



International Initiative for Impact Evaluation

## **Protocol**

# **An Evidence Gap Map of energy efficiency interventions**

### **Deliverable 1 – Evidence Gap Map Protocol**

#### **Version 1**

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## **Project summary**

To add

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# 1 Background

## 1.1 Global emissions and energy efficiency trends

To mitigate the worst impacts of climate change, improving efforts to reduce carbon emissions and limit global warming is imperative. Global anthropogenic greenhouse gas emissions (carbon related emissions (CO<sub>2</sub>) and non-carbon related emissions i.e. methane (CH<sub>4</sub>), nitrous oxide (N<sub>2</sub>O) and fluorinated gases) have continuously risen in the period 1970 – 2010, with the energy supply sector responsible for 47 per cent, industry sector 30 per cent, transport sector 11 per cent, and buildings 3 per cent (IPCC, 2014). Global emissions continue to rise at an increased rate – the growth rates for CO<sub>2</sub>, CH<sub>4</sub> and N<sub>2</sub>O during the 2015 – 2017 period are each around 20 per cent higher than they were in the previous five years (WMO, 2019). In 2018, total global carbon emissions grew by two per cent, ‘the fastest growth for seven years’ (BP, 2019a).

Carbon emissions (CO<sub>2</sub> emissions only) from the building sector grew by two per cent between 2017 and 2018 and was responsible for 36 per cent of global final energy use (GABC, 2019). At the same time, the rate of improvement in energy intensity<sup>1</sup> has slowed to 1.2 per cent. This means that almost eight per cent of emissions will need to be cut every year from 2020 onwards and energy efficiency in buildings will need to increase by three per cent a year to meet the UN Sustainable Development Goals and energy goals from other organisations, such as the International Energy Agency (IEA) Sustainable Development Scenario (GABC, 2019).

In 2018, global primary energy demand rose by 2.3 per cent from 2017 (IEA, 2019). Global final energy consumption in buildings increased by one per cent, and around seven per cent since 2010, with residential buildings making up more than 70 per cent of the global building energy consumption (GABC, 2019). The increases in emissions and energy use has been driven largely by the expanding use of electricity which rose over 19 per cent since 2010 (GABC, 2019). The electricity production is primarily generated by fossil fuels, and there is an immediate priority to source renewable energy production, as well as enhance energy efficiency in buildings (IADB, 2017). To reach climate stabilization at the target temperatures relies on a zero-carbon electricity consumption scenario, and this is an achievable possibility even without nuclear power, carbon capture and storage, or other prominent low carbon energy source technologies (IADB, 2017).

In Europe, the situation is showing signs of improvement compared to other developed and emerging economies, with emission trends beginning to reduce overall. Across the EU-28 member states emissions had levelled off between 2014 and 2016, and the 2018 estimates show a decrease of 2.1 per cent from the previous year (EEA, 2019). Apart from transport, all sectors have shown emission reductions compared to 1990 levels, and in 2018, the energy sector was responsible for the largest sectoral decrease as primary fossil fuel consumption lowered by 1.7% and more renewable energy sources entered the energy mix (EEA, 2019). Mitigation strategies such as the EU Emissions Trading System and Effort Sharing Decision also showed reductions of emissions of 4.2 per cent and 0.8 per cent, respectively (EEA, 2019). Warmer weather conditions in 2018 meant that there was a lower demand for heating, which explains overall reductions but it remains important to improve energy efficiency (EEA, 2019).

Access to sustainable energy, part of SDG7, is a related issue considering the rise in global power demand and electricity (UN DESA, 2018). Around one billion people do not have access to electricity, meaning their ability to develop and improve welfare, health, education, and labour market participation is severely limited (UN DESA, 2018). Barriers to modern energy access, particularly in developing nations, include low connection rates in on-grid areas and the weak impact of electricity expansion in the

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<sup>1</sup> Global energy intensity, defined as the ratio of primary energy supply to GDP, is the indicator used to track progress on global energy efficiency (IEA).

short-run as well as the mid-run, as can be seen in the case of the African context (Bonan, Pareglio and Tavoni, 2017).

Given the energy situation and the expanding role that electricity has in global power needs, reducing energy consumption is a necessary measure. There are two ways to achieve this: the first is through energy efficiency and the other one through low-carbon energy. This map will be focused on energy efficiency to highlight the opportunities that are often underutilised despite they are cost-effective and immediately available (Allcott and Greenstone, 2012).

Dubbed as the ‘first fuel’ by the IEA, energy efficiency, broadly defined as ‘the ratio of output of performance, service, goods or energy, to input of energy,’ plays a key role in tackling emissions (EPRS, 2015). It is also gaining increasing importance to support rising energy demand, especially for the expanding list of rapidly developing countries across the globe which use disproportionate amounts of energy (BP, 2019b). Studies have shown that there is a positive correlation between economic growth and energy consumption, as well as economic growth and carbon emissions from the electricity sector (Ntanos et al., 2015). Therefore, improving energy efficiency is “key to solving the dual challenge of providing more energy and less carbon” (BP, 2019b, p.23). Furthermore, improving energy efficiency has shown to be one of the most cost-effective ways to target emissions, and it also provides other benefits, such as improving energy supply security, lowering the costs in producing goods and services, and creating a significant number of jobs (EIB, 2016).

Energy efficiency solutions act as an important tool to overcome the lack of access to electricity in many parts of the world (Bonan, Pareglio and Tavoni, 2017) and to ensure that future global energy consumption trends stop increasing at an unsustainable rate; these improvements will enhance the environmental state of the Earth and the socio-economic conditions of the world population.

## **1.2 Why is it important to do this Evidence Gap Map?**

An Evidence Gap Map (EGM) aims to establish what we know, and do not know, about the effects of interventions in a thematic area (Snilstveit et al., 2016). An EGM collects the scattered evidence from different bibliographic databases and grey literature (non-academic and unpublished studies) by providing a visual representation of the available studies in an interactive platform which provides a graphical display of the evidence in a grid-like framework, with links to easily access studies summaries.

### **1.2.1 Investments in the sector**

There is global focus on action against climate change, with the SDGs 7 (Affordable and clean energy), 12 (Responsible consumption and production), and 13 (Climate action) all relating to fighting climate change and improving energy efficiency (UN 2015). Energy efficiency – including energy savings in residential, industrial, and municipal sectors – will play a key role to achieving climate and energy goals for countries across the globe. Energy efficiency is often referred to as the ‘first fuel’ – the resource to be used before all other energy options as it is the lowest-cost option in meeting countries’ climate change commitments (EPRS, 2015). In effect, numerous countries and organisations are investing large amounts of money into energy efficiency measures.

In 2018 \$240 billion was invested in energy efficiency across the industry, building and transport sectors globally. By region, Europe invested the most with around \$70 billion, North America invested around \$45 billion, China invested around \$60 billion, and other regions invested around \$65 billion, and they have been growing since 2015 (IEA 2019a). A report by the OECD has shown that investments in energy efficiency will have to grow by eight times between 2011-2035, jumping from \$130 billion to \$1100 billion.

billion to meet the climate change goals of the 2015 Paris Agreement on Climate Change, demonstrating the importance of investments in energy efficiency (OECD 2016).

A number of international organisations have set up dedicated budgets and funds to tackle climate change. Responding to calls for more action on climate change, the EIB announced new climate ambitions in late 2019. One of them is to support investment in climate action and environmental sustainability worth one trillion EUR from 2021 to 2030. The EIB and European Commission are already at the forefront of climate action and run various initiatives and programmes aimed at cutting emissions and increasing energy efficiency. One example is the ‘Smart Finance for Smart Buildings Initiative’, which aims to unlock billions of euros in public and private energy efficiency investment. The European Local Energy Assistance facility (ELENA) programme is another example. ELENA has provided more than €168 million in grants for technical assistance on energy efficiency and renewable energy in buildings, homes, and urban transport. The 95 projects supported by ELENA so far, are expected to lead to over €6 billion in investment in energy and transport efficiency. (EIB 2019).

Organisations such as the World Bank Group place emphasis on the importance of energy efficiency. The World Bank Group, through the International Finance Corporation (IFC), promotes sustainable growth and development of the private sector by investing in critical resource efficiency projects (World Bank 2017). The World Bank has also stated other development benefits of energy efficiency including enhanced energy security, improved reliability in the power-system, reduced pressure on budgets nationally and in households, increased competitiveness, and improved performance in critical areas like health and education. IFC have supported various programmes across the world including China and India, where they have provided over \$925 million to help improve energy efficiency to help meet climate change goals and address challenges in the energy sector (World Bank 2017).

However, despite the enormous potential of energy efficiency contributing to decrease greenhouse gas emissions and boost economic growth, the progress rate worldwide is slowing (IEA 2019b). This slowdown has major implications for businesses, consumers, governments and the environment. The strength of mandatory policies is also stagnating increasing by less than 0.5% in 2018 from 2017. Although \$240 billion was invested in 2018, levels of investment in energy efficiency have remained at a similar level since 2014, which is well below the amount that is needed to achieve the cost-effective opportunities available (IEA 2019b).

The amount of investments but also the lack of growth in capturing cost-effective opportunities in energy efficiency highlights the importance of obtaining clear evidence on which types of energy efficiency programmes work most effectively.

### **1.2.2 Existing impact evaluations and evidence synthesis**

Given the high value of current energy efficiency investments as well as the expectation for this to increase in the future, it is of primary importance to understand which interventions work most effectively and the impacts that can be attributed to the energy efficiency programmes (Gillingham 2018, Ferraro 2009, Shiller 2007, Vine 2006, Frondal 2005).

