Australian Foundry Institute

Measuring Carbon Emissions: A Guide for the Australian Foundry Sector

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Encader Consulting

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Measuring carbon emissions – A guide for the Australian Foundry Sector was developed for the Australian Foundry Institute by:

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All images taken by T. Overman.

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CONTENTS

1 INTRODUCTION

1.1 AUSTRALIA'S CAST METAL INDUSTRY

Australia's cast metal industry – Foundries - are a major part of the country's steel and metal sector. Steel and other metals are critically important materials across Australia and the world and essential to the structure of the world around us.

Australia's 150-plus cast metal operations generate more than three quarters of a billion in sales annually and directly employs more than 2000 people across the country. The industry is emerging from a period of significant contraction, with the exit offshore of many major clients particularly automotive and heavy manufacturing and the downturn in mining.

The past five years has seen stabilisation, with some larger clients returning and stronger local demand. Recent estimates indicate that the sector manufactures in excess of 110,000 tonnes of ferrous metal cast annually and 35,000 tonnes of non-ferrous metal cast (A Cooke, pers. comm).

One of the most significant changes in that time has been the rapid increase in power costs, which has a direct impact on the industry bottom line given the high energy intensiveness of melting and associated processes. Meeting the growing energy demands of the sector while containing costs is one of the most important strategic challenges for the sector (A Cooke, pers. comm).

The Australian Foundry Institute (AFI) represents most of the businesses in Australia that cast metal. The mission of the AFI is to 'distribute technical information and the latest updates within the foundry industry to promote education amongst our country-wide Australian Foundry Institute members'. The industry has been proactive on several sustainability fronts, particularly with waste management, introducing LEAN manufacturing models and promoting energy efficiency.

The AFI National Executive has also identified carbon emissions from the sector and its contribution to climate change as an emerging priority which could impact public perceptions and recruitment of talent. The Executive has commissioned the development of this guide to measuring carbon emissions as a first step in a more comprehensive strategy to tackle the sector's emissions profile.

The guide is designed to provide a basic awareness level of knowledge and skills for staff. It is intended to be used 'in-house' by managers and technical specialists who have a role in sustainable operations and or reporting.

The guide is based on existing standards and regulations for measuring emissions including the National Energy and Greenhouse Regulations (NGER) and the National Carbon Offset Standard (NCOS). Given that most businesses within the sector do not trigger mandatory emissions reporting thresholds under NGER, the guide is targeted to those business who choose to voluntarily measure and report their carbon emissions as part of business practice.

The guide is not highly technical but reflects the operational context for foundries and casting businesses. It describes the steps to determine the carbon footprint of a foundry and/or casting business across the production value chain, but does not cover calculating the embodied carbon of a particular product.

1.2 GUIDE OVERVIEW

Measuring carbon emissions (greenhouse gases) is a relatively straightforward function for most businesses. Measuring emissions is the first step in what could be a broader agenda to reduce the carbon footprint of the business, as part of the Plan–Do–Check–Act (PDCA) cycle for continuous improvement (Figure 1).

For most smaller and medium sized Foundries quantifying a carbon footprint will be a voluntary undertaking, as they are unlikely to hit the triggers for mandatory measuring and reporting emissions (See box).

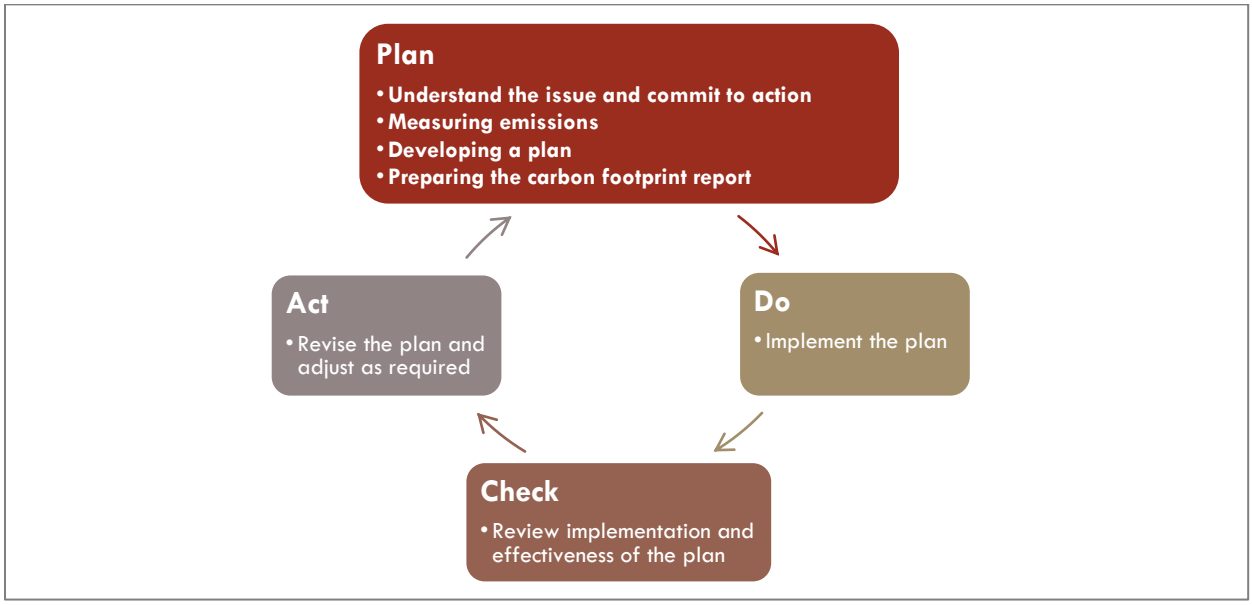

Figure 1 Continuous improvement cycle for carbon emissions reduction

This Guide provides information on the Planning stage of this process only, including:

- **Background -** introduces the global issue of climate change, the link to carbon emissions and the rationale for foundry businesses to measure and reduce emissions;
- **Measuring emissions** – explains the steps to identify potential emissions sources, clarify what to include, obtain the necessary data and calculate emissions;
- **Developing a plan** – provides an overview of how to develop a plan to reduce emissions;
- **Preparing the carbon footprint report** – provides suggestions for carbon footprint reporting.

2 BACKGROUND

2.1 CLIMATE CHANGE

The energy to sustain life on Earth comes from the sun. Gases such as carbon dioxide and methane occur naturally in the earth's atmosphere. These and other '**greenhouse gases**', most of which are **carbon-based**, have a blanketing, or warming effect on the planet, hence the phenomenon known as the '**greenhouse effect**' (Figure 2). It is this **greenhouse effect** that makes the planet warm enough to be habitable for life.

However, since the industrial revolution in the past 200 years, human actions have led to a rise in the total amount of greenhouse gases in the atmosphere. This has been due mainly to the release of carbon gases from the burning of fossil fuels (oil, coal and gas) for energy and heat, as well as land clearing and agriculture. This has led to a general warming of the planet, hence the term '**global warming**' caused by the '**enhanced**' greenhouse effect.

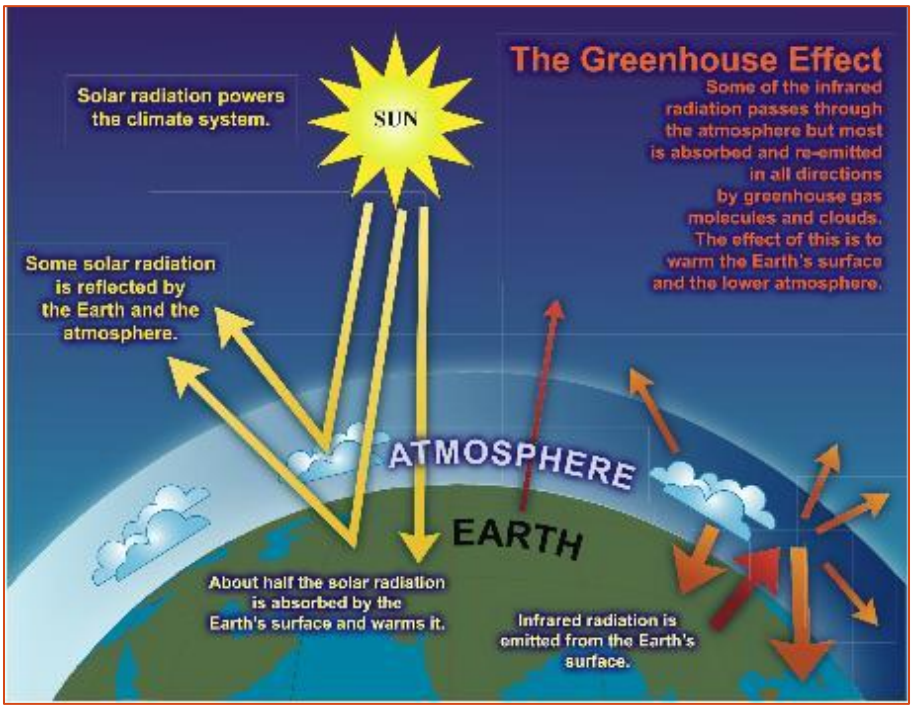

Figure 2 Model of the natural greenhouse effect (source: https://wg1.ipcc.ch/publications/wg1-ar4/faq/wg1_faq-1.3.html)

The Earth has experienced an increase in global average temperature over the past 200 years and especially since the latter half of the 21st century. This warming has been rapid by geological timescales, due to the fact that global atmospheric concentrations of these gases now far exceed pre-industrial values.

Because energy drives Earth's climate, this increase in global temperature is contributing to a wide range of climatic changes, hence the term, '**climate change**'.

Some of the key climate changes we are experiencing now include widespread melting of ice sheets and snowfields, sea level rise, variations in rainfall, increased ocean salinity and stronger wind patterns. The frequency of extreme weather events such as droughts, heavy rains, heat waves and cyclones are also increasing (see box for links to links outlining other potential impacts of climate change).

