Overall Issues for Accounting for the Emissions Reductions of JI Projects

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Abstract

In this paper we examine some of the accounting issues concerning Joint Implementation (JI) under Articles 6 and 12 of the Kyoto Protocol, particularly methodologies for the accounting of emissions reduction of JI projects in the face of the large uncertainties in the estimations. Since these uncertainties can be exploited to the detriment of environmental protection, measures to limit gaming and increase environmental efficiency are discussed. We also consider the differences between the accounting processes for Article 6 JI and Article 12 (the Clean Development Mechanism). This work is drawn from an EC-supported study 'Accounting and Accreditation of Activities Implemented Jointly under the UN FCCC'. Much of the research is based on an analysis of data from thirteen bilateral pilot emissions reduction projects in the energy sectors of Estonia and the Czech Republic. Under accounting, we consider environmental efficiency issues such as baseline construction and possible standardised approaches. Sources of uncertainty are also examined and possible packages of measures for the operationalisation of JI in a simple, yet environmentally efficient manner are constructed.

1. Introduction

The concept of Joint Implementation (JI), whereby a 'donor' country (or countries) funds pollutant emissions reduction projects in a 'host' country in return for a relaxation of its domestic emissions targets, has been incorporated into the Kyoto Protocol to the UN Framework Convention on Climate Change (UN FCCC). In principle, it is argued, this should allow for greater cost-efficiency in meeting global targets, since abatement action can be taken first, where it is least costly to do so.

Whilst the exact term 'Joint Implementation' has not been used in the Kyoto Protocol, the mechanism clearly forms the basis of Articles 6 and 12. Under Article 6, countries with emissions reduction targets may fund JI projects in other countries with targets (known as Annex I countries) and receive credits which may contribute to compliance with their targets. Article 12 defines a Clean Development Mechanism (CDM) under which countries with targets may receive credits for funding JI projects which take place in countries *without* targets (known as non-Annex I countries).

In this paper we summarise some of the main research and policy recommendations produced by the European Commission-supported study 'Accounting and Accreditation of Activities Implemented Jointly under the UN FCCC' particularly with respect to accounting for emissions reductions. It then look at similarities and differences between Article 6 JI (A6JI) and the CDM. The choices available and the final approach to accounting implemented is placed in the multi-objective context of the Convention and Protocol.

In terms of accounting for GHG emission reductions from JI projects, one of the main issues has been the need for a methodology to be able to construct simple, credible baselines for the emissions path for what would have happened in the absence of the JI project. This is then compared to the JI project emissions path to estimate the reductions achieved. The counterfactuality of this baseline is one of the main problems in that no-one can ever know exactly what would have happened. The choice of the technology in the baseline and the timing of its introduction is open to interpretation and cheating. A methodology must therefore balance the need for a credible baseline incorporating suitable checks to ensure environmental goals are achieved with the need to make it practical and minimise transaction costs. Our approach has been to examine the uncertainties associated with different ways of constructing the baseline by examining specific energy sector projects in Estonia and the Czech Republic. By doing this we are able to assess the environmental efficiency of different approaches and to simplify where undue effort is required for little gain. There has been much discussion in the literature on possible baseline approaches (eg Luhmann et al, 1997; Ardone et al, 1997; CCAP, 1998; Michaelowa, 1998), and hence we compare these approaches to those proposed here.

The paper is divided as follows. In section 2, we discuss the issue of accounting for emissions reduction from a JI project, with particular reference to uncertainty, baseline construction, and possible standardisation of the procedures. 'Packages' of measures in addition to the standardisation of the baseline are then proposed as a methodological approach to minimise gaming and limiting the bounds of the uncertainties. In section 3, we look at the JI accounting procedure approach and how they may be applied in the A6JI and CDM cases. We then examine some of the accounting issues relevant to the CDM. In section 4, we summarise some policy recommendations from the analysis.

2. Accounting

In this section we discuss the analytical methods we have used for the estimation of GHG emissions reduction from JI projects, and the conclusions we have drawn from this work. First, in section 2.1, we briefly describe the JI projects we have assessed. In section 2.2, we review the types of accounting analysis we have carried out, whilst in section 2.3 we look at sources of uncertainty, and suggest how they may be reduced. In section 2.4 we go into some detail about baseline construction methodologies, and the possibilities for standardisation. We then discuss how the recommendations from sections 2.2-2.4 can be combined to form a 'package' of measures to guide the accounting process. Finally, in section 2.6, we draw some policy relevant conclusions.

2.1 Projects

The work in this section is based on a detailed examination of thirteen bilateral emissions reduction projects in Estonia and the Czech Republic. These projects are summarised in Table 1. Many of the projects examined have been approved under the 'Activities Implemented Jointly' (AIJ) pilot programme of the FCCC. They cover the areas of heat supply and demand, electricity supply and cogeneration, using a variety of fuels. Data was obtained initially from the donor organisations. However, reliable data was difficult to obtain and has required in some cases a series of site visits.

2.2 Types of Analysis

As we have mentioned, accounting for GHG emissions reductions involves the comparison of the JI project situation with that of a counterfactual baseline. In this study we have carried this out using three types of analysis:

- project level assessment
- system level assessment
- uncertainty analysis

The first was carried out for all of the projects, whilst (2) and (3) were only applied to a smaller subset. All three methods have been applied to both emissions reduction calculations and costs calculations, but we only deal with the former here. (Analysis of costs can be found elsewhere, eg Begg et al, forthcoming; Parkinson et al, 1997.)

Project level assessments of GHG emissions have be carried out using a spreadsheet model, which has taken into account a wide range of relevant project variables. However, given a particular technology and fuel, the specific GHG emissions (tonnes of CO_2 equivalent emissions[1] per MWh of output), *s*, is simply given by

$$s = 3.6 e_f / \mathrm{r} \qquad (1)$$

where

e_f = emission factor of fuel/ plant in tCO_2/GJ
r = plant efficiency
3.6 is the factor needed to convert GJ into MWh

Since standard values for e_f and r are available from data tables (eg McInnes, 1996; Grohnheit, 1996) for a given technology and fuel, standard values for *s* can be easily calculated. For example, a typical district heating boiler run on heavy fuel oil has specific GHG emissions of 0.33 t/MWh. Data obtained from the actual performance of boilers in this study found that there is little variation in these figures in practice: less

[1] Emissions of GHGs have been converted into 'CO_2 equivalent emissions' by use of the standard values for Global Warming Potentials or GWPs (IPCC, 1996).

than ±10% (Begg et al, forthcoming). Hence, we feel that a set of standard values for *s* for a number of commonly used technology and fuel combinations would be a useful simplification that would not significantly reduce the accuracy of estimating GHG emissions. However, as we discuss in section 2.3.3, calculation of actual emissions *reduction* is not necessarily as straightforward as differencing the two values of *s* for the JI project and the baseline. The point should also be made that if account is taken of the GHG emissions of the whole fuel cycle, or indeed or possible leakage[2] then this value is likely to change. It is important that consistent assumptions are made.

