8 Greenhouse Gas Emissions

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Summary

The Queensland Coke and Power Plant Project (the Project) will emit greenhouse gases (GHGs) during the processing of coal into the coke product. The EIS considers operational GHG emissions within the physical boundary of the Project. For operational Stages 1 and 2 combined within the project boundary, the calculated GHG emissions for the Project will average (over 40 years) 342,650 tonnes of carbon dioxide equivalent per year (t CO_2e/yr), based on the upper production estimate of 3.2 Million tonnes per annum (Mtpa) of coke and a power plant of 350 MW capacity. This annual emissions estimate includes an offset amount of 2,458,901 t CO_2e/yr (post year two), from the re-use of the heat generated by the coke process for power generation. This annual amount represents approximately 0.24% of Queensland's total annual GHG emissions (145 Mt in 2002) and approximately 0.06% of Australia's annual emissions (550 Mt in 2002).

The carbon held in the coke will not be released to the atmosphere or oxidised and is therefore excluded from the greenhouse calculations. The waste energy (as steam), a significant proportion of which would be otherwise lost, is used to generate electricity. This single action effectively offsets 2,458,901 t CO_2e/yr after year two.

In addition to the emissions and offsets from within the project boundary, there exist additional benefits in reducing transport related GHG emissions in Australia and internationally, through the 30% reduction in weight of coal to coke. This transport offset represents 3,500 t CO_2e/yr associated with rail inside Australia, and 86,500 t CO_2e/yr associated with shipping.

The proposed coke making technology is based on modern full combustion, heat recovery processes used in China, the United States of America and elsewhere. The comparative GHG emissions associated with different coke plant technology options located either within Australia or overseas have been considered. The technology options evaluated include full combustion coke plant and power plant identical to the Project, full combustion coke plant without associated power plant, by-product coke plant and power plant, and by-product coke plant with no associated power plant.

Typically, the production of coke using by-product coking technology yields a range of by-products, including coke oven gas, coal tar, benzene, toluene, xylene (BTX) and naphthalene. The Project will use full combustion technology, which eliminates the production of by-products that are generated using the by-product technology. An analysis of the relative GHG emissions from coke plants in different locations concludes that the Project will have lower GHG emissions than an equivalent plant built overseas using coal sourced in Queensland.

SCL is currently a member of the Greenhouse Challenge program with a Greenhouse Challenge Plus agreement and is a participant in national Generator Efficiency Standards. QCE commits to join the Australian Greenhouse Office Greenhouse Challenge Plus program and report performance annually.

8.1 Description of Environmental Values

8.1.1 Greenhouse Gas Emission Policy

Greenhouse gas emissions over time accumulate in the upper atmosphere, trapping heat resulting in an increase in the earth's temperature. This is commonly known as the greenhouse effect that is related to possible climate change. The release of GHGs is a global issue, as GHG emissions will contribute to the greenhouse effect irrespective of where on the planet the gases are emitted.

While Australia has not ratified the Kyoto Protocol, there are an increasing number of Government schemes that facilitate the creation of tradeable GHG-related certificates within Australia. Current schemes include Queensland's 13% Gas Scheme (Qld Scheme), the NSW Greenhouse Gas Abatement Scheme (NSW Scheme), and the Greenhouse Friendly Program and Mandatory Renewable Energy Target (MRET) both administered by the Australian Government. In addition, State and Territory Premiers and Chief Ministers have commenced discussions on developing a States-based national emission-trading scheme.

The NSW Scheme and Greenhouse Friendly Program are both focused on encouraging companies to reduce their GHG emissions, through the creation of markets where high-cost abators can offset their emissions by purchasing credits from low-cost abators. The MRET and Qld Scheme are focused on the creation of new, more greenhouse-friendly electricity generation.

The NSW Scheme creates demand for NSW Greenhouse Gas Abatement Certificates (NGACs) by legislating targets with specified penalties for retailers of electricity. Retailers may meet demand by creating or purchasing tradable certificates called NGACs. NGACs can be created through projects that reduce GHG emissions below the threshold intensity. The electricity generation from the Project may meet the requirements of the NSW Scheme, and therefore possibly create NGACs.

