Constanza Gonzalez Parrao
Cem Yavuz
Zafeer Ravat
Miriam Berretta
Dina Rodrigues
Megha Bhattacharyya
Andrea Floridi
Benjamin Sovacool
Alison Bethel
et al.

Promoting Sustainable Energy Development through Access, Renewables and Efficient Technologies

An evidence gap map

May 2024

Evidence Gap Map Report 32

Energy and extractives

3ie International Initiative for Impact Evaluation

SUSTAINABLE ENERGY FOR ALL

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Sustainable Energy for All (SEforALL) is an independent international organisation that works in partnership with the United Nations and leaders in government, the private sector, financial institutions, civil society and philanthropies to end energy poverty and fight climate change. Our vision is a world where everyone can live dignified, productive and healthy lives powered by sustainable energy. Our work directly contributes to Sustainable Development Goal 7 (SDG) – access to affordable, reliable, sustainable and modern energy for all by 2030 – and the Paris Agreement on climate change.

3ie evidence gap maps

3ie Evidence Gap Maps (EGMs) are thematic collections of impact evaluations and systematic reviews that measure the effects of international development policies and programmes. The maps provide a visual display of completed and ongoing systematic reviews and impact evaluations in a sector or sub-sector, structured around a framework of interventions and outcomes. The report provides supporting documentation for the map, including background information for the theme of the map, the methods applied to systematically search and screen the evidence base, as well as the main results and implications.

About this evidence gap map report

This report presents the findings of a systematic search to identify and map the evidence base of impact evaluations and systematic reviews of interventions that aim to promote sustainable energy in low- and middle-income countries. The online EGM is available here. The EGM conceptualisation was initiated and tendered by SEforALL. The final EGM project was co-funded and co-produced by 3ie and SEforALL.

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Suggested citation: Gonzalez Parrao, Constanza, Cem Yavuz, Zafeer Ravat, Miriam Berretta, Dina Rodrigues, Megha Bhattacharyya, Andrea Floridi, Benjamin Sovacool, Alison Bethel, Quinn Reifmesser, Frederick Gaved, Samantha Pilato, Solomon Asfaw and Birte Snilstveit. 2024. *Promoting sustainable energy development through access, renewables and efficient technologies: An evidence gap map.* 3ie Evidence Gap Map Report 32. New Delhi: International Initiative for Impact Evaluation (3ie). Available at: https://doi.org/10.23846/EGM032

Executive editors: Birte Snilstveit
Managing editor: Tanvi Lal
Publications and web design: Akarsh Gupta
Production manager: Mallika Rao

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Constanza Gonzalez Parrao
International Initiative for Impact Evaluation (3ie)

Cem Yavuz
3ie and University of East Anglia (UEA)

Zafeer Ravat
3ie and UEA

Miriam Berretta
3ie

Dina Rodrigues
3ie

Megha Bhattacharyya
3ie

Andrea Floridi
3ie

Benjamin Sovacool
Boston University and University of Sussex

Alison Bethel
University of Exeter

Quinn Reifmesser
Sustainable Energy for All (SEforALL)

Frederick Gaved
SEforALL

Samantha Pilato
SEforALL

Solomon Asfaw
SEforALL

Birte Snilstveit
3ie

Evidence Gap Map Report 32

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Executive summary

Sustainable Development Goal 7 (SDG) aims to ensure sustainable energy for all through universal access to energy and clean cooking, the adoption of renewables and an increase in energy efficiency. Halfway through the implementation of the SDGs, progress towards this goal is mixed. The share of populations with access to electricity in low- and middle-income countries (L&MICs) has risen 10% in the past decade. Yet this progress has been concentrated in select countries with a focus on urban areas, with 72% of the world's rural poor still without access to electricity, most of which reside in Sub-Saharan Africa. Progress has also been partly eroded due to global trends in energy pricing as a result of the COVID-19 pandemic and the Ukraine-Russia conflict. Where electricity has been provided, this does not equate to the use of renewables, with non-renewable energy sources making up much of the electricity supply.

To ensure that efforts to promote sustainable energy are able to utilise the most rigorous and updated evidence available, we have conducted a systematic search and screening process to populate an evidence gap map (EGM) on sustainable energy. This EGM is a global public good and, to the best of our knowledge, the first to address sustainable energy. It provides researchers and policymakers with easy and quick access to the rigorous evidence base on the effects of sustainable energy interventions. With the large costs associated with conducting impact evaluations and other forms of research, EGMs can save time, effort and resources by reducing research duplication and by providing examples of how interventions and study designs have been utilised in the field. With this evidence base, and the findings in this report, the limited resources available to address SDG 7 can be used in a more cost-effective manner. They can also help guide evidence-informed policymaking by highlighting where evidence exists and where gaps may be filled through future research and evaluation investments.

The framework for the sustainable energy EGM, based on interventions and outcomes, covers a set of activities and goals that align with the three outcome targets of SDG 7: access, efficiency and renewable energy. Interventions were separated into four domains: legal and regulatory framework and policies; financial incentives and market enabling activities; electrification and energy infrastructure; and information and capacity development. The outcomes of interest were grouped into three domains: intermediate/behaviour change outcomes; energy and environmental outcomes; and socio-economic and community welfare outcomes.

We searched 22 academic databases and 29 grey literature sources, including websites from specialist organisations and research repositories in international development, in July 2023 and supplemented the search by performing citation tracking in September 2023. We identified a total of 144,393 records. After removing duplicates and screening these records based first on their title and abstract and then their full text, we included a total of 703 studies in the map: 668 impact evaluations (IEs) and 35 systematic reviews (SRs).

The evidence base has grown rapidly, with nearly half of the studies being published in the past three years (2021–2023). Roughly half of the evidence base is concentrated around four intervention categories: *sustainable upgrades; other energy regulations and policies*; *subsidies and other transfers;* and *on-grid systems*. We did not identify studies in three categories: *insurance and other risk guarantee instruments*; *push and pull*

finance; and *advocacy and diplomacy* interventions. Three-quarters of the IEs reported outcomes within five categories: *energy net savings or consumption*; *income, savings and expenditures*; *health status, comfort and wellbeing*; *energy security*; and *air quality/pollution*.

SDG 7's outcome targets, access, efficiency and renewable energy, were evaluated in near equal numbers of evaluations, with interventions often targeting more than one of these targets at once. The geographic evidence base is heavily skewed: nearly half of the IEs evaluated an intervention conducted in China or India. In terms of the regional evidence, East Asia and the Pacific is the largest, followed by Sub-Saharan Africa, South Asia and Latin America and the Caribbean, respectively. Europe and Central Asia and the Middle East and North Africa were the only regions with fewer than 20 IEs. We were also unable to identify studies for the countries with the most pressing electrification needs: in Burundi, Central African Republic, Chad, Democratic Republic of Congo, Malawi and South Sudan fewer than 20% of people have access to electricity, yet we did not find evidence on on-grid electrification or off-grid electrification for these countries.

Within *sustainable upgrades*, the largest intervention category in the map, over 100 IEs evaluated the effects of improved cookstoves. This makes cookstoves the most evaluated technology, and clean cooking the most common energy use among IEs. We also identified a variety of study designs across IEs, dominated by fixed effects estimations (including difference-in-difference) and randomised controlled trials (RCTs).

We critically appraised the 35 reviews in the map against international standards for conducting and reporting SRs. Eight were appraised as having high or medium confidence. These SRs evaluated electricity sector reforms, access to on-grid electrification, and mostly sustainable upgrades and the use of improved cookstoves. The eight SRs provide the following conclusions. However, readers are encouraged to explore the original reviews for details on their methods and findings and should be mindful of the caveat that, in some cases, evidence from the SRs was insufficient to draw strong policy conclusions.

- **Energy management reforms**: There is not enough evidence to conclude that market-based electricity sector reforms are effective on electrification rates and other intermediate indicators of these reforms' causal chain. Indicators of supply and investment may be an exception, which showed some positive effects across studies with either a global focus or a particular focus on Latin America.
- **On-grid systems**: Top-down interventions do not generally improve access to electricity in informal settlements across L&MICs. Community participation, tenure security and political commitment may be relevant factors that could improve service delivery across L&MIC contexts.
- **Sustainable upgrades**: Interventions aimed at improving household indoor air quality and health (mostly improved cookstoves) can:
    - reduce particulate matter and carbon monoxide concentrations at the individual and kitchen levels
    - reduce respiratory and ocular symptoms among women
    - reduce the risk of low birth weight, the incidence of burns in children and acute lower respiratory infections among children living in high-altitude settings in Latin America

These conclusions form the basis of our recommendations for policymakers. Further to this, across the high and medium confidence SRs, there were a number of suggestion relevant to future research. First, mixed method evaluations in understudied contexts could help untangle answers around context-specific barriers or facilitators to intervention effectiveness. Second, the incorporation of cost data into evaluations would allow for exploration of cost-effectiveness analysis across studies. Finally, the utilisation of similar key outcome measures would allow for a more comparable evidence base.

The following are priority areas for future evaluations based on the evidence gaps in the EGM:

1) **Absolute intervention gaps**. The EGM identified *insurance and other risk guarantee instruments*, *push and pull finance*, and *advocacy and diplomacy* as the three intervention categories where no rigorous evidence currently exists.
2) **Geographical gaps**. This includes countries with low electrification rates for which we identified no electrification evaluations: Burundi, Central African Republic, Chad, Democratic Republic of Congo, Malawi and South Sudan. There are also 101 L&MICs for which we identified no IEs.
3) **Technologies beyond improved cookstoves**. This also applies to activities where the energy use is not clean cooking, such as those related to health and education.

The commissioning of future synthesis work may consider focusing its attention to areas with large numbers of IEs, but no recent high or medium confidence SRs, such as *energy targets and enforcement mechanisms*, *financial regulations and investments*, *other energy regulations and policies*, *subsidies and other transfers*, *energy pricing*, and *off-grid systems*.

Given the large number of evaluations identified in the past three years, maintaining a 'living' EGM where the evidence base is updated periodically is likely to become an asset to help the sector access to the most up-to-date resources. In the shorter term, the EGM will immediately be utilised as these results will inform an SR to address questions around the effects of a subset of interventions on specific outcomes of interest. We encourage decision-makers in the energy sector to access, use and disseminate this evidence to inform their next steps.

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Acronyms

3ie	The International Initiative for Impact Evaluation
CO2	Carbon dioxide
DEP	Development Evidence Platform
EGM	Evidence gap map
EPPI	Evidence for Policy & Practice Information Centre
GHG	Greenhouse gases
HIC	High-income country
ICS	Improved cookstove
IE	Impact evaluation
IEA	International Energy Agency
IEG	Independent Evaluation Group
I-O	Intervention-outcome (pairing)
L&MIC	Low- and middle-income country
LPG	Liquified petroleum gas
PICOS	Population, interventions, comparator, outcomes, and study designs framework
PRISMA	Preferred Reporting Items for Systematic Reviews and Meta-Analyses
RCT	Randomised controlled trial
SDG	Sustainable Development Goal
SR	Systematic review
SEforALL	Sustainable Energy for All
UN	United Nations
UNDP	United Nations Development Programme

1. Background

Halfway through the implementation of the 2030 Sustainable Development Goals (SDGs) Agenda, progress on SDG 7 is mixed. SDG 7 aims to ensure sustainable energy for all through access to energy, the adoption of renewables and an increase in energy efficiency. By working towards these three targets, advancements in climate and human welfare goals can also be achieved (International Council for Science, 2017).

Substantial headway has been made in access to electricity, with the share of the population served in low- and middle-income countries (L&MICs) increasing approximately 10% in the past decade, currently standing at 89% access in L&MICs (World Bank, n.d.). However, progress has been concentrated on populous countries in South Asia, mostly India and Bangladesh. In low-income countries, most of the population (59%) is still unserved, with the figure increasing to an overwhelming 72% if considering the world's rural poor (World Bank, n.d.). Regional inequalities also exist in regard to energy, with Sub-Saharan Africa suffering from both the greatest energy access and clean cooking deficits (IEA, 2023a). Access to clean cooking is also a global concern with one in three people globally having no access to clean cooking technologies and fuels (IEA, 2023b).

Furthermore, energy access does not equate to the use of renewable energy sources. The International Energy Agency (IEA) reported that of 50 energy system components, which are key to renewable energy transitions globally, only three are on target to achieve the 2050 goals: solar photovoltaics, electric vehicles and lighting (IEA, 2023c). There is also a distinction to be made between renewable energy and modern renewables, which exclude the use of biomass. For instance, though Africa has the highest share of renewables at 57%, this only includes 8% of modern renewables (SEforALL, 2023). Globally, the growth of modern renewables has been modest, with an increase of 4% between 2010-2020, accounting for just 13% of the global share of renewables (SEforALL, 2023).

