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PROMOTING ENERGY EFFICIENCY INVESTMENTS FOR CLIMATE CHANGE MITIGATION AND SUSTAINABLE DEVELOPMENT

A Guidebook for Project Developers for Preparing Energy Efficiency Investments Business Plans

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- Deltcho Vitchev, international financing expert and consultant to ECE under the DA project. Mr Vitchev reviewed the final draft of the guidebook, which was much appreciated. He developed some of the material adapted in the guidebook during his prior assignment with ECE.

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Introduction

This guidebook is intended for energy efficiency project developers operating at a national level. It aims to help in the preparation of business plan documents to be presented to relevant parties to seek finance for energy efficiency (EE) projects. It introduces a standard step-by-step procedure for preparing business plans for EE projects and provides guidance for project identification and feasibility studies that will meet the requirements of potential financing institutions and related instruments.

The guidebook is divided into eight chapters as follows:

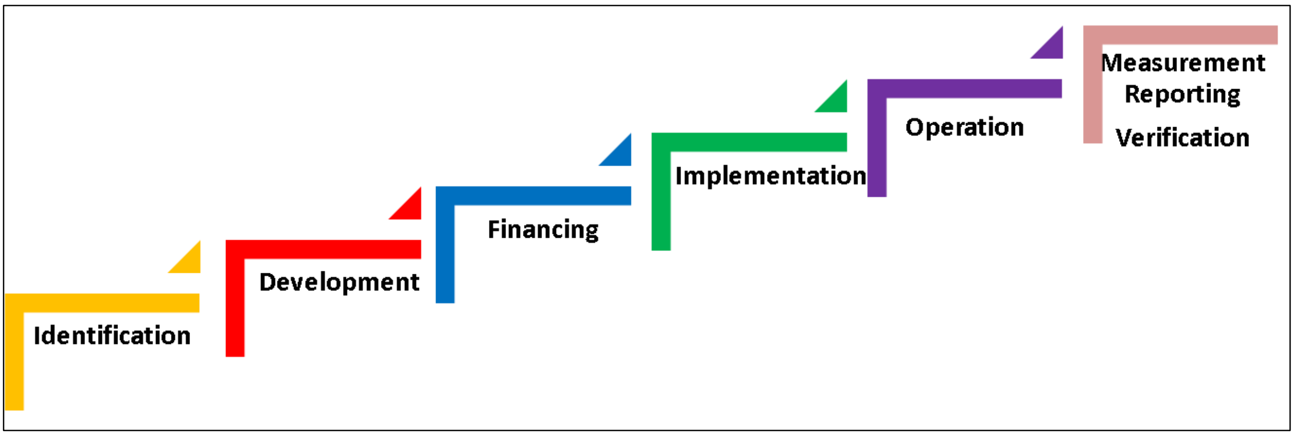
- Required project development and implementation steps;
- Business plan preparation;
- Profitability calculation;
- Evaluation of environmental and other benefits;
- Financial instruments for EE projects;
- Criteria and requirements of financial institutions.

Templates for presenting the business plans of EE projects can be found in Annex II. A comprehensive, user-friendly tool for financial and economic analysis using an Excel worksheet can be downloaded from ESCWA Energy Section/Sustainable Development Policies Division webpage. The tool is designed to help prepare all financial and economic input for the business plan of a particular project.

I. REQUIRED PROJECT DEVELOPMENT AND IMPLEMENTATION STEPS

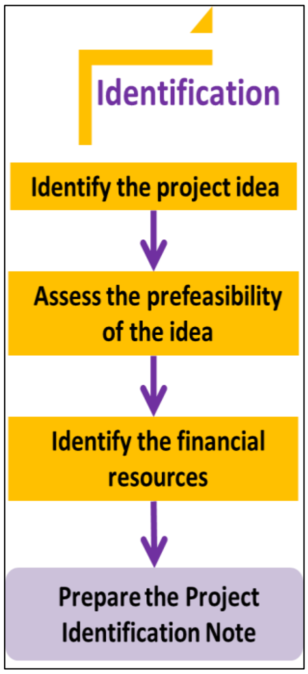
In general, to ensure the success of a project, the developer should follow a comprehensive process, divided into various steps, with control points defined. Each step is subject to a specific deliverable and to validation so that the project complies with needs and objectives in terms of costs, profitability and deadlines. EE projects are no exception to this rule. In addition, they should consider a number of specific factors.

The process of developing an EE project should follow six main steps, from project identification, through development, financing and implementation, to operation, followed by measurement reporting and verification, as shown in the following illustration.



A. STEP 1: PROJECT IDENTIFICATION

The objective of this step is to identify the EE project idea, judging it as a genuine business opportunity with a good chance of implantation. Within this step, the developer should carry out the following tasks.



1. *Identify the project idea*

Identifying the idea is the starting point of the project process and will determine to a large extent its success. The idea can be identified from several sources, depending on the nature of the activity target by EE. The main sources include the following:

(a) *The energy audit*

The energy audit is a technical study to diagnose the energy consumption situation of the target activity and to identify the options for improving its energy performance. It must be conducted by a qualified energy auditor on the basis of a detailed analysis of the electricity and fuel consumption of main facilities and the identification of energy waste sources. Examples include energy audits of a building used for commercial activity, a factory producing a given good, or a transport fleet.

(b) *Benchmark with similar projects*

An idea might arise from seeing results obtained by EE projects already undertaken with regard to similar activities. Standard measures can be used to assess the impact of proven energy savings. Such measures include thermal insulation of buildings and replacing old motors with newer, higher efficiency ones.

(c) *National energy efficiency programmes*

National energy efficiency programmes can provide a source of ideas for projects, as they sometimes include information guides developed after extensive studies of energy diagnosis in different sectors.

(d) *Existing studies*

Existing studies on energy efficiency can provide sources of information leading to project ideas for potential developers.

2. *Assess the prefeasibility of the idea*

At this stage, the developer must evaluate the project's feasibility to ensure that there are no major barriers to implementation. The developer must also identify the specific requirements to be considered in the project design before embarking on subsequent phases of development. Three areas should be explored as follows:

(a) *Regulatory and normative aspects*

The developer should analyse the relevant regulatory and normative national frameworks in order to identify the main requirements and to decide whether or not the project is likely to comply. The developer should take into account, for example, laws and standards related to energy efficiency, building regulations, regulations in the electricity sector, environmental and other regulations. The developer must ensure that implementing the project idea is feasible in terms of relevant laws and regulations.

(b) *Initial analysis of the institutional and political support for the project*

Reviewing support policies will enable the developer to maximize the chance of gaining support for the project idea from national authorities. It will also help identify potential sources of project support, in terms of financial and/or technical assistance.

(c) *Initial analysis of the technical and financial*

Based on available information and, if necessary, additional expert advice, the developer should ensure that the project idea is technically feasible and would not encounter insurmountable technical barriers.

The developer should also gain a broad idea of the project's key economic parameters, including, for example, investment costs, annual operating costs, energy savings or expected energy production, and project profitability.

Project profitability should be assessed in broad terms. For example, the approximate gross payback period of a project can be calculated as follows:

Payback period = Investment cost/(average annual saving on energy bills – annual average operating costs)

The saving on energy bills is calculated by multiplying the energy saving of each type of energy by its average price.

Although evaluation of project profitability need not be accurate at this stage, it must be robust and conservative.

3. *Identify the financial resources*

Before proceeding further, the developer must ensure that the project is financially viable, taking into account the developer's own funds and identifying potential other sources of financial support within existing national and/or international programmes.

Finally, the developer should identify the most appropriate sources of funding available in the country, including commercial bank financing and specific credit lines. Assessing these and other factors will provide an initial idea of funding options and help develop a financing scheme outline.

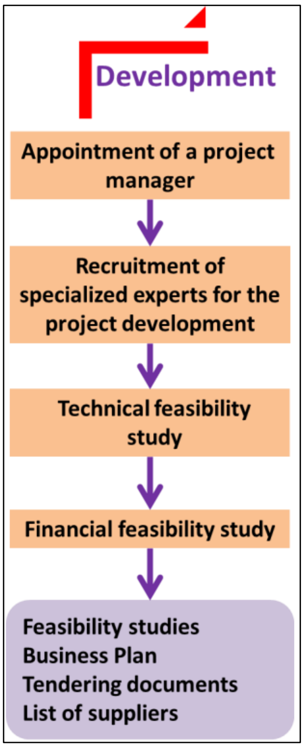
4. *Prepare the Project Identification Note*

The exploratory process, although important, should be efficient in order to minimize financial outlay should the project idea appear unfeasible.

Once the idea does seem feasible, the developer should provide a brief project identification note, to include the following:

- Brief description of the developer;
- Brief description of the project;
- Compliance with the national context and local regulations;
- Key risks and their mitigation;
- Investment costs, including project-preparation costs;
- Operation costs;
- Energy saving or energy output assessment;
- Revenues or energy bill saving;
- Financing scheme outline.

B. Step 2: Project development



On the basis of the project identification note, the developer, the project sponsor/owner and/or investor must decide whether or not to develop the project further, make adjustments or perhaps a abandon the idea.

If the parties decide to go ahead, the developer proceeds to design the project and undertake detailed technical and financial feasibility studies. This phase requires the following activities.

1. *Appointment of a project manager*

It is necessary at this stage to appoint a project manager responsible for coordinating the activities of the different parties throughout the project implementation process. Depending on the project's size and complexity, the project manager can be part time or full time, recruited by the developer internally or externally. If necessary, the project manager should be able to draw upon a multidisciplinary project unit created to help the project proceed.

The project manager must have a strong project management track record and communication skills good enough to liaise with specialized experts.

2. *Recruitment of specialized experts for project development*

At this stage, the developer might need to hire specialists to develop and structure the project. Such specialists are likely to include the following:

- A technical expert, to provide technical advice and undertake the technical feasibility study, prepare tender documents, negotiate with suppliers and contractors;

- A financial expert, to conduct the financial feasibility study, prepare the business plan, advise on the financial scheme, and help the developer negotiate with financial partners.

A legal adviser, to handle legal and contractual aspects with different partners.

As a first step, the developer should prepare the terms of reference for recruiting experts. The terms of reference could be written by the project manager, with external help if necessary. The terms of reference should be as clear as possible.

In accordance with the project's size and with the rules normally used by the developer, recruitment could be done by mutual agreement or by consulting several experts.

3. *Technical feasibility study*

The technical feasibility study should assess the existing types and amounts of energy consumed for key uses. It should then describe in detail the proposed options to reduce energy consumption, along with specifications for equipment and work required to implement the project.

The technical feasibility study must present the following:

- The net energy savings to be made, by form and use;
- Investment costs, based on preliminary consultations with equipment suppliers and service providers;
- The means to be provided for the operation of the EE solutions.

4. *Financial feasibility study*

The objective of the financial feasibility study is to provide comprehensive simulation of the business plan for the activity during the project period of, for example, five to 10 years. Using the technical study as a basis, the financial feasibility study should be able to help determine the following:

- Investment cost, detailed by component;
- Proposed financing scheme, including equity and debts;
- Saving on energy bills, based on forecast domestic energy prices;
- Additional transaction costs generated by proposed EE solution;
- Finance charges;
- Asset depreciation;
- Predicted project cash flows;
- Indicators of project profitability and returns on equity, including Internal Rate of Return (IRR), IRR on equity, payback period and Net Present Value;
- Analysis of the ability of project-generated cash to service project debt.

As part of the financial feasibility study, a sensitivity analysis should be conducted with respect to key assumptions in the business plan in order to ensure the robustness of the profitability indicators.

5. *Legal arrangements*

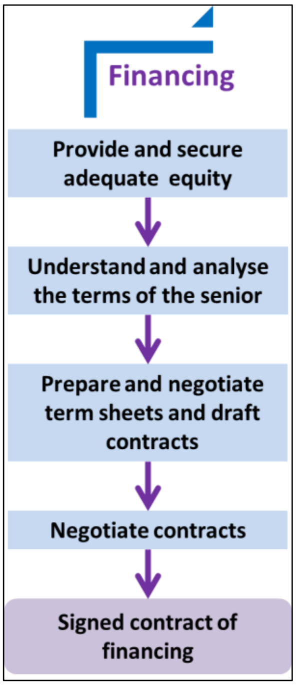
Depending on the type of project, the legal adviser could be required to organize and secure the necessary legal arrangements to implement and operate the project. Such arrangements could include specific administrative authorization, permits and licenses. The legal adviser could be required to organize all furniture and service supply contracts.

6. *Outputs of the phase*

The main outputs of this phase are the following:

- Technical feasibility study;
- Business plan, with clear financial analysis of project, including investment costs, proposed financing scheme, profitability evaluation, and project capacity to repay equity and loans;
- Tender documents for services and the materials required for project implementation;
- Identification of the best potential equipment suppliers and service providers.

C. Step 3: Project financing



Project financing is determined on the basis of the business plan, developed within the framework of the financial feasibility study. The developer must enter into final negotiations with financial partners, which are essentially the equity providers, including individuals, investment funds and lending institutions.

Within this framework, supported by the financial expert, the developer must take the following steps:

1. Provide and secure adequate equity or source appropriate instruments to complement the required equity.

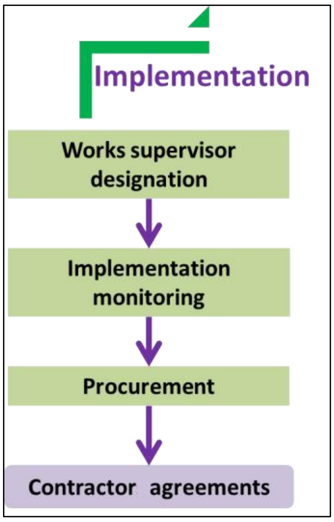
2. Understand and analyse the terms of the senior, subordinated debt and equity providers.

3. Prepare and negotiate term sheets, draft contracts and agreements. The developer must take into account the following:

    - The role of shareholders in decision making;
    - The guarantees and securities required by banks for loans;
    - The interest rate and payment period for the loans.

4. Negotiate and sign the legal, financial and other necessary agreements and contracts.

D. STEP 4: PROJECT IMPLEMENTATION



The business plan should be followed as closely as possible in order to minimize cost overruns and implementation delays that could reduce expected profitability.

The main activities within this step are as follows.

1. *Works supervisor designation*

The implementation supervisor is hired in order to lead and coordinate the technical and financial implementation phase of the project. This can be the project manager (see below) or another specialist if the first one doesn't have the required qualifications. The supervisor should have the minimum technical expertise necessary to be able to communicate and follow up contractor interventions.

2. *Implementation monitoring*

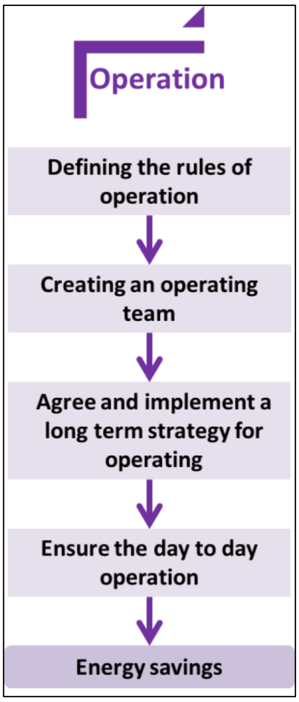
The main aims of this phase are the following:

- To establish and implement planning that is as accurate as possible but realistic enough to cope with the constraints of the project environment;

- To organize, provide and ensure appropriate methods for monitoring and reporting project implementation. This must include the required adjustment if gaps in planning become apparent during implementation.

3. *Procurement*

The procurement process begins once project financing has been secured. Procurement depends on the nature of the project and the developer but can include the following:



- Turnkey procurement. One contract is issued. One contractor has overall responsibility for the project;

- Procurement by lot. Different contracts are issued to different contractors. Each contractor is responsible for one lot. The project manager is responsible for coordinating the different lots.

Contactors can be hired through open competitive bid or direct negotiation.

E. STEP 5: PROJECT OPERATION

The operation and maintenance of EE projects can be more or less complex, depending on the nature of the project. Some projects do not require special provisions for operation, which might include building insulation, for example. Other types of projects, which might include cogeneration or process improvement, require a specialized team to conduct day-to-day operation.

In general, the developer should provide activities for the preparation and operation phase that include the following:

- Define the rules of operation and allocate responsibilities. This could include developing an operation manual that takes into account technical specifications of key installed equipment as provided by manufacturers;

- Create an operating team trained to ensure effective daily operation and maintenance of installed facilities. Operation could be outsourced to specialized companies on the basis of a clearly defined operation contract;

- Agree and implement a long-term strategy for operating the project and/or an exit strategy;

- Ensure the day-to-day operation and maintenance of the system.

F. STEP 6: MEASUREMENT, REPORTING AND VERIFICATION

Measurement, Reporting and Verification (MRV) is the process of verifying energy savings as a result of the implementation of an EE measure.

1. *Why MRV energy saving?*

The reasons that MRV could be required or desired include the following:

- Public incentive programmes require MRV in order to verify project savings;

- Some financing programmes require MRV to ensure that the terms of financing are met, for example that project payback does not exceed the term of the loan;

- The need to credit energy cost savings to an internal energy revolving fund;

- An energy performance contract bases project finance payments on an agreed-upon MRV approach that establishes project savings.

2. *How to determine Energy Saving?*

There are several methods to determine energy savings for a project. The three primary methods are as follows:

- Deemed savings. For projects that install relatively simple measures, or when it is impractical to measure project savings, a deemed savings approach is generally used. Deemed savings are standard predetermined savings values, for example the quantity of energy saved by SWH or by a CFL);

- Engineering calculations or modelling. For projects that are more complex and require more variables to determine energy savings, such savings can be determined using engineering calculations or, in some cases, by modelling the system in order to understand and quantify complex interactions. Determining energy savings requires a high degree of expertise. The technical consultant performing the audit and/or proposing the energy project should recommend and use the most appropriate method to determine energy savings;

- Energy consumption measurement. This requires the installation of measuring equipment in order to measure energy consumption and then compare it with the baseline situation.

From the point of view of investors and financiers, the most important measure for energy savings is reduced energy expenditure.

3. *How to report?*

The reporting should include the following:

- Analysis methodology used to calculate savings;
- All assumptions and sources of data, including all stipulated values used in calculations;
- Equations and technical details of all calculations made;
- Any baseline or savings adjustments made;
- Energy tariffs used to calculate cost savings;
- Expected annual savings;
- Comparison of specific energy consumptions per unit of production before and after project implementation;
- Comparison of energy bills before and after implementation, including correction factors, for example correction of the quantity of production effect.

II. PREPARING A BUSINESS PLAN

The business plan of the proposed project should always be prepared in accordance with the standard procedures of the partner bank considering the investment. As far as possible, a format should be adopted which clearly sets out the following:

- The project justification;
- The objective and the content of the project;
- The technical solidity and robustness of the proposed project;
- The financial impact of the project and the other expected benefits.

These points outline the detail of the proposal, which must be presented in a form that the financial partners require and can understand. The proposal must aim to help the decision-making process.