There are two main types of responses to the climate change issue:

Mitigation (or abatement) responses deal with the underlying cause of rising greenhouse gas levels. They are the measures society implements to physically reduce the greenhouse gas emissions caused by human activity.

Adaptation responses deal with the impacts of climate change such as increased temperature, rising sea levels and drier conditions. Adaptation responses help society adjust and adapt to a living in a changing climate.

Where to learn more about climate change impacts

Global impacts: https://www.ipcc.ch/

National scale impacts: http://www.environment.gov.au/climate-change/climate-science-data/climate-science/impacts

2.2 CARBON EMISSIONS

2.2.1 What are emissions?

Many of the activities undertaken by Foundries may result in emissions of substances that can adversely affect the environment and human health. There is increasing demand for the community to know what toxic substances might be emitted from a particular facility or industry. There are two main groups of emissions:

1. Substances listed on the National Pollutant Inventory (NPI) which might be directly harmful to human health or the environment; and
2. Greenhouse gas (carbon) emissions which affect global warming and contribute to climate change and are tracked under the National Greenhouse and Energy Reporting Scheme (NGERS).

The first group of substances are tracked and recorded under the National Pollutant Inventory, which contains data on 93 substances which is accessible to the community.

The second group are the gases which contribute to the greenhouse effect in the earth's atmosphere. These 'greenhouse', or 'carbon' emissions are the subject of this guide.

2.2.2 What are carbon emissions?

Elevated concentrations of greenhouse gases, or 'carbon emissions' in the Earth's atmosphere are the root cause of the rapid climate change impacts we are now experiencing. A global effort is underway to reduce carbon emissions.

The Paris Agreement, signed at the United Nations Climate Change Conference in Paris, COP 21, commits signatory governments (including Australia) to mobilising stronger and more ambitious climate action urgently. This agreement emphasises that everyone has a role to play to understand their carbon emission footprint and take action to reduce it.

For measuring and reporting purposes, there are six greenhouse gases which are covered under agreed international standards and procedures[1] including:

- carbon dioxide (CO_2)
- methane (CH_4)
- nitrous oxide (N_2O)
- Synthetic gases
    - hydrofluorocarbons (HFCs)
    - sulphur hexafluoride (SF_6)
    - carbon tetrafluoride (CF_4)
    - hexafluoroethane (C_2F_6)

Note: all emissions, regardless of the greenhouse gas, are expressed as metric tonnes of carbon dioxide equivalent, 'tCO_2-e' for national and international reporting consistency.

[1] Greenhouse Gas (GHG) Protocol Corporate Accounting and Reporting Standard

2.2.3 What are the different types of emissions?

Understanding what emissions to include in a carbon footprint for a business or organisation can be highly complex. To help clarify and standardise the measurement and management of the six greenhouse gases, the International Greenhouse Gas Protocol identifies three different categories, or 'scopes' of greenhouse gas emissions:

- **Scope 1** Emissions and are those which are produced directly by the activities of the business by its own facilities, such as the combustion of natural gas for heating, or emissions arising directly from manufacturing and/or production processes, as well as fuels used to power company vehicles;
- **Scope 2** emissions are associated with the business use of electricity, which was generated elsewhere from the burning of fossil fuels (e.g. coal, natural gas);
- **Scope 3** emissions are the emissions incurred by third parties (not electricity) involved in servicing the business needs, such as waste, business travel and accommodation, paper and water use. Scope 3 emissions also include the carbon emissions arising from processes associated with the broader 'life cycle' of the production chain, both upstream activities and downstream.

Each of these types of emissions are attributable to the business entity, either directly or indirectly as shown in Figure 3.

However, whereas Scope 1 emissions are within the direct control of the business, Scope 2 and 3 emissions are beyond its direct control. In the case of Scope 2 emissions, that is the business use of grid sourced electricity, these could be said to be within the business' 'sphere of influence', whilst Scope 3 emissions are typically beyond this again, that is within the business' sphere of concern, as shown in Figure 4.

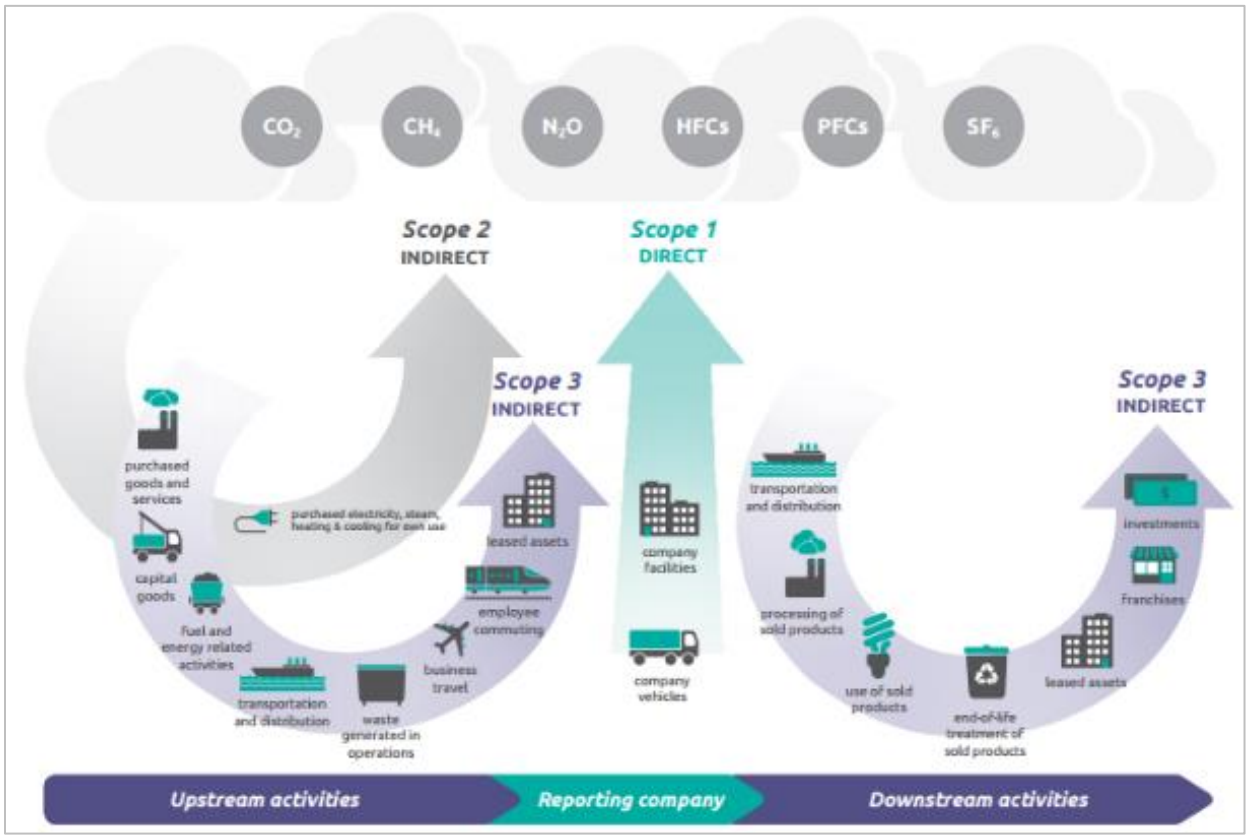

Figure 3 Emission types from a company or entity (https://ghgprotocol.org)

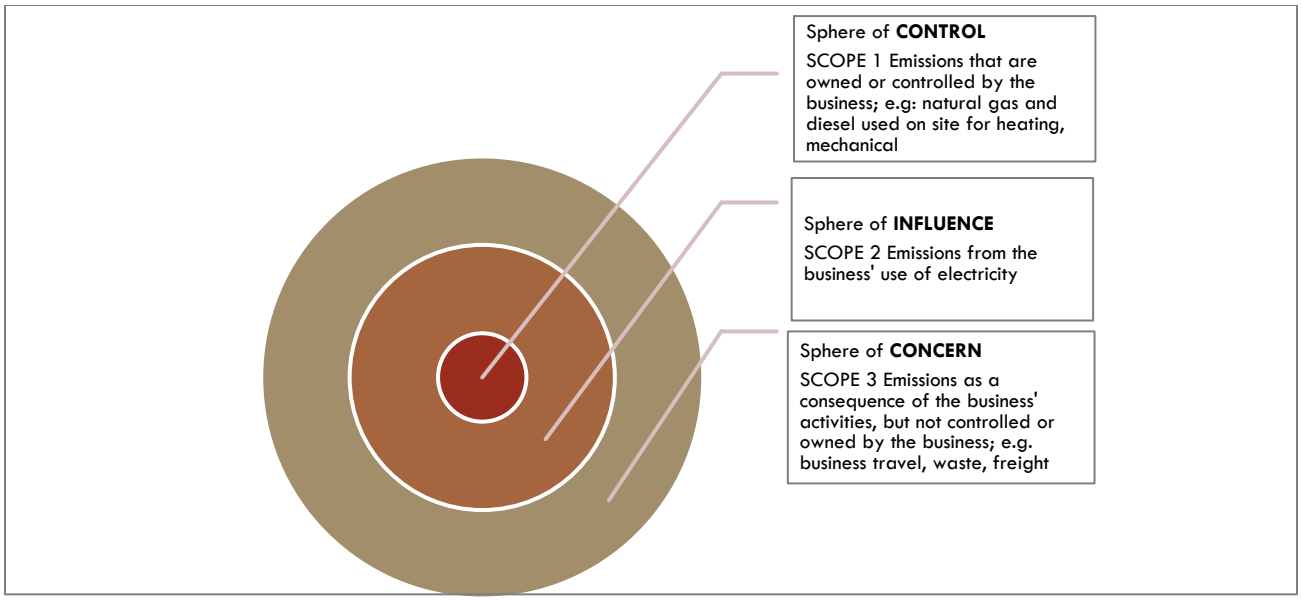

Figure 4 Emissions scopes within a business spheres of control, influence and concern.

