The challenges of ex-post impact evaluation in the context of Intelligent Energy Europe

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Abstract

In reviewing the outputs and impacts of 47 Intelligent Energy Europe (IEE) bioenergy projects, our team encountered a wide range of challenges. The aim of IEE in the bioenergy sector is to increase the rate of uptake of bioenergy, and our evaluation centered on identifying evidence from the projects themselves that they had influenced bioenergy policy, market development, supply chains and skills/knowledge in their target European countries and beyond.

From the 47 projects that we reviewed, and building on the work we previously undertook in 2012[1], we found that projects delivered prior to 2013 were not required to record output and impact data in a standardised fashion, which led to highly varied records of the achievements of each project. Many projects focussed on the outputs of the work and did not address methods to estimate, measure, or evaluate their short and long term impacts. As we know, evaluations are only as good as the data they are based on, so it was imperative to develop methodologies that helped to tackle these challenges. This paper explores both the challenges presented by inconsistent data capture, and potential solutions that allow us to draw some reliable impact conclusions from the programme.

Intelligent Energy Europe II (IEE II)

The IEE programme is designed to help realise EU energy objectives by supporting work to address non-technical barriers that could prevent these objectives from being achieved. The IEE programme ran from 2003 -13 in two phases, the second running from 2007-2013. IEE's role was to fund specific actions within the market place to overcome non-technological barriers to both the efficient use of energy and the greater use of new and renewable energy sources, with the overall aim of contributing to the provision of secure, sustainable and competitively priced energy for Europe.

This paper is concerned only with those actions supported in the second phase of IEE (IEE II) to enhance the use of bioenergy as part of the programme of work supporting new and renewable energy sources. Bioenergy projects were supported under the ALTENER element of the IEE II programme, which had the objective of promoting new and renewable energy sources and supporting energy diversification. The core objectives were: to provide support for innovative market initiatives; to share best practice; to support EU policy implementation; provision of information for decision makers; promotion of use of proven products, systems and infrastructure; and to trigger investment.

Each project supported addressed one or more of five defined fields of delivery, which were:

(1) **Shaping policy development and implementation** (e.g. by provision of technical inputs and market feedback to policy makers in the European Commission and Member States (MS); actions to support the implementation of EU Directives and policies; and actions that assist local and regional policy makers and civil servants to develop and implement local strategies and action plans).

(2) **Creating favourable market conditions** (e.g. accelerated uptake of certified products and services; improved standards and information campaigns; tackling common barriers etc.).

(3) **Changing behaviour** (e.g. large scale information exchange and awareness raising; actions encouraging market players to change behaviour etc.).

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1 https://ec.europa.eu/energy/intelligent/files/implementation/doc/executive-summary-iee-project-performance-indicators.pdf

(4) **Mobilising investments** (e.g. projects facilitating use of structural and other investment funds; provision of necessary information; mobilising decision makers and funding technical assistance; preparation of tendering procedures and contractual arrangements etc.).

(5) **Building skills and capacities** (e.g. supporting the development of appropriate skills and competencies of market players).

Bioenergy in IEE II

Bioenergy is central to achievement of the EU 2020 Renewable Energy targets: it features heavily in many Member State National Renewable Energy Action Plans and is relevant to all sectors: transport, heat, electricity and cooling. This wide range of use is only part of the complexity of bioenergy. There are also a range of feedstock options, drawing from different sectors including forestry, agriculture, agri-industrial processing and waste management. Consequently the bioenergy area involves a number of different players in a number of sectors and a range of stakeholders with interests in the area (including local authorities, planners, regulators and policy makers as well as suppliers, developers and financiers). IEE II support reflects this. Further information on the spectrum of bioenergy projects supported in IEE II is shown in Table 1.

