EUROPEAN COMMISSION
Executive Agency for Small and Medium-sized Enterprises (EASME)

Unit B1 Energy

Guidelines for the Calculation of Project Performance Indicators

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Applicable for energy efficiency projects funded under Societal Challenge III 'Secure, Clean and Efficient Energy' of the Horizon 2020 programme.

Table of contents

Important notice

The guidelines serve for information purposes only and are not legally binding.

These guidelines are based on a methodology developed for the Executive Agency for Small and Medium-sized Enterprises (EASME)[1] and on illustrative examples, data and lessons learnt from past energy efficiency projects. The illustrative examples are presented in Annex 2 to this document. The data in the examples is representational, but fictive: it should not necessarily be used for the calculation of project performance indicators of a specific project. The references and the information provided are meant as concrete examples and should be used as reference for your own calculation when applying the methodology.

The EASME has made every effort to check and review the references, data and examples. If there are any identified errors, feedback can be sent to the functional mailbox EASME-Energy@ec.europa.eu.

[1] Service Contract EACI/IEE/2011/01/SI2.616046

1. Introduction

This document offers guidance on the calculation of impacts of proposals seeking funding under the energy efficiency part of the 'Secure, clean and efficient energy' Work Programme of Horizon 2020.

When evaluating Horizon 2020 proposal one of the three evaluation criteria focusses specifically on impacts, i.e. 'the extent to which the outputs of the project would contribute to each of the expected impacts mentioned in the work programme'. Consequently, proposal submissions are expected to set out in their application form to

- How the project will contribute to each of the expected impacts mentioned in the work programme, under the relevant topic (all types of actions);
- Describe any substantial impacts not mentioned in the work programme, that would enhance innovation capacity; create new market opportunities, strengthen competitiveness and growth of companies, address issues related to climate change or the environment, or bring other important benefits for society (RIA and IA types of actions);
- Describe any barriers/obstacles, and any framework conditions that may determine whether and to what extent the expected impacts will be achieved (all types of actions).

This document provides guidance for the calculation of the following energy related project **performance indicators:**

- Energy savings triggered.
- Renewable energy production triggered.
- Greenhouse gas emissions reduced.
- Cumulative investments made by European stakeholders in sustainable energy.

After a first section with a list of common terms used throughout the document, the guide presents the recommended approach for estimating project performance indicators, based on five steps. Then a list of links and references that might be useful when applicants estimate project performance indicators and three non-exhaustive illustrative examples are given.

2. Terminology

In order to have a clear understanding of the project performance indicators, it is important to explain the relation between inputs, activities, outputs, impacts, performance indicators and targets:

- **Inputs** are the resources required to deliver the project.
- **Activities** are the tasks or processes undertaken. These are set out in the work packages in the section “Work Programme” of your project / proposal.
- **Outputs** are the direct products and services delivered by your project. They include material deliverables (e.g. brochures, reports, CD ROM) as well as services provided (e.g. hours of training, number of people taught). However, usually they say very little about the actual effect of the action or benefits to your target group.
- **Impacts** are identifiable changes which demonstrate the extent to which your activities have an effect on your target group. These changes - the impacts of your project - can take place during its lifetime (**specific – or short term - impacts**) or beyond its lifetime (**strategic – or long term - impacts**), and come under the five fields of delivery above mentioned.
- **Performance indicators** should be used to determine the success of your project in reaching its objectives and creating an impact. The performance Indicators should be SMART (specific, measureable, achievable, relevant and time-bound).
- The changes caused by your project include **quantifiable energy-related impacts** both within the duration of the project and beyond its lifetime**.** These are the **sustainable energy investments** triggered, **renewable energy production**, **primary energy savings**, and **reduction of greenhouse gas emission**, demonstrating the contribution to the EU energy targets.

You need to provide an **estimation** of your project performance indicators**, based on robust assumptions and a credible baseline**. For the longer term impacts, it would be reasonable to do an extrapolation for a time period of up to 5 years after the end of the project, taking account of market potential and trends, the triggering effect of your promotion and dissemination activities, and the 'snow-ball effect'. Your project should at least induce positive developments towards the strategic objectives – even if fully achieving them will usually also depend on other factors.

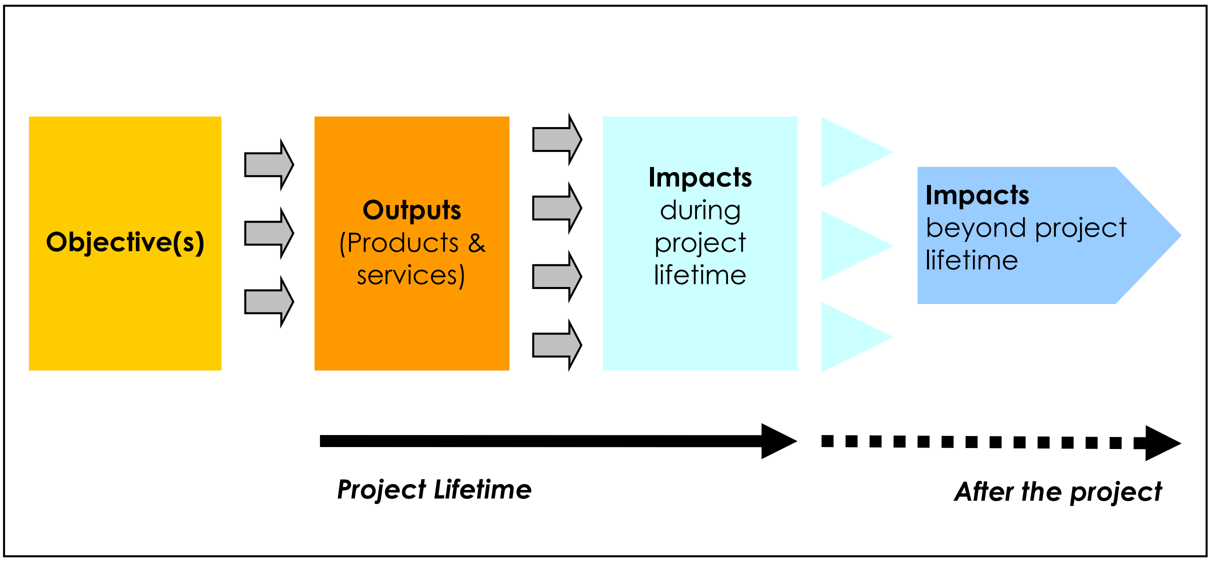

Figure 1: The results chain, own course?

3. Project performance indicators

The project performance indicators measure the impacts of your project, within its duration and / or the time after the project officially ended. The topic descriptions in the work programme always also identify the expected impacts. Table 1 below offers an overview of indicators typically referred to in the work programme. However, the specific requirements depend on the call topic and the type of actions proposed (RIA, IA, CSA, PDA[2]). However, nearly all energy efficiency projects funded under the energy challenge of Horizon 2020 are expected to quantify their impacts on primary energy savings and investments triggered.

Project Performance Indicator	Quantification	Measurement unit
Energy savings triggered by the project		Primary energy savings triggered (GWh/year)
Cumulative **investments** made by European stakeholders in sustainable energy		Million Euros
Renewable energy production triggered by the project within project duration		Renewable energy production (GWh/year)
Reduction of **greenhouse gas emissions**		GHG emission reduction (tCO_2e)
Policies & strategies created/adapted to include sustainable energy issues at any governance levels		Number of citations / statements from governance bodies
Market stakeholders (professionals) with **increased skills** / capability / competencies on energy issues		Number of people
Market stakeholders (professionals) participating in **trainings** on energy issues		Number of people
Market stakeholders (professionals) with additional recognised **qualifications** covering energy issues		Number of people
Stakeholders reached through media and events		Number of people
People who changed their **behaviour** towards sustainable energy production or consumption		Number of people
Organisations changed their **behaviour** towards sustainable energy production or consumption		Number of organisations
Building **renovations** triggered by the project		sqm of gross floor area
Cost reductions triggered by the project		Million Euros
Jobs created		Number of full-time equivalent jobs

Figure 1: Typical project performance indicators mentioned in the work programme.

In the following pages guidance on the calculation of the project performance indicators is provided to help proposers quantify impacts related to energy savings, renewable energy production, GHG reductions and investment in sustainable energy. However, the guidance provided here will also be of relevance to coordinators responsible for implementing an energy efficiency project and for monitoring its impacts.

[2] RIA = Research and Innovation Action; IA = Innovation Action; CSA = Coordinator and Support Action; PDA – Project Development Assistance.

4. Recommended approach to estimating project performance indicators

Figure 2 outlines the recommended five-step approach for estimating project performance indicators. This section takes you through each step, describes the sort of challenges you might face and the ways in which you could overcome them.