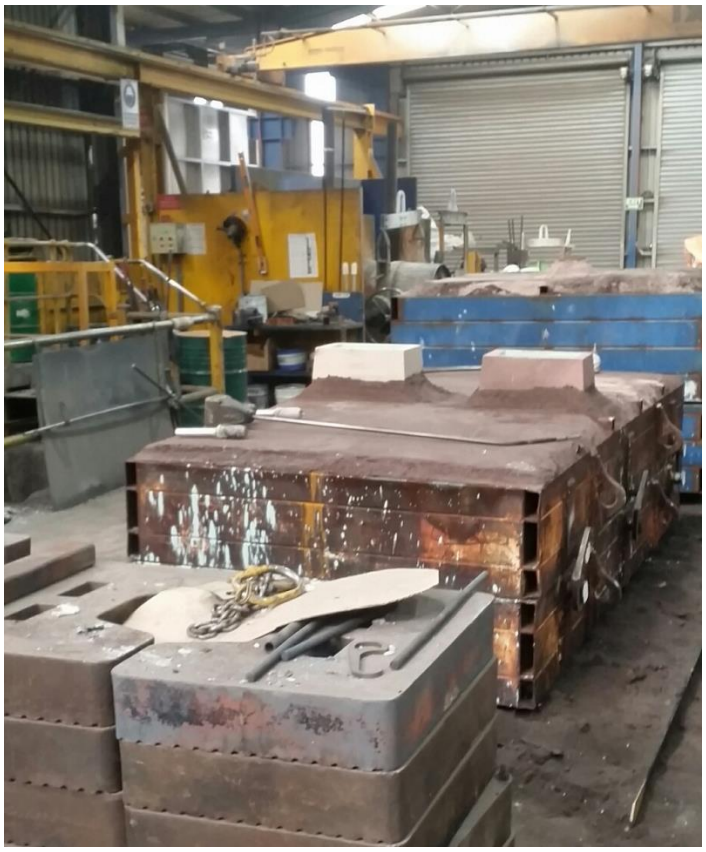

Figure 5 Foundry activities involve significant energy

2.2.4 What rules and principles should apply?

Foundries which choose to measure the carbon emissions should refer to the following key standards for guidance:

- **National Greenhouse and Energy Reporting** (NGER) System which provides framework for mandatory reporting of emissions and energy
- **National Carbon Offset Standard** is the guide for voluntary management of greenhouse gas emissions and the process to achieve carbon neutrality. It provides best-practice guidance on how to measure, reduce, offset, report and audit emissions for organisations, products & services, events, precincts and buildings.
- **National Greenhouse Accounts (NGA) Factors** are used by businesses, organisations and individuals who voluntarily chose to estimate greenhouse gas emissions. The NGA Factors are updated annually by government.

The Integrational Greenhouse Gas Protocol proposes that businesses should adopt the following principles to guide their carbon emissions measurement and reporting[2].

- **Relevance** - ensure the carbon footprint appropriately reflects the emissions attributable to the business;
- **Completeness** - account for and report all emissions sources and activities within the boundary of the business and explain any exclusions;
- **Consistency** – use consistent methodologies to allow for comparisons of emissions over time, clarifying any changes to data, boundaries, methods, or other relevant factors;
- **Transparency** - compile, analyse and document the carbon footprint clearly so it can be assessed and evaluated, including any assumptions, calculations and data sources;
- **Accuracy** – be accurate as far as possible with results, reducing uncertainty and assumptions.

Do I have to report?

Under the National Greenhouse and Energy Reporting Act, 2007, only business which trigger a threshold for emissions or energy must report. For all other businesses, emission measurement and reporting will be voluntary. The thresholds are:

Corporate group - 50 ktCO2e or more (scope 1 &2), or consumption of 200 TJ or more of energy

Facility - 25 ktCO2-e or more (Scope 1 & 2) or consumption of 100 TJ or more of energy

Note that most foundry businesses in Australia will not meet these thresholds and therefore not required to report. Therefore, most carbon emission measuring and reporting in the foundry sector will be voluntary.

[2] Greenhouse Gas Protocol: http://www.ghgprotocol.org/

2.3 WHY FOUNDRIES SHOULD MEASURE CARBON EMISSIONS?

2.3.1 Why are Foundries important?

Foundries are an essential part of manufacturing within the steel and metal production life cycle (Figure 6). From start-to-finish, this is an energy intensive process. It takes considerable energy to extract ore from the ground and transport it to steel and metal production facilities. It then takes high temperatures and special conditions to create steel and other metals and alloys.

By the time these products arrive at a foundry, they have significant embodied energy. At a foundry, it again takes high temperatures to convert these solid products into molten form so they can be cast into moulds to make items suitable for use in a wide range of applications.

After being used, much of this material makes its way back to foundries in the form of scrap metal, which is reintegrated into the production process. Foundries are critical to the circular economy of steel and metal and therefore have an important role in sustainable development.

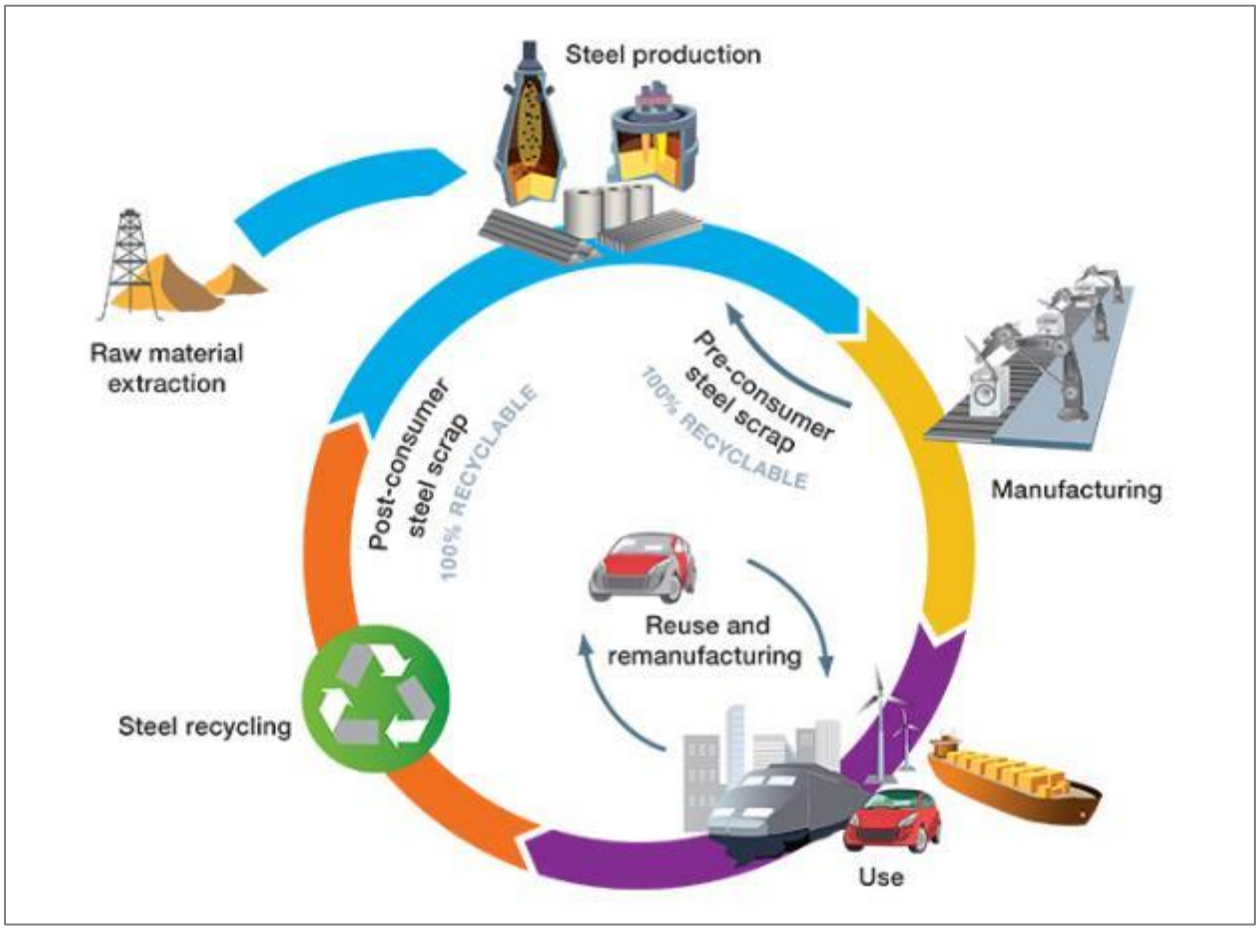

Figure 6 Steel and metal production life cycle (source: https://www.worldsteel.org/steel-by-topic/life-cycle-thinking.html).

2.3.2 What are the business drivers?

Most foundries are likely to be relatively high users of energy given the energy intensive processes involved in melting of metals. As production volumes increase to meet demand, energy usage in the sector will increase.

This, coupled with rapid energy price increases will add significant business costs which either need to be absorbed or passed on to the customer. Given the correlation between energy and emissions, a strategy that addresses both is becoming a more attractive proposition for many businesses.

