EBRD Methodology for Assessment of Greenhouse Gas Emissions

Guidance for consultants working on EBRD-financed projects

Introduction to the scope of EBRD GHG assessments

1. Projects covered by GHG assessment

EBRD has assessed the impact on greenhouse gas (GHG) emissions of its direct investments (loan and equity) since 2003. Summaries have been published in the Bank's annual Environmental or Sustainability Reports since that date. Although in most years all direct investment projects with emissions, or emissions savings, exceeding 20 kt CO_2e per annum have been assessed, the focus has been on large projects, i.e. those emitting > 100 kt per annum, mainly in the energy and industrial sectors, which dominate the portfolio GHG footprint. Some sectors (see GN1) are screened out on the basis of low GHG impact. Some direct investments involving corporate loans and most projects supported through financial intermediaries (FI) are generally not assessed as there is insufficient information on the precise nature of these investments.

From November 2008, the Bank's Environmental and Social Policy mandates, *inter alia*, clients to procure and report the data necessary for GHG assessment for projects whose emissions are expected to exceed 100 kt CO_2e per annum (see Annex 1 to this Guidance).

2. Project GHG and ΔGHG

In keeping with the Bank's *transition* mandate, the assessment has sought to estimate the *change* in GHG emissions (ΔGHG) brought about by investments. This is the difference between the emissions following the implementation of the project investment and the emissions that would have occurred in its absence. Estimation of the post-investment emissions is relatively straightforward and amenable to routine monitoring during the project lifetime. In contrast, definition and estimation of the *baseline* or *reference* emissions, reflecting the emissions that would have occurred in the absence of the investment, are not well defined. The concept of baseline or reference emissions may be interpreted in a variety of ways. Baseline or reference emissions are not amenable to measurement. They must be based on a set of assumptions, which may range from the very simple to the highly complex. There is generally no 'right answer'. EBRD has generally followed a simple approach, but depending on the extent of information available and the extent to which future developments can be predicted, an attempt is made to provide the best estimate possible of the GHG impact of the project.

3. Project and baseline (reference) emissions and project boundaries

For projects seeking to benefit from the Kyoto Protocol flexibility mechanisms (e.g. Joint Implementation (JI) and the Clean Development Mechanism (CDM)) project and baseline emission assessments are based on methodologies approved under the United Nations Framework Convention on Climate Change (UNFCCC)[1].

[1] Although such methodologies are also available for the building sector, emission reductions realised in EBRD projects in the building sector are assessed based on the energy savings resulting from the project compared to a baseline. These energy savings are calculated according to: the ISO EN 13790/2008 *Energy performance of buildings — Calculation of energy use for space heating and cooling;* the EN 15603/2008 *"Energy performance of buildings — Overall energy use, CO_2 emissions and definition of energy ratings"* and other EN standards complementary to the European Directive on Energy Performance of Buildings 2002/91/EC. This approach is

For most other projects, the project emission is taken as the annual emission occurring once the project has been fully implemented; the baseline emission is a representative pre-project emission, usually zero where the project is a green-field development or the facility annual emissions pre-investment where the project comprises upgrading or refurbishment[2]. In general, estimates of project GHG and ΔGHG aggregated (or averaged) over the lifetime of the project (actual or investment lifetime) have not been made, although such estimates could easily be calculated if required.

Some projects, particularly those involving high emissions, may have a sufficiently large impact on their sector to generate consequences well beyond the project boundary and influence future sector scenarios over a period of time. In these circumstances, if sufficient information can be obtained, it may be appropriate to replace the static baseline (pre-project emissions) with a dynamic reference ('without-project') scenario over the project lifetime. This would be compared with a similar 'with-project' scenario to derive the GHG impact. This more sophisticated form of assessment (closer in nature to that required for JI and CDM projects) is only likely to be undertaken for projects with emissions of order 1 Mt CO_2 pa or above, and its need would be discussed between the Bank and the client.

The project boundary is generally defined as the geographical boundary of the facility but may need to include associated facilities where these exist solely to serve the project[3]. Where a project involves, say, a change from in-house production to external sourcing of a feedstock, project boundaries may need to be drawn to include external operations to ensure no fundamental difference in the scope of 'service provision' between the baseline and the project. Where a project is a direct replacement for some, or all, of another, separate, existing facility (e.g. one owned by the same entity) this latter facility may be brought within the project boundary, provided the closure is certain to take place within a short time of project implementation. Renewable energy power generation projects are assumed to displace the emissions associated with the national average grid electricity generation (see GN5).

4. Scope of emissions assessed

Direct emissions from within the project boundary together with the estimated emissions associated with the generation of grid electricity used by the project are included in the assessment. Other upstream emissions associated with the provision of materials used by the project or downstream emissions from the use of the goods and services generated by the project are not included.[4]

5. GHG Performance metrics

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consistent with available UNFCCC methodologies for the building sector (UNFCCC approved small-scaled methodology AMS-II.E.).

[2] For built environment projects, the Baseline is defined by the energy performance of existing premises for building refurbishment projects. In case of change of operational patterns or purpose of use of existing premises, the energy performance is assessed according to characteristics of existing building structures under indoor climate requirements for the new facility. For greenfield projects the Baseline is defined based on the energy use resulting from the application of the technical requirement and minimum performance criteria set by national standards and technical rules, as these are mandatory for builders and designers. It is assumed that even without the Bank investments projects are compliant with these requirements.

[3] This conditional extension of the project boundary to encompass other facilities is consistent with the definition of 'area of influence' over which EBRD projects must be appraised, according to paragraph 6 of Performance Requirement 1 of EBRD's Environmental and Social Policy, May 2008

[4] Using the definitions adopted by the GHG Protocol of the WBCSD/WRI, direct emissions are termed 'Scope 1', emissions from grid electricity used are 'Scope 2' while other upstream and downstream emissions are 'Scope 3'.

Project GHG and ΔGHG are generally calculated/reported for the whole project, rather than in proportion to the Bank's financial involvement, on the premise that the project would be unlikely to proceed without the Bank's participation.

EBRD investments invariably improve the efficiency of production even where increased production outweighs this, leading to an increase in overall emissions. To demonstrate this benefit, GHG emissions *per unit of product output* should be calculated for the project and baseline cases, in addition to the absolute GHG emissions.

6. Contents of this guidance

This document contains guidance for EBRD-appointed consultants or in-house practitioners on applying the EBRD Methodology for Assessment of Greenhouse Gas Emissions.

The methodology outlined seeks to ensure that greenhouse gas emission assessments are carried out in a systematic manner, using data whose sources are documented and recording all assumptions and methods of calculation. However, no generalised methodology can hope to meet the needs of every project; inevitably, the consultant will find occasion where he or she needs to use his or her own professional judgement. In such instances, any assumptions made and any departures taken from the recommended methods should be recorded. As a general guide, procedures and assumptions that are accepted in the preparation of projects for JI and CDM support will be acceptable for the assessment of EBRD projects.

This methodology is intended for use on all projects for the purposes of estimating the impact of project implementation on overall GHG emissions and identifying during project appraisal opportunities for GHG reduction. For projects seeking JI or CDM accreditation under the Kyoto Protocol Mechanisms, an analysis will be required following protocols approved by the UNFCCC for such projects. These requirements are not covered by this guidance.