The Greenhouse Friendly program allows for the sale of products tagged as greenhouse friendly by offsetting all GHG emissions associated with the creation of the product. Greenhouse Friendly encourages the reduction of GHG emissions by facilitating financial assistance to greenhouse abatement projects that would otherwise not be implemented because they do not meet reasonable financial targets. This financial test applied in the evaluation of a project, which is known as "financial additionality", is one of the key product/project accreditation tests applied by the Australian Government under Greenhouse Friendly. The "financial additionality" test evaluates all project cash flows (cost and revenue) to determine if the project meets reasonable financial targets for the particular industry/company. If the financial analysis concludes that the project meets reasonable financial performance targets and does not require financial assistance to proceed then the product or project would not be accredited as Greenhouse Friendly. The Project has not been analysed against the Greenhouse Friendly criteria.

The MRET is focused on creating additional renewable energy generation. However, the MRET specifically excludes electricity generated from "other products derived from coal or natural gas". The Qld Scheme operates in a similar manner to the MRET and is focused on increasing the percentage of gas-fired generation in Queensland. The Qld Scheme is specifically focused on natural gas and, as such, it appears that the Project, which produces combustible gases of a significantly different composition (Section 7 - Air), is unable to meet the scheme's currently regulated requirements.

The details of the States-based national emission-trading scheme are still being developed. Whilst there is a general commitment from the States to develop such a scheme, it is likely that obtaining agreement on common rules will take significant time and effort. Consequently, there is considerable uncertainty regarding the scope and timing of such a national scheme. Therefore, the Project has not been evaluated against this proposed scheme.

The electricity generated using the waste heat from the Coke Plant is potentially eligible to create NGACs within the NSW Scheme, which reinforces the positive attributes of using the waste heat to generate electricity. This eligibility is also likely to apply nationally, should a similar scheme be adopted on a national basis in the future.

8.1.2 Calculating Emissions

Using the approach defined in the Australian Greenhouse Office (AGO) workbook titled "Australian Methodology for the Estimation of Greenhouse Gas Emissions and Sinks 2003, Energy (Stationary Sources)" (the Workbook), creating coke is considered to be energy transformation. The primary objective of the Project is the production of coke for export to international steel production markets. The capture and use of the waste heat generated in the coking process in a heat recovery steam generator (HRSG) is a secondary project. Therefore, the GHG emissions associated with the Project have been attributed to the Coke Plant, and not the electricity generation activity of the Power Plant. On this basis, the electricity generation can be considered to have emissions approaching zero. In comparison, the average GHG emissions due to electricity generation (excluding line losses) on the Queensland grid are 0.931 kg CO_2e/kWh [1].

Coke is produced through the heating of coal, while controlling the amount of air, and consequently oxygen, in the coke oven. Air is controlled to produce oxygen levels approaching zero, restricting the creation of carbon dioxide (CO_2). Coke oven gas will be yielded and consumed in the coke ovens and associated flue network. The process drives off moisture and volatiles from the coal and oxidises a small amount of coal (5%) to create coke, with the remaining carbon being heavily complexed within the coke, thus stabilising potential carbon emissions. The capture and control of the volatile gases and waste heat enables electricity generation by producing steam to drive a steam turbine. The carbon held within the coke is not oxidised or released to the atmosphere and therefore not included in the calculation of the GHG emissions. The majority of coke produced is consumed in the steel production process. A proportion of the coke (carbon) is absorbed into the steel, effectively sequestering the carbon from the coke production process.

[1] AGO Factors and Methods Workbook August 2004, Table 5, Qld, less transmission losses.

This approach is consistent with the methodology recommended by the AGO for the calculation of GHG emissions associated with iron and steel production, where the carbon held in the steel is considered to be sequestered.

