UNEP

Anticipating the Environmental Effects of Technology

A workbook for
decision-makers, planners
and other technology stakeholders

Prepared by

John E. Hay

for the

United Nations Environment Programme
Division of Technology, Industry and Economics
Consumption and Production Unit, Paris, France
and
International Environmental Technology Centre, Osaka, Japan

The EnTA Workbook

1 Introduction

This Workbook describes the worksheets that facilitate completion of an environmental technology assessment (EnTA). The worksheets can be reproduced as many times as required. The material in this Workbook explains the purpose, the desired outputs, and the steps that are required to complete each worksheet. Reviewing the diagram showing the EnTA steps, and the relevant parts of an EnTA case study, will also help illustrate the assessment procedures. There are five main steps involved in completing an assessment, but in addition there are the preparations and follow-up activities. All are described below.

2 Preparing for an EnTA

Preparation for the EnTA requires the goals of the assessment to be established, along with identification of the ways these goals will be achieved. In addition, preparations should include securing the commitment of key players in the assessment and identifying the resources (financial, human, technical etc) that are available to the assessment team. The two most important activities are elaborated below.

Establishing the goals of the assessment

It is important at the start of the EnTA process that a consensus be reached with respect to what the assessment is intended to achieve, and how this might best be done. The assessment goals should be transparent to all stakeholders, achievable and measurable. The minimum goals of any EnTA should ensure that:

- all stakeholders are involved in, or informed about, the assessment, as appropriate;
- all major detrimental effects associated with a technology are identified, if not fully evaluated; and
- a consensus will be reached amongst the stakeholders regarding what actions, if any, should be taken following completion of the assessment.

Identification of Resources

The resources required to complete the EnTA, and thus achieve the assessment goals, also need to be mobilized at this stage. The resources include:

- an assessment team that has the skills and knowledge necessary to achieve the assessment goals;
- information required in the assessment; and
- an assessment timetable, allocation of funds and access to appropriate technical resources.

Resource requirements will vary according to the scale and complexity of the technology intervention under consideration.

The methodology detailed below is designed in such a way that a person with a broad interdisciplinary background in environmental science, environmental engineering or similar areas of expertise could complete the assessment, complementing their own knowledge with that obtained through consulting with informed parties.

In some instances one person may not have all the required knowledge required, or know how to access it. In such cases experts in the environmental and social sciences, engineering and economics would normally be present on the assessment team, or arrangements made for ready access to such expertise. In the more complex cases there may be considerable merit in having an individual with a regulatory background on the team. For contentious cases one or more representatives of relevant interest groups may help facilitate successful completion of the assessment.

If the assessment is being undertaken in relation to a process technology a number of technical documents would help ensure adequacy of the information available to the assessment team. These include documents that describe the process, a process diagram, simplified materials and energy balances, the amounts and physical and chemical forms of raw materials, products and wastes, investment and production costs, conceptual basic engineering information and details of the critical points where decisions have to be made on environmental, economic and social grounds.

3 Step 1: Describe the proposed technology

Completion of this step requires reasonably detailed information on the following:

- Nature and function of the technology;
- Characteristics of the location;
- Principal goals the technology is intended to meet;
- Beneficiaries and other stakeholders in the technology intervention;
- Overall operation of the technology; and
- Visual representation of the inputs, outputs, processes and environmental interactions associated with the technology.

At the conclusion of this step the assessment team will have a comprehensive understanding of the life cycle of the technology intervention, including inputs and outputs and other resource requirements, and the associated environmental pressures. This information is fundamental to the subsequent identification of potential environmental impacts.

At this stage of the assessment it is important to undertake consultations with the various parties (both individuals and groups) who have an interest in the technology intervention, either because of the benefits it will bring, or due to the adverse impacts they or other elements of the environment might experience.

Background

This step will help focus the assessment on the potential environmental pressures and resource demands the technology intervention will create. The level of detail provided in

this step will vary depending on the assessment goals, and will influence the consequent scope of the assessment.