Seven Guidance Notes are provided to assist Consultants in applying the Methodology: GN 0 identifies project types for which GHG assessment is generally not required. GN 1 covers the principles involved in setting the scope of the assessment. GN 2–6 provide technical guidance on the identification of principal direct and indirect emission sources and the recommended methods for estimating greenhouse gas emissions or emissions savings:

GN 0 Initial GHG Screening
GN 1 Assessment Scope
GN 2 Direct emission sources from various industrial sectors
GN 3 Direct GHG Emissions: Data Requirements and Recommended Methods of Calculation
GN 4 Estimation of indirect emissions from imported electricity and heat
GN 5 Generation of electricity from renewable resources
GN 6 Global Warming Potentials for calculation of total GHG (CO_2 equivalent) emissions

EBRD GHG ASSESSMENT METHODOLOGY GUIDANCE NOTE GN0

GN 0 Initial GHG Screening

The Bank needs to know the overall level of GHG emissions from operation of facilities with which, through investment, it will become associated, and the change in emissions brought about by the investment. All projects should therefore be subject to initial screening to assess the likely scale of GHG emissions involved. The purpose of screening is to provide an early indication of the likely importance of the project as a contributor to the Bank's GHG footprint and the scope that might exist for GHG reduction initiatives. The screening process allocates a project to an emission category reflecting the scale of existing or, in the case of new-build projects, future emissions from the facilities where the investment is to be made[5]. The following categories are based on previous analysis of typical Bank projects:

- Negligible (no GHG assessment necessary)
- Low (< 20 kt/y CO_2-equivalent per year. See GN 6 for relative importance of different GHGs and their CO_2-equivalence (CO_2-e))
- Medium-Low (20 – 100 kt CO_2-e /y)
- Medium-High (100 kt – 1 Mt CO_2-e /y)
- High (>1 Mt CO_2-e /y)

Negligible emission category

For the purposes of GHG assessment for the Bank, projects involving the following activities are categorised as *Negligible*, with no GHG assessment required:

- Telecommunications
- Wood processing using wood waste as the principal fuel
- Civil construction projects
- Drinking water supply networks
- Industrial waste water treatment
- Municipal waste water treatment where sewage sludge is digested or incinerated
- Small-size built environment projects (overall floor area bellow 1,000 m^2)

Projects in the Low and Medium-Low categories (see below) are not subject to mandatory GHG assessment under the EBRD Environment and Social Policy. However, there may be occasions when projects falling within these categories are assessed and in such cases the same methodology should be used.

Low emission category (< 20 kt CO_2e pa)

Typical Bank investments in the following areas are likely to have *Low* emissions, although in some cases the size of project may result in emissions above the 20 kt threshold. It would be more acceptable to use default emission parameters in the evaluation of these projects than in

[5] Note that the category does not necessarily reflect the scale of change in GHG emissions that the project will bring about. However, the screening is conservative in the sense that investment in projects with negligible or low existing emissions cannot generate a large absolute change in emissions, so screening them out of the GHG assessment process does not risk missing significant GHG change, Projects in the medium and high emission categories may or may not lead to significant GHG change, but the larger changes across the portfolio will necessarily come from these categories. Medium and High emission projects will be screened for assessment and this will reveal the scale of change.

the evaluation projects screened in the Medium and High categories:

- Property developments (offices, hotels, retail)
- Municipal facilities, including waste water treatment involving sludge landfill without methane flaring/collection
- Light industrial facilities (non-energy intensive, e.g. assembly)
- Food manufacturing facilities
- Agricultural processing facilities
- Road development schemes (only assessed if traffic modelling studies available)

Medium-Low category (20 - 100 kt CO_2e pa)

- Municipal solid waste landfill
- Brick, tyre, manufacture
- Locomotive, ship, transport fleet purchases
- Power transmission line upgrades (GHG savings) (may be Medium-High, depending on generation mix and scale of investment)

Projects in the Medium-high and High categories (see below) are subject to mandatory GHG assessment under the EBRD Environment and Social Policy (see Annex 1 to this Guidance).

Medium-High category (100 kt – 1 Mt CO_2e pa)

- Power transmission line upgrades (GHG savings) (may be Medium-Low, depending on generation mix and scale of investment)
- Fuel production and processing (may be High for major oil and gas developments)
- Glass manufacturing
- Petrochemicals manufacturing
- Small metal manufacturing and processing plants
- Small cement and lime works
- Small power generating plants
- District heating networks (savings)

High category (> 1Mt CO_2e pa)

- Large fossil-fired power generating plant
- District heat and power systems
- Large metal smelting and processing facilities
- Major oil and gas production/transportation systems
- Large cement works

The above lists are not exhaustive and serve only as an initial guide.

Additional guidance on the likelihood of emissions exceeding the 100 kt CO_2e pa threshold mandated for GHG assessment is provided in Annex A of IFC's Guidance Note 3 Pollution and Prevention[6]. This may be used to inform initial assessment of whether a project is likely to fall above or below the threshold.

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6 http://www.ifc.org/ifcext/sustainability.nsf/AttachmentsByTitle/pol_GuidanceNote2007_3/$FILE/2007+Updated+Guidance+Note_3.pdf

EBRD GHG ASSESSMENT METHODOLOGY GUIDANCE NOTE GN1

GN 1 Assessment Scope

1. Greenhouse Gases

For many projects, carbon dioxide emissions will constitute the bulk of the greenhouse gas emissions. However, some combustion and industrial processes release amounts of other GHGs which have significant global warming potential. Guidance Note GN 2 lists the potentially significant GHG emissions from a wide range of processes. Assessment should be undertaken for those gases listed against project-relevant processes, using the calculation methods set out in Guidance Note GN 3. If consultants have valid reasons for departing from the recommended methods of assessment and calculation, these should be clearly stated.

2. Project Boundary

The default project boundary is the physical (geographical) boundary of the project facility. Consideration should be given to extending the default boundary in the following circumstances:

- where upstream or downstream processes directly linked with the project, and which exist/operate only as a result of the project, have GHG emissions which are likely to be significant relative to project GHG emissions (e.g. a dedicated mining operation that would otherwise not exist, or an associated waste or by-product utilisation facility)

- where an integral part of the business of the project is contracted out to a third party operator on whom the operation of the project is dependent.

It is essential that the project boundary definition is applied consistently to the project and to the baseline/reference scenario (see below) to ensure that a valid comparison of 'with-project' and 'without-project' emissions can be made.

3. Baseline or Reference Scenario

The Baseline or Reference Scenario emissions are the hypothetical emissions that would prevail in the absence of the project.

For projects not seeking JI or CDM accreditation, a static baseline is generally considered adequate, although, as described in Paragraph 3 of the Introduction, for 'High' emission projects a more sophisticated assessment using a dynamic reference scenario, similar to that adopted for JI/CDM projects, may be appropriate. The need for such an assessment would be discussed with the client.

In the majority of cases where a static baseline is appropriate, an assessment should therefore be made of the emissions that would have continued to occur in the absence of the project at a single point in time at or near the time of project commissioning. For a plant upgrade project, the baseline will typically be the emissions from the plant prior to upgrade. For a new facility, the baseline will ideally be the emissions from other operations that are certain to be displaced by the operation of the new facility. Attempts should be made to secure a clear and reliable statement of such closures. If no such firm commitments exist, a conservative approach for new facility projects should be taken, assuming all the emissions are additional – i.e. zero emissions for the pre-project baseline.

Once the Baseline has been established, the GHG emissions associated with the baseline should be calculated using the EBRD methodology. This will require data and information about existing emissions from the facilities that will be modified or replaced by the project. It is essential that the methods used to calculate the baseline and post-investment emissions are consistent to ensure valid comparison of emissions.