A. DESCRIPTION OF THE DEVELOPER/PROJECT SPONSOR/OWNER

This section should provide a clear description of the developer's profile and intrinsic capacity to manage the proposed project, in order to reassure the financial partners, including borrowers and equity providers. If the developer is a company, the description should demonstrate the company's structural financial solidity, its current and future ability to solve problems.

The following aspects should be highlighted:

- The developer's present activity, including the services and products marketed;
- Historical data on the developer's activity development;
- General business strategy and forecast future development of the activity;
- Experience and the skills of the management staff;
- Structure of capital and major shareholders;
- Description of the market and the company's position regarding the competition;
- Financial situation of the developer and associated assets, based on certified financial statements.

B. SUMMARY OF THE BUSINESS PLAN

The business plan should outline the key elements of the proposal, in a maximum of two pages, covering the following:

- The main features of the project;
- How the project meets the developer's needs;
- The cost of the project and its financial scheme;
- The profitability of the project and its likely benefits.

C. PROJECT DESCRIPTION

This document should describe the components of the proposed EE project and the technologies to be used. The developer should explain in detail the baseline situation and how the project would improve the situation in terms of energy savings. Relevant disadvantages and risks should be mentioned, in order to show the credibility of the proposal.

The developer should show that other options, where they exist, have been considered and found to be less relevant to the proposed EE project, whether more expensive, less efficient, more complex or more difficult to implement.

The developer should elucidate the following:

- The implementation planning of the project;
- How the implementation will be carried out and by whom;
- The strategy for the project operation and the means to be provided.

D. Financial and economic analysis

This section provides the crux of the business plan. Based on the financial feasibility study, the developer should outline the key elements as follows:

- Investment costs identified by component and procurement, whether local or imported;
- Financing needs of the project, including the need for working capital;
- Financial scheme, describing the amount of equity and the level of term debts;
- Terms of the debts, including interest rates, payback period and grace period;
- Financial profitability, determined by presenting the main profitability ratios of the EE project, using such measures as NPV, Payback and IRR. Eventually, a benchmark analysis can be done comparing the project to other possible options;
- Other impacts of the project, including job creation and local pollution reduction.

E. Project solvency

This part will focus mainly on the forecast cash flows during the loan period. The objective is to show that these cash flows will remain positive, including the eventual future capital expenditures.

F. Sensitivity analysis

The objective of this part is to show the robustness of the project and its solvency regarding the assumptions used in the financial analysis.

During the evaluation of a project, values will have to be assumed for some of the project's external and internal aspects. These include factors outside management control, for example the cost of fuel or materials; economic factors, for example inflation and market growth; and factors partially within management control, for example current production costs, timing and production rate. Sensitivity analysis involves testing the assumptions used in deriving the cash flow to determine the impact of an assumption that proves to be erroneous. For each area of assumption, there will be a range of plausible values for the parameter concerned. The financial evaluation of the project is not complete until financial parameters have been calculated using the limits of these assumptions.

A crucial parameter in sensitivity analysis is the amount of energy saved, as this will largely determine an EE project's profitability.

G. Mitigation of risks

To prepare EE projects as bankable investments, it is necessary to determine, manage and minimize project risks. Generally, the risks relating to these types of projects can be classified into a number of risk categories that affect the planned investment directly or indirectly. The most important risks are as follows.

1. *Technical risks*

During the development phase of the energy efficiency project, the decrease in facility efficiency regarding devices, equipment and the company as a whole should be defined. This could include, for example, a decrease in boiler efficiency or of insulation. The decrease of technical and energy efficiency is standard and must be taken into account during project design. Specific risks can be identified as follows:

- Construction risk. This depends largely on an investor's technical capacity to undertake the project and the fieldwork, its managerial capacity and the quality of its subcontractors. To address and mitigate this risk, the project developer should have a good organizational plan with clear responsibilities, competencies and precise implementation timing. Selected subcontractors should have experience in their respective fields;

- Technology risk. This can arise when new, innovative technology is used in a situation where it is difficult to make a comparative evaluation to test its efficiency;

- Operation risk. There are many reasons that industrial production capacity can be adversely affected, including partial loading and reduced operating hours of different types of facilities. Operation risk can be minimized by negotiating long-term contracts with specialist companies for the provision of services relating to the operation and repair of equipment;

- Changes in initial parameters and different energy flows. The energy flows might include fuel and compressed air. It is necessary to take into account the company's plans for the future, for example with regard to changes in production.

2. *Commercial risks*

There are two types of commercial risks, as follows:

- Price risk. Operation costs, including raw material costs, influence a project's profitability, as do product sale prices. Expected price development should be analysed, as well as potential suppliers and purchasers. Long-term contracts with regard to delivery and supply are a good way of ensuring a positive cash flow;

- Market risk and competitiveness. Financiers should request to see predicted cash flows, a well-prepared business plan that includes predicted returns, and an analysis of market demand. Declaration of long-term delivery contracts with customers can impact on a profitability analysis and strongly enhance the project's credibility.

3. *Approvals, regulatory and environmental risks*

The risk of not obtaining required regulatory approvals to begin a project should be considered prior to any proposal. For example, some large cogeneration installations could require specific approval from the relevant electricity company to be connected to the grid. Other regulatory risks, such as environmental risk, could affect lenders if the transaction fails.

Many EE projects depend on specific government incentives and support schemes. A risk analysis report must show the impact on forecast cash flow in the event that government incentives are withdrawn or modified, suggesting possible mitigation measures.

III. PROFITABILITY CALCULATION

A. SOME BASIC CONCEPTS

- *Inflation*

Inflation is a sustained increase in the general price level of goods and services in an economy over a period of time. It can be defined as too much money chasing too few goods. When the general price level increases, each unit of currency buys fewer goods and services. Consequently, inflation reflects a reduction in the purchasing power per unit of money, a loss of real value in the medium of exchange and unit of account within the economy.

A chief measure of price inflation is the inflation rate, the annualized percentage change in a general price index, usually the consumer price index, over time.

The inflation in a country can have several sources, the main ones being as follows:

- Demand-pull inflation, increased prices resulting from increased demand but not a large enough increased supply;

- Cost-Push Inflation, increased prices resulting from increased production costs of goods and services due to several factors or combination of factors, including the following:

    - Increases in wages;
    - Increases in prices of imports;
    - Increases in prices of raw materials;
    - Profit-Push Inflation;
    - Decreases in productivity;
    - Increases in taxes;

- Imported inflation, higher costs in the country determined by factors outside the country, which are due to the following:

    - Increases in the price of imports;
    - Devaluation of the local currency;

- Monetary policy;

    - Printing more money;
    - Devaluing the local currency.

For the financial analysis of projects, the inflation rate is generally assumed to be constant over the project life of the period for all goods and service inputs. However, if the energy price increase annual rate is known, this should be applied to the energy price, so that the financial model includes an annual increase rate net from the general inflation rate.

For EE projects (and all types of other projects), the financial analysis is carried out with constant money of the initial year, which means that the analysis does not take into account inflation.[*] This gives clear information on the value of project cash flows over the period.

- *Discounting and discount rate*

[*] Except for energy price, the expected annual increase of tariffs can be applied net from inflation.

Because money is subject to inflation and is able to earn interest, and because investors incur risk when investing, one unit of money today is worth more than the same unit tomorrow. Discounting, then, is the act of determining how much less one unit of money will be worth tomorrow. For example, an investor who invests a sum of money today can discount the value of the expected dividends to determine how much will be received, in today's currency, after a specific period of time.

To compensate for this shortfall and for the element of risk, investors demand remuneration from such future cash flows as a fraction t_{real}, **known as the real discount rate**.

From an investor's point of view, the choice of discount rate is a key variable in the valuation of an EE project's future cash flows and can significantly affect the financial analysis results. The discount rate generally reflects the cost of capital, so the market interest rate will be needed for a comparable term increase and could entail a risk premium.

Hence, the discount rate will depend on the type of investor and the type of country. Is the investor public or private? How wealthy is the investor? What is the country's situation with regard to political stability, for example, or the cost of financial and other resources?

For the capital cost, reference needs to be made to the following:

- The money market rate for short durations;
- The Treasury bonds rate for longer durations.

If we take into account the inflation rate for the discount rate consideration, we define the nominal discount rate t_{nom}. It is calculated as follows:

$$t_{real} = \frac{(t_{nom} - i)}{(1+i)}$$

- *Weighted Average Cost of Capital*

The Weighted Average Cost of Capital (WACC) is the minimum return that a company must earn on an existing asset base in order to satisfy its creditors, owners and other providers of capital before those providers decide to invest elsewhere. Companies raise money from a number of sources, including common equity, preferred stock, straight debt, convertible debt, exchangeable debt, warrants, options, pension liabilities, executive stock options and government subsidies. Different securities, which represent different sources of finance, are expected to generate different returns. The WACC is calculated by taking into account the relative weights of each component of the capital structure. The more complex a company's capital structure, the more laborious it is to calculate the WACC.

Companies can use WACC to see if the investment projects available to them are worth backing.

Where a company is financed entirely through equity and debt, the average cost of capital is calculated as follows:

$$WACC = \frac{D}{D+E} K_d + \frac{E}{D+E} Ke$$

Where D is the total debt, E is the total shareholder equity, K_e is the cost of equity and K_d is the cost of debt.

- *Depreciation of an asset*

Depreciation is a method of spreading the cost of an asset over its useful life. This is needed for both accounting and tax purposes.

For accounting purposes, depreciation indicates how much of an asset's value has been used up. Depreciation is used in accounting to try to match the expense of an asset to the income that the asset helps the company earn.

For tax purposes, businesses can deduct the cost of the tangible assets they purchase as business expenses. However, they must depreciate these assets in accordance with national official reporting standards about how and when the deduction may be taken, based on what the asset is and how long it is projected to last.

- *Cash flows of a an investment project*

Cash flow is the movement of money into or out of a business, project or financial product. The cash-flow in a given business can have three sources, as follows:

- Cash flows from operating activities, money generated by a company's core business activities;
- Cash flows from investing activities, from the buying and selling of assets;
- Cash flows from financing activities, lending and borrowing.

Cash flow of a project = Total revenues – total expenses, using depreciation values

B. Profitability indicators

The profitability of an EE project is based on the calculation of many indicators that can be used in a complementary way. The possible indicators include the following:

- The Net Present Value (NPV);
- The payback period (PB);
- The Internal Rate of Return (IRR);
- The Profitability Index (PI).

1. *Net Present Value (NPV)*

In an economic context, the most relevant rule for investments is to "create value" by maximising the Net Present Value (NPV) resulting from the project's operation. The project's NPV is the sum of discounted cash flows during the observation period minus the initial investment. NPV is calculated as follows:

$$NPV = -I + \sum_{1}^{n} \frac{CF_i}{(1+t)^i}$$

***i*:** The year of the cash flow

t: The discount rate (the rate of return that could be earned on an investment in the financial markets with similar risk) or the opportunity cost of capital

CF_i: The net cash flow, that is cash inflow minus cash outflow, at the year ***i***

I: the initial investment

If annual cash flows are constant, the formula of NPV becomes $NPV = -I + \frac{CF}{Ka}$, where K_a is called *Capital Recovery Factor (CRF)* and is given by the following formula: $Ka(t,n) = CRF = \frac{t.(1+t)^n}{(1+t)^n - 1}$

CRF is the **minimum acceptable fraction** of the investment outlay that needs to be covered yearly by the cash flow of the project. For NPV = 0, $\mathbf{K_a = CF/I}$.

The first rule of EE investment profitability is that it should show **a positive NPV**. The condition "NPV=0" allows us to define the limit of a project's profitability. For a project with constant cash flow, the project is profitable when **(CF/I) >** $\mathbf{K_a}$.

Excel software provides an integrated formula for the calculation of NPV with the following syntax: "=*NPV (discount rate,* Val_1, Val_2, ... Val_n)" where Val_i are the values to be discounted.

- *Example*

Using a discount rate (DR) of 8 per cent, NPV and CRF for two projects with an investment of US$750,000 will generate, over eight years, the following cash flows:

	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Total
Project 1	-100 000	-30 000	200 000	300 000	450 000	300 000	350 000	200 000	1 670 000
Project 2	300 000	250000	150 000	200 000	20 000	-25 000	365 000	184 217	1 444 217

The results are as follows:

	Total CF ($)	NPV ($)	CRF	CF/I
Project 1	1 670 000	318 551	0,174	0,278
Project 2	1 444 217	318 551	0,174	0,241

- The two projects show positive cash flows and CRF less than CF/I. Both projects can be considered profitable;
- Although the two projects have different total cash flows, they have the same NPV. This demonstrates the effect of the difference in the timing of cash flows during the project operation period;
- The effect of the DR on the profitability level of a project is important. For example, using a DR of 6 per cent, Project 1 is more profitable than Project 2. Yet, Project 2 is more profitable than Project 1 when using a DR of 10 per cent, as shown by the following table:

	DR=6%	DR=8%	DR=10%
Project 1	440 519	318 551	211 128
Project 2	395 527	318 551	250 187

2. *Payback period*

The payback period (PB) is the number of years it will take for a positive annual cash flow generated by an EE project to cover the initial investment made. Two options are used to calculate PB. These are Simple PB (SPB) and Discounted PB (DPB).

- *The simple payback period*

The measure of SPB is defined as the ratio between the initial investment and the average annual cash flow expressed in constant value and **not discounted**. A project is profitable when NPV is positive, so SPB is lower than $1/k_a$ (k_a is also CRF) for a discount rate t and an observation period of the economic analysis n.

Some conventions are commonly used to assess whether or not an EE project is profitable for the investor. Example include the following:

- For EE projects in industry, SPB should be less than between 3 and 5 years;
- For EE projects in the building sector, SPB should be less than between 7 and 10 years.

The measure of SPB can give a broad idea about project profitability but does not take into account the discount rate. This can yield misleading information for investors.

- *Discounted payback period*

To counter the limitation of SPB as an indicator, an alternative indicator called DPB can be used. This takes into account the time value of money by discounting the project's cash flows. The measure of DPB is the number of years which, when involved in calculating Ka, makes NPV equal zero.

The measure of DPB, therefore, is always higher than SPB. The project is profitable when DPB is less than the duration of the economic observation.

- *Example*

Calculations of SPB and DPB for the two projects presented in Section 4.2.1, using DR of 6 per cent, 8 per cent and 10 per cent. The results are as follows:

	SPB	$1/K_a$			DPB		
		DR= 6%	DR= 8%	DR= 10%	DR= 6%	DR= 8%	DR= 10%
Project 1	3,59	6,21	5,75	5,33	5,04	5,62	6,24
Project 2	4,15	6,21	5,75	5,33	5,24	5,62	6,00

- Based on SPB, the two projects are profitable. Each project has a SPB of less than 1/ka, using the three DR. Project 1is more profitable than Project 2 because Project 1 has a lower SPB;

- Based on DPB, the two projects are also profitable, since their DPB are less than the project operation period of eight years. However, using a DR of 6 per cent, Project 1 is more profitable than Project 2. When using a DR of 10 per cent, Project 2 is more profitable than Project 1.

3. *Internal Rate of Return (IRR)*

The Internal Rate of Return (IRR) is the discount rate that makes NPV equal zero. The IRR can be seen from the point of view of the **project as a whole** or from the point of view of **the investor**.

- *From the point of view of the project*

In this case, IRR is calculated using all project cash flows and all investment amounts when calculating NPV.

From the definition of IRR, the profitability on an investment project leads to the following rule: **The project is profitable if its IRR is higher than its WACC**. If IRR is not higher than WACC, the project will generate a negative NPV, in which case the investor would be better off not investing in the project.

The measure IRR is useful to investors because it gives an indication of potential returns from a project by comparing them to the returns that would be obtained by placing the funds corresponding to the initial investment *I* during the project period (*n* years) at a rate of interest equal to the WACC.

- *From the point of view of investors*

In this case, the project is seen from the point of view of investors, the equity shareholders. The measure of Investor IRR is calculated by the same formula as above, but tweaking it as follows to use:

The **equities** amount, instead of the total investment of the project.

The net cash flows of the project **after the reimbursement of the principal** of the debt, instead of the whole cash flows.

This indicator is the main one that investors use when deciding whether or not to invest in a project. From the point of view of equity shareholders, a project is profitable if their invested equity IRR **is higher than the cost of the equities.**

- *Example*

The IRR for the project and for the investor with regard to the two projects presented in section 4.2.1 can be calculated using the following variables with suggested values for the examples given, as follows:

Equities share	40%
Debt share	60%
Loan duration	7 years
Grace period	1 year
Interest rate	15%
Equity cost	22%

The results are as follows:

	IRR project	IRR investor	WACC	Equity cost
Project 1	15%	25%	13%	22%
Project 2	20%	60%	13%	22%

- The two projects can be internally considered as profitable, since IRR is higher than WACC. They are also profitable from the point of view of equities shareholders, since investor IRR is higher than equity cost;

- The situation changes if we modify some parameters, for example the share of equities, the loan condition or the equities' cost. For instance, if the loan interest rate increases to 15 per cent, Project 1 is no longer profitable, since IRR is less than WACC, shown as follows:

	IRR project	IRR investor	WACC	Equity cost
Project 1	**15%**	25%	**18%**	22%
Project 2	20%	60%	**18%**	22%

4. *Profitability index*

However, NPV alone does not give an idea of the size of earned cash flows by investor (present value of cash flows) compared to initial investment. A Profitability Index can be used to provide a better indication.

Profitability index (PI), also known as profit investment ratio (PIR) and value investment ratio (VIR), is the ratio of payoff to investment. It is a useful tool for ranking projects because it allows the amount of value created per unit of investment to be quantified.

The ratio is calculated as follows:

$PI = \frac{PV}{I}$, where PI is Profitability Index, I is the initial investment and PV is the discounted sum of cash flows.

Assuming that the cash flow calculated does not include the investment made in the project, a profitability index of 1 indicates breakeven point. Any value lower than 1 would indicate that the project's PV is less than the initial investment. As the value of the PI increases, so does the financial attractiveness of the proposed project. Hence, the rule for selection or rejection of a project can be stated as follows:

- If PI > 1 then accept the project;
- If PI < 1 then reject the project.

C. CONDITIONS FOR PROFITABILITY

The relative merits of using NPV, IRR, PB and PI methods to evaluate a project are discussed often, because the results of the evaluation will sometimes differ depending on adopted indicator used. For the financial analysis of the investments in EE projects, it would be recommended to check all indicators that have an impact on one another, according to the following steps:

1. NPV > 0.
2. SPB < 1/Ka(t,n).
3. DPB < n (economic observation period).
4. IRR > WACC.
5. Profitability Index > 1.

The financial ratios and indicators described above are designed to help owners/developers when selecting a project.

The banks financing the project will look at a number of ratios describing the project and the project owner's business, including the following:

- Gross Profit Margin;
- Net Profit Margin;
- Return on Equity;
- Current Ratio;
- Acid Test (Quick Ratio);
- Gearing;
- Cash Flow to Debt Service Ratio.

For more details, see chapter 7.

IV. ENVIRONMENTAL AND OTHER BENEFITS EVALUATION

In addition to financial profitability for the investor, EE projects should be evaluated according to other positive impacts, including the following:

- Primary energy saving and its impact on the energy independence of the country;
- Socioeconomic impacts in terms of national energy bill reduction, energy subsidy saving and job creation;
- Environmental impact, mainly in terms of CO_2 emission mitigation.