The scope of an assessment can be defined in many ways, including the time horizon, geographical scope, institutional coverage, technology options and applications, number of impact sectors and the range of policy options considered in the assessment.

In practical terms the scope of the assessment is likely to be determined by such factors as:

- expert judgement as to the importance of any subsystem to the overall findings of the assessment, in terms of such aspects as the potential impacts, stakeholder concerns and possible interventions to avoid or mitigate the impacts;
- limits on funds, time, personnel, information and other resources required for the assessment;
- lack of knowledge, understanding and proven methodologies related to assessment procedures; and
- political considerations such as policy implications and constraints, institutional ownership and sensitivities related to who or what might be adversely impacted.

Given considerations such as those described above, it is important at this early stage to define the scope of the assessment – i.e. the boundaries that determine what aspects of the technology intervention will be considered. These limits will determine the extent of the analysis to be undertaken in subsequent steps. For example, the boundaries placed on an assessment of lead-acid battery recycling might include the recycling network and all reprocessing and reuse steps, or it might include only the crushing, smelting and refining processes. Such process-based boundaries will often lead to the defining of spatial boundaries. The time frame used in the assessment will also influence its scope. Ideally the full life cycle of the technology intervention should be assessed – from initial concept, through design, development, procurement, operation and modification, to replacement, decommissioning or disposal. While this appears to escalate the complexity and demands of the assessment, absence of a long-term view can sometimes mean that a technology considered to be environmentally friendly in the first instance can become a significant burden on the environment some time later in its life.

The specific tasks identified in this step can be varied depending on circumstances. The fundamental requirements are a comprehensive understanding of the proposed technology intervention, clarity regarding the goals the intervention is to meet, and identification of the stakeholders who should be consulted during the course of the assessment.

Completing Step 1

a. Identify the nature and function of the technology

A descriptive name for the technology, and details of its function, should be provided.

b. Identify and characterize the existing or proposed location of the technology

Brief details on site location and important features of the natural and managed surroundings, or environs, should be described.

c. Describe the technology

The technology should be described, perhaps using the check list provided. This will provide information as to whether the technology already exists at the location, or is proposed, and whether it is an indigenous technology that is to be enhanced, an imported technology (with or without adaptation to local conditions) or a new technology that is under development. It is also helpful to indicate if the technology is going to be applied to the natural resource (extractive), process/manufacturing or service sectors.

For example, in the case of a proposed battery recycling plant, the technology would be hardware based, it might be imported from abroad with little or no local adaptation and it would involve processing a waste product.

d. In order of importance, identify the principal achievement goals for this technology and the beneficiaries and stakeholders

The outcomes the proposed technology intervention is intended to achieve should be identified and described. A distinction is made between goals that must be achieved and those which are more discretionary. The information on goals will be referred to again in Step 4 where alternative technology interventions are assessed in terms of their ability to satisfy the same goals.

In addition, the intended beneficiaries and other stakeholders associated with each goal should be listed. This information provides a check as to whether the appropriate individuals and groups have been consulted with respect to the goals of the EnTA itself, and helps facilitate further consultations during the subsequent stages of the assessment.

e. Description of the technology

Where possible and practical, the technology intervention should be described in a logical and sequential manner. For example, description of battery recycling technologies might start with delivery of the spent batteries to the processing plant and subsequently follow the various reprocessing stages until all the resulting products and wastes have left the plant's precincts.

The functions and operations described in this step will have a significant influence on the scope of the assessment – that is, they will help define the boundaries of the assessment.

f. Flow diagram of the technology

A technology intervention typically has many interacting components. It is useful and informative to show these in diagrammatic form, for this will help identify the various ways in which the technology might interact with the external environment. For example, the interactions might be in the form of flows of materials and energy, including the production and discharge of wastes.

It may be desirable to show complicated and detailed sub-systems in additional diagrams.