System level assessment involves the use of an energy-economic model for the host country. In this study we used the EFOM model for the Czech Republic (van Harmelen et al, 1995). In deciding whether or not to carry out a system level assessment, consideration must be given to whether a project is 'separable' or 'non-separable' from the energy system. Separable projects, eg many district heating supply projects, do not interact significantly with the energy supply system, hence assessment at a project level would be expected to be accurate. However, this is not the case for 'non-separable' projects. For example, a plant supplying electricity can replace a range of different types of plant depending on whether the plant is replacing base, medium or peak load stations, hence such 'system effects' must be included in the assessment.

The final assessment of emissions reduction undertaken is uncertainty analysis. In particular we have used Monte Carlo Simulation (eg Parkinson and Young, 1998) to estimate the range of uncertainty in the emissions reduction for each project. This is discussed in the next section.

2.3 Uncertainty

In this section we discuss the issue of uncertainty in accounting for emissions reduction. We begin by assessing the sources of uncertainty and then investigate ways of dealing with this uncertainty.

2.3.1 Sources of Uncertainty

The main sources of uncertainty in estimating the total emissions reduction of a JI project over its lifetime are shown in Table 2. We have grouped them into four categories:

- project performance;
- counterfactuality;
- measurement;
- background.

Figure 1 shows an estimate of the combined uncertainty (due to all four types) in the emissions reduction for one AIJ pilot project using a project level assessment. The

[2] 'Leakage' is the term applied when the GHG emissions reduction achieved by the JI project is partly or totally offset by an emissions increase outside of the system boundaries of the project.

range of uncertainty is 97ktCO_2 ± 112% (95% confidence limits). Similar levels of uncertainty are seen for the other projects assessed (Begg et al, forthcoming). Sensitivity analysis reveals that it is the counterfactual uncertainty of the choice and timing of the baseline fuel/ technology, together with the background demand variations that contributes most towards this range. Annual monitoring can significantly reduce the uncertainty in the demand: bringing the uncertainty in the emissions reduction down to ±80% (see the next section). However, our assessment concludes that, despite detailed analysis of projects, *counterfactual uncertainty cannot be reduced by baseline construction methods*. Consequently, the choice of baseline has to be specified to avoid exploitation. This is shown by Figure 2 which compares the counterfactual uncertainty in emissions reduction for five AIJ projects assessed in this study with the values officially reported to the FCCC secretariat (UN FCCC, 1998). As can be seen, the official values vary from the lower end of the range to the upper, mainly due to different assumptions about how long the existing plant could have continued.

2.3.2 Dealing with Uncertainty

There are a number of ways in which the uncertainty in accounting can be reduced and/ or managed. In this section, we summarise the main approaches to limiting the uncertainties, but deal with the issue of baseline construction separately in section 2.4. Table 3 contains a summary of these approaches.

Operating Data

Figure 3 shows that calculations of emissions reduction based on feasibility data have tended to be overestimates by as much as 70%. Assessments reveal that, in these cases, the main reason has been a large drop in demand due to re-organisation of the energy sector in the countries concerned. However, design and operator faults, multi-firing with a range of fuels and fires and flooding have also played a role. Consequently feasibility data should not be used in the calculation of emissions reductions. We recommend that they should be calculated annually based on the reported output and fuels used from the JI plant. A further benefit of this practice is that it would give an incentive for the donor and host to ensure the long term viability of the JI project. It also limits opportunities for gaming as long as there are verification protocols for spot checks. The risk of crediting a project which has failed is removed by using operating data.

Baseline Revision

The counterfactual uncertainty in the baseline and increases considerably over time, due to unforeseeable changes in host country energy sector, technology, policies, fuel availability and prices etc. The baselines therefore need to be checked and revised after a period of time which we would recommend to be about 8-12y. We should clarify that we are advocating corrections to the baseline *for the remainder* of the JI project lifetime, not for the period up to revision. If the latter were to be applied, this would cause the revaluation of credits already issued (if we assume annual crediting of JI): this could significantly increase investor risk and undermine confidence in the system. It may even be found that, around that time, the project would have been undertaken anyway because of host country development and hence should not be credited further. Increased stringency could require 5 yearly checks.

Limiting crediting lifetime

Limiting the lifetime for crediting also limits the uncertainty of assumptions about the future and hence reduces the possibility of overestimation of the reductions. It could also be attractive from an investor perspective as there could be more certainty over the crediting compared with, eg, a system which involved baseline revision. However, for long term projects, it may not be an attractive option.

Verification

There is an incentive for the donor and, in the case of the CDM, the host as well to overestimate emissions reductions by over-reporting the output from the plant. Hence, independent verification procedures would be required. (Implicitly, this process would ensure that the JI project actually exists!) The number and frequency of these checks is open to discussion, the trade-off being between the transaction cost and environmental efficiency. At a minimum there should be one spot check during the project lifetime.

2.4 Baseline Construction

As we stated in the section 2.3, the counterfactual uncertainty of the baseline is, to a large extent, irreducible and hence the choice of one particular baseline is very subjective. The purpose of baseline construction, therefore, is not so much to reduce this uncertainty, more to prevent its exploitation by interested parties. The key aim of baseline construction, therefore, is *to reduce the chance of overestimation of emissions reductions* due to JI projects.

The following sections give a brief description of our approach. This is based on experience with a range of real AIJ and AIJ-type projects, and hence the uncertainties and possible biases in the calculation of emissions reduction are well understood. The trade-offs between ensuring environmental effectiveness, equity and minimising transaction costs can therefore be made transparent. We start, in section 2.4.1, with a review of the other approaches to baseline construction. Then we discuss the basis for our approach (section 2.4.2) and the elements which should be included in a baseline for separable and non-separable projects. This is followed by our proposals for a range of different types of simplified baselines for use under a range of conditions (section 2.4.3).

