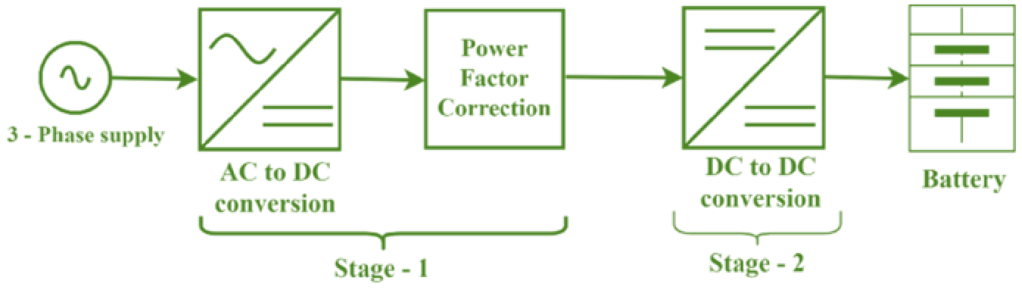


Fig. 1. The charging process of an EV battery [7]

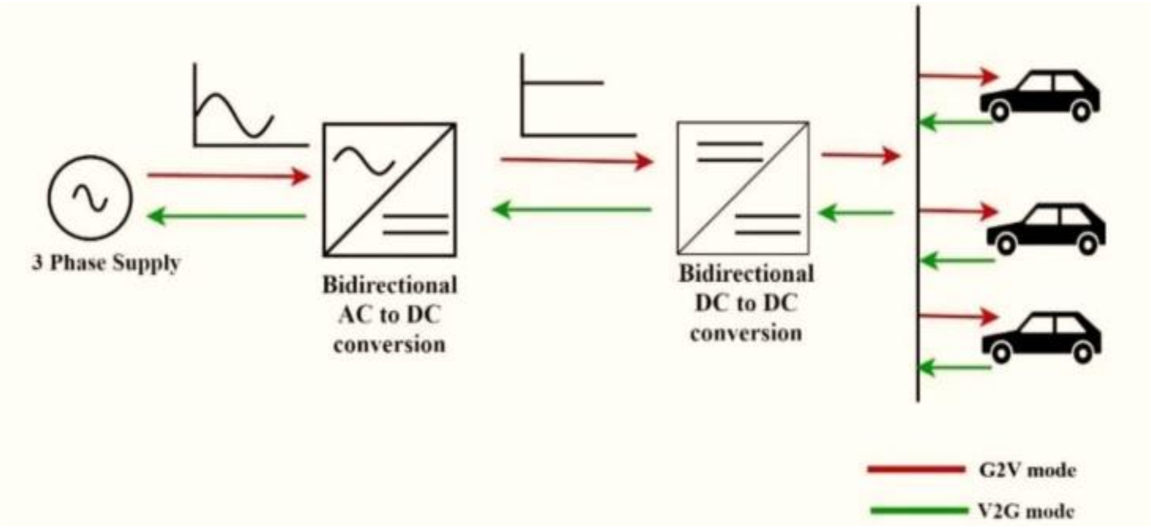


Fig. 2. G2V and V2G mode of operation of EV [7]

It is becoming more and more crucial to optimize isolated MG operation. To improve PF scheduling, for instance, [10], [11] uses a two-layer MPC with a SARIMA predictor. The charging and discharging capability of EV chargers has been investigated in many studies [12], [13]. Despite advancements in MPC-based EM, a comprehensive, forward-looking analysis of how it works and its challenges, as well as the future of its application for MGs and V2G systems, is still not provided. Being capable of energy shedding in peak times and recharging during off-peak hours, EVs serve as distributed ES devices. The communication framework adopted has a significant impact on the reliability of MGs, which puts a premium on the need for fast and reliable information exchange between the grid and the participating units [14], [15]. The Q support, V-regulation, THD mitigation, and primary FC are some of the services that the V2G system can offer, which again depend on proper communication between EVs and the charging network. From an economic viewpoint, V2G can also benefit customers [16], [17]. For example, using the stored energy of EVs at homes when the electricity price soars during peak hours, the houses can recharge their storage at night when the price is lower. This advantage, however, stands valid only if variable electricity prices are in place [18], [19].

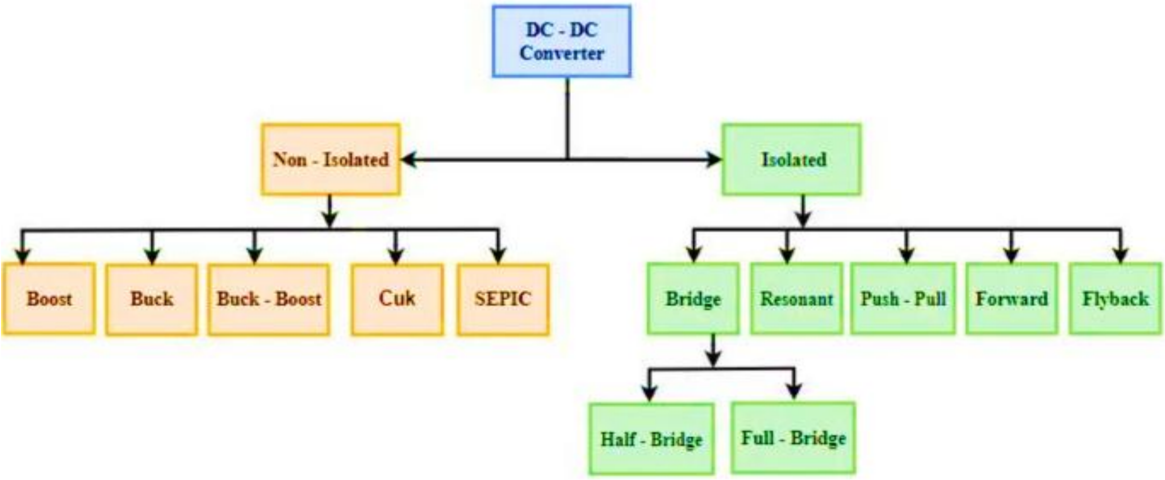


Fig. 3. DC–DC converter topologies for EV application [7]

User satisfaction is important because it forms a basis for the willingness to participate in V2G programs [20], [21]. Discharge rates have to be handled with care since V2G operations impact the battery life; higher discharge speeds increase the wear rate. Furthermore, most of the research indicates that EVs within an SoC range below 80% or above 90% are usually excluded from V2G control activities [22]. The behavior of EV users is increasingly influencing the performance of MGs. There is now an unprecedented need for EM frameworks considering the growth in RESs penetration and user-driven uncertainty coupled with EV-grid interactions [23]-[25]. EV aggregators, therefore, who coordinate the participation of EVs in power markets, become important. In principle, support services like FC, V-regulation, and inertia support become mandatory for system stability in a V2G scenario [26], [27].

In particular, there are various aspects in which their control and optimization methods are lacking and need further research to enable practical deployment of these services [28]-[31]. Some flaws of existing optimization approaches to the sizing problem in energy storage are high-power parallel processing requirements for neural networks, expensive iterative computations for nonlinear programming, the lack of guarantees of optimality with heuristic methods, reliance on unrealistic stochastic model assumptions, recursion-driven complexity issues inherent in dynamic programming, potential inaccuracies associated with FLCs, and strictly linear objectives in linear programming [18]. These issues highlight the growing need for more practical and effective optimization approaches for MG applications.

This growing amount of control variables over different MG components and timescales has driven an increased demand for advanced optimization techniques [32]-[35]. Because of its capacity to manage multivariable constraints and provide enhanced dynamic performance, MPC has gained popularity in a variety of applications, including plug-in electric automobiles and industrial systems [36], [37]. Because of the unpredictability of RE, traditional controllers are frequently insufficient, which makes MPC, with its quick dynamic response, ideal for today's MG problems. MPC is used at the grid and converter levels. A cost function, optimization method, and PC model are its main components. MPC controls power converter signals at the converter level and uses state projections at the grid level to coordinate power exchange and ES capacity among DERs [10], [38], [39]. Stochastic MPC is advised to handle RE uncertainty through economical choices, while receding-horizon MPC has been demonstrated to be successful for real-time scheduling and EM. DMPC, which enables EV chargers to provide V2G-Q support and contribute to real-time voltage regulation without compromising PF, has been proposed to reduce communication latency and assist distributed control [40], [41]. To balance power variations from RES and EV charging, additional research uses MPC for F-management in isolated MGs, either by itself or in conjunction with adaptive droop control. For coordinated F-management in linked MG groups, robust methods like LQR-based RMPC have also been presented [42]-[44].

While the LQR improves control actions under restrictions, the dynamic state-feedback gain technique increases system robustness. A two-layer MPC that coordinates aggregated EV charging/discharging and energy distribution is presented in [45], [46]. A TLMMPC framework that makes use of nominal and auxiliary PC models enhances F-stability and ES system control in [47], [48]. FLCs are used for HMG operation by the authors in [49]; however, their application is limited by their high memory and parameter needs. Gain tuning based on metaheuristics has also been extensively studied. To improve V2G and G2V operations, study [50] creates an EV charge/discharge EM system based on FLC. Gaussian processes are included in learning-based MPC in [51], demonstrating increased control and prediction accuracy. In order to manage real-time dispatch under RES and load uncertainty, a combination robust–stochastic MPC technique is suggested in [52]. A robust optimization technique that assesses uncertainty scenarios for safe MG performance is examined in [53]. Finally, [54] uses battery-discharge simulations to compare PID and MPC controllers, emphasizing the necessity of synchronous reinforcement for better performance. Even while MPC has many benefits, there are still issues that limit its usefulness, especially in large EV fleets with dispersed MGs. Limited scalability, inadequately robust optimization for high-RES situations, and the absence of sophisticated AI- and FLC-based improvements to lessen computational load, safeguard battery health, and simulate user behavior are some of the main problems [55]. Modeling a system becomes more complex owing to such uncertainties. MPC is still affected by the quality of the data. A summary description involving MPC for EV integration and MG-EM with important outcomes is given in Table 1.

With the PRISMA methodology being utilized for openness and reproducibility assurance for this study to cover the above gaps in MPC applications for EV integration and V2G operations, the principal contributions for this research include:

- Categorization of MPC methods: For easier classification and direction for future research, MPC applications can be classified based on four categories: (i) V2G-EM, (ii) FC within RES-rich networks, (iii) MPC with AI and FLC support, and (iv) MG optimization [10].
- Quantitative performance analysis: It is possible to compile empirical evidence that supports MPC being able to increase battery life by 15-20% and THD by 20-30% while reducing FDs by 35% for EV grids [22], [42].
- Trend and gap identification: Issues such as computational intensity, scalability, and compatibility within V2G networks have remained constant issues. However, innovative combinations and approaches such as MPC with AI and prediction models based on DT offer great potential [51], [52].
- Decision-support for stakeholders: This study is a useful resource for researchers, operators, and legislators looking to improve RES integration and smart-grid stability through predictive control by examining more than 100 pertinent publications [54], [55].

Table 1. Overview of MPC applications for EV integration and MG energy management with key results

Refs.	MPC Type	EV/V2G Role	Work area	EM focus	Contribution	Results
[56]	General MPC	V2G overview	MG control	Yes	Summarizes MPC strategies; identifies gaps	—
[12]	Distributed MPC	V-regulation	V-stability	Partially	Real-time V-control using V2G	VD reduced 10–15%
[13]	Distributionally robust MPC	User behavior coupling	Multi-MG EM	Yes	Optimization under uncertainties with EV behavior	—

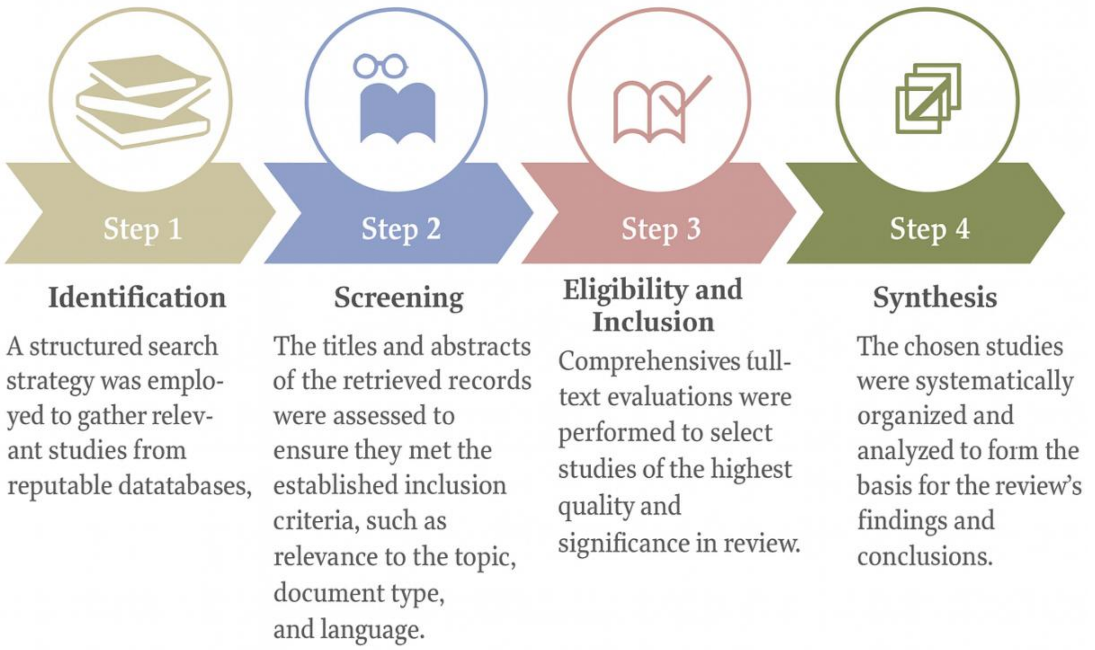
Refs.	MPC Type	EV/V2G Role	Work area	EM focus	Contribution	Results
[57]	PC models	V2G capacity prediction	Capacity forecasting	Yes	Forecasts aggregate EV capacity for grid services	Prediction error <5%
[14]	Decentralized MPC	EV-MG interaction	Short-term MG response	Partially	Improves MG performance	FD reduced 2–5%
[58]	Review	EV integration	MG operation	Yes	Highlights EV benefits; identifies gaps	—
[18]	MPC	V2G integration	Sizing & EM	Yes	Critical review of MG design and EMS	—
[20]	Adaptive MPC	EV owner expectations	Islanded MG stability	Yes	Incorporates user behavior to improve EMS	FD reduced 3–4%
[22]	Adaptive intelligent MPC	EV SoC control	F-stabilization	Yes	Stabilizes F while managing EV SoC	FD<2%; THD 20–25%
[23]	MPC + DRL	EVs	F- regulation	Partially	DRL-enhanced MPC for F- support	FD reduced by 35%
[24]	MPC	F-stabilization	EV charging	Partially	EV charging control under uncertainty	FD reduced 5–7%
[26]	Review	EV ancillary services	Ancillary services	Yes	Summarizes EV participation in grid EMS	—
[32]	Adjustable robust MPC	V2G	RES- and EV-integrated MG	Yes	Optimizes MG EMS under uncertainty	—
[36]	MPC review	Distributed resources	Smart grid evolution	Yes	PC overview for EMS	—
[59]	MPC	EV & fuel cells	Integrated MG planning	Yes	Optimizes planning & design	—
[38]	Literature review	EVs	RES integration	Yes	Highlights MPC performance & gaps	THD reduction 20–30%; battery life extended 15–20%
[10]	Review	EVs	MG control	Yes	Concise review of MPC strategies	—
[40]	Robust MPC	EV charging	PV-integrated scheduling	Yes	EV-PV scheduling optimization	Peak load reduction 10–15%
[42]	Adaptive & MPC	EV & ESS	F- regulation	Partially	Combines adaptive + MPC for stability	FD <3%
[60]	Robust MPC	V2G	Multi-MG F	Partially	FC across MGs	FD reduced 4–6%
[45]	MPC	EVs	Multi-uncertainty MG	Yes	Handles RES & EV uncertainties in EMS	FD <5%
[47]	Two-layer MPC	EVs	Islanded MG-F	Yes	Virtual inertia + MPC for EMS & stability	FD reduced 2–3%
[49]	MPC	EV & ESS	Load FC	Yes	Stabilizes hybrid MG–EMS	THD reduced 20–25%; FD <3%
[50]	Intelligent MPC + ANN-PSO	EVs	V2G efficiency	Yes	Optimizes battery usage in EMS	Battery life extended 15–18%
[51]	Learning-based MPC	PV-ESS-EV MG	Secondary FC	Yes	Combines learning + MPC for EMS	FD <2.5%
[52]	Robust + stochastic MPC	EV charging	Optimal dispatch	Yes	Balances uncertainty & EMS efficiency	Peak load reduction 12%