4 Step 2: Requirements of the technology intervention, and the resulting environmental pressures

Completion of this step requires reasonably detailed information on the environmental *pressures* resulting from:

- Providing material and energy inputs and meeting other resource requirements;
- Production, storage, transportation, use and disposal of wastes and of any hazardous products;
- Changes in human resources requirements;
- New or modified infrastructure requirements; and
- New or modified requirements for supporting technologies.

At the conclusion of this step the assessment team will have a comprehensive understanding of the inputs, outputs and other requirements generated by the technology intervention, the resulting pressures imposed on environmental systems and the hazards for public and occupational health.

Background

In this step the environmental pressures and human health and safety hazards that might arise from the technology intervention are identified. The resource and other requirements will typically fall into the following broad categories:

- Input materials;
- Land;
- Energy;
- Human resources;
- Supporting technologies; and
- Infrastructure

All may be considered in the assessment, as appropriate.

With reference to material inputs, the aim should always be to have the lowest possible requirements. In other words, material resource productivity should be maximised wherever possible. Similarly, the energy intensity of processes should be the lowest possible. Likewise, land use per unit of production or service should be minimised.

The aim should always be to maximise the service intensity of processes, products and services. Similarly, the material and energy intensity of products and services should be the lowest possible, including enhancing the longevity and recycling potential of any products.

Non-valued outputs of the technology intervention include tangible but undesired products, the generation of which would be avoided if alternative socially acceptable, technically feasible and economically viable methods were available. Examples include waste products that are discharged to air, water or land. Such disposal will incur at least indirect (i.e. uninteralized) costs, as well as reflecting the inefficient use of energy and materials.

Completing Step 2

a. List the raw materials, land and energy resources required by the technology, and identify the associated environmental pressures

In addition to providing a descriptive list of these requirements, each of the resource demands is characterised in terms of the level of demand relative to total demand for the resource at national, sub-national/regional or another appropriate level. Relative demand is used to avoid the need for precise quantitative information, and as an indicator of the likely pressures and impacts created by the incremental demand for the resource. The "consequences of concern" can also be helpful in identifying possible pressures on each of the environmental outcome categories.

Worksheet A provides a check list to assist in this aspect of the assessment.

These findings provide background to the subsequent assessment of impacts on human health and safety, the local natural environment, the global environment, sustainability of resource use and impacts on society and culture (Step 3).

b. List the wastes and any hazardous products produced by the technology, and identify the associated environmental pressures

All wastes and products are characterized in terms of their potential to produce hazards or impose significant pressures on valued environmental and related systems.

The wastes and potentially hazardous products are assessed in terms of the level of production relative to total amount produced at national, sub-national/regional or another appropriate level. Relative production is used to avoid the need for precise quantitative information, and as an indicator of the likely pressures and impacts created by the additional waste or hazardous products that will be generated. The "consequences of concern" can also be helpful in identifying possible pressures on each of the environmental outcome categories.

Worksheet A provides a check list to assist in this aspect of the assessment.

These findings provide background to the subsequent assessment of the impacts on human health and safety, the local natural environment, the global environment, sustainability of resource use and impacts on society and culture (Step 3).

c. List the infrastructure required by the technology, and identify the associated environmental pressures

It is important to assess the ability of the infrastructure and services to meet the incremental demands generated by the technology intervention. Both additional infrastructure demands, and the capacity of existing systems to meet these requirements in reasonable ways, should be considered. The environmental pressures arising from these demands can then be identified. Worksheet A provides a check list to assist in this aspect of the assessment.

An indicative list of possible infrastructure requirements is provided in the worksheet. Those that are not applicable can be ignored, while there is space to specify additional requirements. When assessing environmental pressures the capacity of the economic, environmental, social and other relevant systems to meet these demands should be taken into consideration.

