Climate change considerations for our business

2016
Our carbon performance

37 Mt CO$_2$e
total scope 1 and 2 emissions

18%
of the energy we consumed in 2015 was from renewable sources

11 Mt CO$_2$e
GHG emissions abated by our Australian coal assets since 2009

59 MW
installed capacity at our Australian coal mines to convert methane to electricity

The Callide Oxyfuel project, a world-first project, has proved the suitability of oxyfuel technology for capturing CO$_2$ for new and existing coal-fired power stations

32%
growth
forecast for total global primary energy demand over the next 25 years

7.8 Bt coal
produced and consumed annually world-wide; Glencore produces 131 Mt
This document is intended to provide stakeholders with information about how our business operates, our position on climate change and how we are managing the opportunities and challenges of climate change across our business.

The document is divided into four sections:

**Section 1**  
*An introduction to Glencore: page 4*

**Section 2**  
*Managing climate change: page 7*

**Section 3**  
*Our business and climate change: page 12*

**Section 4**  
*A case study: Glencore’s coal business: page 16*

As the geopolitical, environmental, societal, economic and regulatory landscape responds to climate change concerns, we are proactively addressing the challenges and opportunities as they arise. As a result, it will be necessary to review this document on a periodic basis.

Although our business encompasses entire supply chains for a number of commodities, for the first edition of this document we have included a case study on our coal business. This is because our coal business has experienced particularly increased interest in the context of climate change. The case study discusses our internal modelling of future supply and demand for this important commodity and lays out the reasons why it is important and prudent to continue investing in carbon-efficient coal technologies.

This document is an important part of our approach to considering climate change issues. Our approach includes enhanced reporting on emissions management; the resilience of our asset portfolio in the context of a range of accepted climate change scenarios; support for the use of low-emission technologies; and engagement with the development of public policy.
Today 18% of the energy used by our operations is from renewable sources. Raglan Mine, our nickel-copper mine in northern Quebec, has constructed a wind turbine and storage facility. In its inaugural year, the 3MW facility has already saved 2.1 million litres of diesel and reduced GHG emissions by 5,850 tonnes.
Glencore is an integrated marketer and producer of a range of commodities. As a commodity company with a global marketing network and portfolio of industrial assets, our views on commodity trade flows, global supply and demand fundamentals are based on many years of successful experience.

Our core business is to supply, trade and transport products in a global marketplace, from areas of surplus to consumers in the places where they are most needed. In doing so, we create value in the geographies where we operate, for our customers and for our shareholders.

Reflecting our commitment to operate in a sustainable and transparent manner, I am pleased to present Climate change considerations for our business. This document sets out Glencore’s approach to managing the opportunities, challenges and risks of climate change.

The world’s population continues to grow, driving both economic growth and energy demand. This is a context in which businesses, policymakers and others are attempting to balance the requirements of economic development with concerns regarding climate change and greenhouse gas (GHG) emissions.

As a consequence of the world’s response to climate change, environmental, societal, economical and political shifts are taking place, all of which are relevant to many industries. At the December 2015 COP21 summit in Paris, global leaders pledged to keep the world’s temperature increase to “well below 2°C” compared with pre-industrial levels, and to pursue sustainable development through a growth in low-carbon technologies. The measures required to achieve this goal, along with the nationally determined contributions (NDCs) pledged by individual countries, will affect the way businesses operate.

Glencore acknowledges the global need to continue reducing carbon emissions. The cost of energy is one of the largest components of our operating costs; we are continually looking for ways to reduce our energy-related costs and to improve our energy and operational efficiency.

Today 18% of the energy used by our operations is from renewable sources – primarily hydroelectricity in Kazakhstan, the DRC, Zambia and Norway, as well as a wide spread of solar power. In addition, we are experimenting with wind power generation at our Raglan Mine nickel asset in Canada. Where it makes commercial sense we will continue to incorporate renewable energy sources at our assets.

Glencore is the largest producer and trader of global seaborne thermal coal. We provide energy for industry and power generation, while actively engaging in public policy debate; we support the establishment of equitable, low-emission pathways.

This document addresses the issues raised by a number of our shareholders and stakeholders, and provides a platform for progress updates on our implementation of the reporting requirements adopted via a shareholder resolution at our 2016 annual general meeting.

I look forward to ongoing engagement with our stakeholders on climate change and the opportunities and challenges it provides to our business.

Tony Hayward
Chairman

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Chairman’s message
Introduction to Glencore

1.1 Our business model
Glencore’s business model is unique. We are a leading integrated marketer and producer of a range of commodities, with a global network that spans entire supply chains.

Our production activities are grouped into three segments: Metals & Minerals; Energy Products; and Agricultural Products.

In addition to our production activities, we market and distribute up to 90 commodities sourced from our own production and third-party producers. We provide financing, processing, storage, logistics and other services for both producers and consumers of commodities.

One of our key strengths is the diversity of our commodities and geographies. Our operations comprise over 150 mining and metallurgical, oil production and agricultural assets. Our production and marketing activities are supported by our global network of offices located in over 50 countries. We employ around 160,000 people, including contractors.

Our participation in the production, transportation and trade of an extremely broad range of commodities gives us an extensive market presence along the supply chain.
1.2 Our products
Our products form the foundations of everyday life. They are used in power generation and distribution, steel making, food processing, industrial goods and common consumer products.

Metals & minerals
This segment includes businesses that deal with copper, zinc & lead, nickel, ferroalloys, alumina & aluminium and iron ore production and marketing. We have interests in both controlled and non-controlled industrial assets that include mining, smelting, refining and warehousing operations.

Energy products
These businesses cover industrial and marketing activities for coal and oil, including controlled and non-controlled coal mining and oil production operations, investments in strategic handling, storage and freight equipment and facilities.

Agricultural products
This business is focused on grains, oils & oilseeds, cotton and sugar. It is supported by controlled and non-controlled storage, handling and processing facilities in strategic locations.