Frameworks such as the SDGs, the United Nations Framework Convention on Climate Change (UNFCCC) and the Paris Agreement have prompted substantial funding strategies to tackle challenges in the energy sector. A prominent example being the UN's Energy Compacts which have raised commitments of USD1.3 trillion to be deployed by 2030 in order to achieve SDG 7 (UN, 2023). However, energy investments are far from matching projected demand from the global south. The large investment target to meet SDG 7 has been disproportionately focused on high- and middle-income countries (UNDP, 2019), and annual investment in clean energy in L&MICs (excluding China) has remained stagnant since 2015 (IEA, 2022). The large investments made towards the energy sector, coupled with the dramatic effects of climate change, have forced alterations to how energy is generated. This change has led to the need to understand better what sustainable energy interventions work and what evidence on effects is available.

To address this evidence need, 3ie and SEforALL have collaborated to produce this EGM. To the best of our knowledge, this EGM is the first to be conducted on the topic of sustainable energy; that is on access, renewables and efficient energy. It is also the first to provide easy access to the available rigorous evidence on the effects of sustainable

energy interventions. Given the high costs of conducting impact evaluations, often upwards of USD 200,000 (Puri & Rathinam, 2019), the results of the EGM can be used to help guide evidence-informed policymaking and research design, while highlighting the existing evidence gaps that may be filled through future research and evaluation investments. By showing the distribution of the rigorous evidence on sustainable energy interventions in an easy-to-use online platform, researchers and policymakers can consult existing evidence to prevent duplication of research and check how other evaluations have been conducted. At the same time, the EGM permits insights into what works through the exploration of high and medium confidence systematic reviews. The results of this EGM will also inform the selection of a topic for an upcoming systematic review conducted by our research team.

1.1 What is an EGM?

3ie Evidence Gap Maps are collections of evidence from impact evaluations and systematic reviews for a given sector or policy issue, organised according to the types of programmes evaluated and the outcomes measured. They include an interactive online visualisation of the evidence base, displayed in a framework of relevant interventions and outcomes. They highlight where there are sufficient impact evaluations to support systematic reviews and where more studies are needed. These maps help decision-makers target their resources to fill these important evidence gaps and avoid duplication. They also facilitate evidence-informed decision-making by making existing research more accessible.

The specific objectives of this EGM were twofold:

- Identify and describe the characteristics of IEs and SRs evaluating the effects of sustainable energy interventions on environmental and welfare outcomes in L&MICs.
- Identify potential primary evidence and synthesis gaps.

The results of this EGM have been displayed on 3ie's online platform and provide the opportunity for users to explore further the findings we discuss in this report.[1]

2. Scope

The interventions and outcomes framework for this EGM encompasses a set of activities and goals that align with the three outcome targets of SDG 7: by 2030 (i) ensure **universal access** to affordable, reliable and modern energy services; (ii) increase substantially the share of **renewable energy** in the global energy mix; and (iii) double the global rate of improvement in **energy efficiency**.

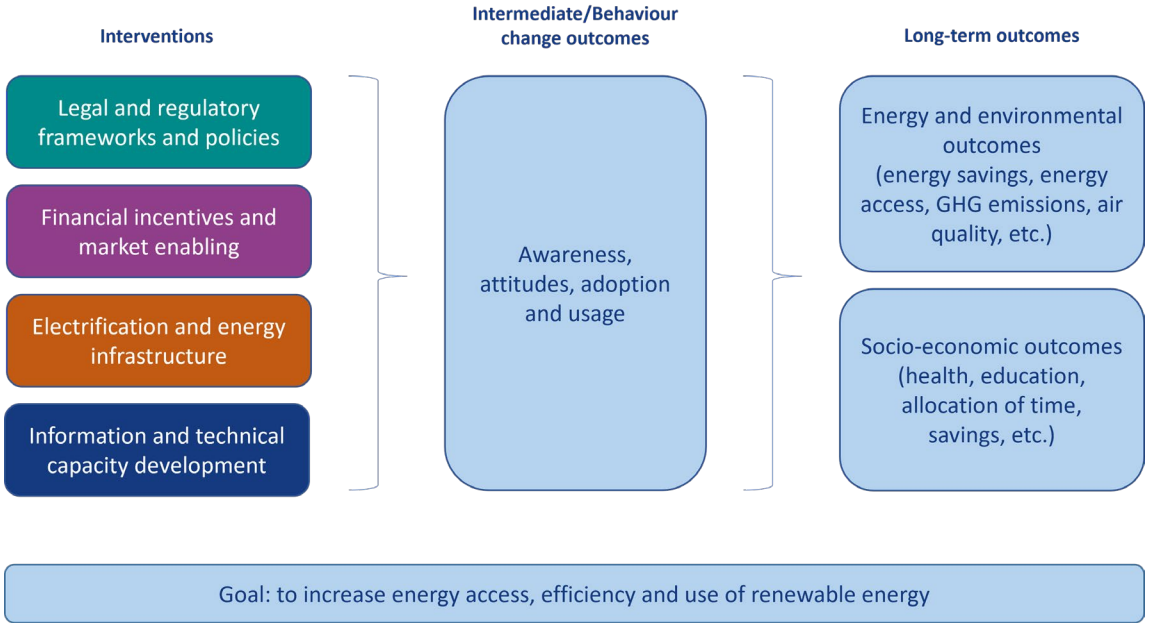
These three targets were used to define how we understood sustainable energy and provided a seemingly intuitive basis for categorising interventions in the framework; yet, due to the overlap in mechanisms and activities which can achieve these goals, using these as the basis for interventions was challenging. Given that access, renewables and efficiency are targets, we expected that programmes or policies may attempt to affect one or more of these goals at once. For instance, the International Council for Science

[1] https://developmentevidence.3ieimpact.org/egm/sustainable-energy-evidence-gap-map

(2017) highlighted that the distribution of energy through renewable sources (e.g. solar lamps) may increase the share of renewables used, while also increasing access to electricity.

Considering this, and drawing from previous 3ie energy related projects (Moore et. al. 2020; Berretta et. al. 2021b), we developed a framework that includes interventions aiming to overcome the most common barriers to energy access, the use of renewables and energy efficiency in L&MICs. The following intervention domains were included in the framework (see Figure 1): Legal and regulatory frameworks and policies; Financial incentives and market enabling activities; Electrification and energy infrastructure; and Information and capacity strengthening. Appendix A provides the full breakdown of all intervention and outcome categories included in the map. Given the map's broad scope, it was difficult to conceptualise the framework based on any one theory. Instead, we present a brief overview of how the included interventions can overcome the common barriers to achieving sustainable energy. The published protocol for this EGM provides further details on the conceptual framework (Gonzalez Parrao et. al. 2023).[2]

Figure 1: Conceptual framework for SDG 7 interventions



Legal and regulatory frameworks and policies can overcome barriers to the development of sustainable energy by encouraging or enforcing governments, firms or households to meet standards and targets in the energy sector. Organisations' behaviours are pressed to change with the implementation of mandatory targets, particularly when previous priorities had been placed on production (Hasanbeigi et. al. 2010), or where decisions had been limited by bounded rationality (Iwaro & Mashwa, 2010). Energy management reforms may also benefit situations where the provision of energy projects is hindered by limited institutional support and tension (Mawhood & Gross, 2014).

Financial incentives and market enabling activities can overcome the financial barriers limiting the achievement towards SDG 7. Financial limitations have hindered

[2] https://3ieimpact.org/sites/default/files/2023-08/3ie-Sustainable-Energy-EGM-protocol.pdf

electrification both on the supply and demand side. For those who supply energy, there has been few financial resources made available to overcome transaction costs (Bhattacharyya 2013; Bos et. al. 2018; Palit & Kumar, 2022); while for households, the up-front cost of grid connectivity is often cited as a common hurdle (IEG, 2008; Jimenez, 2017; Bonan et. al. 2017; Bos et. al. 2018; Palit & Kumar, 2022). The inability to afford new technologies has also been identified as a major barrier for both the increase in renewables share (Gribkova & Milshina, 2022; Singh & Ru, 2022) and the use of efficient technologies (Cattaneo, 2019). That said, there has been progress on this front with the costs of renewable energy technologies decreasing at a faster rate than expected (UNDP, 2022), providing a promising avenue for addressing these financial challenges.

Electrification and energy infrastructure encompass activities which directly provide electricity, through renewable and non-renewable sources, as well as the provision of energy efficient upgrades and the maintenance of electrification systems. These activities can directly overcome barriers related to access, which can be particularly prevalent for rural and last mile communities (Liao et. al. 2021), while the upgrade of efficient infrastructure can help prevent non-technical losses, a common issue in L&MICs (Fowlie & Meeks, 2021). Furthermore, activities related to distributed energy systems can diminish greenhouse gas emissions whilst decreasing both operational and maintenance costs (Nadeem et. al. 2023).

Finally, the provision of information and capacity strengthening can overcome information barriers on both the supply and demand side. Limited technical capacity to implement electrification has been cited as a challenge particularly common to rural settings (Jimenez 2017; Almeshqab & Ustin, 2019), in relation to renewable technologies (Numata et. al. 2020) and to the benefits of efficient buildings (Iwaro & Mashwa, 2010). On the demand side, there may be limited public awareness of the benefits of renewable technologies (Qazi et. al. 2019) and constrained opportunities for households to learn about and improve their energy consumption habits (Dianshu et. al. 2010).

As shown in Figure 1, we anticipated that the four sets of interventions included in the EGM would work towards achieving SDG 7 through two steps. In the first step, interventions may change the behaviours of governments, firms, communities and individuals, leading to the adoption and use of energy efficient and renewable technologies. In the second step, these behavioural changes can lead to long-term and more general outcomes related to environmental, socio-economic and welfare measures.

3. Research methods

We followed the standards and methods for EGMs developed by 3ie throughout the search, screening and data extraction processes (Snilstveit et. al. 2016; Snilstveit et. al. 2017). EGMs are developed using systematic methods to identify and describe all completed and ongoing impact evaluations and systematic reviews relevant to research objectives. We included the scope and methods for the implementation of the EGM in the published protocol (Gonzalez Parrao et. al. 2023).

3.1 Developing the framework

The scope and framework for this EGM was developed collaboratively by 3ie and SEforALL, with additional consultation with Benjamin Sovacool, an academic on global energy policy, energy justice and energy security, who served as the subject expert for this project. Further discussions and feedback from an advisory group of experts helped to ensure the framework was relevant to practitioners and researchers in the wider energy sector. Further details on the advisory group are available in Appendix B.

3.2 Inclusion Criteria

Table 1 summarises the criteria used to select studies for the EGM following the PICOS framework and additional categories such as language, publication date and status. Further details of the inclusion criteria are presented in Appendix A.

Table 1: Summary of inclusion criteria

Criteria	Description
Population	Studies that evaluate interventions within L&MICs as defined by the World Bank income group classifications. No other restrictions for populations were set.
Intervention	Included interventions fell under one of four domains: Legal and regulatory frameworks and policies; Financial incentives and market enabling activities; Electrification and energy infrastructure; Information and capacity development.
Comparator	Evaluations must have included a comparison condition, though no restrictions were set on the type of comparison made.
Outcomes	Included outcomes fell under one of three domains: Intermediate/ behaviour change; Energy and environmental outcomes; Socio-economic and community welfare.
Study designs	Included studies employed either experimental or quasi-experimental methods which estimated effects that could be attributed to an intervention, as compared to what would have happened in the absence of the intervention.
Language	No exclusion restrictions were placed on language, though the search strategy was conducted in English.
Publication date	Studies published from January 1st, 2000, or after.
Study **s**tatus	No restrictions were placed on whether the study was completed or was a protocol.

3.3 Search strategy and selection of studies

We adopted a systematic search strategy following guidelines for systematic literature searching (Kugley et. al. 2017). The search strategy was developed in collaboration with the information specialist Alison Bethel. The search was designed to address potential publication bias issues by systematically searching academic bibliographic databases and implementing additional searches for grey literature in specialist organisational websites, websites of bilateral and multilateral agencies and repositories of research in international development. The full list of literature sources searched and an example of

the search strings used for one database is presented in Appendix C. The precise strings and logic (e.g. index terms and truncation operators) were adapted for each database and platform.