To estimate unbiased effects of a programme/project/policy the most effective are impact evaluations that use counterfactual analysis. This methodology permits the isolation of the project’s effects from unknown variables which cause confounding due to the timing and location of the environmental program (Gillingham 2018, Ferraro 2009, Shiller 2007, Vine 2006, Frondal 2005). Counterfactual analysis makes use of experimental and quasi-experimental methods to draw inferences about programme effectiveness of behavioural theories which generate dubious predictions about environmental program impacts (Ferraro 2009). After conducting some exploratory work, a considerable number of studies that use rigorous methods have already identified. They evaluate, for instance, weatherization programs (Fowlie 2018), building code policies (Kotchen 2017), smart meters and feedback information (Shimada et al.

2015), light-bulb market interventions (Allcott et al. 2015), energy audits in the industrial sector (Duflo et al. 2013), and the uptake of efficient cookstoves in developing countries (Bensch et al 2015, Calzada et al. 2018) to mention some of them. These early findings suggest that the high-quality evidence<sup>2</sup> in this field is vast and there is an emerging need to synthesise and draw lessons from it.

There have been some efforts to synthesize the evidence on various energy efficient interventions such as industrial energy efficiency and non-energy benefits (Rasmussen 2017, Nehler 2018, Solnørddal & Foss 2018), social effects and costs of energy efficiency (Kamal et al. 2019), and interventions in buildings (Gonzalez-Caceres et al. 2019, Kivimaa & Martiskainen 2017). Other syntheses were focused on non-price interventions (Andor & Fels 2018), household energy efficiency interventions (Russell-Bennett et al. 2019), and finally Tsang and colleagues (Tsang et al. 2012) have assessed and mapped high-quality impact evaluations of energy-use households behaviours interventions. However, these are systematic reviews that, for their nature, often are focused only on one or a few specific interventions types, while an evidence gap map has the additional value to give a broader picture of the evidence in the sector and show the evidence gaps.

The aim of this map is to create a comprehensive review of high-quality evidence from both HICs and LMICs on interventions that promote and facilitate the uptake of energy efficiency technologies and practices. This evidence gap map will provide a fuller overview of experimental and quasi-experimental studies of policies, programmes, projects, and schemes that aim to increase the uptake of energy efficient technologies and practices at the households, public institutions, and business and industry level. This exercise will provide researchers, practitioners, commissioners, and policy makers a better understanding of the available evidence in the sector and the clusters of studies that can be synthesised to understand the effectiveness of certain interventions.

### 1.3 Study objectives and questions

The project is divided in two phases:

**Phase 1:** creation of an Evidence Gap Map to identify the existing evidence

**Phase 2:** realisation of a Systematic Review, based on the results from the map

The EGM will identify and describe the available evidence related to the effects of energy efficiency (EE) interventions at the household, public institutions, and business and industry level around the world. Mapping the evidence that assesses the effectiveness of these interventions will identify the gaps in the literature<sup>3</sup> where the number of evaluations or synthesis efforts are low. It will also facilitate the use of evidence to inform decisions by making this evidence easily accessible. The specific objectives of this EGM are fourfold:

- Identify and describe the evidence on the effects of interventions to promote energy efficiency technologies and practices around the world;
- Improve access to this evidence for policy makers, project implementers and researchers;
- Identify potential primary evidence and synthesis gaps;

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<sup>2</sup> High-quality evidence in this field is referred to impact evaluations that use one of the methods listed in section 2.2.4.

<sup>3</sup> Literature is here intended as impact evaluations and effectiveness systematic reviews.

- Plan a systematic review (SR) on one of the clusters of evidence where no other SRs have been recently published.

### **Research questions:**

1. What is the extent and characteristics of empirical evidence<sup>4</sup> on the effects of energy efficiency (EE) interventions to promote the uptake of EE technologies and practices?
2. What are the major gaps in the primary evidence base?
3. What intervention/outcome areas should be prioritised for primary research and/or evidence synthesis?

## **2 Scope of the EGM**

### **2.1 Conceptual framework and theory of change**

A standard definition of energy efficiency is “the ratio of energy required to perform a specific service to the amount of primary energy used for the process. Improving energy efficiency increases the productivity of basic energy sources by providing given services with less energy resources” (Goswami and Kreith, 2007).

For the purpose of this Evidence Gap Map, the definition of energy efficiency has been narrowed down to focus on interventions that facilitate the uptake of technologies and services aimed at improving energy efficiency at the level of households, public institutions, business and industry.

A conscious decision has been taken not to add energy efficiency aspects of other sectors, such as transport or agriculture. This is not to deny that other sectors have important contributions to make to improving energy efficiency, but expanding the framework to include some additional sectors would have made it difficult to argue why others have been excluded – thus leading to a potentially very large map (which we could not deliver with the resources and time available for this Review).

Nonetheless, energy efficiency - even when focused on residential, public and commercial buildings, SMEs and industrial facilities - covers a broad area of intervention that cuts across different levels of society: individuals/ households, businesses, industry, as well as public institutions.

To build a framework of interventions and outcomes for energy efficiency for this EGM, the innovation diffusion model developed by Vine and colleagues has been used as basis to understand potential blockages in the adoption process (Vine et al. 2006). This model highlights the linkages between the development of energy efficiency technologies or services and their adoption in society, including market, information and/or behavioural failures which the energy efficiency interventions included in this EGM aim to overcome. The theory of change diagram below (see figure 1) provides a visual overview of the model.

Vines’ theory represents the innovation diffusion process in two main phases, the first one is called ‘build infrastructure’ and the second one ‘fund and promote adoption’. The first phase includes the development of technical information to make energy efficiency more accessible and implementable, this is followed by public entities adopting new frameworks to enable the take up of the innovation, and by firms and businesses create and enhance energy efficiency products, develop installation, and support

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<sup>4</sup> Empirical evidence: all the studies that use experimental methods and analyse of quantitative or qualitative data.



infrastructures. The second phase is focused on how to deliver the energy efficient technology or service to end-users in a way that enables them to effectively use it; this phase includes economic support, provision knowledge and decision support tool, technical assistance and information (Vine et al. 2006).

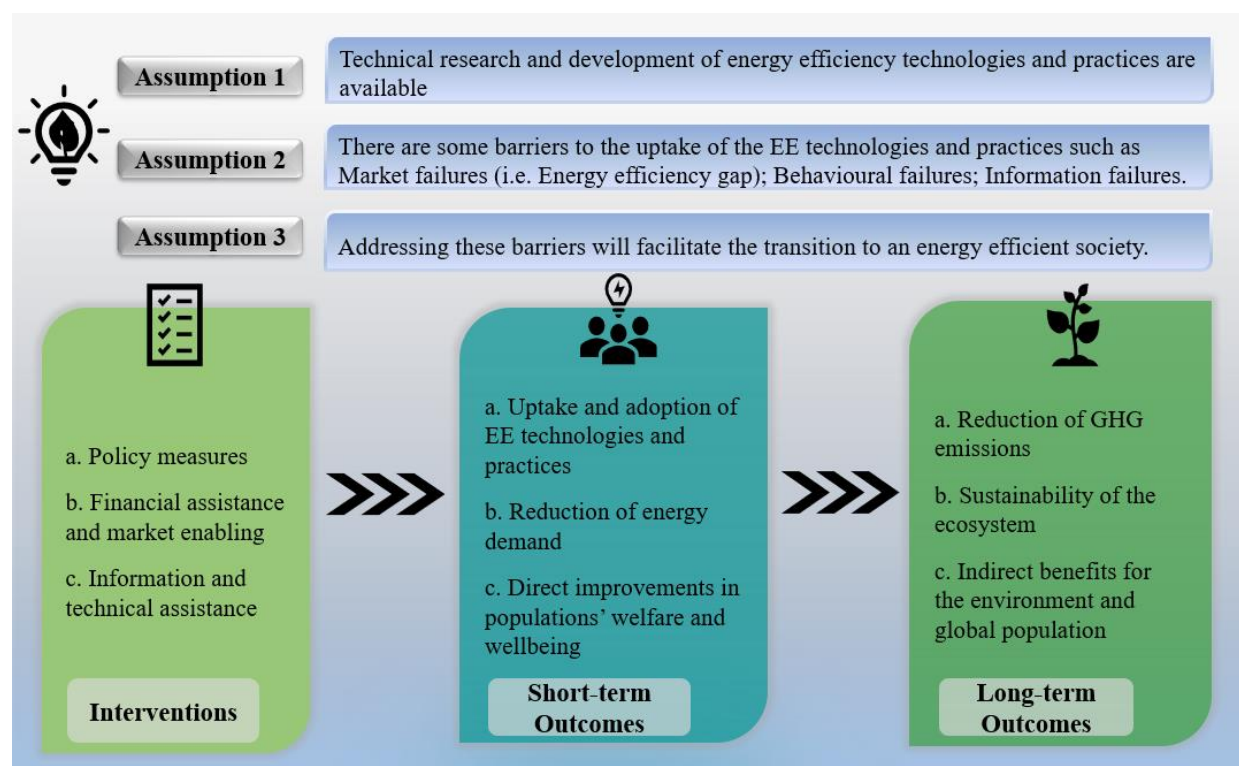
There are a number of barriers to the adoption of a new technology in the energy efficiency sector, including market failures, information failures and/or behavioural failures<sup>5</sup> (Allcott and Greenstone, 2012, Ramos 2015, Gillingham 2018). To address these issues, various interventions can be implemented at the policy, economic, and knowledge levels (Andor et al. 2018, Quansah et al 2017, Ramos 2015, Shiller 2007, Tsang et al. 2012, WB 2015). This map is focused on understanding the effectiveness of these interventions.