4. Direct and Indirect Emissions

Direct emissions are those from processes occurring within the physical project boundary, together with those emissions from any integral component of the project which, although located elsewhere, has been included within the project boundary as defined in 2 above. Where the scope of project activity differs between the project and the baseline it may be necessary for consistency to include in either the project or baseline assessment an emission source that would otherwise be excluded. An example would be where a feedstock previously manufactured on site is to be imported as part of the new project. In this case, emissions from the external manufacture of the feedstock should be included as direct project emissions, or, alternatively, emissions from on-site manufacture should be excluded from the baseline emissions.

Direct emissions should comprise the relevant principal energy and process emissions listed in GN 2.

Indirect emissions are those which arise solely as a result of the project's existence but which occur outside the project boundary. This definition *could* be interpreted in a 'cradle-to-grave' manner, including all upstream emissions, e.g. those associated with fuel and feedstock production, and downstream emissions, e.g. those associated with product use. However, such a life-cycle approach is not considered practical or appropriate. In most cases assessment of indirect emissions may reasonably be restricted to the emissions associated with electricity or heat imports where these provide a significant source of energy for the project. (The rationale for including third party electricity generation emissions as part of the project emissions is that electricity use is under the control of the user - if the power is not demanded the emissions do not occur[7].) Specific guidance on the estimation of emissions arising from the production of imported electricity and heat is given in GN 4. The assessor should consider whether any features of the project give rise to other significant indirect emissions which need to be evaluated – for example the creation of a new feedstock production facility dedicated to supplying the project, if this has not already been incorporated within the defined project boundary. Note, however, that emissions from third party use of marketed fuels and products arising from a project are conventionally regarded as third party emissions and not as indirect emissions from the project. These are therefore not regarded as indirect emissions in the methodology and are not assessed.

As in the case of direct emissions, there must be consistency between project (post-investment) and baseline over the scope of indirect emissions included.

5. Adequacy of data

Annual GHG emissions may in principle be derived, with varying accuracy, from a range of primary or secondary data sources. Project documentation may often appear to provide sufficient data to enable a choice of calculation method, although assumptions used in deriving secondary data are not always adequately stated in project documents. Inconsistency

[7] Notwithstanding this approach, emissions from fuel use are ascribed to power generation projects in the EBRD portfolio. The issue of 'double counting' these emissions would only need to be addressed in the context of a national inventory.

between alternative calculation methods may then arise. Assessors should, where possible, aim to use methods of calculation based on primary rather than secondary data, thereby minimising the need to use non-project-specific default parameters.

6. Specific Emissions / Emissions per unit of output

Where a new facility has a substantially higher output than the facilities displaced and thus contributes to an increase in the size of service provision, the project emissions may exceed the baseline emissions even though the project may be operating at much greater efficiency. Where a change in service provision occurs, it is not considered appropriate to scale the baseline emission upwards to match the new service level as this distorts the net greenhouse gas emissions impact of the project. Instead, the assessment should include a calculation of GHG emissions per unit of output from the facility (e.g. t CO_2 / KWhe, t CO_2 / tonne product) to demonstrate the efficiency improvement.

EBRD GHG ASSESSMENT METHODOLOGY IMPLEMENTATION GUIDANCE NOTE **GN 2**

GN 2 Direct emission sources from various industrial sectors

Sector	Major direct emission sources	Notes
Energy resource exploration and refinery/processing projects (EBRD Natural Resources)	Fossil Fuel combustion: CO_2 Flaring: CO_2 Leakage, fugitive emissions, venting: CH_4 Coal mining releases: CH_4	
Energy conversion and distribution projects (EBRD Power & Energy)	Fossil Fuel combustion: CO_2 Fossil Fuel combustion in fluidised beds: $CO_2 + N_2O$ Biomass Fuel combustion: $CH_4 + N_2O$ Electricity transmission equipment: SF_6 Flue Gas Desulphurisation: CO_2	CO_2 emissions from biomass combustion assumed to be GHG neutral as they are part of the biological cycle
Energy efficiency and conservation projects (EBRD Energy Efficiency)	Fossil Fuel combustion: CO_2 Fossil Fuel combustion in fluidised beds: $CO_2 + N_2O$ Biomass Fuel combustion: $CH_4 + N_2O$	
Industrial production projects - Aluminium - Other non-Fe metals - Iron & steel - Nitric Acid - Ammonia - Adipic Acid - Cement - Lime - Bricks/tiles - Glass - Pulp & Paper - Refrig'n/Air conditioning (EBRD Sector and Country Teams)	Fuel combustion (CO_2, CH_4, N_2O) as per energy emissions above plus the following **PROCESS** emissions, which may or may not be partially controlled: CO_2 , PFCs (CF_4, C_2F_6,) & possibly SF_6 if used as cover gas CO_2 if C used as reducing agent & possibly SF_6 CO_2 from reducing agent, from carbonate flux & C loss ore to steel N_2O CO_2 from regeneration of CO_2-stripping solvent N_2O from ketone-alcohol reaction with HNO_3 CO_2 from calcining of limestone to produce lime for clinker prod'n CO_2 from calcining of limestone None CO_2 from limestones where used in process Process emissions are biomass related and considered CO_2-neutral HFCs from manufacture of HFCs, and from system leakage/disposal	In iron production, fossil fuel carbon plays dual role of fuel and reducing agent: hence need to ensure double counting is avoided
Municipal and Environmental Infrastructure projects - solid waste landfill - solid waste inciner'n - waste-water treatment (EBRD MEI)	CH_4 CO_2 (from fossil-derived waste) + N_2O CH_4	CO_2 from landfill and from biomass-derived waste incineration assumed to be GHG neutral as part of biological cycle. (CH_4 from waste incineration considered by IPCC to be insignificant)
Transport projects (EBRD Transport)	Fuel combustion: CO_2 Fuel combustion – gasoline + 3-way cat: $CO_2 + N_2O$	CO_2 accounts for 97% of transport GHG emissions. N_2O may be a significant contributor from gasoline cars with 3-way catalysts.

EBRD GHG ASSESSMENT METHODOLOGY **GN 3**
IMPLEMENTATION GUIDANCE NOTE

GN 3 Direct GHG Emissions: Data Requirements and Recommended Methods of Calculation

Data input requirements and methods of calculation are provided for the following sector or cross-sector emission sources. Note that the Stationary Combustion calculations will need to be carried out for any project in which where fuels are burned to provide energy.

- Stationary Fossil Fuel Combustion (CO_2)
- Stationary Fossil Fuel Combustion in Fluidised Beds (N_2O)
- Stationary Biomass Fuel Combustion (CH_4 and N_2O)
- Oil / Gas production and processing (CO_2 and CH_4)
- Coal Mining (CH_4)
- Electricity Transmission (SF_6)
- Flue Gas Desulphurisation (CO_2)
- Aluminium Production (CO_2)
- Aluminium Production (PFCs)
- Iron and Steel Production (CO_2)
- Nitric Acid Production (N_2O)
- Ammonia Production (CO_2)
- Adipic Acid Production (N_2O)
- Cement (Clinker) Production (CO_2)
- Lime Production (CO_2)
- Glass Manufacture (CO_2)
- Refrigeration/Air conditioning/Insulation industry (HFCs)
- Solid Waste Landfill (CH_4)
- Municipal Solid Waste Incineration (CO_2 and N_2O)
- Municipal Waste Water Treatment (CH_4)
- Transport (CO_2)
- Transport (N_2O)

Note for Users:

The methods of calculation and default data provided in this Guidance Note are, unless otherwise stated, based on approaches recommended by the 1996 IPCC Guidelines for National Greenhouse Gas Inventories and IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories. The former document has been updated by the 2006 edition referenced below which should be consulted to check for any changes in default parameters if these are employed, although for most purposes, the parameters tabulated based on the 1996 IPCC guidance should be adequate.