Despite ongoing debate about climate change (and energy) policy in Australia, many businesses have begun to measure and manage their greenhouse gas emissions as part of their core business. Some of the key drivers for this include:

- The impact of electricity and natural gas price rises on the financial bottom line, driving business to better contain costs through energy efficiencies, the foundation of which is knowing where energy is being used;
- The dependence of many energy intensive sectors on single sources of electricity and the need to diversify energy sources to manage business continuity risks;
- Regulatory pressures - a growing likelihood that all businesses and organisations will need to account for and reduce their emissions, so business may as well be 'on the front foot'.
- Increasing community awareness of climate change and its implications and greater expectations on businesses to be more accountable and transparent to maintain their 'social license to operate'

Figure 7 Ladle

2.3.3 What might be the potential benefits?

The potential benefits of the AFI member businesses adopting carbon mitigation could be significant, including:

- **Shareholder/community interest** –tapping into the growing awareness amongst shareholders and the community that businesses need to manage to the 'triple bottom line' including environmental issues such as carbon emissions;
- **Competitive advantage** – Given that business' response to climate change is still a relatively new area in the sector, early adopters may be able to position themselves as sector leaders
- **Improving business capability** – leveraging the carbon mitigation process to generate data and activities that can lead directly to cost savings (such as energy efficiencies) and revenue generation;
- **Reputation and brand** - with climate change becoming a more mainstream issue, a strong position on emissions reduction can help to enhance the reputation of the sector, positioning it as being environmentally responsible in the broader national context.

Case Study: IXL Metal Castings, Geelong

IXL Metal Castings has been making high quality ferrous castings from its Geelong foundry since 1858. It specialises in cast Iron, cast iron alloys, cast steel, white iron and other alloys.

With a strong commitment to safety, innovation and environmental responsibility, the business has made many improvements to its production process that increase energy efficiency and reduce carbon emissions.

Examples include:

- Changeover to LED lighting across the entire site
- Switch to use of induction furnaces
- Various energy audits
- Shift towards longer lasting parts and equipment
- Upgrades to electronic monitoring and control systems

The result has been a gradual shift to a cleaner, greener production cycle which fits in with the company's corporate commitment to sustainability.

3 MEASURING EMISSIONS

3.1 ESTABLISH THE BOUNDARY OF THE CARBON FOOTPRINT

It is important for the business to define the boundaries of its carbon footprint, which involves clarifying:

- Which parts of the business to include (organisational boundary);
- What emissions generating activities to include (operational boundary); and
- What emissions sources to include

3.1.1 What parts of the business should be included in a carbon footprint?

Businesses can be highly varied in their organisational structure and ownership. Some foundries might be small family owned companies, whereas others may be part of an international consortium. Each business needs to decide what parts of its business will be included in the carbon footprint.

These choices are likely to be based on the business' primary drivers and the extent to which it can take control and effect change in the value chain. A common way of deciding this is to include all the emissions from operations over which it has direct control and exclude emissions from operations it has an interest in but no control.

The operational boundary should be realistic, the wider in scope the more complicated the carbon footprint. Key issues to consider include multiple facilities at more than one location, owned or leased premises and sub-leasing to third parties.

3.1.2 What operational processes should be included?

Once the business has decided what parts of its organisation are included, it then needs to decide on what activities within its operations to include. This involves identifying the activities within the business' operational control and identify the carbon emissions occurring at each activity and categorising the scope

The casting of metal in foundries is one of the oldest manufacturing processes in the world. Foundry work involves casting molten metal into a mould. A typical process includes preparing a mould for casting, melting, pouring metal into the mould, and removing and finishing the casting. This process is energy intensive, as it involves heating metal to high enough temperatures to achieve a molten state so the casting can occur.

Table 1presents the main processes and activities that are likely to occur in a typical foundry business. It includes three groups of business activity:

- Metal – the processes and activities associated with the use of metal within the foundry
- Sand – activities associated with the use of sand within the foundry
- Facilities – activities associated with the office and administrative functions of the foundry

Table 1 Foundry processes and activities – Metal

Main process	Activity	Energy required?	Purpose	Energy sources	Emissions Scope
Metal in the production cycle					
Raw material (inc. scrap, runner system returns, alloys)	Transport	Yes	Transport of alloys from overseas raw metal to site	Transport Fuels	1, 3
	Metal preparation (including pre-heating)	Yes	Optimise the melting process	Gas, Electricity	1,2
	Plant activation and equipment preheat (ladles etc)	Yes	Activating mechanical devices, compressed air, exhaust systems	Electricity, Gas	2, 1
Melting	Melting	Yes	Furnace heating	Electricity; Gas	2, 1
	Insert charge materials	Yes	Cranes and hydraulics	Electricity	2
	Furnace tilting	Yes	Hydraulics	Electricity	2
	Holding	Yes	Heating	Electricity, Gas	2, 1
	Cooling & exhaust	Yes	Fans, blowers	Electricity	2
Tapping & treating	Pouring the molten metal into the mould	Yes	Hydraulics	Electricity	2
	Treatment	Yes	Fume control, extraction, removing soluble gases	Electricity	2
Casting	Casting	Yes	Manual or automated	Electricity	2
	Cooling	Yes	Fume control, extraction	Electricity	2
Shakeout	Shakeout/knockout	Yes	Vibration or mechanical	Electricity	2
Cleaning	Shot blasting	Yes	Firing shot	Electricity	2
Fettling and Finishing	Runner system removal, cleaning joint line flash, casting preparation	Yes	Grinders, air compression,	Electricity	2
	Heat Treatment, Impregnation	Yes		Electricity, Gas	2, 1
Machining		Yes	Cutting and finishing	Electricity	2
Inspection		Yes	Some testing	Electricity	2
Shipping		Yes	Product distribution	Transport fuels	1, 3
Sand in the production cycle					
Raw sand		Yes	Transport to site	Transport Fuels	3,1
Mould preparation	Materials mixing	Yes	Mixing machinery; heating	Electricity	2
	Mould making	Yes	Compressing onto patterns hydraulics	Electricity	2
Core preparation	Materials mixing	Yes	Mixing machinery; heat	Electricity	2
	Core making	Yes		Electricity, Gas	2,1
Sand recycling	Bonded sands reclamation	Yes		Electricity	2
Offices and facilities					
	ICT equipment; sub-stations	Yes	ICT equipment	Electricity	2
	Lighting	Yes	Lighting	Electricity	2
	HVAC	Yes	HVAC	Electricity, Gas	2,1
	Cooking	Yes	Cooking	Electricity, Gas	2, 1
	Waste	Yes	Waste disposal		3
	Staff work travel	Yes	Work vehicles	Transport Fuels	1, 3
	Staff commuting travel	Yes	Staff Vehicles	Transport Fuels	3

3.1.3 What emissions should be included in the footprint?

The final step in establishing the boundaries of the carbon footprint involves deciding which sources of emissions will be included and which will be excluded. There are no specific rules guiding this decision, so it is up to each business to decide which emissions to include in its carbon footprint and from what parts of its business.

Of the three different emissions categories, Scope 1 emissions are typically the highest priority for a business to measure and report as they are within the business' direct control to change.

Scope 2 emissions, those arising from the business' use of electricity will be next priority. Business can exert some influence over the quantity and timing of their use of grid sourced electricity, they can also choose to change their mix of electricity such as using on-site renewable energy.

Scope 3 emissions present the most complex group of emissions for a business to include. Because these emissions are not within sphere of control or influence of the business, they can be difficult to quantify and measure.

There is typically a spectrum for measuring and reporting business emissions, depending on the extent of types of emissions measured and the purpose of reporting (Figure 8). Most businesses which chose to measure emissions voluntarily (i.e. they do not trigger NGERS reporting thresholds) will include Scope 1 and Scope 2 emissions. For businesses which must report under NGERS, Scopes 1 and 2 are mandatory and strict rules apply. Businesses may choose to go beyond this level, particularly if they have significant business drivers to be seen to tackling climate mitigation and or they are seeking to become Carbon Neutral.

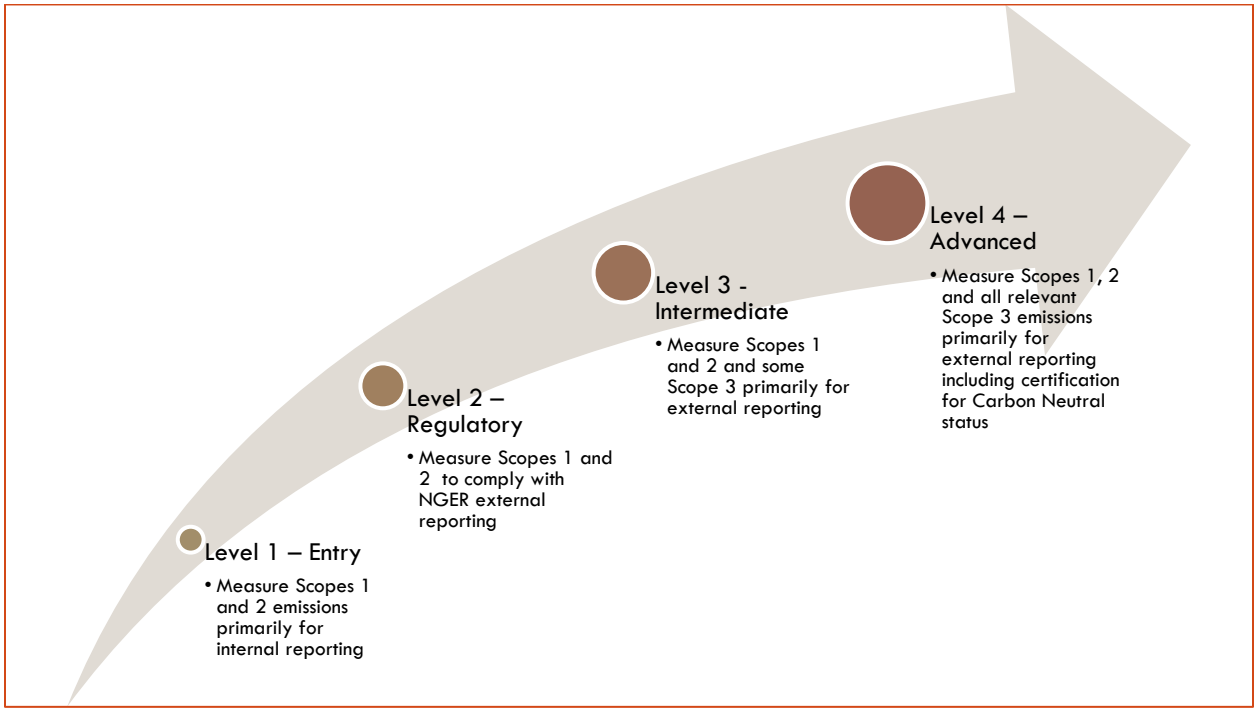

Figure 8 Spectrum of carbon emissions reporting by business

3.2 IDENTIFY EMISSIONS SOURCES

3.2.1 What emissions come from the metal process?

This section describes the likely carbon emissions from each activity that could be undertaken in a typical foundry business. As a general rule, the melting process is likely to be the most energy intensive and therefore generate most emissions, but there will be various other high-emissions activities in the process (Figure 9)

Note that your business operations may not necessarily include every activity outlined here.