2.4.1 Review of Methods

Proposed approaches to baseline construction in the literature are carried out either at a project level or system level[3]. An example of a project level approach is that of Luhmann et al (1997), who suggest a 'filter' method to identify the reference plant for suitable JI projects followed by the use of specific GHG emission calculations for project and baseline (similar to those described in section 2.2 above) corrected by the utilisation factors as required. Hence, for each project type and country (or region) a reference situation is defined which is valid for the crediting life of the JI project. The 'matrix' approach (CCAP, 1998) is very similar to this. CCAP (1998) also suggest two other approaches to baseline construction. The first, known as 'benchmarking', is where some projections of the baseline are made into the future in a standard defined way either at a project or system level. The second approach, called the 'project scenario' method, is where the baseline technology is identified based on investment criteria at a project level, and the estimate for emissions reduction is made conservatively.

A system level approach is favoured by Ardone at al (1997). They have developed the Perseus model, based on the EFOM energy-economic model, and have applied it in countries such as Russia, Germany, and Indonesia. This model is much more complex than EFOM, containing a higher degree of detail concerning load curves and technological characteristics. Puhl and Hargrave (1998) also favour a system level approach and use an energy-economic model to calculate baselines. Some of the current approaches have been reviewed by Michaelowa (1998) who concluded that a project level approach is the way forward.

2.4.2 Considerations in Baseline Construction

This section summarises the main considerations necessary in order to construct a baseline. We particularly look at where projects are ‘separable’ or independent of the energy system and the ‘non-separable’ situation where there would be expected to be significant interaction with an energy system. Table 3 shows where careful baseline construction can minimise the chance of overestimation and manage some of the uncertainty and reduce the opportunities for cheating.

Elements in Separable Project Baselines

A number of decisions have to be made in constructing a baseline:

- *choice and timing of reference technology/ fuel*: which defines technical variables such as efficiency, emission factor;
- *equivalence of energy service*: consideration needs to be given to whether the baseline plant can provide the same energy service as the JI project over the plant lifetime;

[3] A number of authors have described project level baselines as 'bottom-up' baselines and system level baselines as 'top-down' baselines. However, system level baselines make use of energy-economic models which are often referred to as 'bottom-up' models to distinguish them from macroeconomic 'top-down' models. So, to avoid confusion, we retain the use of the terms 'project level' and 'system level'.

- *crediting lifetime*: this is either the technical lifetime of the JI project, or the estimated time until the JI project becomes financially viable for the host to carry out.

Baseline construction also needs to consider the following:

- *background country scenario:* economic and policy developments within the host country, international fuel prices, structure of energy system and fuel supplies;
- *costs:* costs (eg investment, operation and maintenance, fuel) of the JI project and possible reference technologies will affect the choice of the baseline;
- *leakage:* account needs to be taken of the possible other GHG emissions in the fuel production cycle and in the fate of the replaced plant and fuel in the country economy;
- *time dependencies, demand projections:* there may be significant variations in the future on key parameters in the calculation of emission reductions.

We have found that even if the project replaced a known plant, which is the case in most of the projects studied, there are still several equally likely baseline situations which reflect the time before the plant would have been changed anyway, or would have been changed to another technology. The construction of such baselines is therefore reasonably detailed and has high data demands.

Non-separable Projects

Baseline construction for non-separable projects can involve the use of an energy systems model, and a series of assumptions particularly concerning national energy demand and international fuel prices. A comparison of the emissions reduction estimated by a system level assessment (using the energy-economic model, EFOM) and a project level assessment for the two electricity supply (windfarm) JI projects in the Czech Republic (Begg et al, forthcoming) has shown little difference between them. Experiments using scaled up versions of these projects (from a few MW to a few hundred MW) also found this. This indicates that the extra effort of using a system model to construct a baseline could not be justified in this case, and hence we do not consider this issue further in this paper. It should be recognised that this result may be specific to the project type (windfarm) or country (Czech Republic), or may change if a model with more sophisticated modelling of load curves, eg Perseus (Ardone at al, 1996), is used. Further work is being undertaken to examine these questions.

2.4.3 Standardised Approach to Baselines

As we have seen, baseline construction is a complex process. Hence, simplification which does not compromise the environmental goals of JI would be very useful. The following approach is one possible way forward which could be applied under a range of circumstances.

Since no significant system interactions have been found by our analysis, we suggest standardisation at the project level. We have also found that country specific conditions are important, along with sector, project type and size. Hence, given these parameters, it would be possible to calculate emissions reductions using the *specific* GHG emissions (tCO_2 equiv./MWh), as described above in section 2.2, for both the baseline technology/ fuel and the JI technology/ fuel. This makes our suggestion similar to the Luhmann and 'matrix' approaches described above. However, since the baseline plant is likely to change during the project lifetime, we feel that a scenario is necessary: similar to the 'benchmarking' approach. However our approach differs from other approaches as we combine the simplification process with other measures designed to reduce uncertainties and limit the risk of overestimation of reductions (section 2.3.2 above). We detail the process below.

Step 1: Choose the relevant baseline type

Four examples of a standardised baseline for energy sector projects are shown in figure 4, expressed in terms of specific emissions. Type 1 is where constant specific emissions is defined for a limited lifetime. The value for the specific GHG emissions is defined as that for the existing plant/ situation, and corrected to ensure equivalence of service with the JI project. The lifetime is limited to about 10y because not only are projections unlikely to have any validity beyond this time period but most significantly, it is highly likely that the project would have been carried out anyway. Therefore the crediting lifetime would not be expected to be longer than 10y. Type 2 is the same as Type 1 for the first period. After about 10y, as the original assumptions lose validity, the baseline becomes the mean of the specific emissions of technologies/ fuels in the sector *at that time* (based on up-to-date energy statistics). This level remains constant either for another 10y (after which this level is again revised) or the end of the technical life of the JI project is reached. Type 3 is a simple constant average of the fuel mix for the relevant sector and Type 4 is where the specific emissions of a number of different baselines are calculated, and the mean taken over the technical lifetime of the JI project. Both would need to be revised regularly, as discussed in section 2.3.2, during their lifetime. Type 4 would be created by independent analysts based on a small number of test JI projects (eg pilot AIJ projects) of the same type and in the same region/ sector.

Table 4 summarises the four types which we suggest could apply in a range of circumstances for the project types studied. For short term projects, or ones which are likely to be implemented anyway in the near future, and where the substituted plant is known, a 'Type 1' baseline is adequate. For longer term projects, the validity of a long term baseline is in question and we would advocate Type 2 where the substituted plant is known and Type 3 or 4 or a variation of that for where the substituted plant is unknown. We do not consider that the possible loss of technical accuracy with the use of the specific emissions method is significant compared to the other uncertainties.