Table 1. Categories of bioenergy projects in IEE II

<table>
<tr><th>Bioenergy areas addressed in IEE II</th><th>Examples of types of Actions supported</th></tr>
<tr><td>Liquid biofuels – including supply infrastructure.</td><td rowspan="4">• Development of tools and guidelines (online and published)
• Training and skills development
• Provision of data and information on performance of bioenergy technologies
• Support to standards and their implementation
• Support to certification schemes and their implementation
• Economic data and analysis of best cost options
• Development of networks and knowledge centres for target stakeholders
• Facilitation of exchange of information between regions and between different types of stakeholders (e.g. policy makers, bioenergy developers, environmental protection associations and different regions)
• Promotion of cooperation between actors in the mobilisation chain
• Set-up of supply chains
• Promotion of actions and exchange of information at local levels
• Development of infrastructure for distribution, collection, harvesting, transformation and use; improvement of use of infrastructure in existence
• Information on sustainability and development of harmonised data on sustainability and GHG emissions</td></tr>
<tr><td>Solid biomass – including information for producers; information on wood supply; assistance with the establishment of supply chains; development of certified supply chains; sustainable sourcing of supply; information provision on technical, legal and economic aspects on biomass supply.</td></tr>
<tr><td>Biogas – including information on small and micro-scale plants; assistance with business plans; information on anaerobic digestion of specific feedstocks; knowledge hubs for biogas projects in food and beverage sector; promotion of biomethane, including injection networks.</td></tr>
<tr><td>Strategic Initiatives: including planning & strategic initiatives; policy development and implementation; resource quantification; regional energy planning tools; harmonisation of Green House Gas (GHG) calculations for biofuels and solid biomass; guidelines for development of biomass trade; knowledge transfer between regions; comparative analysis of options.</td></tr>
</table>

Among the work supported in phase II of the IEE programme there were 47 bioenergy projects[2]:

- 6 on liquid biofuels (total funding (€5.25M);
- 18 on solid biomass (total funding: €17.48M);
- 14 on biogas (total funding €15.94M);
- 9 on strategic initiatives (total funding €9.6M).

Since May 2015, Ricardo Energy & Environment have been working under contract to the Executive Agency for Small and Medium Enterprises (EASME) to review and assess the data produced by each of these 47 bioenergy projects in order to understand the potential impact of these projects on the uptake of bioenergy across Europe.

Evaluation requirements

The key evaluation requirements are to look at the impacts of all 47 bioenergy projects, and to determine common points that can be aggregated into programme-level achievements, supplemented with specific key examples of success. The final impacts will be categorised (by type of bio-resource, Bioenergy carrier and country) into:

- Bioenergy produced/mobilized;
    - Tonnes and toe of solid biomass mobilised (with a breakdown between agricultural and forest biomass),
    - Cubic metres and toe of biogas produced,
    - Cubic metres and toe bio-methane produced,
    - Tonnes and toe of liquid biofuels produced (by type, e.g. biodiesel and bioethanol),
- Final renewable energy production;
    - Mtoe in total,
    - (GWh/year for electricity, Mtoe for heat and Mtoe for transport fuels),
- Investments (million EUR) triggered by project, by country and by topic/application;
- Leverage effect, per project and in total, in terms of;
    - EUR triggered per Million EUR EU funding,
    - GWh/year or Mtoe triggered per Million EUR EU funding,
    - Differentiating per end use (thermal energy, electricity and transport fuel),
- Contribution to the Renewable Energy Directive (2009/28/EC) overall target: share of country gross final energy consumption (GFEC);
- Contribution to the Renewable Energy Directive (2009/28/EC) sectorial targets: share of energy/electricity/transport sectorial GFEC;
- Reduction of GHG emissions (tonne CO2-eq/year).

A key part of this project will be to identify the key programme-level indicators and specific examples that allow us to produce a reliable evidence base on which to base any statements around the importance of market support intervention funding.

Baseline data

Each project was required to produce a table in Annex 1 of their application for funding that detailed their specific objectives, their planned activities and outputs, and the measures to identify whether the outputs were achieved, such as training 300 individuals in the use of a new tool, measured by the number of participants that engaged in the training.