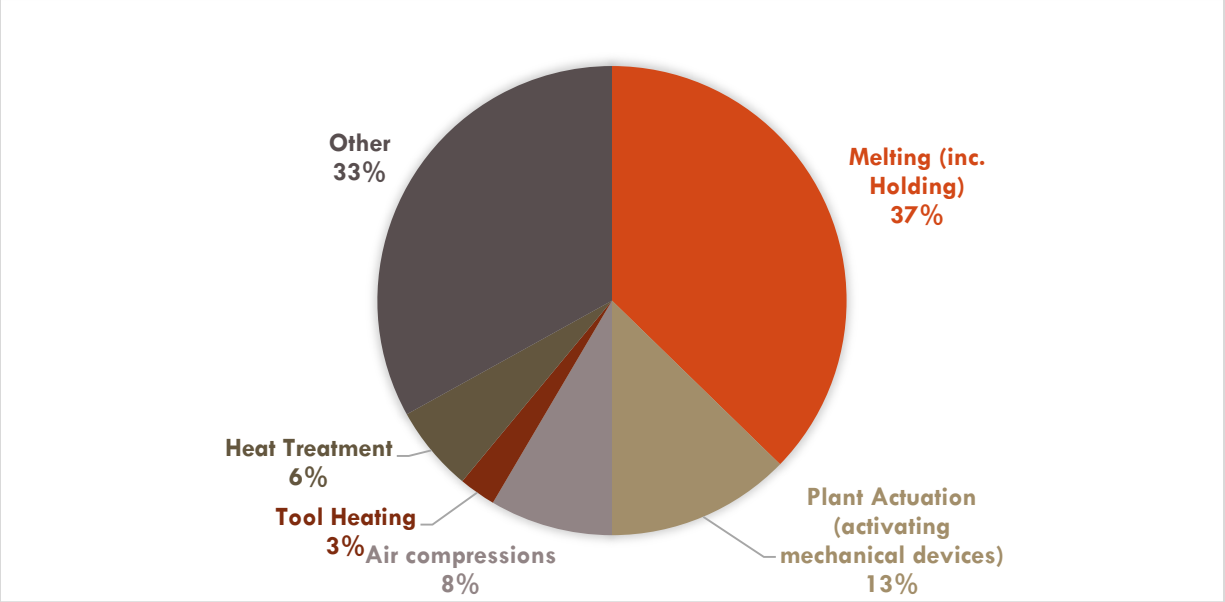

Figure 9 Typical energy consumption in Ferrous foundries[3]

3.2.1.1 Raw materials, preparation and activation

Sourcing the raw materials for the Foundry involves collecting and receiving materials such as scrap metal, runner system returns and alloys. This activity is the first point at which the foundry has control of associated emissions, such as transport fuels used in forklifts to stockpile and load raw materials. These will be a source of Scope 1 emissions.

Many foundries have a metal preparation step. This activity may include the use of Natural Gas on site (Scope 1) and Electricity – Scope 2. Some foundries might have a plant activation that could include warming up equipment and machinery, such as ladle pre-heating to optimise the melting process. It could also include activating mechanical devices, for compressed air or exhaust systems. This activity may include the use of Natural Gas on site (Scope 1) and Electricity – Scope 2.

Of course, considerable energy will have been used in the upstream activities of extraction, production and distribution involved in making the raw materials available at the Foundry. These would be considered Scope 3 emissions for the Foundry. Similarly, emissions associated with steel and metal recycling for raw materials that leave the Foundry would be considered Scope 3 emissions.

[3] QLD Gov (2010) Melting Efficiency F2A Energy eco-efficiency opportunities in Queensland Foundries

3.2.1.2 Melting

Melting involves heating solid metal to a liquid form ready for casting. One tonne of steel needs to be heated to 1600 degrees Celsius to be ready for pouring. It takes considerable energy to achieve this change in state, with most foundries using up to 800 kWh per tonne of steel. Significant energy is lost during this process as heat.

For most foundries, the melting process is likely to be the largest energy using process and therefore is also likely to be the source of the highest proportion of emissions. Many foundries use electricity sourced from the grid to heat their furnaces, so Scope 2 emissions will be a large part of their footprint. For foundries using natural gas to melt the metal, the emissions will be Scope1.

Typically, foundries need to **insert charge materials** at this point in the process. This is likely to involve the use of cranes and or hydraulic equipment, which is most likely to be powered by electricity (Scope 2).

Furnace Tilting equipment will also be required and these too are likely to be hydraulically powered using electricity (Scope 2). ***Holding*** metal in its liquid state also requires energy and this will be another source of emissions, Scope 2 if electricity and Scope 1 if gas.

The heat and fumes generated through the melting and holding steps means that foundries need extensive factory and equipment ***cooling and exhaust systems***, such as fans and blowers. This equipment is likely to be powered by electricity, Scope 2.

3.2.1.3 Tapping & treating

Tapping and treating is an interim process step for some foundries. This requires hydraulic equipment which is likely to be electrically powered (Scope 2). Treatment of the metal could require fume control and extraction and the removal of soluble gases, using electrically powered equipment (scope 2).

3.2.1.4 Casting

Casting will be either manual or automated, both of which are likely to use electricity (scope 2). Electrically powered fume extraction and cooling equipment will also be in use (Scope 2).

Figure 10 A mould being cast

Figure 11 Casting involves electricity for heat and fume extraction

3.2.1.5 Shakeout

Shakeout or knockout of the metal from the mould can be by vibration or mechanical which in both cases will likely use electricity (Scope 2).

3.2.1.6 Cleaning

Shot blasting involves cleaning of the preliminary product by firing of steel shot at the cast metal. This process is likely to be electrically powered (Scope 2).

3.2.1.7 Fettling and Finishing

Fettling and finishing include removal of the Runner system, cleaning the joint line flash, preparing the casting for the next use. These activities are likely to include use of grinding equipment and air compression, both of which require electricity (Scope 2). Where additional heat treatment and/or impregnation of the cast product is required, this could be either electricity (Scope 2) of gas (Scope 1).

Figure 12 Shakeout of sand involves electricity for vibration and extraction

3.2.1.8 Machining

For those businesses that include machining of the castings, this process will be with electrically powered equipment (Scope 2)

3.2.1.9 Inspection

Inspection of the final product could require some testing, so electricity may be required (Scope 2).

3.2.1.10 Distribution

Distribution of the product (shipping) is likely to involve the use of trucks which use transport fuels. It will depend on who is 'in control' (owns and operates) the distribution vehicles as to the type of emissions;- if the trucks are owned and operated by the foundry, then those transport fuel emissions would be Scope 1; if they are outsourced to a transport logistics company, then they would be scope 3 emissions.

Figure 13 Finished product ready for distribution

3.2.2 What emissions come from sand in the production cycle?

3.2.2.1 Raw sand

Sourcing the raw sand for the Foundry involves transport of the sand to the site, which is likely to involve third party use of transport fuels. These would be considered Scope 3 emissions for the foundry (unless the vehicles were owned and operated by the foundry, in which case the fuel associated emissions would be Scope 1).

3.2.2.2 Mould preparation

Mould preparation involves mixing of materials and sometimes heat, both process which will use energy in the form of electricity (Scope 2 emissions). **Mould making** involves compressing the mixed materials into patterns which is likely to require hydraulic or pneumatic equipment powered by electricity and therefore also incur Scope 2 emissions.

Figure 14 Mould preparation involves mixing, compression and heat

3.2.2.3 Core preparation

Core preparation also involves materials mixing requiring electricity for mixing equipment and heat (Scope 2) whilst core making will involve electricity (Scope 2) and potentially some natural gas (Scope 1)

3.2.2.4 Sand recycling

Reclamation of bonded sands is likely to require electricity (Scope 2), particularly if the foundry operates a 'closed sand system'.

3.2.3 What emissions come from offices and other facilities?

A Foundry business is likely to have Scope 1 and Scope 2 emissions associated with the operation of its administrative offices and other facilities. ICT equipment like computers and screens use electricity (Scope 2 emissions), as does lighting and some aspects of Heating, Ventilation and Cooling (HVAC).

Natural gas (Scope 1 emissions) is likely to be used for some heating and cooking, whilst Transport fuels (scope 1 emissions) are likely to be required for vehicle fleets and factory floor equipment such as forklifts. Some facilities may also operate electrical substations which also use electricity to operate (scope 2).