Refs.	MPC Type	EV/V2G Role	Work area	EM focus	Contribution	Results
[53]	Robust MPC	EV charge/discharge	Industrial MG	Yes	Optimizes industrial EMS with EVs	THD reduced 15–20%
[54]	MPC + synchronous boost	V2G	EV charger performance	Partially	Enhances V2G charging efficiency	Efficiency increased 5–7%
[55]	Review	EVs	MG-EM	Yes	Reviews EMS optimization under uncertainty	—

The structure of the paper is as follows: The PRISMA methodology is described in Section 2, the MPC review results for MGs with EV/V2G integration are shown in Section 3, a critical assessment of the reviewed techniques is also provided in the same part, and the study is concluded in Section 4.

2. Methodology for Choosing Works

In order to guarantee methodical, transparent, and repeatable study selection, this review adheres to the PRISMA paradigm. Research on MPC applications in EV integration and V2G technologies was compiled after studies were found in several databases, evaluated for methodological quality, and screened for relevance. The four steps of identification, screening, eligibility, and synthesis are depicted in Fig. 4 [61], [62]. Four primary research issues are addressed in this study's systematic review, as declared in Fig. 5 [61].



Identification

A structured search strategy was employed to gather relevant studies from reputable datatabases,

Screening

The titles and abstracts of the retrieved records were assessed to ensure they met the established inclusion criteria, such as relevance to the topic, document type, and language.

Eligibility and Inclusion

Comprehensives full-text evaluations were performed to select studies of the highest quality and significance in review.

Synthesis

The chosen studies were systematically organized and analyzed to form the basis for the review's findings and conclusions.

Fig. 4. Four-step methodology for systematic review: identification, screening, eligibility, and synthesis [61]

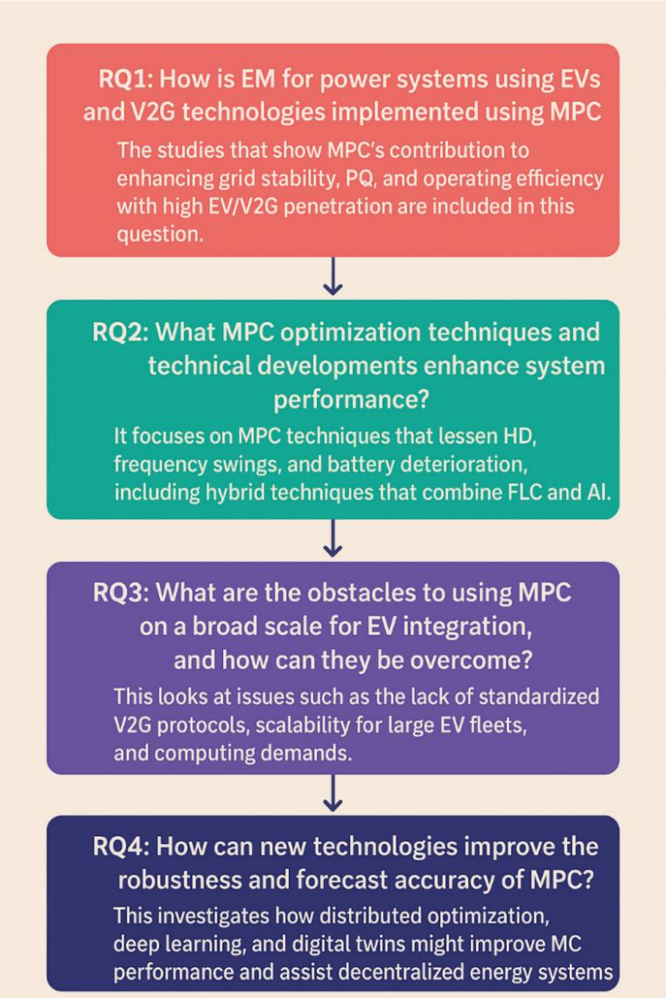
2.1. Identification Stage

To find research on MPC for EV integration and V2G systems published between 2019 and 2024, a thorough search was carried out in Scopus and WoS. Reviews, editorials, theses, and books were not included; only full-text original research articles and conference papers in English were. Database-specific queries used filters for year, document type, and language in addition to focusing on pertinent keywords. 1,739 Scopus and 4,484 WoS records were found in the first search; 1,073 duplicates were eliminated, leaving 5,150 unique studies (33.5% Scopus, 66.5% WoS; 89.5% journal articles, 10.5% conference papers).

2.2. Screening Stage

The titles and abstracts of the 5150 records that were found were filtered to keep studies on MG-EM with EVs and ES systems. Publication years 2019-2024, original research or conference papers, English language, full-text availability, and a clear emphasis on MPC applications in EV integration and V2G technologies were the inclusion criteria. After a binary evaluation of each study (include/exclude), 443 studies (8.6%) made it to the eligibility stage.

Bibliometric Overview: WILEY, SPRINGER, and the IEEE Computer Society provided the remaining 192 studies (43.4%), MDPI 64 (14.4%), and Elsevier 54 (12.2%). Beginning with 51 publications in 2019 to 106 publications in 2024, there was a consistent increase. Prior to being selected for inclusion within this review, all selected articles would undergo a full-text screening process. Fig. 6 highlights the contribution and publishing trends from the publishers [61].



RQ1: How is EM for power systems using EVs and V2G technologies implemented using MPC

The studies that show MPC's contribution to enhancing grid stability, PQ, and operating efficiency with high EV/V2G penetration are included in this question.

RQ2: What MPC optimization techniques and technical developments enhance system performance?

It focuses on MPC techniques that lessen HD, frequency swings, and battery deterioration, including hybrid techniques that combine FLC and AI.

RQ3: What are the obstacles to using MPC on a broad scale for EV integration, and how can they be overcome?

This looks at issues such as the lack of standardized V2G protocols, scalability for large EV fleets, and computing demands.

RQ4: How can new technologies improve the robustness and forecast accuracy of MPC?

This investigates how distributed optimization, deep learning, and digital twins might improve MC performance and assist decentralized energy systems

Fig. 5. The four primary research issues

2.3. Eligibility and Inclusion Stage

The "Eligibility and Inclusion" phase included a full-text review process for all studies that successfully went through the initial screening process. This stage allowed for more careful selection among the studies by applying a rigorous and systematic assessment process. To apply a uniform and unbiased assessment among all documents, a total of five eligibility criteria were employed for evaluation, and each criterion was assessed on a three-level scale.

- Relevance for MPC-based EV/V2G Control: In this criterion, attention was given to the extent to which each research contributes to MPC formulations for predictive EM functions and features involving EV/V2G. The criteria assessed the relevance relative to this review.

- Methodological rigor: The strength and quality of analytical methods with respect to model faithfulness and simulations' closeness to reality, stability issues, and validation were assessed. The scoring was from methodologically strong (3) to poorly supported (1).
- In terms of novelty and innovation: In this category, the uniqueness and innovation brought forth by possible approaches to controlling within MPC frameworks were judged. Some submissions made small innovations (rating 1) while others made significant innovations (rating 3).
- Data quality and transparency: Research was judged for sufficient analysis depth and the ability to reproduce research findings. The quality range was from very strict and transparent (3) to satisfactory (1).
- Scientific and practical contribution: With a scale from modest (1) to substantial (3), this criterion made reference to the possible impact on contemporary research and actual MPC application within EV/MG setups.

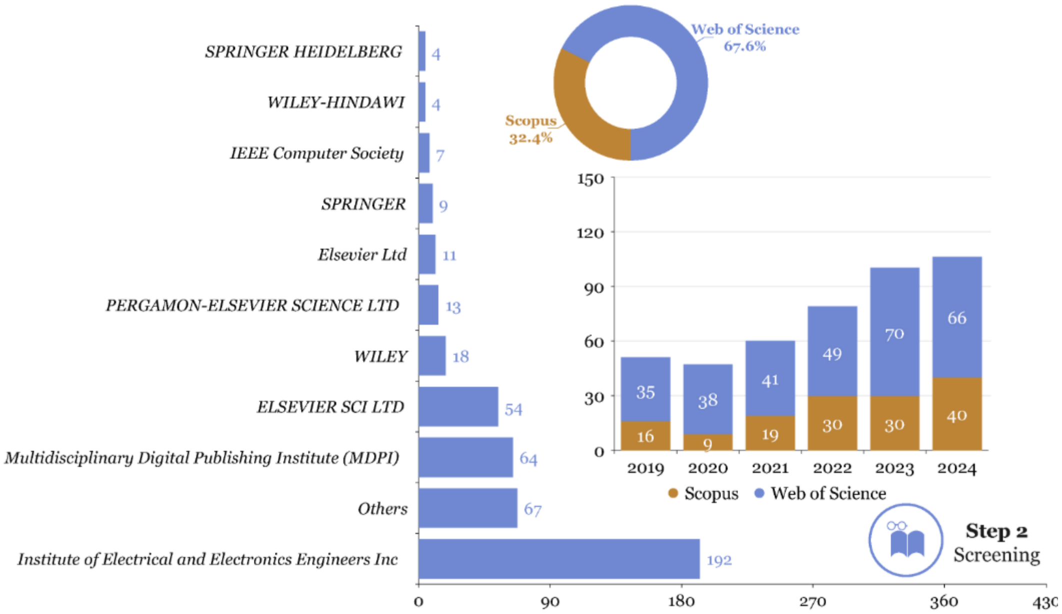
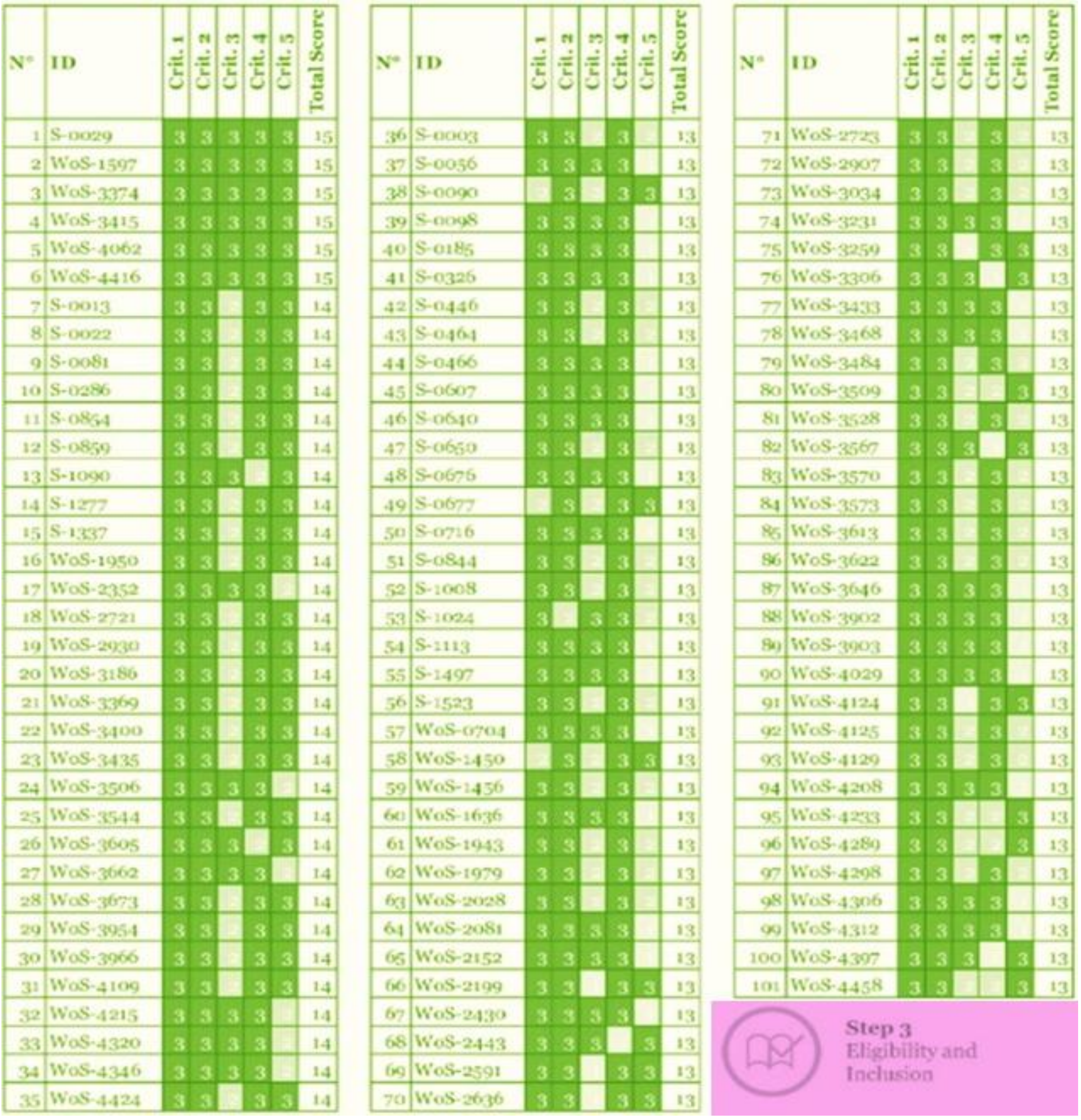


Fig. 6. Study spreading by producer and time [61]

A score of 15 points was the highest possible one. A stringent filtering criterion of 13 points (around 87%) was employed to ensure that only quality and technically significant literature was selected. A high degree of relevance to MPC-based EV/V2G system functioning and good method quality, and visible technological advancements were normally observed for literature satisfying this criterion. To increase objectivity and eliminate personal bias at this stage, all the analysis tasks were separately conducted by two reviewers. The final literature list after synthesis included over 100 studies satisfying all eligibility criteria. The stringent filtering criteria ensure that the discussion analysis is well grounded in trusted and significant literature. A detailed eligibility screening matrix employed at Step 3 within the framework of the system-wide review process is represented in Fig. 7 [61]. It identifies more than 100 research articles with unique IDs and checks all that satisfy five predetermined criteria. To increase readability and facilitate easy identification of various criteria and cumulative full scores for all articles, this matrix employs a green and white color combination. Studies with higher full scores (mostly between 13 and 15 points) can be readily identified with this representation. The transparent and impartial selection of research for the final evaluation is ensured by this systematic grading method.