These findings are intended to provide background to the subsequent assessment of the impacts on human health and safety, the local natural environment, the global environment, sustainability of resource use and impacts on society and culture (Step 3).

d. List the supporting technologies required, and identify the associated environmental pressures

Typically a technology intervention will generate requirements for supporting technologies and associated services. This step involves identification of any additional requirements, over and above those previously considered in Steps 2a through 2c.

Additional technologies and associated services required to establish and maintain the technology should be listed, along with information on their availability and the associated environmental pressures. Worksheet A provides a check list to assist in this aspect of the assessment. When assessing environmental pressures the capacity of the economic, environmental, social and other relevant systems to meet these demands should be taken into consideration.

These findings are intended to provide background to the subsequent assessment of the impacts on human health and safety, the local natural environment, the global environment, sustainability of resource use and impacts on society and culture (Step 3).

e. List the human resources demands of the technology, and identify the associated environmental pressures

This step identifies the various skills and other abilities required to establish and maintain the technology. This step considers only those skills and other abilities directly required to implement and maintain the technology. Where additional technologies, expertise and other supporting services are also required, they will be considered in Step 2f.

Two key issues to be addressed in this step are whether the necessary expertise could be sourced locally, and whether in reality the new human resource requirements would be met by either recruiting the individuals with the requisite skills from other labour markets, or by retraining local people. Such information will assist recognition of the environmental pressures resulting from meeting the requirements for human resources.

These findings are intended to provide background to the subsequent assessment of the impacts on human health and safety, the local natural environment, the global environment, sustainability of resource use and impacts on society and culture (Step 3).

f. Identify where there are environmental pressures associated with any other aspects of the technology intervention

This step allows for the recognition and assessment of environmental pressures arising from aspects of the technology intervention not already identified. In this respect, it is important to recognise any environmental pressures that may occur when the technology is decommissioned, and any such pressures that might remain after the decommissioning. Other aspects not already considered might include nuisance effects (such as continuous but low level noise), pressures on intrinsic and amenity values and degraded aesthetic conditions.

These findings are intended to provide background to the subsequent assessment of the risks to human health, the local natural environment, the global environment, sustainability of resource use and impacts on society and culture (Step 3).

5 Step 3: Preliminary judgement

The assessments in this step make use of the environmental pressures identified in a general way in Step 2, by expressing these pressures in terms of the resulting environmental impacts, and aggregating them for each of the environmental outcome categories, or endpoints. The economic viability of the technology intervention is also considered. Completion of this step requires additional information on the impacts likely to be imposed on valued environmental and related systems and also on indicators of the economic performance of the technology.

At the conclusion of this step it should be possible to reach a consensus regarding the significance of the environmental pressures and impacts associated with the technology, and with respect to the overall economic viability of the technology intervention.

Background

Step 2 involved assessing the *pressures* the technology intervention might impose on environmental and related systems. The present step considers these general findings in more detail and subsequently produces an overall assessment of the *impacts*, expressed in terms of the environmental endpoints. A simple assessment is also undertaken in order to provide an indication of the *economic viability* of the technology intervention. A decision is made as to the sufficiency of information, after consideration of gaps in information and uncertainties in understanding.

Completing Step 3

EnTA focuses on characterising potential impacts associated with outcome categories, or endpoints. The outcome categories are: Human Health Impacts, Local Natural Environment Impacts, Social and Cultural Impacts, Global Impacts, and Resource Sustainability. The performance of each technology option is evaluated using these broad categories.

Often the most difficult part of an assessment is evaluating the ‘significance’, or

'importance', of the environmental impact resulting from a particular pressure.

A series of basic questions can be asked for each environmental pressure:

- Will the pressure have a significant adverse impact on the health and safety of the community and workforce?
- Will the pressure have a significant adverse impact on natural ecosystems and species?
- Will the pressure have a significant adverse impact on global warming or ozone depletion?
- Will the pressure compromise, in a significant way, the ongoing sustainable use of resources?
- Will the pressure have a significant adverse effect on society?