Each project also produced a table in Annex 1 for their strategic objectives (focusing on long term objectives after the end of the project, up to 2020), and their specific objectives (focusing on the

2 Data sourced through desk review of project data

lifetime of the project) and the estimated impacts that the project would need to achieve to meet those strategic/specific objectives. Projects were asked to give quantified impacts, but were not required to outline how they would be measured for the strategic impacts. Our review took into account 47 Annex 1 documents.

From 2010 onwards each project was required to set quantitative impact targets for the programme level Common Performance Indicators (CPIs). These were:

- The sustainable energy investment triggered (million Euros per annum and cumulative to 2020);
- The renewable energy production (tonnes of oil equivalent (toe) per annum and cumulative to 2020);
- The primary energy saved (tonnes of oil equivalent (toe) per annum and cumulative to 2020)3;
- The reduction of greenhouse gas emissions (tonnes CO_2 equivalent per annum and cumulative to 2020).

Each project supported after 2009 submitted estimated CPIs with their application for funding, and were then required to review these CPI estimates in an 'Updated CPI report'. Our review took into account 17 Updated CPI reports.

Each completed project produced a Final Technical Implementation report, which outlined the achievements of the project against the tables from Annex 1 and from the Updated CPI reports (where relevant). Our review took into account 36 Final Technical Implementation reports. For the remaining 11 ongoing projects, our review took into account their Interim Report on progress.

Immediate challenges present in the baseline data

Previous assessments of IEE II[4] have shown a number of common issues that are present in almost all projects, including the 47 bioenergy projects delivered between 2007-2013:

1. It is not straight forward to assess the impact of all IEE projects quantitatively. In the earlier IEE II projects, impacts were presented using specific performance indicators related to the project rather than CPIs. This was partially addressed from 2010 when CPIs were introduced, but the issue remains for the assessment of the whole programme, and for the assessment of bioenergy projects as a sub-set of IEE II.
2. Most project specific indicators are outputs rather than impacts, i.e. they are a measure of the outputs of the actions of the projects, such as the number of reports, factsheets, workshops or tools produced rather than quantitative impacts such as the amount of energy generated or the biomass mobilised as a direct or indirect result of the project. Thus, although many projects provided quantitative results these were often outputs rather than impacts. Many projects provided information on, for example, numbers of events held, number of tools/ reports/ guidelines produced and the number of stakeholders reached. Such data should be substantiated in the project reports and other material. However, to go further, to assign biomass deployment (renewable energy generated), investments triggered or greenhouse gas emission reduction to these projects is more difficult. Project Coordinators found it difficult to obtain data to calculate quantitative impacts. There is evidence that this situation improved in later projects as CPIs were required.
3. There is only qualitative ('soft') evidence that many of the projects supported have provided useful actions or tools that enable bioenergy stakeholders to overcome barriers (such as development of fuel standards or provision of clarity on greenhouse gas emissions to support policy requirements) without a defined methodology to identify quantifiable evidence of their impact.

3 Note this is not a required CPI for bioenergy projects and is aimed at energy efficiency projects
4 For example, see: DG ENER (2011) Final evaluation of the Intelligent Energy Europe II programme within the Competitiveness and Innovation Framework Programme; Deloitte (2011) for DG ENER Ex-ante evaluation of a successor of the Intelligent Energy Europe II (2007-2013); Ricardo-AEA (2012) IEE Project performance indicators

4. Where quantitative data are available they are presented in a range of units in different projects (e.g. Mtoe, MWh, oven dried tonnes mobilised, capacity of MW etc.)
5. The data can be viewed from many perspectives. There is difficulty when aggregating data as it is often provided in different units across different projects (as described above) and at different levels of granularity, such as measuring electricity and heat separately as a part of Combined Heat and Power (CHP) or biomethane for transport vs. biomethane for grid injection. Some projects provided data by participating country, while many others did not. A particular example would be Biomass Trade Centre who classify all biomass feedstocks as lignocellulosic material, creating a large challenge to determine approximate values for forestry residues, Short Rotation Coppice (SRC) etc.
6. There was a tendency for projects to underestimate the short term impacts, while overstating the likely long term (2020) impacts. The multiplication effect was often unexplored or explained by projects in their estimates of impacts to 2020.
7. Project Coordinators wanted better guidance on methodologies to calculate impacts that allowed comparison between projects and that would establish plausible linkages between their outputs and their long term impacts.