A simple conceptual framework for energy efficiency interventions is presented in Figure 2. It starts from an assumption that energy efficient technologies and services are available, but that financial, market, information and behavioural barriers prevent adoption and scale up. This gives rise to the need for specific interventions to overcome those barriers and improve the uptake, and ultimately achieve the energy efficiency and carbon emission reductions which motivate the development of the technology in the first place. The interventions have divided in four main types: policy measures that encourage or force the adoption of EE technologies/practices; interventions that provide economic assistance or facilitate the introduction of a technology/practice in the market; initiatives that increase the circulation of detailed information and technical assistance to support the adoption of EE technologies/practices. The implementation of these interventions will lead to short-term outcomes and long-term outcomes. In the short-term people at different levels of the society will start adopting EE technologies/practices which will lead to lower demand of energy (and fuel) with direct effect on their welfare (i.e. cheaper utility bills) and health (i.e. lower rate of pollution in the house with the adoption of efficient cookstoves). In the long-term, those improvements will reduce the GHG emissions contributing to sustain a balance ecosystem and long-term benefits both for the environment (i.e. slower global warming) and for the population (i.e. less respiratory diseases, migrations due to desertification/flood etc.).

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<sup>5</sup> Behavioural failures: unexpected and/or unintended people's behaviours that deviate from rational choice theory.

Figure 1: Theory of change



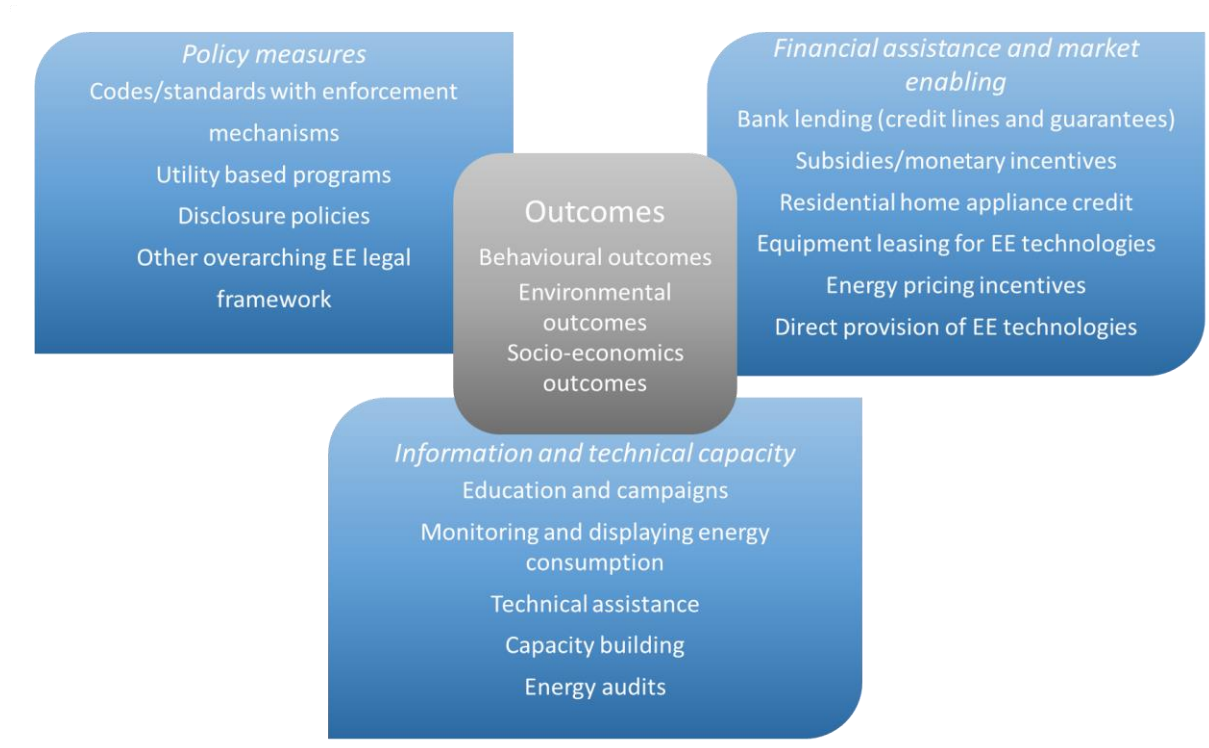
Source: Authors

To identify the interventions domains to insert in the framework of the map, we have adapted a simple framework on energy efficiency interventions from the World Bank (2015). Figure 2 shows a summarised list of the interventions types included in the framework. The intention is to give an overview of the different EE policies/projects/programme than are being implemented to promote the diffusion of EE technologies and practices within society.

The first group of interventions captures policies and regulations that encourage or oblige individuals, businesses, or other public institutions (i.e. municipalities) to become energy efficient, for instance by enforcing energy codes/standards for buildings. The second group of interventions is made up of all the economic and financial instruments that can be used to enable the adoption of a certain EE technology or service, such as bank lending, subsidies and cash transfers, or home appliance credits. The third group of interventions are those focusing on providing information and technical capacity with two broad objectives. Firstly, it includes interventions that enable people, companies and government agencies to acquire necessary technical skills and knowledge (i.e. capacity building, energy audits) to adopt energy efficient technologies and behaviours. Second, it also includes interventions that use information to nudge people, companies and government agencies to change their behaviours and use less energy, for example by providing them more information on the potential benefits (i.e. education, peer-comparison, feedback) of certain behaviours.

The outcomes captured in the EGM have been divided into three broad domains: intermediate/behavioural, environmental, and socio-economic outcomes. The first group includes any change in people's behaviour that lead to increased awareness of EE solutions; the second includes decrease in energy use, energy access, air pollution rates, and GHG emissions; socio-economic outcomes will capture, for instance, savings on energy bills, health status, and employment rate.

Figure 2: Interventions categories and outcomes included in the framework



Source: authors, adopted from (WB 2015)

### 3 Methods

#### 3.1 Overall methodological approach

We will follow the standards and methods for EGMs developed by 3ie (Snilstveit et al., 2016; Snilstveit et al., 2017). An evidence gap map aims to establish what we know, and do not know, about the effects of interventions in a thematic area (Snilstveit et al., 2016).

The map is populated by systematically searching and screening all relevant completed, and ongoing, impact evaluations and systematic reviews. The included studies are mapped onto the framework of interventions and outcomes and will be presented on an interactive platform which provides a graphical display of the evidence in a grid-like framework. This provides a visual display of the volume of evidence for intervention-outcome combination, the type of evidence (impact evaluation, systematic reviews, completed or ongoing), and a confidence rating of the quality for systematic reviews. The final map will be published on an online interactive platform that provides additional filters so that users can further explore the available evidence, for example by global regions, income levels, or population.

The interactive map will be accompanied by a report addressing the key research questions, including an analysis of the characteristics of the available evidence, key trends (i.e. number of impact evaluation published over the time, geography, focus on interventions and outcomes, targeted audiences).

Evidence gap maps highlight both absolute gaps, which should be filled with new primary studies, and synthesis gaps, which are ready for new systematic reviews and meta-analyses. They are envisioned as a

global public good, and this allows them to be used as a tool which facilitates access to high-quality research.

## 3.2 Criteria for including and excluding studies in the EGM

### 3.2.1 Population of interest

End-users of EE technology and practices such as households, public institutions, business and industries across the world.

### 3.2.2 Interventions

The interventions inserted in the map include projects, programmes, and policies that aim at increasing the adoption of EE technologies and practices as specified in section 2.1. They fall under three main domains as illustrated in the Figure 1: public institutions, fund assistance and market enabling, information and technical capacity.

Table 1: Interventions included in the framework

Domain	Category	Description
Policy measures	Codes/standards with enforcement mechanisms policies	The introduction of EE standards, for example, in the construction or renovation of buildings/houses to make them energy efficient, (i.e. building energy codes which are a subset of building codes, that establish baseline requirements and govern building construction to ensure energy efficiency)
	Utility based programs	Utility based programmes, are also called Energy Efficiency Obligations, Energy Savings Obligations and White Certificates. These mechanisms place obligations on utilities to find energy savings equivalent to a certain percentage of their energy sales; depending on the program design, utilities can invest in end-use efficiency with their customers, or purchase energy savings from third parties. Some schemes also allow for trading of the energy savings. (Denysenko et al. 2018)
	Disclosure policies	Disclosure policies seek to reduce information asymmetries between building owners and prospective investors or renters so that this information can factor into decision-making processes (Kontokosta et al. 2020). Disclosure laws improve, for example, consumers' awareness of the energy use of homes and buildings, which can have a significant impact on its economic value.
	Other overarching EE legal framework	Any type of law or policy framework that encourages users to adopt energy efficiency technologies/services
Financial assistance and market enabling	Bank lending (credit lines and guarantees)	Credit lines or green mortgages from local banks to support EE investments. They can be, for example, support the portfolio of EE smaller investments, or increase the energy efficiency of production process in factories/businesses/SMEs. Examples of this are:  - renovation of existing housing stock to adapt it to better preserve the temperature over different types of weather reducing the amount of energy to heat or cool the building/house (i.e. weatherization interventions, insulation, retrofit), or