> *2006 IPCC Guidelines for National Greenhouse Gas Inventories (5 volumes)*
> *http://www.ipcc-nggip.iges.or.jp/public/2006gl/index.html*

For many of the sectors covered, the WRI/WBCSD GHG Protocol provides spreadsheet tools based on the same calculations as presented here. Users of the EBRD Methodology may choose to use these tools where appropriate to automate the calculations or to construct a project-specific spreadsheet for this purpose. However, in order to have a formal record of the basis of the GHG assessment calculations, the assessment should show clearly the data employed and their sources and the calculations performed.*

** http://www.ghgprotocol.org*

Sector Emission	Input Data Requirements	Calculation Method	Notes

Stationary fossil fuel combustion - CO_2	(i) Annual fuel use in energy units, or mass units
	
	(ii) Carbon intensity of fuel (tC/TJ)
	or
	(iii) Carbon content of fuel (tC/t fuel)
	or
	(iv) Calorific Value of fuel (TJ/t fuel)
	
	(v) Carbon Fraction oxidised
	
	Where site-specific data unavailable, use default emission factors::
	
	For (ii): Carbon intensity
	Coal 25.8 tC/TJ
	Lignite 27.6 tC/TJ
	Oil 20.0 tC/TJ
	Gas 15.3 tC/TJ
	
	For (iii): Carbon content
	Coal 0.61 tC/t fuel
	Oil 0.84 tC/t fuel
	Gas 0.80 tC/t fuel
	
	NB Default C content of crude oil may be derived from:
	C (% wt) = 76.99 + (10.9 x SG) – (0.76 x sulphur (% wt))
	where SG = 141.5 / (API + 131.5)
	
	For (v): Carbon fraction oxidised:
	
	Coal 0.98
	Oil 0.99
	Gas 0.995
		CO2 (t) =
		
		Fuel energy use (TJ) x Carbon Intensity (tC/TJ) x Carbon fraction oxidised x 3.664
		
		Or
		
		Fuel mass use (t) x carbon content (tC/t fuel) x Carbon fraction oxidised x 3.664
		
		Or
		
		Fuel mass use (t) x calorific value (TJ/t) x Carbon Intensity (tC/TJ) x Carbon fraction oxidised x 3.664
		
		Note default carbon content values are the same as the product of a default calorific value and a default carbon intensity
			NB Default carbon content data are less reliable than default carbon intensity data and should only be used as last resort when no information on fuel energy content available.
			
			(Note factor 3.664 is the ratio of the molecular weights of CO_2 and C (44/12)

Sector Emission	Input Data Requirements	Calculation Method	Notes
Stationary fossil fuel combustion in Fluidised Beds – N_2O	(i) Fuel energy input (derive from data above) (ii) Default emission factor: 0.096 t N_2O / TJ energy input	N_2O (t) = Fuel energy input x emission factor	
Stationary biomass fuel combustion - CH_4 and N_2O	(i) Fuel energy input (derive from data above) (ii) Default emission factors: CH_4: Energy/manufacturing : 0.03 t CH_4 / TJ energy input Commercial/residential: 0.3 t CH_4 / TJ energy input N_2O: All sectors: 0.004 t N_2O / TJ energy input	CH_4 (t) = Fuel energy input x emission factor N_2O (t) = Fuel energy input x emission factor	
Oil/gas production and processing – CO_2 and CH_4	(i) CO_2 from on-site gas and oil combustion and flared gas emissions derived as per stationary combustion above (ii) vented gas – energy or mass or volume units (iii) flared gas - energy or mass or volume units (iv) CH_4 content of gas (% wt or volume) (iv) % efficiency of flaring (v) estimates of on-site fugitive emissions Note: For volume to mass conversion note that 16g CH_4 occupies 22.4 litres at STP. Use gas law to convert to STP if data given at non standard temperature and pressure (pv = RT)	CH4 (t) = Mass gas vented x CH_4 (% wt) + Mass gas flared x (100 - % efficiency of flaring) x CH_4 (% wt) + fugitive emissions x CH_4 (% wt) (Note: Published default emission rates related to oil production show very wide variation and are not recommended for use. If no site data available, data acquisition plan should be implemented.)	For guidance on potential sources of fugitive emissions, refer to BP Amoco Environmental Performance Group Reporting Guidelines (http://www.bp.com/downloads/273/Environmentalguidelines2000.doc)

Sector Emission	Input Data Requirements	Calculation Method	Notes

Coal mining CH_4	(i) Annual mass of coal mined
	
	(ii) CH_4 emission per tonne coal mined
	
	(iii) CH_4 emission per tonne coal post-minimg
	
	Where site-specific data unavailable, use default emission rates:
	
	For (ii): underground coal: 10 – 25 m^3 CH_4 / t coal
	surface-mined coal: 0.3 – 2 m^3 CH_4 / t coal
	
	For (iii): underground, post-mining: 0.9 - 4 m^3 CH_4 / t coal
	surface-mined, post-miming: 0 – 0.2 m^3 CH_4 / t coal
	
	Default factors relate to 20°C , 1 atmosphere, at which 1 m^3 CH_4 weighs 0.67 kg
		CH_4 (t) =
		
		Coal mined (t) x (emission per tonne mined + emission per tonne post-mining) x 0.00067	

Electricity Transmission SF_6	(i) Total quantity of SF_6 in switchgear and circuit breakers	SF_6 (t/y) = SF_6 content of equipment (t) x 0.01	IPCC 1996 suggest 1% of existing SF_6 charge lost each year and remaining 70% is lost on destruction at end of 30y life.
Flue gas desulphurisation (limestone based) CO_2	(i) Annual usage of limestone (t) (ii) calcium carbonate content (% wt) (iii) magnesium carbonate content (% wt)	CO_2 (t) = Annual usage (t) x [(% $CaCO_3$ x 12/100) + (% $MgCO_3$ x 12/84)] x 3.664	Assumes all carbonate converted to CO_2. If % carbonate unconverted figure available from gypsum and waste solids analyses, emission figure can be reduced accordingly
Aluminium production CO_2	(i) Annual use of reducing agent consumed in mass units (ii) % carbon in reducing agent or (iii) C emission factor of reducing agent (t CO_2 / t reducing agent) Where site-specific data unavailable, use default emission factors: For (i): Al manufacture CO_2 emission factor (t CO_2 / t Al): Soderberg - 1.8; Pre-baked anode – 1.5	CO_2 (t) = Annual use of reducing agent x %C x 3.664 Or Annual use of reducing agent x emission factor (tCO_2 per tonne reducing agent)	Add 5% to process CO_2 emissions to account for CO_2 emission in anode pre-baking process WBCSD/WRI Aluminium worksheet, IPCC 1996