These issues make it difficult to aggregate and compare data and result in the need for assumptions for conversion of units or aggregation of data. Preliminary assessment of the 47 bioenergy projects showed that the methodologies used for estimation of impact varied widely in terms of their reliability. For example, in the assessment of reliability estimates of short-term renewable energy production for the 32 projects that had completed CPI estimates, 9 projects were ranked as reliable; 13 projects as acceptable and 10 projects as uncertain relative to the results estimated for this single impact.

Thus the evidence provided by a project needs to be assessed in terms of whether or not it applies to outputs or to impacts; evidence on impacts needs to be critically checked for reliability of method and assumptions; the impacts reported need to be differentiated between short term and long term impacts; evidence needs to substantiated; and ‘soft’ or qualitative impacts need to be included. This required a methodology built on our previous work clearly stated the impacts that are important, checked the results reported and substantiated these through evidence provided and stakeholder views.

Challenges to address in the design of our approach

In defining our methodology there were a number of issues that needed to be addressed, including: ensuring that the results reflect the needs of EASME (and other DGs involved in related work who could also benefit from this analysis); identification of the most appropriate stakeholders to represent the many thousands estimated to be impacted by this programme; assessment of projects on a common basis; ensuring that the data was accurate and there was no double counting; and rationalisation of the quantity of the work and results that needed to be included in this assessment.

In addition, to understand the impact of this support on different sectors, our approach needed to distinguish the results in relation to:

- The type of biomass resource;
- The bioenergy carrier (e.g. pellets, biogas, biodiesel);
- The final end use (e.g. electricity or heat);
- Country specific data (as opposed to aggregated data).

The resulting methodology made use of the existing baseline datasets from each project. After completing preliminary data capture for each project we then checked the data by comparing similar projects and contrasting the approaches in similar projects, questioned the data with each Project Coordinator, and made reasoned and evidenced assumptions to enhance the existing data where necessary. Figure 1 outlines the wider activities that took place during the project to try to improve both the quantity and the quality of impact data for the 47 bioenergy projects.

