



Health, safety and environment management approach



-
- Health, Safety and Environment 1
-
- Safety 2
-
- Process safety 2
-
- Wellbeing 3
-
- Emissions 3
-
- Water 4
-
- Waste 6
-
- Rehabilitation and Restoration 7
-
- Biodiversity 7
-

All Origin employees and contractors are encouraged and empowered to stop any activity they find unsafe.

Health, safety and environment in all Origin workplaces is governed by legislation and regulations applicable to those operations. At a minimum, we seek to meet these requirements. Where appropriate, we apply higher standards.

At Origin, we care about the wellbeing of our people and our impact on the environment, including in relation to climate change.

All Origin employees and contractors are encouraged and empowered to stop any activity they find unsafe and to conduct our business in a way that causes no harm to the health and safety of people and has no unforeseen impacts to the environment.

Health, Safety and Environment (HSE) is governed by legislation, regulations, codes and standards, which we comply with, and apply higher standards as applicable to Origin's operations.

We continue to build and monitor our HSE culture through a range of programs, training and activities that create:

- effective safety leadership;
- operational discipline and compliance;
- open communication at all levels of the organisation;
- environment and climate change awareness; and
- capable and empowered HSE teams.

Origin's aspiration to health, safety and the environment is prescribed by our Health, Safety and Environment (HSE) Policy. This policy explains how we think about, plan and manage HSE risks and initiatives across our business. Our approach is outlined in our HSE System and HSE Risk Controls Directive, which underpin our HSE management system which conforms to the requirements of ISO 14001. Our

HSE management system mandates the minimum performance-based outcomes for the management of health, safety and environment risks and/or impacts.

All Origin managed activities and contractor activities must be covered by an emergency response plan (ERP) based on an assessment of foreseeable incidents and emergencies (including typical types of injuries and environmental incidents) identified through risk management processes. ERPs must include protocols for identifying and communication with internal and external stakeholders. Our ERPs are aligned with the Origin Emergency Management Procedure and Group Emergency Management Plan.

The Board is responsible for the oversight of HSE matters including key HSE risks and/or impacts arising out of the activities and operations of Origin (and its related companies). The Board HSE Committee supports and provides advice to the Board in these respects. The Board Risk Committee oversees climate change risk and related issues.

The Executive HSE Committee meets quarterly and supports the Executive Leadership Team to monitor and manage operational risks, including HSE. Matters overseen by the Executive HSE Committee include, but are not limited to, safety, process safety, emissions, water, waste, restoration and rehabilitation, and biodiversity.

Our approach is designed to prevent major accidents that could impact the health and safety of our people or members of the public, or that could harm the environment.

HSE Committees operate across Origin's sites and major office locations. They provide the basis of an effective consultative framework for employees to be actively involved in the resolution of health, safety and environmental issues at work.

The Board Risk Committee oversees climate change risk and related issues. The Executive Leadership Team Risk, Assurance and Compliance Committee is responsible for identifying and assigning responsibilities for climate-related risks.

Origin is committed to engaging with its stakeholders, including communities and landholders, on the environmental impacts of our activities.

Origin measures HSE performance using a variety of performance metrics. Key health, safety and environmental performance measures and material issues are published in our Sustainability Report each year, including those that are linked to remuneration.

Safety

We strive for a safe working environment.

Our management approach is to ensure that everyone at work is mindful of health and safety risks, enabled to manage them, accountable for doing so, continuously learning, and improving the way we work safely. Our systems of work require, among other tools, personal job safety assessments, permit-to-work systems, correct tool selection, supervision task assessments and continuous training to ensure a competent workforce.

Anyone can stop a work activity if they believe it, or the work area, is unsafe.

Our equipment, facilities and work practices are subject to detailed hazard identification and risk management processes designed to prevent harm to our people, contractors and visitors to our sites. We have HSE committees at our operational sites and major office locations to continually update our understanding of health and safety issues. Our field verification activities, assurance programs and audits test the effectiveness of the management system and its implementation.

We have processes in place for the onsite registration, training, induction, monitoring and evaluation of our contractors. All contractor personnel must undertake an appropriate HSE induction prior to the commencement of work, and the Origin contract owner must develop, implement and maintain a contractor HSE assurance plan based on the scope of work and risks and/or impacts associated with the work.

We manage the health and safety risks associated with our operations and activities using Australian Standards, international Standards, and Codes of Practice for occupational health and safety management. In addition, we also draw upon industry guidance from the International Association of Oil & Gas Producers (IOGP), Safer Together, National Road Safety Partnership Program (NRSPP) and other similar industry bodies. This keeps us abreast of leading practices.