Marketing
Our marketing activities are supported by a worldwide network of storage and logistics assets in key strategic locations, including metal warehouses accredited by the London Metal Exchange, and many oil and grain storage facilities. Our marketing teams source a broad spectrum of physical commodities from our own production and from third parties and then sell these with value-added services such as blending, freight, insurance, financing and storage to meet customer requirements.
1.3 Our sustainability framework
Glencore is committed to operating transparently and responsibly. We recognise our operations have a direct and indirect impact on the environment in regions where we operate. We consistently strive to identify, understand and mitigate our environmental impact, with environmental responsibility integrated into our strategic planning, management systems and day-to-day operations.

Glencore Corporate Practice (GCP) is our sustainability management system. It is a framework for the integration of our sustainability principles, guidance and policies throughout our business.

GCP consists of four tiers, implemented at a Group, departmental and asset level:

1. Glencore’s statement of values
2. Glencore’s Code of Conduct
3. Glencore’s Group Health, Environment, Safety and Community (HSEC) policies
4. Operational policies

Our values and Code of Conduct represent our commitment to upholding good business practice; along with the policies derived from them, they support our ongoing integration of sustainability into our operational management procedures. They define what it means to work at Glencore for all our people, regardless of location or role.

Our Group HSEC policies detail our management processes and procedures, which are integrated into corporate decision-making processes.

Glencore is proud to be a signatory of the UN Global Compact, as well as a member of the Voluntary Principles on Security and Human Rights and the International Council on Mining and Metals (ICMM). We are an active participant in the Extractive Industries Transparency Initiative (EITI), the International Energy Agency (IEA) and the Coal Industry Advisory Board; we are also the current Chair of the World Coal Association. We disclose our energy and emissions performance as part of the CDP (previously known as the Carbon Disclosure Project).

We uphold international standards, including the UN Universal Declaration of Human Rights and the International Labour Organisation (ILO) Declaration on Fundamental Principles and Rights at Work.
2.1 Introduction
In December 2015, COP21 participants committed to keeping any “global temperature rise this century well below 2° Celsius” and “to drive efforts to limit the temperature increase even further, to 1.5° Celsius above pre-industrial levels.” This broad consensus among nation states will see a global shift towards a lower carbon economy, supported by policy and regulation leading to significant economic changes.

Glencore recognises the science of global climate change as laid out by the Intergovernmental Panel on Climate Change (IPCC). We believe this, along with COP21 and public sentiment, will continue to drive a greater number of decisions, policy developments and programmes to restrict GHG emissions. These changes are likely to affect our business.

Our response, and our management of climate change issues, can be grouped into four broad areas:

1. Internal risk and materiality assessments
2. Management of our energy and carbon footprint
3. Proactive engagement with a range of stakeholders
4. Support for the development of low-emission technologies

2.2 Carbon disclosure
Glencore is a significant producer of energy products and also a significant consumer of energy. Energy is a key input and cost to our business and a material source of carbon emissions.

Our business has a standardised approach to capturing data and reporting on emissions and we openly and transparently disclose our carbon and energy footprint. Our emissions profile varies across our different business units, reflecting the diversity of our business.

We participate in the CDP and report on our CO2 emissions in accordance with the Greenhouse Gas Protocol. We have other mandatory reporting obligations in many of the jurisdictions where we operate.

In 2015, our CDP disclosure score was 99 out of 100, with a performance rating of C (on a scale from A to E).

Our business continues to undertake activities related to the monitoring, measuring and managing of our energy and emissions footprint.

We take energy and carbon regulation into consideration as part of our business planning and investment decision processes. Our business proactively works to understand and manage our footprint, and continues to invest in solutions to use energy more efficiently and reduce emissions from the production and end use of our products.

In 2015, Glencore’s scope 1 and 2 emissions, as defined by the Greenhouse Gas Protocol, totalled 37 million tonnes of CO2e; our total energy use was approximately 242PJ.
2.3 Reducing emissions

**Carbon targets**

We have identified the systematic management of energy and carbon across our business as a key focus area for our HSEC strategy. For this reason we have started work on determining how an internal carbon target might be applied across our business. This project will consist of a phased review across our commodity businesses, with the following steps:

- Maintaining an understanding of our energy and carbon footprint on a long-term business planning basis
- Reviewing historic and existing energy and carbon initiatives at individual assets and sharing these learnings across the Group
- Deploying a common set of guidelines, templates and tools to assist our assets in assessing, costing and ranking potential energy and carbon reduction opportunities
- Identifying options for achieving meaningful reductions across the Group, including energy savings, efficiency measures, abatement or mitigation
- Determining how a carbon target could be effectively and meaningfully applied either to parts of our business or the entire Group
Glencore’s 25 highest emitting sites account for 70% of our total Scope 1 and Scope 2 emissions. Our emissions reduction activities will initially focus on sites within this group.

Within that group, the majority of our GHG emissions originate from ferroalloys and coal assets. Over half the GHG emissions from the group are derived from smelters, refineries or coal mines, with most of those facilities located in Australia and South Africa.

Our carbon target project will initially focus on our ferroalloys and coal businesses to determine what, if any, additional meaningful energy savings or emission reductions can be made by these assets.

### GHG emissions (top 25 sites) by department (2015)

<table>
<thead>
<tr>
<th>Department</th>
<th>Emissions (%)</th>
</tr>
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<tbody>
<tr>
<td>Aluminium</td>
<td>7</td>
</tr>
<tr>
<td>Coal</td>
<td>6</td>
</tr>
<tr>
<td>Copper</td>
<td>8</td>
</tr>
<tr>
<td>Oil</td>
<td>35</td>
</tr>
<tr>
<td>Ferroalloys</td>
<td>36</td>
</tr>
<tr>
<td>Nickel</td>
<td>4</td>
</tr>
<tr>
<td>Zinc</td>
<td>4</td>
</tr>
</tbody>
</table>

### GHG emissions (top 25 sites) by country (2015)

<table>
<thead>
<tr>
<th>Country</th>
<th>Emissions (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Australia</td>
<td>35</td>
</tr>
<tr>
<td>Canada</td>
<td>7</td>
</tr>
<tr>
<td>Chad</td>
<td>0</td>
</tr>
<tr>
<td>Colombia</td>
<td>3</td>
</tr>
<tr>
<td>Italy</td>
<td>1</td>
</tr>
<tr>
<td>Kazakhstan</td>
<td>0</td>
</tr>
<tr>
<td>New Caledonia</td>
<td>0</td>
</tr>
<tr>
<td>Peru</td>
<td>0</td>
</tr>
<tr>
<td>South Africa</td>
<td>35</td>
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<tr>
<td>Spain</td>
<td>5</td>
</tr>
<tr>
<td>UK</td>
<td>1</td>
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<tr>
<td>USA</td>
<td>10</td>
</tr>
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</table>