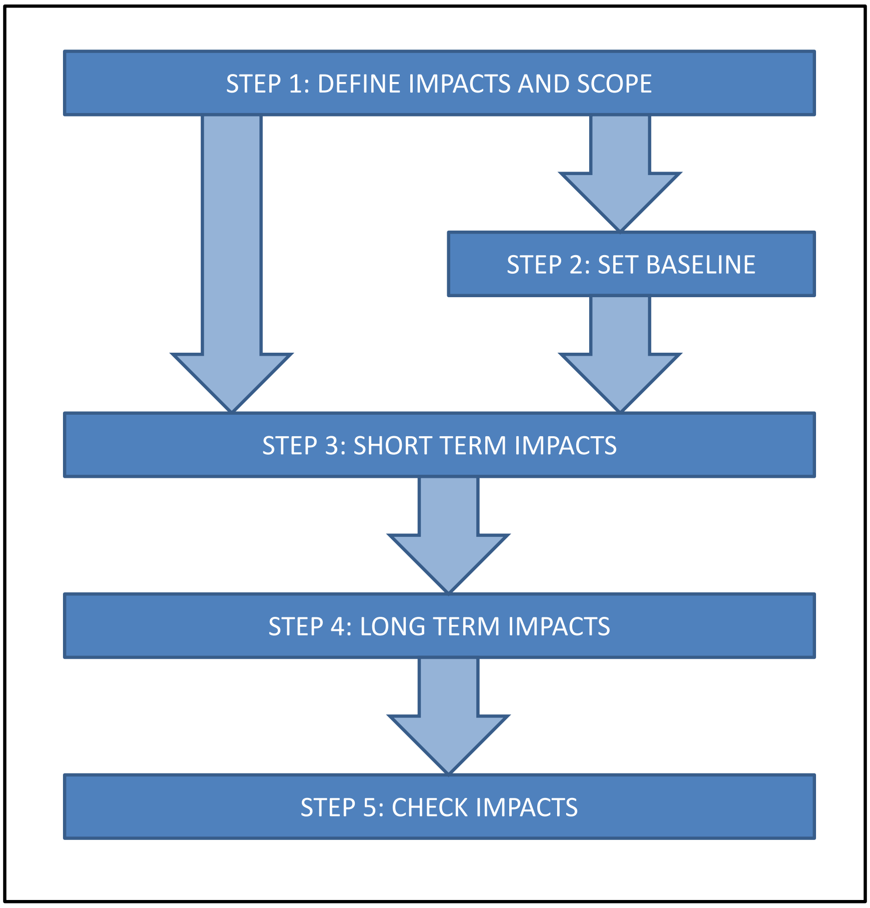

Figure 2: Five-step approach to estimating project performance indicators

Step 1: Define the impacts and scope

The first step is to establish which of your expected project impacts can be related to energy savings, renewable energy, GHG reduction and/or investment in sustainable energy.

At this stage, you should also define the scope of the project. For example, for a project tackling sustainable energy in cities, how many cities of what size are likely to be involved. For a project training energy auditors in industrial SMEs, how many SMEs and how many auditors will be involved, etc.

A clear definition of scope is important before setting the baseline (step 2) or estimating impacts (steps 3 and 4).

The project performance indicators identified should be consistent with requirements set out in the work programme as well as the aims of your project.

Once you have established the scope of your project and identified the project performance indicators to be estimated, you can begin to estimate the impacts. There are two ways of doing this:

- **Method 1 'Bottom-up method':** Work out the impact of each unit of project output (e.g. energy audit, sustainability plan) and multiply it by the number of units that you expect to achieve.
- **Method 2 'Top-down or empirical method':** Estimate the likely percentage uptake of a technology or reduction in energy consumption by looking at the results achieved by past projects similar to the one you are proposing. For example, for a project on consumer engagement you might look in the literature for the level of behaviour change that has been achieved through local campaigns or for a project on training the level of energy savings achieved by a training programme.

If you are using Method 1, you do not need to use the baseline for calculation of your project performance indicators as each impact can be directly attributed to the project, so you should move straight to Step 3.

Step 2: Set the baseline (Method 2 only)

The baseline should be estimated for the time period from the beginning of the project to 2020. Here the aim is to establish what the energy consumption, GHG emissions and/or the level of investment in sustainable energy would be in the absence of your project. For example, for a project encouraging the introduction of green procurement policies for city authorities in 10 European cities, the baseline would be the predicted annual purchase of renewable energy, energy consumption and GHG emissions for these cities through the time period to 2020.

The starting point for the baseline calculation will typically be historical EU, national or regional energy consumption statistics. The base year energy consumption can then be projected forward to 2020 using growth projections, by extending historical growth rates or by making other reasonable assumptions. The GHG emissions baseline is then calculated from the fuel mix and the energy consumption baseline using appropriate emissions factors (see also Annex 2).

Step 3: Estimate the short-term impacts

There are two different approaches to the estimation of short-term impacts depending whether you are following the **bottom-up method** (Method 1) or the **top-down method** (Method 2). In both cases, it is usually easiest to start with renewable energy or energy savings impacts and then move on to estimate GHG reduction and investment impacts (where appropriate) from there.

Using the bottom-up method (Method 1) to estimate short-term impacts from project outputs

You first estimate the on-the-ground impacts of the project, such as the amount of different energy efficient technologies deployed or the modal shift achieved, and then you work out the corresponding energy impacts. It may be helpful to map this out in a diagram that links outputs to impacts to project performance indicators, such as the example for energy audits shown in Figure 3.

You then follow the causal links from the left to the right of the diagram making assumptions at each step, and documenting these assumptions.

It can sometimes be particularly difficult to link the outputs of projects addressing non-technical barriers to concrete long-term impacts such as renewable energy deployment or energy savings. This is known as the **attribution gap** and is a challenge common to many projects and programmes. Because your project is not the only activity which influences / has an impact on the development of the market, it can be difficult to identify separately the contribution which your project has made. Therefore, you should aim at providing ‘plausible linkages’ for your project’s contributions to high level impacts.

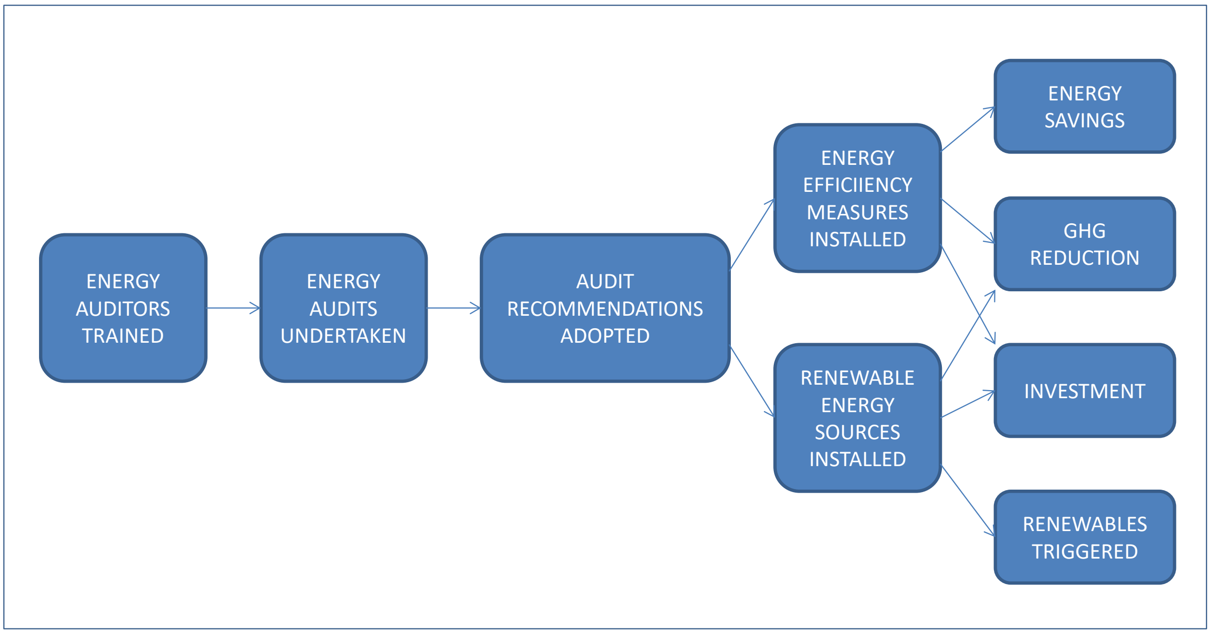

Figure 3: Illustrative example of mapping outputs to impacts for a project on training of energy auditors

In order to formulate these linkages you should consult with project stakeholders and use their feedback to help you to propose plausible linkages between your project outputs and the impacts of the project. This may require reviews of published theories of change which can then be linked to the specific activities and outputs being deployed by your project.

It is important to fully document the method used, the data sources and the evidence behind the assumptions. The supporting evidence for your plausible linkages between outputs and impacts will provide you with a sound basis for bridging of the attribution gap. So for the example in Figure 3 you would:

- Estimate the number of auditors to be trained.
- Estimate the number of additional audits that each trainee will undertake.
- Estimate the likely recommendations from a typical audit, including renewable energy and energy efficiency measures.
- Assume that only a certain proportion of these recommendations are taken up by the organisations audited, or perhaps that some are taken up initially and some others are taken up after a few years.
- Work out the total energy savings from the energy efficiency measures to be installed (number of audits x average uptake x savings per measure).
- Work out the GHG reduction benefits from energy efficiency by multiplying the energy savings by the appropriate emissions factor/s for the fuel/s saved.
- Work out the average annual power generated from the renewable energy sources installed using the appropriate load factor(s).
- Work out the GHG reduction benefits from renewable energy by comparing the emissions from the renewable technologies installed with the emissions that would have been associated with the generation of electricity or heat from conventional sources.
- Estimate the investment associated with the installation of energy efficient and renewable technologies (typically only the capital cost is considered).

A worked example of the calculation of project performance indicators for this illustrative project is presented in **ANNEX 2**.