Our occupational health and safety management performance is tracked using leading and lagging indicators, and reported to the Executive HSE Committee as well as the Board HSE Committee.

Process safety

We focus on keeping our equipment and facilities well designed, safely operated and properly maintained. Our approach is designed to prevent major incidents that could impact the health and safety of our people, members of the public or harm the environment.

We align our process safety management practices with recognised international standards. We draw on industry guidance from the International Association of Oil & Gas Producers (IOGP), the Institution of Chemical Engineers (IChemE) Safety Centre (ISC), the UK Energy Institute and the American Institute of Chemical Engineers (AIChE) Center for Chemical Process Safety (CCPS).

We implement safety critical control elements at all of our assets. Process safety performance is tracked daily using leading and lagging indicators. Process safety reporting is conducted through our management-level Executive HSE Committee as well as the Board HSE Committee.

We use assurance programs and audits to test the effectiveness of the management system and the operational discipline with which it is implemented. We also record, investigate and examine trend data for lower-consequence process safety incidents, to ensure the integrity of our system.

Origin has a robust risk-based inspection and infrastructure integrity program that is designed to manage venting and minimise leaks.

Wellbeing

Protecting the health and wellbeing of our people is as important as protecting their safety. We have a range of resources and support in place to help everyone at Origin look after their wellbeing.

Positive mental wellbeing is an essential part of good health. Origin employees can access a range of services and resources to help support their mental health and wellbeing, including a confidential and free Employee Assistance Program, and our online Mental Health and Wellbeing Hub. The Hub provides access to regular webinars, factsheets, videos, mindfulness exercises and support information.

Emissions

Our business activities result in emissions which we report on, and seek to reduce.

The majority of the carbon emissions we report are categorised as Scope 1, which are direct emissions created through our business activities. The remainder of what we report include Scope 2 emissions from electricity we purchase to undertake those activities, and Scope 3 emissions which are largely associated with the combustion of fuels we deliver to the domestic market.

When identifying, assessing, selecting and designing new plant, equipment and work activities, consideration must be given to maximising energy efficiency and minimising greenhouse gas emissions, including:

- economic valuation to include carbon costs (both regulatory and voluntary);
- energy efficiency rating;
- minimising controlled cold venting of hydrocarbon gases except for maintenance or emergency scenarios; and
- minimising fugitive emissions including flaring, venting and leaks, and shallow gas migration.

Our generation portfolio

Australia's National Electricity Market (NEM) is an aggregate of different sources of electricity. In our generation portfolio, the majority of Scope 1 emissions relate to Eraring Power Station, our only coal-fired power station, which uses black coal. Gas-fired power stations are typically less emissions intensive than coal-fired power stations.

The majority of our Greenhouse Gas (GHG) emissions are direct emissions (Scope 1) resulting from our role as an electricity generator. We also have GHG emissions in our oil and gas operations. Indirect emissions from purchased energy (Scope 2)

and other indirect emissions account for a small portion of Origin's total GHG emissions.

Fugitive and migratory emissions

To ensure safe gas production, the production and processing facilities require pressure relief mechanisms, such as venting or flaring gas. Venting emits methane to the atmosphere, whereas flaring converts methane to carbon dioxide, a less potent greenhouse gas. Emissions from these practices are reported annually in Origin's National Greenhouse and Energy Report.

Origin has a robust risk-based inspection and infrastructure integrity program that is designed to manage venting and minimise leaks. It includes an annual maintenance program for wellheads and surface facilities, and continual testing of pipework and vessels for cracking and erosion.

We are focused on minimising flaring at our gas processing facilities through enhanced operational excellence and an improved well turnaround focus.

Survey methods and emission factors used to estimate leaks are in line with the Queensland Government's regulatory requirements. We continue to focus on our gas monitoring program, aiming to reduce our reliance on regulatory emission factors. This monitoring data also informs about whether to retrofit or change the design of new infrastructure to reduce these emissions.

Methane gas can also occur naturally from the surrounding landscape. Queensland gas fields have a history of natural methane emissions that predates the coal seam gas (CSG) industry. We work with the Queensland Government, the CSIRO and other research organisations to understand this phenomenon and to quantify methane emissions from abandoned coal exploration bores, landholder bores and from geological structures

Other air emissions

As a part of the Australian National Pollutant Inventory (NPI), a publicly available database of emissions from Australian industrial facilities, Origin's larger operating sites track and report emissions of oxides of nitrogen (NO_x), sulphur oxides (SO_x), volatile organic compounds (VOC), particulate matter (PM) and mercury (Hg). These primarily arise from the combustion of fuels such as natural gas, diesel and coal. Eraring's emission calculations are independently verified, and its Environmental Protection Licence monitoring data is available via Origin's website.