#### 2.4 Project examples

Glencore is committed to playing a role in the reduction of global GHG emissions. For some time, we have invested in a range of emission reduction projects and initiatives, focusing on both our operations and the use of our products. Since 2009 our Australian coal business has abated over 11 million tonnes of CO₂e GHG emissions. Our approach includes:

**Using waste coal mine gas for power: our Australian coal business captures methane emissions from its mines and converts the methane into electricity that is used onsite, with a total installed capacity of 59MW. This is used to supplement existing energy sources at a number of our Australian coal assets.**

**Flaring waste coal mine gas:** we have installed flares at coal mining assets that have the necessary supply and concentration of methane; these use coal seam gas drainage to capture methane gas, then flares to burn it off. This produces carbon dioxide and water vapour, reducing the impact of emissions.

**Wind power in Quebec:** Raglan Mine, our nickel-copper mine in Nunavik, northern Quebec, has constructed a wind turbine and storage facility, the largest in the province. Energy is Raglan Mine’s second largest budget item, as its remote location means it cannot connect to the hydroelectric grid or natural gas network. A combination of climate change considerations, environmental impact limits and rising production costs gave us a strong business case for exploring renewable energy solutions. Arctic weather conditions at the site provide some of the world’s richest wind resource.

Raglan Mine began investigating opportunities to include wind power in its energy mix. The project was a private public partnership between Raglan Mine, TUGLIQ Energy (a Canadian power...
producer specialising in remote and complex energy diversification for mining sites) and the federal and provincial governments.

In its inaugural year, the 3MW facility has already saved 2.1 million litres of diesel and reduced GHG emissions by 5,850 tonnes. Based on these results, we estimate that the turbine will save more than CAD40 million in fuel costs over its projected 20-year lifetime.

We hope that this successful pilot will have transformative impacts across northern Canada, helping to pave the way for the more widespread adoption of greener energy alternatives.

Hydropower in Kazakhstan: Kazzinc operates the Bukhtarma hydroelectric plant, which has a total generating capacity of 675MW. The plant is integrated into Kazakhstan’s national electricity grid as a peak producer. The Bukhtarma plant generated around 3 billion KW hours of electricity in 2015, covering up to 68% of Kazzinc’s electricity requirements. If this energy were generated by a conventional fossil fuel-based power plant, it would have released the equivalent of 1.5 million tonnes of CO₂ on an annual basis.

Hydropower in Africa: almost all the electricity used by our assets in the DRC and Zambia, which run some of the Group’s largest operations, is generated from renewable hydroelectric facilities.

Supporting research into low-emission technologies

In addition to our work on GHG emission reduction, we actively support low-emission coal technology projects and GHG-related studies, including:

The Callide Oxyfuel project: a AUD245 million large-scale demonstration project in Queensland, Australia. This world-first project proved the suitability of oxyfuel technology for capturing CO₂ from new and existing coal-fired power stations. Completed in March 2015 at the Callide A power station, it involved burning coal in a mixture of oxygen and recirculated exhaust gases instead of air, providing a concentrated stream of CO₂ suitable for storage. The project was a joint venture between CS Energy, the Australian and Japanese governments, ACA Low Emissions Technologies (ACALET), Glencore and Schlumberger, as well as Japanese participants J-Power, Mitsui & Co Ltd and IHI Corporation.

The CTSCo CO₂ storage project: an upcoming carbon capture and storage project and CO₂ hub in the Surat Basin, Queensland. With funding support from ACALET and the Australian and Queensland governments, CTSCo has undertaken a pre-feasibility study (including a 1,200m deep exploratory well into the storage zone) and is undertaking a feasibility study at a total cost of AUD40 million. The work involves a 3D seismic survey, updating of a CO₂ storage plume model and post-combustion capture CO₂ and transport studies in conjunction with a coal-fired power station.

2.5 Participating in public policy

Our role

We believe that the corporate sector has an important role to play in the process of developing climate change policy, and can make a valuable contribution towards the development of effective, efficient and equitable climate change policy.

Glencore actively engages in public policy discussions with a range of stakeholders on issues related to energy, carbon and climate change. We also have a range of technical experts who are able to assist policymakers in the development of complex regulations through governmental technical working groups.
Climate change policy
Glencore monitors the evolution of climate change policy at the international and national level. While we anticipate that some countries will move faster in establishing their climate change regulatory frameworks, we expect others may find it difficult to achieve their targets without significant financial and technical support.

We continue to play an informed and constructive role in the public policy development process on climate change across our different commodity businesses and in multiple jurisdictions. We work with policy makers directly and through trade associations, on issues related to clean energy, carbon reporting and carbon pricing.

Carbon pricing
Glencore supports a pragmatic and practical global approach that prioritises a least-cost, logical transition towards lower global emissions. Glencore supports policy mechanisms aimed at achieving cost-efficient emissions reductions without compromising the development goals of nation states.

Market mechanisms are a sound tool to regulate carbon emissions, provided that they are designed to be equitable. In relation to pricing carbon, we support the following principles:

- Clear policies to allow a predictable and measured transition to a long-term price for carbon
- Using revenues from carbon pricing to manage the transition to a low-carbon future
- Maintaining international trade competitiveness across sectors and preventing carbon leakage
- Broad-based application across sectors
- Policies that are simple and effective to implement
- Support for low-emission technology development (including for fossil fuels)
- Ensuring that the price of carbon flows through to users at the end of the supply chain

Public engagement
Glencore is a member of a number of industry organisations at a national and international level, which provide valuable input into public policy development. These include:

- International Council on Metals and Mining (ICMM)
- Coal Industry Advisory Board, reporting to the International Energy Agency (IEA)
- World Coal Association (WCA)
Our business and climate change

3.1 Risk management
We recognise that the effective management of risk across all aspects of our business is vital to ensure our growth and provide greater certainty to all stakeholders.