Judgements as to the severity of the impacts can be aided by reference to appropriate environmental legislation, regulations, standards, guidelines and codes of good practice. For example, if the pressures, and consequent impacts, are likely to result in non-compliance with such requirements, the impacts should be classified as "moderate" or "large", depending on the extent of non-compliance.

Acknowledgement of diverse opinions is essential to the successful conclusion of an assessment. It may be therefore be appropriate to check more than one of the boxes provided when recording the response for a given impact category. This might be done in order to acknowledge both variations in opinion and the existence of uncertainties. Uncertainty might be indicated by checking two or more adjacent boxes. A diversity of opinions could also be indicated by entering in each box the percentage of individuals who consider that box reflects the most appropriate response.

Step 3 includes assessment of the overall impact of the technology intervention for each endpoint. Again it may be appropriate to check more than one box. In addition to again indicating divergent opinions and or significant uncertainties, such a result may be used to signify that it is inappropriate or impossible to aggregate the separate impacts. In more sophisticated methodologies, such as environmental impact assessment, it is common to use weighting schemes that facilitate aggregation of the impacts for individual impact categories, resulting in an assessment of the overall impact for the given endpoint. Such an approach is not used in EnTA as it is inconsistent with the goal of keeping EnTA practical and simple, and the information requirements within reasonable limits. If the EnTA findings reveal that a more comprehensive and objective assessment is required, consideration can be given to undertaking an environmental, health, social, economic or other more rigorous assessment, as appropriate.

a. Assess the impacts on human health and safety that are likely to arise from the pressures identified in Step 2

The pressures on human health and safety that were identified in Step 2 are now described in terms of the impacts they are likely to cause. Any known adverse impacts on human health and safety are characterised as being at one of six levels, first for each impact category and subsequently overall.

b. Assess the local natural environmental impacts likely to arise from the pressures identified in Step 2

The pressures on the local natural environment that were identified in Step 2 are now described in terms of the impacts they are likely to cause. Any known adverse impacts on the local natural environment are characterised as being at one of six levels, first for each impact category and subsequently overall.

c. Assess the global environmental impacts likely to arise from the pressures identified in Step 2

The pressures on the global environment that were identified in Step 2 are now described in terms of the impacts they are likely to cause. Any known adverse impacts on the global environment are characterised as being at one of six levels, first for each impact category and subsequently overall.

d. Assess the impacts on the sustainability of resource use likely to arise from the pressures identified in Step 2

The pressures on the sustainability of resources used that were identified in Step 2 are now described in terms of the impacts they are likely to cause. Any known adverse impacts on the sustainability of resource use are characterised as being at one of six levels, first for each impact category and subsequently overall.

e. Assess the social impacts likely to arise from the pressures identified in Step 2

The pressures on social and cultural systems that were identified in Step 2 are now described in terms of the impacts they are likely to cause. Any known adverse impacts on social and cultural systems are characterised as being at one of six levels, first for each impact category and subsequently overall.

f. Assess the impacts likely to arise from pressures not identified in Step 2

Some specific pressures may not have been identified in Step 2; for example they may relate to endpoints other than those identified in Step 2. In the present step any such pressures should be described in terms of the impacts they are likely to cause. The adverse impacts are characterised as being at one of six levels, first for each impact category and subsequently overall.

g. Assess the economic viability of the proposed technology intervention

As previously noted, this part of the assessment is designed to prevent the environmental and related damage that may occur if a technology investment fails to meet its goals because of poor economic performance.

Two simple economic performance indicators are used to guide the assessment - payback time and internal rate of return. To determine the latter the net present value of the technology investment must also be estimated.

Generally a payback time of three years or less is preferred. The internal rate of return for the planned technology investment can be compared with current and anticipated interest rates and with the internal rate of return for other technology options and, indeed, other

investment opportunities. It is important that any intercomparisons of internal rates of return and of interest rates take into account the complicating factor of risk.