Calculating emissions from coke production is not common and not extensively covered in the AGO documents. The "Australian Methodology for the Estimation of Greenhouse Gas Emissions and Sinks - 2003" (AGO 2003) refers to the Intergovernmental Panel on Climate Change (IPCC) guidelines and sets out a methodology for calculating GHG emissions for Australia. The IPCC and AGO methodologies, wherever possible, use the mass of carbon in the calculations to determine the total GHG emissions. The default emission factors for this sector, published by the AGO, are based on best estimates provided by industry. The IPCC and AGO methodologies recommend the use of the most accurate information available in determining GHG emissions. A carbon balance is considered a more accurate method of determining GHG emissions than using the AGO emission factor. Therefore, the emission calculations for the Project are based on a process carbon balance, prepared by Ultra-Systems Technology Pty Ltd.

The carbon balance considers the total carbon contained in the coal entering the process, the total carbon held in the coke leaving the process and the carbon that is oxidised and released as a GHG emission. The calculation of GHG emissions associated with the coal use the following steps:

- Estimate the consumption of each fuel;
- Determine the amount of carbon in the coal;
- Determine the amount of carbon in the coke after coking the coal;
- Evaluate the amount of carbon oxidised in the process; and
- Convert emissions calculated as carbon to full molecular weight of CO_2.

The Coke Plant at full capacity is estimated to use 4.4 Mtpa (dry) of coal (which is approximately 5.0 Mtpa wet) to produce 3.2 Mtpa of coke. The 1.8 Mtpa lost in the process represents the oxidised coal, ash, particulates, moisture and volatiles driven off the coal in the coking process.

The transport emissions associated with the coke, which are outside the project boundary, are calculated using emission factors for rail and ship transport inserted in the following simple formula:

A x B x C = Emissions

Where:

A = The reduction in weight of material shipped (5.0 – 3.2 Mtpa)

B = Distance carried (km)

C_{rail} = Emission factor for rail (kg CO_2e/t km)

C_{ship} = Emission factor for shipping - calculated using average fuel consumption for sea freight (MJ/t km) multiplied by a full cycle emission factor for shipping (g/MJ)

All other GHG emissions are relatively minor, but are included for completeness. The calculation of these GHG emissions use standard GHG emission factors identified by the AGO and are specifically referenced.

8.1.3 Assessment of Emissions

The key issues relevant to the evaluation of the project GHG emissions comprise:

- Total GHG emissions resulting from the coking process (from coal feedstock at initial delivery stockpile to coke product as loaded onto train for transport);
- GHG offset resulting from coking process waste heat recovery used for generation of electricity;
- Sequestration of carbon in coke product;
- Coking technologies used elsewhere; and
- GHG offset from reduction in transport emissions resulting from processing feedstock locally and transporting the resulting reduced-weight product.

Total GHG emissions include the direct process outputs to atmosphere and emissions attributable to the energy supply used to operate the Coke Plant and associated activities, including electricity and diesel fuel.

The offset attributable to electricity generation results from the recovery of heat produced during the coking process being used to create steam and generate electricity. The electricity generated in the Power Plant on-site is fed directly into the Queensland and National power grid and will generate approximately 2,640 GWh/annum of electricity. The steam-generated electricity is using the waste heat from the coke process and therefore effectively results in no GHG emissions being directly attributable to the Power Plant.

The coke production process will consume 228 GWh/annum of electricity, which will be sourced from the Queensland power grid. A large proportion of the Coke Plant will be operational over 12 months before the Power Plant will be operational. In addition the site-based power generation will have periods of down time for scheduled and unscheduled maintenance. Therefore, recognising the delay in the availability of the Power Plant and to ensure more consistent supply availability, the electricity requirements for the Coke Plant will be sourced directly from the Queensland grid. The Queensland power grid is more than 80% reliant on coal-fired generation, and more than 12% reliant on gas-fired generation, both being producers of GHGs. However, all GHG emissions from the electricity consumed by the Coke Plant will be offset by the GHG emission-free electricity produced by the waste heat power plant connected to the grid.