The simplified approach described above has to be based on conservative values (for particular countries, sectors, and project types and sizes - both separable and non-separable) to counter possible leakage and gaming effects as discussed earlier. Type 2 and 3 requires data on the energy system of the host country, whilst type 4 also needs to take into account the energy and environmental policy context in order to produce the relevant values. However once these are calculated for a project type/ country/ sector/ size and made available, the results can be applied to the appropriate JI projects with minimum effort by investors. It will of course have a limit on the time for which it remains valid.

Step 2: Calculating the emission reductions

GHG emissions for the JI project and the baseline are calculated by multiplying the specific emissions of each by the annual output (using measured values as discussed in section 2.3.2) of the JI plant. The emissions reduction is thus the difference. This procedure assumes that the baseline technology can deliver the same energy service as the project. If this cannot be assumed, eg some electricity supply projects where the utilisation factors are different, then corrections should be made (Begg et al, forthcoming). As mentioned above the specific emission figures would be valid only for a limited time and a reappraisal would be required after 8-12y. For biomass plants there are the added questions of the long term carbon neutrality of the fuel source and its avoidance of additional counting as a sink. These aspects would have to be incorporated as part of the 8-12y appraisal procedure for these projects.

2.5 Package of Measures for Emission Reductions Accounting

From this discussion it is clear that though standardisation goes some way to limit gaming, 'packages' of measures are required to balance concerns for environmental efficiency as the uncertainties are still high. There are many possible combinations of the simple measures discussed above, but here we give one example.

Example 'Package'

- Type 2 standardised baseline - specific emissions based on conservative values
- specific emissions for the JI project
- annual operating data for output
- baseline revision every 10y
- annual crediting over operating life of plant
- one verification check for confirmation of operating conditions

An environmental and social assessment of the JI project should also be carried out to ensure that the local impacts in the host are acceptable.

This option requires more work initially for an independent body to prepare the baselines but allows more long term projects to be assessed. It does address most concerns of an appropriate reduction in the risk of overestimation of emission reductions and it is relatively simple to put into operation.

The process is summarised in Figures 5 and 6. Figure 5 shows the standardisation procedure to be followed by an independent body who would allocate the resulting choice of baseline to the investor. In Figure 6 the investor would interact with the independent body and supply simple project description and annual operating data.

This would be used to calculate the emissions reductions. There are several possible accounting option combinations besides the one illustrated. For example a standardised baseline and limited crediting life would not require baseline revisions and would deal with the residual and still significant uncertainty in the estimations.

2.6 Implications for policy

From the analysis in this EU study, the baseline construction proposals are made on a simplified basis in recognition of the large irreducible uncertainty introduced by having a counterfactual baseline. Baseline construction protocols cannot by themselves address all the issues in the calculation of emission reductions and therefore additional simple measures are proposed which start to form 'packages' of measures for the successful implementation of JI as fair and efficient. Our work elsewhere (Begg et al 1997, forthcoming) indicates that, in addition, the approval criteria are important and need to be well defined and the host country requires a clear JI country strategy to avoid overcommitments and underpricing of credits.

3. Broader Issues related to Accounting

3.1 Application of package approach to A6JI and the CDM

The analysis detailed in the foregoing sections dealt with projects in transition economy countries. In our view, the conclusions concerning simplifications made and the need for a package of additional measures could be applied to CDM host countries. The approach of using assessment at project level is even more important for a CDM project as there are likely to be less well developed energy systems.

Empirically, consideration of A6JI with Annex I donors and hosts, both with targets, would suggest that A6JI should be treated separately from the CDM and the two forms of JI should probably require a different range of processes and safeguards. This has been suggested because there is theoretically an in-built safeguard for the environment where countries have targets. However in the case of some countries in transition, where institutional structures are still being developed and other factors have a more pressing priority, this may not be the case and targets may not be adhered to. Additional measures would have to be funded by the host to maintain compliance with its targets. Either that or non-compliance procedures penalising countries already struggling economically would be enforced which seems counterproductive. For countries without targets it is considered that there are incentives for gaming or ‘talking up’ the baselines to achieve as many credits as possible and more verification procedures would thus be required. Therefore, in both types of host it is important to ensure that the emission reductions are not overestimated although for different reasons.

There has also been a suggestion that for the CDM, the baseline should be constructed in a more complex fashion. From the analysis above, where we showed that there is a limit to the usefulness of the baseline construction methodology for decreasing uncertainties, we would suggest that increased stringency would be better manifested by increasing the safeguards to minimise gaming and decrease the bounds of the uncertainties as indicated in the suggested example package above in section 2.5. Thus the frequency of revisions or verification checks could be increased for CDM projects or there could be limited crediting life or partial crediting which would ensure environmental efficiency without increased institutional requirements.

3.2 CDM Accounting Issues

In the following discussion we would like to draw attention to some areas where the CDM would pose some quite different problems or where more work is required.

First of all consideration needs to be given to the range of the stage of development of host countries. The transition economies studied were at very similar stages and moving towards EU standards and procedures for membership status. For the 'most developed' developing countries such as Argentina, Brazil, etc there could be easily applied parallels. However a range of circumstances not covered by the considerations above could emerge when considering CDM hosts where the development agenda is even more important and the contribution of the project to its development priorities and to its sustainable development path is and should be an important aspect of the project. Under these circumstances the size of the 'appropriate' projects could be very small and there may need to be arrangements similar to those applied to 'umbrella' projects in Costa Rica where the government spreads the risk for the investor. Data availability and quality could also be very low.

The dual function aspect of the projects means that the projects invariably increase the energy service supplied and therefore the equivalence of energy service between the baseline and the project has to be dealt with either by assuming that the new total service would have been supplied in the baseline or that only that part of the new service, eg lighting to replace candles, is accounted for.

Indirect effects of this are that the original criterion of additionality of the project may be hard to apply in practice as additionality is designed to encourage projects which will reduce emissions more than the normal market choice and that this is likely to cost more. In this way real reductions are ensured as these projects would not have been carried out by the market anyway. However, this definition of additionality assumes there is an efficient market in the host country and that 'no regrets' options would have been carried out. The operationalisation of additionality in the less well developed countries must be addressed to ensure reductions are real but recognising the limitations of the original definition in terms of both financial and environmental additionality.