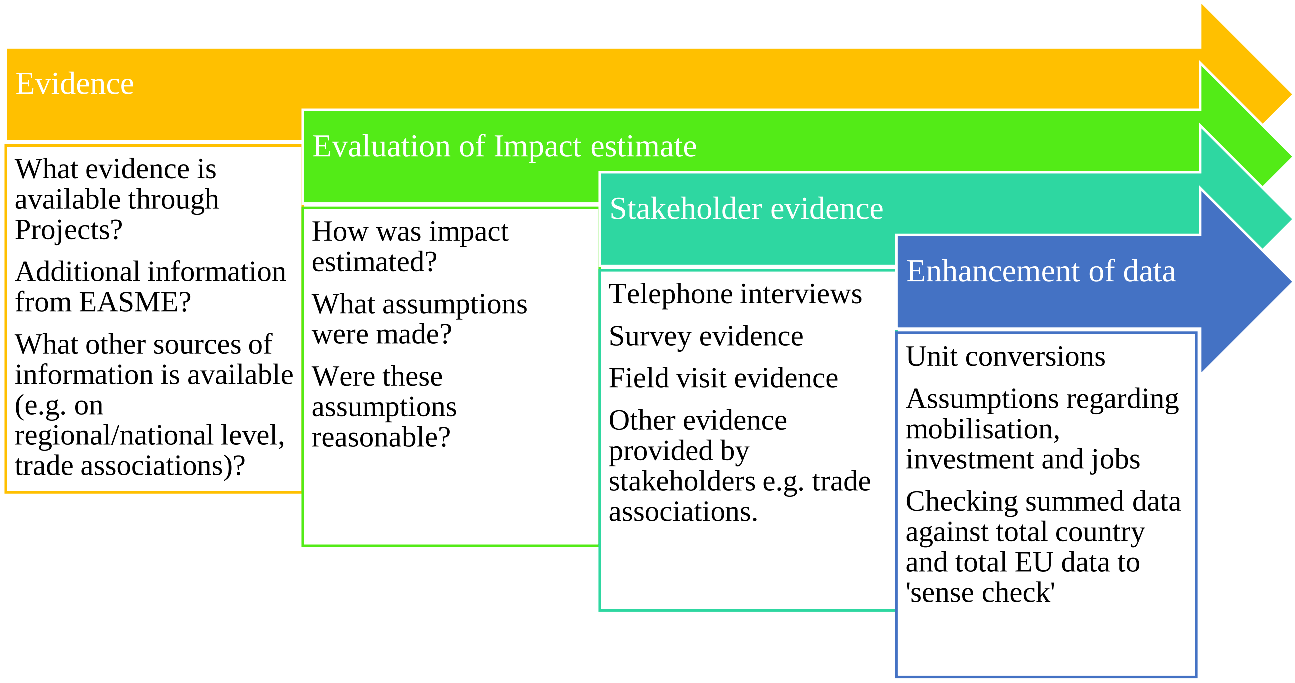

Figure 1. Main activities to support the assessment of impact for IEE II bioenergy projects

The methodology was supported by the development of an Excel template for each project that was completed in an initial review of existing project data during September/October 2015. The template looked to capture all available data from each project in a structured manner, allowing us to compare and contrast between the projects for the first time. Table 2 outlines the top-level indicators and sub-indicators used in our Excel template. This template was then the basis of a number of further reviews between November 2015 and February 2016 both with Project Coordinators (to identify additional data that could be added or improved), and internally to determine what other steps could be taken to fill data gaps or improve the reliability of the existing data.

Table 2. Top-level indicators split by CPI, Impacts and Outputs, the analysis includes direct and assumed data

Indicator Type	Top-level indicator	Sub-indicator
CPIs (planned) for ongoing projects and (achieved) for completed projects	Total investment triggered - cumulative	
	Total Renewable Energy Production	
	Renewable Energy Production by type	Electricity (differentiated for CHP)
		Heat (differentiated for CHP)
		Cooling
		Transport fuel
		Biomethane for grid injection
		District Heating
	Primary energy saving	
	Total Reduction in GHG	
	Reduction in GHG by energy type	Electricity (differentiated for CHP)
		Heat (differentiated for CHP)
		Cooling
		Transport fuel
		Biomethane for grid injection

		District Heating
Impacts (planned) for ongoing projects and (achieved) for completed projects	Biomass mobilised	Type of biomass
		Total quantity of biomass mobilised (direct)
		Total quantity of biomass mobilised (assumed)
	Decentralised energy production for small scale biomass	Scale of production
	Socio economic	Jobs created
		Increase in income
	Capacity building	Number of people trained
		Improvement in skills
	Sustainability of feedstock	Feedstock types (e.g. crop, wood, residue, waste)
		Feedstock related land use (by feedstock type)
	Land converted	Conversion of land from?
		Conversion of land to?
	Dissemination	Type of dissemination impact
		Number of participants impacted by type of dissemination (workshop, site visit etc.)
	Changes in consumer behaviour linked to demand side impacts	Type of behaviour change
	Bioenergy policy	Policy development
		Policy implementation
	Supply chain development	Cost of biomass resource
		Cost of mobilisation
		Cost of the final product
		Bioenergy fuels/carriers produced
	Improvement in logistics	Infrastructure development (investment)
		Storage infrastructure
		Bioenergy supply companies
		Transport provision
Outputs (planned) for ongoing projects and (achieved) for completed projects	Supply chain actions	Type of supply chain concrete activity
		Total number of supply chain activities achieved
	Policy implementation	Type of policy implementation activity
		Total number of policy activities
	Capacity building	Type of capacity building
		Total number of capacity building activities
		Target group
	Dissemination	Type of dissemination output
		Total number of dissemination activities

At the time of writing this paper, the project team had completed our final updates to the Excel records, and had begun analysing the amalgamated data to understand the programme-level impacts. The data was drawn together by a macro at several stages throughout the review process to enable identification of data that required further investigation, such as data that was not in the correct units, or that looked to be too high or too low for the specific indicator (such as an impact indicator being 10 times the production value of a single Member State).