2.4. Synthesis Stage

An H-index of 33 indicates that the bibliometric assessment of the 101 selected works proves noteworthy study action and consequence in PC, MG-EM, and EV/V2G tenders. The majority of contributions come from prestigious conference papers and high-impact IEEE and Elsevier publications, demonstrating the field's maturity and continued innovation. Up until 2019, publication trends show a strong increase. After that, there were fluctuations brought on by world events, which were followed by stabilization in 2021–2024. MPC-based EM for EV/V2G coordination, F-stability in renewable-rich MGs, AI- and FLC-enhanced predictive control, and optimization of DERs are the four main themes identified by keyword analysis. These themes serve as the framework for this review, with visual summaries of publishing sources, keyword clusters, thematic structure, and the PRISMA-based study selection procedure presented in Fig. 8 and Fig. 9 [61].



N°	ID	Crit. 1	Crit. 2	Crit. 3	Crit. 4	Crit. 5	Total Score
1	S-0029	3	3	3	3	3	15
2	WoS-1597	3	3	3	3	3	15
3	WoS-3374	3	3	3	3	3	15
4	WoS-3415	3	3	3	3	3	15
5	WoS-4062	3	3	3	3	3	15
6	WoS-4416	3	3	3	3	3	15
7	S-0013	3	3	[illegible]	3	3	14
8	S-0022	3	3	[illegible]	3	3	14
9	S-0081	3	3	[illegible]	3	3	14
10	S-0286	3	3	[illegible]	3	3	14
11	S-0854	3	3	[illegible]	3	3	14
12	S-0859	3	3	[illegible]	3	3	14
13	S-1090	3	3	3	[illegible]	3	14
14	S-1277	3	3	[illegible]	3	3	14
15	S-1337	3	3	[illegible]	3	3	14
16	WoS-1950	3	3	[illegible]	3	3	14
17	WoS-2352	3	3	3	3	[illegible]	14
18	WoS-2721	3	3	[illegible]	3	3	14
19	WoS-2930	3	3	[illegible]	3	3	14
20	WoS-3186	3	3	[illegible]	3	3	14
21	WoS-3369	3	3	[illegible]	3	3	14
22	WoS-3400	3	3	[illegible]	3	3	14
23	WoS-3435	3	3	[illegible]	3	3	14
24	WoS-3506	3	3	3	3	[illegible]	14
25	WoS-3544	3	3	[illegible]	3	3	14
26	WoS-3605	3	3	3	[illegible]	3	14
27	WoS-3662	3	3	3	3	[illegible]	14
28	WoS-3673	3	3	[illegible]	3	3	14
29	WoS-3954	3	3	[illegible]	3	3	14
30	WoS-3966	3	3	[illegible]	3	3	14
31	WoS-4109	3	3	[illegible]	3	3	14
32	WoS-4215	3	3	3	3	[illegible]	14
33	WoS-4320	3	3	3	3	[illegible]	14
34	WoS-4346	3	3	3	3	[illegible]	14
35	WoS-4424	3	3	[illegible]	3	3	14
36	S-0003	3	3	[illegible]	3	[illegible]	13
37	S-0056	3	3	3	3	[illegible]	13
38	S-0090	[illegible]	3	[illegible]	3	3	13
39	S-0098	3	3	3	3	[illegible]	13
40	S-0185	3	3	3	3	[illegible]	13
41	S-0326	3	3	3	3	[illegible]	13
42	S-0446	3	3	[illegible]	3	[illegible]	13
43	S-0464	3	3	[illegible]	3	[illegible]	13
44	S-0466	3	3	3	3	[illegible]	13
45	S-0607	3	3	3	3	[illegible]	13
46	S-0640	3	3	3	3	[illegible]	13
47	S-0650	3	3	[illegible]	3	[illegible]	13
48	S-0676	3	3	3	3	[illegible]	13
49	S-0677	[illegible]	3	[illegible]	3	3	13
50	S-0716	3	3	3	3	[illegible]	13
51	S-0844	3	3	[illegible]	3	[illegible]	13
52	S-1008	3	3	[illegible]	3	[illegible]	13
53	S-1024	3	[illegible]	3	3	[illegible]	13
54	S-1113	3	3	3	3	[illegible]	13
55	S-1497	3	3	3	3	[illegible]	13
56	S-1523	3	3	[illegible]	3	[illegible]	13
57	WoS-0704	3	3	3	3	[illegible]	13
58	WoS-1450	[illegible]	3	[illegible]	3	3	13
59	WoS-1456	3	3	[illegible]	3	[illegible]	13
60	WoS-1636	3	3	3	3	[illegible]	13
61	WoS-1943	3	3	[illegible]	3	[illegible]	13
62	WoS-1979	3	3	[illegible]	3	[illegible]	13
63	WoS-2028	3	3	[illegible]	3	[illegible]	13
64	WoS-2081	3	3	3	3	[illegible]	13
65	WoS-2152	3	3	3	3	[illegible]	13
66	WoS-2199	3	3	[illegible]	3	3	13
67	WoS-2430	3	3	3	3	[illegible]	13
68	WoS-2443	3	3	3	[illegible]	3	13
69	WoS-2591	3	3	[illegible]	3	3	13
70	WoS-2636	3	3	[illegible]	3	3	13
71	WoS-2723	3	3	[illegible]	3	[illegible]	13
72	WoS-2907	3	3	[illegible]	3	[illegible]	13
73	WoS-3034	3	3	[illegible]	3	[illegible]	13
74	WoS-3231	3	3	3	3	[illegible]	13
75	WoS-3259	3	3	[illegible]	3	3	13
76	WoS-3306	3	3	3	[illegible]	3	13
77	WoS-3433	3	3	3	3	[illegible]	13
78	WoS-3468	3	3	3	3	[illegible]	13
79	WoS-3484	3	3	[illegible]	3	[illegible]	13
80	WoS-3509	3	3	[illegible]	[illegible]	3	13
81	WoS-3528	3	3	[illegible]	3	[illegible]	13
82	WoS-3567	3	3	3	[illegible]	3	13
83	WoS-3570	3	3	[illegible]	3	[illegible]	13
84	WoS-3573	3	3	[illegible]	3	[illegible]	13
85	WoS-3613	3	3	[illegible]	3	[illegible]	13
86	WoS-3622	3	3	[illegible]	3	[illegible]	13
87	WoS-3646	3	3	3	3	[illegible]	13
88	WoS-3902	3	3	3	3	[illegible]	13
89	WoS-3903	3	3	3	3	[illegible]	13
90	WoS-4029	3	3	3	3	[illegible]	13
91	WoS-4124	3	3	[illegible]	3	3	13
92	WoS-4125	3	3	[illegible]	3	[illegible]	13
93	WoS-4129	3	3	[illegible]	3	[illegible]	13
94	WoS-4208	3	3	3	3	[illegible]	13
95	WoS-4233	3	3	[illegible]	[illegible]	3	13
96	WoS-4280	3	3	[illegible]	[illegible]	3	13
97	WoS-4298	3	3	[illegible]	3	[illegible]	13
98	WoS-4306	3	3	3	3	[illegible]	13
99	WoS-4312	3	3	3	3	[illegible]	13
100	WoS-4397	3	3	3	[illegible]	3	13
101	WoS-4458	3	3	[illegible]	[illegible]	3	13

Step 3
Eligibility and
Inclusion

Fig. 7. Finalized eligibility and inclusion assessment form [61]

3. Discussions of the Investigated Studies

Using only the initial computed input, MPC forecasts future states and updates the control action at each stage to govern system behavior (Fig. 10) [7]. Ref. [63] uses an MPC-based V2G technique to control F-variations brought about by large-scale EV integration (Fig. 11). In other research, MPC is used to choose converter switching states by minimizing costs, attaining unity PFT, and maintaining THD below 1.5%. To facilitate bidirectional energy transfer and improve grid stability, a finite control set MPC was presented in [64]. The converter duty cycle is derived directly from the optimized cost function (Fig. 12) [7].

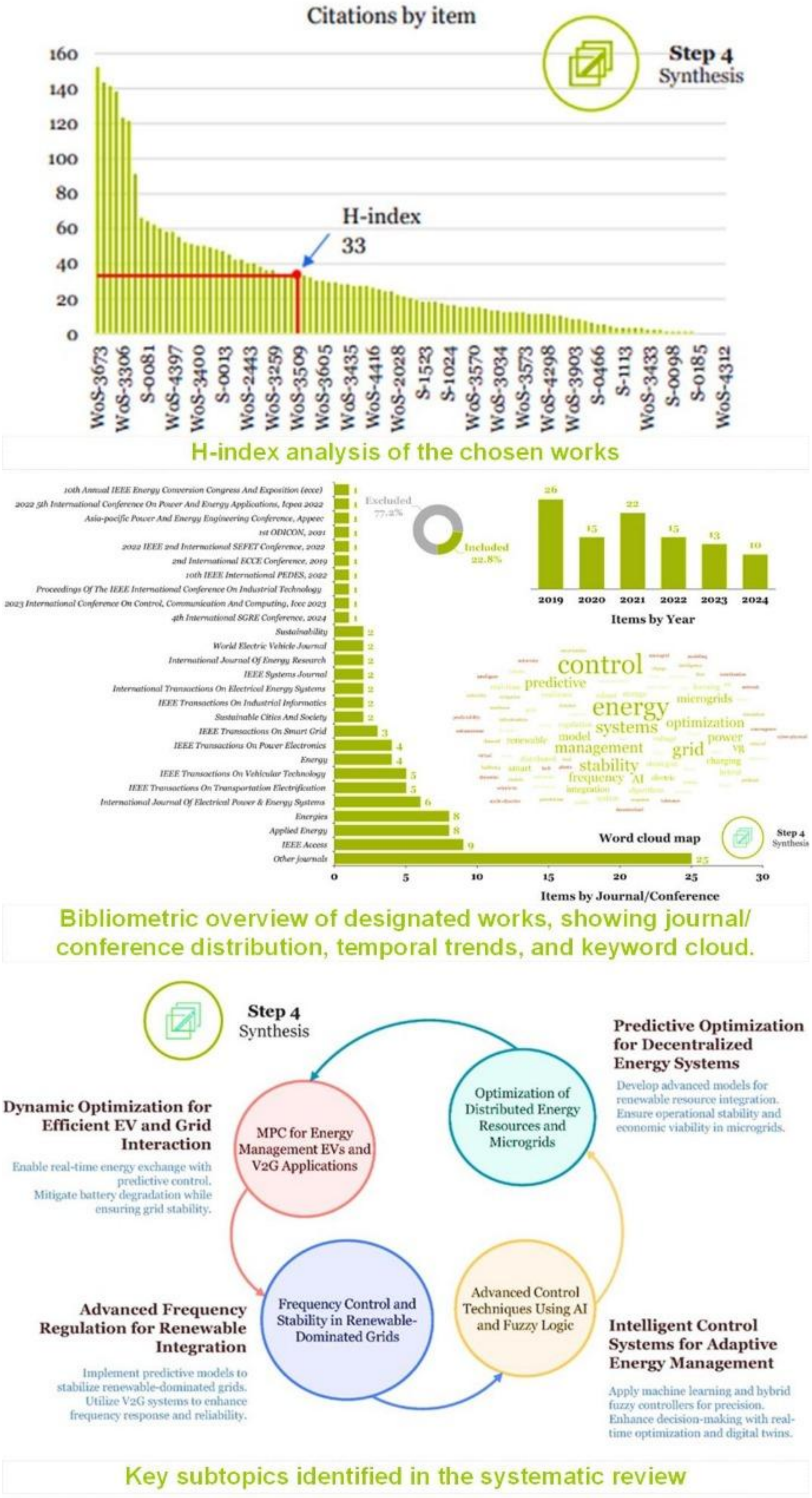


Fig. 8. Synthesis stage analysis [61]