The 'appropriateness' of the technology being transferred is also an important issue for these host countries if the criteria of 'sustainable development' and 'in line with the host country priorities' are to be meaningful. In line with the Århus Convention, we suggest that these require a process of strategic planning involving public participation. It is particularly important as development experience indicates that without due attention to local benefits and conditions the project may well fail and there will be no long term reductions. In other words, the equity of the process of the CDM is extremely important. Consideration of the local benefits and any adverse impacts from the project, whether it is affordable and easily maintained by the local community, whether it fits with the existing or wanted lifestyle, and what the strategic resource implications are, are all crucial in the choice of technology for the CDM project.

4. Conclusions and Policy Recommendations

This EC funded project has examined the implications of different types of approaches to the assessment of emission reduction of GHGs using real AIJ and AIJ-type projects in the energy sector in Eastern Europe. The analysis has concentrated on the environmental efficiency of the approaches and looked in detail at the inherent uncertainties and how to minimise them with a package of measures including a simplified approach to baseline construction. The analysis points the way for possible options for the implementation of JI as a fair and efficient means of reducing GHG emissions. The following points emerge from the study.

- The largest source of uncertainty in accounting for emissions reductions is the counterfactuality of the baseline.
- Within the baseline, the main sources of uncertainty tend to be the choice of technology and timing of its introduction. To a large extent such uncertainty cannot be reduced even with a detailed case by case assessment.
- No evidence was found that the use of an energy systems model enhanced the estimate of emissions reduction due to a JI project up to a capacity of a few hundred megawatts. However, our analysis was limited in that it only looked at two windfarms in one country.
- Our analysis shows that significant simplifications in baseline construction can be made without compromising the environmental objectives of the FCCC and examples are given for some separable and non-separable JI projects.
- In estimating total emissions reductions, it is important to include safeguards in the accounting procedure to minimise uncertainties not addressed by the baseline construction and to minimise scope for gaming which will act against the environmental objectives of the FCCC. Consequently we suggest a combination of the following:
    - use of conservative values for specific GHG emissions (ie tCO_2/MWh) of particular technologies/ fuels;
    - the use of annual operating data rather than feasibility data;
    - baseline revision every (eg) 10y; or limited crediting life
    - independent verification of the project data.
- Hence 'packages' which combine some of these measures can be produced to ensure the environmental efficiency of the process.

- By using these packages of measures as a basis for implementing A6JI and the CDM, explicit trade-offs can be made of practicality, cost efficiency, environmental efficiency and equity.
- Due to the particular requirements of the CDM, ie in being compatible with the development needs of the host country, the accounting framework must take account of:
    - different market circumstances, which affects the operationalisation of additionality;
    - the 'appropriateness' of the technology; and
    - problems with the assumption of equivalence of energy service.

This EU study has examined in detail packages of measures which are intended to address the overall implementation of JI while reconciling equity, efficiency and environmental goals. Full details will be published elsewhere (Begg et al, forthcoming).

References

Ardone, A., Fichtner, W., Wietschel, M., Rentz, O., (1997), A Techno-Economic Approach to Obtain Comparable Baselines for Joint Implementation, International Workshop on Activities Implemented Jointly, Leipzig 5th and 6th March 1997.

Begg, K.; Parkinson, S.D.; Jackson, T. (forthcoming) Accounting and Accreditation of Activities Implemented Jointly under the UN Framework Convention on Climate Change and the Oslo Protocol - Final Report; Centre for Environmental Strategy, University of Surrey, UK; forthcoming.

CCAP (1998) "Meeting minutes of the JI Braintrust Group", Holiday Inn, Old Town Alexandria, USA, February 18^{th}-19^{th}. Produced by Centre for Clean Air Policy, USA.

Grohnheit, P-E. (1996) *Energy Tariff Project - Latvia: Development and Application of Energy Models*; Riso National Laboratory, Roskilde, Denmark; p20-23.

van Harmelen, T.; de Kruijk, H.; Stoffer, A.; Maly, M. (1995) Strategies for Reducing Emissions and Depositions in Central and Eastern European Countries: The Case of the Czech Republic; ECN-Petten, The Netherlands; project no. 7141.

Luhmann, H.J.; Bakker, L.; Beuermann, C.; Fischedick, M.; Hennicke, P.; Ott, H.E. (1997) "Joint Implementation - Project Simulation and Organisation"; Prepared for German Federal Environment Ministry, by the Wuppertal Institute for Climate, Environment and Energy, Germany.

McInnes, G., Ed. (1996) *Atmospheric Emission Inventory Guidebook, First Edition*, European Environment Agency, Copenhagen, Denmark.

Michaelowa A. (1998) AIJ - the baseline issue from an economic and political viewpoint, *Global Environmental Change* 1, forthcoming

Parkinson, S.D.; Begg, K.; Bailey, P.; Jackson, T.; Morthorst, P-E. (1997) "Joint Implementation under the UN FCCC: conflicts between sustainability, equity and cost-effectiveness", Presented at the 'Science for a Sustainable Society - Integrating Natural and Social Sciences' Conference, Roskilde University, Denmark, October 27-29th.

Parkinson, S.D.; Young, P.C. (1998) "Uncertainty and sensitivity in global carbon cycle modelling", *Climate Research*, 9, p157-174.

Puhl I. and Hargrave T. (1998) Top-down baselines to simpify setting of project emission baselines for JI and the CDM. Paper presented to AWMA Second International Speciality Conference - Global Climate Change: Science, Policy and Mitigation/ Adaptation Strategies, Crystal City Hyatt Regency Hotel, Washington DC, USA, 13-15 October

UN FCCC (1998) List of AIJ projects, Official web-site of the Climate Change Secretariat. http://www.unfccc.de/fccc/ccinfo/aijproj.htm (21/10/98)

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Table 1 - Summary of the emiss16ions reduction projects examined in this study

Project	Type	Fuel	Donor
Estonia			
Aardla-Tartu	Heat supply	Biomass	Swedish Govt.
Haabneeme	Heat supply	Biomass	Swedish Govt.
Mustamaa (2 stages)	Heat demand	n/a	Swedish Govt.
Turi	Heat supply	Biomass	Danish Govt.
Valga	Heat supply	Biomass	Swedish Govt.
Voru	Heat supply	Biomass	Swedish Govt.
Czech Republic			
Decin-Bynov	Cogeneration	Natural gas	Danish Govt/ USA industry
Jesenik	Electricity supply	Wind	Danish Govt
Kardasova Recice	Heat supply	Biomass	Austrian Govt
Lettland*	Electricity supply	Wind	German Govt
Mrakotin	Heat supply	Biomass	Austrian Govt
Stare Mesto	Heat supply	Biomass	Austrian Govt
Velesin	Heat supply	Natural gas	Austrian Govt

* This project was actually undertaken in Latvia, but the assessment was carried out as though it had been situated in the Czech Republic in order to carry out a comparison between a project level assessment and a system level assessment using the Czech EFOM model.