The transport reduction offset is based on the assumption that if the coke were not produced locally then the feedstock coal would be transported to an overseas coking plant. Australia exports both coal and coke to other countries primarily for the production of steel. When coal is exported, the steel producer needs to coke the coal in a similar process (though typically in older and more polluting by-product recovery technology) to that proposed by the proponents. However, as coke is approximately 30% lighter than coal for the same volume, the export of coal for coking results in GHG transport emissions and costs to transport this additional weight. Assuming equivalent environmental standards are applied, the export of coke versus coal would result in a reduction in GHG emissions associated with transportation. The production of coke in Australia therefore assists in reducing overall global GHG emissions.

Coking technologies used elsewhere have been considered in evaluating comparative GHG emissions from a consideration of alternative scenarios to the proposed Project. A number of scenarios have been assessed, including use of alternative coking technology in Queensland, use of the same technology proposed for the Coke Plant overseas using Queensland coal and use of existing coking technology overseas using Queensland coal.

The coke ovens will require initial heating (using natural or coal seam gas) to create the necessary operating temperature. Combustion of this externally supplied gas will contribute to the GHG emissions of the Project. However, this activity is only necessary during initial firing of the coke ovens as there is ample heat produced during the coking process to drive the ovens during operation. Once operational the coking process maintains the ovens at the required temperature, which may be maintained for the next 20 years before a major maintenance event requires a coke oven to be cooled. The GHG emissions have been calculated based on the total production of both stages (3.2 Mtpa coke at full capacity), following commissioning of all ovens. The GHG emissions associated with the initial heating of the coke ovens are included in the “other emissions”.

8.2 Potential Impacts and Mitigation Measures

8.2.1 Estimated Greenhouse Gas Emissions

Project Emission Boundary

As the Project is proposed to be located along the rail network for coal transport from the Bowen Basin to the port of Gladstone, emissions arising from transport of coal to the project site are assumed to be the same with or without the commencement of the Project. Without the construction of the Coke Plant, coal would be freighted directly to the coal-shipping terminal for export to meet international demand. With the introduction of the Coke Plant, GHG emissions associated with rail transport of coke product from the Coke Plant to the Gladstone shipping terminal and sea transport from the shipping terminal to overseas destination are reduced by approximately 30% due to a reduction in weight converting coal to coke.

However, it is not practical for the project GHG boundary to be considered to be the point of final delivery of coke, due to uncertainty of the final destinations and quantities to be delivered. Therefore, the practical boundary for detailed calculation of GHG emissions has been identified as the physical site boundary for the project facilities, as transport offsets cannot be calculated with sufficient rigor. However to ensure a balanced position is presented, the report separately identifies an estimate of the transport emissions, which are outside the project boundary.

Coke Plant Emission Factors

The total operational emissions for the Coke Plant include emissions due to combustion/oxidation of coal during coke production, electricity consumption by the Coke Plant and other fuels consumed by associated on-site activities. Key factors used to evaluate coke production are that:

- The energy content of the coal is considered to be 31.2 GJ/t [2];
- Total coal consumed per annum for Stages 1 and 2 is 4.4 Mt (dry); and
- For each tonne of coal consumed (which contains 807 kg carbon), 726 kg of coke is created which contains 647 kg of carbon, and 160 kg of carbon is combusted [3].

Electricity Consumption

The Project will use the waste heat created during the coke production to generate electricity exported to the National Electricity Market (NEM). Therefore, for the purpose of calculating the GHG emissions associated with the coke production, electricity has been considered as a process input and added to the total emissions. The GHG emissions factor for electricity consumption in the emissions calculation is 1.058 kg CO_2e/kWh, based on the average of conditions in Queensland and includes the losses of the Queensland grid. The Coke Plant will draw electricity from the local grid, which is adjacent to the Stanwell Power Station (SPS). Therefore, in consideration of the close proximity of the Project to the SPS, any transmission losses are insignificant and the GHG emissions factor for Queensland has been reduced by 0.127 to reflect the actual situation on site. This results in a reduction in GHG emissions of 28 t CO_2e/annum.

The Coke Plant will operate continuously and is expected to have an average electrical demand of 26 MW (or 228 GWh/annum) at full production, for the operation of service equipment, water pumps, fans, conveyor belts, lighting and air-conditioning.