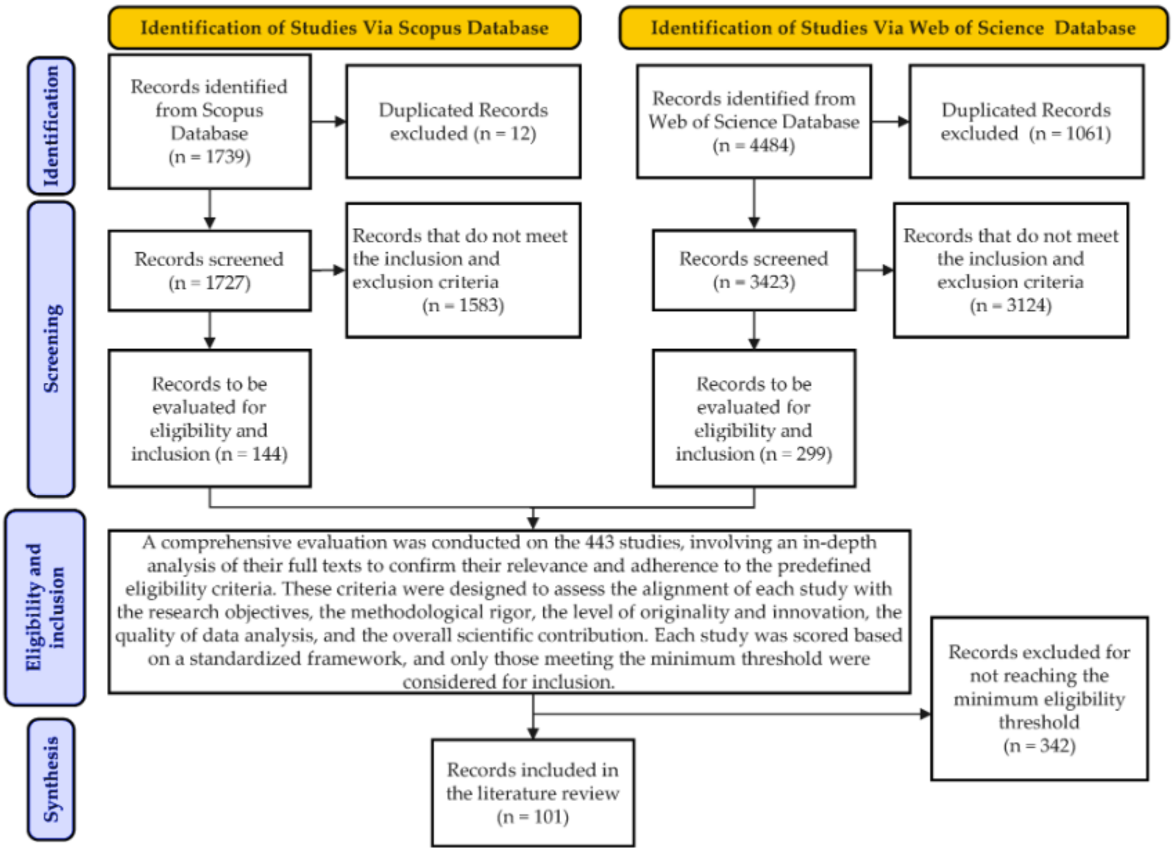


Fig. 9. PRISMA flow diagram of the study selection process [61]

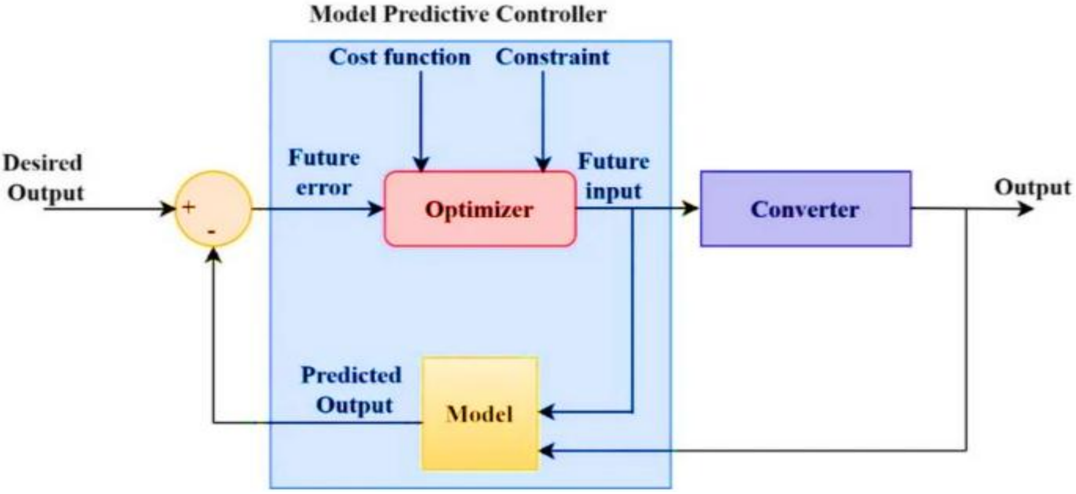


Fig. 10. MPC framework [7]

3.1. MPC for EM in EVs and V2G

MPC is now a crucial tactic for EM in V2G and EV systems. MPC optimizes energy flows, maintains grid stability, and supports ancillary services like F-regulation, V-stabilization, and THD mitigation by forecasting system behavior [65]-[68]. Its adaptableness reduces ES deterioration and functioning expenditures while allowing tenders in lonely and mixed grids [69], [70].

Important findings from current research show that PQ is much improved by using bidirectional converters and sophisticated filtering methods, with voltage variations kept below 2% and THD usually lowered to 3-5%. Even while functioning in both tips, V2G/G2V evangelists exhibit noteworthy efficacy, attaining 92–96%. By dipping FDs by 25–40% and diminishing voltage sags to less than 2%, the integration of EVs as mobile storage in conjunction with MPC or VSG techniques increases F and voltage stability. Predictive EM methods maximize the consumption of SoC and give a potential saving for energy costs between 10% and 30% while prolonging the battery life between 15% and 20%. Moreover, tube MPC, distributed MPC, AI-based DRL, and FLC methods can be referred to as advanced approaches popular for enhancing system response to disturbances, mitigating the effects of RES intermittent behavior, and supporting stable low-inertia grid operations.

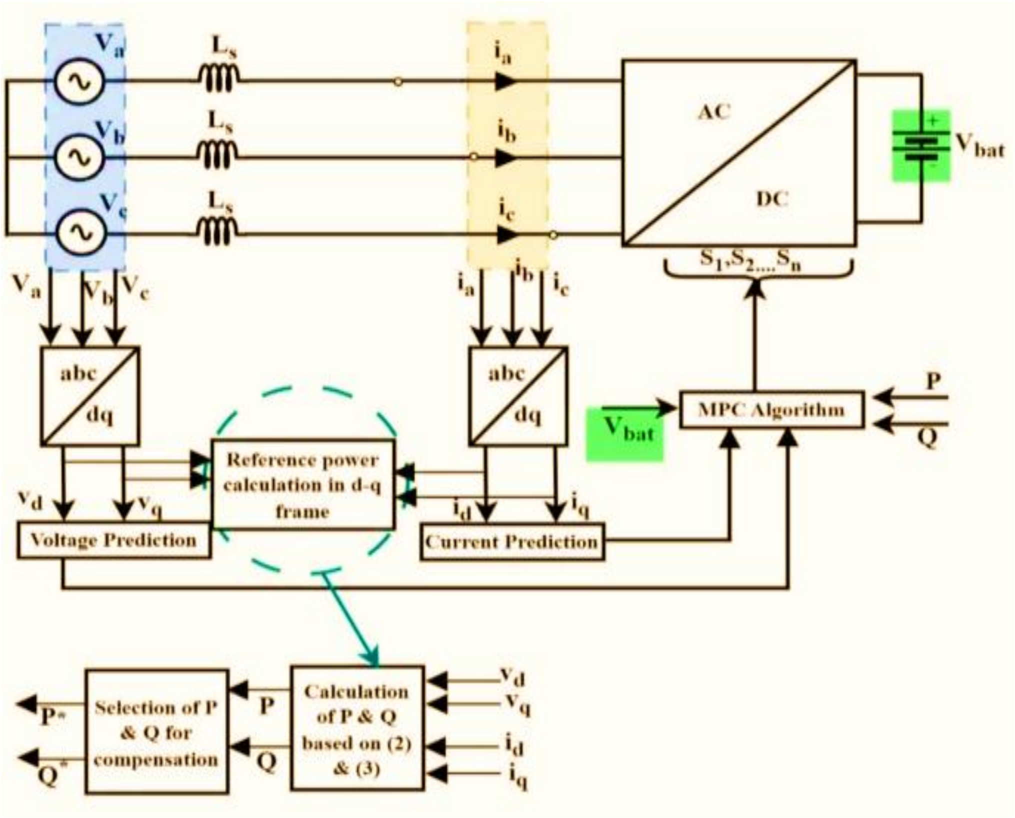


Fig. 11. MPC control structure for V2G [7]

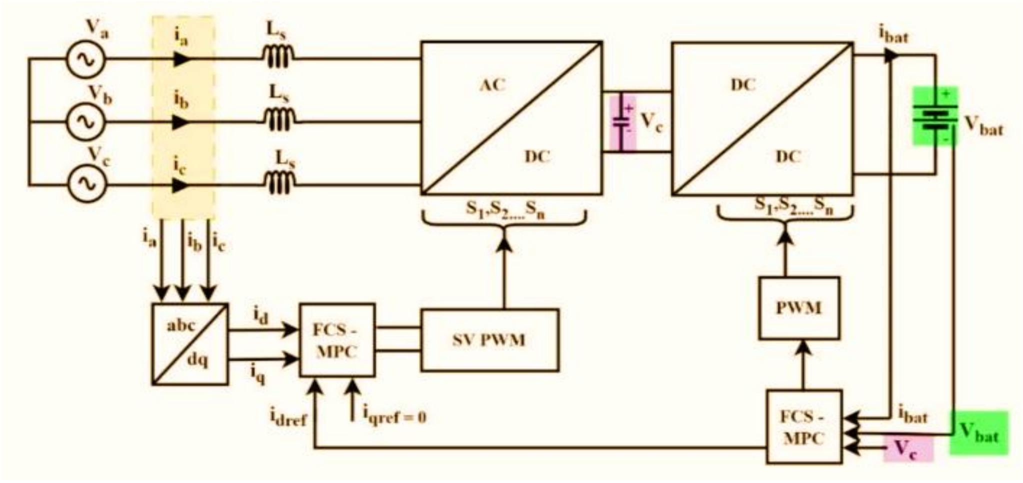


Fig. 12. MPC control scheme for G2V and V2G application in EV [7]

3.1.1. PQ Optimization

Through the reduction of harmonics, voltage fluctuation, and F aberrations, MPC ensures the quality of power within the context of the V2G system. For example, B2B DAB converters implemented with MPC can increase the power factor parameter and minimize THD levels [70]-[72]. In networks with substantial EV share, A/AR/C EMI filters can be implemented to remove noise and compensate for the current tracking process within power networks with higher EV shares [73]. In MGs with strong renewable penetration, tube-MPC applications have improved market income forecasts for EV aggregators by mitigating deviations and smoothing F-trends [74], [67].

3.1.2. Management of Uncertainties

Tube-MPC addresses variability and disturbances in dynamic grids. It maintains stable F-trajectories in isolated MGs, reduces control effort compared to conventional PI or LQR methods, and improves response under RESs intermittency [67], [75], [76]. Combined with reinforcement learning, Tube-MPC enhances adaptability and ensures resilient operation in hybrid systems.

3.1.3. Innovative Applications

FDs and balance power exchange in hybrid MGs [77], [78]. Dynamically redistributing Vs and Fs reduces the computational complexity of a system, allowing the system to operate with diverse configurations. MPC enables virtual inertia via EV penetration, CHP systems, and RESs integration, ensuring stability at varying load and supply [79]. The summary of MPC works for EM in EVs and V2G is presented in Table 2.

3.2. Control and Stability in Renewable-Dominated Networks

MPC manages ESS and EVs, considers RESs generation to decrease F. Important results obtained from the literature are that the V2G approach, controllers based on EV, and MPC have potential for MG operation and grid stability support. In the case of F regulation, these approaches yield continuous occurrence of FD less than 0.04 Hz irrespective of changing operating conditions like MG disturbance or cyber-attack [92]-[94]. Voltage stability is also retained, as variations in voltage are typically within 2%, which supports the stable integration of RESs. Optimal EV charging and fleet management increase total energy efficiency by 10–20%, accounting for driving and charging needs of electric vehicles, decreasing operating costs, and maximizing renewable energy use. Additionally, SOC management is very successful; most approaches keep SOC errors below 2%, which increases battery life and boosts grid support dependability. Additionally, aggregated EVs show significant flexibility and value for contemporary power systems by offering primary and secondary F-support, peak shaving, and other ancillary services [95]-[98].

3.2.1. Advanced Predictive Mechanisms

By coordinating DERs, ES, and EV charging, MPC improves F stability in low-inertia, renewable-rich grids [79], [99]-[101]. While SARIMA-based predictive models maximize aggregator revenue and optimize ancillary services, Tube-MPC smoothed FDs during emergencies [102], [103].

3.2.2. EVs as Mobile Buffers

When there is a shortage of energy, EVs act as mobile ES, absorbing excess generation and replenishing it. Battery life is extended, FDs are decreased, and RE waste is reduced through coordinated PC [104]-[107].

3.2.3. Droop in FC

Advanced droop techniques improve F-stability in networks dominated by RESs, frequently in conjunction with virtual inertia or ES. While controlling power sharing between AC and DC subsystems, hybrid droop and MP droop controllers minimize FDs [108]-[111]. The numerical performance of EV-based EM and V2G control strategies has been listed in Table 3.

3.3. Advanced Control with AI and FLC

By managing nonlinearities, uncertainties, and dynamic demand, AI and FLC increase the resilience of energy systems. NNs and DRL optimize EV charging and ESS management, lowering FDs and increasing energy efficiency [76], [128]-[130]. In V2G applications, hybrid controllers that combine conventional algorithms with FLC stabilize V and F while addressing nonlinear dynamics [80], [131]-[133]. In order to support predictive maintenance and enable optimized energy flows, EV coordination, and RESs integration, DT simulates real-time operations for PC [104], [109].