To minimise the likelihood of missing studies, we conducted forward and backward citation tracking of studies included from the academic and grey literature search. We also published a blog[3] calling for additional studies.

3.4 Data extraction and critical appraisal

Trained reviewers extracted data from the studies and entered it into 3ie's DEP, thus populating the online map. The data extracted covered publication information about the study (e.g. title, authors, year of publication), general programme and contextual information (e.g. country, programme funder, research funder) and evaluation methods (e.g. study design, ethics approval). We also extracted a number of fields relevant to sustainable energy and used these as the basis for the filters shown on the online map. Appendix G outlines the data extracted.

Some of the systematic reviews (SRs) identified were already part of the DEP, and hence, had been critically appraised previous to this EGM. We critically appraised newly identified SRs, following the practices suggested by Lewin and colleagues (2009). The appraisal assessed SRs in terms of the search, screening, data extraction, quality appraisal of primary studies and synthesis conducted, and covered the common areas where biases are introduced. SRs were single coded and reviewed by a methods expert in cases of doubt. Each SR was rated as low, medium or high confidence drawing on guidance provided by Snilstveit and colleagues (2017). The critical appraisal tool used, an adapted version of the Specialist Unit for Review Evidence checklist (SURE, 2018), is presented in Appendix H. We did not critically appraise impact evaluations as this activity is typically beyond the scope of EGMs.

3.5 Deviations from protocol and EGM limitations

Two deviations from the published protocol occurred during the implementation of the EGM. First, one grey literature source (United Nations Disaster Assessment and Coordination (UNDAC) Resource Centre) was removed as it was evident this was not a source of impact evaluations or programme reports. Hence, it was not appropriate as a grey literature source for this map. Second, one additional outcome category was created during the implementation of the EGM: *land productivity*. We identified relevant indicators related to land productivity in over 20 impact evaluations which were not suitable for any other outcome category. We believe these deviations were necessary and helped improve the final EGM.

Though the EGM meets best practices, there are three limitations that must be noted. Firstly, the scope of the map includes only rigorous quantitative IEs or SRs. We appreciate there is other evidence available which may be able to support decision-makers in addressing other questions. Secondly, we only included studies when effects were explicitly attributed to an intervention. This means that studies looking at

[3] https://www.3ieimpact.org/blogs/towards-sdg-7-mapping-evidence-access-sustainable-energy-lmics

downstream effects of uncoordinated activities, such as having electricity access, were excluded unless there was a clear intervention in place. Finally, for practical reasons, we did not include interventions on general environmental policies, such as carbon taxes, unless there was a specific link to the energy sector.

4. Search results and analysis of the evidence

4.1 Search results

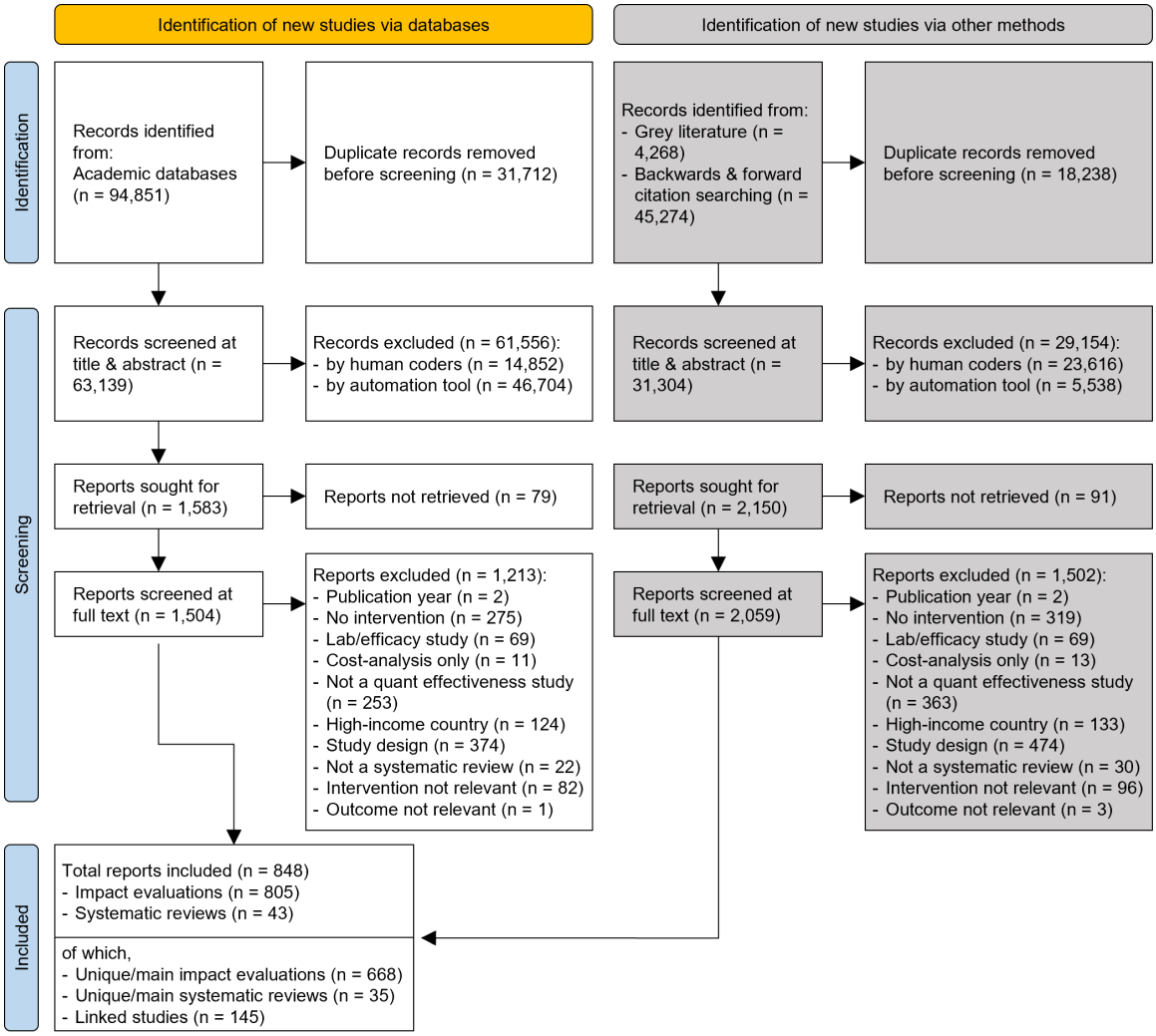
Following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA; Page et. al. 2021), the EGM flowchart in Figure 2 details the search and screening process. Through a search of 22 databases and 29 grey literature sources in July 2023 and citation tracking in September 2023, we identified a total of 144,393 records. After removing duplicates, there were 94,443 records left to screen based on their title and abstract. Appendix D provides a full breakdown of the screening and data extraction methods.

Utilising the machine learning classifier tool within EPPI-Reviewer (Thomas et. al. 2010), we classified all records based on a model created by 3ie's Development Evidence Portal (DEP), which judges a record's relevance based on its study design and country. After applying the classifier model, we automatically excluded any study with a likelihood of inclusion below 15%, leading to the exclusion of 52,242 records. A team of trained reviewers single screened all remaining studies based on their title and abstract. This led to the inclusion of 3,733 records for review based on their full text.

We were unable to retrieve the full text of 170 records[4], and the remaining 3,563 records were screened at full text by two independent reviewers. At full text, the most common reason a record was excluded was due to not using one of the study designs outlined in our PICOS (n = 848). There was also a large number of records which did not seek to evaluate the effectiveness of a given intervention (n = 616) and records which did not include an intervention (n = 594). Appendix E provides examples of studies excluded at full text screening.

[4] The two main reasons these records could not be retrieved were (i) studies behind academic paywalls the research team could not access and (ii) studies with broken URLs the team could not trace back.

Figure 2: PRISMA flowchart



We ultimately identified 848 records eligible for inclusion. This corresponds to 703 unique studies (668 impact evaluations and 35 systematic reviews) and 145 linked papers.[5] The full list of included studies, both main and linked papers, is presented in Appendix F.

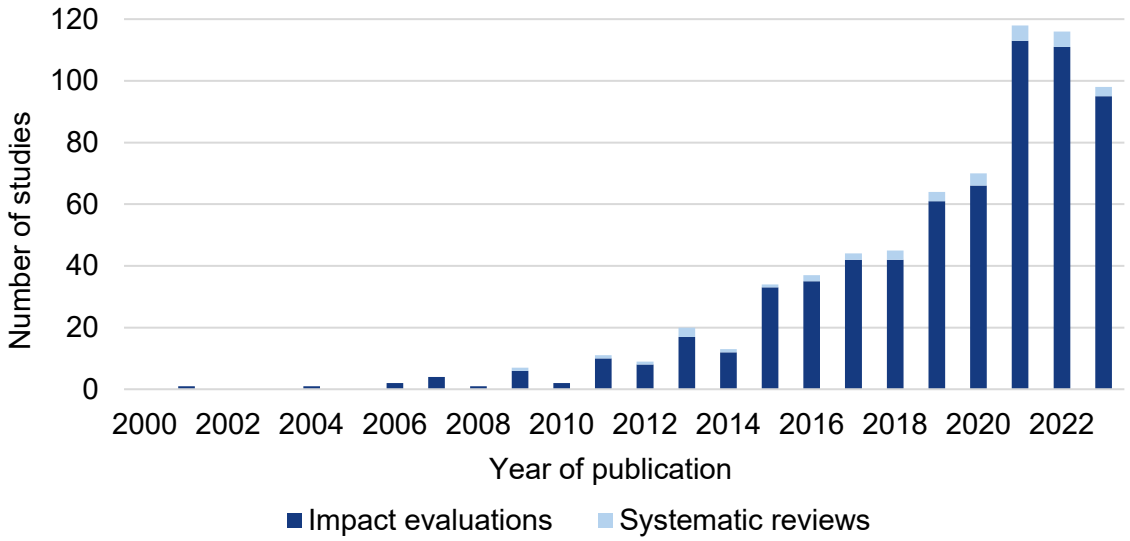
4.2 Characteristics of the body of evidence

4.2.1 Growth of the evidence

Figure 3 illustrates the distribution of included studies by the year of publication. It indicates that until 2014, few IEs on the energy sector were published but there has been substantial growth of the evidence base from 2015 onwards. Over 47% of the studies have been published between 2021 and 2023.

[5] We considered two or more papers linked when they were published by the same authors studying the same intervention and research question. In many cases, linked papers would have the same sample and analysis but a different publication status (e.g. working paper and journal article). In other cases, papers used a subset of a dataset shared by the main paper(s), and/or included additional analysis and/or focused on additional outcome measures.

Figure 3: Distribution of studies by year of publication



Note: the number of published studies for 2023 should be taken as a partial count, given that the search for literature was conducted between June and September 2023.