Typically there are one or two assumptions which introduce a higher degree of uncertainty into your estimated project performance indicators and a lot of other assumptions that are accurate enough for the purpose. In the example above, the key assumptions with a higher degree of uncertainty are the number of audits to be undertaken by each trainee and the proportion of audit recommendations that are taken up. These are the two areas where you should look particularly hard for supporting evidence from past studies and projects, e.g. how many audits were undertaken by each trainee in a similar national programme? It is probably not worth spending a lot of time determining the exact mix of technologies that would be taken up or the emission factor for the fuel displaced, although you should document your assumptions and the data sources used.

Using the top-down method (Method 2) to estimate short term impacts by comparing with previous projects/schemes

With this method, you estimate the likely impacts of your project from the impacts achieved by similar projects in the past. This is likely to be a good method to use where similar activities have been undertaken before (e.g. a pilot project or a programme at national or regional level), and there is a good evidence base on their impacts. However, care must be taken to ensure that your project really is similar to the reference project(s) and that their impact assessments were done well.

There may also be challenges in interpreting ranges of impact, e.g. some non-technical measures have been reported as having saved between 1% and 25% of energy – is it reasonable just to take the mid-point of such a wide range as the basis of your estimate? In general you are encouraged to base your estimates on a number of past examples of project or programme impacts rather than just one, even when you are transferring a national or local project into other European countries or cities and you have evidence that the impacts will be the same in these other regions.

The impacts of your project (e.g. renewable energy deployment, energy efficiency improvement, modal shift) should be estimated from the baseline situation in the countries, regions, cities, sectors or organisations that you project will address (from step 2) and the percentage change that you anticipate due to your project (based on data from past projects). Then the project performance indicators can be estimated from these project impacts in a similar way to Method 1.

Taking as an example a project to introduce sustainable mobility plans into 10 cities in Europe, you could:

- Determine the baseline for each of the 10 cities in terms of modal split and associated fuel consumption and GHG emissions (step 2). This should take account of existing trends in the use of cars, public transport and cycling, and future changes in the average efficiency of car and bus fleets due to improved vehicle standards. If the existing modal split of some cities is not known then its determination should already be seen as part of your project (perhaps for selected traffic routes to keep down costs) and you could base your estimates on data from a similar city in a similar part of Europe in the meantime.
- Look for evidence of modal shift from similar sustainable mobility planning in the past, gathering as wide a base of evidence as possible so you can determine the average proportion of car trips (in passenger-km) shifted to public transport and cycling and whether this varies depending on the initial modal split, the size of the city, the geographical location or other factors.
- Estimate what level and type of modal shift will be achieved by your project in each of the 10 cities and when it will happen based on the evidence from past projects. You may want to make different assumptions for those cities that already have relatively low car usage.

- Apply the proportional modal shifts to the baselines for each city to calculate the energy savings (petrol and diesel) achieved by moving from cars to public transport and cycling.
- Use the relevant emission factors to calculate the GHG reduction impacts.
- For this project, there is no renewable energy generation.

Step 4: Estimate the long-term impacts

Long-term impacts (i.e. for a period of about 5 years after the project officially ended) should be expressed as a range where:

- **Minimum impacts** are those (energy, carbon, investment) that can be directly attributed to the project, e.g. for a project on energy efficiency in industry a continuation of auditing programmes in the companies involved or for a project on urban transport a continuation of sustainable mobility planning in the cities involved.
- **Maximum impacts** assume that the influence of the project spreads and its activities are replicated in other sectors, regions, countries or stakeholder groups. Referring again to the above mentioned examples, more companies or industry sectors start auditing programmes or more cities adopt sustainable mobility planning.

To estimate the minimum long-term impacts you should consider what is likely to happen after the project officially ended. To do this, you should make reference to the sustainability plan you have foreseen for the project activities. Will the organisations involved want to continue with the activities supported by Horizon 2020? Will they reduce, maintain or increase funding for these activities after the end of the project? Will the relevant stakeholders be required to make commitments during the project that will make future long-term impacts more likely? Will further investments be less attractive once the 'low hanging fruit has been picked'?

To estimate the maximum long-term impacts you should consider the scope for replication of your project to other organisations, regions, sectors or groups, and what might realistically be achieved after your project officially ended.

Long-term impacts too should be estimated against a baseline, so some assumptions may be different from those that you used when calculating short-term impacts. For example, there will be a lower emissions factor for electricity for the EU and most Member States in the years after the project ended due to the increased penetration of renewable energy. The average efficiency of a car will be higher too, due to stock turnover and the introduction of tighter CO_2 standards for new cars.

Cumulative values of project performance indicators must be calculated by summing the annual values of each performance indicator. This means within the methodology impacts must be estimated year by year and then summed up to obtain the cumulative figures.

Step 5: Check impacts

The final step is to check the project performance indicators that you have estimated. There are three simple checks that should give you confidence that your calculations are accurate and your assumptions are realistic.

Check No. 1: Compare the minimum long-term impacts with the short-term impacts. Is it realistic to expect this level of increase between the end of the project and the period, of say 5 years, thereafter? Have you allowed for the possibility that activities may slow down once Horizon 2020 funding ends? Have you allowed for the time that it takes to implement actions, e.g. - referring again to the above mentioned examples - for organisations to take up energy audit recommendations or for city authorities to implement transport measures?

Check No. 2: Compare the ratios between short-term impact, minimum long-term impact and maximum long-term impact for each of the project performance indicators. You would expect the ratios to be very similar for energy saving, GHG reduction and investment for most projects, though not quite identical because of changes in the baseline. So, for example, if you find that your minimum long-term energy saving impact is five times the short-term energy saving impact and the long-term GHG reduction impact is eight times the short-term GHG reduction impact then you have probably overestimated your long-term savings.

Check No. 3: Compare your maximum long-term impact estimates with the overall energy consumption or carbon emissions associated with the sectors or end-uses that your project will address. For example, if you have a project that will lead to energy savings in the retail sector in six countries, check what the total energy consumption is currently for these six countries, and if data are available, how much of this energy consumption is associated with the retail sector. Then compare your maximum long-term impact estimate with the total energy consumption from the sector – is it realistic to expect your project to reduce total sector emissions by the calculated percentage (10% or 50% or xy%)? Are you perhaps underestimating or overestimating the likely long-term impact? This is also a good way of checking whether your project is likely to make a significant difference to the energy and environmental performance of the target group or region or sector. If not then there may be scope to redesign the project to increase its impact.

5. Monitoring and evaluation of project performance indicators

Monitoring your indicators is vital to understanding the success and achievements of your project, both during its lifetime, at the end of the project, and beyond.

All Horizon 2020 projects are required to report on their project performance indicators in SyGMa and the periodic reports. If necessary additional information on baselines, benchmarks, references, assumptions and the calculations have to be provided to substantiate the claims.

The project coordinator should make each of the project partners aware of their responsibilities to achieve the set targets, and make them aware of the best available data sources for estimating the project impact indicators.

An appropriate monitoring and evaluation strategy should be built into the project activities to establish whether the impacts anticipated at proposal stage have materialised in practice.

Indicators should be reviewed at each project meeting, reminding each project partner of what is to be achieved.

If an indicator which may have appeared sensible at the outset of the project is reviewed as the project progresses and it can be shown that a different indicator may be more suitable, then discussions should be held with the EASME Project Adviser about whether to adjust the indicators.

Annex 1: Reference sources

The following list provides some references and links that might be useful when you are estimating your energy performance indicators. These include reference sources for energy conversion factors, emission factors and baseline efficiencies such as the efficiency of an average house or car.

The list also includes guidance documents providing greater detail on how you can estimate the impacts of particular types of project or policy. Lastly, it includes a preliminary list of reports and case studies that show the energy and GHG impacts of energy efficiency projects.

Conversion/emission factors

- IEA energy unit converter http://www.iea.org/statistics/resources/unitconverter/
- UNFCCC/IPPC emission factor database http://www.ipcc-nggip.iges.or.jp/EFDB/main.php
- The 'Covenant of Mayors for Climate and Energy Reporting Guidelines', which includes in Annex 1 'Default Emission Factors' http://www.covenantofmayors.eu/IMG/pdf/Reporting_Guidelines_Final_EN.pdf (also available in BG, CS, DA, DE, EL, ES, FR, HR, IT, LT, LV, HU, NL, PL, PT, RO, Sk, SL, FI, SV)

Baseline data

- Modelling tools for EU analysis – PRIMES, PRIMES-TREMOVE https://ec.europa.eu/clima/policies/strategies/analysis/models_en
- ODYSSEE database of energy consumption by end-use http://www.indicators.odyssee-mure.eu/energy-efficiency-database.html
- Eurostat energy statistics http://ec.europa.eu/eurostat/web/energy
- Eurostat “Indicators to support the Europe 2020 strategy – 2017 edition” http://ec.europa.eu/eurostat/en/web/products-statistical-books/-/KS-EZ-17-001
- Eurostat – Housing statistics in the European Union http://ec.europa.eu/eurostat/statistics-explained/index.php/Housing_statistics
- SETIS – JRC reports https://setis.ec.europa.eu/related-jrc-activities/jrc-setis-reports
- SETIS – Issues papers https://setis.ec.europa.eu/actions-towards-implementing-integrated-set-plan
- SETIS – Roadmaps https://setis.ec.europa.eu/summary-of-roadmaps
- SULTAN model for European Commission http://www.eutransportghg2050.eu/cms/illustrative-scenarios-tool/
- Solar Power Europe – Global Market Outlook 2017-2021 http://www.solarpowereurope.org/reports/global-market-outlook-2017
- EPOMM modal split datatbase http://www.epomm.eu/tems/index.phtml
- Eltis – Facts & Figures http://www.eltis.org/discover/facts-figures
- ERF European Road Statistics – Year Book 2014-2015 http://www.erf.be/images/Statistics/BAT-AD-Stats-2015Inside-ERF.pdf
- UTIP statistics http://www.uitp.org/statistics