Challenges encountered during our assessments

Below is a list of specific challenges that the project team encountered during the assessment and review process. It is not exhaustive, and could well apply to many other non-bioenergy IEE II projects. We have also outlined the approach we took to addressing these challenges and which were agreed with EASME as the project progressed:

- Indicators that should have been easily calculated within the original project were incomplete. For example, if CPIs were calculated for renewable energy production then this should have been straight forward to convert into estimates for feedstock used and jobs created. Our project team had to provide conversions for almost all cases of feedstock used and biomass mobilisation linked to renewable energy production estimates.
- There was a lack of clearness in many projects. Quite a few projects had CPIs with no indication of how they were calculated (i.e. on what basis). For example, the project Biomass Policies provided very high CPIs but did not include a method for the calculation of the CPIs, although one was requested. This meant that we could not see whether they had assumed that all bioenergy mobilisation was down to their project or how they calculated such high CPIs.
- Very few projects had estimates for jobs created and, if they did, they were usually based on counting the actual number of people employed on a site with no consideration of how these roles might be replicated. Our enhancement work focussed on improving job data on an annual basis using the EurObserv'ER Barometer annual report on renewable energy and calculating the jobs per Mtoe for each technology.
- Many of the projects did not provide information on which feedstocks were used. This was particularly common for biogas and strategic initiative projects where it was very difficult to know what feedstocks were used and what the energy was then used for (e.g. electricity, biomethane for grid injection etc.). This meant that for a number of projects, particularly biogas and strategic projects, we had to assume a feedstock and conversion factor to estimate feedstocks.
- Some projects provided little data on the conversion technologies. This meant that we did not know what the conversion technologies were (heat, power or both?), what the energy is used for, what the load factor is or what the efficiency is. Consequently we have had to make assumptions about all of these.
- Many projects did not capture biomass mobilised. In particular this data is difficult to calculate after the project is complete for biogas projects. Better information on potential biogas feedstocks would improve confidence in such estimates.

As a result of the above challenges, we had to use our expert judgement of appropriate average/gross conversion factors to estimate the number of jobs, the feedstock used, and the renewable energy produced (in the correct units of tonnes of oil equivalent – toe). All of these estimates and conversions were marked as potential in terms of their reliability, as they do not take differences between feedstock and regions into account.

Conversions

Most of the conversions used in the project for unit conversions were straight forward and involved standard conversion factors. However, some conversions required assumptions that made the calculations more complex and reduced the accuracy of the results. For example, in converting MW capacity of plant to heat generated in kWh we needed to make assumptions on (1) the number of hours of operation and (2) the efficiency of conversion. To make our work effective we then needed to use the same assumption for every project where conversions were required. This was the best information available but may have resulted in the use of generalised conversion assumptions that were not appropriate for every project. Table 3 outlines the key conversions used to tackle the most common unit issues.

Table 3. Conversion units requested and conversions necessary

Unit requested	Alternative reported in projects	Conversion
Tonnes of solid biomass mobilised	Tonnes/year solid biomass mobilised	Figures are reported as tonnes or tonnes per year, according to the data provided.
Toe solid biomass mobilised	Tonnes/year solid biomass mobilised	Figures are reported as tonnes or tonnes per year according to the data provided.
Cubic meters biogas	MWh	MWh biogas was converted to cubic m, using assumptions about the amount of biogas per MWh, if the number of MWh is provided. Alternatively if the raw material is provided we converted this to m^3 biogas, using figures provided by the projects or by AEBIOM (2015).
Tonnes biomethane	m^3 biomethane	We have assumed that biomethane in biogas from animal manures and agricultural feedstock is 60% and from food and municipal wastes is 50%.
Tonnes of liquid biofuels	Tonnes/year biomass feedstock	We have assumed conversion of biofuel feedstock to biofuels using AEBIOM conversion factors (AEBIOM 2015).
Toe biofuels	Tonnes	Using tonnes liquid biofuels, convert to GJ and then use standard conversion to toe. We also used AEBIOM figures and Biograce figures where relevant.
Investment (M EUR triggered by year)	MW capacity or MWh/y	Only refer to investments stated by the projects + those easily calculable (for example when they inform about a number of new plants triggered, where you can use assumptions)