Sector Emission	Input Data Requirements	Calculation Method	Notes
	For (iii): coal - 2.5 tCO_2/ t coal: coke from coal – 3.1 tCO_2/ t coke petroleum coke – 3.6 tCO_2/ t petcoke; pre-baked anodes and coal electrodes – 3.6 tCO_2/ t anode	or (Mass aluminium produced x emission factor)	
Aluminium production PFCs	(i) Annual mass Al produced (t) (ii) Annual PFC emissions (CF_4 and C_2F_6) per tonne Al produced based on site-specific analysis of 'anode effects' in smelting process Site-specific emission factors should be determined as emissions are very variable from one plant to another. IPCC 1996 gives guidance. If no site-specific data available, use default emission factors per tonne Al produced, but recognise the wide uncertainty in value:. WRI/WBCSD suggest: Soderberg: CF_4: 0.6 kg / t Al; C_2F_6: 0.06 kg / t Al Pre-baked (centre worked): CF_4: 0.31 kg / t Al; C_2F_6: 0.04 kg / t Al	CF_4 (kg) = Annual mass Al produced x CF_4 emission factor C_2F_6 (kg) = Annual mass Al produced x C_2F_6 emission factor	The contribution of PFCs may be the major contribution to GHG emissions from this sector. Site-specific expertise on 'anode effect' emissions should always be sought when assessing aluminium projects. Also see discussion of available information in IPCC 1996.
Iron and Steel production CO_2	(i) Annual use of reducing agent consumed in mass units (net of fuel use) (ii) % carbon in reducing agent or (iii) CO_2 emission factor of reducing agent (iv) annual carbonate flux (dolomite/limestone) use in mass units (v) calcium carbonate content of flux (% wt) (vi) magnesium carbonate content of flux (% wt) (vii) Annual mass of ore used and annual mass of iron and steel produced (viii) % carbon in each of ore, iron produced, steel produced	CO_2 (t) = Annual mass reducing agent used (t) x % C x 3.664 or Annual mass reducing agent used (t) x emission factor + Annual flux usage (t) x [(% $CaCO_3$ x 12/100) + (% $MgCO_3$ x 12/84)] x 3.664 + (Annual mass of ore used (t) x % carbon content in ore – annual mass metal produced (t) x % carbon in metal) x 3.664	WBCSD/WRI Iron & Steel worksheet IPCC 1996

Sector Emission	Input Data Requirements	Calculation Method	Notes

	Where site-specific data not available, use default emission factors:
	
	For (i): iron/steel manufacture C emission factor: 1.6 t CO_2 / t iron or steel produced
	
	For (iii): coal - 2.5 tCO_2/ t coal: coke from coal – 3.1 tCO_2/ t coke petroleum coke – 3.6 tCO_2/ t petcoke
		OR
		
		Annual mass iron and steel produced (t) x 1.6	

Nitric Acid production N_2O	(i) Annual mass of nitric acid produced (ii) N_2O emission factor for plant (kg / t nitric acid produced) (iii) fractional abatement (y) achieved by any abatement technology employed (e.g. selective non-catalytic reduction which reduces N_2O as well as NOx) As emissions are technology-dependent, emission measurements should be made. Where no measurement data available use default emission factors: For (ii): 2 – 9 kg N_2O / t nitric acid produced (see IPCC 1996)	N_2O (kg) = Annual mass nitric acid produced (t) x emission factor (kg N_2O per t nitric acid) x (1-y)	N_2O produced as a by-product of high temperature catalytic oxidation of ammonia.
Ammonia production CO_2	(i) Annual mass of feedstock used (ii) carbon content (% wt) of feedstock If site-specific data not available, use default emission factor: For (i): 1.5 t CO_2 per tonne NH_3 produced	CO2 (t) = Annual mass of gas used (t) x carbon content x 3.664 Or Annual mass NH_3 produced (t) x 1.5	Ammonia produced by catalytic steam reforming of natural gas. All carbon in feedstock assumed converted to CO_2 which is vented to atmosphere. Check that CO_2 is not recovered and used elsewhere without release to atmosphere.
Adipic Acid production N_2O	(i) Annual mass of adipic acid produced (t) (ii) Default emission factor: 300 kg/ t adipic acid produced (iii)fractional abatement (y) achieved by any abatement technology employed (e.g. selective non-catalytic reduction which reduces N_2O as well as NOx)	N_2O (kg) = Annual mass adipic acid produced (t) x 300 x (1- y)	Produced as a by-product by nitric acid oxidation of cyclohexanone-cyclohexanol mixture

Sector Emission	Input Data Requirements	Calculation Method	Notes

Cement (clinker) process CO_2	(i) Annual mass of clinker produced (t)
	
	(ii) fractional lime (CaO) content of clinker
	
	Where site-specific data not available, use default emission factors:
	
	For (i): If only mass of cement produced known use 0.635 t CaO per tonne cement
	
	For (ii): If lime fraction in clinker not known, use 0.646
		CO_2 (t) =
		
		Annual mass clinker produced x fractional lime content x [44/56]
		
		OR
		
		Annual mass clinker produced (t) x 0.646 x [44/56]
		Or
		Annual mass cement produced (t) x 0.635 x [44/56]
			The lime (CaO) content of clinker results from the decomposition of $CaCO_3$ to CaO + CO_2. Thus for each mole of CaO in clinker, one mole of CO_2 is released
			
			Add 2-5% to total CO_2 release to account for kiln cement dust lost from system (use 2% if recycling of dust occurs or 5% if no recycling)

Lime production CO_2	(i) Annual mass of lime produced (t) (ii) fractional CaO content of lime produced (iii) fractional MgO content of lime produced or (iv) fractional CaO.MgO content of lime produced If site-specific data not available, use default emission factors: For (ii)-(iv): 0.79 t CO_2 per tonne lime produced from calcite ($CaCO_3$) or 0.91 t CO_2 per tonne lime produced from dolomite ($CaCO_3.MgCO_3$)	CO2 (t) = Annual mass of lime produced (t) x [fraction CaO x 44/56 + fraction MgO x 44/40] or Annual mass of lime produced (t) x [fraction CaO x 44/56 + %fraction CaO.MgO x (2x44)/96] OR Annual mass lime produced (t) x 0.79 (or 0.91)	2 moles of CO_2 produced for each mole of dolomitice lime (CaO.MgO) produced from dolomite ($CaCO_3.MgCO_3$) Reductions should be applied if lime purity less than 100%
Glass	Where limestone used in process, assess process emissions using limestone methodology detailed above.		
Refrigeration / Air conditioning / Insulation Industry HFCs	A variety of industrial processes involve refrigeration and air conditioning and thus indirectly employ HFCs. It is recommended that only where the manufacture and use of such equipment is a major aspect of a project should an assessment be undertaken. In such cases the user is referred to IPCC 1996 Reference Manual for recommended sector -specific calculation methods.		

Sector Emission	Input Data Requirements	Calculation Method	Notes
Municipal Solid Waste landfill CH_4	Methane emissions from landfill are time-dependent over the active lifetime of the facility and after closure. Emission rates are a complex function of waste characteristics, including composition, moisture content and age, and the design of the landfill. First order decay models have been developed to estimate time-dependent emissions (see WRI/WBCSD methodology and IPCC 1996) but are considered too complex for EBRD non-JI/CDM projects. It is recommended that the IPCC 1996 Default Methodology Tier 1 be used. This evaluates the <u>total potential yield of methane from the waste deposited</u>. This may be expressed as an average annual emission, but will not reflect actual emissions in any particular year. The following data are required for insertion in the estimation formula: (i) Annualised mass of MSW to be deposited, MSW_T (t/y) (This figure may be estimated from population served times per capita production for the region) (ii) Methane Correction Factor (MCF) - reflecting the nature of the waste disposal practices and facility type. Recommended values are as follows: *Managed* (i.e. controlled waste placement, fire control, and including some of the following: cover material, mechanical compacting or levelling): MCF = 1 *Unmanaged - deep* (> 5m waste): MCF = 0.8 *Unmanaged - shallow* (< 5m waste): MCF = 0.4 *Uncategorised* (default): MCF = 0.6 (iii) Degradable Organic Carbon (DOC) - fraction of MSW that is degradable carbon . To evaluate DOC, local data must be obtained on a) the fractions of MSW that are: paper and textile (A); garden waste and other non-food putrescibles (B); food waste (C); wood or straw (D).	CH4 (t/y) = $[\ MSW_T \times L_0 - R\ ] \times [\ 1 - OX\ ]$ where L_0, the *methane generation potential* in t CH_4 / t MSW_T is calculated as: $L_0 = MCF \times DOC \times DOC_F \times F \times (16/12)$	The CO_2 fraction of landfill gas and CO_2 from landfill gas flaring are assumed to be GHG neutral as part of the biological cycle.