		-energy efficient improvements in industrial facilities (i.e. interventions to increase the efficiency of factories' power plants by upgrading old ones, or replacing them with more efficient models); -upgrades of energy transmission systems to reduce the leakages and waste of energy.
	Subsidies/monetary incentives	Subsidies/monetary incentives (i.e. cash transfer) to uptake energy efficiency technologies/behaviours. For example, renovations, weatherisation, or purchases of more EE efficient technologies.
	Residential home appliance credit	Private or public credit lines for households to purchase more EE appliances.
	Energy pricing incentives	Interventions to change the energy price inducing reduction of energy consumption. This can be, for example, based on time-of use (TOU) pricing, aimed at reducing the energy consumption in peak hours. Another example is prepaid electricity meters.
	Provision of EE technology/services	Direct provision by public/private organisations of more efficient technologies (or appliances) to heat/cook, cool, and light up the house/building (i.e. replacement of old refrigerators and air-conditioners with energy-efficient models).
	Equipment leasing for EE technologies	Leasing schemes to adopt more efficient technologies, especially in the industrial sector.
<b>Information and technical capacity development</b>	Education and campaigns	Contagion processes such as education, communication campaigns, or peer comparison to nudge people to change their behaviours and practices for energy consumption. This could be delivered for instance, by flyers or face-to-face discussions to explain to consumers how to reduce their energy consumption by changing their behaviours and/or adopting a certain technology or service (i.e. pre-commitment and simplified information highlighting the new technology/practice benefits).
	Monitoring and displaying energy consumption	Interventions that provide households with their energy consumptions records inducing them to use less energy. Some examples are home energy reports, feedback, and smart meters delivered to the household (i.e. Power program)
	Technical assistance	Interventions that provide access to specific technical assistance to implement and scale up EE technologies/practices. This include, for example, one stop shop option, where information on potential opportunities and funding access for EE investments are available.
	Capacity building	Interventions to build people's or communities' capacity (including local authorities) to understand, implement, and use the energy efficient technologies, services, practices and behaviours by, for example, delivering training, workshops (i.e. training associated with the introduction of an energy efficient technology).
	Energy audits	Energy audit requirements aim to improve building owners' awareness of cost-effective EE technologies opportunities.

### 3.2.3 Outcomes

The outcomes are categorised into three main domains: behavioural change; environmental; and socio-economic. The list presented in Table 2 includes some examples of the outcomes that will be included in the map, but additional outcomes will be added as we go through the screening phase and we come across different outcomes.

Table 2: Outcomes included in the framework

Outcome Domain	Category	Description
<b>Intermediate/ Behaviour change</b>	Changes in awareness/attitudes	Those targeted by the programme recognise that their knowledge and attitudes toward EE options and opportunities has changed after the programme.
	Adoption of energy saving behaviours	Those targeted by the program decide to adopt energy savings practices such as switching off the lights more often, using less water, or following specific instructions.
	Uptake of the technology	Beneficiaries of the programme decide to act and uptake a certain technology.
	Upgrade of the efficient technology	Decision by the beneficiaries of the programme to act and <u>upgrade</u> a certain technology.
	Usage of the technology (once received)	Measurement of usage of the technology after it has been received (for examples disseminated by an organisation, or purchased by the beneficiaries).
	-other	
<b>Energy and environmental outcomes</b>	Energy net savings/consumption	Net energy or demand savings refer to the portion of gross savings that is attributable to the programme. This involves separating out impacts that are a result of other influences, such as consumer self-motivation. Given the range of influences on consumers' energy consumption, attributing changes to one cause (i.e., a particular programme) or another can be quite complex
	Energy security/access	Energy security is intended as the uninterrupted availability of energy sources at an affordable price. In this context, an EE intervention might have increased energy security by reducing the energy costs due to more efficiency technologies, for example.
	GHG emissions	Carbon related emissions (CO <sub>2</sub> ) and non carbon related emissions i.e. methane (CH <sub>4</sub> ), nitrous oxide (N <sub>2</sub> O) and fluorinated gases
	Water consumption	Net water consumption deriving from the EE intervention.
	Air quality index/pollutions rates	Air pollution or greenhouse gases that would have been emitted if more energy had been consumed in the absence of the energy efficiency program. These emissions can be from combustion of fuels at an electrical power plant or from combustion of heating fuels, such as natural gas and fuel oil, at a project site.

<b>Socio-economic outcomes</b>	Income savings	Increased economic savings due to more efficient new/upgraded equipment or changing energy savings behaviours.
	Health status, comfort and wellbeing	Better quality of life resulting from the adoption of EE technologies or practices that improve the living environment for examples, by reducing the air pollution rate, decreasing rate of illnesses, or increasing access to electricity.
	Job creation	New job creation due to the installation of new equipment or adoption of innovative practices that require more expert personnel or simply additional workers.
	Building stock value	Increased property value due to the installation of new equipment/renovation
	-other	

### 3.2.4 Types of study

We will include studies that look at the impact of an intervention aimed at promoting and adopting EE technologies and practices by overcoming financial, marketing, information, and behavioural barriers as explained in section 2.1. Specifically, we will include studies that adopt methods that estimate the effects that can be attributed to an intervention, as compared to what would have happened in the absence of the intervention. We define the specific criteria required for inclusion below, drawing on commonly accepted standards for impact evaluation (Gillingham 2018, Ferraro 2009, Shiller 2007, Vine 2006, Frondal 2005).

We will exclude any studies that do not fall under any of the criteria defined above. Examples of types of studies that will be excluded are simulation studies that aim to predict the effect of a certain technology, studies that assess the efficacy of a specific technology, observational studies with no control for selection bias, life-cycle analysis, feasibility studies, acceptability studies; and non-systematic literature reviews.

The reason for excluding these types of studies is that they either address different research questions, or they provide a high risk of biased estimates of intervention effects. For instance, efficacy trials are studies that look at the effectiveness of a specific intervention, but they are implemented in controlled settings, rather than in the real-world conditions, therefore the results might not be scaled up. Appendix E provides a more detailed definition of efficacy studies, drawing on the definitions included in existing tools (Gartlehner et al., 2006). Correlation studies provide results on the relationship between two variables, but it does not necessarily correspond to causality. On the other side, life-cycle assessments do not intend to look at the effectiveness of the intervention, but they rather focus their attention on the environmental impact of a technology/process/service during the stages of its lifecycle. Finally, feasibility studies look at the resources needed to implement a certain intervention rather than evaluating its effects.

#### Included study designs:

A) Prospective studies allocating the participants to the intervention using randomised or quasi-randomised mechanisms at individual or cluster levels:

1. Randomised control trial (RCT) with assignment at the individual or cluster level.
2. Quasi-RCT using a quasi-random method of prospective assignment (e.g. alternation of clusters)

- B) Non-randomised designs with selection on unobservable:
3. Natural experiments using methods like regression discontinuity (RD), where assignment is done on a threshold measured at pre-test, and the study uses prospective or retrospective approaches of analysis to control for unobservable confounding or which exploit natural randomness in implementation assignment by decision makers.
  4. Panel data or pseudo-panels with analysis to account for time-invariant unobservable (e.g. difference-in-difference, DID, or fixed- or random-effects models)
  5. Cross-sectional studies using multi-stage or multivariate approaches to account for unobservable (e.g. instrumental variable (IV) approaches such as two- or three-stage least squares procedures, or Heckman twostep estimation approaches)
  6. Interrupted time series (ITS)
  7. Cross-sectional or panel (controlled before and after) studies with an intervention and comparison group using methods to match individuals and groups statistically (e.g. propensity score matching) or control for observable confounding in adjusted regression.
  8. Synthetic controls
- D) Systematic reviews will be included if they describe the search, data collection and synthesis methods according to the 3ie database of systematic reviews protocols (Snilstveit et al. 2016).

### 3.3 Additional inclusion and exclusion criteria

- There are no restrictions in regards to geography or income status of the countries for which evidence is included in the map.
- We will include both ongoing and completed impact evaluations and systematic reviews.
- Timeframe: we will include papers published from 2000 onwards. EE is one of the fast-growing climate change sectors in the world with several new technologies, programmes and policies being developed each year and many other old ones modified as well as phased-out. Thus, focusing on studies published over the last 20 years will ensure that the EGM identifies and describes the EE evidence that is relevant to the contemporary world. For instance, the evidence relating to the effects of EE interventions in 1970's would not be of much use and may distort the evidence base if such interventions are no longer in use or have been adapted.
- Agriculture and transport sectors are excluded. We recognise that increase the energy efficiency in these two sectors is crucial to fight climate change; however, for pragmatical reasons, the map will be focused on interventions in the buildings/houses, and industrial systems.
- We will not exclude studies on the basis of language, but the search will at least initially focus on English language databases. Where non-English studies are identified in the search results these will be included provided resources are available to do so.



### 3.4 Search strategy

This project will implement a sensitive search strategy<sup>6</sup> primarily constructed by a combination of intervention and study design terms. The strategy has been developed by an information specialist and an example of the strategy developed for Cab Abstracts Search is provided in Appendix A.2. The strategy will be translated<sup>7</sup> according to the requirements and functionalities of different databases.

The search for evidence will be conducted using a range of different sources of academic and grey literature, including bibliographic databases (a combination of general social science and environmental-focused databases), repositories of impact evaluations and systematic reviews, specialist organisational databases and websites of bilateral and multilateral agencies. An additional list of websites consulted can be found in Appendix A.1.