A. ENERGY SAVING

- *Final energy saving*

To evaluate final energy saving, the developer should first calculate the energy consumption of the baseline, the energy consumption expected without implementing the proposed EE project. Baseline consumption should be estimated by analysing historical data to forecast consumption over the project operation period. Baseline consumption must be calculated for each energy product, including the following:

- Electricity (in kWh);
- Natural gas (in toe);
- Fuel oil (in toe);
- Gasoil (in toe).

The developer should then estimate final consumption for the same products if the project were to go ahead. Many methods can be used to estimate energy consumption after project implementation, depending on the type of project being considered. Methods include the following:

- Deemed method. For simple measures, such standard predetermined consumptions as CFL can be used;
- Modelling. For more complex projects with more variables that determine energy consumption, engineering calculations or modelling can be used. This is the case, for example, in thermal retrofitting of a complex building.

The energy saving is then calculated, for each energy product, as follows:

Final energy savings = baseline energy consumption – Project energy consumption

- *The primary energy saving*

Primary energy saving from the project is calculated as follows:

$PE = E.Sc + \sum F_i$, where PE is the primary energy saving, E is the electricity saving in kWh, S_c is the specific consumption of the electricity sector including the grid losses, F_i is the energy saving of the fuel i.

B. SOCIOECONOMIC IMPACTS

1. *Energy bill reduction for the country*

The energy bill reduction is an indicator from the point of view of the country, an estimate of the monetary value of the energy saving in national terms. It is calculated by multiplying the energy savings by the international prices of the consumed primary fuels, including those used for electricity generation. The formula is as follows:

$B = \sum F_i . P_i$, where B is energy bill saving, F_i is the energy saving of the primary fuel (including fuels for electricity generation), Pi is the international price of the fuel i.

To estimate future international fuel prices, the developer can use scenarios offered by such international institutions as the International Atomic Energy Agency, the Organization for Economic Cooperation and Development and the European Union.

2. *Energy bill reduction for the individual enterprise*

The energy bill reduction for the individual enterprise or project is the monetary saving from reduced energy consumption. The savings are determined by comparing the energy bills before and after project implementation. Frequently, the implementation of new or improved technology involves technology that is more productive as well as more energy efficient. In such cases, the measure of the saving should be calculated on the basis of specific energy consumption reduction per unit of production.

In any case, the implementation of EE measures and technologies should lead to improved overall financial performance of the enterprise, reducing the energy use per unit of production and increasing competitiveness.

3. *Energy subsidy saving*

The energy subsidy saving is an indicator from the point of view of the country. It is calculated by multiplying the energy savings by the government's public subsidy for each final energy product, including final electricity. The calculation formula is as follows:

$S = \sum E_i . S_i$, where S is energy subsidy saving, E_i is the final energy saving of each product, including final electricity, Si is the public subsidy for the energy product i.

As the level of future subsidy depends on government policies and is usually unknown, S_i are those of the base year, the initial year of project operation.

4. *Job creation*

Jobs created by EE projects fall into two types: temporary and permanent.

- The temporary jobs are those created during the construction of the project. They include experts, planners and construction workers. The jobs are expressed in terms of man-months;

- The permanent jobs are those required for the operation and maintenance of the project. The jobs are expressed in terms of persons.

The estimation methods of job creation depend largely on the size and type of the project. They should be discussed in the technical feasibility study.

C. CO_2 EMISSION MITIGATION

The amount of reduced CO_2 emissions during a given period is defined as the product between the amount of energy saved during the period and the emission factor, defined in $TeCO_2$ per toe, depending on the type of energy product saved in the respective country.

For reasons of simplification and of consistency with other countries, this calculation emission reduction is made on the basis of the default emission factor provided by the Intergovernmental Panel on Climate Change (IPCC). Please see annex II.

Hence, for a given year, the reduction of CO_2 emission is calculated by the following formula:

$E = \sum F_i.EF_i$, where E is the CO_2 emission reduction from the project ($TeCO_2$), F_i is the energy saving of the primary fuel, expressed in toe (including fuels for electricity generation), EF_i is the emission factor of the fuel i, according to the default values of IPCC.

D. OTHER CO-BENEFITS

EE projects could have other co-benefits, depending on the nature of the projects and on the type of businesses in which they are implemented. However, these co-benefits are usually difficult to evaluate and to quantify.

In certain contexts, implementing EE projects can lead to improved product standards and reduced raw material losses by providing a better quality of energy through, for example increased stability and/or reduced heat loss.

By reducing production cost, EE projects can also make companies more competitive and, as a result, increase their market share. This is particularly true for such energy-intensive industries as cement, paper, steel and bricks, where the energy share of production cost is high and expected to increase.

Insulating buildings can have various beneficial social and environment impacts. It improves household comfort and the health of the inhabitants in both winter and summer by regulating inside temperature and reducing moisture. For the environment, building insulation can be considered not only as a greenhouse gas (GHG) mitigation measure, but also as an adaptation activity that will increase the population’s resilience to global warming.

EE measures reduce household energy expenses and help alleviate poverty, especially at the lower end of the socioeconomic spectrum.

In addition to GHG mitigation, EE projects reduce air pollution, significantly improving human health.

When implemented in a company, EE projects can help develop a new corporate culture of social and environmental responsibility, helping fight climate change and conserve natural resources.

V. FINANCING PLAN

A. Financial instruments for energy efficiency projects

Several financial instruments can be used to finance EE projects, depending on project size, complexity, level of profitability, level of risk and type of technology implemented. Projects sometimes can be combined to optimize resources, reduce risk and/or match a developer's investment capacity.

This section deals with the nature of financial instruments used to address specific gaps in financing for energy efficiency. The instruments include debt, equity, subordinated debt, and others types.

1. *Equity financing*

Equity financing refers to the acquisition of funds by issuing *shares* of common or preferred stock in anticipation of income from dividends and capital gain as the value of stock rises.

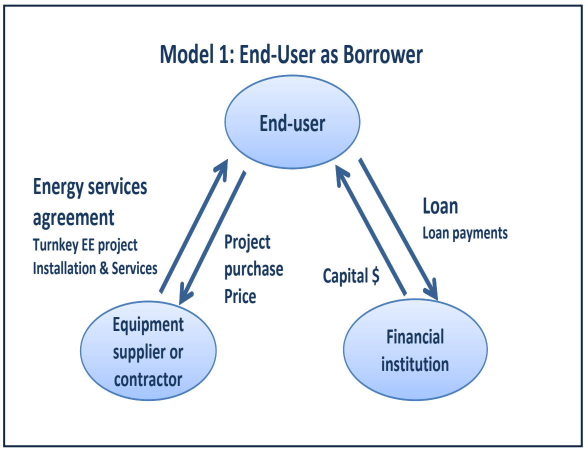
Equity financing can also come from professional venture capitalists. Venture capital (VC) is a specific sub-segment of private equity investment. It entails investing in start-up companies with strong growth potential. VC investors obtain equity shares in the companies that provide EE goods or services and generally play a significant role in the management and technical aspects of the company.

Private equity is essential for businesses wanting to expand their activities, as well as for large-scale project developers. Several public agencies and funds have developed finance mechanisms that provide equity investment opportunities for sustainable energy businesses and projects, often leveraging large amounts of investment from other private financing sources.

Depending on the viability and solvency of the project, and the solidity of the developer, banks tend to require the developer to provide capital or equity of between 10 per cent and 40 per cent of total investment cost. The most common minimum share required is 30 per cent.

2. *Bank debt*

The most common EE financing sources that complement equities are *loans* provided by banks to the project developer. A loan is an agreement to lend a principal sum for a fixed period of time, to be repaid by a certain date and with an interest calculated as a percentage of the principal sum per year and other transaction costs. The accompanying figure summarizes the organization of this type of financing.



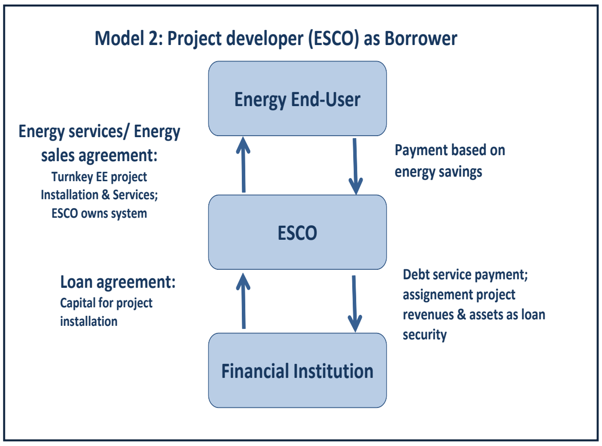
3. *Third party financing*

For EE projects, there is an additional financial model. Third party financing involves funds provided partly or totally by an Energy Service Company (ESCO), which invests partly or totally in the EE project and then shares the energy bill savings with the project owner. The ESCO, therefore, is closely involved in ensuring and guaranteeing EE performance.

When the end-user is the borrower, end-user credit risks are separated from project performance and technical risks. The Financial Institution (FI) assumes the end-user credit risk, while the responsibility for technical and performance matters is shared between the ESCO and the end-user. The loan is on the balance sheet of the end-user. Loan financing can be combined with savings guarantees from the contractor.

When the ESCO borrows, it effectively packages together financing with turnkey project implementation and a services agreement. In this case, the financier must evaluate not only end-user credit risk, but also project economics, project engineering and technical performance, ESCO financials and equity contribution, ESCO management and performance track record, and all project contracts including the Energy Services Agreement. The loan is on the balance sheet of the ESCO and the ESCO is exposed to the end-user credit risk.

The accompanying figure summarizes the contractual relationship when the ESCO is the borrower.



4. *Leasing*

Leasing is a common way of dealing with the initial cost barrier. Leasing is a way of obtaining the **right to use an asset**, rather than owning the asset. In many markets, finance leasing can be used for EE equipment, even when the equipment lacks collateral value. Leasing companies, often bank subsidiaries, have experience with vendor finance programmes and other forms of equipment finance that are analogous to EE.

From the lessee's standpoint, there are essentially two main types of leases: capital lease and operating lease. A lessee is required under a *capital lease* to show the leased equipment as an asset. The present value of lease payments is shown as a debt on its balance sheet. *Operating leases* are not capitalized on a company's balance sheet. Lease payments are treated as an expense for accounting purposes. The contract period is less than the life of the equipment. The lessor pays all maintenance and servicing costs.

Leasing is the most common form of vendor financing by equipment manufacturers. It is often applied in the case of cogeneration equipment.

5. *Mezzanine financing*
(*subordinated debt finance*)

Mezzanine financing, sometimes called subordinated debt financing, is capital that sits midway in repayment priority between senior debt and equity, and has features of both kinds of financing. Subordination refers to the order or priority of repayments. Subordinated debt is structured so that it is repaid from project revenues after all operating costs and senior debt service has been paid. There are much fewer sources of subordinated debt than there are of senior debt or equity, so mezzanine financing is often regarded as specialty financing.

Subordinated debt financing is generally made available directly from **insurance companies, subordinated debt funds, or finance companies**. These funds are loaned on the basis that the project's amount and predictability of cash flow exceeds that required to service senior debt.

Subordinated debt funds can be undertaken in partnership with senior lenders. Alternatively, a subordinated credit facility can be provided to the CFI, which acts as senior lender. The senior lender then on-lends to the project, blending the subordinated debt with the senior debt provided from the developer's own resources. The borrower sees one single loan, but the senior lender applies loan payments to repay the senior debt component on a priority basis.

For sustainable energy project developers, subordinated debt financing is cheaper than what would be available on the equity market. Also, it usually does not involve sacrificing any control of the company and can allow companies to raise sufficient capital to meet the debt-equity requirements of senior lenders.

Subordinated debt is considered as a complementary or alternative solution to portfolio guarantees. It can substitute or reduce the amount of senior debt. This can improve the loan-to-value ratio and the debt service coverage ratio for the senior lender, thereby reducing risk and strengthening the project's financial structure from the senior lender's point of view.

Subordinated debt instruments have proved to be most successful when operating in mid- to well-developed capital markets where equity and debt instruments are well established. Given that subordinated debt finance can be regarded as a hybrid of debt and equity, it can improve a company's credit rating and put it in a better position to acquire further debt and equity investment. Because of the high return requirements, mezzanine finance instruments are used mainly in the case of companies with stable cash flows and high growth expectations.

6. *Project financing*

Unlike conventional debt financing, which relies on an individual company's creditworthiness, project financing relies only on a project's cash flow expectations. It spreads the risk among the different actors. As already indicated, third party financing can be sought by an end-user engaging in financing the project directly, or by an ESCO or similar entity that executes the project. Projects initiated by ESCOs are largely project-financed and off the balance sheet of the company. Project finance is often based upon a complex financial structure in which project debt and equity, rather than the balance sheets of project sponsors, are used to finance a project.

Usually, a project financing structure involves a number of equity investors, as well as a syndicate of banks providing loans. The loans are most commonly non-recourse loans and are secured by project assets. They are paid entirely from project cash flow, rather than from the general assets or creditworthiness of the project sponsors, a decision in part supported by financial modelling.

The ratio of debt to equity is much higher in project finance than in corporate finance. As indicated earlier, a project with 70-80 per cent debt and 20-30 per cent equity is common in project financing.

The limitations and success factors involved in project financing can be summarized as follows:

- Because a typical project finance structure includes contracts between the different actors that transfer risk and allow adequate risk coverage and division, project financing is associated with large transaction costs and intricacies that imply a high threshold investment price, typically above €10 million;

- EE finance marketing will prosper where lenders can make credit decisions on the basis of free cash flow and ability to pay, while including a prudent portion, for example 70 per cent, of estimated energy cost savings;

- Off-balance sheet financing is attractive from a risk-management point of view. When assets and liabilities are moved from one balance sheet to another, the risks associated with those assets and liabilities go with them. Off-balance sheet financing also allows more flexibility.

7. *Vendor financing*
(*equipment supplier/vendor credit*)

Many general equipment manufacturers offer either captive or third party vendor financing relationships in order to increase sales. Vendor financing helps manufacturers sell their products by helping finance customer purchases. Vendor financing occurs when financiers provide vendors with capital to enable point-of-sale financing for their equipment. Leasing is the most common form of vendor financing.

There are two types of arrangements under a vendor-financing scheme: one between the vendor and the financier, the other between the vendor and the customer. The former defines the terms that can be offered to the customer, including rates, length of term and necessary documentation. The vendor/customer agreement defines the repayment terms of the loan. For EE equipment, these agreements can be structured so that customer payments are lower than the value of energy savings associated with the new equipment.

If vendor financing is done by a third party, that party has most likely done the work necessary to become comfortable with the technical aspects of the product as well as its collateral value.

B. CONTRIBUTION CONDITIONS OF FINANCING INSTRUMENTS

The contribution conditions of different types of financing instruments are summarized in the accompanying table.

Financing instrument	When is it appropriate?	What is the range of contribution?	Comments
Equity financing	After the project owner has shown faith in the project and taken the first risk.	Usually 10-40 per cent of investment cost, depending on the developer and the project's nature, size and risk level.	Equity can be provided by the developer and by other shareholders, which could include individuals, companies, investment and venture capital funds.
Bank debt	As a complementary source to equities, recommended especially for capital-intensive projects and when the project developer wants to leverage its investment and share the project risk with banks.	Usually 60-90 per cent, depending on the level of confidence the bankers have in the project and project owner.	For capital-intensive projects, banks usually want to leverage their capital and share the risk with other financial institutions and so will ask the project holder to create a pool of lenders.
Third party financing	When the EE project is technically complex, and the project developer does not have the technical or managerial capability to implement and operate the project. The investment is covered partly or totally by an Energy Service Company (ESCO), which will share the energy bill savings and help ensure EE performance.	Depending on the project and the agreement between the ESCO and the project holder, the ESCO can provide partial or total investment financing. The ESCO contribution can be also 0 per cent, in which case its role will be limited to the guarantee of energy saving quantities.	Third party investment through ESCOs requires the implementation of a transparent and comprehensive system of Measurement, Reporting and Verification) (MRV) of energy savings.
Leasing	Recommended when the investment comprises identified equipment that can be rented to the project holder and can have a value when recovered by the lessor should the lessee default on payment.	Can be 100 per cent of the overall cost of the leased asset, but leasing companies usually require a contribution from the project holder not greater than 20 per cent.	The financing tends to be high, because no extra guarantees are required.
Mezzanine financing	Usually used for capital-intensive projects and for projects in which the project holder did not want or get enough equities to meet the required debt-to-equity (D/E) ratio. Some insurance and financing companies can provide second lien loans.	Subordinating debts rarely exceed 20-30 per cent of total financing.	Subordinating debts are reimbursed after senior debts. They are less expensive than equity but more expensive than senior debt.
Project financing	Recommended for large investment projects where risk needs to be spread among many contributors.	Usually, 70-80 per cent comes from debts provided by a syndicate of banks, and the	Project financing instruments involve high set-up costs and so are

Financing instrument	When is it appropriate?	What is the range of contribution?	Comments
		rest from a pool of equities holders.	not appropriate to fund small projects.
Vendor financing	A type of leasing where the lessor is the equipment supplier.	Supplier usually covers 100 per cent of equipment cost.	The financing cost tends to be high and the payment period is usually short, under three years.

C. Disbursement and repayment plan

In a given project, the equity usually is the first part of financing to be disbursed, proving the commitment of the project holder and reassuring the other sources of finance. A bank will ask the project holder to vest the equity in a non-accessible bank account, from which suppliers' invoices are paid after bank authorization.

Once equities have been disbursed, the bank disburses the loans on the basis of verified invoices from suppliers. Banks usually have guideline prices and can refuse an invoice if they consider that the cost is much higher than expected.

Loan reimbursement is based usually on regular installments each month, trimester, semester or year, depending on the loan agreement. The repayment period also is negotiated in the loan agreement and can change according to national banking regulations, investment cost and the lifetime of the project. For EE projects, the loan duration usually ranges from three to 10 years, sometimes with a grace period of up to two years. During the grace period, the borrower pays only the interest on the loan, but it is possible to "capitalize" the accumulated interest during this period by adding it to the loan principal.

Lenders should assess the project business plan to calculate if the activity generated during the loan period is likely to provide enough cash flow to enable credit repayment. For each year, the cumulative cash flow must be higher than the annual principal and interest repayment amount of the loan. The required minimum Debt Service Coverage Ratio is above 1.3 in most cases. If, for any year, this condition is not satisfied, the borrower must show that loan repayments can be made from resources external to the project.

VI. CRITERIA AND REQUIREMENTS OF FINANCIAL INSTITUTIONS

A. PROJECT DOCUMENTATION REQUIRED BY FINANCIAL INSTITUTIONS

A loan applicant must develop a project presentation package for potential financiers regardless of the loan application format. A standard package includes the documentation listed as follows:

- *Letter of Application*

  This is a letter from the applicant to the bank.