Assessment of the economic viability of the proposed technology investment should also include consideration of "uninternalized cost elements" – these are described as environmental, social and other externalities. In an EnTA it is impractical to derive a monetary estimate of these costs; rather, this step simply requires that the external cost elements be identified and described in terms of their *relative* contribution to the total cost of that stage of the technology investment.

External costs include both monetary and non-monetary costs. An example of the former is the additional health care costs incurred by individuals living in a community impacted by air pollution from an industrial plant, where these costs are not paid for by the plant owners or operators. An example of a non-monetary cost is the value individuals place on a landscape that is not degraded due to air and other forms of pollution. Sound environmental management calls for external costs to be internalised as much as possible, thus becoming a cost of production that would be included in the calculation of the payback time and the internal rate of return.

The viability of the technology investment may be compromised by unanticipated changes in production costs - such as undesirable fluctuations in raw material, labour and energy costs. Such cost elements should be identified for each stage of the technology life cycle, and an assessment made as to the extent to which they pose a significant threat to the economic viability of the technology investment.

Finally, the overall economic viability of the technology investment should be described in qualitative terms, with the assessment based on the economic performance indicators, on the relative size of the uninternalized costs, on the importance of the critical cost elements, and on any other relevant information available to the assessment team.

h. Describe information gaps and uncertainties

Information gaps that have impeded the assessment of impacts to the outcome endpoints are identified. The associated uncertainties in assessing the impacts should also be described. Provision is made for identifying gaps and uncertainties that are not directly related to any of the outcome categories, or are related to the assessment of the economic viability of the technology intervention.

i. Is there sufficient information to characterise and evaluate the environmental pressures and impacts and the overall economic viability of the technology?

Step 3 of the assessment concludes with consideration being given to whether it is possible to reach a consensus regarding the extent to which the technology will impact on the environment, and hence its acceptability.

If the information gaps and uncertainties in the assessment are such that it is not possible to reach a consensus, measures should be taken to reduce the critical gaps and uncertainties and address any other shortcomings in the approach taken to the assessment. The latter might include improved stakeholder consultation and increased participation of interested parties. Steps 2 and 3 should then be repeated, as appropriate.

On the other hand, if the findings, gaps and uncertainties are such that a consensus is likely be reached, Step 4 of the assessment can begin.

6 Step 4: Comparative assessment of alternative technologies

This step requires the assessor(s) to consider if there are alternative ways to achieve the same goals as those to be met by the existing or proposed technology. These alternatives may be either macro (e.g. a significantly different approach) or micro (e.g. a variation of the same process) in nature. The assessor(s), working on behalf of all interested parties, must decide whether to consider only macro or micro alternatives, or both.

Step 4 provides the opportunity to assess if the alternative technologies are likely to have significantly higher or lower environmental impacts than the proposed technology.

At the end of this step it should be possible to identify whether there is a feasible alternative technology intervention that is associated with less adverse impacts on environmental and related systems.

Background

As noted earlier, the ultimate purpose of an EnTA is to inform the decision makers, and the stakeholders, at the pre-investment stage of the planned technology intervention. Ideally, therefore, the assessment is not limited to examining just one proposed technology intervention. Rather, if the aim of adopting best practices is pursued, the assessment will identify and consider a range of alternative technologies, some of which might well have been overlooked if a formal EnTA had not been undertaken.

Each alternative technology should, by and large, be capable of fulfilling the articulated generic goals of the intervention. A check list that will assist in making this assessment is provided as Worksheet B.

Completing Step 4

a. Identify and briefly describe alternatives to the technology being assessed

Desirably, one or more alternative ways to achieve the goals for the technology intervention (as identified in Step 1d) should be listed, and the specific nature of each alternative intervention described. Generally “No new intervention” (that is, maintain the status quo) should also be considered as a possible alternative.

b. Evaluate the degree to which each alternative satisfies the goals that must be achieved by the technology intervention

With reference to each of the goals to be satisfied by the intervention, compare the extent to which the alternative technology will achieve the goal, relative to the performance of the existing or originally proposed technology.