Further guidance on impact assessment

- IEA DSM Technology Collaboration Program Evaluating Energy Efficiency Policy Measures & DSM Programmes - Volume 1: Evaluation Guidebook, October 2005, IEA Demand Side Management Implementing Agreement http://www.ieadsm.org/wp/files/Exco%20File%20Library/Key%20Publications/Volume1Total.pdf

- EMEEES project, European Commission, 2007-2009 http://www.evaluate-energy-savings.eu/emeees/en/publications/reports.php
- Guidelines for the monitoring, evaluation and design of energy efficiency policies – How policy theory can guide monitoring & evaluation efforts and support the design of SMART policies, 2006 https://ec.europa.eu/energy/intelligent/projects/sites/iee-projects/files/projects/documents/aid-ee_guidelines_en.pdf
- BetterEvaluation, RMIT University http://www.betterevaluation.org/plan
- International Performance Measurement and Verification Protocol (IPMVP), Efficiency Valuation Organisation https://evo-world.org/en/products-services-mainmenu-en/protocols/ipmvp
- State Energy Program National Evaluation of Program Operations for Program Year 2008 http://weatherization.ornl.gov/evaluation_sep.shtml
- United States Environmental Protection Agency, Evaluation guides and tools https://www.epa.gov/evaluate/program-evaluation-resources

Measured impacts from non-technical measures

- ODYSSEE-MURE database on energy efficiency policies and measures http://www.measures-odyssee-mure.eu
- 'Ecodesign Impact Accounting', DG ENER, status report on impacts related to energy consumption, jobs, revenues and technology development over the period 1990-2050 for a range of products. https://ec.europa.eu/energy/en/studies/ecodesign-impact-accounting-0
- PROPOLIS Planning and Research of Policies for Land Use and Transport for Increasing Urban Sustainability https://trimis.ec.europa.eu/project/planning-and-research-policies-land-use-and-transport-increasing-urban-sustainability

Annex 2: Illustrative worked examples

This annex presents worked examples of the estimation of project performance indicators for three hypothetical projects:

1) Energy auditor training (Building capacities and skills) using Method 1

2) Promotion of bioenergy schemes (Preparing the ground for investment) using Method 1

3) Market strategies for solar energy (Enabling policy) using Method 2

The examples provided here are only illustrative, they are non-exhaustive and not covering all areas that energy efficiency projects might address under Horizon 2020.

Worked example 1:

Energy auditor training (Building capacities and skills)

using Method 1 (bottom-up method)

Project Background

The project will train people in five participating countries (Bulgaria, Hungary, Poland, Slovakia and Slovenia) so that they are able to carry out energy audits and make recommendations for energy efficiency improvements. It is known that there is a shortage of trained energy auditors in these countries and that this is a barrier to organisations undertaking energy and carbon saving initiatives.

Project Objectives

The key objective of this project is:

- To train at least 20 energy auditors in each of the 5 participating countries.

Which Project performance indicators?

For an energy efficiency project with capacity building as its primary field of delivery, no renewable energy generation is expected to result from this project. The project performance indicators to be calculated are:

Within the project duration:

- Cumulative investment made by European stakeholders in sustainable energy (**Euro**)
- Primary energy savings compared to projections (**toe/year**)
- Reduction of greenhouse gas emissions (**t CO2e/year**)

By 2020:

- Cumulative investment made by European stakeholders in sustainable energy (**Euro**)
- Cumulative Primary energy savings compared to projections (**toe**)
- Cumulative Reduction of greenhouse gas emissions (**t CO2e**)

Which methodology?

Method 1 (bottom-up method) is the preferred approach if it can be applied. For this project it is possible to build up the project performance indicators from the project outputs, i.e. the number of energy auditors trained can be used to estimate the number of additional audits undertaken and hence the impacts in terms of energy savings, GHG savings and investment. Therefore Method 1 is chosen.

Step 1: Defining scope and impacts

The direct impacts are expected to be on the energy efficiency of the organisations that are audited by the people who have been trained during this project. In the longer term, there may also be indirect effects through an expansion of the training programme within the original 5 countries and replication in other Member States. This would be dependent on finding additional funding for the courses to be continued and expanded into other countries after the duration of this project. In the calculation of longer-term impacts (Step 4) we have therefore taken a conservative approach and assumed that:

- For the minimum impact in 2020, the people who were trained by the project continue to operate as energy auditors but no additional auditors are trained.
- For the maximum impact in 2020, an additional 100 people are trained as auditors after the project finishes, meaning there are 200 auditors in total by 2020.

Step 2: Setting the baseline

This step is not needed for Method 1.

Step 3: Estimating short-term impacts

The training courses will be run in years 2 and 3 of the project, with 10 people per country trained in each year. By the end of the project, the people who were trained in year 2 will have delivered advice as energy auditors for one year each, while the people who were trained in year 3 will only just be entering the market. We therefore assume that 50 people in total will have delivered one year of savings as energy auditors by the end of the project. It is also assumed that each energy auditor will carry out 20 energy audits in that year and subsequent years.

The organisations audited will be primarily Small- and Medium-sized Enterprises (SMEs) in the services sector. For the purposes of this calculation, we assume that the organisations audited have an average number of employees of 200, and that their annual energy consumption would remain the same through to 2020 in the absence of an energy audit.

Annual energy savings (toe/year) by the end of the project

According to the ODYSSEE energy indicators database[3], the average annual energy consumption per employee in the services industry in Europe is approximately 1 toe/employee/yr and the average electricity consumption per employee in the services sector in Europe is approximately 5 000 kWh/employee/yr (= 0.43 toe/employee/yr using the IEA unit converter[4]). This means the average heat and fuel consumption per employee is 1 – 0.43 = 0.57 toe/employee/yr.

For an average organisation of 200 employees, the annual electricity consumption would be 0.43 x 200 = 86 toe/yr and the annual heat and fuel consumption would be 0.57 x 200 = 114 toe/yr.

According to the EMEEES project[5], a typical energy audit in the services sector will save 2% of electricity and 3% of heat and fuels. Hence the annual savings from a single audit would be:

Electricity:	86 toe/yr x 2%	=	1.72 toe/yr
Heat and fuels:	114 toe/yr x 3%	=	3.42 toe/yr

We assume that the savings from each audit are achieved for 5 years, i.e. the average lifetime of the energy efficiency measures implemented is 5 years. In practice some

[3] The ODYSSEE database at http://www.odyssee-mure.eu
[4] IEA unit converter at http://www.iea.org/statistics/resources/unitconverter is used here and throughout this example.
[5] EMEEES case illustration 18 Table 1 at http://www.evaluate-energy-savings.eu/emeees/downloads/EMEEES_WP42_Method_18_Energy_Audits_Revised_draft_080530.pdf

measures (e.g. boilers, insulation) will have longer lifetimes while some of the behavioural change measures will have shorter lifetimes.

Therefore each energy auditor conducting 20 audits per year would be expected to save in the year after he/she does the training and for the four years following that:

Electricity: 20 x 1.72 = 34.4 toe/yr

Heat and fuels: 20 x 3.42 = 68.4 toe/yr

Total energy: 102.8 toe/yr

We assume that in year 2 of this project 50 people are trained and carry out audits in year 3. For the sake of simplicity, we also assume that all the audit recommendations will be carried out. So, the total energy savings by the end of the project will be:

Electricity: 50 x 34.4 toe/yr = 1,720 toe/yr

Heat and fuels: 50 x 68.4 toe/yr = 3,420 toe/yr

Total energy saved by the end of the project = 5,140 toe/yr

Annual GHG savings (tCO_2/year) by the end of the project

GHG savings are calculated from energy savings using the appropriate emissions factors. We assume the emissions factor for heat and fuels is that of natural gas since natural gas is the fuel of choice for heating in most of Europe. If we had a breakdown by fuel for energy consumption for heat and fuels in the service sector in each of the countries concerned then these breakdowns could be used to give more accurate GHG emissions savings estimates.

The project is due to be completed at the end of three years and all the short term energy savings will be in that year.

According to the guidance for Sustainable Energy Action Plans produced for the EU Covenant of Mayors initiative[6], the average emissions factor for natural gas for Europe is currently 0.202 tCO_2/MWh and this is assumed to be constant for the duration of the project. Therefore the GHG savings from heat and fuel savings within the project are estimated at 3 420 toe/yr x 11.63 MWh/toe x 0.202 tCO_2/MWh = 8 034 tCO_2/yr.

The emissions factor for electricity varies by country as it depends on the power generation mix. The table below uses current emissions factors for power generation for each of the participating countries, again taken from the Covenant of Mayors guidance, to estimate the GHG savings from electricity savings.

Country	Emission factor for electricity in tCO_2/MWh	Energy savings in toe/yr	Energy savings in MWh/yr	GHG savings in tCO_2/yr
Bulgaria	0.819	344	4,001	3,277
Hungary	0.566	344	4,001	2,264
Poland	1.191	344	4,001	4,765
Slovakia	0.252	344	4,001	1,008
Slovenia	0.557	344	4,001	2,228
Total		**1,720**	**20,004**	**13,542**

In practice the emissions factors in 2015 will be a little lower than this due to the impact of the Renewable Energy Directive but this is a reasonable approximation.