- *Financial Information on the Applicant*

  This information should include the following:

  - Audited financial statements for the past three years, if available;

  - Tax returns for the past three years;

  - Articles of incorporation and corporate resolution, if a private company;

  - Financial Analysis Report that indicates the financial health of the applicant: current assets/current liabilities; long-term debt ratio (total long-term debt/(total long-term debt + shareholders' equity); debt to equity ratio (total liabilities/(total liabilities + shareholder debt)); debt service coverage ratio (the ability to service debt, defined as annual cash flow before interest and taxes divided by the interest and principal payment; and total debt ratio (annual cash flow before interest and taxes divided by the total loan);

  - Information relating to creditworthiness, including assets for collateral and any credit guarantees.

- *Project documents*

  The main documents that must be provided are as follows:

  - Business plan, including financial model;
  - Technical feasibility study;
  - Financial feasibility study;
  - Environmental and social impact study, if required;
  - Any other relevant documents for the project, including legal authorization or partnership agreements.

B. WHAT DO FINANCIAL INSTITUTION WANT TO EXAMINE? CREDITWORTHINESS APPRAISAL

A financial institution aims to minimize its risk regarding loans to a developer. Therefore, when assessing a proposed EE project, the institution will examine a number of criteria in order to decide whether or not the project is worth financing from the lender's point of view.

- *Analysis process*

Credit analysis is the process of evaluating an applicant's loan request or a company's debt issue to assess the likelihood that borrowers will meet their obligations. Credit analysts, therefore, examine the financial history of individuals or companies to determine their creditworthiness. A key element is predicting the likelihood that an individual or company will face financial distress.

Accurately evaluating the borrower is the most important part of a financial institution's appraisal of an EE project. No matter how strong an investment project might be from a technical and financial point of view, lenders will want to check the potential borrower's overall creditworthiness. Profitability estimates and cash flow projections will be analysed not just for the specific EE project but for the company as a whole.

Evaluating an EE investment project requires a detailed analysis process that includes the following:

- Promoter Creditworthiness Appraisal, that is Credit Analysis;
- Technical Appraisal;
- Financial Appraisal;
- Environmental Appraisal;
- Legal Appraisal.

For the technical, environmental and legal appraisals, lenders rely on expert opinions conveyed in technical studies and due diligence files. Banks sometimes have relevant internal expertise but usually ask external consultants to review the documents presented by the borrower and answer questions that might include the following:

- Are the projected energy savings realistic? Is the basis of calculation appropriate?

- Which technology will be used for the project? Is this a proven technology or an innovative and, therefore, more risky one?

- Are there any drawbacks, for example an adverse impact on production or production schedules, during the project's implementation phase?

- Are pollution levels likely to decrease or increase after project implementation? Are there any environmental permissions or measures required?

- Prior to loan disbursement, legal due diligence is needed to ensure that all licenses, permits and clearances have been obtained and that the loan agreement and security package accords with the bank's standard lending procedures.

- *Components of the credit analysis*

A creditworthiness appraisal requires a detailed analysis of the borrowers' financial position and debt-servicing ability, a thorough understanding of the borrower's background, the purpose of the loan and an evaluation of the collateral pledged. The basic components of credit analysis, the **Five Cs**, comprise the following:

- **Capacity** refers to the developer's ability (from a technical, financial and managerial point of view) to run the business and repay the loan. Capacity to repay is the most critical of the five factors. The prospective lender will want to know exactly how the borrower intends to repay the loan. The lender will consider business cash flow, timing of repayment, and probability of from the business, the timing of the repayment, and the probability of total repayment. Payment history regarding previous credit relationships is considered an indicator of future payment performance. Prospective lenders will also want to know about contingent sources of repayment;

- **Capital** refers to the long-term sustainability of the company and of its sources of finance. Capital also refers to the developer's own money invested in the business and indicates how much the developer has at risk should the business fail. Prospective lenders and investors will expect developers to have contributed from their own assets and to have undertaken personal financial risk before asking for outside funding;

- **Collateral** involves additional security for lenders in case the expected means of repayment fails, as a result of cash flow being lower than expected, for example. Giving a lender collateral means that the developer offers an asset, which might be a mortgage on real estate or a pledge on equipment, to the lender with the agreement that proceeds from capital can be used to repay a loan in the event that cash flow cannot. Some lenders require guarantees in addition to collateral as security. A guarantee is a legal document in which a third party promises to repay the loan should the developer default;

- **Conditions** focus on the intended purpose of the loan, for example working capital, additional equipment or inventory, and concomitantly on the market and how the company performs in the market. The lender will also consider the local economic climate and conditions both within the applicant's industry and in other industries that could affect the applicant's business;

- **Character:** The lender will review the integrity of the business and its management and form an opinion as to whether or not the company is sufficiently trustworthy to repay the loan or generate a return on funds invested. In the case of a large company, the reputation and business experience of the shareholders and managers will be considered. For a small business, the quality of references and the staff will be taken into account.

C. WHAT FINANCIAL INSTITUTIONS DO NOT LIKE: EARLY WARNING SIGNS OF FINANCIAL DISTRESS

Bankers will not only analyse the information provided in a company's business plan but also investigate the industry and try to obtain references about the company from its business partners and from fellow lenders. Bankers will check the national databases related to borrowers' debt levels and repayment history, general transactional behaviour and existing liens on business assets.

Examiners of the loan application will carefully review a company's financial statements and their dynamics over time to look for any indicators of poor or deteriorating creditworthiness. Applicants should be prepared to provide comprehensive explanations and documented answers to questions. The types of indicators that bankers will regard as "red flags" that could highlight an imminent problem include the following:

- *Debt*

  - Material increase in long-term debt that causes dependence on cash flow and longer-term operating performance to support repayment of long-term debt;

  - Irregular debt payments, unusual or too frequent extensions of terms of payment, credit renewal with little or no principal reduction, renewal with capitalized interests, and credits with high interest rate compared to market rate.

- *Balance sheet and income statements*

  - Longer collection period. This symptom indicates that borrowers intend to extend debt repayment and soften collection practices, which could lead to cash flow problems;

  - Increases in inventory levels or lower turnover ratios. Increases in inventory can increase risk if turnover ratios are declining. Increases in inventory levels could also result from reluctance to liquidate excessive or obsolete goods at a reduced price, as most businesses are willing to sacrifice liquidity to maintain profit margins. Such situations could eventually lead to cash flow problems;

  - Decreasing inventory turnover. This could indicate overbuying or an imbalanced purchasing policy. Decreasing inventory turnover often arises from a decline in sales. If the inventory is undervalued, the inventory turnover will be even slower, that is longer, than the calculations show.

- *Cash*

  - Existence of heavy liens on assets. Holding a second or third lien on assets is a sign of greater than normal risk. It could indicate that a business is over-leveraged and unable to withstand pressures from an economic downturn for too long;

  - Concentration of non-current assets other than fixed assets. Borrowing companies might use funds to invest in affiliates or subsidiaries. For this type of lending, financial institutions should have adequate information, conduct a credit analysis and structure the funds as a direct loan. Lending to subsidiaries should have collateral in addition to a guarantee from the parent company;

  - High level of intangible assets in the balance sheet, for example goodwill. The value of such assets is uncertain and could shrink more quickly than tangible assets. However, some intangible assets, for example patents and trademarks, do have a high value and should be included in a credit-risk analysis;

  - Significant difference between gross and net sales. Such difference indicates the level of product returns and reserves. Lower product quality and customer dissatisfaction could be leading to slower sales, which could decrease a company's profitability;

  - Increasing percentage of cost. This could indicates the inability or unwillingness of a company to pass higher costs to customers or a more general inability to control cost;

  - Rising level of total assets compared to sales. When a company expands its business, there is a need for more current assets in the form of inventory, receivables and fixed assets. Loan examiners should pay attention when a company's asset growth is higher than sales growth, as this situation could lead to a decline in efficiency;

  - Declining trend in sales and profits, rapidly increasing expenses, dividend payments inappropriate to operating performance, increasing level of debt to net worth, and an increase in operation net worth solely from the evaluation of fixed assets.

- *Flow documentation*

Negative cash flow, cash flow projections that indicate inadequacy in principal and interest payments, and statements reflecting cash flow from sale of fixed assets, special items that are nonrecurring business situations, and lack of cash flow statements or projections.

<u>Annex I</u>

DEFAULT EMISSION FACTORS FOR ENERGY COMBUSTION BASED ON IPCC RECOMMENDATIONS

The tables below provide the IPCC recommended values as follows:

- Net Calorific Values (NCVs) for various types of fuels (Section 8.1.1).
- Default emission factors for stationary combustion (Section 8.1.2).
- Default emission factors for mobile combustion (Section 8.1.3).

DEFAULT NET CALORIFIC VALUES PER FUEL TYPE[1]

TABLE 1.1 DEFINITIONS OF FUEL TYPES USED IN THE 2006 IPCC GUIDELINES

English Description		Comments
LIQUID (Crude oil and petroleum products)		
Crude Oil		Crude oil is a mineral oil consisting of a mixture of hydrocarbons of natural origin, being yellow to black in colour, of variable density and viscosity. It also includes lease condensate (separator liquids) which are recovered from gaseous hydrocarbons in lease separation facilities.
Orimulsion		A tar-like substance that occurs naturally in Venezuela. It can be burned directly or refined into light petroleum products.
Natural Gas Liquids (NGLs)		NGLs are the liquid or liquefied hydrocarbons produced in the manufacture, purification and stabilisation of natural gas. These are those portions of natural gas which are recovered as liquids in separators, field facilities, or gas processing plants. NGLs include but are not limited to ethane, propane, butane, pentane, natural gasoline and condensate. They may also include small quantities of non-hydrocarbons.
Gasoline	Motor Gasoline	This is light hydrocarbon oil for use in internal combustion engines such as motor vehicles, excluding aircraft. Motor gasoline is distilled between 35°C and 215°C and is used as a fuel for land based spark ignition engines. Motor gasoline may include additives, oxygenates and octane enhancers, including lead compounds such as TEL (Tetraethyl lead) and TML (Tetramethyl lead).
	Aviation Gasoline	Aviation gasoline is motor spirit prepared especially for aviation piston engines, with an octane number suited to the engine, a freezing point of -60°C, and a distillation range usually within the limits of 30°C and 180°C.
	Jet Gasoline	This includes all light hydrocarbon oils for use in aviation turbine power units. They distil between 100°C and 250°C. It is obtained by blending kerosenes and gasoline or naphthas in such a way that the aromatic content does not exceed 25 percent in volume, and the vapour pressure is between 13.7 kPa and 20.6 kPa. Additives can be included to improve fuel stability and combustibility.
Jet Kerosene		This is medium distillate used for aviation turbine power units. It has the same distillation characteristics and flash point as kerosene (between 150°C and 300°C but not generally above 250°C). In addition, it has particular specifications (such as freezing point) which are established by the International Air Transport Association (IATA).
Other Kerosene		Kerosene comprises refined petroleum distillate intermediate in volatility between gasoline and gas/diesel oil. It is a medium oil distilling between 150°C and 300°C.
Shale Oil		A mineral oil extracted from oil shale.
Gas/Diesel Oil		Gas/diesel oil includes heavy gas oils. Gas oils are obtained from the lowest fraction from atmospheric distillation of crude oil, while heavy gas oils are obtained by vacuum redistillation of the residual from atmospheric distillation. Gas/diesel oil distils between 180°C and 380°C. Several grades are available depending on uses: diesel oil for diesel compression ignition (cars, trucks, marine, etc.), light heating oil for industrial and commercial uses, and other gas oil including heavy gas oils which distil between 380°C and 540°C and are used as petrochemical feedstocks.
Residual Fuel Oil		This heading defines oils that make up the distillation residue. It comprises all residual fuel oils, including those obtained by blending. Its kinematic viscosity is above 0.1cm^2 (10 cSt) at 80°C. The flash point is always above 50°C and the density is always more than 0.90 kg/l.
Liquefied Petroleum Gases		These are the light hydrocarbons fraction of the paraffin series, derived from refinery processes, crude oil stabilisation plants and natural gas processing plants comprising propane (C3H8) and butane (C4H10) or a combination of the two. They are normally liquefied under pressure for transportation and storage.

[1] Default Net Calorific values extracted from http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/2_Volume2/V2_1_Ch1_Introduction.pdf.

TABLE 1.1 (*continued*)

English Description		Comments
LIQUID (Crude oil and petroleum products)		
Ethane		Ethane is a naturally gaseous straight-chain hydrocarbon (C2H6). It is a colourless paraffinic gas which is extracted from natural gas and refinery gas streams.
Naphtha		Naphtha is a feedstock destined either for the petrochemical industry (e.g. ethylene manufacture or aromatics production) or for gasoline production by reforming or isomerisation within the refinery. Naphtha comprises material in the 30°C and 210°C distillation range or part of this range.
Bitumen		Solid, semi-solid or viscous hydrocarbon with a colloidal structure, being brown to black in colour, obtained as a residue in the distillation of crude oil, vacuum distillation of oil residues from atmospheric distillation. Bitumen is often referred to as asphalt and is primarily used for surfacing of roads and for roofing material. This category includes fluidised and cut back bitumen.
Lubricants		Lubricants are hydrocarbons produced from distillate or residue; they are mainly used to reduce friction between bearing surfaces. This category includes all finished grades of lubricating oil, from spindle oil to cylinder oil, and those used in greases, including motor oils and all grades of lubricating oil base stocks.
Petroleum Coke		Petroleum coke is defined as a black solid residue, obtained mainly by cracking and carbonising of petroleum derived feedstocks, vacuum bottoms, tar and pitches in processes such as delayed coking or fluid coking. It consists mainly of carbon (90 to 95 percent) and has a low ash content. It is used as a feedstock in coke ovens for the steel industry, for heating purposes, for electrode manufacture and for production of chemicals. The two most important qualities are "green coke" and "calcinated coke". This category also includes "catalyst coke" deposited on the catalyst during refining processes: this coke is not recoverable and is usually burned as refinery fuel.
Refinery Feedstocks		A refinery feedstock is a product or a combination of products derived from crude oil and destined for further processing other than blending in the refining industry. It is transformed into one or more components and/or finished products. This definition covers those finished products imported for refinery intake and those returned from the petrochemical industry to the refining industry.
Other Oil	Refinery Gas	Refinery gas is defined as non-condensable gas obtained during distillation of crude oil or treatment of oil products (e.g. cracking) in refineries. It consists mainly of hydrogen, methane, ethane and olefins. It also includes gases which are returned from the petrochemical industry.
	Waxes	Saturated aliphatic hydrocarbons (with the general formula C_nH_{2n+2}). These waxes are residues extracted when dewaxing lubricant oils, and they have a crystalline structure with carbon number greater than 12. Their main characteristics are that they are colourless, odourless and translucent, with a melting point above 45°C.
	White Spirit & SBP	White spirit and SBP are refined distillate intermediates with a distillation in the naphtha/kerosene range. They are sub-divided as: i) Industrial Spirit (SBP): Light oils distilling between 30°C and 200°C, with a temperature difference between 5 percent volume and 90 percent volume distillation points, including losses, of not more than 60°C. In other words, SBP is a light oil of narrower cut than motor spirit. There are 7 or 8 grades of industrial spirit, depending on the position of the cut in the distillation range defined above. ii) White Spirit: Industrial spirit with a flash point above 30°C. The distillation range of white spirit is 135°C to 200°C.
	Other Petroleum Products	Includes the petroleum products not classified above, for example: tar, sulphur, and grease. This category also includes aromatics (e.g. BTX or benzene, toluene and xylene) and olefins (e.g. propylene) produced within refineries.

TABLE 1.1 (*continued*)

English Description		Comments
SOLID (Coal and coal products)		
Anthracite		Anthracite is a high rank coal used for industrial and residential applications. It has generally less than 10 percent volatile matter and a high carbon content (about 90 percent fixed carbon). Its gross calorific value is greater than 23 865 kJ/kg (5 700 kcal/kg) on an ash-free but moist basis.
Coking Coal		Coking coal refers to bituminous coal with a quality that allows the production of a coke suitable to support a blast furnace charge. Its gross calorific value is greater than 23 865 kJ/kg (5 700 kcal/kg) on an ash-free but moist basis.
Other Bituminous Coal		Other bituminous coal is used for steam raising purposes and includes all bituminous coal that is not included under coking coal. It is characterized by higher volatile matter than anthracite (more than 10 percent) and lower carbon content (less than 90 percent fixed carbon). Its gross calorific value is greater than 23 865 kJ/kg (5 700 kcal/kg) on an ash-free but moist basis.
Sub-Bituminous Coal		Non-agglomerating coals with a gross calorific value between 17 435 kJ/kg (4 165 kcal/kg) and 23 865 kJ/kg (5 700 kcal/kg) containing more than 31 percent volatile matter on a dry mineral matter free basis.
Lignite		Lignite/brown coal is a non-agglomerating coal with a gross calorific value of less than 17 435 kJ/kg (4 165 kcal/kg), and greater than 31 percent volatile matter on a dry mineral matter free basis.
Oil Shale and Tar Sands		Oil shale is an inorganic, non-porous rock containing various amounts of solid organic material that yields hydrocarbons, along with a variety of solid products, when subjected to pyrolysis (a treatment that consists of heating the rock at high temperature). Tar sands refers to sand (or porous carbonate rocks) that are naturally mixed with a viscous form of heavy crude oil sometimes referred to as bitumen. Due to its high viscosity this oil cannot be recovered through conventional recovery methods.
Brown Coal Briquettes		Brown coal briquettes (BKB) are composition fuels manufactured from lignite/brown coal, produced by briquetting under high pressure. These figures include dried lignite fines and dust.
Patent Fuel		Patent fuel is a composition fuel manufactured from hard coal fines with the addition of a binding agent. The amount of patent fuel produced may, therefore, be slightly higher than the actual amount of coal consumed in the transformation process.
Coke	Coke Oven Coke and Lignite Coke	Coke oven coke is the solid product obtained from the carbonisation of coal, principally coking coal, at high temperature. It is low in moisture content and volatile matter. Also included are semi-coke, a solid product obtained from the carbonisation of coal at a low temperature, lignite coke, semi-coke made from lignite/brown coal, coke breeze and foundry coke. Coke oven coke is also known as metallurgical coke.
	Gas Coke	Gas coke is a by-product of hard coal used for the production of town gas in gas works. Gas coke is used for heating purposes.
Coal Tar		The result of the destructive distillation of bituminous coal. Coal tar is the liquid by-product of the distillation of coal to make coke in the coke oven process. Coal tar can be further distilled into different organic products (e.g. benzene, toluene, naphthalene) which normally would be reported as a feedstock to the petrochemical industry.
Derived Gases	Gas Works Gas	Gas works gas covers all types of gases produced in public utility or private plants, whose main purpose is manufacture, transport and distribution of gas. It includes gas produced by carbonization (including gas produced by coke ovens and transferred to gas works gas), by total gasification with or without enrichment with oil products (LPG, residual fuel oil, etc.), and by reforming and simple mixing of gases and/or air. It excludes blended natural gas, which is usually distributed through the natural gas grid.
	Coke Oven Gas	Coke oven gas is obtained as a by-product of the manufacture of coke oven coke for the production of iron and steel.
	Blast Furnace Gas	Blast furnace gas is produced during the combustion of coke in blast furnaces in the iron and steel industry. It is recovered and used as a fuel partly within the plant and partly in other steel industry processes or in power stations equipped to burn it.
	Oxygen Steel Furnace Gas	Oxygen steel furnace gas is obtained as a by-product of the production of steel in an oxygen furnace and is recovered on leaving the furnace. The gas is also known as converter gas, LD gas or BOS gas.