Table 2. Summary of MPC works for EM in EVs and V2G

Ref.	Technology	Key numerical outcomes	Remarks
[66]	Five-level ANPC bidirectional converter	THD reduced to 3.5%, bidirectional efficiency > 95%	PQ enhancement during G2V/V2G operation
[68]	V2G charging control for harmonics	THD minimized by ~4%	Reduces grid disturbances from EVs
[80]	Integrated power conversion system	DC link V ripple reduced by 50%, efficiency ~94%	Small film capacitor improves V2G operation
[81]	DRL-based EM for series HEV	Energy cost reduction 15–18%, improved SOC utilization	Predictive trip-based learning for hybrid EVs
[82]	Single-phase on-board V2G charger	Bidirectional efficiency ~93%	Compact design suitable for distributed grids
[74]	EV-based F & V-regulation	FD reduced by 35%, voltage sag <2%	EV batteries used as dynamic grid stabilizers
[83]	SoC and SOP co-estimation via MPC	SOC error <2%, power tracking error <3%	Fractional-order MPC improves battery EM
[67]	MPC with online inductance ID	FD reduced by 25%, improved robustness	V2G inverter stabilization under grid variations
[69]	EV cluster charge/discharge model	Accuracy of energy estimation >95%	Optimized aggregator-level energy scheduling
[70]	Aggregated EV economic dispatch & F-regulation	Cost reduction 10–15%, FDs <0.05 Hz	Market-aware V2G coordination
[71]	Bidirectional off-board charger	THD <5%, efficiency 92–94%	Grid PQ improvement
[72]	Soft-switched DAB AC–DC converter	Efficiency 96%, harmonic mitigation THD ~3.2%	Single-stage V2G implementation
[73]	Wireless V2G-to-home interface	V-fluctuation <2%, adaptive DC link	Enables home energy integration
[84]	Optimal PEV charging for F-regulation	FD reduced ~30%	Aggregator-level optimization
[85]	VSG	FD <0.03 Hz, voltage deviation <1%	Islanded MG support
[86]	Ultra-fast DC charger	Efficiency >95%, THD ~4%	High-power V2G/G2V integration
[87]	FLC-super twisting EV battery control	SoC deviation <2%, response time <50 ms	Battery/supercapacitor hybrid EM
[76]	DMPC EV-based virtual energy router	FD reduced ~40%, voltage sag <1.5%	Hybrid MG optimization
[75]	Tube-MPC EVs for isolated grid	FD <0.04 Hz, THD ~3%	Robust to disturbances and grid inertia loss
[88]	Solid-state transformer for EVCS	Efficiency >96%, compact design	High-power station implementation
[89]	EV aggregator with user preferences	Charging cost reduction 12–18%, user satisfaction >90%	Demand-side participation
[90]	V2G aggregator optimization	Energy cost reduction 10–15%, grid load smoothing ~20%	Economic and operational benefits
[77]	MPC in wireless power transfer	Efficiency >94%, voltage ripple reduced by 50%	Dynamic EM for EVs
[78]	Predictive DTC of SRM	Torque ripple <5%, efficiency >90%	EV drive performance enhancement
[91]	EMI filter design for V2G	High-frequency harmonics reduced 60%, VD <2%	Improved grid integration for single-phase inverters

3.4. Optimization of DERs

MPC and advanced control approaches improve MG resiliency by integrating DERs, ESS, and renewables. Predictive models help make a trade-off between the supply-demand cycles and the charging/discharging cycles to improve the health of the battery [22], [83], [134]. Hierarchical and adaptive control structures can guarantee stability under wide dynamics, and support a proper nesting of multi-level energy systems [70], [76], [135]-[139].

3.5. MPC Advances and Applications

Current breakthroughs occur within the realm of hybrid MPC solutions with AI framework integration and online dispatch operators. These approaches promote improvements within the arena of services such as V-regulation and management, F-services, and EV support for V2G services with respect to energy saving by 30% with additional improvements within battery life enhancement parameters around 15-20% [45], [117]. Issues still needing attention pertain to computation and scaling.

Table 3. Numerical performance of EV-based EM and V2G control strategies

Ref.	Control Strategy	Key Numerical Outcomes	EM Impact
[112]	PMSM EV speed & current control (SVPWM)	Speed tracking error <1%, current ripple <3%	Efficient energy use, improved drive performance
[79]	Improved MPC for PMSM under variable DC-bus	THD <4%, current distortion <5%, reduced CMV	Enhanced battery efficiency, reduced losses
[113]	Multi-MG F-stabilization via DSMPC	FD <0.03 Hz, VD <1.5%	Stabilized MG, better RES utilization
[100]	Battery-protective EV charging	SOC deviation <2%, charging efficiency >95%	Extended battery life, optimized PF
[63]	V2G with MPC	THD ~3.5%, grid support power >90%	Peak shaving and F-regulation
[108]	Optimal EV pool composition for V2G	Fleet energy dispatch efficiency ~92%, cost reduction 12–18%	Maximized energy service delivery across markets
[109]	MA-DDPG-based LFC in multi-MGs	FD <0.03 Hz, VD <2%	Coordinated EV-based energy balancing
[104]	V2G for primary FC	F-support up to 0.05 Hz, fast response <2 s	Primary F- stabilization via EV aggregation
[114]	V2G aggregators & HVDC links	FD <0.04 Hz	Grid support in the presence of nonsynchronous units
[115]	Droop-ANN for V2G PQ	THD reduced by 40%, VD <2%	Improved renewable integration & energy efficiency
[116]	Multi-objective EV optimization	Energy cost reduction 15–20%, emissions reduced ~10%	Optimized energy services and grid-friendly operation
[117]	DC MG droop control with EVs	VD <1%, FD <0.03 Hz	Ancillary services and efficient energy dispatch
[118]	EV virtual power plants for PFR	FD <0.035 Hz, response time <1 s	Fast energy support and F-stabilization
[119]	Multi-time scale V2G management	Power balance deviation <3%, improved SOC utilization	Better coordination between EVs and the grid
[120]	EV charging for RESs support	Renewable utilization >90%, cost reduction 12–15%	Optimized EM for low-carbon grids
[121]	Dual-PSS V2G regulation	FD <0.03 Hz, voltage sag <1.5%	MG stability and efficient energy dispatch
[105]	Grid-forming controller with SOC	SOC deviation <2%, VD <1%	Optimized EV charging and grid support
[122]	MPC-VSG EV station control	FD <0.03 Hz, response time <2 s	Fast F support in islanded MGs
[123]	Coordinated V2G & LFC	FD <0.035 Hz, improved load tracking	Statistical power imbalance compensation via EVs
[124]	Multi-time hierarchical PC	SOC deviation <2%, power balancing error <3%	Multi-time scale EV-EM
[125]	OCV-based SOC model for V2G	SOC error <1.5%, efficiency >95%	Accurate SOC tracking for energy optimization
[126]	Optimal PF + V2G scheduling	Cost reduction ~15%, load deviation <2%	Optimized energy dispatch across the grid and EVs
[127]	Observer-based H∞ LFC	FD <0.04 Hz, robust under DoS attacks	Resilient EM with EV integration

3.6. Core Arguments

The process of adopting RESs is accompanied by challenges and opportunities, and more specifically, concerning managing the process of controlling V2G in real-time conditions. The process between EVs and the energy network must be smooth and efficient with minimal delay, as this can affect the efficiency of PCs such as Tube-MPC while managing the MG with varying demand and renewable resources. Hybrid approaches involving MPC with FLC-based approaches can be more stable and energy-efficient. Integration with AI, such as DRL and NN, may increase predictability while contributing to increased computational complexity when integrating with deterministic approaches. Open and validation platforms with standardized protocols play a significant role that ensuring interoperability and reproducibility. Hierarchical multi-time scale PC enables optimizing fast (F and V) and slow functionalities (energy dispatch), though it demands computational resources.

Because DERs and wireless communication enhance susceptibility, cybersecurity issues are also brought up by RESs integration. Resilience is increased by combining PC with anomaly detection, fault-tolerant MPC, and AI monitoring. To safeguard V2G operations, future tactics should include blockchain, decentralized identity management, and AI-enhanced prediction models in addition to legal frameworks. For sustainable, scalable, and secure energy systems, Table 4 highlights communication, hybrid control, and AI integration as key potential and difficulties.

Table 4. Key tasks and emerging chances in contemporary systems

Category	Key insights	Numerical outcomes	Refs.
Robust communication	Real-time data transfer is essential; delays reduce control effectiveness.	Tube-MPC MGs show FD increases by up to 15% with 100 ms network delays. EV fleets require near-instantaneous communication for dynamic load balancing.	[42], [73]
Hybrid control methods	Combining MPC and adaptive (FLC/learning) strategies improves stability.	FLC-MPC reduced FD by 25–35% and harmonic distortion by 3–5% in renewable-heavy MGs.	[76], [113]
AI with deterministic systems	AI (DRL, neural nets) improves optimization but increases computational load.	EV SOC prediction accuracy improved 10–15%; real-time control delays up to 50 ms were observed under high computational demand.	[109]
Standardization & interoperability	Lack of unified protocols limits scalability and reliability.	Diverse EV charging systems hinder V2G deployment, reducing grid support efficiency by ~10%.	[140]
Open collaborative platforms	Shared platforms enable faster deployment and testing.	Sandbox DER testing reduced integration time by 20–30% and lowered deployment costs.	[117], [123]
Cost & scalability	High upfront cost and complexity restrict adoption; modular designs help.	Modular MGs in rural regions achieved 90–95% operational uptime with reduced CAPEX.	[141], [142]
Technology convergence	Integrating MPC, AI, and distributed optimization enhances efficiency.	Combining AI-based PC and virtual inertia cuts FDs by 30% and energy costs by 15%.	[142], [109]
Sustainability & energy equity	Advanced systems should optimize environmental and social benefits.	Remote renewable MGs using PC increased energy access by 40–50% while reducing carbon footprint.	[123], [141]

Table 4 highlights both technological and operational factors while summarizing the main potential and difficulties in contemporary energy systems. For advanced control in V2G and hybrid grids, real-time communication is the lifeblood since any delay can threaten stability and, by implication, predictive schemes. By boosting frequency content and trimming harmonic distortions, hybrid schemes such as predictive and adaptive methods-like MPC, possibly combined with FLC or DRL-build resilience when the grid is unpredictable and leans heavily on renewables. With AI winding into traditional control frameworks, fine-tuning EM and battery use becomes possible, although the demanding computations challenge execution in real-time. Open, collaborative platforms speed deployment and reduce costs, spreading knowledge and experience, but standardization and interoperability are essential for growing microgrids and V2G networks. Low-cost and modular decentralized designs redress scalability hurdles and increase access to state-of-the-art technologies. Overall, the integration of distributed optimization, AI, and power control holds a transformative promise for stability, efficiency, and renewable integration, while sustainability and energy equity center attention on making those benefits available to a wide constituency.

4. Conclusions and Future Work

This review of over 100 papers on MPC in EVs and V2G settings shows the critical importance of MPC in modern energy systems. In hybrid and islanded MGs, this approach contributes to grid stability, PQ optimization, and diminishing uncertainty. As the important figures show, operating costs remain low, while fault disturbances are reduced by up to 35%, THD by 20-30%, and battery life is extended by 15-20%. Under uncertain conditions, MPC, combined with FLC or AI-based approaches, enhances responsiveness by around 25% due to hybrid strategies. In this way, MPC can be applied in real-time energy dispatching, dynamic EV charging control, and mitigation of RESs' intermittency. Further improvements in forecast accuracy (15-20%), decision-making capacity, and system resilience have been achieved with AI-driven prediction models, DT, and decentralized optimization. Nonetheless, there are challenges that linger, such as non-universally accepted V2G protocols, scalability issues for large-scale fleets, and high computational demands. In order to fully realize the potential of MPC for scalable, efficient, sustainable EVs and V2G integration, future research should emphasize cloud-based and/or parallel computing, standardization, and collaborative validation platforms. Additionally, for enhanced real-time flexibility, scalable decentralized MPC frameworks for large EV fleets, DT, and AI-empowered predictions should be further developed. These will serve to enhance system reliability by improving battery health and reducing costs, integrating renewables better, and assuring cybersecurity via blockchain, with standardized V2G protocols. Lastly, coordinating multi-objective optimization with smart aggregators can further improve operational effectiveness in support of resilient and sustainable energy systems.

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Sustainable Development Goals: Sustainable Development Goals mapped to this document, Affordable and Clean Energy Goal 7.

Data Availability: The data used to support the findings of this study are available at reasonable request from the corresponding author.

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Conflicts of Interest: The authors declare that they have no conflicts of interest.

List of Abbreviations

EVs	: Electric vehicles	RESs	: Renewable energy sources
MPC	: Model predictive control	DMPC	: Distributed MPC
ES	: Energy storage	EV	: Electric vehicle
V2G	: Vehicle to grid	FLC	: Fuzzy logic controller
EM	: Energy management	PQ	: Power quality
MG	: Microgrid	VD	: Voltage deviation
FD	: Frequency deviation	AI	: Artificial intelligence
WOS	: Web of Science	DERs	: Distributed energy resources
Q	: Reactive power	P	: Active power
FC	: Frequency control	PC	: Predictive control
PF	: Power flow	NLP	: Natural language processing
NNs	: Neural networks	SARIMA	: Seasonal autoregressive integrated moving average
LQR	: Linear quadratic regulator	VSG	: Virtual synchronous generator
DRL	: Deep reinforcement learning	DAB	: Dual active bridge
CHP	: Combined heat and power	THD	: Total harmonic distortion
SOC	: State-of-charge	DT	: Digital twins
VD	: Voltage deviation	G2V	: Grid to vehicle
PFT	: Power factor	SG	: Smart grid

References

[1] W. F. Mbasso *et al.*, “Policy-driven expansion of renewable energy in Cameroon: A technical and sustainability-centered analysis of growth trends and cross-sectoral impacts (2015–2024),” *Energy Strategy Reviews*, vol. 62, p. 101912, 2025, https://doi.org/10.1016/j.esr.2025.101912.

[2] N. Benalia *et al.*, “Enhancing electric vehicle charging performance through series-series topology resonance-coupled wireless power transfer,” *PLOS ONE*, vol. 19, no. 3, p. e0309545, 2024, https://doi.org/10.1371/journal.pone.0309545.

[3] P. Sinha *et al.*, “Classifying Power Quality Issues in Railway Electrification Systems Using a Nonsubsampled Contourlet Transform Approach,” *Engineering Reports*, vol. 7, no. 8, p. e70301, 2025, https://doi.org/10.1002/eng2.70301.

[4] A. Maheshwari *et al.*, “Real-Time Parameter Identification and State of Charge Estimation of Electric Vehicle Batteries,” *Engineering Reports*, vol. 7, no. 8, p. e70346, 2025, https://doi.org/10.1002/eng2.70346.

[5] S. Nadweh, M. M. Mahmoud, I. M. Elzein, and D. E. M. Wapet, “Optimizing control of single-ended primary inductor converter integrated with microinverter for PV systems: Imperialist competitive algorithm,” *Energy Exploration & Exploitation*, 2025, https://doi.org/10.1177/01445987251382002.

[6] H. Abdelfattah *et al.*, “Supporting the reactivity of nuclear power plants using an optimized FOPID controller with arithmetic algorithm: Toward an environmentally sustainable energy system,” *Energy Exploration & Exploitation*, 2025, https://doi.org/10.1177/01445987251357362.