The **total annual GHG savings by the end of the project** are therefore the savings from heat and power plus the savings from electricity, i.e. 8.03 ktCO_2/yr + 13.54 ktCO_2/yr = **21.6 ktCO_2/yr.**

[6] From http://www.eumayors.eu/IMG/pdf/technical_annex_en.pdf

Cumulative investment (€) triggered during the project

The investment figure is defined here as the capital investment stimulated by the energy audits conducted by the newly trained auditors; it does not include the investment in the training programme or take account of any financial savings from reduced energy consumption.

We have not been able to find reliable data on the typical capital investment stimulated by an energy audit of a 200 employee organisation in the countries targeted by this project so instead we estimate the capital investment from the energy savings data assuming an average 3 year payback at a 10% discount rate[7], as follows.

From the energy savings calculations above, each energy auditor is expected to save in the year after he/she does the training and for the four years following that:

Electricity: 34.4 toe/yr

Heat and fuels: 68.4 toe/yr

If we assume a 3-year payback then the capital investment associated with the audits completed within 3 years will be equal to the fuel cost savings over that time. Fuel prices are assumed to be 0.093 Euro/kWh for electricity and 8.99 Euro/GJ for gas[8]. This gives the following fuel cost savings.

	Year 1	Year 2	Year 3
Electricity saved toe	34.4	34.4	34.4
Gas saved toe	68.4	68.4	68.4
Electricity saved kWh	400,072	400,072	400,072
Gas saved GJ	2,864	2,864	2,864
Electricity cost saving Euro	37,207	37,207	37,207
Gas cost saving Euro	25,745	25,745	25,745
Total fuels cost saving Euro	62,952	62,952	62,952

In other words, the capital investment associated with each year an auditor is auditing is equal to the Net Present Value (NPV) of the above fuel cost savings = 142,000 Euro per auditor-year[9].

50 auditors are assumed to be operating for one year within the duration of the project, so the **short-term impact on investment** is 50 x 142,000 = **7,100,000 Euro** = 7.1 m€.

Step 4: Estimating long-term impacts

As explained in Step 1, we assume that:

- For the minimum impact in 2020, the people who were trained by the project continue to operate as energy auditors but no additional auditors are trained.
- For the maximum impact in 2020, an additional 100 people are trained as auditors after the project finishes, meaning there are 200 auditors in total by 2020.

The additional trainees may be in the same countries or different countries.

Cumulative energy savings (toe) by 2020 (as a range)

As before, a typical energy auditor conducting 20 audits per year is expected to save in the year after he/she does the training and for the four years following that:

Electricity: 20 x 1.72 = 34.4 toe/yr = 0.0344 ktoe/yr

Heat and fuels: 20 x 3.42 = 68.4 toe/yr = 0.0684 ktoe/yr

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[7] These assumptions were verified using expert opinion.

[8] EU27 average prices for 2011 for industry customers from Eurostat energy statistics http://epp.eurostat.ec.europa.eu/portal/page/portal/energy/data/main_tables

[9] Calculated using as the NPV in Year 0 using the NPV function in Excel.

50 auditors will be trained in 2014 and a further 50 auditors in 2015 so for the minimum impact figures we calculate the energy savings on a year-by-year basis as follows:

	2014	2015	2016	2017	2018	2019	2020
Auditors in training	50	50	0	0	0	0	0
Active auditors	0	50	100	100	100	100	100
Electricity saved from audits in year (ktoe)	0	1.7	3.4	3.4	3.4	3.4	3.4
Heat & fuel saved from audits in year (ktoe)	0	3.4	6.8	6.8	6.8	6.8	6.8
Electricity saved from audits in last 5 years (ktoe)	0	1.7	5.2	8.6	12.0	15.5	17.2
Heat & fuel saved from audits in last 5 years (ktoe)	0	3.4	10.3	17.1	23.9	30.8	34.2
Total saved from audits in last 5 years (ktoe)	0	5.1	15.4	25.7	36.0	46.3	51.4

For the maximum impact (and for the purpose of this example) we assume a further 50 auditors will be trained in 2016 and 50 more in 2017, after which the training will cease but the auditors will continue in their roles. This gives:

	2014	2015	2016	2017	2018	2019	2020
Auditors in training	50	50	50	50	0	0	0
Active auditors	0	50	100	150	200	200	200
Electricity saved from audits in year (ktoe)	0	1.7	3.4	5.2	6.9	6.9	6.9
Heat & fuel saved from audits in year (ktoe)	0	3.4	6.8	10.3	13.7	13.7	13.7
Electricity saved from audits in last 5 years (ktoe)	0	1.7	5.2	10.3	17.2	24.1	29.2
Heat & fuel saved from audits last 5 years (ktoe)	0	3.4	10.3	20.5	34.2	47.9	58.1
Total saved from audits in last 5 years (ktoe)	0	5.1	15.4	30.8	51.4	72.0	87.4

The range of annual energy savings by 2020 is therefore 51 - 87 ktoe/year.

The cumulative energy savings over the period 2014-2020 are calculated by adding up the savings in each of those years, i.e. summing the figures in the bottom row of each of the two tables above. This gives a range of **cumulative energy savings by 2020 of 180 - 262 ktoe.**

Cumulative GHG savings (tCO_2) by 2020 (as a range)

To work out the annual and cumulative GHG savings associated with these energy savings, we first establish the relevant emissions factors. For heating and fuels we assume the savings are all natural gas and the emission factor is constant at 0.202 tCO_2/MWh, as in Step 3. In practice the emission factor may change a little in future as more shale gas enters the gas network. We have no data on the projected future emissions factors for electricity in the five countries concerned but we do know that on average emission factors for power generation must reduce by 1-2% per year over this time period in order to meet the EU's 20:20:20 targets. Therefore we assume that the emission factor for electricity for each country falls by 1.5% per year between 2010 and 2020, as follows. All emission factors are shown in tCO_2/MWh.

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Bulgaria	0.819	0.807	0.795	0.783	0.771	0.759	0.748	0.737	0.726	0.715	0.704
Hungary	0.566	0.558	0.549	0.541	0.533	0.525	0.517	0.509	0.502	0.494	0.487
Poland	1.191	1.173	1.156	1.138	1.121	1.104	1.088	1.071	1.055	1.040	1.024
Slovakia	0.252	0.248	0.244	0.241	0.237	0.234	0.230	0.227	0.223	0.220	0.217
Slovenia	0.557	0.549	0.540	0.532	0.524	0.516	0.509	0.501	0.494	0.486	0.479
Average	**0.677**	**0.667**	**0.657**	**0.647**	**0.637**	**0.628**	**0.618**	**0.609**	**0.600**	**0.591**	**0.582**

The calculations for the minimum annual GHG savings are shown in the table below. In each case we multiply the electricity or heat & fuels savings in each year by the relevant emission factor for that year. The electricity emission factors are calculated as an average of the five countries' emission factors since the same number of auditors are assumed to be trained in each country.

	2014	2015	2016	2017	2018	2019	2020
Electricity savings (ktoe)	0	1.7	5.2	8.6	12.0	15.5	17.2
Heat & fuel savings (ktoe)	0	3.4	10.3	17.1	23.9	30.8	34.2
Electricity tCO_2/MWh	0.637	0.628	0.618	0.609	0.600	0.591	0.582
Gas tCO_2/MWh	0.202	0.202	0.202	0.202	0.202	0.202	0.202
Electricity GHG saving ($ktCO_2$)	0	13	37	61	84	106	116
Heat & fuels GHG saving ($ktCO_2$)	0	8	24	40	56	72	80
Total GHG saving ($ktCO_2$)	**0**	**21**	**61**	**101**	**140**	**179**	**197**

The same approach is taken for the maximum annual GHG savings, as shown below. For ease of calculation, the same average electricity emission factor is used for the savings achieved by the second group of 100 trained auditors.

	2014	2015	2016	2017	2018	2019	2020
Electricity savings (ktoe)	0	3.4	10.3	20.5	34.2	47.9	58.1
Heat & fuel savings (ktoe)	0	5.1	15.4	30.8	51.4	72.0	87.4
Electricity tCO_2/MWh	0.637	0.628	0.618	0.609	0.600	0.591	0.582
Gas tCO_2/MWh	0.202	0.202	0.202	0.202	0.202	0.202	0.202
Electricity GHG saving ($ktCO_2$)	0	13	37	73	120	165	198
Heat & fuels GHG saving ($ktCO_2$)	0	8	24	48	80	112	137
Total GHG saving ($ktCO_2$)	**0**	**21**	**61**	**121**	**200**	**278**	**335**

The range of annual GHG savings by 2020 is therefore 197 - 335 $ktCO_2$/yr.

The cumulative GHG savings over the period 2014-2020 are calculated by adding up the savings in each of those years, i.e. summing the figures in the bottom row of each of the two tables above. This gives a range of **cumulative GHG savings by 2020 of 699 - 1,016 $ktCO_2$.**

Cumulative investment (€) stimulated by 2020 (as a range)

From Step 3, capital investment is estimated to be 142,000 Euro per auditor-year.

The number of auditor-years is equal to the sum of the values in the relevant row of the following table, i.e. 550 auditor-years in the minimum case and 900 auditor-years in the maximum case.

	2014	2015	2016	2017	2018	2019	2020
Active auditors – minimum case	0	50	100	100	100	100	100
Active auditors – maximum case	0	50	100	150	200	200	200

Multiplying the number of auditor-years by the capital investment per auditor-year gives a range of **cumulative investment stimulated by 2020 of 78 - 128 million Euro**.