TABLE 1.1 (*continued*)

English Description		Comments
GAS (Natural Gas)		
Natural Gas		Natural gas should include blended natural gas (sometimes also referred to as Town Gas or City Gas), a high calorific value gas obtained as a blend of natural gas with other gases derived from other primary products, and usually distributed through the natural gas grid (eg coal seam methane). Blended natural gas should include substitute natural gas, a high calorific value gas, manufactured by chemical conversion of a hydrocarbon fossil fuel, where the main raw materials are: natural gas, coal, oil and oil shale.
OTHER FOSSIL FUELS		
Municipal Wastes (non-biomass fraction)		Non-biomass fraction of municipal waste includes waste produced by households, industry, hospitals and the tertiary sector which are incinerated at specific installations and used for energy purposes. Only the fraction of the fuel that is non-biodegradable should be included here.
Industrial Wastes		Industrial waste consists of solid and liquid products (e.g. tyres) combusted directly, usually in specialised plants, to produce heat and/or power and that are not reported as biomass.
Waste Oils		Waste oils are used oils (e.g. waste lubricants) that are combusted for heat production.
PEAT		
Peat [5]		Combustible soft, porous or compressed, sedimentary deposit of plant origin including woody material with high water content (up to 90 percent in the raw state), easily cut, can contain harder pieces of light to dark brown colour. Peat used for non-energy purposes is not included.
BIOMASS		
Solid Biofuels	Wood/Wood Waste	Wood and wood waste combusted directly for energy. This category also includes wood for charcoal production but not the actual production of charcoal (this would be double counting since charcoal is a secondary product).
	Sulphite Lyes (Black Liquor)	Sulphite lyes is an alkaline spent liquor from the digesters in the production of sulphate or soda pulp during the manufacture of paper where the energy content derives from the lignin removed from the wood pulp. This fuel in its concentrated form is usually 65-70 percent solid.
	Other Primary Solid Biomass	Other primary solid biomass includes plant matter used directly as fuel that is not already included in wood/wood waste or in sulphite lyes. Included are vegetal waste, animal materials/wastes and other solid biomass. This category includes non-wood inputs to charcoal production (e.g. coconut shells) but all other feedstocks for production of biofuels should be excluded.
	Charcoal	Charcoal combusted as energy covers the solid residue of the destructive distillation and pyrolysis of wood and other vegetal material.

[5] Although peat is not strictly speaking a fossil fuel, its greenhouse gas emission characteristics have been shown in life cycle studies to be comparable to that of fossil fuels (Nilsson and Nilsson, 2004; Uppenberg *et al*., 2001; Savolainen *et al*., 1994). Therefore, the CO_2 emissions from combustion of peat are included in the national emissions as for fossil fuels.

TABLE 1.1 (*continued*)

English Description		Comments
Liquid Biofuels	Biogasoline	Biogasoline should only contain that part of the fuel that relates to the quantities of biofuel and not to the total volume of liquids into which the biofuels are blended. This category includes bioethanol (ethanol produced from biomass and/or the biodegradable fraction of waste), biomethanol (methanol produced from biomass and/or the biodegradable fraction of waste), bioETBE (ethyl-tertio-butyl-ether produced on the basis of bioethanol: the percentage by volume of bioETBE that is calculated as biofuel is 47 percent) and bioMTBE (methyl-tertio-butyl-ether produced on the basis of biomethanol: the percentage by volume of bioMTBE that is calculated as biofuel is 36 percent).
	Biodiesels	Biodiesels should only contain that part of the fuel that relates to the quantities of biofuel and not to the total volume of liquids into which the biofuels are blended. This category includes biodiesel (a methyl-ester produced from vegetable or animal oil, of diesel quality), biodimethylether (dimethylether produced from biomass), fischer tropsh (fischer tropsh produced from biomass), cold pressed bio oil (oil produced from oil seed through mechanical processing only) and all other liquid biofuels which are added to, blended with or used straight as transport diesel.
	Other Liquid Biofuels	Other liquid biofuels not included in biogasoline or biodiesels.
Gas Biomass	Landfill Gas	Landfill gas is derived from the anaerobic fermentation of biomass and solid wastes in landfills and combusted to produce heat and/or power.
	Sludge Gas	Sludge gas is derived from the anaerobic fermentation of biomass and solid wastes from sewage and animal slurries and combusted to produce heat and/or power.
	Other Biogas	Other biogas not included in landfill gas or sludge gas.
Other non-fossil fuels	Municipal Wastes (biomass fraction)	Biomass fraction of municipal waste includes waste produced by households, industry, hospitals and the tertiary sector which are incinerated at specific installations and used for energy purposes. Only the fraction of the fuel that is biodegradable should be included here.

TABLE 1.2 DEFAULT NET CALORIFIC VALUES (NCVS) AND LOWER AND UPPER LIMITS OF THE 95 PER CENT CONFIDENCE INTERVALS[1]

Fuel type English description		Net calorific value (TJ/Gg)	Lower	Upper
Crude Oil		42.3	40.1	44.8
Orimulsion		27.5	27.5	28.3
Natural Gas Liquids		44.2	40.9	46.9
Gasoline	Motor Gasoline	44.3	42.5	44.8
	Aviation Gasoline	44.3	42.5	44.8
	Jet Gasoline	44.3	42.5	44.8
Jet Kerosene		44.1	42.0	45.0
Other Kerosene		43.8	42.4	45.2
Shale Oil		38.1	32.1	45.2
Gas/Diesel Oil		43.0	41.4	43.3
Residual Fuel Oil		40.4	39.8	41.7
Liquefied Petroleum Gases		47.3	44.8	52.2
Ethane		46.4	44.9	48.8
Naphtha		44.5	41.8	46.5
Bitumen		40.2	33.5	41.2
Lubricants		40.2	33.5	42.3
Petroleum Coke		32.5	29.7	41.9
Refinery Feedstocks		43.0	36.3	46.4
Other Oil	Refinery Gas [2]	49.5	47.5	50.6
	Paraffin Waxes	40.2	33.7	48.2
	White Spirit and SBP	40.2	33.7	48.2
	Other Petroleum Products	40.2	33.7	48.2
Anthracite		26.7	21.6	32.2
Coking Coal		28.2	24.0	31.0
Other Bituminous Coal		25.8	19.9	30.5
Sub-Bituminous Coal		18.9	11.5	26.0
Lignite		11.9	5.50	21.6
Oil Shale and Tar Sands		8.9	7.1	11.1
Brown Coal Briquettes		20.7	15.1	32.0
Patent Fuel		20.7	15.1	32.0
Coke	Coke Oven Coke and Lignite Coke	28.2	25.1	30.2
	Gas Coke	28.2	25.1	30.2
Coal Tar [3]		28.0	14.1	55.0
Derived Gases	Gas Works Gas [4]	38.7	19.6	77.0
	Coke Oven Gas [5]	38.7	19.6	77.0
	Blast Furnace Gas [6]	2.47	1.20	5.00
	Oxygen Steel Furnace Gas [7]	7.06	3.80	15.0
Natural Gas		48.0	46.5	50.4
Municipal Wastes (non-biomass fraction)		10	7	18
Industrial Wastes		NA	NA	NA
Waste Oil [8]		40.2	20.3	80.0
Peat		9.76	7.80	12.5

TABLE 1.2 (*continued*)

Fuel type English description		Net calorific value (TJ/Gg)	Lower	Upper
Solid Biofuels	Wood/Wood Waste [9]	15.6	7.90	31.0
	Sulphite lyes (black liquor) [10]	11.8	5.90	23.0
	Other Primary Solid Biomass [11]	11.6	5.90	23.0
	Charcoal [12]	29.5	14.9	58.0
Liquid Biofuels	Biogasoline [13]	27.0	13.6	54.0
	Biodiesels [14]	27.0	13.6	54.0
	Other Liquid Biofuels [15]	27.4	13.8	54.0
Gas Biomass	Landfill Gas [16]	50.4	25.4	100
	Sludge Gas [17]	50.4	25.4	100
	Other Biogas [18]	50.4	25.4	100
Other non-fossil fuels	Municipal Wastes (biomass fraction)	11.6	6.80	18.0

Notes:

[1] The lower and upper limits of the 95 percent confidence intervals, assuming lognormal distributions, fitted to a dataset, based on national inventory reports, IEA data and available national data. A more detailed description is given in section 1.5.

[2] Japanese data; uncertainty range: expert judgement

[3] EFDB; uncertainty range: expert judgement

[4] Coke Oven Gas; uncertainty range: expert judgement

[5-7] Japan and UK small number data; uncertainty range: expert judgement

[8] For waste oils the values of "Lubricants" are taken

[9] EFDB; uncertainty range: expert judgement

[10] Japanese data ; uncertainty range: expert judgement

[11] Solid Biomass; uncertainty range: expert judgement

[12] EFDB; uncertainty range: expert judgement

[13-14] Ethanol theoretical number; uncertainty range: expert judgement;

[15] Liquid Biomass; uncertainty range: expert judgement

[16-18] Methane theoretical number uncertainty range: expert judgement;

DEFAULT EMISSION FACTORS FOR STATIONARY COMBUSTION PER ECONOMIC SECTOR[2]

TABLE 2.1 DETAILED SECTOR SPLIT FOR STATIONARY COMBUSTION*

<table>
<tr><th colspan="4">Code number and name</th><th>Definitions</th></tr>
<tr><td colspan="4">1 ENERGY</td><td>All GHG emissions arising from combustion and fugitive releases of fuels. Emissions from the non-energy uses of fuels are generally not included here, but reported under Industrial Processes and Product Use.</td></tr>
<tr><td colspan="4">1 A Fuel Combustion Activities</td><td>Emissions from the intentional oxidation of materials within an apparatus that is designed to raise heat and provide it either as heat or as mechanical work to a process or for use away from the apparatus.</td></tr>
<tr><td>1 A 1</td><td colspan="3">Energy Industries</td><td>Comprises emissions from fuels combusted by the fuel extraction or energy-producing industries.</td></tr>
<tr><td>1 A 1</td><td>a</td><td colspan="2">Main Activity Electricity and Heat Production</td><td>Sum of emissions from main activity producers of electricity generation, combined heat and power generation, and heat plants. Main activity producers (formerly known as public utilities) are defined as those undertakings whose primary activity is to supply the public. They may be in public or private ownership. Emissions from own on-site use of fuel should be included.
Emissions from autoproducers (undertakings which generate electricity/heat wholly or partly for their own use, as an activity that supports their primary activity) should be assigned to the sector where they were generated and not under 1 A 1 a. Autoproducers may be in public or private ownership.</td></tr>
<tr><td>1 A 1</td><td>a</td><td>i</td><td>Electricity Generation</td><td>Comprises emissions from all fuel use for electricity generation from main activity producers except those from combined heat and power plants.</td></tr>
<tr><td>1 A 1</td><td>a</td><td>ii</td><td>Combined Heat and Power Generation (CHP)</td><td>Emissions from production of both heat and electrical power from main activity producers for sale to the public, at a single CHP facility.</td></tr>
<tr><td></td><td></td><td>iii</td><td>Heat Plants</td><td>Production of heat from main activity producers for sale by pipe network.</td></tr>
<tr><td>1 A 1</td><td>b</td><td colspan="2">Petroleum Refining</td><td>All combustion activities supporting the refining of petroleum products including on-site combustion for the generation of electricity and heat for own use. Does not include evaporative emissions occurring at the refinery. These emissions should be reported separately under 1 B 2 a.</td></tr>
</table>

* Methods for mobile sources occurring in sub-categories 1 A 4 and 1 A 5 are dealt with in chapter 3 and the emissions are reported under Stationary Combustion.

[2] Emission tables for Stationary Combustion extracted from http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/2_Volume2/V2_2_Ch2_Stationary_Combustion.pdf.

TABLE 2.1 (*continued*)

Code number and name				Definitions
1 A 1	c	Manufacture of Solid Fuels and Other Energy Industries		Combustion emissions from fuel use during the manufacture of secondary and tertiary products from solid fuels including production of charcoal. Emissions from own on-site fuel use should be included. Also includes combustion for the generation of electricity and heat for own use in these industries.
1 A 1	c	*i*	*Manufacture of Solid Fuels*	Emissions arising from fuel combustion for the production of coke, brown coal briquettes and patent fuel.
1 A 1	c	*ii*	*Other Energy Industries*	Combustion emissions arising from the energy-producing industries own (on-site) energy use not mentioned above or for which separate data are not available. This includes the emissions from own-energy use for the production of charcoal, bagasse, saw dust, cotton stalks and carbonizing of biofuels as well as fuel used for coal mining, oil and gas extraction and the processing and upgrading of natural gas. This category also includes emissions from pre-combustion processing for CO_2 capture and storage. Combustion emissions from pipeline transport should be reported under 1 A 3 e.
1 A 2	*Manufacturing Industries and Construction*			Emissions from combustion of fuels in industry. Also includes combustion for the generation of electricity and heat for own use in these industries. Emissions from fuel combustion in coke ovens within the iron and steel industry should be reported under 1 A 1 c and not within manufacturing industry. Emissions from the industry sector should be specified by sub-categories that correspond to the International Standard Industrial Classification of all Economic Activities (ISIC). Energy used for transport by industry should not be reported here but under Transport (1 A 3). Emissions arising from off-road and other mobile machinery in industry should, if possible, be broken out as a separate subcategory. For each country, the emissions from the largest fuel-consuming industrial categories ISIC should be reported, as well as those from significant emitters of pollutants. A suggested list of categories is outlined below.
1 A 2	a	Iron and Steel		ISIC Group 271 and Class 2731
1 A 2	b	Non-Ferrous Metals		ISIC Group 272 and Class 2732
1 A 2	c	Chemicals		ISIC Division 24
1 A 2	d	Pulp, Paper and Print		ISIC Divisions 21 and 22
1 A 2	e	Food Processing, Beverages and Tobacco		ISIC Divisions 15 and 16
1 A 2	f	Non-Metallic Minerals		Includes products such as glass, ceramic, cement, etc.; ISIC Division 26
1 A 2	g	Transport Equipment		ISIC Divisions 34 and 35
1 A 2	h	Machinery		Includes fabricated metal products, machinery and equipment other than transport equipment; ISIC Divisions 28, 29, 30, 31 and 32.

TABLE 2.1 (*continued*)

Code number and name				Definitions
1 A 2	i	Mining (excluding fuels) and Quarrying		ISIC Divisions 13 and 14
1 A 2	j	Wood and Wood Products		ISIC Division 20
1 A 2	k	Construction		ISIC Division 45
1 A 2	l	Textile and Leather		ISIC Divisions 17, 18 and 19
1 A 2	m	Non-specified Industry		Any manufacturing industry/construction not included above or for which separate data are not available. Includes ISIC Divisions 25, 33, 36 and 37.
1 A 4	*Other Sectors*			Emissions from combustion activities as described below, including combustion for the generation of electricity and heat for own use in these sectors.
1 A 4	a	Commercial / Institutional		Emissions from fuel combustion in commercial and institutional buildings; all activities included in ISIC Divisions 41, 50, 51, 52, 55, 63-67, 70-75, 80, 85, 90-93 and 99.
1 A 4	b	Residential		All emissions from fuel combustion in households.
1 A 4	c	Agriculture / Forestry / Fishing / Fish farms		Emissions from fuel combustion in agriculture, forestry, fishing and fishing industries such as fish farms. Activities included in ISIC Divisions 01, 02 and 05. Highway agricultural transportation is excluded.
1 A 4	c	*i*	*Stationary*	Emissions from fuels combusted in pumps, grain drying, horticultural greenhouses and other agriculture, forestry or stationary combustion in the fishing industry.
1 A 4	c	*ii*	*Off-road Vehicles and Other Machinery*	Emissions from fuels combusted in traction vehicles on farm land and in forests.
1 A 4	c	*iii*	*Fishing (mobile combustion)*	Emissions from fuels combusted for inland, coastal and deep-sea fishing. Fishing should cover vessels of all flags that have refuelled in the country (include international fishing).

TABLE 2.1 (*continued*)

Code number and name				Definitions
1 A 5	*Non-Specified*			All remaining emissions from fuel combustion that are not specified elsewhere. Include emissions from fuel delivered to the military in the country and delivered to the military of other countries that are not engaged in multilateral operations.
1 A 5	a	Stationary		Emissions from fuel combustion in stationary sources that are not specified elsewhere.
1 A 5	b	Mobile		Emissions from vehicles and other machinery, marine and aviation (not included in 1 A 4 c ii or elsewhere).
1 A 5	b	*i*	*Mobile (aviation component)*	All remaining aviation emissions from fuel combustion that are not specified elsewhere. Include emissions from fuel delivered to the country's military as well as fuel delivered within that country but used by the militaries of other countries that are not engaged in multilateral operations.
1 A 5	b	*ii*	*Mobile (water-borne component)*	All remaining water-borne emissions from fuel combustion that are not specified elsewhere. Include emissions from fuel delivered to the country's military as well as fuel delivered within that country but used by the militaries of other countries that are not engaged in multilateral operations.
1 A 5	b	*iii*	*Mobile (other)*	All remaining emissions from mobile sources not included elsewhere.
Multilateral operations (Information item)				Emissions from fuels used in multilateral operations pursuant to the Charter of the United Nations. Include emissions from fuel delivered to the military in the country and delivered to the military of other countries.

