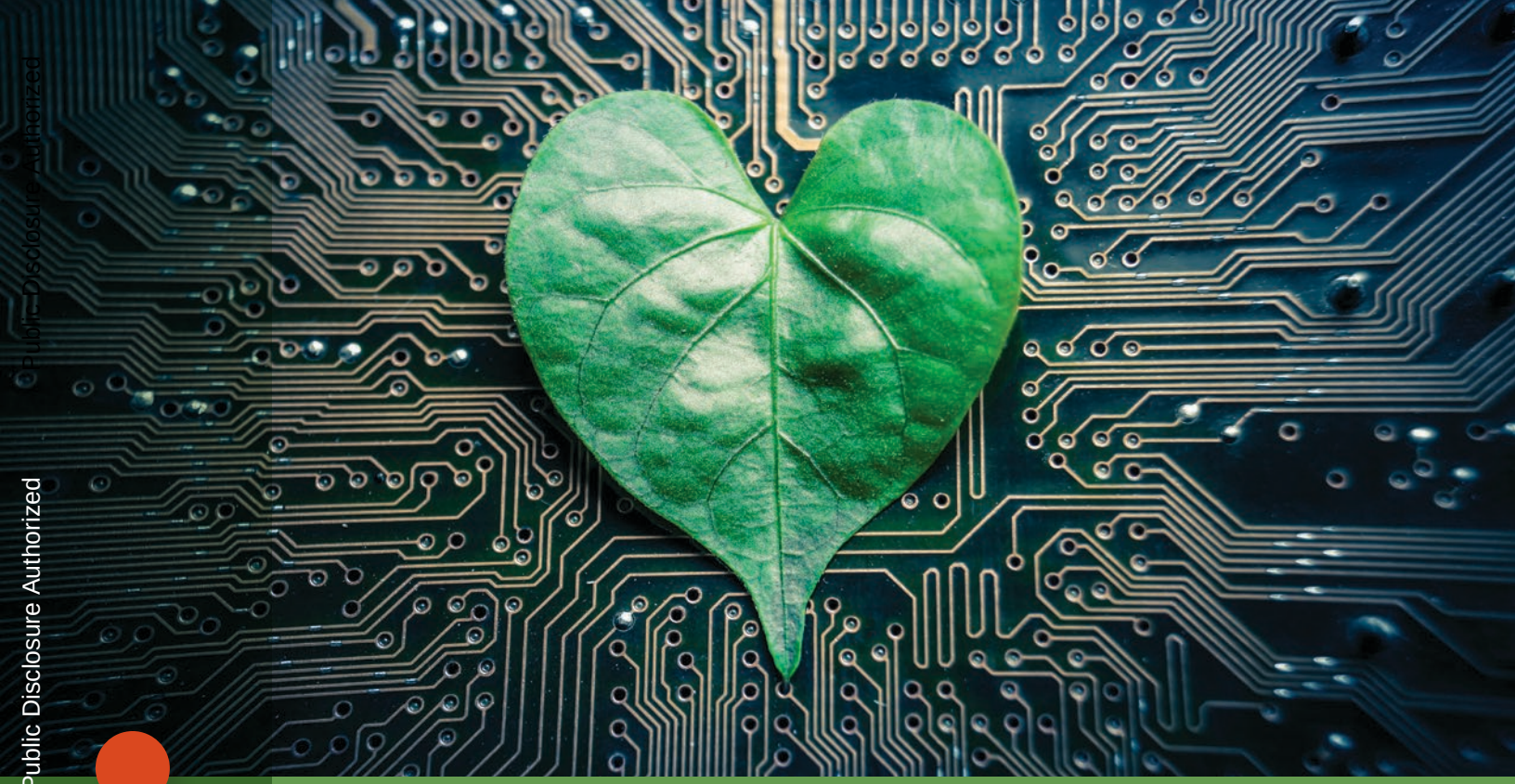

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INTERNATIONAL DEVELOPMENT IN FOCUS

Policy Approaches to Climate Change in Mineral Rich Countries

Background Paper for *Building Resilience: A Green Growth Framework for Mobilizing Mining Investment*

Sri Sekar, Kyle Lundin, Christopher Tucker, Joe Figueiredo, Silvana Tordo, and Javier Aguilar

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Cover design: Debra Naylor / Naylor Design Inc.