[7] R. Rana, T. S. Saggu, S. S. Letha, and F. I. Bakhsh, “V2G based bidirectional EV charger topologies and its control techniques: a review,” *Discovery Applied Sciences*, vol. 6, 2024, https://doi.org/10.1007/s42452-024-06297-z.

[8] M. S. Priyadarshini *et al.*, “Microcontroller-based Prototype Model of a Solar Wireless Electric Vehicle-to-Vehicle Charging System with Real-Time Battery Voltage Monitoring,” *Buletin Ilmiah Sarjana Teknik Elektro*, vol. 7, no. 3, pp. 527-540, 2025, https://doi.org/10.12928/biste.v7i3.13232.

[9] A. Rachid *et al.*, “Electric Vehicle Charging Systems: Comprehensive Review,” *Energies*, vol. 16, no. 1, p. 255, 2023, https://doi.org/10.3390/en16010255.

[10] S. Shahzad, M. A. Abbasi, M. A. Chaudhry and M. M. Hussain, “Model Predictive Control Strategies in Microgrids: A Concise Revisit,” *IEEE Access*, vol. 10, pp. 122211-122225, 2022, https://doi.org/10.1109/ACCESS.2022.3223298.

[11] M. S. Priyadarshini, S. A. E. M. Ardjoun, A. Hysa, M. M. Mahmoud, U. Sur, and N. Anwer,, “Time-domain Simulation and Stability Analysis of a Photovoltaic Cell Using the Fourth-order Runge-Kutta Method and Lyapunov Stability Analysis,” *Buletin Ilmiah Sarjana Teknik Elektro*, vol. 7, no. 2, pp. 214-230, 2025, https://doi.org/10.12928/biste.v7i2.13233.

[12] J. Hu, C. Ye, Y. Ding, J. Tang and S. Liu, “A Distributed MPC to Exploit Reactive Power V2G for Real-Time Voltage Regulation in Distribution Networks,” *IEEE Transactions on Smart Grid*, vol. 13, no. 1, pp. 576-588, 2022, https://doi.org/10.1109/TSG.2021.3109453.

[13] B. Tan *et al.*, “Distributionally robust energy management for multi-microgrids with grid-interactive EVs considering the multi-period coupling effect of user behaviors,” *Applied Energy*, vol. 350, p. 121770, 2023, https://doi.org/10.1016/j.apenergy.2023.121770.

[14] M. Bayati, M. Abedi, G. B. Gharehpetian, and M. Farahmandrad, “Short-term interaction between electric vehicles and microgrid in decentralized vehicle-to-grid control methods,” *Protection and Control of Modern Power Systems*, vol. 4, no. 5, 2019, https://doi.org/10.1186/s41601-019-0118-4.

[15] A. Hysa *et al.*, “Advanced Modeling and Comparative Error Analysis of Photovoltaic Cells Using Multi-Diode Models and EQE Characterization,” *Journal of Robotics and Control*, vol. 6, no. 5, pp. 2308-2321, 2025, https://doi.org/10.18196/jrc.v6i5.27539.

[16] H. Yu, X. Lei, S. Niu, Z. Shao, and L. Jian, “Enhancing electric vehicle penetration and grid operation performance in old residential communities through hybrid AC/DC microgrid reconstruction,” *Applied Energy*, vol. 347, p. 121459, 2023, https://doi.org/10.1016/j.apenergy.2023.121459.

[17] D. Cui *et al.*, “Enhancing Short-Term Electricity Forecasting with Advanced Machine Learning Techniques,” *Journal of Electrical Engineering & Technology*, 2025, https://doi.org/10.1007/s42835-025-02430-z.

[18] O. Ouramdane, E. Elbouchikhi, Y. Amirat, and E. S. Gooya, “Optimal sizing and energy management of microgrids with Vehicle-to-Grid technology: A critical review and future trends,” *Energies*, vol. 14, no. 14, p. 4166, 2021, https://doi.org/10.3390/en14144166.

[19] N. V. A. Ravikumar *et al.*, “Design and real-time simulations of robust controllers for uncertain multi-input wind turbine,” *Energy Exploration & Exploitation*, 2025, https://doi.org/10.1177/01445987251373101.

[20] M. Mousavizade *et al.*, “Adaptive control of V2Gs in islanded microgrids incorporating EV owner expectations,” *Applied Energy*, vol. 341, p. 121118, 2023, https://doi.org/10.1016/j.apenergy.2023.121118.

[21] Y. Maamar *et al.*, “A Comparative Analysis of Recent MPPT Algorithms (P & O / INC / FLC) for PV Systems,” *Journal of Robotics and Control*, vol. 6, no. 4, pp. 1581-1588, 2025, https://doi.org/10.18196/jrc.v6i4.25814.

[22] B. Khokhar and K. P. S. Parmar, “A novel adaptive intelligent MPC scheme for frequency stabilization of a microgrid considering SoC control of EVs,” *Applied Energy*, vol. 309, p. 118423, 2022, https://doi.org/10.1016/j.apenergy.2021.118423.

[23] F. Alfaverh, M. Denaï, and Y. Sun, “Optimal vehicle-to-grid control for supplementary frequency regulation using deep reinforcement learning,” *Electric Power Systems Research*, vol. 214, p. 108949, 2023, https://doi.org/10.1016/j.epsr.2022.108949.

[24] C. Jamroen, I. Ngamroo and S. Dechanupaprittha, “EVs Charging Power Control Participating in Supplementary Frequency Stabilization for Microgrids: Uncertainty and Global Sensitivity Analysis,” *IEEE Access*, vol. 9, pp. 111005-111019, 2021, https://doi.org/10.1109/ACCESS.2021.3102312.

[25] S. Basu *et al.*, “Applications of Snow Ablation Optimizer for Sustainable Dynamic Dispatch of Power and Natural Gas Assimilating Multiple Clean Energy Sources,” *Engineering Reports*, vol. 7, no. 6, pp. 1-12, 2025, https://doi.org/10.1002/eng2.70211.

[26] A. Pradana, M. Haque, and M. Nadarajah, “Control Strategies of Electric Vehicles Participating in Ancillary Services: A Comprehensive Review,” *Energies*, vol. 16, no. 4, p. 1782, 2023, https://doi.org/10.3390/en16041782.

[27] R. Bousseksou *et al.*, “Utilizing Short-Time Fourier Transform for the Diagnosis of Rotor Bar Faults in Induction Motors Under Direct Torque Control,” *International Journal of Robotics and Control Systems*, vol. 5, no. 2, pp. 1441-1457, 2025, https://doi.org/10.31763/ijrcs.v5i2.1886.

[28] I. M. Elzein, Y. Maamar, M. M. Mahmoud, M. I. Mosaad, and S. A. Shaaban, “The Utilization of a TSR-MPPT-Based Backstepping Controller and Speed Estimator Across Varying Intensities of Wind Speed Turbulence,” *International Journal of Robotics and Control Systems*, vol. 5, no. 2, pp. 1315-1330, 2025, https://doi.org/10.31763/ijrcs.v5i2.1793.

[29] A. F. A. Ahmed, I. M. Elzein, M. M. Mahmoud, S. A. E. M. Ardjoun, A. M. Ewias, and U. Khaled, “Optimal Controller Design of Crowbar System for DFIG-based WT: Applications of Gravitational Search Algorithm,” *Buletin Ilmiah Sarjana Teknik Elektro*, vol. 7, no. 2, pp. 122-137, 2025, https://doi.org/10.12928/biste.v7i2.13027.

[30] A. M *et al.*, “Prediction of Optimum Operating Parameters to Enhance the Performance of PEMFC Using Machine Learning Algorithms,” *Energy Exploration & Exploitation*, vol. 43, no. 2, pp. 676-698, 2024, https://doi.org/10.1177/01445987241290535.

[31] O. M. Kamel *et al.*, “Effective energy management strategy with a novel design of fuzzy logic and JAYA-based controllers in isolated DC/AC microgrids: A comparative analysis,” *Wind Engineering*, vol. 49, no. 1, pp. 199-222, 2025, https://doi.org/10.1177/0309524X241263518.

[32] R. Shi, S. Li, P. Zhang, and K. Y. Lee, “Integration of renewable energy sources and electric vehicles in V2G network with adjustable robust optimization,” *Renewable Energy*, vol. 153, pp. 1067-1080, 2020, https://doi.org/10.1016/j.renene.2020.02.027.

[33] S. Heroual *et al.*, “Enhancement of Transient Stability and Power Quality in Grid-Connected PV Systems Using SMES,” *International Journal of Robotics and Control Systems*, vol. 5, no. 2, pp. 990-1005, 2025, https://doi.org/10.31763/ijrcs.v5i2.1760.

[34] T. Boutabba *et al.*, “Design of a Small Wind Turbine Emulator for Testing Power Converters Using dSPACE 1104,” *International Journal of Robotics and Control Systems*, vol. 5, no. 2, pp. 698-712, 2025, https://doi.org/10.31763/ijrcs.v5i2.1685.

[35] S. A. Mohamed, N. Anwer, and M. M. Mahmoud, “Solving optimal power flow problem for IEEE-30 bus system using a developed particle swarm optimization method: towards fuel cost minimization,” *International Journal of Modelling and Simulation*, vol. 45, no. 1, pp. 307-320, 2025, https://doi.org/10.1080/02286203.2023.2201043.

[36] O. Babayomi, Z. Zhang, T. Dragicevic, J. Hu, and J. Rodriguez, “Smart grid evolution: Predictive control of distributed energy resources-A review,” *International Journal of Electrical Power & Energy Systems*, vol. 147, p. 108812, 2023, https://doi.org/10.1016/j.ijepes.2022.108812.

[37] S. Heroual, B. Belabbas, Y. Diab, M. M. Mahmoud, T. Allaoui, N. Benabdallah, “Optimizing Power Flow in Photovoltaic-Hybrid Energy Storage Systems: A PSO and DPSO Approach for PI Controller Tuning,” *International Transactions on Electrical Energy Systems*, vol. 2025, no. 1, pp. 1-23, 2025, https://doi.org/10.1155/etep/9958218.

[38] N. L. Tumeran *et al.*, “Model Predictive Control Based Energy Management System Literature Assessment for RES Integration,” *Energies*, vol. 16, no. 8, p. 3362, 2023, https://doi.org/10.3390/en16083362.

[39] A. Hysa, M. M. Mahmoud, A. Ewais, “An Investigation of the Output Characteristics of Photovoltaic Cells Using Iterative Techniques and MATLAB ® 2024a Software,” *Control Systems and Optimization Letters*, vol. 3, no. 1, pp. 46-52, 2025, https://doi.org/10.59247/csol.v3i1.174.

[40] Y. Yang, H. -G. Yeh and R. Nguyen, “A Robust Model Predictive Control-Based Scheduling Approach for Electric Vehicle Charging With Photovoltaic Systems,” *IEEE Systems Journal*, vol. 17, no. 1, pp. 111-121, 2023, https://doi.org/10.1109/JSYST.2022.3183626.

[41] P. Sinha *et al.*, “Efficient automated detection of power quality disturbances using nonsubsampled contourlet transform & PCA-SVM,” *Energy Exploration & Exploitation*, vol. 43, no. 3, pp. 1149-1179, 2025, https://doi.org/10.1177/01445987241312755.

[42] M. U. Jan, A. Xin, H. U. Rehman, M. A. Abdelbaky, S. Iqbal and M. Aurangzeb, “Frequency Regulation of an Isolated Microgrid With Electric Vehicles and Energy Storage System Integration Using Adaptive and Model Predictive Controllers,” *IEEE Access*, vol. 9, pp. 14958-14970, 2021, https://doi.org/10.1109/ACCESS.2021.3052797.

[43] P. Fan, J. Yang, S. Ke, Y. Wen, Y. Li, and L. Xie, “Load frequency control strategy for islanded multimicrogrids with V2G dependent on learning-based model predictive control,” *IET Generation, Transmission & Distribution*, vol. 17, no. 21, pp. 4763-4780, 2023, https://doi.org/10.1049/gtd2.12994.

[44] A. M. E. Raj *et al.*, “Wavelet Analysis-Singular Value Decomposition Based Method for Precise Fault Localization in Power Distribution Networks Using k-NN Classifier,” *International Journal of Robotics and Control Systems*, vol. 5, no. 1, pp. 530-554, 2025, https://doi.org/10.31763/ijrcs.v5i1.1543.

[45] C. Wu, S. Gao, Y. Liu, T. E. Song, and H. Han, “A model predictive control approach in microgrid considering multi-uncertainty of electric vehicles,” *Renewable Energy*, vol. 163, pp. 1385-1396, 2021, https://doi.org/10.1016/j.renene.2020.08.137.

[46] Y. Maamar *et al.*, “Design, Modeling, and Simulation of A New Adaptive Backstepping Controller for Permanent Magnet Linear Synchronous Motor: A Comparative Analysis,” *International Journal of Robotics and Control Systems*, vol. 5, no. 1, pp. 296-310, 2025, https://doi.org/10.31763/ijrcs.v5i1.1425.

[47] S. Oshnoei *et al.*, “A novel virtual inertia control strategy for frequency regulation of islanded microgrid using two-layer multiple model predictive control,” *Applied Energy*, vol. 343, p. 121233, 2023, https://doi.org/10.1016/j.apenergy.2023.121233.

[48] F. Menzri, T. Boutabba, I. Benlaloui, H. Bawayan, M. I. Mosaad, and M. M. Mahmoud, “Applications of hybrid SMC and FLC for augmentation of MPPT method in a wind-PV-battery configuration,” *Wind Engineering*, vol. 48, no. 6, pp. 1186-1202, 2024, https://doi.org/10.1177/0309524X241254364.

[49] R. R. Shukla, M. M. Garg, and A. K. Panda, “Driving grid stability: Integrating electric vehicles and energy storage devices for efficient load frequency control in isolated hybrid microgrids,” *Journal of Energy Storage*, vol. 89, p. 111654, 2024, https://doi.org/10.1016/j.est.2024.111654.

[50] A. Nouri, A. Lachheb, and L. El Amraoui, “Optimizing efficiency of Vehicle-to-Grid system with intelligent management and ANN-PSO algorithm for battery electric vehicles,” *Electric Power Systems Research*, vol. 226, p. 109936, 2024, https://doi.org/10.1016/j.epsr.2023.109936.

[51] C. Zhong, H. Zhao, Y. Liu, and C. Liu, “Learning-based model predictive secondary frequency control of PV-ESS-EV microgrid,” *International Journal of Electrical Power & Energy Systems*, vol. 159, p. 110020, 2024, https://doi.org/10.1016/j.ijepes.2024.110020.