TABLE 2.2 DEFAULT EMISSION FACTORS FOR STATIONARY COMBUSTION IN THE ENERGY INDUSTRIES

(*Kg of greenhouse gas per TJ on a Net Calorific Basis*)

Fuel		CO_2			CH_4			N_2O		
		Default Emission Factor	Lower	Upper	Default Emission Factor	Lower	Upper	Default Emission Factor	Lower	Upper
Crude Oil		73 300	71 100	75 500	r 3	1	10	0.6	0.2	2
Orimulsion		r 77 000	69 300	85 400	r 3	1	10	0.6	0.2	2
Natural Gas Liquids		r 64 200	58 300	70 400	r 3	1	10	0.6	0.2	2
Gasoline	Motor Gasoline	r 69 300	67 500	73 000	r 3	1	10	0.6	0.2	2
Gasoline	Aviation Gasoline	r 70 000	67 500	73 000	r 3	1	10	0.6	0.2	2
Gasoline	Jet Gasoline	r 70 000	67 500	73 000	r 3	1	10	0.6	0.2	2
Jet Kerosene		r 71 500	69 700	74 400	r 3	1	10	0.6	0.2	2
Other Kerosene		71 900	70 800	73 700	r 3	1	10	0.6	0.2	2
Shale Oil		73 300	67 800	79 200	r 3	1	10	0.6	0.2	2
Gas/Diesel Oil		74 100	72 600	74 800	r 3	1	10	0.6	0.2	2
Residual Fuel Oil		77 400	75 500	78 800	r 3	1	10	0.6	0.2	2
Liquefied Petroleum Gases		63 100	61 600	65 600	r 1	0.3	3	0.1	0.03	0.3
Ethane		61 600	56 500	68 600	r 1	0.3	3	0.1	0.03	0.3
Naphtha		73 300	69 300	76 300	r 3	1	10	0.6	0.2	2
Bitumen		80 700	73 000	89 900	r 3	1	10	0.6	0.2	2
Lubricants		73 300	71 900	75 200	r 3	1	10	0.6	0.2	2
Petroleum Coke		r 97 500	82 900	115 000	r 3	1	10	0.6	0.2	2
Refinery Feedstocks		73 300	68 900	76 600	r 3	1	10	0.6	0.2	2
Other Oil	Refinery Gas	n 57 600	48 200	69 000	r 1	0.3	3	0.1	0.03	0.3
Other Oil	Paraffin Waxes	73 300	72 200	74 400	r 3	1	10	0.6	0.2	2
Other Oil	White Spirit and SBP	73 300	72 200	74 400	r 3	1	10	0.6	0.2	2
Other Oil	Other Petroleum Products	73 300	72 200	74 400	r 3	1	10	0.6	0.2	2
Anthracite		98 300	94 600	101 000	1	0.3	3	r 1.5	0.5	5
Coking Coal		94 600	87 300	101 000	1	0.3	3	r 1.5	0.5	5
Other Bituminous Coal		94 600	89 500	99 700	1	0.3	3	r 1.5	0.5	5
Sub-Bituminous Coal		96 100	92 800	100 000	1	0.3	3	r 1.5	0.5	5
Lignite		101 000	90 900	115 000	1	0.3	3	r 1.5	0.5	5
Oil Shale and Tar Sands		107 000	90 200	125 000	1	0.3	3	r 1.5	0.5	5
Brown Coal Briquettes		97 500	87 300	109 000	n 1	0.3	3	r 1.5	0.5	5
Patent Fuel		97 500	87 300	109 000	1	0.3	3	n 1.5	0.5	5
Coke	Coke Oven Coke and Lignite Coke	r 107 000	95 700	119 000	1	0.3	3	r 1.5	0.5	5
Coke	Gas Coke	r 107 000	95 700	119 000	r 1	0.3	3	0.1	0.03	0.3
Coal Tar		n 80 700	68 200	95 300	n 1	0.3	3	r 1.5	0.5	5
Derived Gases	Gas Works Gas	n 44 400	37 300	54 100	n 1	0.3	3	0.1	0.03	0.3
Derived Gases	Coke Oven Gas	n 44 400	37 300	54 100	r 1	0.3	3	0.1	0.03	0.3
Derived Gases	Blast Furnace Gas	n 260 000	219 000	308 000	r 1	0.3	3	0.1	0.03	0.3
Derived Gases	Oxygen Steel Furnace Gas	n 182 000	145 000	202 000	r 1	0.3	3	0.1	0.03	0.3
Natural Gas		56 100	54 300	58 300	1	0.3	3	0.1	0.03	0.3

TABLE 2.2 (*continued*)

Fuel		CO_2 Default Emission Factor	CO_2 Lower	CO_2 Upper	CH_4 Default Emission Factor	CH_4 Lower	CH_4 Upper	N_2O Default Emission Factor	N_2O Lower	N_2O Upper
Municipal Wastes (non-biomass fraction)		n 91 700	73 300	121 000	30	10	100	4	1.5	15
Industrial Wastes		n 143 000	110 000	183 000	30	10	100	4	1.5	15
Waste Oils		n 73 300	72 200	74 400	30	10	100	4	1.5	15
Peat		106 000	100 000	108 000	n 1	0.3	3	n 1.5	0.5	5
Solid Biofuels	Wood / Wood Waste	n 112 000	95 000	132 000	30	10	100	4	1.5	15
	Sulphite lyes (Black Liquor)[a]	n 95 300	80 700	110 000	n 3	1	18	n 2	1	21
	Other Primary Solid Biomass	n 100 000	84 700	117 000	30	10	100	4	1.5	15
	Charcoal	n 112 000	95 000	132 000	200	70	600	4	1.5	15
Liquid Biofuels	Biogasoline	n 70 800	59 800	84 300	r 3	1	10	0.6	0.2	2
	Biodiesels	n 70 800	59 800	84 300	r 3	1	10	0.6	0.2	2
	Other Liquid Biofuels	n 79 600	67 100	95 300	r 3	1	10	0.6	0.2	2
Gas Biomass	Landfill Gas	n 54 600	46 200	66 000	r 1	0.3	3	0.1	0.03	0.3
	Sludge Gas	n 54 600	46 200	66 000	r 1	0.3	3	0.1	0.03	0.3
	Other Biogas	n 54 600	46 200	66 000	r 1	0.3	3	0.1	0.03	0.3
Other non-fossil fuels	Municipal Wastes (biomass fraction)	n 100 000	84 700	117 000	30	10	100	4	1.5	15

(a) Includes the biomass-derived CO_2 emitted from the black liquor combustion unit and the biomass-derived CO_2 emitted from the kraft mill lime kiln.
n indicates a new emission factor which was not present in the 1996 Guidelines
r indicates an emission factor that has been revised since the 1996 Guidelines

TABLE 2.3 DEFAULT EMISSION FACTORS FOR STATIONARY COMBUSTION
IN MANUFACTURING INDUSTRIES AND CONSTRUCTION
(*Kg of greenhouse gas per TJ on a Net Calorific Basis*)

Fuel		CO_2			CH_4			N_2O		
		Default Emission Factor	Lower	Upper	Default Emission Factor	Lower	Upper	Default Emission Factor	Lower	Upper
Crude Oil		73 300	71 100	75 500	r 3	1	10	0.6	0.2	2
Orimulsion		r 77 000	69 300	85 400	r 3	1	10	0.6	0.2	2
Natural Gas Liquids		r 64 200	58 300	70 400	r 3	1	10	0.6	0.2	2
Gasoline	Motor Gasoline	r 69 300	67 500	73 000	r 3	1	10	0.6	0.2	2
Gasoline	Aviation Gasoline	r 70 000	67 500	73 000	r 3	1	10	0.6	0.2	2
Gasoline	Jet Gasoline	r 70 000	67 500	73 000	r 3	1	10	0.6	0.2	2
Jet Kerosene		71 500	69 700	74 400	r 3	1	10	0.6	0.2	2
Other Kerosene		71 900	70 800	73 700	r 3	1	10	0.6	0.2	2
Shale Oil		73 300	67 800	79 200	r 3	1	10	0.6	0.2	2
Gas/Diesel Oil		74 100	72 600	74 800	r 3	1	10	0.6	0.2	2
Residual Fuel Oil		77 400	75 500	78 800	r 3	1	10	0.6	0.2	2
Liquefied Petroleum Gases		63 100	61 600	65 600	r 1	0.3	3	0.1	0.03	0.3
Ethane		61 600	56 500	68 600	r 1	0.3	3	0.1	0.03	0.3
Naphtha		73 300	69 300	76 300	r 3	1	10	0.6	0.2	2
Bitumen		80 700	73 000	89 900	r 3	1	10	0.6	0.2	2
Lubricants		73 300	71 900	75 200	r 3	1	10	0.6	0.2	2
Petroleum Coke		r 97 500	82 900	115 000	r 3	1	10	0.6	0.2	2
Refinery Feedstocks		73 300	68 900	76 600	r 3	1	10	0.6	0.2	2
Other Oil	Refinery Gas	n 57 600	48 200	69 000	r 1	0.3	3	0.1	0.03	0.3
Other Oil	Paraffin Waxes	73 300	72 200	74 400	r 3	1	10	0.6	0.2	2
Other Oil	White Spirit and SBP	73 300	72 200	74 400	r 3	1	10	0.6	0.2	2
Other Oil	Other Petroleum Products	73 300	72 200	74 400	r 3	1	10	0.6	0.2	2
Anthracite		98 300	94 600	101 000	10	3	30	r 1.5	0.5	5
Coking Coal		94 600	87 300	101 000	10	3	30	r 1.5	0.5	5
Other Bituminous Coal		94 600	89 500	99 700	10	3	30	r 1.5	0.5	5
Sub-Bituminous Coal		96 100	92 800	100 000	10	3	30	r 1.5	0.5	5
Lignite		101 000	90 900	115 000	10	3	30	r 1.5	0.5	5
Oil Shale and Tar Sands		107 000	90 200	125 000	10	3	30	r 1.5	0.5	5
Brown Coal Briquettes		n 97 500	87 300	109 000	n 10	3	30	n 1.5	0.5	5
Patent Fuel		97 500	87 300	109 000	10	3	30	r 1.5	0.5	5
Coke	Coke Oven Coke and Lignite Coke	r 107 000	95 700	119 000	10	3	30	r 1.5	0.5	5
Coke	Gas Coke	r 107 000	95 700	119 000	r 1	0.3	3	0.1	0.03	0.3
Coal Tar		n 80 700	68 200	95 300	n 10	3	30	n 1.5	0.5	5
Derived Gases	Gas Works Gas	n 44 400	37 300	54 100	r 1	0.3	3	0.1	0.03	0.3
Derived Gases	Coke Oven Gas	n 44 400	37 300	54 100	r 1	0.3	3	0.1	0.03	0.3
Derived Gases	Blast Furnace Gas	n260 000	219 000	308 000	r 1	0.3	3	0.1	0.03	0.3
Derived Gases	Oxygen Steel Furnace Gas	n 182 000	145 000	202 000	r 1	0.3	3	0.1	0.03	0.3
Natural Gas		56 100	54 300	58 300	r 1	0.3	3	0.1	0.03	0.3

TABLE 2.3 (*continued*)

Fuel		CO_2			CH_4			N_2O		
		Default Emission Factor	Lower	Upper	Default Emission Factor	Lower	Upper	Default Emission Factor	Lower	Upper
Municipal Wastes (non-biomass fraction)		n 91 700	73 300	121 000	30	10	100	4	1.5	15
Industrial Wastes		n143 000	110 000	183 000	30	10	100	4	1.5	15
Waste Oils		n 73 300	72 200	74 400	30	10	100	4	1.5	15
Peat		106 000	100 000	108 000	n 2	0.6	6	n 1.5	0.5	5
Solid Biofuels	Wood / Wood Waste	n 112 000	95 000	132 000	30	10	100	4	1.5	15
	Sulphite lyes (Black Liquor)[a]	n 95 300	80 700	110 000	n 3	1	18	n 2	1	21
	Other Primary Solid Biomass	n 100 000	84 700	117 000	30	10	100	4	1.5	15
	Charcoal	n 112 000	95 000	132 000	200	70	600	4	1.5	15
Liquid Biofuels	Biogasoline	n 70 800	59 800	84 300	r 3	1	10	0.6	0.2	2
	Biodiesels	n 70 800	59 800	84 300	r 3	1	10	0.6	0.2	2
	Other Liquid Biofuels	n 79 600	67 100	95 300	r 3	1	10	0.6	0.2	2
Gas Biomass	Landfill Gas	n 54 600	46 200	66 000	r 1	0.3	3	0.1	0.03	0.3
	Sludge Gas	n 54 600	46 200	66 000	r 1	0.3	3	0.1	0.03	0.3
	Other Biogas	n 54 600	46 200	66 000	r 1	0.3	3	0.1	0.03	0.3
Other non-fossil fuels	Municipal Wastes (biomass fraction)	n100 000	84 700	117 000	30	10	100	4	1.5	15

(a) Includes the biomass-derived CO_2 emitted from the black liquor combustion unit and the biomass-derived CO_2 emitted from the kraft mill lime kiln.
n indicates a new emission factor which was not present in the 1996 Guidelines
r indicates an emission factor that has been revised since the 1996 Guidelines

TABLE 2.4 DEFAULT EMISSION FACTORS FOR STATIONARY COMBUSTION IN THE COMMERCIAL/INSTITUTIONAL CATEGORY
(*Kg of greenhouse gas per TJ on a Net Calorific Basis*)

Fuel		CO_2			CH_4			N_2O		
		Default Emission Factor	Lower	Upper	Default Emission Factor	Lower	Upper	Default Emission Factor	Lower	Upper
Crude Oil		73 300	71 100	75 500	10	3	30	0.6	0.2	2
Orimulsion		r 77 000	69 300	85 400	10	3	30	0.6	0.2	2
Natural Gas Liquids		r 64 200	58 300	70 400	10	3	30	0.6	0.2	2
Gasoline	Motor Gasoline	r 69 300	67 500	73 000	10	3	30	0.6	0.2	2
Gasoline	Aviation Gasoline	r 70 000	67 500	73 000	10	3	30	0.6	0.2	2
Gasoline	Jet Gasoline	r 70 000	67 500	73 000	10	3	30	0.6	0.2	2
Jet Kerosene		r 71 500	69 700	74 400	10	3	30	0.6	0.2	2
Other Kerosene		71 900	70 800	73 700	10	3	30	0.6	0.2	2
Shale Oil		73 300	67 800	79 200	10	3	30	0.6	0.2	2
Gas/Diesel Oil		74 100	72 600	74 800	10	3	30	0.6	0.2	2
Residual Fuel Oil		77 400	75 500	78 800	10	3	30	0.6	0.2	2
Liquefied Petroleum Gases		63 100	61 600	65 600	5	1.5	15	0.1	0.03	0.3
Ethane		61 600	56 500	68 600	5	1.5	15	0.1	0.03	0.3
Naphtha		73 300	69 300	76 300	10	3	30	0.6	0.2	2
Bitumen		80 700	73 000	89 900	10	3	30	0.6	0.2	2
Lubricants		73 300	71 900	75 200	10	3	30	0.6	0.2	2
Petroleum Coke		r 97 500	82 900	115 000	10	3	30	0.6	0.2	2
Refinery Feedstocks		73 300	68 900	76 600	10	3	30	0.6	0.2	2
Other Oil	Refinery Gas	n 57 600	48 200	69 000	5	1.5	15	0.1	0.03	0.3
Other Oil	Paraffin Waxes	73 300	72 200	74 400	10	3	30	0.6	0.2	2
Other Oil	White Spirit and SBP	73 300	72 200	74 400	10	3	30	0.6	0.2	2
Other Oil	Other Petroleum Products	73 300	72 200	74 400	10	3	30	0.6	0.2	2
Anthracite		r 98 300	94 600	101 000	10	3	30	1.5	0.5	5
Coking Coal		94 600	87 300	101 000	10	3	30	1.5	0.5	5
Other Bituminous Coal		94 600	89 500	99 700	10	3	30	1.5	0.5	5
Sub-Bituminous Coal		96 100	92 800	100 000	10	3	30	1.5	0.5	5
Lignite		101 000	90 900	115 000	10	3	30	1.5	0.5	5
Oil Shale and Tar Sands		107 000	90 200	125 000	10	3	30	1.5	0.5	5
Brown Coal Briquettes		n 97 500	87 300	109 000	n 10	3	30	r 1.5	0.5	5
Patent Fuel		97 500	87 300	109 000	10	3	30	n 1.5	0.5	5
Coke	Coke Oven Coke and Lignite Coke	n 107 000	95 700	119 000	10	3	30	1.5	0.5	4
Coke	Gas Coke	n 107 000	95 700	119 000	5	1.5	15	0.1	0.03	0.3

TABLE 2.4 (*continued*)

Fuel		CO_2 Default Emission Factor	CO_2 Lower	CO_2 Upper	CH_4 Default Emission Factor	CH_4 Lower	CH_4 Upper	N_2O Default Emission Factor	N_2O Lower	N_2O Upper
Coal Tar		n 80 700	68 200	95 300	n 10	30	30	n 1.5	0.5	5
Derived Gases	Gas Works Gas	n 44 400	37 300	54 100	5	1.5	15	0.1	0.03	0.3
	Coke Oven Gas	n 44 400	37 300	54 100	5	1.5	15	0.1	0.03	0.3
	Blast Furnace Gas	n 260 000	219 000	308 000	5	1.5	15	0.1	0.03	0.3
	Oxygen Steel Furnace Gas	n 182 000	145 000	202 000	5	1.5	15	0.1	0.03	0.3
Natural Gas		56 100	54 300	58 300	5	1.5	15	0.1	0.03	0.3
Municipal Wastes (non-biomass fraction)		n 91 700	73 300	121 000	300	100	900	4	1.5	15
Industrial Wastes		n 143 000	110 000	183 000	300	100	900	4	1.5	15
Waste Oils		n 73 300	72 200	74 400	300	100	900	4	1.5	15
Peat		106 000	100 000	108 000	n 10	3	30	n 1.4	0.5	5
Solid Biofuels	Wood / Wood Waste	r 112 000	95 000	132 000	300	100	900	4	1.5	15
	Sulphite lyes (Black Liquor)[a]	n 95 300	80 700	110 000	n 3	1	18	n 2	1	21
	Other Primary Solid Biomass	n 100 000	84 700	117 000	300	100	900	4	1.5	15
	Charcoal	n 112 000	95 000	132 000	200	70	600	1	0.3	3
Liquid Biofuels	Biogasoline	n 70 800	59 800	84 300	10	3	30	0.6	0.2	2
	Biodiesels	n 70 800	59 800	84 300	10	3	30	0.6	0.2	2
	Other Liquid Biofuels	n 79 600	67 100	95 300	10	3	30	0.6	0.2	2
Gas Biomass	Landfill Gas	n 54 600	46 200	66 000	5	1.5	15	0.1	0.03	0.3
	Sludge Gas	n 54 600	46 200	66 000	5	1.5	15	0.1	0.03	0.3
	Other Biogas	n 54 600	46 200	66 000	5	1.5	15	0.1	0.03	0.3
Other non-	Municipal Wastes (biomass fraction)	n 100 000	84 700	117 000	300	100	900	4	1..5	15

(a) Includes the biomass-derived CO_2 emitted from the black liquor combustion unit and the biomass-derived CO_2 emitted from the kraft mill lime kiln.
n indicates a new emission factor which was not present in the 1996 Guidelines
r indicates an emission factor that has been revised since the 1996 Guidelines

TABLE 2.5 DEFAULT EMISSION FACTORS FOR STATIONARY COMBUSTION IN THE RESIDENTIAL AND AGRICULTURE/FORESTRY/FISHING/FISHING FARMS CATEGORIES
(*Kg of greenhouse gas per tj on a net calorific basis*)