3.3 COLLECT DATA ON IDENTIFIED EMISSIONS SOURCES

3.3.1 What activity data is required?

For most Australian foundries not required to report under NGERS, a simple process using 'activity data' and standard 'emissions factors' is how they will calculate their carbon footprint. In this method, the activity data which quantifies an emission causing activity is simply multiplied by an approved emissions factor to calculate the emissions.

Activity data quantifies an activity that results in a source of emissions, for example:

- Kilojoules of natural gas consumed in heating (Scope 1)
- litres of fuel consumed in business vehicles (Scope 1)
- kilowatt hours of electricity used, (Scope 2)
- Distance travelled by vehicle for commuting (scope 3)

In the case of the natural gas, the financial records (i.e. invoices) of gas used from the gas retailer will provide the data of how much gas has been used over that period. The activity may be heating, the source of emission is the combustion of the natural gas and the activity data is the volume of natural gas purchased in kilojoules.

For a work vehicle, the fuel dockets will provide a record of how much fuel was purchased for a particular vehicle by the business. The activity is transport, the source of emission is the combustion of say diesel and the activity data is the volume of fuel purchased in litres.

Activity data can be obtained from a variety of sources, including;

- financial records, such as bills, invoices
- direct entries of quantities, such as litres of fuel on fuel dockets, fleet cards
- estimates from previous records.

If a business does not have operational control for the whole emissions from the activity (such as occupying only part of a building), then it needs to obtain the data related to its share of the activity or determine an appropriate way of allocating its level of operation control. For example, a business may not occupy whole of the premises where electricity is being used. In this case, the business could choose to get separate metered data, or contact the facility manager and work out the proportion of the electricity used. This may be an estimate based on the proportion of area occupied.

3.3.2 What are emission factors?

An emission factor is a factor that enables a unit of activity to be converted into a weight of carbon dioxide equivalent emitted per unit of activity. These factors are issued annually in the National Greenhouse Account Factors published by the Department of Environment and Energy[4] and designed for use by companies and individuals to estimate greenhouse gas emissions.

They are activity specific and relate to the scope of the emissions, direct and indirect. Direct emissions factors apply to activities that cause point of use emissions and provided in $KgCO_2$-e per unit of activity, including fossil fuel use (e.g. gas, diesel, petrol, coal).

Emission factors are used to calculate Scope 2 emissions from electricity sourced via the grid. These emissions are incurred at the power station due to the burning of fuels (coal, natural gas, etc.) to make the electricity. These are provided in kilograms of CO2-e per unit of electricity consumed.

Emissions factors are also provided for Scope 3 emissions, including the indirect emissions attributable to the extraction, production and transport of fossil fuels or the extraction, production and transport of fuel burned at generation and the indirect emissions attributable to the electricity lost in delivery in the transmission and distribution network.

Ideas for collecting emissions data

Carbon emissions data is generally associated with other data types, especially financial.

You may be able to work closely with your accounts and finance staff who have existing data collection and analysis processes already occurring within the business.

This could help with the data collection process and ensure that the footprint information is current and reported simultaneously

[4] http://www.environment.gov.au/climate-change/climate-science-data/greenhouse-gas-measurement/publications/national-greenhouse-accounts-factors-july-2018

3.4 CALCULATE THE CARBON FOOTPRINT

3.4.1 Scope 1 emissions

Direct emissions arise from combustion of solid, gaseous or liquid fuels and these can be either stationary (e.g. natural gas used on site in a foundry) or for transport (e.g. diesel used in tucks).

For calculating direct emissions from combustion of these fuels, emission factors are expressed as a quantity of emissions per unit of energy, i.e.: kg CO_2-e /GJ.

The emissions are calculated by multiplying the quantity of fuel combusted by the appropriate fuel specific emissions factor. by a fuel-specific energy content factor and a fuel-specific emission factor. This is performed for each relevant greenhouse gas (in this case, carbon dioxide, methane and nitrous oxide). Separate calculations should be carried out for each fuel type[5]

The following formula (COA, 2018) can be used to estimate greenhouse gas emissions from the combustion of Scope 1 fuels: $E = [Q \times EC \times EF(CO_2)]/1000 + [Q \times EC(CH_4)]/1000 + [Q \times EC \times EF(N_2O)]/1000$

Where:

- E is emissions of gas type (carbon dioxide, methane or nitrous oxide), from fuel type (CO2-e tonnes)
- Q is the quantity of fuel type (tonnes for solids, cubic metres for gases)
- EC is the energy content factor of fuel type (gigajoules per tonne/ cubic metre)
- If Q is measured in gigajoules, then EC is 1
- EF is the emission factor for each gas type.

Example: calculation of emissions from natural gas consumption

A facility consumes 100,000 gigajoules of natural gas.
The energy content factor of Natural gas measured in gigajoules is 1
The emissions factors for natural gas are:

- carbon dioxide 51.4
- methane 0.1
- nitrous oxide 0.03

Emissions in tonnes of CO_2-e are estimated as follows:
Emissions of carbon dioxide = (100,000 x 1 x 51.4)/1,000 = = 5,140 t CO_2-e
Emissions of methane = (100,000 x 1 x 0.1)/1,000 = 10 t CO_2-e
Emissions of nitrous oxide = (100,000 x 1 x 0.03)/1,000 = 3 t CO_2-e

Total scope 1 GHG emissions = 5,140 + 10 + 3 = **5,153 t CO_2-e**

Source 2018 National Greenhouse Accounts Factors, COA, 2018; p 13

[5] COA (2018) National Greenhouse Accounts Factors

Example: calculation of emissions from transport fuels consumed

A freight company consumes 10000 kL of automotive diesel for transport purposes.
The energy content factor of Diesel fuel is 38.6
The emissions factors for Diesel are:

- carbon dioxide 69.9
- methane 0.1
- nitrous oxide 0.5

Emissions in tonnes of CO_2-e are estimated as follows:
Emissions of carbon dioxide = (10,000 x 38.6 x 69.9)/1,000 = 26,981 t CO2-e
Emissions of methane = (10,000 x 38.6 x 0.1)/1,000 = 39 t CO2-e
Emissions of nitrous oxide = (10,000 x 38.6 x 0.5)/1,000 = 193 t CO2-e
Total scope 1 GHG emissions = 26981 + 39 + 193 = 27,213 t CO2-e

Source 2018 National Greenhouse Accounts Factors, COA, 2018; p 18

3.4.2 Scope 2 emissions

Scope 2 emission factors vary slightly between States due to the different mix of generation between coal, gas and renewables and the flow of electricity as illustrated in Table 2. Typically, electricity generated in Victoria has the highest Scope 2 emissions factor because it is produced mainly from burning brown coal, a very carbon intensive fossil fuel. Tasmania generally has the lowest Scope 2 emissions factor because most of its energy comes from 'zero emissions' hydro energy.

State or Territory	Emission factor kg CO_2-e/kWh
New South Wales and Australian Capital Territory	0.82
Victoria	1.07
Queensland	0.80
South Australia	0.51
South West Interconnected System (SWIS) in Western Australia	0.70
North Western Interconnected System (NWIS) in Western Australia	0.60
Darwin Katherine Interconnected System (DKIS) in the Northern Territory	0.56
Tasmania	0.19
Northern Territory	0.64

Table 2 Electricity (Scope 2) emission factors for each State or Territory[6]

The factors estimate emissions of CO2, CH4 and N2O expressed together as carbon dioxide equivalent (CO2-e). The greenhouse gas emissions in tonnes of CO2-e attributable to the quantity of electricity used may be calculated with the following equation: Y = E [Q x EF/1000], where:

- Y is the scope 2 emissions measured in CO2-e tonnes
- Q is the quantity of electricity purchased (kilowatt hours). For Q, if the electricity purchased is measured in gigajoules, the quantity of kilowatt hours must be calculated by dividing the number of gigajoules by 0.0036.
- EF is the scope 2 emission factor, for the State, Territory or electricity grid in which the consumption occurs (kg CO2-e per kilowatt hour).

Example: calculation of emissions from electricity consumption

A company in New South Wales consumes 100,000 kWh of purchased electricity from the grid. The emissions factor for grid sourced electricity in NSW is 0.82.
Emissions of greenhouse gases (scope 2) in tonnes of CO2-e are estimated as follows:
= 100,000 x (0.82/1000)
= 82 tonnes.
Total scope 2 GHG emissions = 82 tonnes CO2-e

Source 2018 National Greenhouse Accounts Factors, COA, 2018

3.4.3 Scope 3 emissions

Because Scope 3 3missions includes all other indirect emissions (apart from scope 2), it covers a potentially wide range of emissions sources and calculations. Full details are available in the National Greenhouse Accounts Factors (2018).

[6] COA (2018) National Greenhouse Accounts Factors 2018, p20

4 DEVELOPING A PLAN

Businesses that deliberately set out to reduce their carbon emissions often develop a Carbon Action Plan. This plan sets out the business' planned agenda for reducing its emissions into the future. This type of plan can be relatively easy to prepare, help get the business started and build commitment to action. Typically, a plan will include:

- the business context for emissions reduction;
- the business' carbon footprint as a baseline and potential future changes;
- actions undertaken to date;
- objectives and targets for emissions reduction;
- strategies to achieve the objectives;
- practical actions to be investigated and implemented;
- priorities, accountabilities, budgets and timelines for implementation.

4.1 WHAT ARE THE GOALS?

The key to any strategic plan is knowing where to focus the business' efforts.

From the carbon footprint report, the business will have identified its largest sources of emissions, understand the root causes of those emissions and the likely trends. Many factors can affect a business emissions profile, such as increasing demand for product, production process changes, acquisitions and mergers or major initiatives. By using the knowledge available in the business, it should be possible to develop a realistic trend for future emissions.

It is also important to establish a base year. A base year is simply a year set for future comparisons of total emissions. It provides a reference point for future changes.