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Acknowledgments

This report was commissioned by the World Bank's Extractives-led Local Economic Diversification (ELLED) Program: a knowledge program that supports inclusive growth in mineral and hydrocarbons rich countries through innovation, long term competitiveness, and regional synergies.

This report is part of a series of background reports underpinning the report on *Building Resilience: A Green Growth Framework for Mobilizing Mining Investment,* which investigates potential for leveraging the mining industry to drive the uptake of climate-sensitive technologies and practices in emerging and developing markets. The series includes four reports: Methodology and Value Chain Analysis, Mining Firms' Climate-Sensitive Initiatives, Climate Sensitive Mining: Case Studies, and Policy Approaches to Climate Change in Mineral Rich Countries.

The research was undertaken by a team comprising Sri Sekar (Mining & Energy Lead), Kyle Lundin (Mining & Energy Research Analyst), Christopher Tucker (Mining Specialist), and Joe Figueiredo (Extractives Policy Associate), all with Deloitte Consulting LLP, with the contribution and under the guidance and direction of Silvana Tordo (Lead Energy Economist, World Bank), and Javier Aguilar (Senior Mining Specialist, World Bank) who co-lead the ELLED Program.

The team would like to thank the Extractives Global Programmatic Support, a multi-donor trust fund administered by the Energy and Extractives Global Practice of the World Bank, for their financial support.

The comments of peer reviewers Jonathan Coony (Senior Private Sector Specialist, World Bank), Sven Renner (EGPS Program Manager, World Bank), Alberto Criscuolo (Senior Private Sector Specialist, World Bank), and Michael Stanley (Global Lead, Extractives, World Bank) are gratefully acknowledged. Comments were also provided by Kirsten Lori Hund and Daniele La Porta (Senior Mining Specialists, World Bank) and Thao P. Nguyen (Consultant). Editorial support was provided by Isabella Lacsamana.

Special thanks go to Barrick Gold,[1] Goldcorp, Newmont Mining, Anglo American, and IAMGOLD for their cooperation.

Extractives-led
Local Economic
Diversification

NOTE

1. A merger between Barrick Gold Corporation and Rangold Resources Limited was completed on January 1, 2019. The new company continues to be known as "Barrick". All references to "Barrick" or "Barrick Gold" or "Barrick Gold Corporation" in this report, refer to the activities and actions of Barrick Gold Corporation prior to the January 2019 merger and do not necessarily reflect the actions or activities of the newly formed company, Barrick.

Abbreviations

AANDC	Affairs and Northern Development Canada
AI	artificial intelligence
ARENA	Australian Renewable Energy Agency
BC	British Columbia
BEE	Black Economic Empowerment
BHP	Broken Hill Proprietary
CAD	Canadian dollar
CCS	carbon capture and storage
CCSU	carbon capture storage and utilization
CEO	chief executive officer
CLP	Climate Leadership Plan
CMA	Cumulative Management Areas
CRATER	Climate Related Adaptation from Terrain Evaluation Results
CSI	Cement Sustainability Initiative
CSIRO	Commonwealth Science and Industrial Research Organization
DMR	Department of Mineral Resources
EE	energy efficiency
ELLED	Extractives-led Local Economic Diversification
EU	European Union
FIT	feed-in tariff
GATT	General Agreement on Tariffs and Trade
GDP	gross domestic product
GHG	greenhouse gas
GVA	gross value added
ICMM	International Council on Mining and Minerals
IDC	Industrial Development Corporation
IEA	International Energy Agency
IFC	International Finance Corporation
IMF	International Monetary Fund
INDC	intended nationally determined contribution
IoT	Internet of things
IRENA	International Renewable Energy Agency
ISO	Independent System Operator