SO_x, NO_x and PM emissions from Eraring stacks are managed through ensuring the use of quality coal and fuel oil, low NO_x burners, boiler tuning and fabric filter maintenance.

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As the upstream operator of Australia Pacific LNG, Origin continues to monitor ambient air quality in the Surat Basin. Managed by the CSIRO through the Gas Industry Social & Environmental Research Alliance (GISERA), a network of ambient air quality stations collects air quality data which is streamed live to the Queensland Government's website to ensure transparency of data collection.¹

Reporting our emissions

We are committed to complying with relevant emissions reporting frameworks. In Australia, GHG emissions reporting is tightly regulated and aligned to the Intergovernmental Panel on Climate Change (IPCC) reporting framework. We report our GHG emissions produced directly and indirectly by our operations to the regulator according to the *National Greenhouse and Energy Reporting Act 2007 (Cth)* (NGER Act) and the National Environment Protection (National Pollutant Inventory) Measure (NPI NEPM).

We report our GHG emissions to the Commonwealth regulator (Clean Energy Regulator) under the *NGER Act* by 31 October each year. The reported Scope 1 and Scope 2 emissions from Eraring Power Station and Integrated Gas undergo external, limited assurance audits annually.

Also, in accordance with the *NGER Act*, there are four NGER reporting field and gas processing facilities operated by Origin, on behalf of Australia Pacific LNG that are participants in the regulatory Emissions Reduction Fund Safeguard Mechanism.

Under the NPI, Origin reports annually on polluting substances that are emitted into the environment. In line with regulatory requirements, our emissions are reported to the relevant state environment regulators by 30 September each year.

Since 2006 we have also undertaken voluntary reporting of our emissions to CDP. Our responses to the CDP climate change survey have been publicly available since 2008 and can be accessed via CDP's website.²

Water

We primarily use water in electricity generation and we also extract water in the development of natural gas as upstream operator of Australia Pacific LNG.

We recognise that managing water is essential to Origin's long-term success. We view water as a valuable resource. Our operations seek to responsibly manage our consumption of water, protect water

resources in the natural environment, and ensure water is available for other users near our operations.

Our water use is monitored in line with legal conditions, and guided by our HSE Risk Controls Directive. We also make additional commitments such as maximising the availability of water for beneficial uses from our CSG activities.

Across our operations, electricity generation at Eraring Power Station (2,992 MW) and the Shoalhaven Hydro Pump Storage Scheme (240 MW), as well as our CSG development operations account for the vast majority of our water use.

Electricity generation

The Eraring Power Station is designed to take salt water from Lake Macquarie as cooling water for its generating units, which is returned to the lake after use in accordance with water quality and temperature limits set within our Environment Protection Licence. When compared to generators using evaporative cooling, this system design means that the power station typically has a lower impact on municipal water supplies and can continue to provide reliable power generation in times of water scarcity.

At Eraring, we also operate a Water Reclamation Plant which further purifies secondary treated effluent from the Dora Creek Waste Water Treatment Facility for boiler and plant use, minimising the use of potable water.

Shoalhaven Scheme

The Shoalhaven Hydro Pump Storage Scheme consists of two pump storage hydropower stations, Kangaroo Valley Power Station and Bendeela Power Station. These are located in the Southern Highlands of New South Wales.

The power stations use the pumped storage hydroelectric principle to generate electricity. Water is released from the Fitzroy Falls Reservoir and passed through the power stations to generate electricity during peak periods. During periods of low demand, water is pumped back to storage headponds above each station in the Fitzroy Falls Reservoir for use when generation is next required.

1 ehp.qld.gov.au/air/data/search.php

2 cdp.net

Monitoring bores installed by Australia Pacific LNG support ongoing and extensive regulatory monitoring of groundwater levels and groundwater quality within and between our areas of operation.

Gas-fired power stations

Gas-fired power stations such as Origin's Darling Downs, Mortlake and Uranquinty typically use less water than coal-fired power stations. Electricity generated by gas-fired power stations relies on heat or a combination of heat and steam, as opposed to steam alone, resulting in lower water use.

The Darling Downs Power Station uses a cooling technology which relies on air rather than water for its steam cycle, further reducing the power station's water usage.

CSG extraction

As the upstream operator of Australia Pacific LNG in the Surat Basin in Queensland, Origin extracts brackish groundwater from coal seams to depressurise the coal seam allowing gas to be extracted. This extracted water is called produced water or CSG water. It has a higher salt content than freshwater but generally contains less than a third of the salt content of sea water.