[52] F. Jiao, Y. Zou, X. Zhang, and B. Zhang, “Online optimal dispatch based on combined robust and stochastic model predictive control for a microgrid including EV charging station,” *Energy*, vol. 247, p. 123220, 2022, https://doi.org/10.1016/j.energy.2022.123220.

[53] S. Guo, P. Li, K. Ma, B. Yang, and J. Yang, “Robust energy management for industrial microgrid considering charging and discharging pressure of electric vehicles,” *Applied Energy*, vol. 325, p. 119846, 2022, https://doi.org/10.1016/j.apenergy.2022.119846.

[54] Y. Hakam, A. Gaga, M. Tabaa, and B. El hadadi, “Enhancing Electric Vehicle Charger Performance with Synchronous Boost and Model Predictive Control for Vehicle-to-Grid Integration,” *Energies*, vol. 17, no. 7, p. 1787, 2024, https://doi.org/10.3390/en17071787.

[55] A. Cabrera-Tobar, A. Massi Pavan, G. Petrone, and G. Spagnuolo, “A Review of the Optimization and Control Techniques in the Presence of Uncertainties for the Energy Management of Microgrids,” *Energies*, vol. 15, no. 23, p. 9114, 2022, https://doi.org/10.3390/en15239114.

[56] J. Hu *et al.*, “Model predictive control of microgrids – An overview,” *Renewable and Sustainable Energy Reviews*, vol. 136, p. 110422, 2021, https://doi.org/10.1016/j.rser.2020.110422.

[57] L. Patanè, F. Sapuppo, G. Napoli, and M. G. Xibilia, “Predictive Models for Aggregate Available Capacity Prediction in Vehicle-to-Grid Applications,” *Journal of Sensor and Actuator Networks*, vol. 13, no. 5, p. 49, 2024, https://doi.org/10.3390/jsan13050049.

[58] J. Sora, I. Serban and D. Petreus, “Enhancing Microgrid Operation Through Electric Vehicle Integration: A Survey,” *IEEE Access*, vol. 12, pp. 64897-64912, 2024, https://doi.org/10.1109/ACCESS.2024.3397587.

[59] T. Hai, J. Zhou, and M. khaki, “Optimal planning and design of integrated energy systems in a microgrid incorporating electric vehicles and fuel cell system,” *Journal of Power Sources*, vol. 561, p. 232694, 2023, https://doi.org/10.1016/j.jpowsour.2023.232694.

[60] Y. Rao, J. Yang, J. Xiao, B. Xu, W. Liu, and Y. Li, “A frequency control strategy for multimicrogrids with V2G based on the improved robust model predictive control,” *Energy*, vol. 222, p. 119963, 2021, https://doi.org/10.1016/j.energy.2021.119963.

[61] C. Minchala-Ávila, P. Arévalo, and D. Ochoa-Correa, “A Systematic Review of Model Predictive Control for Robust and Efficient Energy Management in Electric Vehicle Integration and V2G Applications,” *Modelling*, vol. 6, no. 1, p. 20, 2025, https://doi.org/10.3390/modelling6010020.

[62] H. He, Y. Wang, R. Han, M. Han, Y. Bai, and Q. Liu, “An improved MPC-based energy management strategy for hybrid vehicles using V2V and V2I communications,” *Energy*, vol. 225, p. 120273, 2021, https://doi.org/10.1016/j.energy.2021.120273.

[63] P. P J, L. P. P.S. and H. K. R., “Vehicle to Grid operation of an Electric Vehicle using Model Predictive Control,” *2023 International Conference on Control, Communication and Computing (ICCC)*, pp. 1-6, 2023, https://doi.org/10.1109/ICCC57789.2023.10164959.

[64] X. Yan, B. Guan and X. Du, “Bidirectional Charging Strategy of Electric Vehicle based on Predictive Control Method,” *2021 International Conference on Power System Technology (POWERCON)*, pp. 789-793, 2021, https://doi.org/10.1109/POWERCON53785.2021.9697595.

[65] O. Dankar, M. Tarnini, A. El Ghaly, N. Moubayed, and K. Chahine, “A Neural Network-Based Model Predictive Control for a Grid-Connected Photovoltaic–Battery System with Vehicle-to-Grid and Grid-to-Vehicle Operations,” *Electricity*, vol. 6, no. 2, p. 32, 2025, https://doi.org/10.3390/electricity6020032.

[66] J. Lara, L. Masisi, C. Hernandez, M. A. Arjona, and A. Chandra, “Novel five-level ANPC bidirectional converter for power quality enhancement during G2V/V2G operation of cascaded EV charger,” *Energies*, vol. 14, no. 9, p. 2650, 2021, https://doi.org/10.3390/en14092650.

[67] L. Guo, Z. Xu, N. Jin, Y. Chen, Y. Li and Z. Dou, “An Inductance Online Identification Method for Model Predictive Control of V2G Inverter With Enhanced Robustness to Grid Frequency Deviation,” *IEEE Transactions on Transportation Electrification*, vol. 8, no. 2, pp. 1575-1589, 2022, https://doi.org/10.1109/TTE.2021.3128362.

[68] M. Gonzalez, F. J. Asensio, J. I. San Martín, I. Zamora, J. A. Cortajarena, and O. Oñederra, “Vehicle-to-grid charging control strategy aimed at minimizing harmonic disturbances,” *International Journal of Energy Research*, vol. 45, no. 11, pp. 16478-16488, 2021, https://doi.org/10.1002/er.6894.

[69] H. Liang, Z. Lee and G. Li, “A Calculation Model of Charge and Discharge Capacity of Electric Vehicle Cluster Based on Trip Chain,” *IEEE Access*, vol. 8, pp. 142026-142042, 2020, https://doi.org/10.1109/ACCESS.2020.3014160.

[70] S. Gao, R. Dai, W. Cao and Y. Che, “Combined Provision of Economic Dispatch and Frequency Regulation by Aggregated EVs Considering Electricity Market Interaction,” *IEEE Transactions on Transportation Electrification*, vol. 9, no. 1, pp. 1723-1735, 2023, https://doi.org/10.1109/TTE.2022.3195567.

[71] R. K. Lenka and A. K. Panda, “Grid power quality improvement using a vehicle-to-grid enabled bidirectional off-board electric vehicle battery charger,” *International Journal of Circuit Theory and Applications*, vol. 49, no. 8, pp. 2612-2629, 2021, https://doi.org/10.1002/cta.3021.

[72] D. Das, N. Weise, K. Basu, R. Baranwal and N. Mohan, “A Bidirectional Soft-Switched DAB-Based Single-Stage Three-Phase AC–DC Converter for V2G Application,” *IEEE Transactions on Transportation Electrification*, vol. 5, no. 1, pp. 186-199, 2019, https://doi.org/10.1109/TTE.2018.2886455.

[73] L. Wang, U. K. Madawala and M. -C. Wong, “A Wireless Vehicle-to-Grid-to-Home Power Interface With an Adaptive DC Link,” *IEEE Journal of Emerging and Selected Topics in Power Electronics*, vol. 9, no. 2, pp. 2373-2383, 2021, https://doi.org/10.1109/JESTPE.2020.2992776.

[74] M. Latifi, R. Sabzehgar, P. Fajri, and M. Rasouli, “A novel control strategy for the frequency and voltage regulation of distribution grids using electric vehicle batteries,” *Energies*, vol. 14, no. 5, p. 1435, 2021, https://doi.org/10.3390/en14051435.

[75] A. Oshnoei, M. Kheradmandi, S. M. Muyeen and N. D. Hatziargyriou, “Disturbance Observer and Tube-Based Model Predictive Controlled Electric Vehicles for Frequency Regulation of an Isolated Power Grid,” *IEEE Transactions on Smart Grid*, vol. 12, no. 5, pp. 4351-4362, 2021, https://doi.org/10.1109/TSG.2021.3077519.

[76] K. Feng and C. Liu, “Adaptive DMPC-Based Frequency and Voltage Control for Microgrid Deploying a Novel EV-Based Virtual Energy Router,” *IEEE Transactions on Transportation Electrification*, vol. 10, no. 3, pp. 4978-4989, 2024, https://doi.org/10.1109/TTE.2023.3319109.

[77] A. Alkasir, S. E. Abdollahi, S. R. Abdollahi, and P. Wheeler, “Enhancement of dynamic wireless power transfer system by model predictive control,” *IET Power Electronics*, vol. 15, no. 1, pp. 67-79, 2022, https://doi.org/10.1049/pel2.12213.

[78] R. Abdel-Fadil and L. Számel, “Predictive direct torque control of switched reluctance motor for electric vehicles drives,” *Periodica Polytechnica Electrical Engineering and Computer Science*, vol. 64, no. 3, pp. 264-273, 2020, https://doi.org/10.3311/PPee.15496.

[79] J. Li, W. Song, H. Yue, N. Sun, C. Ma and R. Feng, “An Improved MPC With Reduced CMV and Current Distortion for PMSM Drives Under Variable DC-Bus Voltage Condition in Electric Vehicles,” *IEEE Transactions on Power Electronics*, vol. 38, no. 4, pp. 5167-5177, 2023, https://doi.org/10.1109/TPEL.2022.3227436.

[80] Z. Wang, Y. Zhang, S. You, H. Xiao and M. Cheng, “An Integrated Power Conversion System for Electric Traction and V2G Operation in Electric Vehicles With a Small Film Capacitor,” *IEEE Transactions on Power Electronics*, vol. 35, no. 5, pp. 5066-5077, 2020, https://doi.org/10.1109/TPEL.2019.2944276.

[81] Y. Li, H. He, J. Peng and H. Wang, “Deep Reinforcement Learning-Based Energy Management for a Series Hybrid Electric Vehicle Enabled by History Cumulative Trip Information,” *IEEE Transactions on Vehicular Technology*, vol. 68, no. 8, pp. 7416-7430, 2019, https://doi.org/10.1109/TVT.2019.2926472.

[82] S. Semsar, T. Soong and P. W. Lehn, “On-Board Single-Phase Integrated Electric Vehicle Charger With V2G Functionality,” *IEEE Transactions on Power Electronics*, vol. 35, no. 11, pp. 12072-12084, 2020, https://doi.org/10.1109/TPEL.2020.2982326.

[83] R. Guo and W. Shen, "Online state of charge and state of power co-estimation of lithium-ion batteries based on fractional-order calculus and model predictive control theory," *Applied Energy*, vol. 327, p. 120009, 2022, https://doi.org/10.1016/j.apenergy.2022.120009.

[84] R. Germanà, F. Liberati, E. De Santis, A. Giuseppi, F. Delli Priscoli, and A. Di Giorgio, "Optimal control of plug-in electric vehicles charging for composition of frequency regulation services," *Energies*, vol. 14, no. 23, p. 7879, 2021, https://doi.org/10.3390/en14237879.

[85] P. Yu *et al.*, "Research on Pre-synchronization Control Strategy for the Integration of Individual Microgrid into Microgrid Clusters," *The Proceedings of 2023 4th International Symposium on Insulation and Discharge Computation for Power Equipment (IDCOMPU2023)*, pp. 535-546, 2024, https://doi.org/10.1007/978-981-99-7413-9_51.

[86] B. Krishna, D. Anusha, and V. Karthikeyan, "Ultra-fast DC charger with improved power quality and optimal algorithmic approach to enable V2G and G2V," *Journal of Circuits, Systems and Computers*, vol. 29, no. 12, p. 2050197, 2020, https://doi.org/10.1142/S0218126620501972.

[87] M. Sellali, S. Abdeddaim, A. Betka, A. Djerdir, S. Drid, and M. Tiar, "Fuzzy-Super twisting control implementation of battery/super capacitor for electric vehicles," *ISA Transactions*, vol. 95, pp. 243-253, 2019, https://doi.org/10.1016/j.isatra.2019.04.029.

[88] A. L. Eshkevari, A. Mosallanejad, and M. Sepasian, "In-depth study of the application of solid-state transformer in design of high-power electric vehicle charging stations," *IET Electrical Systems in Transportation*, vol. 10, no. 3, pp. 310-319, 2020, https://doi.org/10.1049/iet-est.2019.0106.

[89] J. M. Clairand, "Participation of electric vehicle aggregators in ancillary services considering users' preferences," *Sustainability*, vol. 12, no. 1, p. 8, 2020, https://doi.org/10.3390/su12010008.

[90] S. -A. Amamra and J. Marco, "Vehicle-to-Grid Aggregator to Support Power Grid and Reduce Electric Vehicle Charging Cost," *IEEE Access*, vol. 7, pp. 178528-178538, 2019, https://doi.org/10.1109/ACCESS.2019.2958664.

[91] S. Jiang, Y. Liu, W. Liang, J. Peng and H. Jiang, "Active EMI Filter Design With a Modified LCL-LC Filter for Single-Phase Grid-Connected Inverter in Vehicle-to-Grid Application," *IEEE Transactions on Vehicular Technology*, vol. 68, no. 11, pp. 10639-10650, 2019, https://doi.org/10.1109/TVT.2019.2944220.

[92] V. Kumar *et al.*, "A Novel Hybrid Harris Hawk Optimization – Sine Cosine Transmission Network," *Energies*, vol. 17, no. 19, p. 4985, 2024, https://doi.org/10.3390/en17194985.

[93] B. Benbouya *et al.*, "Dynamic Assessment and Control of a Dual Star Induction Machine State Dedicated to an Electric Vehicle Under Short-Circuit Defect," *International Journal of Robotics and Control Systems*, vol. 4, no. 4, pp. 1731-1745, 2024, https://doi.org/10.31763/ijrcs.v4i4.1557.

[94] Y. Maamar *et al.*, "Design, Simulation, and Experimental Validation of a New Fuzzy Logic-Based Maximal Power Point Tracking Strategy for Low Power Wind Turbines," *International Journal of Fuzzy Systems*, vol. 5, no. 1, pp. 296-310, 2025, https://doi.org/10.31763/ijrcs.v5i1.1425.

[95] S. R. K. Joga *et al.*, "Applications of tunable-Q factor wavelet transform and AdaBoost classifier for identification of high impedance faults: Towards the reliability of electrical distribution systems," *Energy Exploration & Exploitation*, vol. 42, no. 6, pp. 2017-2055, 2024, https://doi.org/10.1177/01445987241260949.