Glencore integrates risk management into its business through a structured risk management process that establishes a common methodology for identifying, assessing, treating and monitoring risks.

Climate change may pose additional risks to our business if not assessed and managed appropriately. Traditionally our risk management in relation to climate change has focussed mainly on its economic, regulatory and physical impacts.

Going forward we will broaden our existing risk management framework to consider the risks and opportunities from climate-related developments. Accordingly, our risk management framework for climate change considers the risks and opportunities from climate-related developments, with a focus on the factors we consider have the potential to put our assets, supply chains, markets and investment most at risk, including:

Technology: technology application will have a substantial bearing on the global capacity to adapt and respond to climate change. The levels of investment in, and rate of development and deployment of, a suite of low-emission and renewable energy technologies could change market dynamics for fossil fuels and renewable energies.

Adaption: long-term weather patterns, including a potential increase in severe weather events, will likely challenge our ability to access and extract resources. Floods, droughts and severe weather have a potential impact on physical assets and supply chains; they may also disrupt operations and the availability or nature of services on which we rely.

Global and domestic policy: following COP21, policymakers have set ambitious nationally determined contributions (NDC) as part of reducing global emissions; there will be further policy development at an international, national and subnational level. This may involve GHG emission targets, and explicit or implicit carbon pricing.

Economic impact: these are risks arising from changes in market and economic conditions having the potential to affect the operational viability or financial profile of a physical asset or company. This includes changes in consumer demand for products, technological advancements and government policy.

Reputational: these are potential financial or non-financial impacts on our corporate licence to operate. They may be as a result of particular projects or investments, and can be impacted by fast-moving social or activist campaigns.

We have a structured process by which we apply our risk and opportunity management framework to our assets and investments. This will be an ongoing process, ensuring we properly account for changes in the business environment due to climate change.
### 3.2 The opportunities and risks of climate change

<table>
<thead>
<tr>
<th>Opportunities</th>
<th>Risks</th>
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<tbody>
<tr>
<td>As markets change due to the economic and environmental impact of climate change, our business is well placed to respond by virtue of a diverse global portfolio of natural resource assets, supported by an industry-leading global marketing and logistics network.</td>
<td>Climate change will pose additional risks to our business if not assessed and managed appropriately.</td>
</tr>
<tr>
<td>As our business does not rely on a single commodity or function, we have greater resilience to the economic impacts of climate change. The breadth of our business also brings economies of scale throughout the supply chain, in finance, freight, logistics, storage and product customisation.</td>
<td>We have incorporated general business risk management into all aspects of our operations through a risk management process. This establishes a common methodology for identifying, assessing, treating and monitoring risk.</td>
</tr>
<tr>
<td>As we operate in fragmented and periodically volatile markets, our breadth and scale also allows us to benefit from the resulting price differentials.</td>
<td>Our assets will continue to adapt to material changes in the physical and regulatory environment as a result of climate change.</td>
</tr>
<tr>
<td>Glencore’s broad range of products will be required as the global economy continues to grow, as countries develop, and for the transition to a lower-emission economy.</td>
<td>We will continue to monitor these changes and ensure our business approach and processes have the flexibility to manage these risks.</td>
</tr>
<tr>
<td>Copper, aluminium, steel and cement are required for renewables-based power stations as well as energy efficient infrastructure and the electrification of the transport sector.</td>
<td>Our industrial assets are required to regularly report on an extensive number of climate-related metrics. Movements in these metrics could contribute to disruption in our operations or access to critical infrastructure.</td>
</tr>
<tr>
<td>Coal is an essential input for 70% of steel, 90% of cement and 41% of electricity produced around the world.</td>
<td>We require that our assets consider these factors as part of normal long-term business planning.</td>
</tr>
<tr>
<td>Nickel and cobalt are required for energy storage and therefore are likely to play an important part in electromobility.</td>
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</tbody>
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1 IEA’s Medium Term Coal Market Report 2015
3.3 Activities going forward

We will continue to integrate new climate change challenges and opportunities into our business strategy and planning. This includes consideration of exposure to physical and regulatory climate change risks, along with action to mitigate or adapt to these risks. Our objectives and key activities are:

<table>
<thead>
<tr>
<th>Objective</th>
<th>Key activities</th>
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</table>
| 1. Monitor and manage the drivers of climate risk | • Monitor NDC implementation and the progress of key countries towards achieving targets  
• Monitor changes to the regulatory, technological, economic and physical environments applicable to our businesses, both where we operate and in jurisdictions that affect our suppliers and customers (e.g., weather risks, technology disruption, and carbon pricing)  
• Continue to engage in public policy processes in our countries of operation |
| 2. Refine our risk assessment process to manage climate change risks and opportunities | • Develop internal climate change policy scenarios  
• Continue to monitor broader energy market dynamics and supply chains  
• Develop a risk and opportunity management framework to assess and respond to climate change risks and opportunities |
| 3. Address climate change impacts and regulatory changes | • Continue internal Group GHG emission measurement and reporting  
• Continue to integrate climate change into business planning at relevant levels  
• Set an internal GHG reduction target where technically and economically feasible |
| 4. Investor and community engagement | • Continued carbon disclosure to stakeholders  
• Continued participation in public policy developments on climate change |
3.4 Business strategy and planning: climate change scenarios

We have developed three scenarios that we consider to be plausible views of the future with regard to the world’s climate change responses. They take into account energy market projections by leading organisations such as the IEA, leading climate science projections from the IPCC, and our analyses of likely shifts in policy and other conditions corresponding to scientific and economic changes.

Glencore will continue to develop these scenarios and test them against our business.