Note: conversions provided by the projects were used where possible, or from AEBIOM (2015) or Biograce version 3 or 4d (2015, see web site) where no conversion data was available from the project. AEBIOM (2015) provide data for calorific value, moisture content, bulk density, energy density (MWh/m3). The Biomass Trade Centre Wood Biomass Handbook provides data on MWh/t wood chips, logs or pellets. Succelog provided the following conversion for agricultural pellets: 0.351toe/t pellets. The BASIS project provides figures for efficiency of conversion.

Calculation of hours of operation for heat plants per year were undertaken using degree day data from Eurostat, as used by DG Energy. We used this data to provide an average for cold climates (4300 hours/y), average climates (3000hours/y) and warm climates (2000hours/y). We believe that these figures are conservative, and they do not take specific regional differences into account.

Conclusions

The assessment of quantitative impacts of the 47 IEE II bioenergy projects has faced many challenges, both inherent in the initial dataset, and emerging through the application of bioenergy expertise. The key challenges being the varied nature of the data, a non-structured approach to impact indicators in the early years of IEE II, and need to account for qualitative data in making an evaluation of programme impact. The next phase of the work requires the data to be assessed against the key evaluation questions to understand the potential overall impact of IEE II funding for bioenergy.

What we have found so far is that there are some good examples within this programme where the Project Coordinator has provided figures that are transparent and reliably estimated, but they are very few. This is mostly due to the lack of structured performance data reporting and standardised indicators and methodologies for all projects to follow. The projects could be a wealth of information on the costs of projects, the costs of feedstock, the factors that make a project succeed or fail, the number of jobs etc., but they do not provide these things because they were not required. As IEE II moves forward into Horizon 2020, we can take comfort from the work we delivered in 2012[5] that set out a standard approach to measuring and estimating outputs and impacts, including detailed methodology guidance for the estimation of the Common Performance Indicators, as this has been taken up by the Horizon 2020 programme. The most reliable data from all of the 47 IEE II bioenergy projects came from the projects that were delivered after 2012, and that used this methodology to transparently calculate their CPIs.

There are some important general observations that we have made during our assessment. The most successful impacts from the projects were recorded for solid biomass and biomethane. This reflects the investment environment at the time of the projects and the lack of data from some of the earlier (biofuels) projects. The most successful implementation of energy was heat, followed by electricity, biomethane and biogas. For biofuels, the projects focusing on used cooking oil had the most implementation success.

Stakeholders in the survey and site visits (case studies) commented that they appreciated the information provided by the projects, the support framework that allowed them to investigate bioenergy with the help of experts, the networking opportunities and the study tours, which put them in direct contact with best practice and with successful schemes. A number commented that the programme accelerated their learning and feasibility assessment and enabled them to set up bioenergy support locally, invest in bioenergy or develop biomass strategies. This would not have happened in the time scale without the support and help of IEE II projects.

As a final conclusion, the outputs of the 47 IEE II bioenergy projects are well recorded and reasonably certain. Regardless of whether they can indicate impact they are a strength of the projects. Our final assessment will be able to show how many people have been ‘exposed’ to biomass and all of the information being provided by IEE II; we should be able to show how many people have actively interacted with IEE II projects (i.e. attended workshops, one to one meetings site visits, web site visits etc.); and how many have sought out a deeper knowledge of biomass through IEE II (e.g. through use of tools on web sites, training, one to one meetings and site visits).

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