Other Fuels

The Coke Plant will use various loaders and trucks operating on diesel fuel, including two front-end loaders, four bulldozers, two water carts and four small light trucks. The combined fuel consumption of these vehicles is estimated to be approximately 1,400 kL of diesel fuel per year. Total petrol consumption has not been quantified, however, petrol consumption is likely to be quite small and therefore not considered in GHG emissions. The energy content and emission factors associated with vehicles in the emissions calculation are identified in Table 8.1. To consider the full impact of the Project, full fuel cycle

[2] Value based on coal testing, advised by Barlow Jonker email 26/5/05

[3] Carbon balance prepared by Ultra-Systems Technology Pty Ltd.

emission factors have been used in the calculations. It should be noted that, should natural gas not be feasible for the pre-heating of the coke ovens, diesel may be investigated as a fuel source.

Table 8.1 Emissions Factors - Vehicles

Transport Fuels	Energy Content [1] (GJ/kL)	Emission Factor [2] – Full Fuel Cycle (tCO_2e/kL)
Diesel	38.60	3.0

Notes: [1] AGO Factors and Methods Workbook (AGO August 2004), Table 3.
[2] AGO Factors and Methods Workbook (AGO August 2004), Table 3, Full Fuel Cycle.

8.2.2 Greenhouse Gas Emission Offsets

Electricity Generation

As discussed above, the GHG emissions associated with the electrical generation can be considered to approach zero. The electricity generated and supplied to the State grid by the Power Plant will offset electricity that would otherwise be generated from coal-fired power stations. This aspect of the Project offsets the GHG emissions from the coke production process. The electricity generation capacity has been determined based on a generation plant capacity of 350 MW operating at full capacity, less 15 MW to operate generator auxiliary loads and with an availability of 90%. Therefore, the generator has a net capacity of 335 MW and is estimated to produce 2,641 GWh/annum of electricity. The Power Plant is adjacent to an existing coal fired power station (SPS) and hence transmission losses are not considered. Therefore, the GHG emissions factor excluding transmission losses has been used, which is the same as the emission factor used for the incoming power to the Coke Plant. It should be noted that the Power Plant may generate up to 370 MW of electricity which would provide a greater GHG emissions offset.

Transport

The transport GHG emissions offset associated with rail and sea freight, which are outside the project boundary, is not included in the calculation of project GHG emissions. However, the offset is discussed here, to more fully describe the total impact of the Project. As noted above, the creation of coke from coal reduces the total weight of product shipped by approximately 30%, thereby reducing fuel required for transport by approximately 30%. This results in a reduction in GHG emissions. An estimate of the emission reduction associated with the transport is based on the factors in Table 8.2.

Table 8.2 Transport Emission Factors

Description	Value	Unit
Emission factor (rail)	0.020	kg CO_2e/t km [1]
Distance from Coke Plant to Gladstone terminal	100	km
Weight coke	3,200,000	tonnes
Average sea freight voyage distance	10,000	km
Sea freight fuel consumption	0.062	MJ/t km [2]
Full cycle emission factor (shipping)	77.771	g/MJ [2]

Notes: [1] Value advised by Queensland Rail as an average for Queensland. Actual value will depend on the efficiency of the contracted carrier.
[2] Source: John Apelbaum Consulting.

8.2.3 Total Greenhouse Gas Emissions

The initiation of the coking process requires significant amounts of heat to bring the coke ovens up to operating conditions, this will occur during the first year of operation for each of the two stages. The nature and extended time line for the commissioning of the Coke Plant means that Stage 1 will be commissioned while Stage 2 is still under construction. In addition, at the completion of Stages 1 and 2 of the Coke Plant, but prior to operation of the Power Plant, the waste heat from the coke ovens will be vented to atmosphere, which means that the GHG emissions abatement due to the electricity generated will not occur during these commissioning phases. Since the GHG emissions during the first year of operation of each stage of the Coke Plant are not a reflection of the long-term emissions of the facility, the results have been presented in Table 8.3 for the three scenarios below:

1. First full year of operation of Stages 1 and 2 of the Coke Plant, venting the waste heat;
2. Coke Plant and electrical generator fully operational; and
3. Annual average of GHG emissions over a 40 year project life.