LCOE	levelized cost of energy
LNG	liquefied natural gas
MCA	Minerals Council of Australia
NCCARF	National Climate Change Adaptation Research Facility
NCRE	non-conventional renewable energy
NDC	nationally determined contributions
NRCAN	Natural Resources Canada
NRDC	Natural Resources Defense Council
OEM	original equipment manufacturers
OGIA	Office of Groundwater Impact Assessments
PV	photovoltaic
R&D	research & development
RE	renewable energy
RPS	renewable portfolio standards
TRIMS	Trade-Related Investment Measures
UN	United Nations
UNFCC	United Nations Framework Convention on Climate Change
USA	United States of America
USD	United States dollar
UWIR	underground water impacts report
WA	Western Australia
WBCSD	World Business Council for Sustainable Development
WRI	World Resources Institute
WTO	World Trade Organization

1 Introduction: The Green Economy and Implications for the Mining Industry

THE GREEN DIMENSION OF THE FOURTH INDUSTRIAL REVOLUTION

The global economy is on the cusp of what many observers believe will be the fourth convulsive transition since 1870. The three preceding such transitions were driven by revolutionary technological innovations known as "industrial revolutions." The first transition was driven by new iron production processes and the advent of the steam engine. The second transition was powered by electricity, and featured the adoption of industrial chemicals and innovations in telecommunications. The innovations of the third industrial revolution have come collectively to be known as the "information age," which featured groundbreaking advances in computing, the internet, and mobile communications.

The fourth industrial revolution will combine artificial intelligence (AI) and "internet of things" (IoT) architecture with the unprecedented speed of 5G telecommunications to automate vast swaths of production across industrial sectors. But unlike the previous revolutions, this transition will extend beyond technology and will likely be supercharged by historic investments into sustainable infrastructure. The implications of this transition cannot be understated—the world will fundamentally change how it does work in the very near future—the World Bank has documented these likely consequences in its report "The Changing Nature of Work." Unless, however, businesses, governments, and workers confront these new realities in a way that is cognizant of the changing climate, productivity or wealth gains that result from this revolution will be unlikely to sustain in the long term. It is within this context of economic overhaul that industry and governments worldwide are beginning to work toward evolving their production processes, policy frameworks, and incentive structures to incorporate climate-sensitive growth strategies.

Fundamentally, the motivations for governments and industry to consider the climate as they transition to a future economy are driven by the desire to: adhere to international compacts like the 2016 Paris Agreement and the 2030 Agenda adopted by world leaders at the 2015 UN Sustainable Development Summit; ensure equality of opportunity given that climate-related economic

displacement is typically borne disproportionately by poor populations; avoid trillions of dollars in disaster recovery costs; and most importantly, seize new opportunities for growth.

This rethinking of economic activity in the context of global climate change is what is known as the green economy. The green economy entails an approach by nations to adopt economic policies designed to develop climate-sensitive industrial sectors that can drive long-run sustainable economic growth. This occurs by providing incentives for markets to shift their products, processes, technologies, and supply chains to not only adapt to and reduce climate impacts, but to drive growth in new value chains. Nations are advised to pass policies that incentivize such growth, as well as to invest in this new climate future: the Global Commission on the Economy and Climate has recommended that countries spend a collective $90 trillion on sustainable infrastructure through 2030 (Global Commission on the Economy and Climate 2018). The key to this climate-sensitive economic policymaking and investment is the notion that the investment is not simply a set of compliance prescriptions that are dilutive to company bottom lines and to overall national wealth, but that it can be *accretive*. By some estimates, near term climate-sensitive investments made by the private sector in terms of their production and procurement processes and by the public sector via fiscal policy could yield $26 trillion in cumulative economic benefits between 2018 and 2030, measured at least in part by new low carbon jobs, female employment, and redeployed carbon tax revenue—see figure 1.1 (Global Commission on

FIGURE 1.1

Economic benefits of climate-sensitive investment

Source: Global Commission on the Economy and Climate 2018. Used with permission; further permission required for reuse.

the Economy and Climate 2018). Indeed, the vision of a green economy is one rooted not simply in the mitigation of risks presented by new climate realities, but in the opportunity to leverage those realities into sustainable *green growth*. This presents industry and jurisdictions with two strategic imperatives: first to seize these opportunities to develop new value chains within the next 1–2 years or risk missing the boat, and second—for low-to-middle income economies—this is a chance to develop an industrial policy to incentivize leapfrog innovation and process reengineering that embraces the climate and sustainable development dimensions of the fourth industrial revolution.