Table 2 - Main sources of uncertainty in estimating emissions reduction of a JI project

Type	Source
Performance	Performance of project (eg based on feasibility data), operator error
Measurement	Efficiency of plant/ network (project or baseline) Emission factor (fuel/ technology characteristics) Utilisation factor
Counter-factuality (applies to baseline)	Choice of baseline technology Performance of baseline technology Timing of replacement; length of crediting lifetime Equivalence of service
Background (applies to project and baseline)	Projections of Demand for heat/ electricity Fuel availability and prices Energy system development Energy and environmental policy changes Indirect economic effects Country priorities Risk of failure

Table 3 - Dealing with Uncertainties in the estimation of emission reductions

Specific Uncertainties	**Measures**
1. Technical parameters for calculation	a) Make specific measurements of plant (reference and project), for the output, efficiency, calorific value of fuel, carbon content of fuel where possible b) Incorporate these into baseline methodology calculation eg specific emissions calculation c) use conservative estimates
2. Changes in efficiency and emission factors for fuel of reference or project over time	a) Use conservative estimates of existing data b) Baseline revision after eg 10y for long lifetime project can revise estimates where necessary c) Use operating data d) Verification check
3. Output / demand variations over time for reference and project	a) Use operating data; specifically output and fuel input data on an annual basis. Feasibility data have been shown to lead to serious overestimations b) verification check
4. Choice of baseline technology and timing of replacement	a) Baseline standardisation attempts to deal with this problem eg type 2 after 10y or type 3 b) Baseline revision for long lifetime projects after eg 10y
5. Fuel availability and prices for project	a) operating data
6. Energy system development, indirect economic effects and changes in policy and country priorities	Baseline revision
7. Leakage	Baseline revision
8. Risk of failure	a) operating data b) verification check

Table 4 - Summary of standardised baselines

	Where applicable	Advantages	Disadvantages
Type 1	a) short to medium lifetime b) substituted plant is known c) **project types:** heat supply	a) low chance of over-crediting b) number of credits relatively certain c) simple	a) higher chance of under-crediting if medium lifetime
Type 2	a) any project lifetime b) substituted plant is known at start c) **project types:** heat supply	a) can be used for any project lifetime	a) more complex than type 1 b) restricted by availability of sector data
Type 3	a) any project lifetime b) substituted plant unknown c) **project types:** electricity supply and demand, heat supply and demand, cogeneration	a) can be used for any project type and lifetime	a) more complex than type 2 b) requires some independent research c) restricted by availability of sector data
Type 4	a) any project lifetime b) substituted plant unknown c) **project types:** heat supply and demand, cogeneration	a) can be used for any project type and lifetime	a) more complex than type 3 b) requires more data from independent research c) restricted by availability of data and cost of obtaining it

Figure 1 - Uncertainty in emissions reduction for Valga AIJ project. Uncertainty is due to baseline choice, operating uncertainty and technical uncertainty.

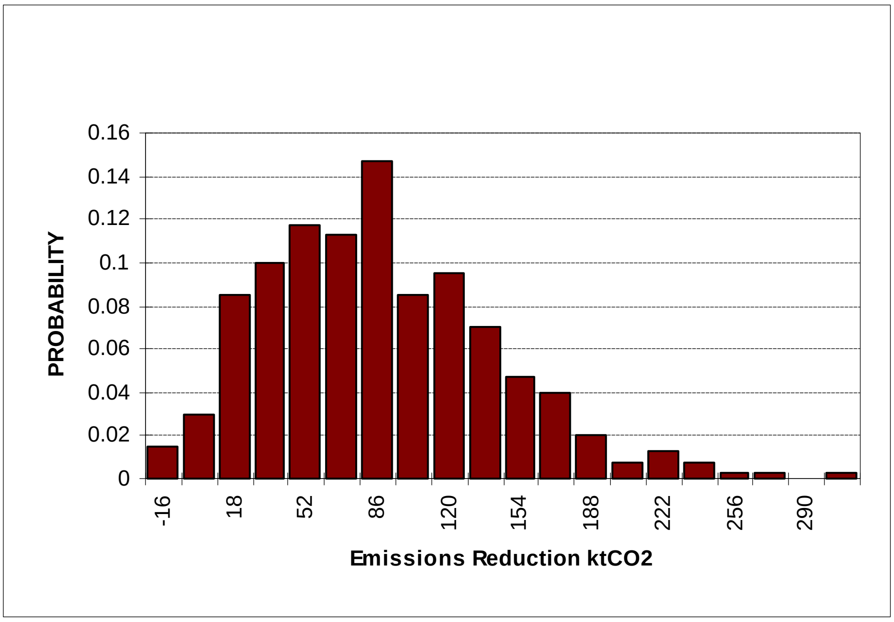


Figure 2 - Comparison between uncertainty in emissions reduction due to baseline and UN FCCC reported values for 5 AIJ projects