4.2.2 Interventions and outcomes coverage

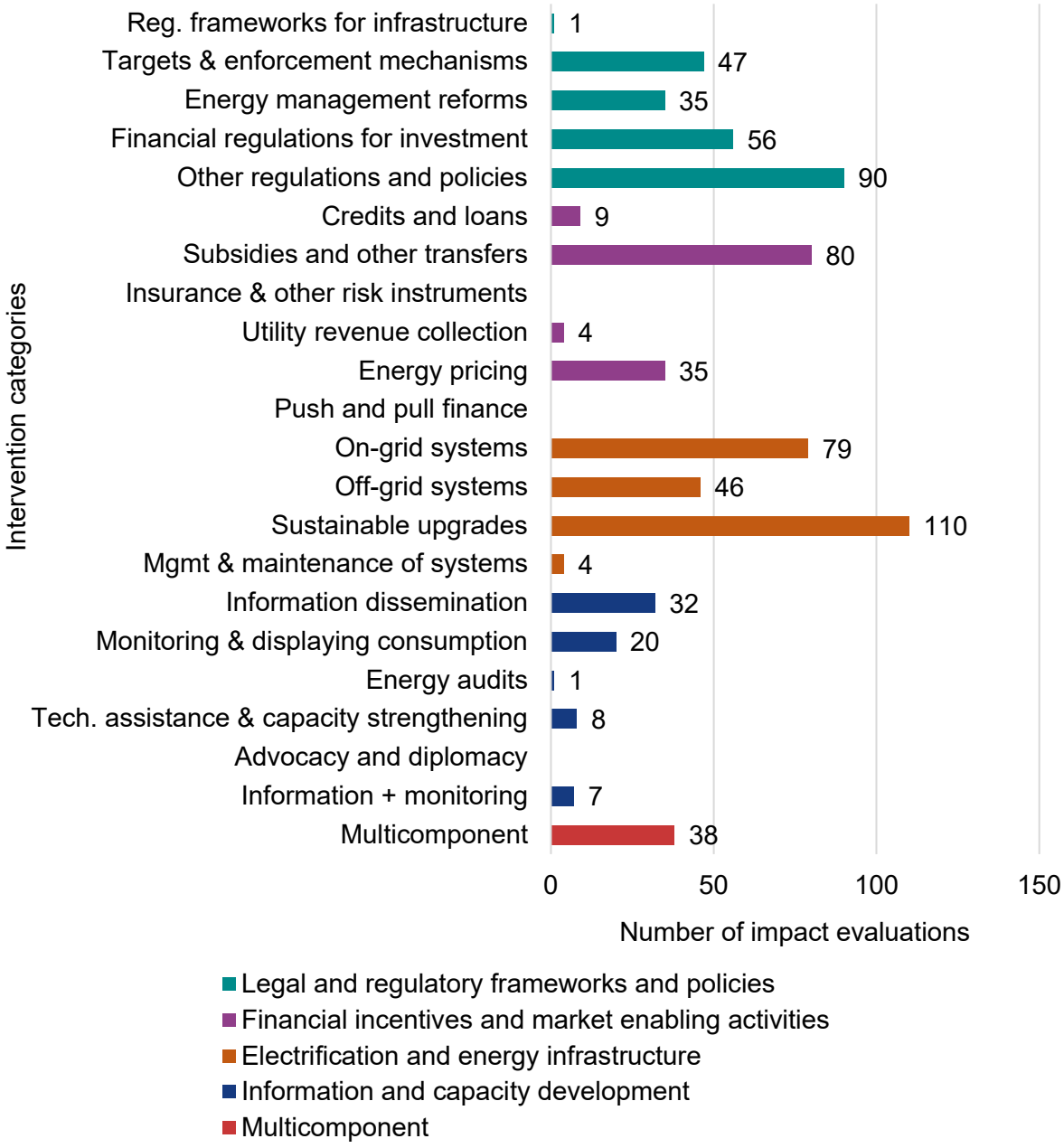
Of the 668 IEs in the map, 642 studies (96%) evaluate a single intervention category, while 26 studies provide effect estimates for multiple intervention categories. We refer to these 26 studies as multi-arm evaluations, and each separate arm is coded against an intervention category. This means that the total number of studies across intervention categories is greater than the number of IEs on the map. We also identified 38 multicomponent IEs (6%) spread across both single-arm and multi-arm evaluations. Figure 4 provides the breakdown of IEs by intervention category.

Legal and regulatory frameworks and policies is the second largest intervention domain. Many of the 225 IEs in this domain are spread across different intervention categories but are heavily concentrated on evaluating interventions in China, which includes 142 IEs (63%; the second largest country in this domain is India, with 20 IEs). Across interventions within the *energy targets and enforcement mechanisms* category, ten studies looked at the effect of energy targets set out in China's 11th Five Year Plan (e.g. Zhang & Gu, 2023; Liu et. al. 2021a), while four studies looked at the Perform Achieve and Trade (PAT) scheme (e.g. Bansal et. al. 2023; Misra, 2019). Outside of China, we identified one other PAT scheme in India (Oak & Bansal, 2022) and energy target programmes in Brazil (e.g. Costa, 2013) and Ghana (e.g. Lee et. al. 2019).

Within the *financial regulations for investment category*, 41 studies were in East Asia and the Pacific, often evaluating different feed-in-tariff interventions (e.g. Azhgaliyeva, 2023; Schmid, 2012). Of these, 10 were conducted in China (e.g. Zhang & Gu, 2023; Liu et. al. 2021a), while one looked at Southeast Asia as a whole (Azhgaliyeva et. al. 2023). In the *other energy regulations and policies* category, consistent with most of the domain, China features strongly; for instance, 17 studies looked at the effect of New Energy Demonstration Cities (NEDC; e.g. Zhang & Ma, 2022; Feng & Nie, 2022). Outside of China, there is a group of studies evaluating the effects of daylight savings time in Turkey, Brazil and Mexico (e.g. Petterini et. al. 2018; Küfeoğlu et. al. 2021).

Within the *energy management reforms* intervention category, we see less concentration from evaluations in China, which includes eight studies (22%). Beyond China, common policies evaluated included the effect of electricity sector privatisation in Peru and Argentina (e.g. Alcázar et. al. 2007; Gonzalez-Eiras & Rossi, 2007).

Figure 4: Number of studies per intervention category



Note: The total number of IEs is less than the sum of the IEs from individual intervention categories given multiple studies evaluate multiple intervention categories.

Financial incentives and market enabling interventions is the third largest domain with 127 IEs. Evidence within this category is again concentrated towards China (n = 59, 46%) and is uneven amongst the intervention categories, with 63% of studies evaluating *subsidies and other transfers* (n = 80). Subsidies can be provided for a number of reasons; for instance, to households to reduce the cost of connecting to electricity grids

(e.g. Barron & Torero, 2017), to individuals to purchase new energy vehicles (e.g. Chen et. al. 2021) or to firms to increase investment in renewable energy (e.g. Lin & Xie, 2023). *Credits and loans* are a rarer financial mechanism to induce sustainable behaviour, though in all nine IEs that evaluated a credit programme, this was provided to households or individuals to increase uptake of a new technology, such as solar home systems (e.g. Lang, 2021; Khandker et. al. 2014), improved cookstoves (e.g. Alem et. al. 2015) or other electrical appliances (e.g. Lukuyu et. al. 2021). No studies were identified using *insurance and other risk guarantee instruments*, though one multicomponent study did include insurance as one if its components (UNICEF, 2022).

Energy pricing encompasses all interventions where consumers' (whether households or firms) energy cost is altered (e.g. Wang et. al. 2020b; Greve et. al. 2021). *Utility revenue collection* includes four studies whereby utility providers are supported in their capacity to collect customer revenue (e.g. Beyene et. al. 2022). No studies were identified which evaluated *push and pull finance*.

Electrification and energy infrastructure is the single largest intervention domain (n = 236) and is heavily skewed towards one intervention category, *sustainable upgrades*, making up 47% of the IEs within this domain (n = 110). Unlike the two previous domains, this domain has greater variance geographically, with no country accounting for more than 20% of studies. *Sustainable upgrades*, which is also the single largest intervention category on the map, encompasses the provision of any sustainable technology (whether it be efficient or renewable) provided as an upgrade over a previously used technology. Of the 110 studies within this category, 87 studies (79%) evaluated the provision of an improved cookstove (e.g. Phogole et. al. 2022; Guzmán et. al. 2020). Beyond cookstoves, other technologies included lightbulbs (e.g. Diaw et. al. 2016) and housing insulation (e.g. Davis et. al. 2018).

On-grid systems, the fourth largest category within the map (n = 79), contains evaluations of electrification projects in countries such as India (e.g. Chindarkar & Goyal, 2023), Brazil (e.g. Mejdalani et. al. 2018) and Ghana (e.g. Adusah-Poku & Takeuchi, 2019). *Off-grid systems* (n = 46) encompass the provision of any off-grid technology, specifically when it is not an upgrade on any previously used technology; for instance, the provision of solar panels (e.g. Ballón et. al. 2019) and solar lamps (e.g. Hassan & Lucchino, 2016). The *management and maintenance of systems* category was evaluated in four studies, which captured improvements to existing grid networks (e.g. Akter et. al. 2023).

Information and capacity development is the smallest of the four intervention domains within the framework (n = 58). The evidence is spread out geographically, with no country making up more than 20% of studies. This domain is also heavily skewed towards one intervention category, *information dissemination,* which makes up 55% of IEs within the domain (n = 32). *Information dissemination* captured interventions to induce energy efficient behaviour in regard to energy conservation at a household level (e.g. Zhang et. al. 2023), as well as the uptake of sustainable technologies (e.g. Beltramo et. al. 2015). *Monitoring and displaying energy consumption* interventions aimed to induce efficient household use of energy through the provision of tailored feedback (e.g. Thampanishvong, 2015). One study evaluated an *energy audit* provided to firms to increase energy efficiency (Ryan, 2018).

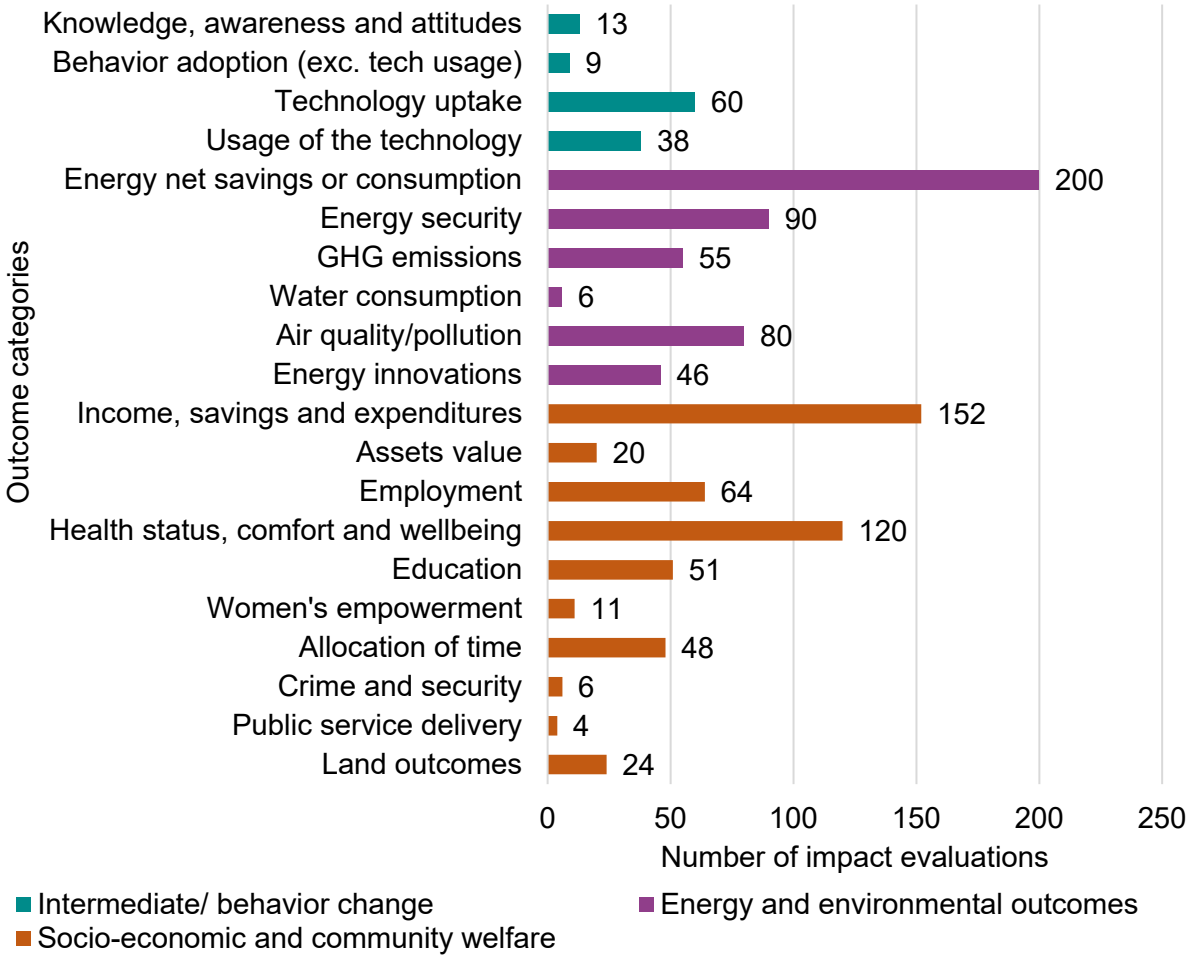
A combination of both *information dissemination* and *monitoring and displaying energy consumption* was evaluated in seven studies, which led to the creation of a new intervention category. These studies often randomised individuals or households to a multicomponent treatment of information and monitoring, while also assigning other units to either *information dissemination* or *monitoring and displaying energy consumption* (e.g. Mi et. al. 2020). Eight studies evaluated interventions on *technical assistance and capacity building* providing expert knowledge on the construction and maintenance of technologies, such as solar technologies (e.g. Urpelainen & Yoon, 2017). No studies were identified for the *advocacy and diplomacy* category.