A MINING PERSPECTIVE ON GREEN GROWTH

Any meaningful transition to a new green economy will require the mining sector as a central stakeholder. This is in part due to the significance of the minerals sector to the overall global economy. Minerals make up and will continue to make up the fundamental building blocks of the global economy. The sector operates to convert natural resources into inputs for a number of existing industrial processes, and into inputs that will fuel the technological innovations heralded by the fourth industrial revolution, including the batteries required to run automated electric vehicles, the sensors that underpin IoT architecture, and the wind turbines that will power the future grid. In 2012 then CEO of AngloGold Ashanti, Mark Cutifani estimated that mining revenue contributed to 11.5 percent of global GDP, and even more compellingly, contributed directly or indirectly to more than 45 percent of the global economy (Creamer 2012). With such a significant impact on the world's economic reality, it is clear that any turn toward green growth cannot take place without impacting the mining industry—and perhaps more importantly, green growth ambitions can only be realized in partnership with the sector. Especially in those low-to-middle income countries where mining comprises a large share of the local economy.

While it is important to underscore the significance of minerals to any economic evolution or industrial policy, it is perhaps even more important to highlight why the industry is particularly well suited to *contribute to* the climate-sensitive innovation and process changes associated with green growth. This is first because while the sector is dedicated to extracting resources used for industrial production, it is also resource dependent—a factor that underlies the estimate that approximately 25 percent of mining production will be exposed to climate related risk by 2030 (Deloitte 2018). Second, the sector is similarly dependent on establishing goodwill with the nations and communities in which its operations are established. The following factors point to the mining sector's potential to create green value:

1. Mining is Energy Dependent: When considered as a portfolio that incorporates diesel, heavy fuel oil, grid electricity, gas, LNG and other sources, energy can represent up to 30 percent of a mining company's total operating costs (Deloitte 2016).
2. Mining is Water Consumptive in an Era of Increasing Water Stress: Water is becoming an increasingly critical issue for mining companies: as ore grades decline, more water is required to extract the same amount of ore. Yet according to the UN water scarcity affects 40 percent of the global population.[1]

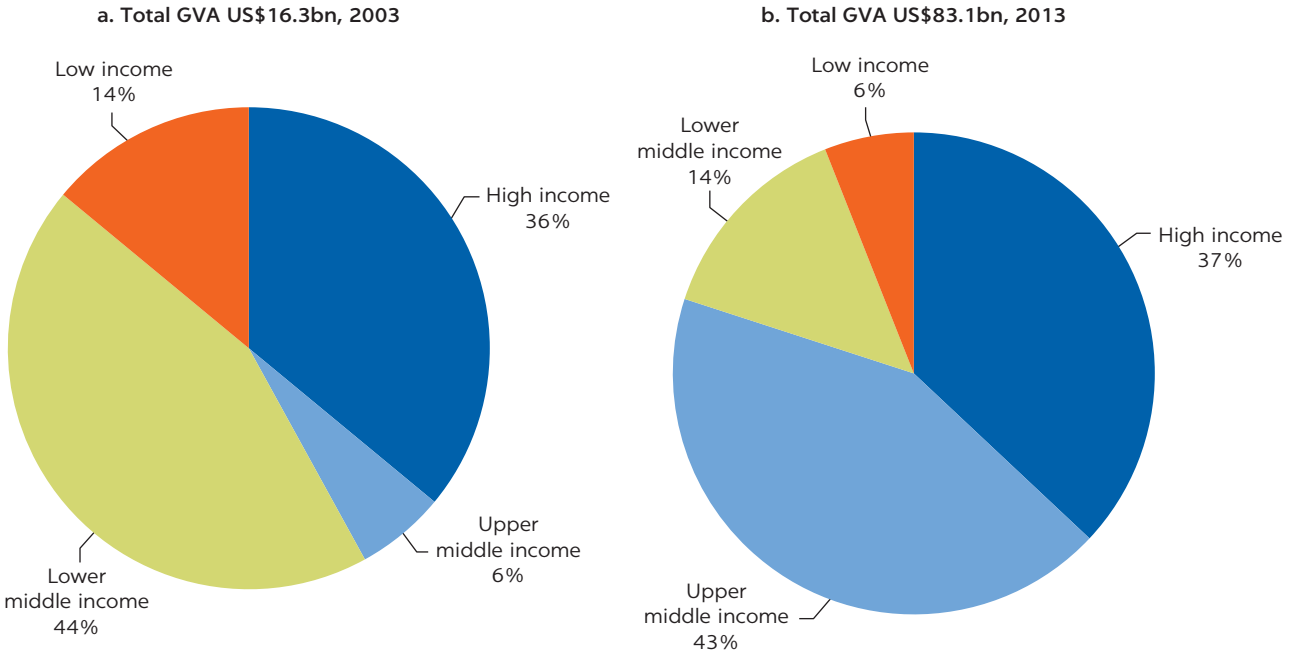
This explains in part why 58 percent of the mining cases lodged with the World Bank Compliance Officer relate to water issues (Deloitte 2018).