In our capacity as the upstream operator, we are required to manage CSG water extraction in accordance with legislative requirements, conditions specified in our permits and agreements we have with stakeholders.

Treated CSG water

Most of the extracted CSG water is treated using reverse osmosis in water treatment facilities. Treated water is supplied for a range of beneficial uses including aquifer injection, irrigation and livestock drinking water.

Origin has established aquifer injection schemes for the beneficial use of treated CSG water. Through these schemes we inject treated CSG water into aquifers to increase available groundwater. Origin pioneered these schemes, and its initial Spring Gully scheme was the first to be approved by the Queensland Government in 2015.

Origin has supplied treated CSG water to landholders since 2014 via the Fairymeadow Road Irrigation Pipeline, which is used for irrigation and livestock drinking water. The scheme is a practical application of the Queensland Government's Coal Seam Gas Water Management Policy (2012) which requires CSG companies to find beneficial uses for treated CSG water.

Origin supplies treated CSG water from its Spring Gully water treatment facility to a local landholder for irrigation and stock watering. In addition to this Origin has made treated CSG water available to other local landholders upon request in line with beneficial use requirements for drought support.

In accordance with strict licence conditions, excess treated CSG water may be released into rivers at approved locations, when water production rates exceed demand for beneficial use applications.

Australia Pacific LNG also uses treated and untreated CSG water for project purposes such as drilling and construction activities, dust suppression and as potable water at a number of facilities and accommodation camps.

The use of treated and untreated CSG water for these purposes reduces pressure on municipal and groundwater supplies in the region and helps to make sites self-sufficient for water.

Water availability to other users

The upstream activities of Australia Pacific LNG cover a large pastoral and agricultural area. Groundwater availability is important to agricultural and other industrial users in the Great Artesian and Surat basins.

In certain areas, where landowners draw their groundwater from the same coal seams as CSG wells, some bores are expected to be impacted by gas production.

Every three years, the Queensland Government issues an Underground Water Impact Report (UWIR) for the Surat Basin cumulative management area which identifies potentially impacted bores. Where reduced groundwater pressure as a result of CSG production is predicted, we are required to assess each bore and 'make good' any impacts under the *Water Act 2000*. 'Make good' measures are guided by the likely impact and individual landholders' preferences, and include monitoring, modification of pumping equipment, compensation and providing alternative water sources such as drilling deeper bores.

In addition to bores identified in the current UWIR, Origin identifies bores that are likely to require make good activity in the future and pro-actively enters into agreements with landowners. These agreements are similar to 'make good' agreements and provide greater certainty for both landowners and Origin.

Monitoring bores installed by Australia Pacific LNG support ongoing and extensive regulatory monitoring of groundwater levels and groundwater quality within and between our areas of operation. Results from these bores are submitted to the Queensland Government for aggregation with other CSG operations for regional monitoring and management. This information is available in the Queensland Government's Surat UWIR which is available on the Department of Natural Resources and Minerals website, and in Australia Pacific LNG's Annual Groundwater Assessments which is available on the Australia Pacific LNG website.^{3,4}

³ dnrm.qld.gov.au/

⁴ aplng.com.au/

A large proportion of CCP generated by Eraring is reused, and we are actively pursuing new supply chain opportunities and non-traditional markets to support increasing our reuse levels.

Hydraulic fracture stimulation

Hydraulic fracture stimulation increases the local permeability of the coal seams or shales so that water and natural gas flows more readily to the surface. Origin uses hydraulic fracturing in a number of wells as the upstream operator of Australia Pacific LNG and in our Northern Territory shale gas exploration program.

The fluid used in our operations for hydraulic fracturing comprises around 99 per cent water and sand. Of the remaining additives, approximately 0.33 to 1.2 per cent of these are used in clay management, gel management and water conditioning. Hydraulic fracturing fluids are subject to strict regulatory control in Australia. All additives used are also found in a typical household; in items such as food and cleaning products.

The additives in hydraulic fracturing fluid used by Origin are available in the [Hydraulic Fracture Stimulation Fact Sheet](#).

Water quality

The presence of wells that cross aquifer boundaries has the potential to result in groundwater migrating vertically from one aquifer to another if well integrity is not maintained. The risk of aquifer connection and leakage, where water from fresher aquifers enters the coal reservoir or vice versa, is managed carefully via high regulatory standards of well design and construction. Our Well Integrity Management Plan sets out our program of ongoing monitoring of well integrity.