Academic databases:

- CAB Abst
- Greenfile
- Econlit
- Repec
- WB e-lib
- Scopus and/or
- WoS (SCI & SSCI)
- Academic Search Complete

Specialist organizational databases, which might include evidence on digital interventions in the energy sector:

- Environmental and Energy Study Institute EESI
- Institute of the Environmental and sustainability
- Institute for European Energy and climate policy
- E2e, group of economists focused on energy efficiency and IEs
- eScholarship University of California
- International Energy Agency (IEA)

Backwards citation tracking of systematic reviews that meet our inclusion criteria, as well as any relevant non-systematic reviews and guidelines identified to identify additional studies will also be conducted. Once the draft EGM is completed, it will be circulated to key experts and stakeholders to identify any studies not already identified.

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<sup>6</sup> Sensitive search strategy: sensitive it is here synonym of comprehensiveness in relation to the types of studies that can be captured in a search strategy. An increase of sensitivity of a search will reduce its precision and will retrieve more non-relevant articles (Higgings et al 2011).

<sup>7</sup> The search strategy run in different databases make us of strings of key words, often truncated and wildcards variations of the same terms, linked between them with Boolean operators (AND, OR, NOT or proximity operator (N3, N5 etc.). These operators are different for each database so they need to be 'translated'.

### 3.5 Screening protocol

The search results will be imported into the systematic review software “EPPI-reviewer4”. This platform will be used to manage references, identify and remove duplicate studies, and screen records for inclusion using the procedures outlined below.

**Title and abstract screening (TAS):** double screening will be combined with EPPI-reviewer’s machine learning functionality to speed up the screening process. Initially, a randomly selected set of around 800-1000 studies will be screened to provide a training to the team. During the training the results given by the researchers will be compared, and any discrepancy in coding decisions will be discussed, including a clarification of the inclusion criteria as needed. The results of this training will be used as a base for the machine-learning algorithm, specifically the classifier functionality which is used to prioritise studies for screening according to their likelihood of inclusion. The entire screening process will continue with a double screening approach where each abstract is screened by two independent researchers and any disagreement is reconciled with the supervision of a senior review team member.

**Full text screening (FTS):** for each study that meets all the TAS inclusion criteria the full text will be retrieved. Two reviewers from the core team will independently examine each full text in detail against the protocol again and will decide to include it or not. The output of this stage will be a set of studies deemed suitable to be included in the EGM. Any disagreements between reviewers will be reconciled with the supervision of a senior review team member.

### 3.6 Data extraction and critical appraisal

**Data extraction:** for both impact evaluations and systematic reviews, data extraction templates will be modified from 3ie’s repository coding protocol and the coding protocols typically used for EGMs. This includes bibliographic, geographic information and substantive data, as well as standardised methods information and data on how studies address equity considerations<sup>8</sup>. In addition, data on interventions (category and intervention description), outcomes (category and outcome definition), population, cost-effectiveness data and timeframe of intervention will be extracted (see the data extraction tool in Appendix B).

**Critical appraisal:** all included systematic reviews will be critically appraised following the practices adopted by 3ie systematic review database protocol, which draws on Lewin et al. (2009). This appraisal assesses systematic review validity according to criteria relating to the search, screening, data extraction, and synthesis activities conducted, and covers all the most common areas where biases can be introduced. Each systematic review will be rated as low, medium, or high confidence drawing on guidance provided in Snilstveit et al. (2017). The project will not critically appraise primary studies, as this is typically beyond the scope of an EGM ( however, the studies will be critically appraised in the systematic review). The tool used for this process is presented in Appendix C.

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<sup>8</sup> This is referred to the SDG n.10 on ‘the social, economic and political inclusion of all, irrespective of age, sex, disability, race, ethnicity, origin, religion or economic or other status.’ It also asks for a commitment to promote ‘equal opportunity and reduce inequalities of outcomes, including by eliminating discriminatory laws, policies and practices and promoting appropriate legislation, policies and action in this regard.’ At the data extraction level, we extract this information to know how the studies that we include in the map take in consideration these aspects.

### 3.7 Final data analysis of the results and dissemination

We will conduct a range of descriptive analyses to provide an overview of included studies across the following dimensions:

- Publication year
- Publication type
- Geography, including national-level income level
- Study participants
- Interventions
- Outcomes
- Study designs
- Study type characteristics
- Results of the systematic review critical appraisal
- Equity and cross cutting themes considerations, e.g. climate change and gender

Where appropriate, we will consider running cross-tabs to provide more nuanced answers to project research questions. We will produce the following analytical outputs:

- **Interactive EGM:** An interactive evidence gap map that visually presents the current evidence base that is categorised by coverage with respect to the pre-determined intervention-outcome framework, quality and completeness. Filters can be incorporated into the map to enable more targeted use – for example, by restricting the studies to a specific unit of analysis.
- **EGM technical report:** The EGM technical report will include a detailed overview of the method, Theory of Change and the key results of the EGM. It will provide high level of analytical details and will be supported by technical annexes. The report will conclude by directly addressing the key research questions stated in Section 2 and provide a set of research, funding, and policy implications.

It may also be beneficial to produce more analytical outputs as the specific needs and interests of key stakeholder groups are identified. For example, it may be of interest to produce short policy brief reports that focus on the implications of the map for policy makers and implementers. The gap analysis will also inform Phase 2 of the project by indicating a potential area to synthesize in the systematic review.



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## 2. Annex

- A. Search strategy
- B. Data extraction tool
- C. Critical appraisal tool for systematic review
- D. Advisory Group

### A Search strategy

#### A.1 Additional Websites consulted for the search strategy

Repositories of evaluations and systematic reviews:

- 3ie Repository of Impact Evaluations
- 3ie RIDIE (Registry for International Development Impact Evaluations):
- African Development Bank (AfDB)
- AgEcon
- Asian Development Bank (ADB)
- BREAD
- CARE International
- Catholic Relief Services
- Center for Effective Global Action (CEGA)
- Centre for Public Impact
- Chemonics International
- Design, Monitoring and Evaluation for Peace
- DFID Research for Development (R4D)
- EGAP (Evidence in Governance and Politics) links from working papers or policy briefs, etc.
- GEF (Global Environmental Facility) evaluation database
- Global Facility for Disaster Reduction and Recovery
- ICNL Research Centre

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- IDEAS / REPEC
- IFPRI
- Independent Development Evaluation, AfDB
- Innovations for Poverty Action (IPA)
- Inter-American Development Bank Publications
- International Growth Centre (IGC) at LSE
- IRC
- J-Poverty Action Lab (J-PAL)
- Locus (International Development Coalition)
- LSE ICG
- Mercy Corps
- Open Governance Partnership
- Oxfam International
- RePEc (via EBSCO Discovery):
- RTI International
- Samuel Hall (evaluations)
- Transparency International (TI):
- United Nations Evaluation Group
- USAID Development Clearing House
- World Bank E-Library (via EBSCO Discovery):
- World Bank Open Knowledge Repository
- World Vision

## A.2 Example of search strategy

### Revised CAB Abstracts Search – 30<sup>th</sup> April 2020

**S20 S18 AND S19**

**2,802**

S19 TI ( (((experimental OR “quasi experiment\*” OR quasi-experiment\* OR “random\* control\* trial\*” OR "random\* trial\*" OR RCT\* or (random\* N3 allocat\*) OR evaluat\* OR impact\* OR assess\* OR dif-dif OR PSM OR “double difference” OR difference-in-difference OR RDD OR “difference in difference” OR “statistical matching\*” OR “propensity score matching” OR “covariate matching” OR “coarsened-exact matching” OR “propensity-weighted” OR “regression analysis” OR “multiple regression” OR “statistical regression” OR “regression discontinuity\*” OR “experimental design” OR “cohort analysis” OR “quantitative method\*” OR “program evaluation” OR “interrupted time series” OR ITS OR (before N5 after) OR (pre N5 post) OR ((pretest OR "pre test") and (posttest OR "post test")) OR (“fixed effect\*” OR “random effect\*” N3 (model OR estimation)) OR “instrumental variable” OR “synthetic control”) ) OR ((quantitative or "comparison group\*" or counterfactual or "counter factual" or counter-factual or experiment\*) N3 (design or study or analysis)))) ) OR AB ( (((experimental OR “quasi experiment\*” OR quasi-experiment\* OR “random\* control\* trial\*” OR "random\* trial\*" OR RCT\* or (random\* N3 allocat\*) OR evaluat\* OR impact\* OR assess\* OR dif-dif OR PSM OR “double difference” OR difference-in-difference OR RDD OR “difference in difference” OR “statistical matching\*” OR “propensity score matching” OR “covariate matching” OR “coarsened-exact matching” OR “propensity-weighted” OR “regression analysis” OR “multiple regression” OR “statistical regression” OR “regression

discontinuity\*" OR "experimental design" OR "cohort analysis" OR "quantitative method\*" OR "program evaluation" OR "interrupted time series" OR ITS OR (before N5 after) OR (pre N5 post) OR ((pretest OR "pre test") and (posttest OR "post test")) OR (("fixed effect\*" OR "random effect\*" N3 (model OR estimation)) OR "instrumental variable" OR "synthetic control") OR ((quantitative or "comparison group\*" or counterfactual or "counter factual" or counter-factual or experiment\*) N3 (design or study or analysis)))) ) OR SU ( (((experimental OR "quasi experiment\*" OR quasi-experiment\* OR "random\* control\* trial\*" OR "random\* trial\*" OR RCT\* or (random\* N3 allocat\*) OR evaluat\* OR impact\* OR assess\* OR dif-dif OR PSM OR "double difference" OR difference-in-difference OR RDD OR "difference in difference" OR "statistical matching\*" OR "propensity score matching" OR "covariate matching" OR "coarsened-exact matching" OR "propensity-weighted" OR "regression analysis" OR "multiple regression" OR "statistical regression" OR "regression discontinuity\*" OR "experimental design" OR "cohort analysis" OR "quantitative method\*" OR "program evaluation" OR "interrupted time series" OR ITS OR (before N5 after) OR (pre N5 post) OR ((pretest OR "pre test") and (posttest OR "post test")) OR (("fixed effect\*" OR "random effect\*" N3 (model OR estimation)) OR "instrumental variable" OR "synthetic control") OR ((quantitative or "comparison group\*" or counterfactual or "counter factual" or counter-factual or experiment\*) N3 (design or study or analysis)))) ) Limiters - Publication Year: 2000-2020