3. Mining Operations are Intensely Focused on Earning their Social License: An investment in a mine often takes decades to recoup while earning a return that is commensurate with the risk associated with the endeavor. In fact, the useful productive life of a mining operation can in many instances extend to 30 years. This long term investment dynamic compels mining companies to develop lasting stakeholder engagement strategies in an effort to ensure the long term viability of the mine—which might otherwise be expropriated, prematurely shut down due to compliance concerns, or otherwise experience interruption to productive use due to stakeholder dissatisfaction.

The confluence of these three factors provides potential avenues for a minerals-focused approach to green growth. Taken in the aggregate, the local value generated by mining for their host countries can be startling. For example, figure 1.2 reflects the economic development impact of gold mining in a set of 47 countries that account for 90 percent of global gold production (World Gold Council 2015). Using the composite metric of "gross value added" (GVA) the world gold council estimates that the industry added $83.1 billion in value to those economies in 2013, contributed to moving 11 countries out of low income status, and adding 12 countries to upper-middle or high income status (box 1.1) (World Gold Council 2015). Policymakers working in concert with industry leaders have the opportunity to create an enabling environment that supports mining-fueled green growth.

FIGURE 1.2

Estimated economic impact of gold mining



Source: World Gold Council 2015.
Note: GVA = Gross Value Added.

BOX 1.1

Gross value added

The World Gold Council measures "gross value added" to an economy as direct and indirect measurements. Direct GVA estimates the value of the gold mining industry's production to an economy; while indirect GVA estimates the value of economic production in associated sectors as a result of gold mining companies' supply chain expenditures.

Source: PWC 2013.

PURPOSE OF THIS REPORT

This report is part of a series of background reports underpinning the report, *Building Resilience: A Green Growth Framework for Mobilizing Mining Investment*, which investigates the potential for leveraging the mining industry to drive the uptake of climate-sensitive technologies and practices in emerging and developing markets. In addition to this report, the background reports series includes three reports: Methodology and Value Chain Analysis, Mining Firms' Climate-Sensitive Initiatives, and Climate Sensitive Mining: Case Studies.

The purpose of this report is to highlight the policies of countries leading the shift toward a green economy, and the implications of those policies for the mining sector in those countries. The report begins with the analysis of key areas of policymaking known to be drivers for the green economy; discusses resulting mining sector impacts and opportunities; and closes with an overview of the individual experiences of mineral-producing countries who are leading the transition to the green economy. This report discusses the following areas of green growth policymaking:

a. Taxes and tariffs;
b. Sector-targeted subsidies;
c. Shared data infrastructure;
d. Climate-sensitive standards; and
e. Local content regulation.

NOTE

1. UNDP. Sustainable Development Goals. Goal 6: Clean Water and Sanitation. https://www.undp.org/content/undp/en/home/sustainable-development-goals/goal-6-clean-water-and-sanitation.html.