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Assumptions</th>
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<tbody>
<tr>
<td><strong>Delayed action</strong></td>
<td>Domestic efforts to reduce emissions (including NDC implementation) are variable, with many countries not meeting their stated targets or objectives. Inconsistent implementation of carbon pricing across mainly developed economies. Fossil fuels continue to be the primary base for electricity generation with slower introduction of low-carbon technologies and retirement of old plants. Stronger global emphasis on efficiency but slow and poor delivery of climate finance.</td>
</tr>
<tr>
<td><strong>Committed action</strong></td>
<td>Domestic efforts to reduce emissions with focused NDC implementation achieved by key countries. Carbon pricing implementation led by developed economies in a coordinated and structured manner. Moderate growth of nuclear, renewables and increasing use of high-efficiency, low-emission (HELE) technologies for use in fossil fuel-based electricity generation. Enhanced energy efficiency and consumption improvements in developed and developing countries supported by climate finance.</td>
</tr>
<tr>
<td><strong>Ambitious action</strong></td>
<td>Globally coordinated efforts to reduce emissions accelerated beyond the implementation of existing NDCs. Universal adoption of carbon pricing supported by a structured global carbon pricing regime Rapid deployment of break-through technologies and non-subsidised investment in renewable energy, battery storage, energy efficiency and carbon capture and storage (CCS).</td>
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Case study: Glencore’s coal business

Executive summary

Glencore has an industry-leading coal business with a good track record on project delivery and operational performance. Our industrial assets are supported by a global logistical and marketing network that delivers our own and third-party products to customers around the world.

This case study has been included as our coal business that has attracted particular interest in the context of climate change. The case study discusses our internal modelling of future supply and demand for coal, and lays out the reasons why it is important and prudent to continue investing in carbon-efficient coal technologies.

Our coal business is progressively integrating climate change challenges and opportunities into its business planning and risk management frameworks.

Our analysis of coal demand and supply is independent and proprietary. Our energy and climate scenario framework is the Delayed Action Scenario (see page 15), which is broadly aligned with the IEA’s NDC Scenario.

We expect our coal business to remain viable under the Delayed or Committed Action Scenarios and the probability of our coal assets becoming ‘stranded’ to be very low. Our ongoing risk management in this area monitors for signs of adoption of the Ambitious Action Scenario, which goes well beyond the current NDCs. This monitoring ensures that we operate our business in a way that will allow us to manage the probable outcomes of this scenario, in a way that is also acceptable to our shareholders.

There are strong indications that the global energy demand and supply outlook for coal, especially in the Asia Pacific region, will continue to support our business. This should include full utilisation of our coal reserves and support future optional investment in resource conversion.

As a low-cost, plentiful and secure energy source, we believe that coal will continue to play a major role in the advancement of developing economies. Future demand will be supported by continued technology enhancement and the deployment of high-efficiency, low-emission (HELE) power stations, underpinning coal as a viable fuel for the future. It is important and necessary under the IEA’s Ambitious Action Scenario that appropriate policy measures are taken to facilitate the broad-scale implementation of these carbon-efficient technologies.

Glencore’s coal business

Glencore is the world’s largest exporter of seaborne-traded coal, with interests in 28 operating coal mines across 19 coal complexes in Australia, Colombia and South Africa as illustrated on the map Glencore coal operations.

In 2015, Glencore produced 131.5 million tonnes of thermal and coking coal (65.8 million tonnes in Australia, 37.0 million tonnes in South Africa and 28.7 million tonnes in Colombia) with revenues of $7.9 billion and an EBITDA of $2.1 billion. In addition, as a leading marketer of coal, Glencore traded or represented 96.4 million tonnes of predominately thermal coal on an agency basis.

Glencore has a strong presence throughout the entire coal supply chain, including: exploration and development; extraction and production; processing, blending; and logistics; and delivery to our customers. Despite this, Glencore only represents a small share of the 7.8 billion tonnes of coal produced, traded and consumed globally.
Global energy demand

In agreement with other global forecasts, we anticipate that global energy demand will continue to increase, in line with population and GDP growth. These forecasts project that the global population will rise to 8.3 billion by 2030, with the growth mainly in emerging economies, especially India, Africa, Southeast Asia and the Middle East. India’s population is likely to grow from 1.3 billion people today to 1.48 billion by 2030, making it the most populous country on the planet. As populations in these countries grow, so does GDP. Between 2013 and 2030, global GDP is projected to increase 3.8% each year. Accordingly, global GDP is likely to be 1.9 times greater in 2030 than in 2013.

Energy demand is closely linked to GDP and population growth. While energy demand elasticity moderates as economies develop, developing economies typically see energy demand grow more rapidly than GDP, as rising per capita wealth drives investment. The number of people living in urban areas is expected to increase from 53% today to 63% by 2040. Urbanisation will drive an increasing demand for energy, as well as supporting demand for the materials used in the construction of buildings and infrastructure. Glencore plays a leading role in providing commodities for urbanisation.

As communities grow, the need for access to secure, reliable and affordable energy also grows. We expect the rising demand in both developed and developing economies to require all forms and sources of energy, as well as a suite of low-emission technologies. This is the only way to fulfill every economy’s objectives on energy security, economic growth and sustainable environmental performance.

The specific energy mix required to meet this expected demand will vary from country to country, depending on each one’s needs, level of economic growth, existing infrastructure and policy. It will also be shaped by the market

Glencore’s coal assets in relation to international thermal coal markets (2015)

1,2,3 IEA World Energy Outlook 2015
cycles of the resources required to build energy infrastructure and to generate energy. Many countries have signalled that a greater percentage of their energy is likely to come from renewable sources in the future. While international policy trends point to carbon-intensive fuel sources making up a decreasing part of the mix, such policies certainly do not contemplate a complete elimination of fossil fuels; this is consistent with international energy demand predictions.

Our assessment, based on multiple global energy forecasts, is broadly consistent with the IEA’s NDC Scenario, which by 2030 is aligned with the New Policies Scenario, predicting that total primary energy demand will grow by 21% during the period 2013 to 2030. The graph Global primary energy demand shows fossil fuels continuing to remain a significant part of the global energy mix. Their use is predicted to increase in absolute terms, despite a decreasing share from 81% to 75% of the total mix. Renewables, excluding hydro- and bioenergy, will increase 267%, from a low starting point in the primary energy mix.