Sector Emission	Input Data Requirements	Calculation Method	Notes
	b) the percentage by weight of degradable organic carbon in each waste type. Default values are paper and textile - 40%; garden waste and other non-food putrescibles - 17% food waste - 15%; wood or straw - 30%. The DOC for the total MSW is then given by: DOC = 0.4A + 0.17B + 0.15C + 0.3D (iv) Fraction of DOC dissimilated (DOC_F) - i.e. the fraction that is ultimately degraded and released: default = 0.5 - 0.6 (IPCC Good Practice Guidelines)) (v) Fraction by volume of CH_4 in landfill gas (vi) Mass of CH4 recovered per year for energy use or flaring, R (t/y) (vii) Fraction of CH4 released that is oxidised below surface within the site, OX. Default is OX = 0.1 for well-managed sites, otherwise 0.		
Municipal Solid Waste incineration CO_2 and N_2O	Data required for calculation of CO_2 emissions: (i) Annual amounts of each of MSW, hazardous waste (HW), clinical waste (CW) and sewage sludge (SS) incinerated (IW_i) (t) (ii) Fractional carbon content of each waste type CCW_i (iii) Fraction of total carbon that is fossil carbon FCF_I (iv) Efficiency of burn out of each waste type EF_i (fraction) Default parameters (IPCC): MSW / SS(dry) / CW(dry) / HW (wet) Carbon content: 0.40 / 0.30 / 0.60 / 0.50 Fossil C fraction of total carbon: 0.40 / 0 / 0.40 / 0.90 Efficiency of comb'n: 0.95 / 0.95 / 0.95 / 0.995	CO_2 (t/y) = Σ_i (IW_i x CCW_i x FCF_i x EF_i x 3.664) N_2O (kg/y) = Σ_i [IW_i x (emission factor)$_i$]	Given the plant-dependence of emissions and the wide range of default emission factors, note that N_2O emission calculations are indicative only.

Sector Emission	Input Data Requirements	Calculation Method	Notes
	Additional data required for calculation of N_2O emissions: (i) N_2O emission factor for each waste type (kg / t waste). Where no data are available, the following plant-dependent default values may be used: Default parameters: (IPCC, kg/t) — MSW — SS(dry) — CW(dry) — HW (wet) Hearth or grate — 0.0055 - 0.066 — 0.4 — - — - Rotating — - — - — - — 0.21-0.24 Fluidised bed — 0.24-0.66 — 0.1-1.5 — - — -		
Municipal Waste Water Treatment CH_4	Significant CH_4 emissions from wastewater treatment (WWT) only arise from the anaerobic part of the process. None of (i) the aerobic component of decomposition of sludge in landfill, (ii) incineration of sewage sludge, and (iii) anaerobic sludge digestion with methane collection for use as a fuel.will give rise to significant methane releases to atmosphere.. However, any anaerobic decomposition in landfilled sewage sludge will give rise to CH_4 emissions. The IPCC Good Practice Guide 'Check Method' suggests a default value of 0.06 kg BOD_5 per capita per day for raw sewage production and suggests that about 50% of the BOD5 in the raw sewage input emerges in sludge. Using IPCC default maximum methane producing capacity of 0.6 g CH_4/ g BOD_5 and the default fraction of BOD_5 in sludge that degrades anaerobically of 0.8, gives a CH_4 production rate from land-filled sludge of 0.03 x 0.6 x 0.8 = 0.015 kg CH_4 per capita per day Conversely, if all the degradable carbon produced decomposes anaerobically, then the maximum CH_4 production rate would be 0.06 kg BOD_5 per capita per day x 0.6 g CH_4/ g BOD_5 = 0.036 kg CH_4 per capita per day	CH_4 (t/y) = Population x 365 x 0.015 / 1000 (assuming aerobic WWT system but anaerobic land-filling of sewage sludge) or Population x 365 x 0.036 / 1000 (assuming totally anaerobic WWT system with all methane vented to atmosphere)	CO_2 emissions from municipal WWT systems are assumed to be GHG neutral as they are part of the biological cycle. It is assumed that all industrial waste water in EBRD projects will be regulated and managed to minimise methane emissions. For a more sophisticated treatment of WWT emissions, see IPCC 1996. If any component of the energy generated by sewage sludge treatment (digestion or incineration) displaces previous use of fossil fuels, a GHG saving may be registered for that displacement.

Sector Emission	Input Data Requirements	Calculation Method	Notes
Transport CO_2	(i) Annual fuel use (t) (ii) Fractional carbon content of fuel, OR (iii) Annual distance travelled by each vehicle type, i (iv) CO2 emission factor (t CO2 / km travelled) for each vehicle type If project specific data unavailable, use default emission factors: For (iv) road transport: cars (gasoline): 0.00027 t CO2 / km light trucks: 0.000325 t CO2 / km heavy trucks: 0.000535 t CO2 / km	CO2 (t) = Annual fuel use (t) x fractional C content x 3.664 OR Σ_i [(Annual distance travelled by vehicle type)$_i$ x (CO2 emissions factor)$_i$]	WRI/WBCSD Note that for transport infrastructure projects, estimating the overall impact of the project on traffic flows is generally the area of largest uncertainty. Methods for assessing GHG impacts of such projects are under development. Assessors should consult the EBRD Transport specialists for advice.
Transport N_2O (only significant for gasoline vehicles with 3-way catalyst)	(i) Annual fuel use (t) OR (ii) Annual distance travelled by vehicles (km) (iii) Default emission factors: 0.2 - 2.0 kg N_2O / t fuel or 0.01 - 0.22 g N_2O / km (higher end of range for older vehicles)	N_2O (kg) = Annual fuel use (t) x emission factor (kg N_2O/ t fuel) or Annual distance travelled (km) x emission factor (g N_2O / km) / 1000	

EBRD GHG ASSESSMENT METHODOLOGY IMPLEMENTATION GUIDANCE NOTE **GN 4**

GN 4 Estimation of emissions from imported electricity and heat

For most projects it will be adequate to use grid electricity emission factors (gCO_2/kWh used) to estimate the GHG emissions associated with electricity purchased from the grid. National electricity grid factors are provided in Table 1 below. As these figures are regularly updated, users should access the latest version, which include references for data sources, at: www.ebrd.com/downloads/about/sustainability/cef.pdf