2 Current State of Green Industrial Policy

Environmental and sustainability considerations (including climate change) increasingly play a role in developed and developing economies' industrial policy. While policies that exclusively benefit national economies are often challenged under international trade agreements, policies with an explicit intention to protect the environment have largely emerged unscathed. Thus countries that are pursuing mineral development within their borders may find it attractive to examine industrial policy in light of both local economic interests and international efforts (and national commitments) to address environmental challenges including climate change. In particular, the Paris Agreement requires signatory countries to establish nationally determined contributions (NDCs) to reduce national emissions and adapt to the impacts of climate change. Naturally, heavy-emitter industries such as mining are a critical part of any mining-intensive country's NDC action plan for reducing GHG emissions. Less obviously, mineral development procurement and supply chains can play a significant role in encouraging national adaptation measures, by building more resilient economies, encouraging domestic food security, and developing shared-use infrastructure. For example, Guinea's intended nationally determined contribution (INDC) states that "as the mining sector is destined to become one of the pillars of the Guinean economy, there is an opportunity to make it a model for the integration of climate issues (mitigation/adaptation) throughout the value chain."

In a world on the brink of making a significant investment into low-carbon infrastructure, the mining sector stands to benefit as the primary supplier of requisite mineral inputs. Additionally, in a world where many environmental challenges, including climate change, are exacerbated by economic inequality between regions and nation-states, mining's traditional role as an economic engine for developing countries remains relevant. To realize this opportunity it is important to understand the enabling policy environment that can steward development along a low-carbon path with broad economic and development benefits.

APPROACH TO POLICY ANALYSIS

This report explores the link between climate-sensitive mining and local value creation through the following logical steps:

a. **Green industrial policy:** Identify relevant elements of industrial policy that have the potential to address both local value creation and climate-sensitive initiatives applicable to the mining industry.
b. **Policy trends:** Determine which green industrial policy areas are being actively applied in mineral-rich economies to drive both local value creation and climate-sensitive initiatives.
c. **Policy leaders**: Analyze mineral-rich jurisdictions with green industrial policy frameworks to highlight examples of the policy trends identified above.

To better contextualize policies within the different mining value chains, this report examines countries and sub-national jurisdictions (e.g., states/provinces with regulatory authority over mineral development) that are actively involved in the exploration and commercial extraction of:

a. Gold (precious metals)
b. Iron ore (ferrous metals)
c. Copper (base metal)
d. Aggregate and cement (construction minerals)
e. Rare earths/cobalt/lithium (critical raw materials).[1]

The representative minerals were selected on the basis of the methodology outlined in the first report of this series (Value Chain Analysis and Methodology report), and provide coverage of both the existing landscape of mineral development and emerging areas of mineral demand driven by low-carbon, climate-sensitive technologies themselves (e.g., battery minerals, renewable energy supply chain minerals, electrical infrastructure inputs).

TAXES AND TARIFFS

Over the last decade, over 100 developed and developing economies (accounting for more than 90 per cent of global GDP) have adopted formal industrial development strategies (UNCTAD 2018). Recent years have seen an increase in green industrial policies (i.e., that incorporate sustainability as well as economic measures). At the same time, conflict between international trade and environmental protection has also been increasing, with the world's major trading powers aggressively challenging each other's pro-environmental policies under global trade rules (Wu and Salzman 2014). Establishing effective green industrial policy, that encourages local economic development while facilitating the achievement of climate risk mitigation strategies, will increasingly require navigating the complexities of global trade agreements while implementing domestic policies to foster local, green value chains. Traditionally, the mining industry has pointed to taxes and job creation as the key economic benefits it provides to host countries. These will remain critical factors in the industry's social license to operate, even as more sophisticated benefit sharing and community development initiatives emerge.