Global primary energy demand (IEA New Policy Scenario) 
Billion tonnes coal equivalent

![Global primary energy demand graph]

The IEA’s World Energy Outlook 2015 (WEO-2015) models three different scenarios for the future global energy demand. The first is its Current Policies Scenario, which takes into account only the policies enacted as of mid-2015. The second is its New Policies Scenario, which is the central scenario in the WEO-2015. This takes into account the policies that governments have implemented by mid-2015, as well as those that the IEA expects governments to implement over the next 25 years. The final scenario is its 450 Scenario, which depicts the pathway required if we are to limit global temperature rises to “no more than 2°C.”

The IEA has also published a separate energy demand outlook based on the NDCs submitted and ratified at COP21. This NDC Scenario follows current policies until 2020 and then closes the gap to the New Policies Scenario by 2030. The energy pathways required by each scenario are illustrated in the graph Projected total global primary energy demand, by scenario.

Under the IEAs NDC Scenario, by 2030 the global demand for energy is expected to rise by 21% compared to 2013, with the majority of demand coming from non-OECD countries. According to this scenario, the demand for coal will increase by 7.4% over the 17 years or 0.4% per year. Demand for oil is also expected to rise, with oil production projected to grow by 0.7% per year. Again, the majority of this demand will come from non-OECD countries. At the same time, with continued government support and declining costs, the

The demand outlook for seaborne-traded coal

While coal’s share of the global energy supply is expected to decline, absolute demand for coal is set to rise in the developing Asia Pacific region, as those economies focus on lowest-cost electricity for their economic growth and urbanisation. Coal is, and will continue to be, the lowest cost fuel source for large-scale power generation. Coal’s relative cost advantage is the driver of current and future investment.

In steel manufacturing, coal is the primary fuel for 70% of global production; it is projected to remain at this level. Urbanisation and industrialisation of developing economies is projected to support steel production growth in the range of 1.0% to 1.5% per annum, supporting a modest incremental growth in demand for metallurgical coal. Cement is another key building material for development; coal is involved in 90% of global cement manufacture.

Glencore regularly updates its proprietary global seaborne coal demand outlook. This forecast, shown in the graph Regional seaborne coal demand outlook, is based on a by-country, by-plant assessment. It takes currently operational plants into account, as well as overlaying the impact of policy changes on the expected closure of outdated capacity and the construction of new plants to meet future demand. The forecast indicates that the demand for seaborne-traded coal in Europe will decline over the period until 2030, as aging coal-fired power plants are closed in line with government policies and alternate energy initiatives. In contrast, the Asia Pacific region will continue to greatly rely on seaborne-traded coal.

Japan, Korea and developing Asian economies are investing in coal-fired power generation due to the perceived risks and high cost of nuclear power and the relatively high cost of LNG supply.
Glencore expects investment of over 107GW, or more than 220 new coal-fired boilers, in markets dependent on seaborne-traded thermal coal. Incremental coal demand from these investments will increase demand for seaborne-traded thermal coal by 360 million tonnes per annum. When combined with demand growth in industrial and steel markets and the forecast decline elsewhere, the growth in the net global seaborne coal trade during the period 2015 to 2030 is 290 million tonnes.

Resource availability
The world’s coal basins are well mapped and understood; we have assets and projects within a number of them. These include basins in Australia (Sydney, Bowen, Surat and Galilee); South Africa (Mpumalanga Province); Colombia (in the departments of Cesar and La Guajira); and Canada (the Pine River formation).

Glencore has a significant coal Resource and Reserve base, which we publicly disclose as part of our annual resource statement.

<table>
<thead>
<tr>
<th>Resource Statement</th>
<th>Coal Reserves</th>
<th>Coal Resources</th>
<th>2015 Saleable Reduction</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Marketable Reserves (bn t)</td>
<td>Measured &amp; Indicated (bn t)</td>
<td>Inferred (bn t)</td>
</tr>
<tr>
<td>Australia</td>
<td>2.2</td>
<td>12.4</td>
<td>13.6</td>
</tr>
<tr>
<td>South Africa</td>
<td>0.7</td>
<td>4.1</td>
<td>0.4</td>
</tr>
<tr>
<td>Colombia</td>
<td>0.8</td>
<td>4.5</td>
<td>0.9</td>
</tr>
<tr>
<td>Canada</td>
<td>–</td>
<td>0.2</td>
<td>0.1</td>
</tr>
<tr>
<td>Total</td>
<td>3.7</td>
<td>21.2</td>
<td>15.0</td>
</tr>
</tbody>
</table>

Measured and Indicated Coal Resources are categorised as ‘well defined’ resources and are therefore capable of being converted to Marketable Reserves with the appropriate technical and economic assessments.

Glencore’s 21.2 billion tonnes of Measured and Indicated Resources represent an additional 50 years-worth of mine production, at the current production rate, beyond our reserve life. Mine life based on coal resources takes into account resource recovery and marketable reserve conversion. These resources represent optional investment opportunities if Glencore’s market assessment and investment criteria are supportive. Any future investment decision will include updated knowledge of how markets and policies are transitioning against stated energy and climate objectives.

Marketable Reserves are associated with developed and producing mines and are established through detailed assessment, planning and scheduling. At 2015 production levels, Glencore has approximately 20 years of marketable reserve life. Thus, absent any investment, in 10 years time our reserves would decline to 1.8 billion tonnes. Reserves are assessed and assured annually as part of the reporting standards requirements.

Maintaining current levels of production will require mine life extension approvals and new investment to replace mines that close as their reserve bases are depleted.

The graph Global seaborne-traded coal reserves depletion illustrates the indicative depletion rate of global seaborne-traded coal, along with
Glencore’s coal supply, assuming we make no further investment, with currently operating assets harvesting future cash flow. Our estimates show that without future investment, 49% of the global seaborne production base would be exhausted by 2030.

Global seaborne traded coal reserve depletion

<table>
<thead>
<tr>
<th>Million tonnes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1,500</td>
</tr>
<tr>
<td>1,000</td>
</tr>
<tr>
<td>500</td>
</tr>
<tr>
<td>0</td>
</tr>
</tbody>
</table>

On the same basis, without investment to extend reserves, Glencore’s production base would decline to 25% of current levels by 2030. While Glencore’s asset life is shorter than the global average, this attribute provides both a degree of certainty in delivering returns on existing investments and greater optionality to consider options for further investment to extend existing assets or secure third-party assets as they are presented to market.