We coded 38 studies as **multi-component**. These studies encapsulate a mix of interventions, where groups of studies with similar combinations of interventions had less than five studies. Included in this category are large-scale government policies, such as the Chinese Energy Savings and Emissions Reduction policy (ESER; e.g. Ren et. al. 2023) and programmes which provided both supply- and demand-side interventions (e.g. Bedi et. al. 2015). Rarer mixes of interventions included *information dissemination* and *sustainable upgrades* (e.g. Nagwekar et. al. 2020) and *information dissemination* and *subsidies and other transfers* (e.g. Jeuland et. al. 2020).

Given the large proportion of IEs published in the last three years, we enquire whether this is driven by the evaluation of certain intervention types. The most common interventions among studies published since 2021 are: *other energy regulations and policies* (n = 63); *subsidies and other transfers* (n = 46); *financial regulations for investment* (n = 34) and *energy targets and enforcement mechanisms* (n = 29). Three of these four intervention categories fall under the **legal and regulatory framework and policies** domain, while none come from the largest domain within the map, **electrification and energy infrastructure**.

In terms of outcomes, 91% (n = 610) of IEs measured an outcome within the **energy and environmental** or **socio-economic and community welfare** domains. Figure 5 indicates that there is a further layer of concentration: 75% of IEs (n = 500) assessed outcomes within five categories: *energy net savings or consumption* (n = 200), *income, savings and expenditures* (n = 152), *health status, comfort and wellbeing* (n = 120), *energy security* (n = 90) and *air quality/pollution* (n = 80).

Figure 5: Number of studies per outcome category



Note: The total number of IEs is less than the sum of the IEs from individual outcome categories given multiple studies evaluate multiple outcome categories.

The **energy and environmental outcomes** domain is the largest. *Energy net savings or consumption* (n = 200) is the single most evaluated outcome across all categories. These mostly constitute of household-level electricity consumption (e.g. Wang et. al. 2020a), but also include firm/enterprise energy consumption (e.g. Bansal et. al. 2023). *Energy security* (n = 90) is often measured as individual/household access to energy (e.g. Mawejje et. al. 2012) or supply of energy (e.g. Nagavarapu & Sekhri., 2013). *Air quality/pollution* (n = 80) is driven by household pollution through cookstoves (e.g. Johnson et. al. 2022), while *GHG emissions* (n = 55) was often measured as carbon emissions (e.g. Wang et. al. 2020).

When delving into the *energy innovation* (n = 46) category, 85% of the studies focused on China (n = 39). These studies predominantly measured *energy innovation* in the context of patents, often assessed as the sole outcome of interest (e.g. Liu et. al. 2023). *Water consumption* was the smallest category within this domain (n = 6), with measures related to farming or firms (e.g. Gupta, 2019; Liu et. al. 2021b).

The *socio-economic and community welfare* domain is heavily skewed towards two outcome categories: *income, savings and expenditures* (n = 152), and *health status,*

comfort and wellbeing (n = 120). The former includes primarily measures of household income or expenditure (e.g. Xiao et. al. 2023; Thomas et. al. 2020), while the latter usually includes measures of child health outcomes and respiratory illness (e.g. Mortimer et. al. 2017). *Employment* (n = 64), *education* (n = 51) and *allocation of time* (n = 48) outcomes were also commonly assessed, with more than 40 IEs each.

Lastly, the *intermediate/behaviour change* outcome domain (n = 98) is the smallest of the three domains. *Technology uptake* (n = 60) and *usage of technology* (n = 38) dominate. These measures were largely focused on the uptake/use of improved cookstoves (e.g. Menghwani et. al. 2019) but also include solar lighting (e.g. Meriggi et. al. 2021) and vehicles (e.g. Zhang et. al. n.d.). Measures within the remaining outcome category, *knowledge, awareness and attitudes* (n = 13), were occasionally measured in the form of awareness, for instance, of the benefits of servicing energy technologies (e.g. Chaturvedi et. al. 2021), while *behaviour adoption* (n = 9) was usually measured as energy saving behaviour (e.g. Wang et. al. 2020b).

Beyond looking at trends for interventions and outcomes separately, it is also important to look at them paired together. That is, identify the intervention-outcome (I-O) pairings that are most common on the map. Table 2 provides the top 10 I-O pairings with 20 or more IEs.

As well as being the single largest intervention category, *sustainable upgrades* is also the intervention within the most populous I-O pairings. *Health status, comfort and wellbeing* was evaluated in 63 *sustainable upgrade* IEs, a pairing that represents 9% of the map and is nearly twice as large as the next most common pairing. *Energy pricing* and *energy management reforms* are not among the five most common interventions within the map, but as these studies frequently measured the same outcomes, they appear in the top 10 pairings list. In contrast, the most populous outcome categories are evaluated in a diverse range of interventions: *energy net savings or consumptions* and *income savings and expenditures* include at least 150 IEs each, but appear in only two I-O pairings of over 20 IEs each. Finally, *employment* and *education* outcomes are not the most common categories on the map but are most frequently reported in evaluations of *on-grid systems*.

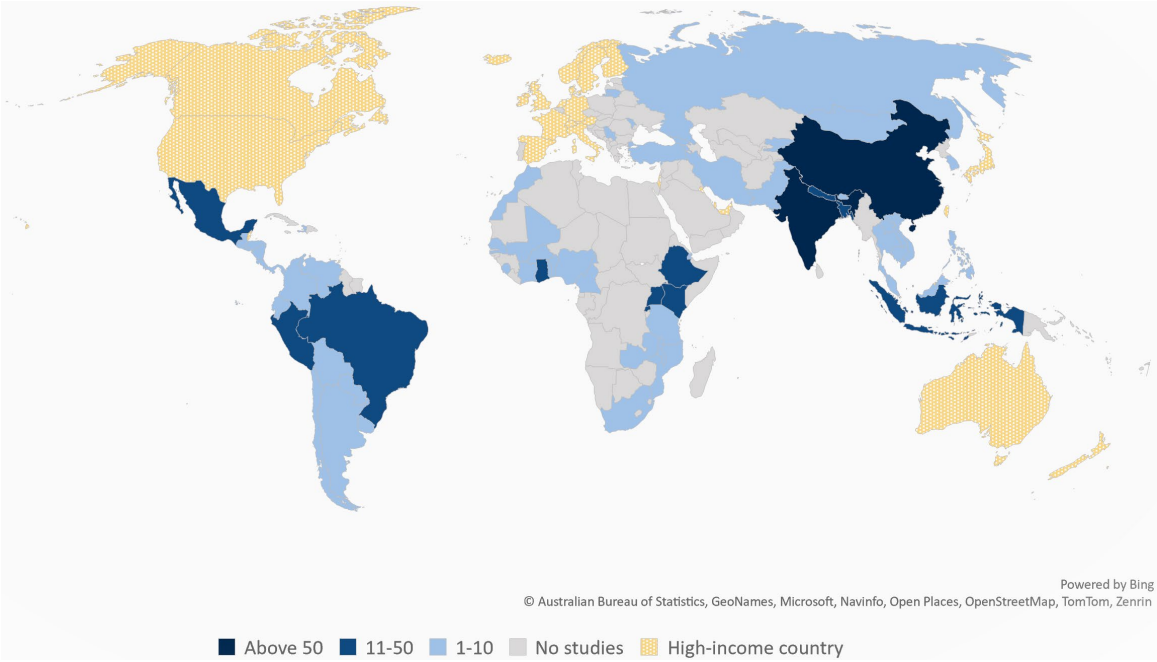
Table 2: Most common intervention-outcome pairings

Intervention category	Outcome category	No. of IEs
Sustainable upgrades	Health status, comfort and wellbeing	63
	Air quality/ pollution	27
	Energy net savings or consumption	22
On-grid systems	Income, savings and expenditures	37
	Employment	31
	Education	26
Energy pricing	Energy net savings or consumption	24
Other energy regulations	Air quality/ pollution	23
Off-grid systems	Income, savings and expenditures	22
Subsidies and other transfers	Income, savings and expenditures	21
	Energy net savings or consumption	20
Energy management reforms	Energy security	20

4.2.3 Geographic distribution

Within the 668 included IEs, we found evaluations of interventions implemented in 64 countries across the world (Figure 6). Over half of all IEs evaluated an intervention implemented in either East Asia and the Pacific (n = 279, 42%) or Sub-Saharan Africa (n = 150, 22%). The next most common regions are South Asia (n = 114, 17%) and Latin America and the Caribbean (n = 84, 13%), while there is a more limited evidence base from Europe and Central Asia (n = 13, 2%) and the Middle East and North Africa (n = 9, 1%).

Figure 6: Distribution of IEs by country



Note: As some studies included evaluations in multiple countries, the total number of countries exceeds the total number of IEs within the map.

The evaluations from East Asia and the Pacific are driven by studies conducted in China. Over one-third (n = 249, 37%) of IEs evaluated an intervention within China, many of which focused on one of the Chinese government's environmental policies and regulations (e.g. New Energy Demonstration Cities (NEDC) and the Photovoltaic Poverty Alleviation (PVPA) programme). Outside of China and India (n = 83), no other country is present within more than 50 IEs. Moreover, 34 IEs were categorised as multi-country. These are evaluations that used large datasets from more than 15 countries, which often assessed government regulations or policies (e.g. Sen et. al. 2018; Zhang et. al. 2008). Appendix I provides a full breakdown of evaluations by country and region, including the 101 L&MICs for which we identified no studies.

We looked at how the distribution of evidence relates to the needs of populations. In terms of access to electricity, we found that there are few evaluations for populations where access is the most limited (see Appendix J; data sourced from IEA, 2023). Six countries have populations where less than 20% of people have access to electricity (Burundi, Central African Republic, Chad, Democratic Republic of Congo, Malawi, and South Sudan). We did not identify any evaluations for electrification interventions (*on-grid systems* or *off-grid systems*) in these countries. This lack of evidence represents an

absolute geographic gap. For countries where 20-50% and 51-90% of the population have access to electricity, we identified 19 and 27 IEs, respectively. More than half of *on-grid* and *off-grid systems* interventions took place in countries where over 90% of the population have access to electricity (n = 69).

In terms of access to clean cooking, the evidence is more equally distributed (see Appendix J). For countries where less than 20% of the population have access to clean cooking, we identified 43 IEs of improved cookstoves as the technology or cooking as the energy use. For countries where 20-50% and 51-90% of the population have access to clean cooking, we identified 41 and 52 IEs, respectively. Three IEs were identified within countries where over 90% of the population have access to clean cooking.

4.2.4 Distribution of studies across energy-related filters

SDG 7 targets

For each included study we captured the SDG 7 outcome targets related to the intervention. These were coded according to three variables: access (to electricity or clean cooking); efficiency (efficient technologies or behaviours), and (the promotion and use of) renewables. Table 3 shows that the evidence on each of the three targets was evenly distributed.

Renewables (n = 321) was the target of focus in the largest number of IEs. The distribution of interventions related to renewables is mostly skewed towards the *electrification and energy infrastructure* intervention domain. This domain captures two aspects of the renewables target: access to electricity through renewable *off-grid systems*, as well as access to renewable clean cooking though *sustainable upgrades*. Nearly 50% of studies focused on renewables also included the access target. These are largely driven by improved cookstove studies, whereby the cookstove ran on renewable energy (e.g. Clark et. al. 2019). Outside of its link to renewables, interventions focused on access (n = 316) are mainly made up of *on-grid systems*, as more than half of the IEs which only targeted access evaluated this intervention.

Table 3: Distribution of IEs by SDG 7 targets

Target	No. of IEs	Target	No. of IEs	Target	No. of IEs
Access total	316	Efficiency total	299	Renewables total	321
Access only	105	Efficiency only	210	Renewables only	108
Access and efficiency				32	
Access and renewables				156	
Efficiency and renewables				34	
Access, efficiency and renewables				23	

Efficiency (n = 299), unlike the access and renewables target, was mostly assessed as a standalone target. This could be attributed to our framework with many intervention categories neatly mapped to efficiency. Almost half of studies on efficiency focused on interventions from the legal and regulatory domain, including *energy targets* and *other energy regulation categories*. Lastly, 23 studies evaluated interventions that considered all three targets. These studies focused on efficient cookstoves which ran on renewable energy (e.g. Mortimer et. al. 2020) and other efficient technologies, such as cold storages (e.g. Takeshima et. al. 2021).