Carbon taxation

In almost any scenario that envisions meeting the ambitious UNFCCC global greenhouse gas emissions targets one of the more accepted and frequently considered policy options to achieve this goal is to put a price on carbon. Notably, Chile's INDC prescribes the establishment of a carbon tax to help meet its GHG reduction targets. While debate continues, particularly with the United States announcing its intention to withdraw from the Paris Agreement, some jurisdictions have moved ahead and established carbon trading or carbon taxation frameworks, including Canada, Costa Rica, Norway, and Australia. South Africa, for instance, is implementing its second draft carbon tax that will begin on June 1, 2019 and would cover all GHG emissions relating to the production of energy and non-energy industrial processes at the rate of 120 rand per metric ton (or approximately 8 USD) (KPMG 2019).

There is no single approach to carbon pricing that will work for every jurisdiction, and similarly, not all jurisdictions manage revenues from carbon levies equally. Some approaches focus on re-investing in low carbon technologies and practices, while others focus on using these funds to support vulnerable communities and industry.

As carbon pricing structures are adopted and new structures developed, the International Council on Mining and Minerals (ICMM) has identified four issues in particular that must be considered for these schemes to ultimately be successful:

a. **Price**—The carbon price will have varying impacts on different commodities, depending on the amount of emissions during production.
b. **Trade exposure and emissions intensity**—Some commodities are less exposed to a potential competitive disadvantages and impacts also depend on the scope of the pricing scheme, whether it is narrow or wide (i.e., a single aspect of production versus across the supply chain).
c. **Volatility over the economic cycle**—Commodity prices are highly variable and economic cycles are volatile, changing unpredictably; carbon pricing systems need to be responsive to these market conditions.
d. **Emissions reduction technologies**—Many companies have already optimized energy usage, so if carbon pricing is enabled, there needs to be an understanding and additional focus on where power savings are to be found (Deloitte 2018).

Together, these issues underscore the need to focus terms and conditions of carbon pricing schemes on specific jurisdictions that incorporate unique aspects of those markets.

While not all jurisdictions currently have a carbon pricing regime, those countries that have adopted and implemented a carbon pricing scheme are being watched very closely. Many mining companies, anticipating future widespread adoption, have begun to forecast these costs into current and future project economics. Box 2.1 contains an example of carbon pricing scheme.

In order to reduce GHG emissions, it is important to understand the volumes and where emissions are coming from. The reporting and measuring of emissions is a potential gap, and jurisdictions can play a larger role in mandating emissions reporting by industry and effectively collecting and maintaining this data. The World Business Council for Sustainable Development

BOX 2.1

Carbon pricing in Canada

The Canadian government has adopted a policy directing provinces to either adopt emissions reduction plans by 2018, or have a federal carbon price imposed on them (Government of Alberta 2018). British Columbia, a large copper producing jurisdiction, established the first carbon tax in Canada, but had to adjust as it impacted the competitiveness of domestic industry large emitters (Government of British Columbia 2018). The province of Alberta, while primarily an oil and gas producing jurisdiction, has one of the more aggressive and mature carbon trading schemes as well as a firm commitment to reinvesting the revenue from carbon prices on initiatives to reduce emissions and supporting the transition to a lower carbon economy, including the creation of employment opportunities (Government of Alberta 2018). (Details of these Canadian carbon pricing techniques will be discussed in further detail later in the report).

(WBCSD) and The Cement Sustainability Initiative (CSI) of the International Energy Agency has led an effort with 24 major cement producers that are operating in over 100 countries and account for 30 percent of world cement production, to provide detailed reporting on emissions data so as to inform reduction strategies.[2] This feeds directly into jurisdictional strategies for reducing emissions from downstream processing (discussed below).

As a traditionally heavy emitter of GHGs, mining is significantly affected by carbon taxation. While there have been critical voices within the industry regarding carbon taxes, the industry as a whole has generally responded favorably to efforts to mitigate climate change generally and to carbon taxation in particular. For example, Vancouver-based Teck Resources, exposed to carbon taxation in British Columbia and in other jurisdictions, includes an endorsement for carbon pricing on their website.[3] Similarly, as a prime example of how mining firms can use the impetus of carbon pricing to generate local value while reducing emissions and operating expenses, Vancouver-based Goldcorp, one of the largest gold miners on the globe, used Ontario's now defunct carbon cap and trade law as a market signal to invest in an all-electric mine at its Borden site (see box 2.2).