		2008	2009	2010	2011	2012
Albania	$EF_{grid,produced}$ (t_{CO2}/MWh)	0.074	0.074	0.074	0.074	0.074
	$EF_{grid,reduced}$ (t_{CO2}/MWh)	0.140	0.140	0.140	0.140	0.140
Armenia	$EF_{grid,produced}$ (t_{CO2}/MWh)	0.437	0.437	0.437	0.437	0.437
	$EF_{grid,reduced}$ (t_{CO2}/MWh)	0.508	0.508	0.508	0.508	0.508
Azerbaijan	$EF_{grid,produced}$ (t_{CO2}/MWh)	0.723	0.723	0.723	0.723	0.723
	$EF_{grid,reduced}$ (t_{CO2}/MWh)	0.831	0.831	0.831	0.831	0.831
Belarus	$EF_{grid,produced}$ (t_{CO2}/MWh)	0.468	0.463	0.459	0.454	0.450
	$EF_{grid,reduced}$ (t_{CO2}/MWh)	0.526	0.520	0.516	0.510	0.506
Bosnia & Herzegovina	$EF_{grid,produced}$ (t_{CO2}/MWh)	0.831	0.831	0.831	0.831	0.831
	$EF_{grid,reduced}$ (t_{CO2}/MWh)	1.039	1.039	1.039	1.039	1.039
Bulgaria	$EF_{grid,produced}$ (t_{CO2}/MWh)	1.059	0.947	0.908	0.884	0.833
	$EF_{grid,reduced}$ (t_{CO2}/MWh)	1,217	1.088	1.040	1.016	0.957
Croatia	$EF_{grid,produced}$ (t_{CO2}/MWh)	0.563	0.554	0.545	0.536	0.527
	$EF_{grid,reduced}$ (t_{CO2}/MWh)	0.623	0.622	0.612	0.602	0.592
Estonia	$EF_{grid,produced}$ (t_{CO2}/MWh)	0.703	0.687	0.672	0.657	0.642
	$EF_{grid,reduced}$ (t_{CO2}/MWh)	0.799	0.781	0.764	0.747	0.730
Georgia	$EF_{grid,produced}$ (t_{CO2}/MWh)	0.333	0.333	0.333	0.333	0.333
	$EF_{grid,reduced}$ (t_{CO2}/MWh)	0.383	0.383	0.383	0.383	0.383
Hungary	$EF_{grid,produced}$ (t_{CO2}/MWh)	0.701	0.687	0.674	0.661	0.648
	$EF_{grid,reduced}$ (t_{CO2}/MWh)	0.779	0.763	0.749	0.734	0.720
Kazakhstan	$EF_{grid,produced}$ (t_{CO2}/MWh)	1.355	1.355	1.355	1.355	1.355
	$EF_{grid,reduced}$ (t_{CO2}/MWh)	1.506	1.506	1.506	1.506	1.506
Kyrgyz Republic	$EF_{grid,produced}$ (t_{CO2}/MWh)	0.114	0.114	0.114	0.114	0.114
	$EF_{grid,reduced}$ (t_{CO2}/MWh)	0.158	0.158	0.158	0.158	0.158
Latvia	$EF_{grid,produced}$ (t_{CO2}/MWh)	0.354	0.354	0.354	0.354	0.354
	$EF_{grid,reduced}$ (t_{CO2}/MWh)	0.400	0.400	0.400	0.400	0.400
Lithuania	$EF_{grid,produced}$ (t_{CO2}/MWh)	0.626	0.626	0.626	0.626	0.626
	$EF_{grid,reduced}$ (t_{CO2}/MWh)	0.688	0.688	0.688	0.688	0.688
FYR Macedonia	$EF_{grid,produced}$ (t_{CO2}/MWh)	0.873	0.873	0.873	0.873	0.873
	$EF_{grid,reduced}$ (t_{CO2}/MWh)	1.078	1.078	1.078	1.078	1.078
Moldova	$EF_{grid,produced}$ (t_{CO2}/MWh)	0.521	0.521	0.521	0.521	0.521
	$EF_{grid,reduced}$ (t_{CO2}/MWh)	0.660	0.660	0.660	0.660	0.660
Mongolia	$EF_{grid,produced}$ (t_{CO2}/MWh)	0.800	0.800	0.800	0.800	0.800

	$EF_{grid,reduced}$ (t_{CO2}/MWh)	0,909	0,909	0,909	0,909	0,909
Poland	$EF_{grid,produced}$ (t_{CO2}/MWh)	0.699	0.684	0.669	0.653	0.638
	$EF_{grid,reduced}$ (t_{CO2}/MWh)	0.768	0.752	0.735	0.718	0.701
Romania	$EF_{grid,produced}$ (t_{CO2}/MWh)	0.595	0.584	0.574	0.564	0.553
	$EF_{grid,reduced}$ (t_{CO2}/MWh)	0.676	0.664	0.652	0.641	0.628
Russia	$EF_{grid,produced}$ (t_{CO2}/MWh)	0.504	0.498	0.492	0.486	0.479
	$EF_{grid,reduced}$ (t_{CO2}/MWh)	0.566	0.560	0.553	0.546	0.538
Serbia & Montenegro	$EF_{grid,produced}$ (t_{CO2}/MWh)	0.792	0.792	0.792	0.792	0.792
	$EF_{grid,reduced}$ (t_{CO2}/MWh)	0.943	0.943	0.943	0.943	0.943
Slovak Republic	$EF_{grid,produced}$ (t_{CO2}/MWh)	0.547	0.539	0.531	0.523	0.514
	$EF_{grid,reduced}$ (t_{CO2}/MWh)	0.582	0.573	0.560	0.556	0.547
Slovenia	$EF_{grid,produced}$ (t_{CO2}/MWh)	0.667	0.654	0.640	0.626	0.613
	$EF_{grid,reduced}$ (t_{CO2}/MWh)	0,710	0,690	0,681	0,661	0,652
Tajikistan	$EF_{grid,produced}$ (t_{CO2}/MWh)	0.064	0.064	0.064	0.064	0.064
	$EF_{grid,reduced}$ (t_{CO2}/MWh)	0.075	0.075	0.075	0.075	0.075
Turkey	$EF_{grid,produced}$ (t_{CO2}/MWh)	0.605	0.605	0.605	0.605	0.605
	$EF_{grid,reduced}$(t_{CO2}/MWh)	0.703	0.703	0.703	0.703	0.703
Turkmenistan	$EF_{grid,produced}$ (t_{CO2}/MWh)	0.521	0.521	0.521	0.521	0.521
	$EF_{grid,reduced}$(t_{CO2}/MWh)	0.620	0.620	0.620	0.620	0.620
Ukraine	$EF_{grid,produced}$ (t_{CO2}/MWh)	0.807	0.807	0.807	0.807	0.807
	$EF_{grid,reduced}$ (t_{CO2}/MWh)	0.896	0.896	0.896	0.896	0.896
Uzbekistan	$EF_{grid,produced}$ (t_{CO2}/MWh)	0.558	0.558	0.558	0.558	0.558
	$EF_{grid,reduced}$ (t_{CO2}/MWh)	0.613	0.613	0.613	0.613	0.613

Note that in Table 1 two factors are provided for each country, one to be used where a project displaces generation and one to be used where grid electricity is used or reduced. The latter (larger) emission factor allows for the fact that for every unit of electricity used or saved by the end-user, a larger amount of electricity must be generated /or is saved to allow for the fact that a portion of electricity generated is lost in transmission and distribution to the end user.

If the supply of electricity to a facility is direct from a known conventional power plant, then the emission factors specific to that generating plant should be employed. If no specific data are available, an estimate of the emission factor based on the fuel used and the likely generation efficiency for the age of plant involved should be used, again allowing for any transmission losses.
Where electricity and/or heat is imported from a combined heat and power plant, the emissions associated with the different power and heat (steam) streams should be apportioned appropriately. The supplier should be asked to provide an emission factor appropriate for the power or heat stream purchased (tonne CO_2 per unit of electricity or heat purchased).

If this is not readily available, the supplier should be asked to carry out the necessary calculation of apportionment, or, at minimum, supply the data to enable this. The method of apportionment should be based on weighting the emissions by the work potential of each electricity and heat stream, as presented in the WRI/WBCSD GHG Protocol (see http://www.ghgprotocol.org). This is summarised below.