In scenario 1, the total GHG emissions (after all offsets within the boundary) are estimated to be 2,875,715 t CO_2e/yr. In scenario 2, the total GHG emissions (after all offsets within the boundary) are estimated to be 338,746 t CO_2e/yr. In scenario 3, the total GHG emissions (after all offsets within the boundary) are estimated to be 342,650 t CO_2e/yr. The GHG emissions in Scenario 3 represent approximately 0.24% of Queensland's total annual GHG emissions (145 Mt in 2002) and approximately 0.06% of Australia's annual emissions (550 Mt in 2002).

As discussed above, the transport of coke that is approximately 30% lighter than coal, from the Coke Plant to the shipping-terminal, results in a reduction of total emissions of approximately 3,500 t CO_2e/yr. In addition, the same weight reduction results in emissions abatement of approximately 86,500 t CO_2e/yr directly associated with shipping.

Table 8.3 Stage 1 and 2 Operational Greenhouse Gas Emissions

Coal consumed = 4.4 Mtpa (dry) Coke produced = 3.2 Mtpa	Scenario 1 No Electricity Generation – Venting (t CO_2e/yr)	Scenario 2 Full Operation GHG Annual Emissions (t CO_2e/yr)	Scenario 3 Annual Average over 40 years (t CO_2e/yr)
Source			
Coke process emissions	2,581,403	2,581,403	2,581,403
Other emission (Year 1 gas and annual power use)	290,112	212,045	215,948
Site transport fuels	4,200	4,200	4,200
Total Emissions (coke production)	2,875,715	2,797,648	**2,801,551**
Project Offsets			
Electricity production (Post Stage 2) 335 MW (net capacity)	NA	2,458,901	2,458,901
Total GHG Emissions (inside boundary)	2,875,715	338,746	**342,650**
Other Offsets (outside the Project Emissions Boundary)			
Rail	3,500	3,500	3,500
Shipping	86,500	86,500	86,500
Total GHG Emissions (including all offsets)	2,785,715	248,746	**252,650**

8.2.4 Project Alternatives

Without the Project, it is assumed that coal will continue to be exported to other countries where it will be used to produce coke and a new coke plant would be built overseas. Based on this assumption, there are a number of possible scenarios that can be considered for comparison of GHG emissions from alternative options to the Project.

There are two main technology options for the production of coke, either “full combustion” or “by-product” production. The following options exist with each coking technology: to generate electricity in a power plant using the waste heat; use the waste heat in processes associated with steel production; or vent the waste heat. Both technologies are focused on producing coke to an acceptable standard while meeting environmental standards at the lowest total cost. The purpose of all coking technologies is to drive off moisture and volatiles from the coal to create a stable coke product for use in the production of steel. Hence the current coking technology construction scenarios include full combustion coke plant and power plant identical to the Project, full combustion coke plant without associated power plant; by-product coke plant and power plant and by-product coke plant with no associated power plant.

Full combustion technology operates by fully combusting all volatiles driven from the coal. When used with power generation, some of this heat from combustion is used to coke the coal, and the remainder is used to create steam to generate electricity.

When full combustion technology is used without associated power generation, surplus heat from the combustion of volatiles that is not used in the coking process is not used for other productive purposes. This situation could potentially occur during the commissioning phase and during Power Plant outages at the Project. This also occurs at a few older coke plants in Australia and other countries.

By-product coke oven technology operates by capturing the volatiles as they are driven off and refining them to produce clean coke oven gas, sulphur, tar, ammonium sulphate, and light oil. Approximately 33% to 40% of the coke oven gas is used to heat the coke oven battery. The remaining waste heat and energy may be available for other industrial uses depending on the proximity of potential downstream users to the coke plant. At various stages of production when less gas is required and to regulate pressure, flaring may occur (representing approximately 6% of the available energy). When by-product coke oven technology is used with power generation, the refined oven gas is used as a source of heat in the steel process and the surplus gas is used to create electricity. The tar and BTX by-products are sold. As these by-products do not liberate all their energy, power generation projects are relatively smaller than heat recovery total combustion coke ovens.