Response to stranded assets campaign
To determine whether further investment into development of coal resources is warranted, Glencore maintains a comprehensive market assessment to continually update our supply and demand projections and assess the economic justification for investment to convert resources into marketable reserves.

We note that some commentaries on coal ‘stranded assets’ infer that company valuations depend on utilisation of coal resources rather than just marketable reserves; these commentaries also treat coal as a homogenous product. This is a fundamental misunderstanding of not only how companies approach ‘resources’ as a source of investment optionality rather than committed investment, but also the dynamic and segmented nature of coal markets and the marketability of a range of coal products. For Glencore, resources represent only around 10% of our coal assets base; this value reflects future, life of mine extension optionality for our business.

Combining the projected demand outlook (the graph Regional seaborne coal demand outlook, page 20) with the estimated reserve depletion (the graph Global seaborne-traded coal reserve depletion, page 21) based on the adoption of an asset cash flow harvest strategy, a supply shortfall would emerge (the graph Global traded coal supply and demand). We anticipate that, as has previously transpired in commodity markets, the markets will respond to this potential deficit, with prices rising to support the investment necessary to maintain a supply and demand balance. This
market response would provide Glencore and other suppliers with the opportunity to invest in resource-to-reserve conversion and the possible construction or acquisition of new assets.

Our operations have the proven flexibility that allows us to manage coal quality to meet market opportunities and requirements. Combined with our global trading network, this provides us with a distinct competitive advantage in complex market environments.

We believe that the realities of future global energy demand and supply will continue to support our business, fully utilising coal reserves and supporting future optional investment in resource conversion.

Further supporting this investment optionality is Glencore’s competitive cost position in seaborne-traded coal markets. Glencore’s coal portfolio is currently positioned in the middle of the global supply cost curve; a position it has maintained consistently over a 10-year period. The geographic distribution of the coal portfolio averages out cost fluctuations in individual jurisdictions and has greatly benefitted the business through time.

The longevity of the seaborne coal trade is well supported in multiple global energy scenarios. These scenarios all require volumes far in excess of Glencore’s existing reserve base and will necessitate resource conversion to meet demand.
Coal’s competitive position as a long-term energy supply source is underpinned by its low cost of extraction and transportation. The current delivered cost of coal, compared to other power generation fuels, continues to support investment in new coal-fired generation in numerous developing economies. Glencore’s modelling of coal’s competitive position compared to alternate power generation technologies shows that the demand for coal will continue to grow in multiple markets dependent on imported product.

A number of divestment campaigns advocate a halt in coal investment, on the basis that future climate change policies will render coal resources and infrastructure ‘stranded assets.’ We do not believe that this is a material risk to our business.

The carbon budget concept used in many cases assumes that the current and future build of coal-fired power plants will not occur. This is contrary to scenarios and commentary from the IEA which continues to push for rapid deployment of low-emission coal technologies, including carbon capture and storage. This is because the underlying reality for global energy is that coal-fired power stations will continue to be built and used.

Further consideration should be given to the relative cost associated with very ambitious climate change scenarios, both in relation to consumer energy costs and the capital required to integrate intermittent power generation technologies (transmission and distribution).

**Seaborne market thermal coal quality**

Coal quality varies significantly with a spectrum from lignite through to anthracite. The graph *Thermal coal energy content* illustrates the significant divergence in energy content of thermal coals used globally. Typically, coal used domestically has an energy content below the global average, while seaborne-traded coals have a higher energy content. This divergence is primarily driven by economics, with higher energy coals being able to support the cost of transportation and remain a competitive fuel source.

![Thermal coal energy content graph](chart.png)

Mines supplying the seaborne coal market, with the exception of Russia, are generally near the coast with developed, low-cost infrastructure, favourable geology and high quality, supporting low-cost extraction. Glencore’s coal assets in Australia, South Africa and Colombia benefit from these attributes while also being amongst the highest quality seaborne-traded coals, with not only higher energy content but also low levels of impurities such as ash and sulphur.

The growth outlook for seaborne-traded coal differentiates companies with a seaborne-traded focus from those exposed to domestic US and European markets. This supports Glencore’s existing mines and provides for optional investment in resource conversion.
Global climate change policy: coal use in NDCs

Coal contributes significantly to the modern world. As already mentioned, coal provides 41% of the world’s electricity generation and is an essential ingredient in the production of 70% of the world’s steel and 90% of its cement. The world will continue to need these vital inputs for industrial and urban growth as the global population increases from 7 billion today to 8.3 billion by 2030.

The continuing use of coal is included in the NDCs for approximately 20 countries following COP21. These NDCs show a key focus on applying low-emission technologies to power generation and other uses of coal. A selection of NDC contributions are summarised below.

<table>
<thead>
<tr>
<th>Country</th>
<th>Post-COP 21 status</th>
</tr>
</thead>
<tbody>
<tr>
<td>China</td>
<td>China’s NDC includes a requirement for the “control of total coal consumption;” “concentrated and highly efficient electricity generation from coal;” and a commitment to “enhance the clean use of coal.”</td>
</tr>
<tr>
<td>Japan</td>
<td>Coal will provide at least 26% of Japan’s electricity needs through to 2030 with Japan’s NDC pointing to the “pursuit of high efficiency in thermal power generation,” including ultra-supercritical (USC) and advanced USC (AUSC) coal generation technology.</td>
</tr>
<tr>
<td>India</td>
<td>India’s NDC notes that “coal will continue to dominate power generation in the future” combined with a “transition to the use of supercritical technologies for coal based power stations.”</td>
</tr>
<tr>
<td>South Korea</td>
<td>Coal’s role in South Korea’s power needs is forecast to increase from 28% to 32.2% by 2029. The country has also committed to an increase in renewables in its NDC.</td>
</tr>
<tr>
<td>Bangladesh</td>
<td>Has committed to switching to 100% new coal-fired power plants with supercritical (SC) technology by 2030, seeking assistance worth $16.5 billion, the largest funding request made.</td>
</tr>
<tr>
<td>Vietnam</td>
<td>Has committed to using innovative technologies and applying advanced management and operation processes. Also has committed to developing procedures for efficient and effective use of energy in production, transmission and consumption, especially in large production facilities where energy consumption is high.</td>
</tr>
</tbody>
</table>

CO₂ emissions throughout the lifecycle of coal and gas power generation

To achieve the climate change goals agreed at COP21, there will be a need to reduce global emissions from all fossil fuels, including the coal and natural gas used in power generation. Technology will play a pivotal role in reducing these emissions.