Fuel		CO_2			CH_4			N_2O		
		Default Emission Factor	Lower	Upper	Default Emission Factor	Lower	Upper	Default Emission Factor	Lower	Upper
Crude Oil		73 300	71 100	75 500	10	3	30	0.6	0.2	2
Orimulsion		r 77 000	69 300	85 400	10	3	30	0.6	0.2	2
Natural Gas Liquids		r 64 200	58 300	70 400	10	3	30	0.6	0.2	2
Gasoline	Motor Gasoline	r 69 300	67 500	73 000	10	3	30	0.6	0.2	2
	Aviation Gasoline	r 70 000	67 500	73 000	10	3	30	0.6	0.2	2
	Jet Gasoline	r 70 000	67 500	73 000	10	3	30	0.6	0.2	2
Jet Kerosene		r 71 500	69 700	74 400	10	3	30	0.6	0.2	2
Other Kerosene		71 900	70 800	73 700	10	3	30	0.6	0.2	2
Shale Oil		73 300	67 800	79 200	10	3	30	0.6	0.2	2
Gas/Diesel Oil		74 100	72 600	74 800	10	3	30	0.6	0.2	2
Residual Fuel Oil		77 400	75 500	78 800	10	3	30	0.6	0.2	2
Liquefied Petroleum Gases		63 100	61 600	65 600	5	1.5	15	0.1	0.03	0.3
Ethane		61 600	56 500	68 600	5	1.5	15	0.1	0.03	0.3
Naphtha		73 300	69 300	76 300	10	3	30	0.6	0.2	2
Bitumen		80 700	73 000	89 900	10	3	30	0.6	0.2	2
Lubricants		73 300	71 900	75 200	10	3	30	0.6	0.2	2
Petroleum Coke		r 97 500	82 900	115 000	10	3	30	0.6	0.2	2
Refinery Feedstocks		73 300	68 900	76 600	10	3	30	0.6	0.2	2
Other Oil	Refinery Gas	n 57 600	48 200	69 000	5	1.5	15	0.1	0.03	0.3
	Paraffin Waxes	73 300	72 200	74 400	10	3	30	0.6	0.2	2
	White Spirit and SBP	73 300	72 200	74 400	10	3	30	0.6	0.2	3
	Other Petroleum Products	73 300	72 200	74 400	10	3	30	0.6	0.2	2
Anthracite		98 300	94 600	101 000	300	100	900	1.5	0.5	5
Coking Coal		94 600	87 300	101 000	300	100	900	1.5	0.5	5
Other Bituminous Coal		94 600	89 500	99 700	300	100	900	1.5	0.5	5
Sub-Bituminous Coal		96 100	92 800	100 000	300	100	900	1.5	0.5	5
Lignite		101 000	90 900	115 000	300	100	900	1.5	0.5	5
Oil Shale and Tar Sands		107 000	90 200	125 000	300	100	900	1.5	0.5	5
Brown Coal Briquettes		n 97 500	87 300	109 000	n 300	100	900	n 1.5	0.5	5
Patent Fuel		97 500	87 300	109 000	300	100	900	1.5	0.5	5
Coke	Coke Oven Coke and Lignite Coke	r 107 000	95 700	119 000	300	100	900	n 1.5	0.5	5
	Gas Coke	r 107 000	95 700	119 000	r 5	1.5	15	0.1	0.03	0.3
Coal Tar		n 80 700	68 200	95 300	n 300	100	900	n 1.5	0.5	5
Derived Gases	Gas Works Gas	n 44 400	37 300	54 100	5	1.5	15	0.1	0.03	0.3
	Coke Oven Gas	n 44 400	37 300	54 100	5	1.5	15	0.1	0.03	0.3
	Blast Furnace Gas	n 260 000	219 000	308 000	5	1.5	15	0.1	0.03	0.3
	Oxygen Steel Furnace Gas	n 182 000	145 000	202 000	5	1.5	15	0.1	0.03	0.3

TABLE 2.5 (*continued*)

Fuel		CO_2			CH_4			N_2O		
		Default Emission Factor	Lower	Upper	Default Emission Factor	Lower	Upper	Default Emission Factor	Lower	Upper
Natural Gas		56 100	54 300	58 300	5	1.5	15	0.1	0.03	0.3
Municipal Wastes (non-biomass fraction)		n 91 700	73 300	121 000	300	100	900	4	1.5	15
Industrial Wastes		n 143 000	110 000	183 000	300	100	900	4	1.5	15
Waste Oils		n 73 300	72 200	74 400	300	100	900	4	1.5	15
Peat		106 000	100 000	108 000	n 300	100	900	n 1.4	0.5	5
Solid Biofuels	Wood / Wood Waste	n 112 000	95 000	132 000	300	100	900	4	1.5	15
	Sulphite lyes (Black Liquor)[a]	n 95 300	80 700	110 000	n 3	1	18	n 2	1	21
	Other Primary Solid Biomass	n 100 000	84 700	117 000	300	100	900	4	1.5	15
	Charcoal	n 112 000	95 000	132 000	200	70	600	1	0.3	3
Liquid Biofuels	Biogasoline	n 70 800	59 800	84 300	10	3	30	0.6	0.2	2
	Biodiesels	n 70 800	59 800	84 300	10	3	30	0.6	0.2	2
	Other Liquid Biofuels	r 79 600	67 100	95 300	10	3	30	0.6	0.2	2
Gas Biomass	Landfill Gas	n 54 600	46 200	66 000	5	1.5	15	0.1	0.03	0.3
	Sludge Gas	n 54 600	46 200	66 000	5	1.5	15	0.1	0.03	0.3
	Other Biogas	n 54 600	46 200	66 000	5	1.5	15	0.1	0.03	0.3
Other non-fossil fuels	Municipal Wastes (biomass fraction)	n 100 000	84 700	117 000	300	100	900	4	1.5	15

(a) Includes the biomass-derived CO_2 emitted from the black liquor combustion unit and the biomass-derived CO_2 emitted from the kraft mill lime kiln.

n indicates a new emission factor which was not present in the 1996 IPCC Guidelines.

r indicates an emission factor that has been revised since the 1996I PCC Guidelines.

DEFAULT EMISSION FACTORS FOR MOBILE COMBUSTION PER TRANSPORTATION MODE[3]

TABLE 3.1.1 DETAILED SECTOR SPLIT FOR THE TRANSPORT SECTOR

Code and Name					**Explanation**
1 A 3	*TRANSPORT*				Emissions from the combustion and evaporation of fuel for all transport activity (excluding military transport), regardless of the sector, specified by sub-categories below. Emissions from fuel sold to any air or marine vessel engaged in international transport (1 A 3 a i and 1 A 3 d i) should as far as possible be excluded from the totals and subtotals in this category and should be reported separately.
1 A 3	a	Civil Aviation			Emissions from international and domestic civil aviation, including take-offs and landings. Comprises civil commercial use of airplanes, including: scheduled and charter traffic for passengers and freight, air taxiing, and general aviation. The international/domestic split should be determined on the basis of departure and landing locations for each flight stage and not by the nationality of the airline. Exclude use of fuel at airports for ground transport which is reported under 1 A 3 e Other Transportation. Also exclude fuel for stationary combustion at airports; report this information under the appropriate stationary combustion category.
1 A 3	a	*i*		*International Aviation (International Bunkers)*	Emissions from flights that depart in one country and arrive in a different country. Include take-offs and landings for these flight stages. Emissions from international military aviation can be included as a separate sub-category of international aviation provided that the same definitional distinction is applied and data are available to support the definition.
1 A 3	a	*ii*		*Domestic Aviation*	Emissions from civil domestic passenger and freight traffic that departs and arrives in the same country (commercial, private, agriculture, etc.), including take-offs and landings for these flight stages. Note that this may include journeys of considerable length between two airports in a country (e.g. San Francisco to Honolulu). Exclude military, which should be reported under 1 A 5 b.
1 A 3	b	Road Transportation			All combustion and evaporative emissions arising from fuel use in road vehicles, including the use of agricultural vehicles on paved roads.
1 A 3	b	*i*		*Cars*	Emissions from automobiles so designated in the vehicle registering country primarily for transport of persons and normally having a capacity of 12 persons or fewer.
1 A 3	b	*i*	1	Passenger cars with 3-way catalysts	Emissions from passenger car vehicles with 3-way catalysts.
1 A 3	b	*i*	2	Passenger cars without 3-way catalysts	Emissions from passenger car vehicles without 3-way catalysts.

[3] Emission tables for Mobile Combustion extracted from http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/2_Volume2/V2_3_Ch3_Mobile_Combustion.pdf.

TABLE 3.1.1 (*continued*)

Code and Name					**Explanation**
1 A 3	b	*ii*		*Light duty trucks*	Emissions from vehicles so designated in the vehicle registering country primarily for transportation of light-weight cargo or which are equipped with special features such as four-wheel drive for off-road operation. The gross vehicle weight normally ranges up to 3500-3900 kg or less.
1 A 3	b	*ii*	1	Light duty trucks with 3-way catalysts	Emissions from light duty trucks with 3-way catalysts.
1 A 3	b	*ii*	2	Light duty trucks without 3-way catalysts	Emissions from light duty trucks without 3-way catalysts.
1 A 3	b	*iii*		*Heavy duty trucks and buses*	Emissions from any vehicles so designated in the vehicle registering country. Normally the gross vehicle weight ranges from 3500-3900 kg or more for heavy duty trucks and the buses are rated to carry more than 12 persons.
1 A 3	b	*iv*		*Motorcycles*	Emissions from any motor vehicle designed to travel with not more than three wheels in contact with the ground and weighing less than 680 kg.
1 A 3	b	*v*		*Evaporative emissions from vehicles*	Evaporative emissions from vehicles (e.g. hot soak, running losses) are included here. Emissions from loading fuel into vehicles are excluded.
1 A 3	b	*vi*		*Urea-based catalysts*	CO_2 emissions from use of urea-based additives in catalytic converters (non-combustive emissions)
1 A 3	c	Railways			Emissions from railway transport for both freight and passenger traffic routes.
1 A 3	d	Water-borne Navigation			Emissions from fuels used to propel water-borne vessels, including hovercraft and hydrofoils, but excluding fishing vessels. The international/domestic split should be determined on the basis of port of departure and port of arrival, and not by the flag or nationality of the ship.
1 A 3	d	i		*International water-borne navigation (International bunkers)*	Emissions from fuels used by vessels of all flags that are engaged in international water-borne navigation. The international navigation may take place at sea, on inland lakes and waterways and in coastal waters. Includes emissions from journeys that depart in one country and arrive in a different country. Exclude consumption by fishing vessels (see Other Sector - Fishing). Emissions from international military water-borne navigation can be included as a separate sub-category of international water-borne navigation provided that the same definitional distinction is applied and data are available to support the definition.
1 A 3	d	ii		*Domestic water-borne Navigation*	Emissions from fuels used by vessels of all flags that depart and arrive in the same country (exclude fishing, which should be reported under 1 A 4 c iii, and military, which should be reported under 1 A 5 b). Note that this may include journeys of considerable length between two ports in a country (e.g. San Francisco to Honolulu).
1 A 3	e	Other Transportation			Combustion emissions from all remaining transport activities including pipeline transportation, ground activities in airports and harbours, and off-road activities not otherwise reported under 1 A 4 c Agriculture or 1 A 2. Manufacturing Industries and Construction. Military transport should be reported under 1 A 5 (see 1 A 5 Non-specified).
1 A 3	e	i		*Pipeline Transport*	Combustion related emissions from the operation of pump stations and maintenance of pipelines. Transport via pipelines includes transport of gases, liquids, slurry and other commodities via pipelines. Distribution of natural or manufactured gas, water or steam from the distributor to final users is excluded and should be reported in 1 A 1 c ii or 1 A 4 a.
1 A 3	e	ii		*Off-road*	Combustion emissions from Other Transportation excluding Pipeline Transport.
1 A 4	c	iii		Fishing (mobile combustion)	Emissions from fuels combusted for inland, coastal and deep-sea fishing. Fishing should cover vessels of all flags that have refuelled in the country (include international fishing).

TABLE 3.1.1 (*continued*)

Code and Name				Explanation
1 A 5	a		*Non specified stationary*	Emissions from fuel combustion in stationary sources that are not specified elsewhere.
1 A 5	b		*Non specified mobile*	Mobile Emissions from vehicles and other machinery, marine and aviation (not included in 1 A 4 c ii or elsewhere). Includes emissions from fuel delivered for aviation and water-borne navigation to the country's military as well as fuel delivered within that country but used by the militaries of other countries that are not engaged in.
			Multilateral Operations (Memo item)	Multilateral operations. Emissions from fuels used for aviation and water-borne navigation in multilateral operations pursuant to the Charter of the United Nations. Include emissions from fuel delivered to the military in the country and delivered to the military of other countries.

TABLE 3.2.1 ROAD TRANSPORT DEFAULT CO_2 EMISSION FACTORS AND UNCERTAINTY RANGES[a]

Fuel Type	Default (kg/TJ)	Lower	Upper
Motor Gasoline	69 300	67 500	73 000
Gas/ Diesel Oil	74 100	72 600	74 800
Liquefied Petroleum Gases	63 100	61 600	65 600
Kerosene	71 900	70 800	73 700
Lubricants [b]	73 300	71 900	75 200
Compressed Natural Gas	56 100	54 300	58 300
Liquefied Natural Gas	56 100	54 300	58 300

Source: Table 1.4 in the Introduction chapter of the Energy Volume.

Notes:

[a] Values represent 100 percent oxidation of fuel carbon content.

[b] See Box 3.2.4 Lubricants in Mobile Combustion for guidance for uses of lubricants.

TABLE 3.2.2 ROAD TRANSPORT DEFAULT N_2O AND CH_4 EMISSION FACTORS AND UNCERTAINTY RANGES[(a)]

Fuel Type/Representative Vehicle Category	**CH_4 (kg /TJ)**			**N_2O (kg /TJ)**		
	Default	**Lower**	**Upper**	**Default**	**Lower**	**Upper**
Motor Gasoline -Uncontrolled [(b)]	33	9.6	110	3.2	0.96	11
Motor Gasoline –Oxidation Catalyst [(c)]	25	7.5	86	8.0	2.6	24
Motor Gasoline –Low Mileage Light Duty Vehicle Vintage 1995 or Later [(d)]	3.8	1.1	13	5.7	1.9	17
Gas / Diesel Oil [(e)]	3.9	1.6	9.5	3.9	1.3	12
Natural Gas [(f)]	92	50	1 540	3	1	77
Liquified petroleum gas [(g)]	62	na	na	0.2	na	na
Ethanol, trucks, US [(h)]	260	77	880	41	13	123
Ethanol, cars, Brazil [(i)]	18	13	84	na	na	na

Sources: USEPA (2004b), EEA (2005a), TNO (2003) and Borsari (2005) CETESB (2004 & 2005) with assumptions given below. Uncertainty ranges were derived from data in Lipman and Delucchi (2002), except for ethanol in cars.

(a) Except for LPG and ethanol cars, default values are derived from the sources indicated using the NCV values reported in the Energy Volume Introduction chapter; density values reported by the U.S. Energy Information Administration; and the following assumed representative fuel consumption values: 10 km/l for motor gasoline vehicles; 5 km/l for diesel vehicles; 9 km/l for natural gas vehicles (assumed equivalent to gasoline vehicles); 9 km/l for ethanol vehicles. If actual representative fuel economy values are available, it is recommended that they be used with total fuel use data to estimate total distance travelled data, which should then be multiplied by Tier 2 emission factors for N_2O and CH_4.

(b) Motor gasoline uncontrolled default value is based on USEPA (2004b) value for a USA light duty gasoline vehicle (car) – uncontrolled, converted using values and assumptions described in table note (a). If motorcycles account for a significant share of the national vehicle population, inventory compilers should adjust the given default emission factor downwards.

(c) Motor gasoline – light duty vehicle oxidation catalyst default value is based on the USEPA (2004b) value for a USA Light Duty Gasoline Vehicle (Car) – Oxidation Catalyst, converted using values and assumptions described in table note (a). If motorcycles account for a significant share of the national vehicle population, inventory compilers should adjust the given default emission factor downwards.

(d) Motor gasoline – light duty vehicle vintage 1995 or later default value is based on the USEPA (2004b) value for a USA Light Duty Gasoline Vehicle (Car) – Tier 1, converted using values and assumptions described in table note (a). If motorcycles account for a significant share of the national vehicle population, inventory compilers should adjust the given default emission factor downwards.

(e) Diesel default value is based on the EEA (2005a) value for a European heavy duty diesel truck, converted using values and assumptions described in table note (a).

(f) Natural gas default and lower values were based on a study by TNO (2003), conducted using European vehicles and test cycles in the Netherlands. There is a lot of uncertainties for N_2O. The USEPA (2004b) has a default value of 350 kg CH_4/TJ and 28 kg N_2O/TJ for a USA CNG car, converted using values and assumptions described in table note (a). Upper and lower limits are also taken from USEPA (2004b)

(g) The default value for methane emissions from LPG, considering for 50 MJ/kg low heating value and 3.1 g CH_4/kg LPG was obtained from TNO (2003). Uncertainty ranges have not been provided.

(h) Ethanol default value is based on the USEPA (2004b) value for a USA ethanol heavy duty truck, converted using values and assumptions described in table note (a).

(i) Data obtained in Brazilian vehicles by Borsari (2005) and CETESB (2004 & 2005). For new 2003 models, best case: 51.3 kg THC/TJ fuel and 26.0 percent CH_4 in THC. For 5 years old vehicles: 67 kg THC/TJ fuel and 27.2 percent CH_4 in THC. For 10 years old: 308 kg THC/TJ fuel and 27.2 percent CH_4 in THC.

TABLE 3.2.3 N_2O AND CH_4 EMISSION FACTORS FOR USA GASOLINE AND DIESEL VEHICLES

Vehicle Type	Emission Control Technology	N_2O		CH_4	
		Running (hot)	Cold Start	Running (hot)	Cold Start
		mg/km	mg/start	mg/km	mg/start
Light Duty Gasoline Vehicle (Car)	Low Emission Vehicle (LEV)	0	90	6	32
	Advanced Three-Way Catalyst	9	113	7	55
	Early Three-Way Catalyst	26	92	39	34
	Oxidation Catalyst	20	72	82	9
	Non-oxidation Catalyst	8	28	96	59
	Uncontrolled	8	28	101	62
Light Duty Diesel Vehicle (Car)	Advanced	1	0	1	-3
	Moderate	1	0	1	-3
	Uncontrolled	1	-1	1	-3
Light Duty Gasoline Truck	Low Emission Vehicle (LEV)	1	59	7	46
	Advanced Three-Way Catalyst	25	200	14	82
	Early Three-Way Catalyst	43	153	39	72
	Oxidation Catalyst	26	93	81	99
	Non-oxidation catalyst	9	32	109	67
	Uncontrolled	9	32	116	71
Light Duty Diesel Truck	Advanced and moderate	1	-1	1	-4
	Uncontrolled	1	-1	1	-4
Heavy Duty Gasoline Vehicle	Low Emission Vehicle (LEV)	1	120	14	94
	Advanced Three-Way Catalyst	52	409	15	163
	Early Three-Way Catalyst	88	313	121	183
	Oxidation catalyst	55	194	111	215
	Non-oxidation catalyst	20	70	239	147
	Heavy Duty Gasoline Vehicle - Uncontrolled	21	74	263	162
Heavy Duty Diesel Vehicle	All -advanced, moderate, or uncontrolled	3	-2	4	-11
Motorcycles	Non-oxidation catalyst	3	12	40	24
	Uncontrolled	4	15	53	33

Source: USEPA (2004b).

Notes:

[a] These data have been rounded to whole numbers.

[b] Negative emission factors indicate that a vehicle starting cold produces fewer emissions than a vehicle starting warm or running warming.