Without associated power generation, surplus waste from by-product coke oven technology is used in the steel blast furnace or other associated activities as a part of steel production. The by-products produced contain carbon and are sold as inputs to other processes (representing approximately 3% of GHG emissions). Therefore, by-product coke oven technology will initially produce less GHG emissions than full combustion plants due to the sequestration of carbon in the by-products. However, GHG emissions will usually be emitted from the by-products at a later stage when the by-products are consumed.

Full combustion technology coke ovens operate at a negative pressure and are effectively a sealed system from the insertion of the coal to the exhaust stack, minimising the opportunity for the escape of gases, dust, ash and GHG emissions. At times of power generation outage or maintenance, large amounts of heat will be wasted due to no productive use. By-product coke ovens operate at a positive pressure, increasing the risk of volatiles escaping and the loss of heat. The coke oven volatiles are refined producing coke oven gas, at which time tar, BTX and other products are removed for separate sale. The composition of the specific coal will dictate the possible by-products that can be produced for sale. In addition, the requirement to flare gas to regulate pressure and dispose of surplus gas, increases the relative GHG emissions. Coke ovens can use varying combinations of blast furnace gas, coke oven gas, pulverised coal and natural gas to coke the coal, introducing opportunities for losses, in particular in plants with older, less efficient design. In the analysis of the technology solutions, a 15% loss of energy has been considered to be associated with coke oven gas and the nature of use of energy in steel production plants.

Whilst there is a range of old and new coke plants operating around the world, GHG performance data is not freely available. It is assumed that the coke by-products, such as tar and BTX, are consumed in most situations coupled with the losses of GHG gases associated with by-product technology. It is assessed that coke produced through by-product coke ovens produces a similar or higher level of GHG emissions compared to a plant using full combustion technology with power generation. On this basis the major consideration is how the surplus energy from coke production is most efficiently used and the GHG offsets associated with each plant.

The full combustion coke plant, when generating electricity using the waste heat, effectively offsets grid based coal-fired generation, which has an emission factor of 93.90 kg CO_2e/kWh [4]. The by-product coke plant, when using the refined coke oven gas for process heat, is offsetting the import of natural gas to the site, which has an emission factor of 52.6 kg CO_2e/GJ [5]. Hence, in consideration of the higher GHG emissions associated with electricity generation, the full combustion coke plant, when generating electricity, offsets approximately 41.3 kg CO_2e/GJ more GHG emissions than a by-product coke plant when using the refined coke oven gas for process heat.

The proportion of refined process gas required for the steel process varies significantly based on plant age and technology for a by-product plant and power plant. It is estimated that approximately 75% of the available refined gas is used to offset the need to use imported gas for process heat. It is also estimated that the remaining 25% becomes available, generally in the form of waste steam that is used for electricity generation. In this case the electricity generation is a by-product of steel production. For a by-product plant and no power plant, it is assumed that 100% of the available refined gas offsets imported gas for process heat.

These calculations assume that the electricity will have a similar emissions factor to the Queensland average of 93.90 kg CO_2e/kWh. Table 8.4 presents the comparative GHG emissions for alternative overseas coke plant options, considering available coking technologies. It assesses GHG emissions, possible GHG emission offsets and process by-products.

It is recognised that the coke plant could be constructed in a range of countries, where the energy source for electricity generation may range from renewable energy and nuclear power to gas or coal. The Overseas Full Combustion and Power Plant scenario assumes that an overseas plant producing coke would have energy sources (coal) and therefore GHG emissions similar to Queensland/Australia. Therefore, in some situations the GHG emission offset attributed to the generation of electricity in an overseas plant may not be considered to offset the same level of emissions as a plant operating in Australia. A conservative position has been adopted by assuming the offset will also occur if the plant was constructed in another country.

From a global GHG emission perspective, construction of the Project in the vicinity of the source coalfields results in a reduction of global GHG emissions due to a reduction in transport related emissions. The technology selected for the Project, including the Power Plant, offers significant benefits in terms of reduced GHG emissions when compared to alternative coke plant options.