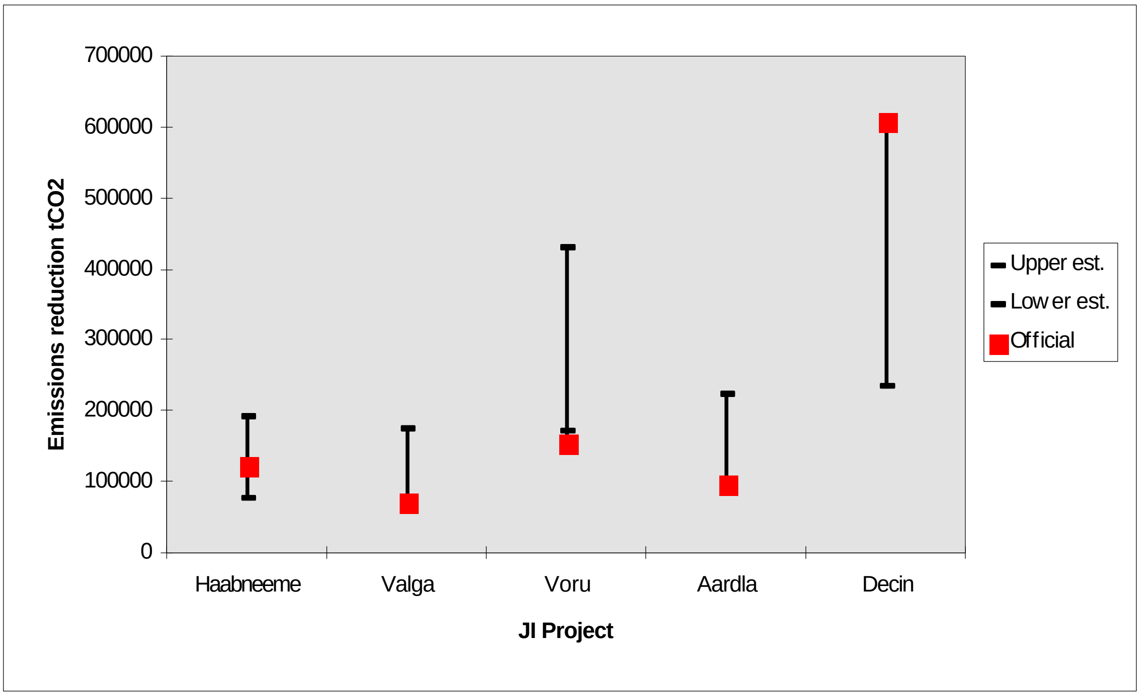
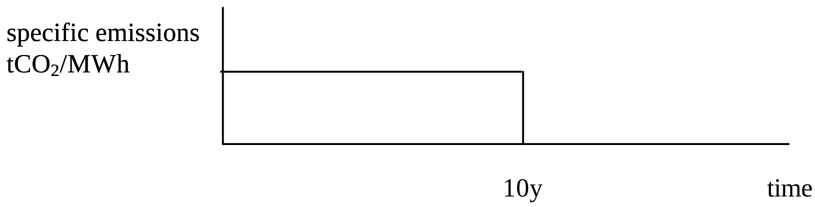
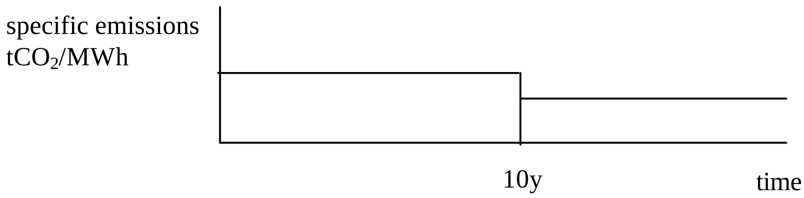


Figure 3 - Standard baselines

Type 1 - Substituted Technology for Limited Life



Type 2 - Substituted Technology initially then average fuel mix in sector



Type 3 or 4 - Average of sector fuel mix or
Average of Project Baselines

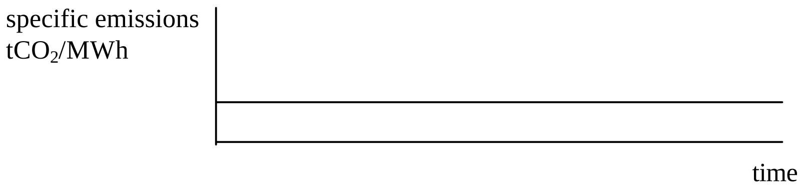
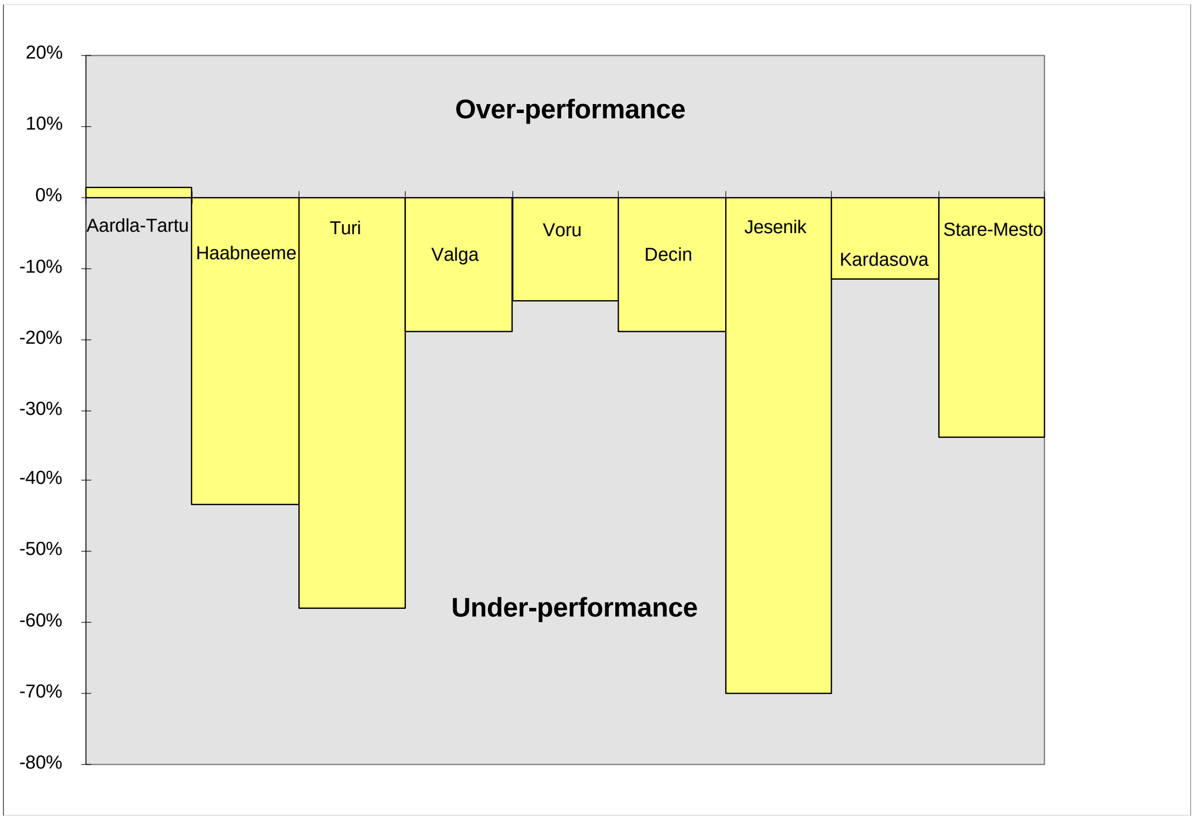


Figure 4 - Comparison between emissions reduction, based on feasibility data, and that based on 1 to 4y of operating data for nine AIJ projects in eastern Europe. (Negative values mean the project has under-performed with respect to the feasibility data.)