[c] A database of technology dependent emission factors based on European data is available in the COPERT tool at http://vergina.eng.auth.gr/mech0/lat/copert/copert.htm.

[d] Because of the total-hydrocarbon limits in Europe, the CH_4-emissions of European vehicles may be lower than the indicated values from USA (Heeb, et. al., 2003)

[e] These "cold starts" were measured at an ambient temperature of 68°F to 86°F (20°C to 30°C).

TABLE 3.2.4 EMISSION FACTORS FOR ALTERNATIVE FUEL VEHICLES
(*mg/km*)

Vehicle Type **Vehicle Control Technology**	**N_2O Emission Factor**	**CH_4 Emission Factor**
Light Duty Vehicles		
Methanol	39	9
CNG	27 - 70	215 - 725
LPG	5	24
Ethanol	12 - 47	27 - 45
Heavy Duty Vehicles		
Methanol	135	401
CNG	185	5 983
LNG	274	4 261
LPG	93	67
Ethanol	191	1227
Buses		
Methanol	135	401
CNG	101	7 715
Ethanol	226	1 292
Sources: USEPA 2004c, and Borsari (2005) CETESB (2004 & 2005).		

TABLE 3.2.5 EMISSION FACTORS FOR EUROPEAN GASOLINE AND DIESEL VEHICLES (MG/KM), COPERT IV MODEL

Vehicle Type	Fuel	Vehicle Technology/ Class	N_2O Emission Factors (mg/km) Urban Cold	N_2O Urban Hot	N_2O Rural	N_2O Highway	CH_4 Emission Factors (mg/km) Urban Cold	CH_4 Urban Hot	CH_4 Rural	CH_4 Highway
Passenger Car	Gasoline	pre-Euro	10	10	6.5	6.5	201	131	86	41
		Euro 1	38	22	17	8.0	45	26	16	14
		Euro 2	24	11	4.5	2.5	94	17	13	11
		Euro 3	12	3	2.0	1.5	83	3	2	4
		Euro 4	6	2	0.8	0.7	57	2	2	0
	Diesel	pre-Euro	0	0	0	0	22	28	12	8
		Euro 1	0	2	4	4	18	11	9	3
		Euro 2	3	4	6	6	6	7	3	2
		Euro 3	15	9	4	4	7	3	0	0
		Euro 4	15	9	4	4	0	0	0	0
	LPG	pre-ECE	0	0	0	0	80		35	25
		Euro 1	38	21	13	8				
		Euro 2	23	13	3	2				
		Euro 3 and later	9	5	2	1				
Light Duty Vehicles	Gasoline	pre-Euro	10	10	6.5	6.5	201	131	86	41
		Euro 1	122	52	52	52	45	26	16	14
		Euro 2	62	22	22	22	94	17	13	11
		Euro 3	36	5	5	5	83	3	2	4
		Euro 4	16	2	2	2	57	2	2	0
	Diesel	pre-Euro	0	0	0	0	22	28	12	8
		Euro 1	0	2	4	4	18	11	9	3
		Euro 2	3	4	6	6	6	7	3	2
		Euro 3	15	9	4	4	7	3	0	0
		Euro 4	15	9	4	4	0	0	0	0
Heavy Duty Truck & Bus	Gasoline	All Technologies	6		6	6	140		110	70
	Diesel	GVW<16t	30		30	30	85		23	20
		GVW>16t	30		30	30	175		80	70
		Urban Busses & Coaches	30		30	30	175		80	70
	CNG	pre-Euro 4	n.a.				5400			
		Euro 4 and later (incl. EEV)					900			
Power Two Wheeler	Gasoline	<50 cm^3	1		1	1	219		219	219
		>50 cm^3 2-stroke	2		2	2	150		150	150
		>50 cm^3 4-stroke	2		2	2	200		200	200

Notes:

[1] Personal Communication: Ntziachristos, L., and Samaras, Z., (2005), LAT (2005) and TNO (2002).

[2] The urban emission factor is distinguished into cold and hot for passenger cars and light duty trucks. The cold emission factor is relevant for trips which start with the engine at ambient temperature. A typical allocation of the annual mileage of a passenger car into the different driving conditions could be: 0.3/0.1/0.3/0.3 for urban cold, urban hot, rural and highway respectively.

[3] Passenger car emission factors are also proposed for light duty vehicles when no more detailed information exists.

[4] The sulphur content of gasoline has both a cumulative and an immediate effect on N_2O emissions. The emission factors for gasoline passenger cars correspond to fuels at the period of registration of the different technologies and a vehicle fleet of ~50 000 km average mileage.

[5] N_2O and CH_4 emission factors from heavy duty vehicles and power two wheelers are also expected to depend on vehicle technology. There is no adequate experimental information though to quantify this effect.

[6] N_2O emission factors from diesel and LPG passenger cars vehicles are proposed by TNO (2002). Increase in diesel N_2O emissions as technology improves may be quite uncertain but is also consistent with the developments in the after treatment systems used in diesel engines (new catalysts, SCR-$DeNO_x$).

TABLE 3.3.1 DEFAULT EMISSION FACTORS FOR OFF-ROAD MOBILE SOURCES AND MACHINERY[(a)]

	CO_2			CH_4 [(b)]			N_2O [(c)]		
Off-Road Source	**Default (kg/TJ)**	**Lower**	**Upper**	**Default (kg/TJ)**	**Lower**	**Upper**	**Default (kg/TJ)**	**Lower**	**Upper**
				Diesel					
Agriculture	74 100	72 600	74 800	4.15	1.67	10.4	28.6	14.3	85.8
Forestry	74 100	72 600	74 800	4.15	1.67	10.4	28.6	14.3	85.8
Industry	74 100	72 600	74 800	4.15	1.67	10.4	28.6	14.3	85.8
Household	74 100	72 600	74 800	4.15	1.67	10.4	28.6	14.3	85.8
				Motor Gasoline 4-stroke					
Agriculture	69 300	67 500	73 000	80	32	200	2	1	6
Forestry	69 300	67 500	73 000						
Industry	69 300	67 500	73 000	50	20	125	2	1	6
Household	69 300	67 500	73 000	120	48	300	2	1	6
				Motor Gasoline 2-Stroke					
Agriculture	69 300	67 500	73 000	140	56	350	0.4	0.2	1.2
Forestry	69 300	67 500	73 000	170	68	425	0.4	0.2	1.2
Industry	69 300	67 500	73 000	130	52	325	0.4	0.2	1.2
Household	69 300	67 500	73 000	180	72	450	0.4	0.2	1.2

Source: EEA 2005.

Note: CO_2 emission factor values represent full carbon content.

[a] Data provided in Table 3.3.1 are based on European off-road mobile sources and machinery. For gasoline, in case fuel consumption by sector is not discriminated, default values may be obtained according to national circumstances, e.g. prevalence of a given sector or weighting by activity

[b] Including diurnal, soak and running losses.

[c] In general, off-road vehicles do not have emission control catalysts installed (there may be exceptions among off-road vehicles in urban areas, such as ground support equipment used in urban airports and harbours). Properly operating catalysts convert nitrogen oxides to N_2O and CH_4 to CO_2. However, exposure of catalysts to high-sulphur or leaded fuels, even once, causes permanent deterioration (Walsh, 2003). This effect, if applicable, should be considered when adjusting emission factors.

TABLE 3.4.1 DEFAULT EMISSION FACTORS FOR THE MOST COMMON FUELS USED FOR RAIL TRANSPORT

Gas	**Diesel (kg/TJ)**			**Sub-bituminous Coal (kg/TJ)**		
	Default	Lower	Upper	Default	Lower	Upper
CO_2	74 100	72 600	74 800	96 100	72 800	100 000
CH_4 [1]	4.15	1.67	10.4	2	0.6	6
N_2O [1]	28.6	14.3	85.8	1.5	0.5	5

Notes:

[1] For an average fuel consumption of 0.35 litres per bhp-hr (break horse power-hour) for a 4000 HP locomotive, (0.47 litres per kWh for a 2983 kW locomotive).(Dunn, 2001).

[2] The emission factors for diesel are derived from (EEA, 2005) (Table 8-1), while for coal from Table 2.2 of the Stationary Combustion chapter.

TABLE 3.4.2 POLLUTANT WEGHTING FACTORS AS FUNCTIONS OF ENGINE DESIGN PARAMETERS FOR UNCONTROLLED ENGINES
(*Dimensionless*)

Engine type	CH_4	N_2O
Naturally Aspirated Direct Injection	0.8	1.0
Turbo-Charged Direct Injection / Inter-cooled Turbo-Charged Direct Injection	0.8	1.0
Naturally Aspirated Pre-chamber Injection	1.0	1.0
Turbo-Charged Pre-chamber Injection	0.95	1.0
Inter-cooled Turbo-Charged Pre-chamber Injection	0.9	1.0
Source: EEA 2005 (Table 8-9);		

TABLE 3.5.2 DEFAULT WATER-BORNE NAVIGATION CO_2 EMISSION FACTORS

		kg/TJ		
Fuel		**Default**	**Lower**	**Upper**
Gasoline		69 300	67 500	73 000
Other Kerosene		71 900	70 800	73 600
Gas/Diesel Oil		74 100	72 600	74 800
Residual Fuel Oil		77 400	75 500	78 800
Liquefied Petroleum Gases		63 100	61 600	65 600
Other Oil	Refinery Gas	57 600	48 200	69 000
	Paraffin Waxes	73 300	72 200	74 400
	White Spirit & SBP	73 300	72 200	74 400
	Other Petroleum Products	73 300	72 200	74 400
Natural Gas		56 100	54 300	58 300

TABLE 3.5.3 DEFAULT WATER-BORNE NAVIGATION CH_4 AND N_2O EMISSION FACTORS

	CH_4 (kg/TJ)	N_2O (kg/TJ)
Ocean-going Ships *	7 $\pm$ 50%	2 +140% -40%

*Default values derived for diesel engines using heavy fuel oil.
Source: Lloyd's Register (1995) and EC (2002)

TABLE 3.6.4 DEFAULT CIVIL AVIATION CO_2 EMISSION FACTORS

Fuel	Default (kg/TJ)	Lower	Upper
Aviation Gasoline	70 000	67 500	73 000
Jet Kerosene	71 500	69 800	74 400

TABLE 3.6.5 DEFAULT CIVIL AVIATION NON-CO_2 EMISSION FACTORS

Fuel	CH_4 Default (Uncontrolled) Factors (in kg/TJ)	N_2O Default (Uncontrolled) Factors (in kg/TJ)	NO_X Default (Uncontrolled) Factors (in kg/TJ)
All fuels	0.5[a] (-57%/+100%)[b]	2 (-70%/+150%)[b]	250 ±25%[c]

[a] In the cruise mode CH_4 emissions are assumed to be negligible (Wiesen *et al.*, 1994). For LTO cycles only (i.e., below an altitude of 914 metres (3000 ft.)) the emission factor is 5 kg/TJ (10% of total VOC factor) (Olivier, 1991). Since globally about 10% of the total fuel is consumed in LTO cycles (Olivier, 1995), the resulting fleet averaged factor is 0.5 kg/TJ.

[b] IPCC, 1999.

[c] Expert Judgement.

Emission factors for other gases (CO and NMVOC) and sulphur content which were included in the 1996 IPCC Guidelines can be found in the EFDB.

Annex II

PROJECT PRESENTATION TEMPLATES[4]

PROJECT IDENTIFICATION FORM

GENERAL COMMENTS AND ADDITIONAL INFORMATION
(*Please add additional pages as necessary*)

This page is to be completed for all projects

Brief project description   **The nature of the market for the enterprise's products or services** (Briefly discuss the nature of the market, its location and size, type of consumers, financial position of buyers, advantages of your product or service over the competition)   **Benefits details** (Describe the benefits to the national and local economy expected from the project, covering the specific impact on: energy and environmental improvements, export promotion, import substitution, job creation, productivity improvements, technology transfer)   **Greenhouse gas emission reduction** (Describe how the project will contribute to this providing an indication of volume)

[4] Adapted from templates developed by UN ECE in the context of the implementation of the UN DA project on "Promoting Energy Efficiency Investments for Climate Change Mitigation and Sustainable Development".

PROPOSED INVESTMENT AND FINANCING NEEDS
(*Please add additional pages as necessary*)

This page is to be completed for all projects

Investment & Financing needs	Detail	**Estimated investment cost** in EUR	**Estimated revenues** in EUR/year
Design and Engineering			
Land, infrastructure			
Equipment			
Construction			
Operation cost			
Others			
Total investments and revenues			

Lifetime of the project		Proposed start of implementation		Expected implementation time	
Years		(day/month/year)		Years	Months

OUTLINE FINANCING PLAN

	Type (in kind/equity/cash)	**EUR**	**% of Total**	**Interest rate** (cost of capital)%
Owner's Equity				
Other Equity				
Bank Loans				
Other Loans				
Grants				
What kind of guarantees are available (bank/utility/government)?				

SUMMARY CASHFLOW ANALYSIS
(*Please add additional pages as necessary*)

This page is to be completed for all projects

All figures in EUR thousand

Year	**0**	**1**	**2**	**3**	**4**	**Add as required**
1. Capital investment						
2. Revenue						
3. Energy generation or savings						
4. Other benefits and income[5],						
5. Operation & Maintenance cost						
6. Other costs						

[5] From the sale of carbon credits, for example.

SPECIFIC PROJECT INFORMATION

(*Please add additional pages as necessary*)

The subsequent pages should only be completed as relevant

A. ENERGY EFFICIENCY IN BUILDINGS

Building category (Hospital, apartments, office, school): ________________						Year of construction: ……… Heated floor area: m^2 Cooled floor area: m^2			
Type of heating system: Type of cooling system: Type of ventilation system: Type of domestic hot water system: Type of automatic control system: Other energy consuming installations? **Legal status of owner/sponsor (mark appropriate box):**									
Public Institution		Municipality		To be privatized		Private Institution		Other (specify):	

Energy Consumption

	Energy meters installed? (Yes/no?)	**Annual consumption** Year Before	Last Year	**Today's price** in EUR
Electricity, total energy			kWh	/kWh
Electricity, max power			kW	/kW
District heating			MJ	/MJ
Oil			tons	/tons
Gas			m^3	$/m^3$
Other				

Energy bill based on (measurement____, m^3___, m^2____):

Who pays the energy bills, and from what source(s)?

SPECIFIC PROJECT INFORMATION

(*Please add additional pages as necessary*)

The subsequent pages should only be completed as relevant

B. ENERGY EFFICIENCY IN INDUSTRY

Industrial category: ______________________ Products:

No of employees: Turnover Last Year (EUR):

Company History, Activities and Prospects (Briefly discuss the nature, strengths, risks, current situation and future plans of the business):

Legal status of owner/sponsor (mark appropriate box):

Public Company		Municipality		To be privatized		Private Company		Other (specify):	

Energy Consumption

	Energy meters installed? (Yes/no?)	**Annual consumption** Year Before	Last Year	**Today's price** in EUR
Electricity, total energy			kWh	/kWh
Electricity, max power			kW	/kW
District heating			MJ	/MJ
Oil			tons	/tons
Gas			m^3	$/m^3$
Other				

SPECIFIC PROJECT INFORMATION
(*Please add additional pages as necessary*)

The subsequent pages should only be completed as relevant

C. ELECTRICITY PRODUCTION AND DISTRIBUTION

Plant/installation capacity: ________________ ____________ MW

Annual generation/savings: MWh/y

Type of project (wind, photovoltaic, hydro, geothermal, biomass, heat only, co-generation, captive, transmission line, substation) and number of units:

Transmission/Distribution network and access (distance, length, voltage):

Number of substations:
Power Purchase Agreement (tariff, duration, guarantees, other conditions):

Feasibility studies and measurements:

Land, environmental, generation, connection and other licences and permits:

Other relevant information:

Legal status of owner/sponsor (mark appropriate box):

Public Company		Municipality		To be privatized		Private Company		Other (specify):		

SPECIFIC PROJECT INFORMATION
(*Please add additional pages as necessary*)

The subsequent pages should only be completed as relevant

D. HEAT PRODUCTION AND DISTRIBUTION

<table>
<tr><td colspan="5">Plant capacity: MW</td><td colspan="5">If existing, year of construction:</td></tr>
<tr><td colspan="10">Type of boilers installed (heat only, co-generation, captive):</td></tr>
<tr><td colspan="10">Distribution net extension: m
Age of net:
Number of distribution substations:</td></tr>
<tr><td colspan="10">Main end-users/customers (number, private/commercial, etc.):</td></tr>
<tr><td colspan="10">Any renovation implemented the last 3 years?

Legal status of owner/sponsor (mark appropriate box):</td></tr>
<tr><td>Public Company</td><td></td><td>Municipality</td><td></td><td>To be privatized</td><td></td><td>Private Company</td><td></td><td>Other (specify):</td><td></td></tr>
</table>

Energy Consumption

	Energy meters installed? (Yes/no?)	**Annual consumption** Year Before Last Year	**Today's price** in EUR
Oil		tons	/tons
Gas		m^3	$/m^3$
Electricity		kWh	/kWh
Others			

SPECIFIC PROJECT INFORMATION
(*Please add additional pages as necessary*)

The subsequent pages should only be completed as relevant

E. CHILLED WATER PRODUCTION AND DISTRIBUTION

<table>
<tr><td colspan="5">Plant capacity: MW</td><td colspan="5">If existing, year of construction:</td></tr>
<tr><td colspan="10">Type of chillers installed (cooling only, tri-generation, etc.):</td></tr>
<tr><td colspan="10">Distribution net extension: m
Age of net:
Number of distribution substations:</td></tr>
<tr><td colspan="10">Main end-users/customers (number, private/commercial, etc.):</td></tr>
<tr><td colspan="10">Any renovation implemented the last 3 years?

Legal status of owner/sponsor (mark appropriate box):</td></tr>
<tr><td>Public Company</td><td></td><td>Municipality</td><td></td><td>To be privatized</td><td></td><td>Private Company</td><td></td><td>Other (specify):</td><td></td></tr>
</table>

Energy Consumption

	Energy meters installed? (Yes/no?)	**Annual consumption** Year Before Last Year	**Today's price** in EUR
Oil		tons	/tons
Gas		m^3	$/m^3$
Electricity		kWh	/kWh
Others			

SPECIFIC PROJECT INFORMATION
(*Please add additional pages as necessary*)

The subsequent pages should only be completed as relevant

F. STREET LIGHTING

Type of street lighting: Year of construction: Total installed capacity (kW): Number of light fittings: Prevailing types and capacities (W): Type of control (manual, timer, day light control): **Legal status of owner/sponsor (mark appropriate box):**										
Public Company		Municipality		To be privatized		Private Company		Other (specify):		

Energy Consumption

	Energy meters installed? (Yes/no?)	**Annual consumption** Year Before	Last Year	**Today's price** in EUR
Electricity, total (energy)			kWh	/kWh
Electricity, total (power)			kW	/kW
Electricity, day			kWh	/kWh
Electricity, night			KWh	/kWh

Who pays the energy bills, and from what source(s)?

Date:________________	Name: _________________________ Signature: ____________________