The full lifecycle emissions from coal and gas power generation are much closer than widely understood.

If we recognise and include production source emissions and transportation leakage, and count these along with combustion emissions, this substantially raises the level of CO₂e emissions associated with natural gas power generation. Addressing emissions at every stage
of the lifecycle will require investment in new technologies for both coal combustion and gas lifecycle management.

**Reducing emissions from coal power generation**

*High efficiency low emission (HELE) technology*

Glencore believes that policies should support innovation, importantly including HELE technology for existing and new fossil fuel energy generation. This will help to target and deploy a finite amount of investment capital where it will be most meaningful, and contribute most to the ultimate goal of reducing GHG emissions at least cost.

There is currently around 1,900GW of installed coal-fired generation capacity globally. Under the *Committed Action Scenario*, Glencore envisages a global net addition of around 450GW by 2030. This equates to an additional 750 power station modules, each with a capacity of 600MW, principally located in China, India, Indonesia, Vietnam and the Philippines.

Building modern HELE coal-fired power stations, or refurbishing older plants, provides the opportunity to reduce not only CO₂ emissions, but also SOₓ, NOₓ and particulate matter (PM) emissions from coal-fired power plants.

Supercritical (SC) and ultra-supercritical (USC) HELE coal-fired power stations produce electricity more efficiently by operating at higher temperatures and pressures, using less coal and reducing emissions.

When a SC or USC unit is used instead of a less efficient sub-critical unit, up to 35% reductions in CO₂ emissions can be achieved. In addition, non-carbon emissions of up to two thirds for SOₓ and NOₓ are achievable. Japan, China, the US, EU and India all have material research programmes under way for the next generation

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**Potential reductions in CO₂ with increased efficiency levels in coal-fired power plants**

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7 IEA Medium Term Coal Market Outlook, 2015
8 “Climate implications of coal-to-gas substitution in power generation”, Hermine Nalbandian, April 2015, IEA Clean Coal Centre
of increased steam pressures and efficiency, known as advanced ultra-supercritical (AUSC), with thermal efficiencies of 50% and emissions of 670g of CO₂/kWh.

The capital cost step-change from sub-critical to SC is in the order of 20 to 25% and the step up to USC plants is the same amount again. Operating costs are only marginally higher, due to more efficient energy conversion. On a cost per abated tonne of CO₂, building more efficient power stations in countries such as India could have a lower cost than using off-shore wind power generation when comparing baseload power sources.

We believe that investment in HELE power station technology, coupled with CCS, is a priority, to provide a necessary low-carbon technology solution for the continuing build of coal-fired power stations, particularly in developing nations.
The Isogo thermal power station is located just 6km from Yokohama, the second largest city in Japan. The power station originally consisted of two 1960s vintage 265MW subcritical units. During the late 1990’s, Yokohama’s environmental improvement plans aimed to enhance the stability of electric power supply while retiring older facilities. J-POWER, formerly EPDC, which owns and operates the Isogo plant, entered into a pollution prevention agreement with the city.

Between 2002 and 2009, J-Power replaced the older units with two new 600MW USC units achieving thermal efficiencies of 43%. The two units have more than doubled the power generated by the small peninsula site, while lowering emissions levels to that of a natural gas-fired combined-cycle plant.

Combined, the two new units emit 50% less SOx, 80% less NOx, 70% less particulate matter, and 17% less CO2 than the older sub-critical units. Isogo’s Unit 2 has permit levels of 10ppm for SO2 and 13ppm for NOx; it usually achieves single-digit ppm concentration emissions. The system provides such exceptional pollution control that it has resulted in the Isogo plant being ranked as the cleanest coal-fired power plant in the world in terms of emissions intensity.
CCS is a proven, established technology and a reality in many parts of the world. A global portfolio of operating CCS projects is emerging, with 15 large-scale projects currently in operation and an additional seven due to become operational in 2016 and 2017. There are a further 11 projects in an advanced stage of planning that will have a combined CO₂ capture capacity of around 15 million tonnes per annum.

CCS is not only required for coal-fired generation, but also for gas-fired power and processing and other industrial processes, such as steel making and chemical processes.

We agree with the views of the IEA and IPCC: there should be investment in the widespread deployment of CCS, not only to reduce emissions but also to manage the costs of achieving our ambitious climate change goals.

In the longer term, HELE and CCS solutions represent a necessary and lower cost option for CO₂ abatement than some other low-carbon technologies. According to the IEA’s *2015 Energy Technologies Perspectives*, by 2050 30% of cumulative GHG emission reductions will need to come from renewables and 13% from CCS, yet in the last 10 years 1% of the $2 trillion spent on renewables has been spent on CCS development.

What is required is greater policy parity of available investment funding to ensure that a broad and necessary suite of emission reduction technologies can be achieved, while maintaining the balance of economic growth, environmental protection and energy security.

*Case study: carbon capture and storage (CCS)*

*Courtesy of the CO₂CRC*
Case study: the Boundary Dam CCS project

The Boundary Dam integrated CCS project in Estevan, Saskatchewan, Canada, is the world’s first and largest post-combustion capture, coal-fired energy generation project of its kind. The project was a CAD1.4 billion government/industry partnership between the Canadian and Saskatchewan governments and SaskPower. The Boundary Dam CCS project came into operation in October 2014.

The project involved the rebuild of the site’s 1960-era third coal unit, replacing it with a 110MW-equivalent unit. Costs were evenly split between the boiler unit upgrade and the new CO₂ capture plant. CO₂ emissions are being reduced from about 1,100kg per MW/hour of electricity to about 120kg. The approximately 1 million tonnes of CO₂ captured annually is mainly used for enhanced oil recovery at an ageing oilfield. This leaves the CO₂ sequestered, with the remaining CO₂ used for proving up storage in a saline aquifer.

Courtesy of Saskpower and World Coal Association, June 2015
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