Energy source

The source of energy is another important topic in regard to sustainable energy, especially as it relates to the renewables SDG target. For any study that reported the source of energy associated with the intervention, we coded whether it was a modern renewable, traditional renewable or non-renewable energy, and the specific energy the intervention used (Table 4).

Less than half of the included IEs provided information on the specific energy source (n = 250, 37%). For evaluations of energy conservation and efficiency interventions, we did not anticipate studies providing information on the specific energy source. Modern renewable energy sources were more common than both traditional and non-renewable sources, with half of the IEs that reported an energy source based on a modern renewable energy (n = 136).

Solar energy was the source evaluated in the largest number of IEs (e.g. Mahajan et. al. 2020). Biomass and LPG were the second and third most common sources and were mainly evaluated in studies of improved cookstoves (e.g. Havens et. al. 2018; Johnson et. al. 2022). Wind and hydroelectric studies primarily focused on interventions which provided financial frameworks to encourage growth in these sectors (e.g. Zhou et. al. 2023; Panse & Kathuria, 2016).

Table 4: Distribution of IEs by energy source

Energy source	No. of IEs	Energy source	No. of IEs	Energy source	No. of IEs
Modern renewable	**136**	**Traditional renewable**	**85**	**Non-renewable**	**53**
Solar	93	Biomass	70	LPG	32
Wind	29	Wood	14	Coal	10
Hydroelectric	24	Charcoal	3	Gasoline or diesel	5
Biogas	7			Natural gas	3
Liquid biofuel	4				
Geothermal	1				

Note: LPG: liquified petroleum gas. As studies evaluated multiple energy sources from within the same category (e.g. both solar and wind) the total number of studies within a category sums to greater than the number of studies for a category.

Distribution of technologies

Our a priori expectation was that not all interventions would be related to a specific technology, considering that the framework includes general regulations and electrification interventions. In line with this, we found that 37% of IEs (n = 262) evaluated a specific technology (Table 5).

Almost half of these studies focused on improved cookstoves (n = 116), while other populous technologies include vehicles (n = 40) and solar lighting (n = 33). Regarding vehicles, interventions primarily concentrated on New Energy Vehicle subsidies, mostly from China, but also focused on other interventions, such as policies that removed subsidies for petrol (e.g. Brucal & Dechezleprêtre, 2021). Evidence on energy production technologies, such as hydropower plants (n = 10) and wind plants (n = 7), account for

3% of the studies in the map. Other technologies were sporadically evaluated, including solar-powered mosquito trapping systems (e.g. Homan et. al. 2016) and solar water pumps (e.g. Gupta, 2019). These technologies were not evaluated in five or more IEs, and as such, we did not create a new category for them.

Table 5: Distribution of IEs by technology

Technology	No. of IEs	Technology	No. of IEs
Improved cookstoves	116	Vehicles	40
Solar lighting	33	Other	15
Hydropower plants	10	Lightbulbs	8
Wind plants	7	Biodigesters	5
Air conditioner	4	Engines	3
Heat pumps	2	Insulation	1

Distribution across energy use

We coded the energy use for each study to understand how the interventions intended energy to be used. Half of the IEs that reported a clear use of energy were related to cooking (n = 128). We also found trends between technologies for other energy uses. For instance, other energy uses that were frequently evaluated include lighting (n = 49) and travel (n = 40), both of which directly relate to a technology in Table 5. Less common uses of energy were also identified across studies on the map: for education (n = 9; e.g. Berkouwer et. al. 2018), cooling (n = 5; e.g. Zhang et. al. 2022), and health (n = 4; e.g. Graham et. al. 2022).

Distribution across intervention target level and population

The map encompasses a broad set of interventions, and as such, different interventions were expected to be targeted at different levels. Evidence on the target level of interventions is well represented, with only 9% of studies not specifying this information, as shown in Table 6.

Households were the most commonly targeted level, with 44% of all IEs evaluating an intervention targeted towards households (n = 294). This is followed by firms/enterprises (n = 127), commonly targeted by interventions within the *legal and regulatory frameworks and policies* domain. Rarer target levels include schools (e.g. Mejdalani et. al. 2018), agricultural producers (e.g. Kishore et. al. 2017) and national governments (e.g. Ali & Qian, 2021).

Fewer studies were targeted towards an equity population. Among those that were, 71% targeted a rural population (n = 198). Besides equity based on location, the only populations explicitly targeted by these studies were women (n = 37; e.g. Williams et. al. 2023; Beltramo & Levine, 2013), individuals based on socioeconomic status (n = 22; e.g. Figueroa et. al. 2019) and heads of households (n = 1; Mutumbi et. al. 2022). We found no studies with interventions targeting notable equity populations, such as youths and displaced populations.

Table 6: Distribution of IEs by target level and equity population

Intervention target level	No. of IEs	Equity population targeted	No. of IEs
Households	294	Rural	198
Firms/ enterprises	127	Urban	48
Communities	77	Women	37
Individuals	65	Socioeconomic status	22
Utility providers	38	Head of household	1
Individual traders	16		
Schools	8		
Agricultural producers	3		
National governments	3		
Health workers	2		

4.3 Impact evaluations methods

Among the 668 included IEs, we found that 75% used a quasi-experimental study design (Table 7). Within these, fixed effects estimations (including difference-in-difference) were the most common, with 71% of quasi-experimental IEs using this study design.

In contrast to the evidence available on 3ie's DEP, which provides evidence across all areas in international development, we found a lower proportion of quasi-experimental evaluations using matching techniques (including statistical matching; 26% within the DEP and 9% within the EGM) and interrupted time series analysis (2% within the DEP and <1% within the EGM).

Table 7: Distribution of IEs by study design

Evaluation design	No. of studies
Experimental impact evaluations	**166**
Quasi-experimental impact evaluations	**502**
Fixed effects (including difference-in-difference)	356
Matching techniques (including statistical matching)	61
Instrumental variable estimation	52
Regression discontinuity design	25
Synthetic control	7
Interrupted time series	1

The EGM also provides some examples of instrumental variables estimation, regression discontinuity design and synthetic control applied to sustainable energy. Examples of novel instruments include a household paying the electricity bill to their landlord (Do & Le, 2023) and the provision of a faulty cookstove (Agurto Adrianzén, 2013). Examples of discontinuities exploited for analysis include a price regulation policy date as a cut-off (Castro Pérez & Flores, 2023) and energy consumption levels in the context of a tariff policy (Bastos et. al. 2015). Five of the seven evaluations that used the synthetic control method stem from regulatory interventions in China; one looked at the effect of energy regulations across a set of developing countries (Lin & Hung, 2016), and the other study used the synthetic control approach to evaluate the effects of hydroelectric powerplants (Catolico et. al. 2021).

We identified trends in the methods used amongst different intervention categories. We did not identify a single use of an experimental design within the *legal and regulatory frameworks and policies* domain. Given that this domain captures government regulations and policies, it is less likely the interventions were implemented under a randomised approach. This is not to say that there are no randomised policies implemented by governments, but rather that policies such as feed-in-tariffs and daylight savings time are most commonly enacted at once to populations as a whole. The opposite is found for *on-grid systems*, which include rural electrification projects, and *management and maintenance of systems*. The evaluations in these categories only used quasi-experimental methods.[6]

Randomised designs were much more prevalent in situations where interventions were targeted at the household level. *Subsidies and other transfers* (e.g. Jeuland et. al. 2023) and *credits and loans* (e.g. Bonan et. al. 2023) can be randomised at both the individual and household level. Similarly, *information dissemination* and *sustainable upgrades* can also be easily randomised towards households, and as such, we found a much larger share of experimental evaluations within these categories. The link between interventions categories and evaluation methods may also partly explain why no studies were identified for categories such as *advocacy and diplomacy*, where a quantitative impact evaluation seems less likely to be conducted compared to a qualitative evaluation.

Finally, ethical clearance is an important step to ensuring that programme participants are protected during the evaluation of interventions across international development sectors. Despite this, 14% of IEs reported having received ethical clearance (n = 96). When focusing only on experimental studies, we found an increase in the share of IEs reporting ethical clearance (46%, n = 77). This does not necessarily indicate that ethical clearance was not obtained for many of these studies, but that improvements in transparency and the standard of ethical reporting are needed.

5. Systematic review appraisal and findings

5.1 Results of the critical appraisal of SRs

Of the 35 reviews included in the map, 74% were appraised as having low confidence, four as having high confidence and four as having medium confidence (Table 8). Reviews were often assessed as having low confidence because they did not incorporate key elements aligned with international standards for conducting SRs. First, the full text screening, data extraction and risk of bias assessment of primary studies were not independently carried out by two reviewers. In some cases, the risk of bias of included studies was not assessed; at other times, the results of this assessment were not incorporated within the analysis, which hinders the analysis of how sensitive the findings are to the quality of included studies. Second, SRs did not conduct comprehensive searches of the literature, as authors did not search relevant or grey literature databases, did not search the reference lists of included studies or the searches were limited to studies published in English.

[6] In the online map, one study (Chaplin et. al. 2017) included two distinct interventions: one evaluated with an RCT and one through a quasi-experimental method. The online map only allows one study design to be selected per study, hence, this study appears as an RCT in the category *on-grid systems*.

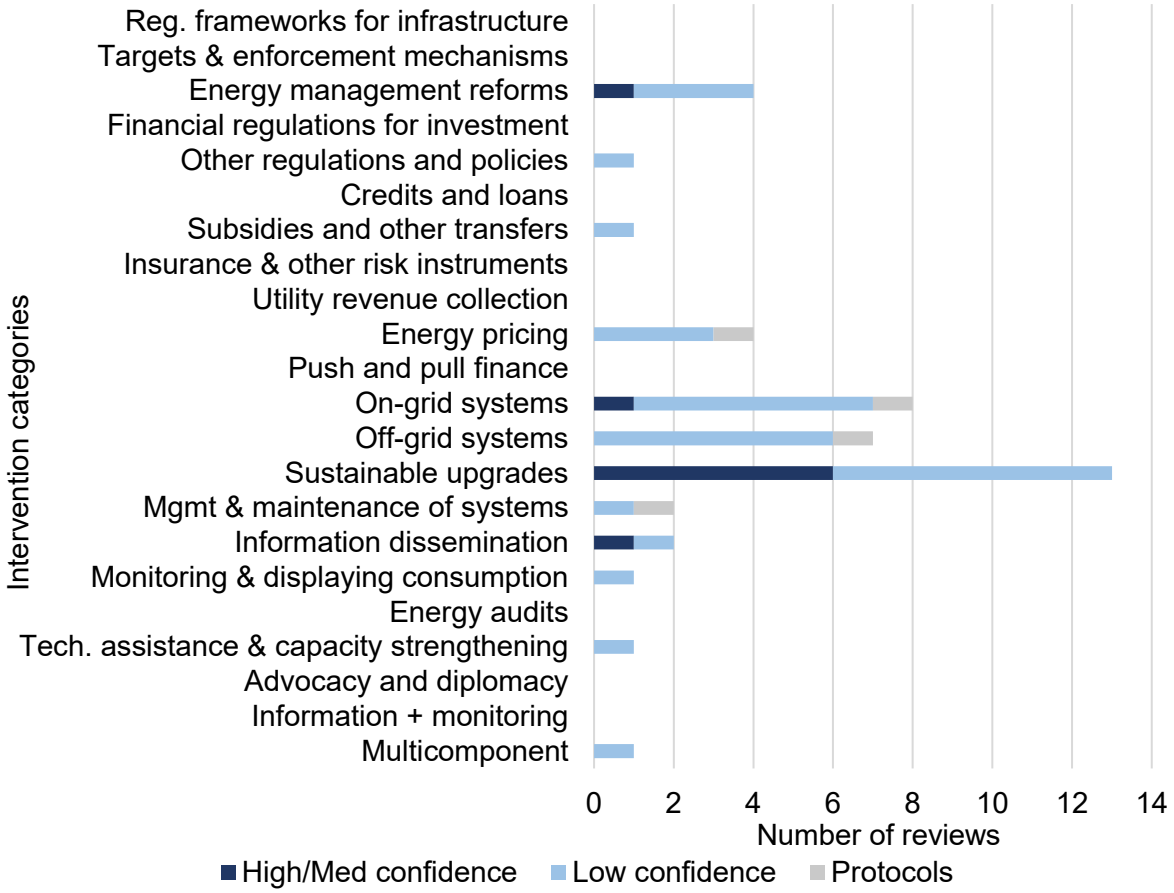
Table 8: Critical appraisal results for included SRs

Confidence rating	No. of reviews
High or Medium confidence	8 (23%)
Low confidence	26 (74%)
Not applicable (ongoing reviews)	1 (3%)
Total	35

Low confidence SRs mainly evaluated *on/off-grid systems* and *sustainable upgrades* interventions (Figure 7). We identified one SR protocol, which was not critically appraised. The protocol presented a review to evaluate interventions related to access to electricity broadly, including increasing physical access, enhancing quality or reliability and incentivising consumer access (Mathur et. al. 2014).