Waste

At Origin, our approach to waste management is governed by operating licences and conditions at an asset level.

Where hazardous materials are present, our HSE Risk Controls Directive sets requirements for the management of hazardous materials to reduce risks to our people, the environment and the community. Hazardous materials must be managed in accordance with applicable law(s), or where there is no applicable law(s) with reference to relevant international standards.

The design of new assets and activities must consider approaches that eliminate, allow reuse or reduce the generation of and need to use, produce, store, maintain, handle and/or interact with waste and hazardous materials.

Most of the waste material that we manage is not considered to be hazardous. However, the greatest potential impact to neighbouring communities and environments comes from Eraring Power Station and our upstream operations in Australia Pacific LNG.

Eraring ash dam

The primary waste output at Eraring Power Station is solid waste from the coal combusted at the power station known as coal combustion products (CCP). CCP is an ash by-product of electricity generation produced through the burning of coal. This comes in the forms of finer fly-ash and a coarser bottom ash which represent 90 per cent and 10 per cent of the waste material respectively. CCP is subject to regulatory controls including the Environmental Protection Licence 1429 at this asset.⁵

A large proportion of CCP generated by Eraring is reused, and we are actively pursuing new supply chain opportunities and non-traditional markets to support increasing our reuse levels. The remainder is stored in an ash dam located north east of the power station. CCP waste is managed under Eraring's environmental approvals.

Australia Pacific LNG brine management

Brine is a waste product generated by the reverse osmosis treatment of CSG water. As the upstream operator of Australia Pacific LNG, we treat groundwater produced during CSG operations through reverse osmosis plants. Treated water is made available for beneficial use. The salt removed during the reverse osmosis process is captured within a brine waste stream, which is sent to specifically designed and lined brine ponds to undergo further concentration through evaporation. As part of Origin's brine and salt strategy, alternative salt management and salt opportunities are assessed for feasibility.

The brine ponds at Australia Pacific LNG's upstream operations are classified as regulated dams under the Environmental Authority (EA) issued by the Queensland Government. In addition to annual certification by registered professional engineers, regular inspections and sampling occurs in line with asset integrity, groundwater and surface monitoring protocols and operational procedures.

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Further information about Origin's performance can be found on our website:

originenergy.com.au

5 NSW EPA, *List of Licences*

We always seek to understand and protect the areas we disturb, ensuring that it can be returned to its original condition.

Rehabilitation and Restoration

Origin's development activities and operations are located across a wide geographical area and include both high and low levels of land disturbance. We always seek to understand and protect the areas we disturb, ensuring that it can be returned to its original condition, or better uses where required by applicable laws and stakeholder expectations, including landholders and the local community.

In Australia, our approach to managing rehabilitation and restoration is governed by the requirements of Federal and relevant state and territory laws and regulations. We are also required to comply with legal and regulatory conditions of the specific operating licenses for our activities with regard to rehabilitation and restoration.

For locations that have been subjected to land disturbance, documented plans that describe rehabilitation and closure controls must be developed in accordance with applicable law and implemented.

Gas field development for Australia Pacific LNG implements progressive rehabilitation as part of construction activities including ongoing monitoring of achieving rehabilitation criteria.

Origin makes financial provisions for rehabilitation and restoration of our sites based on the best estimate of the costs to be incurred for restoration activities. Our rehabilitation and restoration plans and associated financial provisions are reviewed and updated at least annually, taking into account the potential or agreed future use of the land.

Biodiversity

Origin's development activities and operations span both marine and terrestrial environments. Our operations are located across a wide geographical area and include a variety of environmental settings with different biodiversity values. We always seek to understand and protect these values in accordance with their significance, applicable laws and stakeholder expectations.

The greatest land footprint of Origin's activities is as the upstream operator of Australia Pacific LNG in the development and operation of the CSG fields in the Surat and Bowen basins in Queensland.

In Australia, our approach to managing biodiversity is governed by the requirements of Federal and relevant state and territory laws and regulations. We are also required to comply with legal and regulatory conditions of the specific operating licenses for our activities with regard to biodiversity management.

The design and site selection of new assets and work activities must consider approaches that avoid development in areas of high conservation value. Work activities that can impact biodiversity must be planned, conducted and documented to consider:

- sensitive seasons where there is a threat to the viability of species or communities;
- local populations, species and ecosystems that have the potential to be impacted;
- habitat loss and/or degradation of the habitat integrity; and
- habitat re-establishment programs that focus on habitat integrity and connectivity.

Origin is committed to engaging with local communities and biodiversity experts on the impacts of our activities.