[96] B. K. Ponukumati *et al.*, "Evolving fault diagnosis scheme for unbalanced distribution network using fast normalized cross-correlation technique," *PLOS ONE*, vol. 19, no. 10, p. e0305407, 2024, https://doi.org/10.1371/journal.pone.0305407.

[97] A. Fatah *et al.*, "Design, and dynamic evaluation of a novel photovoltaic pumping system emulation with DS1104 hardware setup: Towards innovative in green energy systems," *PLOS ONE*, vol. 19, no. 10, p. e0308212, 2024, https://doi.org/10.1371/journal.pone.0308212.

[98] R. Moumni *et al.*, "Optimizing Single-Inverter Electric Differential System for Electric Vehicle Propulsion Applications," *International Journal of Robotics and Control Systems*, vol. 4, no. 4, pp. 1772-1793, 2024, https://doi.org/10.31763/ijrcs.v4i4.1542.

[99] R. Kassem *et al.*, "Enhanced Multiphase Interleaved Boost Converter Interface for Grid-Connected PV Power System," *IEEE Access*, vol. 12, pp. 151940-151954, 2024, https://doi.org/10.1109/ACCESS.2024.3469540.

[100] S. Li, P. Zhao, C. Gu, J. Li, S. Cheng and M. Xu, "Battery Protective Electric Vehicle Charging Management in Renewable Energy System," *IEEE Transactions on Industrial Informatics*, vol. 19, no. 2, pp. 1312-1321, 2023, https://doi.org/10.1109/TII.2022.3184398.

[101] D. Ronanki and H. Karneddi, "Electric Vehicle Charging Infrastructure: Review, Cyber Security Considerations, Potential Impacts, Countermeasures, and Future Trends," *IEEE Journal of Emerging and Selected Topics in Power Electronics*, vol. 12, no. 1, pp. 242-256, 2024, https://doi.org/10.1109/JESTPE.2023.3336997.

[102] X. Xian *et al.*, "Comparison of SARIMA model, Holt-winters model and ETS model in predicting the incidence of foodborne disease," *BMC Infectious Diseases*, vol. 23, no. 803, 2023, https://doi.org/10.1186/s12879-023-08799-4.

[103] H. Alnami, S. A. E. M. Ardjoun, and M. M. Mahmoud, "Design, implementation, and experimental validation of a new low-cost sensorless wind turbine emulator: Applications for small-scale turbines," *Wind Engineering*, vol. 48, no. 4, pp. 565-579, 2024, https://doi.org/10.1177/0309524X231225776.

[104] S. Iqbal *et al.*, "V2G strategy for primary frequency control of an industrial microgrid considering the charging station operator," *Electronics*, vol. 9, no. 4, p. 549, 2020, https://doi.org/10.3390/electronics9040549.

[105] A. Ordono, F. J. Asensio, J. A. Cortajarena, I. Zamora, M. González-Pérez, and G. Saldaña, "A grid forming controller with integrated state of charge management for V2G chargers," *International Journal of Electrical Power & Energy Systems*, vol. 157, p. 109862, 2024, https://doi.org/10.1016/j.ijepes.2024.109862.

[106] H. M. I. Saleeb *et al.*, "Highly Efficient Isolated Multiport Bidirectional DC/DC Converter for PV Applications," *IEEE Access*, vol. 12, pp. 114480-114494, 2024, https://doi.org/10.1109/ACCESS.2024.3442711.

[107] F. Menzri *et al.*, "Applications of Novel Combined Controllers for Optimizing Grid-Connected Hybrid Renewable Energy Systems," *Sustainability*, vol. 16, no. 16, p. 6825, 2024, https://doi.org/10.3390/su16166825.

[108] B. Tepe *et al.*, "Optimal pool composition of commercial electric vehicles in V2G fleet operation of various electricity markets," *Applied Energy*, vol. 308, p. 118351, 2022, https://doi.org/10.1016/j.apenergy.2021.118351.

[109] P. Fan *et al.*, "A load frequency coordinated control strategy for multimicrogrids with V2G based on improved MA-DDPG," *International Journal of Electrical Power & Energy Systems*, vol. 146, p. 108765, 2023, https://doi.org/10.1016/j.ijepes.2022.108765.

[110] M. N. A. Hamid *et al.*, "Adaptive Frequency Control of an Isolated Microgrids Implementing Different Recent Optimization Techniques," *International Journal of Robotics and Control Systems*, vol. 4, no. 3, pp. 1000-1012, 2024, https://doi.org/10.31763/ijrcs.v4i3.1432.

[111] A. T. Hassan *et al.*, "Adaptive Load Frequency Control in Microgrids Considering PV Sources and EVs Impacts: Applications of Hybrid Sine Cosine Optimizer and Balloon Effect Identifier Algorithms," *International Journal of Robotics and Control Systems*, vol. 4, no. 2, pp. 941-957, 2024, https://doi.org/10.31763/ijrcs.v4i2.1448.

[112] A. Kasri *et al.*, "Real-time and hardware in the loop validation of electric vehicle performance: Robust nonlinear predictive speed and currents control based on space vector modulation for PMSM," *Results in Engineering*, vol. 22, p. 102223, 2024, https://doi.org/10.1016/j.rineng.2024.102223.

[113] A. Latif, M. A. Aftab and S. M. Suhail Hussain, "Robust Frequency Stabilization of Renewable-Bio-Electric Vehicle Integrated Multi Microgrid under Diverse Structure Model Predictive Controller," *2022 IEEE 2nd International Conference on Sustainable Energy and Future Electric Transportation (SeFeT)*, pp. 1-5, 2022, https://doi.org/10.1109/SeFeT55524.2022.9908661.

[114] S. Debbarma and R. Shrivastwa, “Grid Frequency Support From V2G Aggregators and HVdc Links in Presence of Nonsynchronous Units,” *IEEE Systems Journal*, vol. 13, no. 2, pp. 1757-1766, 2019, https://doi.org/10.1109/JSYST.2018.2846282.

[115] M. Aurangzeb *et al.*, “A Novel Hybrid Approach for Power Quality Improvement in a Vehicle-to-Grid Setup Using Droop-ANN Model,” *International Journal of Energy Research*, vol. 2023, no. 1, pp. 1-30, 2023, https://doi.org/10.1155/2023/7786928.

[116] R. Das *et al.*, “Multi-objective techno-economic-environmental optimisation of electric vehicle for energy services,” *Applied Energy*, vol. 257, p. 113965, 2020, https://doi.org/10.1016/j.apenergy.2019.113965.

[117] M. Jiménez Carrizosa, A. Iovine, G. Damm and P. Alou, “Droop-Inspired Nonlinear Control of a DC Microgrid for Integration of Electrical Mobility Providing Ancillary Services to the AC Main Grid,” *IEEE Transactions on Smart Grid*, vol. 13, no. 5, pp. 4113-4122, 2022, https://doi.org/10.1109/TSG.2022.3156693.

[118] H. H. Alhelou, P. Siano, M. Tipaldi, R. Iervolino, and F. Mahfoud, “Primary frequency response improvement in interconnected power systems using electric vehicle virtual power plants,” *World Electric Vehicle Journal*, vol. 11, no. 2, p. 40, 2020, https://doi.org/10.3390/wevj11020040.

[119] S. Li *et al.*, “Vehicle-to-grid management for multi-time scale grid power balancing,” *Energy*, vol. 234, p. 121201, 2021, https://doi.org/10.1016/j.energy.2021.121201.

[120] A. Colmenar-Santos *et al.*, “Electric vehicle charging strategy to support renewable energy sources in Europe 2050 low-carbon scenario,” *Energy*, vol. 183, pp. 61-74, 2019, https://doi.org/10.1016/j.energy.2019.06.118.

[121] H. Abubakr, A. Lashab, J. C. Vasquez, T. H. Mohamed, and J. M. Guerrero, “Novel V2G regulation scheme using Dual-PSS for PV islanded microgrid,” *Applied Energy*, vol. 340, p. 121012, 2023, https://doi.org/10.1016/j.apenergy.2023.121012.

[122] S. Ke *et al.*, “A Frequency Control Strategy for EV Stations Based on MPC-VSG in Islanded Microgrids,” *IEEE Transactions on Industrial Informatics*, vol. 20, no. 2, pp. 1819-1831, 2024, https://doi.org/10.1109/TII.2023.3281658.

[123] J. Yang *et al.*, “Coordinated optimization of vehicle-to-grid control and load frequency control by considering statistical properties of active power imbalance,” *International Transactions on Electrical Energy Systems*, vol. 29, no. 3, 2019, https://doi.org/10.1002/etep.2750.

[124] Y. Zou, Y. Dong, S. Li, and Y. Niu, “Multi-time hierarchical stochastic predictive control for energy management of an island microgrid with plug-in electric vehicles,” *IET Generation, Transmission & Distribution*, vol. 13, no. 10, pp. 1794-1801, 2019, https://doi.org/10.1049/iet-gtd.2018.5332.

[125] H. Mehrjerdi, “Dynamic and multi-stage capacity expansion planning in microgrid integrated with electric vehicle charging station,” *Journal of Energy Storage*, vol. 29, p. 101351, 2020, https://doi.org/10.1016/j.est.2020.101351.

[126] S. Zhang and K. -C. Leung, “Joint Optimal Power Flow Routing and Vehicle-to-Grid Scheduling: Theory and Algorithms,” *IEEE Transactions on Intelligent Transportation Systems*, vol. 23, no. 1, pp. 499-512, 2022, https://doi.org/10.1109/TITS.2020.3012489.

[127] M. M. Hossain and C. Peng, “Observer-based event triggering H∞ LFC for multi-area power systems under DoS attacks,” *Information Sciences*, vol. 543, pp. 437-453, 2021, https://doi.org/10.1016/j.ins.2020.07.042.

[128] I. E. Maysse *et al.*, “Nonlinear Observer-Based Controller Design for VSC-Based HVDC Transmission Systems Under Uncertainties,” *IEEE Access*, vol. 11, pp. 124014-124030, 2023, https://doi.org/10.1109/ACCESS.2023.3330440.

[129] A. M. Ewias *et al.*, “Advanced load frequency control of microgrid using a bat algorithm supported by a balloon effect identifier in the presence of photovoltaic power source,” *PLOS ONE*, vol. 18, no. 10, p. e0293246, 2023, https://doi.org/10.1371/journal.pone.0293246.

[130] M. M. Mahmoud, M. K. Ratib, M. M. Aly, and A. M. M. Abdel–Rahim, “Application of Whale Optimization Technique for Evaluating the Performance of Wind-Driven PMSG Under Harsh

Operating Events," *Process Integration and Optimization for Sustainability*, vol. 6, no. 2, pp. 447-470, 2022, https://doi.org/10.1007/s41660-022-00224-8.

[131] H. Abdelfattah *et al*., "Optimal controller design for reactor core power stabilization in a pressurized water reactor: Applications of gold rush algorithm," *PLOS ONE*, vol. 19, no. 1, p. e0296987, 2024, https://doi.org/10.1371/journal.pone.0296987.

[132] H. Miloudi *et al*., "Electromagnetic Compatibility Characterization of Start-Capacitor Single-Phase Induction Motor," *IEEE Access*, vol. 12, pp. 2313-2326, 2024, https://doi.org/10.1109/ACCESS.2023.3349018.

[133] M. Awad *et al*., "A review of water electrolysis for green hydrogen generation considering PV/wind/hybrid/hydropower/geothermal/tidal and wave/biogas energy systems, economic analysis, and its application," *Alexandria Engineering Journal*, vol. 87, pp. 213-239, 2024, https://doi.org/10.1016/j.aej.2023.12.032.

[134] N. A. N. Aldin, W. S. E. Abdellatif, Z. M. S. Elbarbary, A. I. Omar and M. M. Mahmoud, "Robust Speed Controller for PMSG Wind System Based on Harris Hawks Optimization via Wind Speed Estimation: A Real Case Study," *IEEE Access*, vol. 11, pp. 5929-5943, 2023, https://doi.org/10.1109/ACCESS.2023.3234996.

[135] S. Ashfaq *et al*., "Comparing the Role of Long Duration Energy Storage Technologies for Zero-Carbon Electricity Systems," *IEEE Access*, vol. 12, pp. 73169-73186, 2024, https://doi.org/10.1109/ACCESS.2024.3397918.

[136] B. S. Atia *et al*., "Applications of Kepler Algorithm-Based Controller for DC Chopper: Towards Stabilizing Wind Driven PMSGs under Nonstandard Voltages," *Sustainability*, vol. 16, no. 7, p. 2952, 2024, https://doi.org/10.3390/su16072952.

[137] O. M. Lamine *et al*., "A Combination of INC and Fuzzy Logic-Based Variable Step Size for Enhancing MPPT of PV Systems," *International Journal of Robotics and Control Systems*, vol. 4, no. 2, pp. 877-892, 2024, https://doi.org/10.31763/ijrcs.v4i2.1428.

[138] R. Kassem *et al*., "A Techno-Economic-Environmental Feasibility Study of Residential Solar Photovoltaic / Biomass Power Generation for Rural Electrification: A Real Case Study," *Sustainability*, vol. 16, no. 5, p. 2036, 2024, https://doi.org/10.3390/su16052036.

[139] S. Iqbal, S. Habib, N. H. Khan, M. Ali, M. Aurangzeb, and E. M. Ahmed, "Electric Vehicles Aggregation for Frequency Control of Microgrid under Various Operation Conditions Using an Optimal Coordinated Strategy," *Sustainability*, vol. 14, no. 5, p. 3108, 2022, https://doi.org/10.3390/su14053108.

[140] L. Zheng, R. P. Kandula and D. Divan, "Soft-Switching Solid-State Transformer With Reduced Conduction Loss," *IEEE Transactions on Power Electronics*, vol. 36, no. 5, pp. 5236-5249, 2021, https://doi.org/10.1109/TPEL.2020.3030795.

[141] M. Y. Metwly, M. Ahmed, M. S. Hamad, A. S. Abdel-Khalik, E. Hamdan, and N. A. Elmalhy, "Power management optimization of electric vehicles for grid frequency regulation: Comparative study," *Alexandria Engineering Journal*, vol. 65, pp. 749-760, 2023, https://doi.org/10.1016/j.aej.2022.10.030.

[142] M. Bhukya, S. K. Injeti, R. P. Ogirala and S. Kotte, "Real-Time Simulation and Validation of Interconnected Microgrid Load Frequency Control With Uncertainties Using PDN-Iλ Dμ Controller Based on Improved Smell Agent Optimization," *IEEE Transactions on Industrial Informatics*, vol. 20, no. 5, pp. 7238-7248, 2024, https://doi.org/10.1109/TII.2024.3353825.