Central to developing practical actions is understanding the degree of control the business has over its largest sources of emissions. If large sources are affected mainly by factors within the business' control, it may be possible to make significant changes, depending on priorities and available funds. However, if the emissions trajectory is driven by factors beyond the business control, it may be difficult to make significant changes.

The Plan also needs to set clear goals and targets, consistent with the broader business vision and goals. Ideally, these would be SMART goals, i.e. Specific, Measurable, Achievable, Realistic and Time-bound. For carbon emissions, there are two types of goals that could be set:

- **Absolute** goals are related to total emissions, such as the total amount of Scope 1 emissions per year;
- **Intensity** goals are emissions related to a particular part of the business' output, such as a 20% reduction in emissions per tonne of steel cast.

Intensity related goals can help focus effort on areas where usage is highest and improvements are most likely. Example of carbon related goals include:

- Achieve a 20% reduction by 2020 in Scope1 and Scope 2 emissions compared to 2018/19;
- Achieve 20% reduction in Scope 2 emissions per tonne of steel cast by 2020.

4.2 WHAT TACTICS ARE POSSIBLE TO REDUCE EMISSIONS?

Central to implementing an effective carbon action plan is having a range of tactics. The general idea is that prevention is better than the cure. This means that businesses should do their best to avoid and reduce emissions before they chose to purchase carbon offsets. There is a recognised hierarchy of tactics for a business to reduce and manage its emissions, as shown in Figure 15.

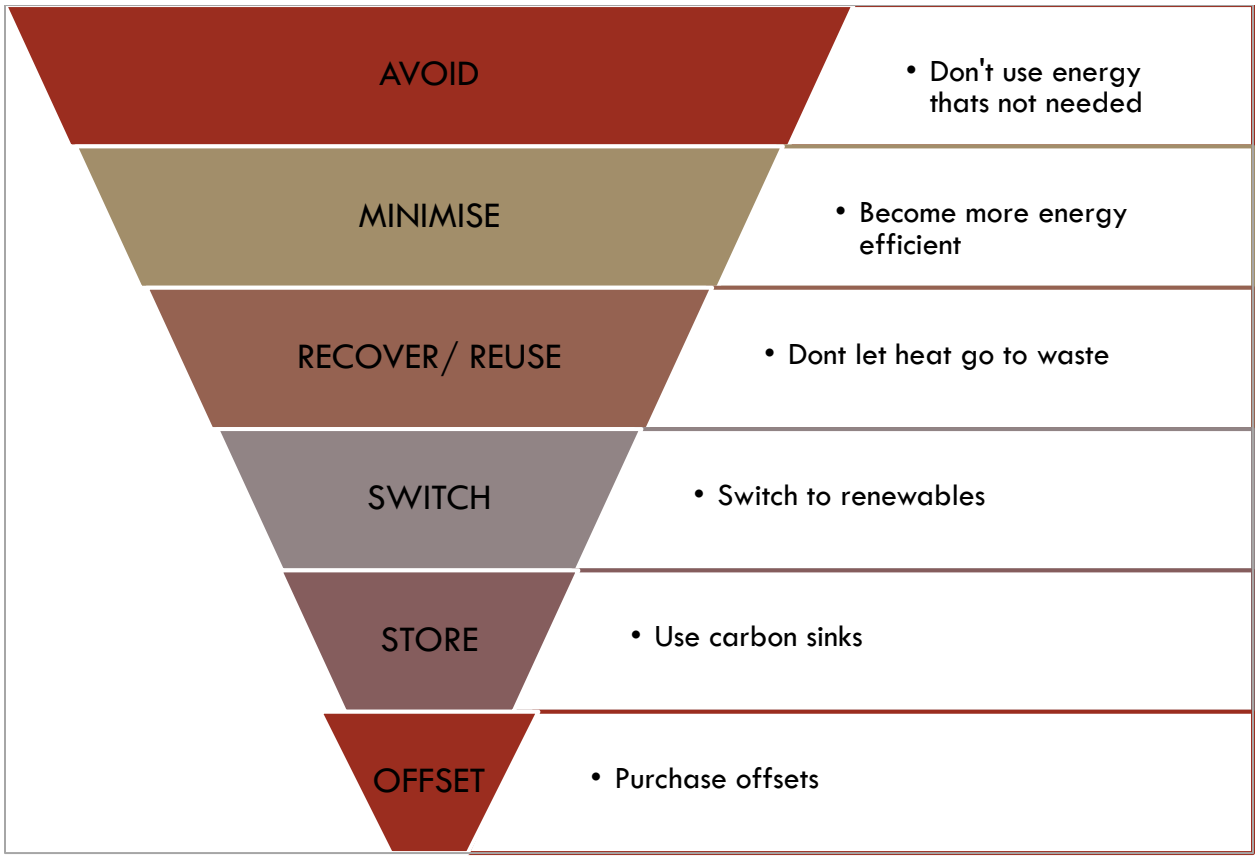

Figure 15 Carbon management hierarchy[7]

[7] Based on Vic EPA Carbon Management Principles: https://www.epa.vic.gov.au/about-us/environmental-performance/carbon-management-at-epa

4.2.1 Avoiding energy use

Avoidance is the first tactic to be deployed in the emissions hierarchy. As emissions are closely linked to energy use, staff behaviours and good planning can help avoid unnecessary energy use. As with many other change processes, simple, easy to deploy actions which have some impact are great to help get the ball rolling. Examples include switching off lighting, computers and other non-critical electricity using equipment when not in use. Energy and future emissions profiles should be taken into account in decision-making when planning and designing new plant and equipment. See box for other examples of emissions avoidance actions for a foundry.

Ideas for avoiding emissions

- Re-organise your production, so that you only use energy when required
- New furnace designs to reduce energy losses
- Improved efficiency through better design during holding
- Drop temperature overnight and or over weekends

4.2.2 Minimise emissions through efficiencies

Energy efficiency through modification of existing processes or equipment can be a major source of energy savings and emissions reduction in foundries. This may require investigation of existing facilities and equipment as well as a commitment to monitoring and continuous improvement, such as through adjustments to fine-tune processes and electrical controls. It is also important to maintain, renew and upgrade equipment when necessary. Simple actions, such as adding a lid whenever possible can save up to 15% energy. See box for other energy efficiency actions that can reduce foundry emissions.

Ideas for minimising emissions through energy efficiencies

- Fine tuning gas burners;
- Ensuring electric controllers are operating well
- Reducing energy leakage around furnaces and compressors/air lines;
- Synchronise pre heater operation with the furnace so excessive temperatures or holding times do not lead to oxidation and energy losses;
- Upgrade from reverberatory gas furnaces, which are typically only 40% efficient;
- Changing set-point of air conditioning systems
- Motor efficiencies, such as installing variable speed drives on cooling tower fan motors

4.2.3 Energy recovery

Many foundries have seen the advantages of the recovery of what was once considered waste heat energy. Examples of energy recovery actions for Foundries include:

- Using waste heat to pre-heat metal for melting
- Capturing wasted energy being lost in hot flues gases to pre-heat charge materials
- Utilise the heat in hot flue gases from melting or holding furnaces to provide the energy for pre-heating systems
- Use stack furnaces to send hot exhaust gases from the melting zone up a shaft loaded with incoming charge thereby improving the energy efficiency of the furnace

4.2.4 Switch to renewable energy

Minimising, avoiding and recovery tactics can only go so far to reduce emissions. Given the energy intensiveness of Foundries and dependence on the grid, partial switching to renewable energy, such as rooftop solar could be a viable alternative for some businesses.

Case Study: ERGON ENERGY

Ergon Energy commissioned Energetics to carry out a detailed energy review at its Northern Iron and Brass Foundry (NIBF) in Wangan (near Innisfail), North Queensland. The audit investigated both options for electricity tariffs as well as various opportunities for reducing energy costs.

The Foundry's three furnaces were the largest consumers of electricity at the site contributing over half of consumption and peak demand. Other large energy users include the compressed air system and dust extraction systems.

Various opportunities were identified and assessed as viable given project off-the-grid cost structures, including:

- Professional compressed air leak inspection
- Installation of a rooftop solar Photovoltaic system
- Replacement of the Office Air conditioning system
- Cooling tower Variable Speed Drive and control
- Replacement of two major compressors
- Lighting upgrades

Case Study: HASCO FOUNDRY PTY LTD

Hasco Foundry in Ballarat, Victoria, installed a roof mounted solar photovoltaic system in October 2015. The system was sized to provide optimal on-site energy use when operating. A lease arrangement was used which was paid out over the past four years.

The system has reduced the demand for grid electricity by 4000 kwh per month in comparison to the 2015 baseline. The energy profile has remained consistent but the benefits are attributable to the fact that all of the energy from the solar system (when operating) is used on site. This has reduced overall demand, which in turn has led to savings in reduced network charges and of course less total use of grid electricity.

Based on 2015 electricity prices, the system saves about $12,000 per year but recent price rises have seen annual estimated savings up to $20,000 per year.

4.2.5 Sequester and offset

Sequestration of carbon involves removing carbon emissions from the atmosphere in some way, such as via tree planting. Generally, only those businesses seeking to become certified carbon neutral will purchase carbon offsets for residual emissions.

4.3 WHAT ARE THE PRIORITIES?

The Action Plan should identify the priority opportunities for reducing emissions and assign accountabilities. Priorities may change over time, but should take into account factors related to importance such as the quantum of emissions likely to be reduced, costs and benefits to the business and cost effectiveness (cost per tCO2e over the life of the action). Priorities should also consider urgency factors, such as external drivers such as funding, ease of implementation and risk, timing and business capability.