3,283,797

S18 S1 OR S2 OR S3 OR S4 OR S5 OR S6 OR S7 OR S8 OR S9 OR S10 OR S11 OR S12 OR S13 OR S14 OR S15 OR S16 OR S17

4,689

S17 TI ( ((energy or electricity or fuel) N2 (efficien\* OR use\* or usage or saving\* or conserv\* or demand\* or low-carbon or sustainable)) N6 (((power or electric\*) N3 (plant or plants or source\*)) N5 (upgrad\* or renew\* or modernis\* or moderniz\* or improv\* or renovat\* or regenerat\*)) ) OR AB ( ((energy or electricity or fuel) N2 (efficien\* OR use\* or usage or saving\* or conserv\* or demand\* or low-carbon or sustainable)) N6 (((power or electric\*) N3 (plant or plants or source\*)) N5 (upgrad\* or renew\* or modernis\* or moderniz\* or improv\* or renovat\* or regenerat\*)) ) OR SU ( ((energy or electricity or fuel) N2 (efficien\* OR use\* or usage or saving\* or conserv\* or demand\* or low-carbon or sustainable)) N6 (((power or electric\*) N3 (plant or plants or source\*)) N5 (upgrad\* or renew\* or modernis\* or moderniz\* or improv\* or renovat\* or regenerat\*)) ) Limiters - Publication Year: 2000-2020

29

S16 TI ( ((energy or electricity or fuel) N2 (efficien\* OR use\* or usage or saving\* or conserv\* or demand\* or low-carbon or sustainable)) N6 (((national N3 (grid or network\*)) or infrastructur\*) N3 (upgrad\* or renew\* or modernis\* or moderniz\* or improv\* or renovat\* or regenerat\*)) ) OR AB ( ((energy or electricity or fuel) N2 (efficien\* OR use\* or usage or saving\* or conserv\* or demand\* or low-carbon or sustainable)) N6 (((national N3 (grid or network\*)) or infrastructur\*) N3 (upgrad\* or renew\* or modernis\* or moderniz\* or improv\* or renovat\* or regenerat\*)) ) OR SU ( ((energy or electricity or fuel) N2 (efficien\* OR use\* or usage or saving\* or conserv\* or demand\* or low-carbon or sustainable)) N6 (((national N3 (grid or network\*)) or infrastructur\*) N3 (upgrad\* or renew\* or modernis\* or moderniz\* or improv\* or renovat\* or regenerat\*)) ) Limiters - Publication Year: 2000-2020

S15 TI ( ((energy or electricity or fuel) N2 (efficien\* OR use\* or usage or saving\* or conserv\* or demand\* or low-carbon or sustainable)) N6 ((Renovat\* or renew\* or improv\* or restor\* or refurbish\* or rehabilitat\* or overhaul\* or refit\* or modernis\* or moderniz\* or insulat\* or weatheri\* or retrofit\* or weatherproof\* or "weather proof\*") N3 (building\* or "built environment\*" or home or homes or housing or house or houses or residen\* or domestic or dwelling\* or domicile\*)) ) OR AB ( ((energy or electricity or fuel) N2 (efficien\* OR use\* or usage or saving\* or conserv\* or demand\* or low-carbon or

sustainable)) N6 ((Renovat\* or renew\* or improv\* or restor\* or refurbish\* or rehabilitat\* or overhaul\* or refit\* or modernis\* or moderniz\* or insulat\* or weatheri\* or retrofit\* or weatherproof\* or "weather proof\*") N3 (building\* or "built environment\*" or home or homes or housing or house or houses or residen\* or domestic or dwelling\* or domicile\*)) ) OR SU ( ((energy or electricity or fuel) N2 (efficien\* OR use\* or usage or saving\* or conserv\* or demand\* or low-carbon or sustainable)) N6 ((Renovat\* or renew\* or improv\* or restor\* or refurbish\* or rehabilitat\* or overhaul\* or refit\* or modernis\* or moderniz\* or insulat\* or weatheri\* or retrofit\* or weatherproof\* or "weather proof\*") N3 (building\* or "built environment\*" or home or homes or housing or house or houses or residen\* or domestic or dwelling\* or domicile\*)) ) Limiters - Publication Year: 2000-2020

98

S14 TI ( ((energy or electricity or fuel) N2 (efficien\* OR use\* or usage or saving\* or conserv\* or demand\* or low-carbon or sustainable)) N6 ((provide or provision or donat\* or supply or deliver\* or equip or equipped or equipping) N3 (public/private or government\* or "local authorit\*" or state or business\* or commerc\* or enterprise\*)) ) OR AB ( ((energy or electricity or fuel) N2 (efficien\* OR use\* or usage or saving\* or conserv\* or demand\* or low-carbon or sustainable)) N6 ((provide or provision or donat\* or supply or deliver\* or equip or equipped or equipping) N3 (public/private or government\* or "local authorit\*" or state or business\* or commerc\* or enterprise\*)) ) OR SU ( ((energy or electricity or fuel) N2 (efficien\* OR use\* or usage or saving\* or conserv\* or demand\* or low-carbon or sustainable)) N6 ((provide or provision or donat\* or supply or deliver\* or equip or equipped or equipping) N3 (public/private or government\* or "local authorit\*" or state or business\* or commerc\* or enterprise\*)) ) Limiters - Publication Year: 2000-2020

21

S13 TI ( ((energy or electricity or fuel) N2 (efficien\* OR use\* or usage or saving\* or conserv\* or demand\* or low-carbon or sustainable)) N6 (pricing or price or prices or cost\* or time-of-use or tou or prepaid or pre-paid or tariff\* or invoic\*) ) OR AB ( ((energy or electricity or fuel) N2 (efficien\* OR use\* or usage or saving\* or conserv\* or demand\* or low-carbon or sustainable)) N6 (pricing or price or prices or cost\* or time-of-use or tou or prepaid or pre-paid or tariff\* or invoic\*) ) OR SU ( ((energy or electricity or fuel) N2 (efficien\* OR use\* or usage or saving\* or conserv\* or demand\* or low-carbon or sustainable)) N6 (pricing or price or prices or cost\* or time-of-use or tou or prepaid or pre-paid or tariff\* or invoic\*) ) Limiters - Publication Year: 2000-2020

2,064

## B Data extraction tool

In addition to the data specified in Annex 1, the project will extract data from included studies in line with Table B1 below.

### B.1 Summary of descriptive codebook

Coder Name	Source	Description
line_id	IER	See Annex 1
database_source	IER	See Annex 1
study_id	IER	See Annex 1

<b>title_name</b>		IER	See Annex 1
<b>foreign_title</b>		IER	See Annex 1
<b>language</b>		IER	See Annex 1
<b>author information</b>	author_name	IER	See Annex 1
	author_ranking	IER	See Annex 1
	author_affiliation_institution	IER	See Annex 1
	author_affiliation_institution_department	IER	See Annex 1
	author_affiliation_country	IER	See Annex 1
<b>publication information</b>	publication_type	IER	See Annex 1
	doi	IER	See Annex 1
	abstract	IER	See Annex 1
	journal_name	IER	See Annex 1
	journal_volume	IER	See Annex 1
	journal_issue	IER	See Annex 1
	pages	IER	See Annex 1
	year_of_publication	IER	See Annex 1
	url	IER	See Annex 1
open_access	IER	See Annex 1	
<b>sector information and equity</b>	sector_name	IER	See Annex 1
	sub-sector_name	IER	See Annex 1
	first_theme	IER	See Annex 1
	sub-theme_1	IER	See Annex 1
	second_theme	IER	See Annex 1
	sub-theme_2	IER	See Annex 1
	third_theme	IER	See Annex 1
	sub-theme_3	IER	See Annex 1
	other_topics	IER	See Annex 1
	equity_focus	IER	See Annex 1
	equity_dimension	IER	See Annex 1
	equity_description	IER	See Annex 1
	keywords	IER	See Annex 1
<b>geographic information</b>	continent_name	IER	See Annex 1
	country_name	IER	See Annex 1
	country_income_level	IER	See Annex 1
	FCV_status	IER	See Annex 1
	region_name	IER	See Annex 1
	state/province_name	IER	See Annex 1
	district_name	IER	See Annex 1
	city/town_name	IER	See Annex 1
	location_name	IER	See Annex 1
<b>methodological information</b>	evaluation_design	IER	See Annex 1
	evaluation_method	IER	See Annex 1
	mixed_method	IER	See Annex 1
	additional_methods1	IER	See Annex 1
	additional_methods2	IER	See Annex 1
	unit_of_observation	IER	See Annex 1
<b>program, funding &amp; implementation</b>	project_name	IER	See Annex 1
	implementation_agency_category	IER	See Annex 1
	implementation_agency_name	IER	See Annex 1
	program_funding_agency_category	IER	See Annex 1
	program_funding_agency_name	IER	See Annex 1