Step 5: Sense checking

As a first sense check, we compare the minimum long-term impacts with the short-term impacts. So for energy savings the short-term impact is 5 ktoe/yr and the minimum long-term impact is 51 ktoe/yr. This seems reasonable since we have assumed only half the auditors will be trained and operational within the project duration and that there will be a cumulative effect with each audit having an energy saving impact for 5 years.

As a second sense check, we compare the ratio between energy saving and GHG saving for each of the following:

- the short-term (ST) impact,
- minimum long-term (LT) impact and
- maximum LT impact

	ST	LT min	LT max	LT min/ST	LT max/ST	LT max/min
Energy saved ktoe/yr	5.1	51.4	87.4	10.0	17.0	1.7
GHG saved ktCO_2/yr	22	197	335	9.1	15.5	1.7

We also compare the ratio between the cumulative ST impacts and the cumulative LT impacts:

	ST	LT min	LT max	LT min/ST	LT max/ST	LT max/min
Energy saved ktoe	5.1	180.0	262	35.0	51.0	1.5
GHG saved ktCO_2	21.6	699.0	1016	32.4	47.1	1.5
Investment m€	7.1	78.3	128	11.0	18.0	1.6

All of these ratios are consistent so no error is suggested in these calculations. You would expect the ratios for cumulative investment to be lower as only 3 years of energy savings were accounted for in the estimation of investment in Step 3 while the energy and GHG savings are accrued over 5 years.

As final sense check, we compare the maximum long-term impact estimate with the overall energy consumption of the industry sectors in the countries that the project will address. The energy consumption data are taken from Eurostat statistics.

	Industry consumption in 2010 in ktoe	Max energy savings in 2020in ktoe/yr	Percentage saved
Bulgaria	2541	17.5	0.7%
Hungary	2913	17.5	0.6%
Poland	15384	17.5	0.1%
Slovakia	4352	17.5	0.4%
Slovenia	1280	17.5	1.4%

These percentages look small enough to be plausible and large enough to indicate a significant impact. We note that the savings are compared against total industrial energy consumption not the energy consumption of SMEs in the services sector, which would have been a better comparison if the data had been available.

Worked example 2:

Promotion of bioenergy schemes (Preparing the ground for Investment)

using Method 1 (bottom-up).

Project description

The project will set up working groups and networking events aimed at investors to promote the uptake of commercial-scale biomass heat schemes. This is expected to generate knowledge sharing and new business contacts, enabling an increase in uptake of biomass heat. The working groups are also expected to generate thought pieces on converting to biomass, and other promotional knowledge sharing material.

Project objectives

The objectives of the project are:

- To set up a working group for commercial-scale biomass in each participating Member State
- To hold 4 working group meetings per year
- To initiate 10 networking events over the lifetime of the project, with at least 30 attendees from working group members, industry representatives, investors and key stakeholders from each participating country and beyond
- To mobilise investment in the bioenergy sector, triggering the installation of new commercial-scale (minimum 1MW) biomass heat schemes.

Which Project performance indicators?

No energy savings are expected to result from this project, then the Project performance indicators to be calculated are:

Within the project duration:

- Cumulative investment made by European stakeholders in sustainable energy (**Euro**)
- Renewable Energy production triggered (**toe/year**)
- Reduction of greenhouse gas emissions (**t CO2e/year**)

By 2020:

- Cumulative investment made by European stakeholders in sustainable energy (Euro)
- Cumulative Renewable Energy production triggered (**toe**)
- Cumulative Reduction of greenhouse gas emissions (**t CO2e)**

Which methodology?

Method 1 is the preferred approach if it can be applied. For this project it is possible to build up the Project performance indicators from the project outputs, i.e. the number of new business connections and deals made at networking events can be used to estimate the likely number of new biomass schemes in development. Therefore Method 1 is chosen.

Step 1: Defining scope and impacts

The direct impacts are expected to be on the investors, who are expected to be encouraged in supporting and funding new commercial-scale biomass heat schemes. In the longer term also indirect effects are expected through expansion of the working groups, and replication of the networking events in other Member States. This would be dependent on finding additional funding for the working groups and events after the duration of this project.

In the calculation of short term and longer-term impacts (Step 3 and 4) we have therefore assumed that:

- Within the project duration (2015), at least 10 investment projects are expected in the partner countries, based on an average biomass scheme of 1 MW.
- For the minimum impact in 2020, the investors directly involved in the project go on to fund additional 20 biomass schemes (1 MW minimum).
- For the maximum impact in 2020, an additional 40 biomass schemes are funded as a result of wider replication and confidence in the technology/market.

Step 2: Setting the baseline

This step is not needed for Method 1.

Step 3: Estimating short-term impacts

There will be one working group set up in each of the 4 Member States participating in this project. Each working group will made up of at least 12 members, with meetings being held with 8 or more attendees, once per quarter. There will be 10 networking events over the lifetime of the project, attracting at least 30 attendees at each event. From these project activities, the consortium expects to trigger the installation of at least 10 new commercial-scale (minimum 1 MW) biomass heat schemes by the end of the project.

Cumulative investment (€) triggered by the end of the project

There are a number of existing biomass networks being run in Europe. Most business networking institutions, and organisations that organise and host network events for investors, claim numerous benefits from networking, the most relevant of which is an increase in the project progression as an outcome of the networking event[10].

The target of this project is to create an additional 10 commercial-scale biomass heat schemes by the end of the project. We have set a target size of 1 MW capacity, although individual schemes may be larger than this, depending on the load size. The average cost of a 1 MW plant is €524,000[11].

As commercial-scale biomass heat projects typically take 2-3 years to complete, we are estimating that a few of the installations will be already in development before the end of the project, and some investment will be in place at the end of the project. For the others, the project must provide evidence that the investments have been launched, even though the real installation will start after the end of the action. In total, 10 new biomass schemed are expected to be triggered before the end of the project.

Then the **short-term impact on investment** is 10 x 524,000 = **5,240,000 Euro**.

Renewable energy production triggered by the end of the project (toe/year)

We have assumed the annual output of a typical commercial-scale 1MW capacity plant is 3,504 MWh. This is calculated by multiplying the size of the boiler by a load factor suitable for the application, then by 8760[12]. Domestic load factor would be 0.2; commercial would be **0.4**; and industrial 0.8[13].

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[10] Pittaway, L., Robertson, M., Munir, K., Denyer, D. and Neely, A. (2004), Networking and innovation: a systematic review of the evidence. International Journal of Management Reviews, 5: 137–168.

[11] Adapted from the Carbon Trust Biomass Heating Guide, http://www.carbontrust.com/media/31667/ctg012_biomass_heating.pdf

[12] 8760 is the number of hours in a year

[13] DECC Evaluation of the Bio-Energy Capital Grants Scheme (2011)

We then need to convert MWh into tonnes of oil equivalent. IEA unit converter[14] is used here and throughout this example. So, the annual heat generation of a 1 MW commercial-scale plant would be 301 toe. As the target for this project is to trigger the installation of 10 plants of at least 1 MW capacity by the end of the project, the minimum annual **renewable energy production triggered** within the project duration will **be 3,010 toe/year**.

Annual GHG savings (tCO_2/year) by the end of the project

GHG savings are calculated from energy savings using the appropriate emissions factors. We assume the emissions factor for heat is that of natural gas, as the intended biomass schemes are expected to be commercial-scale. If we had a breakdown by fuel for energy consumption for heat in each new scheme then these breakdowns could be used to give more accurate GHG emissions savings estimates.

The average emissions factor for gas for Europe is currently 0.202 tCO_2/MWh according to the guidance for Sustainable Energy Action Plans produced for the EU Covenant of Mayors initiative[15], and this is assumed to be constant to 2015. Therefore the GHG savings from a 1 MW capacity biomass heat plant are estimated at 3,504 MWh x 0.202 tCO_2/MWh = 707.8 tCO_2/year.

As the target for this project is to trigger the installation of 10 plants of at least 1 MW capacity, the **minimum annual GHG savings by the end of the project will be 7,078 tCO_2/year**.

Step 4: Estimating long-term impacts

Cumulative investment made by European stakeholders in sustainable energy by 2020 (as a range)

The minimum long-term target of this project is to create an additional 20 commercial-scale biomass heat schemes by 2020; the maximum is further additional 40 schemes triggered by 2020.

As before, a typical 1 MW biomass-heat installation will cost approximately €524,000, with wide variation expected due to specific site needs, especially in cases where a district heating network is required.

We have assumed that investors will invest more strongly in new plants once initial schemes have been completed in 2016, giving a non-linear growth curve.

Year	2016	2017	2018	2019	2020
Minimum no. installations	2	5	10	15	20
Total cumulative investment	1,048,000	2,620,000	5,240,000	7,860,000	**10,480,000**
Maximum no. installations	4	10	20	30	40
Total cumulative investment	2,096,000	5,240,000	10,480,000	15,720,000	**20,960,000**

Therefore, the range of **cumulative investment triggered by 2020 is 15,720,00 – 26,200,000 Euro**.

Cumulative renewable energy production triggered (toe) by 2020 (as a range)

The cumulative renewable energy production over the period 2016-2020 is calculated by adding up the production in each of those years, i.e. summing the figures in the total energy production rows for minimum and maximum below.