High and medium confidence reviews are more suitable for drawing policy and research insights. For the rest of this section, we focus on the eight high or medium confidence SRs.

Figure 7: Distribution of SRs by intervention category



Note: some SRs reviewed more than one intervention category, and hence were counted more than once in the figure. From the High/Med confidence SRs, Berretta and colleagues (2021) evaluated interventions combining two categories: *sustainable upgrades* and *information dissemination*. Likewise, we identified one SR protocol in the map (Mathur et. al. 2014), which covered four categories: *energy pricing*, *on-grid* and *off-grid systems*, and *management and maintenance of systems*.

5.2 Characteristics of high/med confidence SRs

The eight high or medium confidence SRs were published between 2009 and 2021, and all had a multi-continent coverage. Six of the eight SRs focused exclusively on L&MICs, while two reviews had a global focus (Berretta et. al. 2021; Thomson et. al. 2009). The eight reviews synthesised evidence from between 13-104 primary studies. Two of these SRs were either authored or funded by 3ie (Berretta et. al. 2021; Bensch et. al. 2016).

Six of these reviews focused on *sustainable upgrades*: five covered only this intervention category and one review evaluated *sustainable upgrades* and *information dissemination*. We also identified one review in each intervention category: *energy management reforms* and *on-grid systems* (Table 9). Two SRs reported on the effects of these interventions on *energy and environmental* outcomes, whilst four reviews reported on *socio-economic and community welfare* outcomes. Two reviews included both types of outcome groups (Quansah et. al. 2017; Berretta et. al. 2021). Examples of *energy and environmental* outcomes included household energy consumption, energy efficiency, electrification, water supply, CO2 emissions, and indoor air pollution. In turn, *socio-economic and community welfare* indicators within these SRs mostly covered health indicators, such as general health, pneumonia, acute respiratory infections, respiratory health, mental health, birth weight, infant mortality and other illnesses or symptoms. Table 9 also includes a summary of the minor concerns identified in the SRs appraised as having medium confidence.

Table 9: Summary of high or medium confidence SRs

First author & year	Intervention category (intervention description)	Outcome categories	Confidence level (summary of concerns)
Bensch et. al. 2016	Energy management reforms (Privatisation of government-owned assets)	Energy net savings or consumption; Energy security	High
Annamalai et. al. 2016	On-grid systems (Water supply management and electrification infrastructure)	Energy net savings or consumption; Energy security; Water consumption	Medium (Data extraction process is unclear. Included studies have an overall quality category; without information on different biases, it is unclear where the major bias concerns lie. It is unclear if/how the authors dealt with dependent effect sizes in each meta-analysis.)
Thomson et. al. 2009	Sustainable upgrades (Housing improvement)	Health status, comfort and wellbeing	High
Saleh et. al. 2020	Sustainable upgrades (Cooking appliances)	Health status, comfort and wellbeing	High
Berretta et. al. 2021	Sustainable upgrades; Information	Air quality/pollution; Energy net savings or	High

First author & year	Intervention category (intervention description)	Outcome categories	Confidence level (summary of concerns)
	dissemination (Energy efficient devices)	consumption; GHG emissions; Health status, comfort and wellbeing	
Quansah et. al. 2017	Sustainable upgrades (Indoor air quality improvement)	Air quality/pollution; Health status, comfort and wellbeing	Medium (There are discrepancies between the SR protocol and report. The protocol described a qualitative synthesis, while the report presents quantitative meta-analyses. It is unclear if the authors appropriately addressed potential clustering or sample dependency in the meta-analyses.)
Thakur et. al. 2018	Sustainable upgrades (Provision of improved energy sources)	Health status, comfort and wellbeing	Medium (The rationale for the time period coverage of the search is unclear (the oldest included study is from 2002). There is also not enough evidence to indicate that studies were analysed separately according to their risk of bias assessment status.)
Woolley et. al. 2021	Sustainable upgrades (Biomass and solar energy generation)	Health status, comfort and wellbeing	Medium (Experts in the field were not contacted to provide feedback on the review or additional information on potentially eligible studies. Following a risk of bias assessment, studies with different quality categories were jointly analysed.)

5.3 Main findings of high/med confidence SRs

5.3.1 Energy management reforms

Bensch and colleagues' review (2016) was appraised as having high confidence and it synthesised evidence from 26 quantitative and 34 qualitative studies in L&MICs. The authors reviewed evaluations of the effect of decentralisation policies, including privatisation, deregulation and liberalisation of energy markets, on electrification rates and other intermediate indicators of these reforms' causal chain. Findings indicated that there is not enough evidence to conclude that market-based electricity sector reforms are effective on the outcomes of interest. The authors highlighted supply and investment

outcomes as an exception, which narrative synthesis indicated some positive effects across studies with either a global focus or particularly focused on Latin America. The cost-effectiveness of these reforms was not possible due to the lack of cost evidence. From the qualitative synthesis, the authors suggested several factors that could strengthen electricity sector reforms: if these are designed under a commercial and competitive approach and have adequate pricing and regulation structures.

5.3.2 On-grid systems

The medium confidence review by Annamalai and colleagues (2016) compared the effectiveness of top-down (i.e. centralised) vis-à-vis bottom-up (i.e. participatory) interventions to improve access to electricity, water and sanitation in informal settlements across L&MICs. The authors synthesised 104 primary studies (27 quantitative, 37 qualitative and 40 mixed-methods studies) and found that top-down interventions do not generally improve these services delivery. Community participation, tenure security and political commitment were also spotlighted as relevant factors that could improve service delivery across L&MICs. However, while a narrative analysis suggested that tenure security and political commitment could improve access to electricity, authors could not replicate this finding when conducting meta-analysis. They also noted that the deployment of bottom-up approaches is less common for the provision of electricity, compared to water and sanitation.

5.3.3 Sustainable upgrades

The SRs within this intervention category are presented according to their confidence level. We first discuss the three SRs that were assessed as having high confidence (Thomson et. al. 2009; Berretta et. al. 2021; Saleh et. al. 2020), followed by the three SRs appraised as having medium confidence (Woolley et. al. 2021; Thakur et. al. 2018; Quansah et. al. 2017).

The review by Thomson and colleagues (2009) analysed housing improvement interventions reporting on health outcomes, including general health, respiratory health, mental health and illness or symptoms. The authors reviewed 45 studies (36 quantitative, 1 qualitative and 8 mixed methods studies) implemented across the globe between 1887 and 2007. Six of these studies focused on the provision of basic housing needs in developing countries, such as the provision of warmth and energy efficiency measures. The heterogeneity of these interventions did not allow for statistical synthesis. Still, the narrative synthesis suggested that improvements in basic housing needs have the potential to be positively related to health and socioeconomic outcomes.

Berretta and colleagues (2021) investigated the effects of energy efficiency measures (e.g. insulations or heating and lighting upgrades) on their own or when paired with the provision of information (e.g. energy audits) on energy consumption, energy affordability, CO2 emissions, air quality indices and pollution levels outcomes. Based on 16 rigorous impact evaluations, the authors found that these interventions, implemented alone or as bundles, have the potential to reduce household energy consumption. Due to the large heterogeneity in effects and the general quality of the evidence base, the authors concluded that better evaluations and more detailed reports are needed to understand these effects better. Moreover, the review had a global scope, and three of the 16 studies included in the synthesis evaluated interventions in L&MICs (studies focused on Ethiopia, Ukraine and the Kyrgyz Republic).

Saleh and colleagues (2020) synthesised 14 randomised control trials assessing the respiratory effects of interventions to reduce indoor and ambient air pollution in L&MICs. Twelve of the 14 primary studies evaluated the effect of *improved cookstoves* across countries in Africa, Asia and Latin America. Differences in study populations and outcome measures reported precluded the authors from conducting meta-analyses; however, from a qualitative synthesis of these studies, the authors found no significant associations between the interventions and the most commonly reported clinical respiratory diagnosis measure, childhood pneumonia. The authors acknowledged that restricting the review to randomised evaluations may have left out other relevant studies but highlighted that the lack of rigorous evidence on respiratory outcomes is nevertheless an important finding.

The review by Quansah and colleagues (2017) evaluated the empirical literature on the effects of interventions aimed at improving household indoor air quality and health by reducing emissions from solid fuel use for cooking and heating. The review included 55 studies in L&MICs, covering countries in Latin America, Asia and Africa, which most often evaluated the use of different improved cookstoves. Fifteen of these studies were synthesised through meta-analyses. The authors found that relevant interventions reduce particulate matter (PM) and carbon monoxide (CO) concentrations, based on both daily personal average and in the kitchen levels (with effects sizes for personal PM standardised mean difference (SMD) = 1.18, 95% confidence interval (CI): 1.05, 1.32; personal CO SMD = 0.81, 95% CI: 0.63, 1.05; kitchen PM SMD = 1.57, 95% CI: 1.22, 2.01; and kitchen CO SMD = 1.03, 95% CI: 0.76, 1.41). Due to the range of health outcomes reported, meta-analysis was not conducted, and results on health outcomes were not conclusive. The authors were also unable to completely address the high level of heterogeneity in these effects, as such authors warranted caution when interpreting the results.

Thakur and colleagues (2018) reviewed 53 studies evaluating the effects of improved biomass cookstoves on health outcomes among women and children under the age of five years in L&MICs. Included studies focused on interventions implemented in rural areas across countries from Africa, Asia and Central America. The results of meta-analyses based on 12 studies suggested that improved biomass cookstoves can reduce respiratory and ocular symptoms among women (with effect sizes for chronic obstructive pulmonary disease risk ratio (RR) = 0.74, 95% CI: 0.61, 0.90; cough RR = 0.72, 95% CI: 0.60, 0.87; phlegm RR = 0.65, 95% CI: 0.52, 0.80; wheezing/breathing difficulty RR = 0.41, 95% CI: 0.29, 0.59; and conjunctivitis RR = 0.58, 95% CI: 0.43, 0.78). However, there was no significant evidence that improved cookstoves have a positive effect on perinatal or child health. Due to the low number of studies quantitatively synthesised and the high variation across studies, the authors highlighted that more evidence is needed to gain confidence in these findings and understand them better (e.g. by assessing the relative effectiveness of different cookstove technologies).

Lastly, the review by Woolley and colleagues (2021) analysed the effects of interventions aimed at reducing household air pollution related to solid biomass fuel combustion on health indicators of pregnant women and children under five years old in L&MICs. The review included 13 studies, ten of which evaluated improved cookstoves across Africa, Asia and Latin America. None of the included studies evaluated interventions related to heating or lighting. By conducting meta-analyses, the authors found that improved

cookstoves can reduce the risk of low birth weight (odds ratio (OR) = 0.73, 95% CI: 0.61, 0.87), the incidence of burns in children (RR = 0.66, 95% CI: 0.45, 0.96), and acute lower respiratory infections among children living in high-altitude settings in Latin America (RR = 0.70, 95% CI: 0.53, 0.93).

5.4 Implications for research from high/med confidence SRs

The eight high or medium confidence SRs covered three of the intervention categories in the EGM, half of which evaluated improved cookstoves. While many research considerations reported in these SRs will relate to health research, some implications for future research can also be applied more generally to other social and development studies. These considerations can be grouped into three interrelated points.

First, these SRs reported a need for more rigorous impact evaluations to identify the causal effect of energy-related interventions and, by extent, to better inform decision-making. This includes leveraging experimental evaluations when possible and following best practices to design evaluations with robust identification strategies that can isolate intervention effects from other confounding factors.

Second, these SRs highlighted the importance of evaluating interventions in different contexts, including understudied regions or rural/urban areas, as well as using mixed methods approaches to help disentangle the underpinning mechanisms driving the estimated effects of these interventions. These approaches can support the identification of context-specific barriers and facilitating factors affecting the implementation, adoption and effectiveness of interventions.