For each goal the relevant box (or boxes if there is uncertainty or indecision) should be checked, and subsequently an assessment should be made with respect to all goals combined.

c. For each alternative technology, compare its potential impacts and economic viability, relative to the technology being assessed

This step evaluates the alternative technologies in terms of the potential environmental impacts and overall economic viability. In all cases the assessment is relative to the performance of the existing or proposed technology. The findings of this and Step 4b will, to a large extent, help decide if a more comprehensive assessment of an alternative technology is appropriate.

Each alternative technology is assessed in terms of its environmental impacts and economic viability. The assessment involves a comparison with the environmental impacts and economic viability of the proposed technology, as determined in Step 3. To aid the comparison, the letter codes used in Step 3 to describe the corresponding environmental impacts and the overall economic viability of the proposed technology should be transferred to the worksheets for Step 4.

Thus, for each of the environmental endpoints and for the economic viability, the conclusions reached in Step 3 should be transferred to the column labelled "Impact or viability of assessed technology". In each case the descriptor will be one of the following, as appropriate to the context:

- U - Impacts unknown; technology intervention uneconomic;
- B - Beneficial impacts
- N - No impacts identified;
- S - Slight impacts; slight level of concern; slight level of economic viability
- M - Moderate impacts; modest level of concern; modest level of economic viability; or
- H - High impacts; high level of concern; economic viability is high.

As noted above, the environmental impacts and economic viability for each of the alternative technologies are expressed relative to the level of impacts and economic viability identified for the assessed technology. A five point scale (much worse, slightly worse, similar, slightly better, much better) is used. Guidance on the categories of environmental impacts can again be obtained by consulting Worksheet A.

It should be noted that this evaluation of each alternative technology is a very simplified analysis - described as the "Short Form". Where appropriate, each alternative technology should be evaluated to the same extent as the proposed technology, through the completion of Steps 1 to 3 – described as the "Long Form".

d. Conclusions regarding alternative technology interventions

As a result of this rapid comparative analysis it may be possible to reach a consensus regarding the performance of an alternative technology, in terms of the goals to be satisfied, the environmental outcomes and the economic performance.

Provision is made for an elaboration of the information gaps and associated uncertainties in the assessment. This information is used when arriving at a decision as to whether it is possible to reach a consensus regarding the relative performances of the alternative technology options.

If the information gaps, the uncertainties or other considerations make it impossible to reach a consensus it may be appropriate to conduct a more comprehensive assessment for one or more of the alternative options – that is, use the "Long Form" of the assessment procedures.

7 Step 5: Decide if a consensus decision can be reached

This is the final substantive step in the assessment. Normally completion of this step will not require any additional information. Rather, it draws on the findings of the preceding four steps.

The aim of this step is to facilitate a consensus regarding the environmental and related performances of the proposed technology intervention.

Background

Identification and characterisation of environmental impacts is never exact. The complexities of the environmental systems themselves, and especially the interactions related to human activities, impair our ability to specify the environmental consequences of a specific technology intervention. Due to the complex nature of environmental systems this would be the case even if all information was available. That is seldom, if ever, the case.

Recognition of the resulting uncertainties is important as it signals to decision makers the relative extent to which they can rely on the guidance provided, and hence make unequivocal and irreversible decisions. Significant uncertainty calls for a more adaptive approach to management, where flexibility is retained and options are kept open until the reduced levels of uncertainty suggest it is appropriate to do otherwise. Thus, an adaptive management approach invokes strategies for reducing uncertainties, to the extent that such efforts are reasonable.

Completing Step 5

a. Can a consensus be reached with respect to the performance of the preferred technology?