	researching_funding_agency_category	IER	See Annex 1
	researching_funding_agency_name	IER	See Annex 1
<b>Population targeting</b>	age	Additional	<2; <5; <18; 18>; multiple
<b>Population targeting</b>	sex	Additional	Male; Female; Both
<b>Population targeting</b>	rural_urban	Additional	Rural; Urban; Both
<b>Cost</b>	cost_data	Additional	Report any cost data?
<b>Cost</b>	cost_description	Additional	Verbatim from study
<b>Framework - Intervention</b>	intervention_main_group	Additional	EGM coding
<b>Framework - Intervention</b>	intervention_subgroup	Additional	EGM coding
<b>Intervention EE technology/service</b>	technology_services	Additional	Verbatim from study
<b>Framework - Intervention</b>	intervention_description	Additional	EGM coding
<b>Societal level</b>	levels	Additional	Public institutions, Households, firms/business
<b>Framework - Outcome</b>	outcome_main_group	Additional	EGM coding
<b>Framework - Outcome</b>	outcome_subgroup	Additional	EGM coding
<b>Framework - Outcome</b>	outcome_description	Additional	EGM coding
<b>Time Spent</b>	time_spent	Additional IER	Time spent coding (mins)

Source: 3ie (2020).

## **C            Critical appraisal tool for systematic reviews**

- (1) Existing record on database:
- (2) Title:
- (3) Author:
- (4) Geographical coverage:
- (5) Sector:
- (6) Sub-sector:
- (7) Equity focus:
- (8) Status:
- (9) Review type:
- (10) Quantitative synthesis method, if applicable:
- (11) Qualitative synthesis method, if applicable:
- (12) Background:
- (13) Objectives:
- (14) Findings:
  - Headline findings:
  - Evidence findings:
  - Policy and implementation findings:
  - Research implications:
- (15) Methodology:
- (16) Applicability/external validity:
- (17) Publication Source:
- (18) Downloadable link:
- (19) Contact details of corresponding author/s:
- (20) Summary of quality assessment (from C3 in checklist below):



**C.1 Checklist for making judgements about how much confidence to place in a systematic review of effects.**

This checklist has been adapted from Supporting the Use of Research Evidence (SURE) Collaboration. SURE, checklist for making judgements about how much confidence to place in a systematic review. In SURE guides for preparing and using policy briefs. [www.evipnet.org/sure](http://www.evipnet.org/sure)

Question	Criteria
<b>Section A: Methods used to identify, include and critically appraise studies</b>	
<p><b>A.1 Were the criteria used for deciding which studies to include in the review reported?</b></p> <p>Did the authors specify:</p> <ul style="list-style-type: none"> <li>▪ Types of studies</li> <li>▪ Participants/ settings/ population</li> <li>▪ Intervention(s)</li> <li>▪ Outcome(s)</li> </ul>	<p>Yes; partially; no; can't tell</p> <p>Coding guide - check the answers above</p> <p>YES: All four should be yes</p> <p>NO: All four should be no</p> <p>PARTIALLY: Any other</p>
<p><b>A.2 Was the search for evidence reasonably comprehensive?</b></p> <p>Were the following done:</p> <ul style="list-style-type: none"> <li>▪ Language bias avoided (no restriction of inclusion based on language)</li> <li>▪ No restriction of inclusion based on publication status</li> <li>▪ Relevant databases searched (<u>Minimum criteria</u>: All reviews should search at least one source of grey literature such as Google; for health: Medline/ Pubmed + Cochrane Library; for social sciences IDEAS + at least one database of general social science literature and one subject specific database)</li> <li>▪ Reference lists in included articles checked</li> <li>▪ Authors/experts contacted</li> </ul>	<p>Yes; partially; no; can't tell</p> <p>Coding guide - check the answers above:</p> <p>YES: All five should be yes</p> <p>PARTIALLY: Relevant databases and reference lists are both reported</p> <p>NO: Any other</p>

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United States of America

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Tel: +1 202 629 3939

Question	Criteria
<p><b>A.3 Does the review cover an appropriate time period?</b></p> <p>Is the search period comprehensive enough that relevant literature is unlikely to be omitted?</p>	<p>Yes; can't tell (only use if no information about time period for search); no; unsure</p> <p>Coding guide:</p> <p>YES: Generally, this means searching the literature at least back to 1990</p> <p>NO: Generally, if the search does not go back to 1990</p> <p>CAN'T TELL: No information about time period for search</p> <p>Note: With reference to the above – there may be important reasons for adopting different dates for the search, e.g. depending on the intervention. If you think there are limitations with the timeframe adopted for the search which have not been noted and justified by the authors, you should code this item as a NO and specify your reason for doing so in the comment box below. Older reviews should not be downgraded, but the fact that the search was conducted some time ago should be noted in the quality assessment. Always report the time period for the search in the comment box.</p>
<p><b>A.4 Was bias in the selection of articles avoided?</b></p> <p>Did the authors specify:</p> <ul style="list-style-type: none"> <li>▪ Independent screening of full text by at least 2 reviewers</li> <li>▪ List of included studies provided</li> <li>▪ List of excluded studies provided</li> </ul>	<p>Yes; partially; no</p> <p>Coding guide:</p> <p>YES: All three should be yes, although reviews published in journals are unlikely to have a list of excluded studies (due to limits on word count) and the review should not be penalised for this.</p> <p>PARTIALLY: Independent screening and list of included studies provided are both reported</p> <p>NO: All other. If list of included studies provided, but the authors do not report whether or not the screening has been done by 2 reviewers review is downgraded to NO.</p>
<p><b>A.5 Did the authors use appropriate criteria to assess the quality and risk of bias in analysing the studies that are included?</b></p> <ul style="list-style-type: none"> <li>▪ The criteria used for assessing the quality/ risk of bias were reported</li> <li>▪ A table or summary of the assessment of each included study for each criterion was reported</li> <li>▪ Sensible criteria were used that focus on the quality/ risk of bias (and not other qualities of the studies, such as precision or applicability/external validity). “Sensible” is defined as a recognised quality appraisal tool/ checklist, or similar tool which assesses bias in included studies. Please see footnotes for details of the main types of bias such a tool should assess.</li> </ul>	<p>Yes; partially; no</p> <p>Coding guide:</p> <p>YES: All three should be yes</p> <p>PARTIALLY: The first and third criteria should be reported. If the authors report the criteria for assessing risk of bias and report a summary of this assessment for each criterion, but the criteria may be only partially sensible (e.g. do not address all possible risks of bias, but do address some), we downgrade to PARTIALLY.</p> <p>NO: Any other</p>



Question	Criteria
<p><b>A.6 Overall – how much confidence do you have in the methods used to identify, include and critically appraise studies?</b></p> <p>Summary assessment score A relates to the 5 questions above.</p> <p>High confidence applicable when the answers to the questions in section A are all assessed as ‘yes’</p> <p>Low confidence applicable when any of the following are assessed as ‘NO’ above: not reporting explicit selection criteria (A1), not conducting reasonably comprehensive search (A2), not avoiding bias in selection of articles (A4), not assessing the risk of bias in included studies (A5)</p> <p>Medium confidence applicable for any other – i.e. section A3 is assessed as ‘NO’ or can’t tell and remaining sections are assessed as ‘partially’ or ‘can’t tell’</p>	<p><b>Low confidence</b> (limitations are important enough that the results of the review are not reliable)</p> <p><b>Medium confidence</b> (limitations are important enough that it would be worthwhile to search for another systematic review and to interpret the results of this review cautiously, if a better review cannot be found)</p> <p><b>High confidence</b> (only minor limitations)</p>
<p><b>Section B: Methods used to analyse the findings</b></p>	
<p><b>B.1 Were the characteristics and results of the included studies reliably reported?</b></p> <p>Was there:</p> <p><input type="checkbox"/> Independent data extraction by at least 2 reviewers</p> <p><input type="checkbox"/> A table or summary of the characteristics of the participants, interventions and outcomes for the included studies</p> <p><input type="checkbox"/> A table or summary of the results of all the included studies</p>	<p>Yes; no; partially; not applicable (e.g. no included studies)</p> <p>Coding guide:</p> <p>YES: All three should be yes</p> <p>PARTIALLY: Criteria one and three are yes, but some information is lacking on second criteria.</p> <p>No: None of these are reported. If the review does not report whether data was independently extracted by 2 reviewers (possibly a reporting error), we downgrade to NO.</p> <p>NOT APPLICABLE: if no studies/no data</p>
<p><b>B.2 Are the methods used by the review authors to analyse the findings of the included studies clear, including methods for calculating effect sizes if applicable?</b></p>	<p>Yes; partially; no; not applicable</p> <p>Coding guide:</p> <p>YES: Methods used clearly reported. If it is clear that the authors use narrative synthesis, they don't need to say this explicitly.</p> <p>PARTIALLY: Some reporting on methods but lack of clarity</p> <p>NO: Nothing reported on methods</p> <p>NOT APPLICABLE: if no studies/no data</p>