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[4] AGO Factors and Methods Workbook (AGO August 2004), Table 5 excluding transmission for comparison purpose.
[5] AGO Factors and Methods Workbook (AGO August 2004), Table 2, point source used for comparison purpose.

Table 8.4 The Project versus Overseas Alternatives (based on 4.4 Mtpa (Dry) Coal Feed)

Technology	Total Annual Average GHG Emissions before Offsets, over 40 years of Operation (t CO_2e/yr)	Applicable Offsets	Effective Net GHG Emissions (t CO_2e/yr)	Other Process By-products Produced
Queensland Coke and Power Plant Project	2,801,551	Electricity Generation (40 years) - 2,458,901 t CO_2e/yr. Coal versus coke transport overseas - 40,774 t CO_2e/yr.	308,875	Nil
Overseas Full Combustion and Power Plant	2,801,551	Electricity Generation (40 years) - 2,458,901 t CO_2e pa.	342,650	Nil
Overseas Full Combustion - No Power Plant	2,801,551	Nil	2,801,551	Nil
Overseas By-product Plant and Power Plant	2,801,551	75% of the available refined gas offsets the need for imported gas for process heat - 811,231 t CO_2e/yr; 25% of the available refined gas can be used to create an offset from coal fired power generation - 395,507 t CO_2e/yr.	1,5494,813	BTX, tar and possibly oils containing unstable carbon complexes, ammonium sulphate and sulphur.
Overseas By-product Plant - No Power Plant	2,801,551	100% of the available refined gas offsets imported gas for process heat - 1,081,642 t CO_2e pa.	1,719,909	BTX, tar and possibly oils containing unstable carbon complexes, ammonium sulphate and sulphur.

8.2.5 Emissions Management

The development of the Project in Australia reduces world GHG emissions through the reduction of the weight of material being exported, therefore reducing transport emissions. In addition, the new plant will be constructed to ensure the GHG emissions are minimised during both construction and operational phases. The opportunities to reduce GHG emissions occur at various stages in the Project, including the original technology selection, detailed design and equipment selection, and operation of the plant. The proponents will evaluate the energy efficiency and GHG emissions for each potential technology provider in the evaluation of the project technology.

The major opportunities to reduce GHG emissions from the operation of the Coke Plant are implemented during both the design and operational phase, including process design, operational efficiency (issues such as duration coke oven doors are open), specifying high-efficiency motors and equipment such as compressors, specifying high-efficiency lighting with appropriate lighting control, and the use of low emission fuels in vehicles such as bio-diesel. To ensure these opportunities are implemented, the proponents undertake to:

- Develop processes to ensure that energy efficiency and low GHG emissions are considered at all stages of the detailed design, equipment selection and construction;
- Retain an external consultant to verify that high-efficiency, low-GHG emitting equipment is selected;
- Evaluate the supply options to use bio-diesel or other low GHG emission fuel mixes for all vehicles; and
- Establish an Environmental Management Plan (EMP). As part of the Air Quality Management Plan in Section 16 some initial commitments are made for the management of GHG issues. A more detailed EMP will be prepared before operations commence. The EMP will include key energy and GHG performance measures in plant operations, monthly reports and the personal objectives of senior staff.

The combination of design, operational and external abatement and offset projects will be used to develop a portfolio approach to a carbon-neutral project. The proponents will consider the following external opportunities to reduce or offset GHG emissions:

- Investigate community partnership arrangements with local interest groups for further carbon offset opportunities;
- Consider potential options relating to investment in carbon sequestration (forestry) schemes; and
- Evaluate transport emissions when contracts for rail freight of coal and coke product are negotiated.

The Coke Plant GHG emission performance will be measured against world's best practice, externally verified and publicly reported, consistent with the Australian Greenhouse Challenge Plus Program. QCE commits to join the AGO Greenhouse Challenge Plus program and report performance annually. SCL is currently a member of the Greenhouse Challenge program with a Greenhouse Challenge Plus agreement and is a participant in national Generator Efficiency Standards.