The third point concerns the data from primary studies included in these SRs. This includes different considerations:

- There is a lack of quantitative and cost data that hinders the evaluation of the effectiveness and cost-effectiveness of these interventions. Bensch and colleagues (2016) propose that if researchers can articulate their data needs, the international community, from governments to local organisations, could provide more detailed and comparable data to conduct these analyses.
- Researchers could do more to evaluate additional key outcome measures (from energy- to health-related outcomes) and do so consistently across the field. This could facilitate building a richer and more comparable evidence base in the field of sustainable energy.
- There is a need to reflect on the use of self-reported outcome measures to avoid introducing biases in the studies. Researchers should consider observer and desirability biases when participants self-report health symptoms or the use of technologies, such as improved cookstoves. In addition, poor translations of research tools (e.g. surveys and questionnaires) can also introduce measurement errors in the studies.
- Particularly related to the evaluation of sustainable upgrades interventions, there is a need to design evaluations with longer follow-up periods. This could help identify longer-term impacts (e.g. health benefits) and assess the role of the (un)sustained use/uptake of interventions on their real-life applicability. For specific health outcomes, such as pregnancy measures, defining key vulnerability/exposure periods can also be critical in determining data collection points.

5.5 Synthesis gaps

Of the 35 SRs identified in the map, 26 were appraised as low confidence because they did not follow best practices for conducting systematic reviews. As these reviews are also heavily driven by the evaluation of improved cookstoves, the synthesis evidence base on which decision-makers can rely is significantly reduced.

The following intervention categories have more than 20 primary studies, but no recent high/medium confidence SR is available:

- *Energy targets and enforcement mechanisms*: the map includes 47 IEs and no SRs
- *Financial regulations and investments*: the map includes 56 IEs and no SRs
- *Other energy regulations and policies*: the map includes 90 IEs and one low confidence SR published in 2012
- *Subsidies and other transfers*: the map includes 80 IEs and one low confidence SR published in 2011
- *Energy pricing*: the map includes 35 IEs, three low confidence SRs published between 2020 and 2023, and one SR protocol published in 2014
- *Off-grid systems*: the map includes 46 IEs and six low confidence SRs published between 2013 and 2022

In addition, the high or medium confidence SRs we identified related to *energy management reforms* and *on-grid systems* were both published in 2016. The EGM now includes 17 and 62 IEs, respectively, published in 2017 or later. This means that there is an opportunity to conduct an updated synthesis and incorporate the latest evidence on these interventions.

Another relevant synthesis gap is the absence of high confidence SRs focused on the *intermediate/behavioural change* outcome domain, which includes measures of knowledge and awareness, behaviour adoption, technology uptake and usage of technology. This outcome domain currently contains 97 completed and 5 ongoing IEs, as well as 3 low confidence SRs published between 2015 and 2023.

6. Funding and implementing agencies

As well as extracting data on study characteristics, we also extracted data on the organisations that implemented the interventions of included IEs, and the organisations that funded these interventions and evaluations. Often this information is absent in evaluation reports: as shown in Table 10, 58% of IEs noted the implementation agency, 33% the programme funder, and 56% the research funder.

In line with other findings across the EGM, the large number of studies that evaluated policies implemented within China is driving many of the most populous categories. Across both programme implementers and programme funders, government agencies are the most common type of funder, with the Government of China making up around 40% of programme implementation (n = 162) and programme funding (n = 90) agencies. Beyond the Chinese government, the Government of India (n = 25) is the only agency which implemented programmes in more than ten IEs.

Government agencies are also the most common research funders, which is again driven by the Chinese government through the National Natural Science Foundation of China (n = 82) and the National Social Science Foundation of China (n = 31). Other common research funding agencies include the World Bank Group (n = 19), the United States Agency for International Development (USAID; n = 14) and the International Growth Centre (n = 13). The second most common research funding agency is academic institutions. We identified 90 different academic institutions that have funded research within the map.

We also found that government agencies (n = 12) and international aid agencies (n = 9) are the most common funders of the systematic reviews included in the map. The remaining agency types that have funded SRs are distributed between academic institutions (n = 3), charitable or private foundations (n = 2), international financial institutions (n = 1) and non-profit organisations (n = 1). Just over a quarter of SRs did not report any research funders.

Table 10: Distribution of implementing and funding agencies

	Programme implementation	Programme funding	Research funding
Studies that reported this data	**58%**	**33%**	**56%**
Academic institution	2%	3%	21%
Charitable or private foundation	<1%	3%	7%
For-profit firm	3%	1%	2%
Government agency	82%	77%	52%
International aid agency	3%	10%	7%
International financial institution	2%	3%	5%
Non-profit organisation	8%	4%	5%

Note: These figures represent the percentage of studies which included this information, e.g. 2% of studies which reported an implementing programme agency, were implemented by academic institutions. Studies could report more than one implementing or funding agency.

7. Conclusion

We identified 668 impact evaluations and 35 systematic reviews of sustainable energy interventions for this EGM. Nearly half of the evidence has been published in the last three years, indicating this is a rapidly growing topic of interest. The evidence base is also spread across intervention and outcome categories, with only three out of 22 intervention categories having no studies. The three targets of SDG 7, access, efficiency and renewables, are also equally represented within this evidence base.

Two factors drive these findings. Firstly, over one-third of studies evaluated an intervention conducted in China. This also explains the large number of studies from the legal and regulatory frameworks and policies intervention domain, many of which focused on energy regulations implemented by the Chinese government. Secondly, there is a large body of evidence evaluating improved cookstoves. These studies drive the *sustainable upgrades* category to be the single largest intervention category, make cookstoves the most prevalent energy-related technology and make cooking the most prevalent energy use on the map.

While this body of evidence has clear driving trends in geography and intervention focus, the EGM offers a wealth of studies that decision-makers can consult when designing programmes and their evaluations. It also highlights immediate research needs to close gaps and update the evidence base within the sustainable energy sector.

7.1 Implications for policymakers

When utilising the findings from this report, policymakers should prioritise consulting systematic reviews assessed as having high or medium confidence. While we summarised the key findings of these reviews in section 5, we urge readers to consult the original reviews for additional methodological and findings details. In brief, the following are the main policy conclusions that have been drawn from these reviews:

- **Energy management reforms**: There is not enough evidence to conclude that market-based electricity sector reforms are effective on electrification rates and other intermediate indicators of these reforms' causal chain. Indicators of supply and investment may be an exception, which showed some positive effects across studies with either a global focus or particularly focused on Latin America.
- **On-grid systems**: Top-down interventions do not generally improve access to electricity in informal settlements across L&MICs. Community participation, tenure security and political commitment may be relevant factors that could improve service delivery across L&MICs.
- **Sustainable upgrades**: From reviews that were able to synthesise the evidence quantitatively through meta-analysis, relevant interventions aimed at improving household indoor air quality and health (mostly improved cookstoves) can:
    - reduce particulate matter and carbon monoxide concentrations at the individual and kitchen levels
    - reduce respiratory and ocular symptoms among women
    - reduce the risk of low birth weight, the incidence of burns in children and acute lower respiratory infections among children living in high-altitude settings in Latin America

Decision-makers can consult the EGM and explore its studies, with the caution not to draw conclusions from low confidence SRs or individual primary studies. For the former, there is a higher risk that the findings are biased, while the latter are single examples of interventions that depend on their contextual factors. Finally, given the number of low confidence SRs identified, decision-makers could invest in training opportunities for conducting and critically assessing future evidence reviews.

7.2 Implications for research

8.2.1 Designing and commissioning impact evaluations

The EGM has identified a large and recent body of evidence, spread across interventions, outcomes and different features of sustainable energy interventions (e.g. technologies, energy use). This evidence can be utilised when designing programmes to promote SDG 7 and a "Just and Equitable Energy Transition". Based on the EGM findings, we put forward the following considerations for commissioning and designing impact evaluations:

- Prioritise research on interventions with no identified evidence (*insurance and other risk guarantee instruments*; *push and pull finance*; *advocacy and*

diplomacy) as well as other intervention categories with scarce evidence (e.g. *energy audits* and *regulatory frameworks for energy infrastructure*).

- Promote conducting research in geographical gaps. This includes evaluations of studies outside of China and India, and specifically in regions where fewer studies exist (e.g. Middle East and North Africa). Countries with low electrification rates and no evaluations of electrification interventions should also be prioritised (Burundi, Central African Republic, Chad, Democratic Republic of Congo, Malawi, and South Sudan). Evaluations from countries with the highest electrification rates may be helpful as guidance for implementing interventions in countries with lower rates and less evidence available.
- Prioritise under-researched topics related to sustainable energy. For instance, the use of technologies beyond improved cookstoves and the use of energy in education and health contexts.
- Ensure targeting of future interventions to address equity challenges. The map includes limited evidence on interventions that targeted equity populations, with the exception of rural locations.
- Safeguard that research uses rigorous methods to address causal questions. The EGM provides ample evidence of appropriate designs for specific interventions; it also offers examples of quasi-experimental designs less commonly used, such as instrumental variables and the synthetic control method.
- Promote having and reporting ethical clearance to ensure the protection of programme participants and to meet standards in relation to research transparency.

Included high and medium confidence SRs also highlight a number of findings pertinent to future research:

- Conduct evaluations across a variety of contexts, including understudied regions or rural/urban areas. Mixed methods across a variety of contexts would also help untangle answers around context-specific barriers or facilitators to intervention effectiveness.
- Incorporate cost data into evaluations to allow for exploration of cost-effectiveness analysis.
- Similar key outcome measures should be assessed in multiple evaluations. When key outcome measures are consistently evaluated across the field, this allows for a more comparable evidence base.
- Across all interventions, but particularly in the evaluation of *sustainable upgrades*, there is a need to design evaluations with longer follow-up periods. This could help identify key longer-term outcomes.

8.2.2 Planning and commissioning synthesis research

One of the major findings from the map is that there is a lack of high-confidence evidence synthesis. Given the increase in evidence within the past three years and the number of areas with high synthesis potential, future synthesis efforts might be able to draw more robust policy conclusions as they draw from a continuously expanding evidence base. When planning future synthesis, it is important that the most rigorous methods are used and international standards for synthesis are met (see Page et. al. 2021; The Methods Group of the Campbell Collaboration 2019a; 2019b; and Higgins et. al. 2022 for internationally recognised standards). We suggest the following

considerations when researchers and funders prepare new synthesis projects:

- Prioritise synthesising evidence where there are large numbers of impact evaluations and no recent high or medium confidence systematic reviews, including, for example, *energy targets and enforcement mechanisms* and *financial regulations and investments*. There is also an opportunity to update the SRs on *energy management reforms* and *on-grid systems* published in 2016.
- Fund, commission or plan for training in rigorous systematic review methodologies. Training programmes or workshops could be an effective means to help raise the bar of SRs within the sector.
- Given the recent growth of evidence, commissioning a 'living' synthesis project could help ensure that researchers, practitioners, and policymakers have the most up-to-date evidence available.

Online appendixes

Online appendix A: Inclusion criteria

https://3ieimpact.org/sites/default/files/2024-05/EGM-SEforALL-Online-appendix-A.pdf

Online appendix B: EGM advisory group

https://3ieimpact.org/sites/default/files/2024-05/EGM-SEforALL-Online-appendix-B.pdf

Online appendix C: Search strategy

https://3ieimpact.org/sites/default/files/2024-05/EGM-SEforALL-Online-appendix-C.pdf

Online appendix D: Screening and data extraction procedure

https://3ieimpact.org/sites/default/files/2024-05/EGM-SEforALL-Online-appendix-D.pdf

Online appendix E: Examples of excluded studies

https://3ieimpact.org/sites/default/files/2024-05/EGM-SEforALL-Online-appendix-E.pdf

Online appendix F: List of included studies

https://3ieimpact.org/sites/default/files/2024-05/EGM-SEforALL-Online-appendix-F.pdf

Online appendix G: Data extraction tool

https://3ieimpact.org/sites/default/files/2024-05/EGM-SEforALL-Online-appendix-G.pdf

Online appendix H: Systematic review critical appraisal tool

https://3ieimpact.org/sites/default/files/2024-05/EGM-SEforALL-Online-appendix-H.pdf

Online appendix I: Individual country data

https://3ieimpact.org/sites/default/files/2024-05/EGM-SEforALL-Online-appendix-I.pdf

Online appendix J: Evidence on access to electricity and clean cooking

https://3ieimpact.org/sites/default/files/2024-05/EGM-SEforALL-Online-appendix-J.pdf

Online appendix K: Appendix references

https://3ieimpact.org/sites/default/files/2024-05/EGM-SEforALL-Online-appendix-K.pdf

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International Initiative for Impact Evaluation
306 3rd Floor, Rectangle One
D-4, Saket District Center
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India

3ie@3ieimpact.org
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