Question	Criteria
<p><b>B.3 Did the review describe the extent of heterogeneity?</b></p> <p>Did the review ensure that included studies were similar enough that it made sense to combine them, sensibly divide the included studies into homogeneous groups, or sensibly conclude that it did not make sense to combine or group the included studies?</p> <p>Did the review discuss the extent to which there were important differences in the results of the included studies?</p> <p>If a meta-analysis was done, was the I<sup>2</sup>, chi square test for heterogeneity or other appropriate statistic reported? If no statistical test was reported, is a qualitative justification made for the use of random effects?</p>	<p>Yes; partially; no; not applicable</p> <p>Coding guide:</p> <p>YES: First two should be yes, and third category should be yes if applicable should be yes</p> <p>PARTIALLY: The first category is yes</p> <p>NO: Any other</p> <p>NOT APPLICABLE: if no studies/no data</p>
<p><b>B.4 Were the findings of the relevant studies combined (or not combined) appropriately relative to the primary question the review addresses and the available data?</b></p> <p>How was the data analysis done?</p> <ul style="list-style-type: none"> <li>▪ Descriptive only</li> <li>▪ Vote counting based on direction of effect</li> <li>▪ Vote counting based on statistical significance</li> <li>▪ Description of range of effect sizes</li> <li>▪ Meta-analysis</li> <li>▪ Meta-regression</li> <li>▪ Other: specify</li> <li>▪ Not applicable (e.g. no studies or no data)</li> </ul> <p>How were the studies weighted in the analysis?</p> <ul style="list-style-type: none"> <li>▪ Equal weights (this is what is done when vote counting is used)</li> <li>▪ By quality or study design (this is rarely done)</li> <li>▪ Inverse variance (this is what is typically done in a meta-analysis)</li> <li>▪ Number of participants (sample size)</li> <li>▪ Other: specify</li> <li>▪ Not clear</li> <li>▪ Not applicable (e.g. no studies or no data)</li> </ul> <p>Did the review address unit of analysis errors?</p> <ul style="list-style-type: none"> <li>▪ Yes - took clustering into account in the analysis (e.g. used intra-cluster correlation coefficient)</li> <li>▪ No, but acknowledged problem of unit of analysis errors</li> <li>▪ No mention of issue</li> <li>▪ Not applicable - no clustered trials or studies included</li> </ul>	<p>Yes; partially; no; not applicable (e.g. no studies or no data); can't tell.</p> <p>Coding guide:</p> <p>YES: If appropriate table, graph or meta-analysis AND appropriate weights AND unit of analysis errors addressed (if appropriate).</p> <p>PARTIALLY: If appropriate table, graph or meta-analysis AND appropriate weights AND unit of analysis errors not addressed (and should have been).</p> <p>NO: If narrative OR vote counting (where quantitative analyses would have been possible) OR inappropriate reporting of table, graph or meta-analyses.</p> <p>NOT APPLICABLE: if no studies/no data</p> <p>CAN'T TELL: if unsure (note reasons in comments below)</p>

Question	Criteria
<p><b>B.5 Does the review report evidence appropriately?</b></p> <p>The review makes clear which evidence is subject to low risk of bias in assessing causality (attribution of outcomes to intervention), and which is likely to be biased, and does so appropriately</p> <p>Where studies of differing risk of bias are included, results are reported and analysed separately by risk of bias status</p>	<p>Yes; partially; no; not applicable</p> <p>Coding guide:</p> <p>YES: Both criteria should be fulfilled (where applicable)</p> <p>NO: Criteria not fulfilled</p> <p>PARTIALLY: Only one criterion fulfilled, or when there is limited reporting of quality appraisal (the latter applies only when inclusion criteria for study design are appropriate)</p> <p>NOT APPLICABLE: No included studies</p> <p>Note on reporting evidence and risk of bias: For reviews of effects of ‘large n’ interventions, experimental and quasi-experimental designs should be included (if available). For reviews of effects of ‘small n’ interventions, designs appropriate to attribute changes to the intervention should be included (e.g. pre-post with assessment of confounders)</p>
<p><b>B.6 Did the review examine the extent to which specific factors might explain differences in the results of the included studies?</b></p> <p>Were factors that the review authors considered as likely explanatory factors clearly described?</p> <p>Was a sensible method used to explore the extent to which key factors explained heterogeneity?</p> <ul style="list-style-type: none"> <li>▪ Descriptive/textual</li> <li>▪ Graphical</li> <li>▪ Meta-analysis by sub-groups</li> <li>▪ Meta-regression</li> <li>▪ Other</li> </ul>	<p>Yes; partially; no; not applicable</p> <p>Coding guide:</p> <p>YES: Explanatory factors clearly described and appropriate methods used to explore heterogeneity</p> <p>PARTIALLY: Explanatory factors described but for meta-analyses, sub-group analysis or meta-regression not reported (when they should have been)</p> <p>NO: No description or analysis of likely explanatory factors</p> <p>NOT APPLICABLE: e.g. too few studies, no important differences in the results of the included studies, or the included studies were so dissimilar that it would not make sense to explore heterogeneity of the results</p>
<p><b>B.7 Overall - how much confidence do you have in the methods used to analyse the findings relative to the primary question addressed in the review?</b></p> <p>Summary assessment score B relates to the 5 questions in this section, regarding the analysis.</p> <p>High confidence applicable when all the answers to the questions in section B are assessed as ‘yes’.</p> <p>Low confidence applicable when any of the following are assessed as ‘NO’ above: critical characteristics of the included studies not reported (B1), not describing the extent of heterogeneity (B3), combining results inappropriately (B4), reporting evidence inappropriately (B5).</p> <p>Medium confidence applicable for any other: i.e. the “Partial” option is used for any of the 6 preceding questions or questions and/or B.2 and/ or B.6 are assessed as ‘no’.</p>	<p><b>Low confidence</b> (limitations are important enough that the results of the review are not reliable)</p> <p><b>Medium confidence</b> (limitations are important enough that it would be worthwhile to search for another systematic review and to interpret the results of this review cautiously, if a better review cannot be found)</p> <p><b>High confidence</b> (only minor limitations)</p>
<p><b>Section C: Overall assessment of the reliability of the review</b></p>	

Question	Criteria
<b>C.1 Are there any other aspects of the review not mentioned before which lead you to question the results?</b>	<ul style="list-style-type: none"> <li>▪ Additional methodological concerns – only one person reviewing</li> <li>▪ Robustness</li> <li>▪ Interpretation</li> <li>▪ Conflicts of interest (of the review authors or for included studies)</li> <li>▪ Other</li> <li>▪ No other quality issues identified</li> </ul>
<b>C.2 Are there any mitigating factors which should be considered in determining the reviews reliability?</b>	<ul style="list-style-type: none"> <li>▪ Limitations acknowledged</li> <li>▪ No strong policy conclusions drawn (including in abstract/summary)</li> <li>▪ Any other factors</li> </ul>
<p><b>C.3 Based on the above assessments of the methods how would you rate the reliability of the review?</b></p> <p><b><u>Low confidence in conclusions about effects:</u></b></p> <p><b><u>Medium confidence in conclusions about effects:</u></b></p> <p>The systematic review has the following limitations...</p> <p><b><u>High confidence in conclusions about effects:</u></b></p> <p>If applicable: The review has the following minor limitations... Coding guide:</p> <p><b>High confidence in conclusions about effects:</b> high confidence noted overall for sections A and B, unless moderated by answer to C1.</p> <p><b>Medium confidence in conclusions about effects:</b> medium confidence noted overall for sections A or B, unless moderated by answer to C1 or C2.</p> <p><b>Low confidence in conclusions about effects:</b> low confidence noted overall for sections A or B, unless moderated by answer to C1 or C2.</p> <p>Limitations should be summarised above, based on what was noted in Sections A, B and C.</p>	

## D Details about the EGM advisory group

### D.1 Advisory Group members

3ie has contacted several organisations to join an impartial advisory group for the project. We are still confirming membership of this group. Currently the following organisations have confirmed their involvement in advising the project's development:

- World Bank – Europe and Central Asia Energy Unit
- DFID – Climate and Environment Division
- UCL – Energy Institute
- Priestley International Centre for Climate

### D.2 Synthesis project advisory group - Terms of Reference

The Terms of Reference for this Advisory Group is stated below:

Authors of synthesis projects establish stakeholder advisory review groups to help them determine the parameters of their proposed project and to provide inputs throughout the project process to help ensure

that the final analytical outputs are policy relevant and have an audience of policy and practice actors that understand the results and that are interested in using the findings. Members of the advisory group can be policymakers, practitioners, influencers, researchers, and other stakeholders with an interest in the project. Members of the advisory group will be asked to provide inputs on various aspects of the project throughout the process. The total time commitment is not likely to exceed two days. The tasks of the advisory group members may include:

- Advice on key decisions regarding the scope of the project, including refining the research question(s) and definitions of key concepts.
- Determine and group important outcomes.
- Suggest relevant background literature and studies for inclusion.
- Provide written comments on draft protocol and draft outputs.
- Help the team draw implications from the findings. This could involve participating in meeting or workshop to review the implications of the project in terms of policy and practice.
- Assist the study team with policy engagement. This can involve advising the team on key stakeholders with whom to communicate to build interest in and understanding of the project results, contribute to developing a communication and uptake plan, facilitate engagement with key audiences and communicate findings.