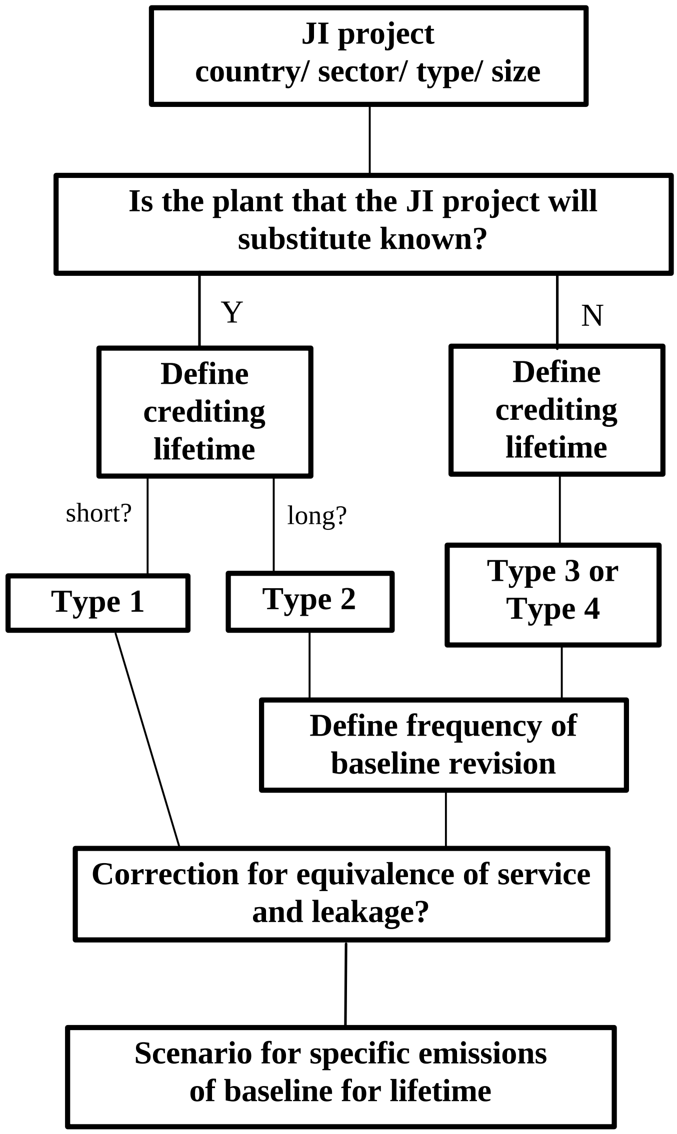


Figure 5 -Standardised Baseline Construction

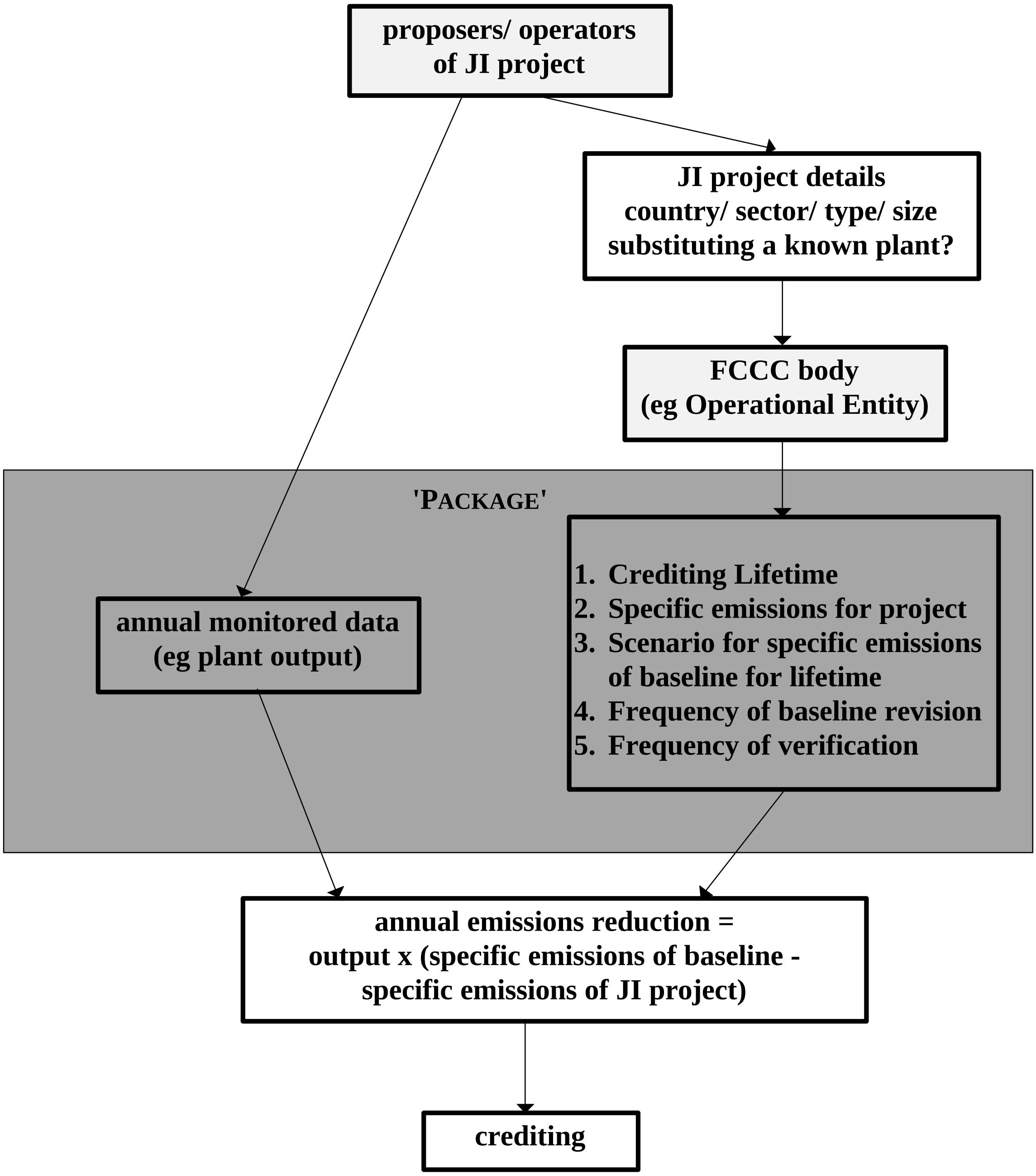


Figure 6- A Standardised Approach to Accounting