CO_2 emission from stream i = total CO_2 emissions x $W_i / \Sigma_i W$, where W_i is the work potential of stream i defined as

W_i (GJ) = $(F_i /1000) \times \{ [h_i - (T \times S_i)] - [h_{ref} - (T_{ref} \times S_{ref})] \}$

where

F_i = mass of steam (tonnes) in stream i

h_i = specific enthalpy of steam flow in stream i (kJ/kg)

T_i = delivery temperature of steam flow (absolute ^oK)

S_i = specific entropy of steam flow in stream i (kJ/kg)

h_{ref} = specific enthalpy at reference conditions (kJ/kg)

T_{ref} = reference temperature (absolute ^oK)

S_{ref} = specific entropy at reference conditions (kJ/kg)

If it is not possible to acquire the estimation or the data, it is recommended that a conservative (i.e. high GHG emission estimate) is made for electricity based on the emission factor appropriate for the fuel and generation technology assuming no heat production (e.g. gas-fired CCGT or coal-fired conventional pulverised fuel).

EBRD GHG ASSESSMENT METHODOLOGY GN 5
IMPLEMENTATION GUIDANCE NOTE

GN 5 Electricity Generation from Renewable Resources

For EBRD renewable energy projects, electricity generated is assumed to displace grid generation, rather than represent new generation. The national GHG emission factor for grid electricity generation (see GN 4) should be employed to determine GHG offsets resulting from project implementation. This is consistent with the procedures adopted for JI/CDM projects and is justified by the relatively low penetration of renewable electricity generation in the Bank's countries of operation.

EBRD GHG ASSESSMENT METHODOLOGY GN 6
IMPLEMENTATION GUIDANCE NOTE

GN 6 Global Warming Potentials for calculation of total GHG (CO_2 equivalent) emissions

Definition of Global Warming Potential

The global warming potential (GWP) of a greenhouse gas is the number of times more effective a unit mass emission of the gas is compared with a unit mass emission of CO_2. The GWP of a GHG depends on the period over which the effect is considered because the lifetime of each GHG in the atmosphere is different from that of CO_2. For example, an emission of CO_2 is likely to remain in the atmosphere on average for about 100 years before transfer through natural processes to the ocean, biosphere or land surface. In contrast methane is chemically transformed to CO_2 with an atmospheric half-life of a decade or so. Thus the integrated effect of a unit emission of methane over a century relative to CO_2 is much less than its effect relative to CO_2 over the decade following its emission.

It is conventional in GHG assessment to use global warming potentials evaluated over a 100 year time horizon in order to standardise the method for aggregating the effects of different GHG emissions. GWP values are subject to periodic revision as science develops, so, where possible, assessors should check latest IPCC estimates recommended for GHG inventory calculations. To illustrate this, the following table shows values from both the IPCC Second Assessment Report 1995 and the Fourth Assessment Report 2007[8]. The 2007 values for the GWPs should be used as factors to convert unit mass emissions of each GHG into CO_2-equivalent, or CO_2e.

GHG	GWP (100 year time horizon) (mass basis) IPCC 1995	GWP (100 year time horizon) (mass basis) IPCC 2007
CO_2	1	1
CH_4	21	25
N_2O	310	298
HFC-23	11,700	14,800
HFC-32	650	675
HFC-41	150	
HFC-43	1,300	1,640
HFC-125	2,800	3,500
HFC-134	1,000	
HFC-134a	1,300	1,430
HFC-152a	140	124
HFC-143	300	
HFC-143a	3,800	4,470
HFC-227ea	2,900	3,220
HFC-236fa	6,300	9,810
HFC-245ca	560	
SF_6	23,900	22,800
CF_4	6,500	7,390
C_2F_6	9,200	12,200
C_3F_8	7,000	8,830
C_4F_{10}	7,000	8,860
c-C_4F_8	8,700	10,300
C_5F_{12}	7,500	9,160
C_6F_{14}	7,400	9,300

[8] Accessible at http://www.ipcc.ch/ipccreports/ar4-wg1.htm, Chpater 2, pp212-213. The Fourth Assessment Report includes an extended range of chemical species not reproduced here.

EBRD GHG ASSESSMENT METHODOLOGY
Annex 1 EBRD Environment and Social Policy requirements concerning GHG

From November 2008, the revised (May 2008) EBRD Environmental and Social Policy includes new requirements concerning GHG emissions. These are presented below to show the context in which the specific requirement to undertake quantitative GHG assessments following requirements:

Environmental and Social Policy, paragraph 40: *The EBRD will publish an annual Sustainability Report on its activities including . . . aggregate information on greenhouse gas emissions . . .*

Performance Requirement 1 (PR1) Environmental and Social Appraisal and Management, Paragraph 7: *. . . The appraisal will also consider potential transboundary and global issues, such as . . . greenhouse gas emissions . . .*

Performance Requirement 3 (PR3) Pollution Prevention Abatement: Paragraph 3:
The objectives of this Performance Requirement (PR) are . . .to promote the reduction of project-related greenhouse gas emissions.

Performance Requirement 3 (PR3) Pollution Prevention Abatement: Paragraph 17-19 (plus footnotes):

17. The client will promote the reduction of project-related greenhouse gas (GHG) emissions in a manner appropriate to the nature and scale of project operations and impacts.

18. During the development of projects that are expected to or currently produce significant quantities of GHGs (see footnote 6) the client will procure and report the data necessary to enable both an assessment of baseline (pre-investment) GHG emissions and an estimate of post-implementation GHG emissions. Guidance on data requirements should be sought from the Bank. The GHG assessment will cover direct emissions from the facilities owned or controlled within the physical project boundary, together with those from any external operations on which the project is dependent, including indirect emissions associated with the offsite production of power used by the project. An indication of the size of project likely to generate emissions of 100,000 tonnes of CO_2 equivalent can be found in Annex A of IFC's Pollution Prevention and Abatement Guidance Note 3 (http://www.ifc.org/ifcext/sustainability.nsf/AttachmentsByTitle/pol_GuidanceNote2007_3/$FILE/2007+Updated+Guidance+Note_3.pdf

Guidance on the definition of project boundary should also be sought from the Bank (see footnote 7). Quantification of the parameters needed to evaluate GHG emissions (see footnote 8) will be conducted annually during the life of the project.

19. In addition, the client will assess technically and financially feasible and cost-effective options to reduce its carbon intensity during the design and operation of the project, and pursue appropriate options.

Footnotes:

6 *The significance of a project's contribution to GHG emissions varies between industry sectors. Guidance on the amounts of GHG emissions likely to be associated with projects in different sectors is given in* EBRD Methodology for Assessment of Greenhouse Gas Emissions – Guidance for consultants working on EBRD-financed projects (GN0). *The significance threshold for this Performance Requirement is generally 100,000 tons of CO_2 equivalent per year for the aggregate emissions of direct sources and indirect sources associated with purchased electricity for own consumption. However, a lower emission threshold may be appropriate where a project aims to bring about large improvements in*

production efficiency. Clients are encouraged to consult the Bank in such cases on whether data procurement for GHG assessment will be required.
7. Guidance on data requirements and the definition of project boundary are provided, respectively, in the Bank's Environmental Audit and Appraisal Protocols *and* EBRD Methodology for Assessment of Greenhouse Gas Emissions – Guidance for consultants working on EBRD-financed projects (GN1) .
8. For example the quantities of fuel or electricity usage.