Following the same installation rate as predicted for the cumulative investment, using an average of 301 toe energy production per plant per year, gives a **minimum cumulative energy production of 15,652 toe, and a maximum of 31,204 toe**.

[14] http://www.iea.org/statistics/resources/unitconverter
[15] From http://www.eumayors.eu/IMG/pdf/technical_annex_en.pdf

Year	2016	2017	2018	2019	2020
Minimum no. installations	2	5	10	15	20
Total energy production (per year)	602	1,505	3,010	4,515	6,020
Maximum no. installations	4	10	20	30	40
Total energy production (per year)	1,204	3,010	6,020	9,030	12,040

Cumulative GHG savings (tCO_2) by 2020 (as a range)

As above mentioned, the average emissions factor for gas for Europe is currently 0.202 tCO_2/MWh according to the guidance for Sustainable Energy Action Plans produced for the EU Covenant of Mayors initiative, and this is assumed to be constant to 2015. Therefore the GHG savings from a 1 MW capacity biomass heat plant are estimated at 3,504 MWh x 0.202 tCO_2/MWh = 707.8 tCO_2/year.

The GHG savings over the period 2016-2020 are calculated by adding up the savings in each of those years, i.e. summing the figures in the total GHG savings rows for minimum and maximum below.

Following the predicted installation rate, using an average of 707.8 tCO_2/year per plant per year, gives a **minimum cumulative GHG saving of 36,806 tCO_2/year, and a maximum of 73,611 tCO_2/year.**

Year	2016	2017	2018	2019	2020
Minimum no. installations	2	5	10	15	20
Total GHG savings / year	1,416	3,539	7,078	10,617	14,156
Maximum no. installations	4	10	20	30	40
Total GHG savings / year	2,831	7,078	14,156	21,234	28,312

Step 5: Sense checking

The checks proposed in the guide are rather straightforward because the calculation is based on a well-defined bottom-up approach, with precise and direct links between the short term and long term impacts and among the different Project performance indicators, all directly linked among themselves.

Worked example 3:

Market strategies for solar energy (Enabling policy)

using Method 2 (top-down)

Project description

The project will facilitate the introduction of solar photovoltaics (PV) across Europe by providing a comprehensive assessment of the market barriers to PV in all EU27 countries and then addressing some of the key barriers through the development of a web-based resource and market assessment tool and the establishment of a "PV marketplace" for suppliers to link with installers.

The main expected outcomes from the project are:

- To produce a report on the key market barriers to PV in all EU27 countries
- To introduce a multi-lingual web-based resource and market assessment tool
- To establish the "PV marketplace" with at least 200 registered users

Which Project performance indicators?

No energy savings are expected to result from this project, then the Project performance indicators to be calculated are:

Within the project duration:

- Cumulative investment made by European stakeholders in sustainable energy (**Euro**)
- Renewable Energy production triggered (**toe/year**)
- Reduction of greenhouse gas emissions (**t CO2e/year**)

By 2020:

- Cumulative investment made by European stakeholders in sustainable energy (Euro)
- Cumulative Renewable Energy production triggered (**toe**)
- Cumulative Reduction of greenhouse gas emissions (**t CO2e)**

Which methodology?

Method 1 would be the preferred method but in this case it is not possible to calculate the overall project impacts by adding up the impacts of individual project outputs. The project is expected to influence market uptake of PV across Europe by addressing various market barriers. The impacts can therefore be estimated by comparing the likely market uptake of PV once this project is implemented with the likely uptake (baseline) without it. This is a Method 2 approach. More precisely, we will use a modified Method 2 approach whereby we attribute a proportion of the difference between the baseline scenario and an accelerated uptake scenario to this project.

We recognise that the assumed attribution of savings to the project will be a crucial assumption and that there is a significant uncertainty inherent in this approach. However we believe that this is the only practical methodology for estimating the impacts of such a broad project, and that the results, while approximate, still provide valuable information on the likely scale of impact of the project.

Step 1: Defining scope and impacts

The project is expected to lead to an accelerated uptake of PV across Europe. The impacts are defined by assuming the project contributes to the difference between the Moderate scenario and the Policy-Driven scenario developed by the industry association XYZ (as indicated in the report ABC). The project runs from 2013 to 2015. It is assumed to have an impact only in 2015 and 2016 for the minimum impacts case, and in 2015, 2016, 2017 and 2018 for the maximum impacts case. No impacts are expected in the first two years of the project (2013 and 2014).

Step 2: Setting the baseline

The baseline is defined by the Moderate scenario in the ABC report. However this report only provides figures to 2016 and so we have extrapolated to 2020 assuming the same annual increase as 2015 to 2016 in each of the following four years. This gives the following baseline projections for PV in Europe.

	2015	2016	2017	2018	2019	2020
Moderate added capacity (MW/year)	9 350	10 272	11 194	12 116	13 038	13 960
Moderate cumulative added capacity (MW)	9 350	19 622	30 816	42 932	55 970	69 930

The cumulative added capacity is then converted into a baseline renewable energy generation using an average load factor for PV in Europe of 12%, based on expert judgement and various data sources including:

- The PRIMES model[16] assumes a 10% average load factor for PV in Europe.
- DECC statistics[17] suggest UK PV load factors have varied from 5.5% to 9.9% over recent years, with an average of 8.3% over the period 2007-2011
- The Eurelectric web site[18] quotes an average load factor for Germany of 18% in 2011

The baseline electricity generation is calculated from the cumulative added capacity by multiplying by the load factor and the number of hours in a year (365 days x 24 hours/day = 8760 hours). The electricity generation in GWh/year is then converted to electricity generation in ktoe/year using a conversion factor of 11.63 GWh/ktoe[19]. This gives:

	2015	2016	2017	2018	2019	2020
Moderate GWh/year generation added	9 829	20 627	32 394	45 130	58 836	73 510
Moderate ktoe/year generation added	845	1 774	2 785	3 880	5 059	6 321

The equivalent figures for the Policy Driven scenario developed in the report ABC, calculated in the same way, are:

	2015	2016	2017	2018	2019	2020
Policy Driven added capacity (MW/year)	21 165	24 845	28 525	32 205	35 885	39 565
Policy Driven cum. added capacity (MW)	21 165	46 010	74 535	106 740	142 625	182 190
Policy Driven GWh/year added	22 249	48 366	78 351	112 205	149 927	191 518
Policy Driven ktoe/year added	1 913	4 159	6 737	9 648	12 891	16 468

Step 3: Estimating short-term impacts

This project is expected to contribute 1% of the difference in added PV generation between the Policy Driven scenario and the Moderate scenario in the ABC report in 2015. This attribution is based on the assumptions that:

- The provision of information on resource availability and the linking of PV suppliers to installers will help to catalyse the market for PV but by far the biggest factor in driving additional uptake will be cost reductions through technology improvements coupled with the financial support available at Member State level, e.g. Feed-in Tariffs

[16] See PRIMES reference manual at http://www.e3mlab.ntua.gr/manuals/PRIMREFM.pdf
[17] UK Digest of Energy Statistics 2012 at https://www.gov.uk/government/statistics/digest-of-united-kingdom-energy-statistics-dukes-2012-printed-version-excluding-cover-pages
[18] See http://www.eurelectric.org/powerstats2012/
[19] The IEA energy converter at http://www.iea.org/stats/unit.asp is used here and throughout this example

- A 1% attribution figure for this project seems a reasonable and conservative estimate; this has been confirmed by in depth discussions with a number of market stakeholders like XYZ and VBN. Moreover, this figure has been verified by impact assessment studies related to similar initiatives in other sectors.

Renewable electricity triggered (toe/year) by the end of the project:

By taking the PV electricity generation added (ktoe/year) under the Moderate scenario away from the PV electricity generation added under the Policy Driven generation we get the difference between the two, i.e. the additional renewable energy generated in 2015.

	2015
Policy Driven ktoe/year added	1 913
Moderate ktoe/year added	845
Additional generation (ktoe/year)	1 068

We then apply the attribution percentage of 1% to calculate the renewable energy (RE) triggered by the project in 2015, i.e. during the project duration:

	2015
RE triggered by project (toe/year)	10 680

The **renewable energy triggered by the end of the project** in 2015 is **10 680 toe/year**.

GHG savings (tCO_2) by the end of the project:

The average emissions factor for electricity generation in the EU27 is 0.46 tCO_2/MWh from the guidance for Sustainable Energy Action Plans produced by the EU Covenant of Mayors initiative[20]. The average emission factors for power generation must reduce by 1-2% per year over the period to 2020 in order to meet the EU's 20:20:20 targets. Therefore, we assume that the emission factor for electricity for the EU27 falls by 1.5% per year between 2010 and 2020, as follows. The emissions factors are then converted to tCO_2/toe using a conversion factor of 11.63 MWh/toe.

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
tCO_2/MWh	0.460	0.453	0.446	0.440	0.433	0.427	0.420	0.414	0.408	0.401	0.395
tCO_2/toe	5.35	5.27	5.19	5.12	5.04	4.97	4.89	4.81	4.75	4.66	4.59

The GHG savings by the end of the project (i.e. in 2015) are then calculated by multiplying the RE triggered (in toe/year) by the relevant emissions factor (in tCO_2/toe):

	2015
RE triggered by project (toe/year)	10 680
GHG savings (tCO_2/year)	53 080

The **annual GHG emissions reduction** by the end of the project are **53 080 tCO_2/year**.

Investment triggered (€) by the end of the project:

The investment stimulated is calculated from the additional PV capacity installed during the relevant year (as a result of the project) multiplied by an average investment cost in € per MW installed. The additional PV capacity installed is calculated from the difference between the Policy Driven and Moderate scenarios from the ABC report.