5 PREPARING A CARBON FOOTPRINT REPORT

5.1 WHAT IS THE PURPOSE OF REPORT AND WHO IS IT FOR?

Its often said that 'what gets measured gets done'. It might be more accurate to say that what gets measured and reported effectively to the right people gets done! An effective report is one which provides information that is useful to the reader.

Generally, carbon footprint reports will either be required by the target audience for some reason (e.g. regulation), or provided voluntarily to the target audience. A well-prepared report can meet both needs, provided it is in accordance with appropriate standards.

By considering the specific information needs of your potential audience, you will be able to create a footprint report that is useful to more than one audience. To ensure your carbon footprint report is useful to your business, consider the following the 'right steps', or the what/who/why/how and when of good reporting (see box).

The right information is the estimate of emissions in the carbon footprint inventory.

The right people are those whom you want to consider the report. Is it for staff, management, shareholders, the general public or a combination of several of these?

The right reason is about the purpose of the report. Is it for internal use and staff awareness, is it for management to consider some form of action, or is it to inform shareholders? This purpose is critical as it will shape the content and form of the report.

The right way refers to how you would like the audience to use the information. Do you want them to make a decision, provide feedback, or promote what the report says?

Timing can be an important factor. It's important to ensure the audience will have the time to consider the report. You could link it with other business reporting, such as the Annual Report.

Reporting the 'right' way

The right information (the what?)

To the right people (the who?)

For the right reason (the why?)

In the right way (the how?)

At the right time (the when?)

5.2 WHAT INFORMATION SHOULD YOU INCLUDE?

A carbon footprint report should include following:

- the organisational boundary and business context
- greenhouse gas emissions associated with activities within the organisational boundary (total and by source and scope where possible)
- greenhouse gas emissions factors, data and calculation methods
- the base year and current reporting period and any significant changes in emissions
- any assumptions and exclusions

5.3 WHAT FORM SHOULD IT TAKE AND HOW WILL YOU COMMUNICATE?

How you present the information in your carbon footprint report needs to be tailored to meet the needs of your target audience. This means taking into account their level of understanding of the topic, their level of interest and the time they have available to focus on the report.

Once you have prepared the carbon footprint report, you may need to advertise it to the intended audience. Making your audience aware of the report helps grab their attention.

Tips for good reports

Keep it simple

Break it into manageable sections,

A picture is worth a thousand words - include images, graphics and charts

Make it relevant to your business

Be creative by using the net or visual presentations.

6 GLOSSARY

Carbon dioxide equivalence (CO2-e): A standard measure that takes account of the different global warming potentials of greenhouse gases and expresses the cumulative effect in a common unit.

Carbon emissions refers to all greenhouse gases, including carbon dioxide, methane, nitrous oxide etc.

Carbon footprint refers to the total carbon emissions caused by an organisation or other entity.

Carbon Neutral means an organisation, product or service which has been proven to have reduced its emissions where possible and compensated for the remainder by investing in carbon offsets to be 'net zero' carbon emissions.

Carbon Neutral Program. This program certifies organisations, products/services and events as carbon neutral against the National Carbon Offset Standard. The program covers the three key actions that a business or organisation must undertake to achieve carbon neutrality, including: measure the carbon footprint, monitor and reduce emissions (to the extent possible) and purchase and cancel enough carbon offsets units to offset the residual emissions.

Carbon offset: Represents a reduction in greenhouse gases, or enhancement of greenhouse gas removal from the atmosphere by sinks, relative to a business-as-usual baseline. Carbon offsets are tradeable and often used to negate (or offset) all or part of another entity's emissions.

Carbon sink: A natural or manmade reservoir that accumulates and stores carbon dioxide for an indefinite period.

Climate change is the phenomenon of changing weather patterns caused by the overall warming of the planet due to excessive greenhouse gas emissions

Emission factor: A factor that gives the kilograms of carbon dioxide equivalent emitted per unit of activity.

Facility: An activity, or a series of activities (including ancillary activities), that involve the production of greenhouse gas emissions, the production of energy or the consumption of energy and that form a single undertaking or enterprise and meet the requirements of the National Greenhouse and Energy Reporting (NGER) Regulations.

Greenhouse gases: The atmospheric gases responsible for causing global warming and climate change. The six Kyoto Protocol classes of greenhouse gases are carbon dioxide (CO2), methane (CH4), nitrous oxide (N2O), hydro-fluorocarbons (HFCs), per-fluorocarbons (PFCs) and sulphur hexafluoride (SF6).

Life cycle assessment: The compilation and evaluation of the inputs, outputs and the potential environmental impacts of a product system throughout its life cycle.

Mitigation refers to activities undertaken to reduce carbon emissions to the atmosphere

National Greenhouse and Energy Reporting (NGER) System: The national reporting framework for information related to the greenhouse gas emissions, and energy production and use of corporations operating in Australia. The framework is established under Commonwealth legislation, which makes registration and reporting mandatory for corporations whose greenhouse gas emissions or energy production or use meet certain thresholds.

National Greenhouse and Energy Reporting Act (2007). This act is the primary legislation for carbon emissions reporting in Australia and is based on the international Greenhouse Gas Protocol. It sets trigger levels for mandatory public reporting of energy and emissions by corporations and facilities. The Corporate group threshold for emissions reporting is 50 ktCO_2-e or more (scope 1 &2), or consumption of 200 TJ or more of energy. The facility threshold is 25 ktCO_2-e or more (Scope 1 & 2) or consumption of 100 TJ or more of energy. *Note that most casting and foundry businesses in Australia will not meet these thresholds and therefore not required to report. Most carbon emission reporting in the sector will be voluntary.*

National Carbon Offset Standard. This is the national standard to guide voluntary management of greenhouse gas emissions and to achieve carbon neutrality. It provides best-practice guidance on how to measure, reduce, offset, report and audit emissions for organisations, products & services, events, precincts and buildings.

National Greenhouse Accounts (NGA) Factors are used by businesses, organizations and individuals who voluntarily chose to estimate greenhouse gas emissions. The NGA Factors are updated annually by the Department of Climate Change and Energy Efficiency. It includes methods for estimating a broad range of greenhouse emissions

Offset: See carbon offset

Operational control: The greatest authority to introduce and implement any or all of the following for the Facility: (i) operating policies; (ii) health and safety policies; (iii) environmental policies. Only one corporation can have operational control over a Facility at any time.

Paris Agreement (2015). This international agreement made under the United Nations Framework Convention on Climate Change (UNFCCC) commits signatory countries (including Australia) to acting to mitigate climate change through emissions reductions. Its sets a global goal to hold average temperature increase to below 2°C and pursue efforts to keep warming below 1.5°C above pre-industrial levels. Australia's target is to reduce emissions by 26-28 per cent below 2005 levels by 2030. Central to achieving this target is reduction of emissions in high energy using sectors and expanding renewable energy.

Renewable Energy Target (RET) is a national goal to increase the proportion of renewable energy in Australia. The target is to achieve 33,000 gigawatt-hours (GWh) of electricity from renewable sources by 2020. It includes both renewable energy from large-scale facilities such as wind farms and small-scale facilities such as rooftop solar panels.

Scope 1 emissions: The release of greenhouse gas into the atmosphere as a direct result of activities at a Facility.

Scope 2 emissions: The release of greenhouse gas as a result of electricity generation, heating, cooling or steam that is consumed by a Facility.

Scope 3 emissions: The release of greenhouse gas into the atmosphere that is generated in the wider economy as a consequence of a facility's activities but that are physically produced by another Facility.

Sequestration: The removal of atmospheric carbon dioxide, either through biological processes (for example, photosynthesis in plants and trees), or geological processes (for example, storage of carbon dioxide in underground reservoirs).

7 REFERENCES

COA (2018) National Greenhouse Accounts Factors 2018, Commonwealth of Australia 2018

COA (2017) National Carbon Offset Standard for Organisations, Commonwealth of Australia 2017

COA (2008) National Greenhouse and Energy Reporting Regulations 2008

COA (2208b) National Greenhouse and Energy Reporting (Measurement) Determination 2008

COA (2009) National Greenhouse and Energy Reporting (Audit) Determination 2009

8 RESOURCES

Energy Rebate Sorter
Owner: Aust. Govt. Department of Environment and Energy
Link: https://www.energy.gov.au/rebates
Portal for finding grants, support and assistance for energy efficiency and emissions reduction.

Energy Efficient Communities Program
Owner: Aust. Govt. Department of Environment and Energy
https://www.energy.gov.au/government-priorities/energy-programs/energy-efficient-communities-program
New scheme offering grants to assist businesses to improve energy efficiency practices and technologies and better manage energy consumption to reduce their power bills. Funding will support activities such as equipment upgrades, energy and emissions monitoring and management systems and energy audits.

ASI Steel Innovation Portal
Owner: *Australian Steel Institute*
Weblink: https://www.steel.org.au/focus-areas/environmental-sustainability/
Portal for sharing and cooperation among steel related sectors including innovations in the sector and promoting the circular economy for steel and the fundamental principles of 'reduce, reuse, remanufacture and recycle'.

Foundry Fact Sheets
Owner: *Queensland Government/ Ecoefficiency Group*
Weblink: https://www.ecoefficiencygroup.com.au/resources/
Series of fact sheets for foundry operators on how to achieve both economic and environmental benefits from eco-efficiency.

The Green Foundry Project
Owner: *America Foundry Society*
Weblink: https://www.afsinc.org/sustainability-metalcasting
Provides examples of sustainability efforts being implemented at metal casting facilities including Management Systems and Metrics, Air Emissions, Water Use and Discharge, Materials and Resource Conservation and Waste Management and Beneficial Reuse.

Steel Recycling Institute of North America
Link: https://www.steelsustainability.org/life-cycle-thinking/energy-reduction
Industry led innovations to reduce intensity of steel production and CO_2 emissions including greener fuels and carbon capture technologies.