The questions to be answered in this step are designed to identify whether all necessary steps have been completed, at least to the extent that some necessary conclusions can be reached. If there are shortcomings, suggestions are given as to which steps need to be repeated in order to move towards a conclusion.

b. Characterise the significant information gaps, and uncertainties that remain

The major gaps and uncertainties identified earlier are described. As noted above, this information should be made available to the decision makers and other stakeholders, in order to show the extent to which they can rely on the guidance provided by the assessment.

c. Summarise the suitability of the preferred technology and the level of certainty in the assessment

This step provides the opportunity to describe the environmental impacts of principal concern and the types of changes in the technology intervention that might result in further reduction of these impacts and hence improved acceptability of the technology.

Once again it is appropriate to describe the level of certainty in this aspect of the assessment, with the findings being made available to interested parties, along with any recommendations.

In some circumstances an EnTA should be followed by a more detailed, rigorous and comprehensive assessment of the environmental performance of the proposed technology intervention. Factors influencing such a decision may well include existence of large information gaps, high levels of uncertainty, inability to reach a consensus due to the continuing polarization of views amongst stakeholders, and the serious nature of the environmental impacts that have been identified. Any one of these circumstances would indicate the need for a more comprehensive study, such as an environmental impact assessment, an environmental or health risk assessment, a comprehensive economic analysis or a social impact assessment.

The nature of the environmental impacts, the measures that may or may not be available to avoid or mitigate these impacts and the gaps and uncertainties should all be considered when making a recommendation as to whether a more comprehensive environmental assessment should be undertaken.

The acceptability of the technology being assessed should be indicated and the viability of any alternative technology interventions should be described.

Finally, the consensus recommendations regarding the preferred technology, and any viable alternatives, should be provided.

8 Completing the EnTA

Once the Workbook and worksheets are completed, there are several additional steps in the EnTA process that should be considered.

Document and present the assessment methods and findings

Careful attention should be given as to how, and to whom, the results of the assessment should be communicated. For example, Step 1 identified the principal beneficiaries of the proposed technology intervention and the stakeholders who would carry the burden if the environmental values were not protected. Consultation with interested parties was also used to help identify the goals of the assessment. All these stakeholders will likely have a

legitimate interest in receiving and reviewing the results of the assessment. This is in addition to those who will use the assessment findings to guide their decisions regarding implementation of the technology intervention.

Different circumstances may call for substantively different ways of reporting the results of the assessment, just as the breadth and depth of the assessment itself is dependent on various circumstances. In light of this, no attempt will be made to give an explicit description of the form, style and content of formal and informal communications arising from the assessment.

However, any communication would normally take the following into account:

- The interests, backgrounds and concerns of the intended recipients;
- The information and methods used in the assessment, and the resulting certainty of the findings;
- The goals of the technology intervention (step 1);
- The options for meeting the goals (Steps 1 and 4);
- The most significant environmental pressures associated with the proposed technology (Step 2);
- The major environment impacts and the likely economic viability of the technology investment (Step 3)
- The ability of alternative technology interventions to achieve the goals, and the relative environmental impacts and economic performances of these alternative options (Step 4)
- Recommendations regarding further assessments and implementation of the proposed technology intervention (Step 5)

Follow-up to assessment

An EnTA is not a one-off action. As new information and understanding comes to light, as the technology cycle evolves, and as values and goals change, there may well be a need to re-evaluate the assessment findings.

Follow-up activities should include, but not be limited to the following:

- Responding to the decisions, needs and actions of the key players and stakeholders;
- Revising the existing assessment and preparing new intervention strategies and recommendations;
- Undertaking, as appropriate, more comprehensive assessments of the proposed and/or alternative technologies;
- Providing additional information and guidance to key players and stakeholders;
- Monitoring and assessing relevant technology transfers, developments, implementations and uses;
- Monitoring and assessing impacts and regulatory, policy and other developments;
- Adapting the technology intervention strategy to reflect new requirements, information and understanding; and
- Revising the environmental technology assessment procedures in light of new information, experience and understanding.