	2015
Capacity added in Moderate scenario (MW/year)	9 350
Capacity added in Policy Driven scenario (MW/year)	21 165
Additional capacity added in Policy Driven scenario (MW/year)	11 815
%age of additional capacity attributed to project	1%
Additional capacity attributed to project (MW/year)	118

[20] From http://www.eumayors.eu/IMG/pdf/technical_annex_en.pdf

The average investment cost is assumed to fall from €2,550,000 per MW[21] installed in 2010 to the SETIS target cost of €1,500,000/MW installed in 2020[22], assuming a straight-line projection. This means the average investment cost in 2015 is mid-way between the 2010 and 2020 costs, i.e. €2,025,000 per MW.

The investment stimulated by the end of the project (i.e. in 2015) is therefore 118 MW/year x €2,025,000 per MW = €239,253,750 = **€239 million**.

Step 4: Estimating long-term impacts

As explained above, we assume that the project can be attributed 1% of the difference in PV uptake between the Policy Driven and Moderate scenarios in 2015 and 2016. For the minimum case, we assume there are no further savings attributable to this project beyond 2016 but the additional PV installed in 2015 and 2016 continues to generate electricity throughout the period to 2020.

To estimate the maximum likely impact from the project, we assume that the project will continue to have an impact until the end of 2018, at a level of 1% of the difference between the Policy Driven and Moderate scenarios. Implicitly, we are assuming that the types of activities undertaken by this project prove successful and are continued or replicated for a further three years beyond the lifetime of the project. No further savings are assumed in 2019 or 2020 but the additional PV stimulated in the period 2015-2018 continues to generate electricity throughout the period to 2020.

Renewable energy triggered (toe) by 2020 (as a range)

We start with the difference between the added RE generated under the Policy Driven scenario and the added RE generated under the Moderate scenario, as before:

	2015	2016	2017	2018	2019	2020
Moderate added generation (ktoe/year)	845	1 774	2 785	3 880	5 059	6 321
Policy Driven added generation (ktoe/year)	1 913	4 159	6 737	9 648	12 891	16 468
Additional added generation (ktoe/year)	1 068	2 385	3 952	5 767	7 832	10 147

For the minimum case, we apply the 1% attribution figure for 2015 and 2016 to calculate the renewable energy (RE) triggered by the project. The impact is then assumed to remain constant from 2016 onwards as no further capacity additions are attributed to the project. This gives:

	2015	2016	2017	2018	2019	2020
Additional RE generation (ktoe/year)	1 068	2 385	3 952	5 767	7 832	10 147
Attribution to project	1%	1%	-	-	-	-
Minimum RE triggered by project (ktoe/year)	11	24	24	24	24	24

For the maximum case, we apply the 1% attribution figure for 2015-2018 to calculate the renewable energy (RE) triggered by the project. In this case, the impact is assumed to remain constant from 2018 onwards as no further capacity additions are attributed. This gives:

	2015	2016	2017	2018	2019	2020
Additional RE generation (ktoe/year)	1 068	2 385	3 952	5 767	7 832	10 147
Attribution to project	1%	1%	1%	1%	-	-
Maximum RE triggered by project (ktoe/year)	11	24	40	58	58	58

This gives a range of RE triggered of 24 - 58 ktoe/year in 2020.

[21] See SETIS report at http://setis.ec.europa.eu/newsroom-items-folder/solar-photovoltaic-energy-generation - the figure of 2.55 €/Wp used here is for sub 100kW PV systems in Germany

[22] See SETIS roadmap at http://setis.ec.europa.eu/about-setis/technology-roadmap/european-industrial-initiative-on-solar-energy-photovoltaic-energy

The cumulative RE triggered over the period 2014-2020 is calculated by adding up the RE triggered in each of those years, i.e. summing the figures in the bottom rows of each of the two tables above. This gives **cumulative RE triggered of 130 – 247 ktoe by 2020**.

GHG savings (tCO_2) by 2020

To work out the annual and cumulative GHG savings associated with this level of renewable electricity generation, we apply the electricity emissions factors calculated above:

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
tCO_2/MWh	0.460	0.453	0.446	0.440	0.433	0.427	0.420	0.414	0.408	0.401	0.395
tCO_2/toe	5.35	5.27	5.19	5.12	5.04	4.97	4.89	4.81	4.75	4.66	4.59

This gives the following annual GHG savings from the project:

	2015	2016	2017	2018	2019	2020
Minimum RE triggered (ktoe/year)	11	24	24	24	24	24
Maximum RE triggered (ktoe/year)	11	24	40	58	58	58
Minimum GHG saved ($ktCO_2$/year)	54.67	117.36	115.44	114.00	111.84	110.16
Maximum GHG saved ($ktCO_2$/year)	54.67	117.36	192.40	275.50	270.28	266.22

The cumulative GHG savings over the period 2015-2020 are calculated by adding up the savings in each of those years, i.e. summing the figures in each of the bottom two rows of the table above. This gives a range of **cumulative GHG savings of 623 - 1176 $ktCO_2$ by 2020**.

Cumulative investment stimulated (€) by 2020 (as a range)

As for the short-term impacts, the investment stimulated is calculated from the additional PV capacity installed during the relevant year (as a result of the project) multiplied by an average investment cost in € per MW installed. The additional PV capacity installed is calculated from the difference between the Policy Driven and Moderate scenarios from the ABC report.

	2015	2016	2017	2018	2019	2020
Capacity added in Moderate scenario (MW/year)	9 350	10 272	11 194	12 116	13 038	13 960
Capacity added in Policy Driven scenario (MW/year)	21 165	24 845	28 525	32 205	35 885	39 565
Difference between Policy Driven and Moderate scenarios (MW/year)	11 815	14 573	17 331	20 089	22 847	25 605
Minimum %age of additional capacity attributed to project	1%	1%	-	-	-	-
Minimum additional capacity attributed to project (MW/year)	118	146	0	0	0	0
Maximum %age of additional capacity attributed to project	1%	1%	1%	1%	-	-
Maximum additional capacity attributed to project (MW/year)	118	146	173	201	0	0

The average investment cost is assumed to fall from €2,550,000 per MW[23] installed in 2010 to the SETIS target cost of €1,500,000/MW installed in 2020[24], assuming a straight-line projection. This gives the following installed costs in €M/MW (or € per watt power) in each year.

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
€M/MW	2.55	2.45	2.34	2.24	2.13	2.03	1.92	1.82	1.71	1.61	1.50

Multiplying the cost per MW installed by the additional capacity attributed to the project gives:

[23] See SETIS report at https://setis.ec.europa.eu/system/files/Technology_Map_2011.pdf - the figure of 2.55 €/Wp used here is for sub 100kW PV systems in Germany
[24] See SETIS roadmap at https://setis.ec.europa.eu/european-industrial-initiative-solar-energy-photovoltaic-energy

	2015	2016	2017	2018	2019	2020
Minimum investment stimulated (M€/year)	239	280	0	0	0	0
Maximum investment stimulated (M€/year)	239	280	315	344	0	0

The **cumulative investment stimulated is the sum of the annual investments in each year, i.e. a range of between 519 – 1177 M**€.

Step 5: Sense checking

As a first sense check, we compare the minimum long-term impacts with the short-term impacts. For RE triggered, the short-term impact is 11 ktoe/year and the minimum long-term impact is 24 ktoe/year. This seems reasonable since we have assumed 1% of the difference between the Policy Driven and Moderate uptake scenarios is attributed in 2015 (within the project duration) and 1% is also attributed in 2016 (outside the project duration). One would therefore expect the minimum long-term impact to be roughly twice the short-term impact.

As a second sense check, we compare all the ratios between short-term (ST) impact, minimum long-term (LT) impact and maximum LT impact for the RE CPI:

	ST	LT min	LT max	LT min/ST	LT max/ST	LT max/min
RE triggered ktoe/yr	11	24	58	2.2	5.4	2.4

These ratios appear consistent. The long term to short term ratios for GHG saved are expected to be slightly lower than the equivalent ratios for RE triggered because the emissions factor for electricity reduces in value between 2015 and 2020.

We also compare ratios between cumulative ST impacts and minimum cumulative LT impacts:

	ST	LT min	LT max	LT min/ST	LT max/ST	LT max/min
RE triggered ktoe	11	130	247	12.2	23.1	1.9
Investment m€	239	519	1 177	2.2	4.9	2.3

All of these ratios appear consistent so no error is suggested in these calculations. You would expect the LT to ST ratios for cumulative investment to be lower than for cumulative RE triggered or cumulative GHG saved as the RE and GHG savings continue to accrue from the installed PV capacity in the years following the investment, and also the investment cost per MW installed falls over time.

As final sense check, we compare the project's maximum cumulative long-term impact of 638 MW[25] of additional PV capacity by 2020 with the total PV capacity expected to be installed by 2020 according to the National Renewable Energy Action Plans (84.5 GW[26]). This gives a percentage contribution from this project of 0.8%. This percentage looks small enough to be plausible and large enough to indicate a significant impact.

[25] Calculated by adding 118MW in 2015, 146 MW in 2016, 173 MW in 2017 and 201 MW in 2018.

[26] See SETIS report at http://setis.ec.europa.eu/newsroom-items-folder/solar-photovoltaic-energy-generation Note the 84.5 GW figure quoted is for 26 of the EU27 Member States, including Germany and Italy.