While carbon taxation or pricing may incentivize more renewable energy (RE) development, it is not certain as to whether such development would catalyze local economic development. Building supporting value chains for advanced technologies such as solar and wind could prove challenging in an emerging market context.

Revenue recycling

The revenues generated by carbon taxes can be used in various ways by host governments. Perhaps the most straightforward option is to include carbon taxes in a government's general revenues. For example, British Columbia's carbon tax of CAD $30 per ton of CO_2 emitted on the use of fuel within the province, is designed to be revenue neutral—meaning, every dollar generated through the carbon tax is returned to British Columbians in the form of personal and business tax reductions, such as reductions in personal income tax rates, the Low

BOX 2.2

Goldcorp's Borden mine

Goldcorp's Borden underground gold mine sits in Northern Ontario just outside the town of Chapleau and is slated to become one of the first all-electric mines in the world. The goal of making Borden one of Goldcorp's most technologically adept assets was achieved through a combination of climate-conscious considerations and seizing upon green industrial policy structures in place in Ontario.

At the time Borden was being developed, the government of Ontario had an ambitious Carbon Cap and Trade program in place for facilities generating more than 25,000 tonnes of carbon dioxide annually. In cooperation with the Government of Ontario and Natural Resource Canada's Clean Growth Program, Goldcorp secured approximately $5 million CAD from the program to help pay the 25–30% premium on a fleet of all-electric mining equipment, including electric vehicles from Maclean Engineering and Sandvik Mining. Goldcorp's challenge in purchasing this equipment was not just that it was more expensive than traditional mining equipment, but that much of the equipment did not exist. Spurred by the Cap and Trade program and their desire to be more climate conscious, Goldcorp asked its potential suppliers to develop this technology or else the company would find a supplier that could do so. The Borden portfolio of all-electric vehicles has expanded beyond just haul trucks and now includes boom trucks, scissor lifts, cassette trucks, bolters, automated drilling trucks, and scoops.

Despite all-electric vehicles having higher up-front costs than traditional diesel-powered mining equipment, Goldcorp has estimated that they will be able to pay off the initial up-front investment in 2–3 years, after which point the electric equipment becomes significantly cheaper than diesel equipment. The company expects to shave as much as $10 million from their OPEX on an annual basis due to this type of procurement. This operational change also reduces the amount of energy.

Goldcorp must expend ventilating the underground mine space. Electric vehicles emit zero GHG and other fumes that would otherwise need to be expelled from the mine cavity. Behind grinding and material movement, ventilation is often one of the most energy-intensive procedures in a mining operation.

Further than the immediate and expected cost savings to Goldcorp, the Borden mine serves as an example of a green industrial policy initiative seized on by industry. The stimulus from the Cap and Trade program allowed them to support the development of local electric mining expertise—a technology at the very forefront of the mining industry—and encouraged suppliers to develop the technology necessary to deliver all-electric mining equipment. This capability, in many cases, did not exist prior to Borden, the project having catalyzed Original Equipment Manufacturers (OEMs) into offering new products and the value chains required to build and maintain them, both for Goldcorp's Borden project and other Goldcorp assets. More broadly, the Borden project is a case study in utilizing green industrial policy such as Ontario's now-defunct Cap and Trade program to incentivize industry to seek out and create entirely new technology categories and value chains focused on green technology that did not exist before. Moving forward, with this expertise already in place, companies or mine sites that with to electrify their operations in Canada, and around the world, will have an established value chain of suppliers and manufacturers of all-electric mining equipment.

Income Climate Action Tax Credit and corporate income tax reductions (Government of British Columbia). However, directing carbon tax revenues toward specific climate-sensitive initiatives may increase the likelihood of meeting national climate change commitments and also demonstrates the sincerity of the government's commitment (to some degree mitigating the risk that carbon taxes be viewed as a simple "cash-grab" by government). One way to do this is to "recycle" the carbon tax revenues in a manner that further supports the

development of climate-sensitive value chains and local value creation, with or without explicit earmarking. For example, carbon tax revenues can be used to spur the development of clean technologies, to support wider governance issues (such as climate change programming inside governments), to protect and/or help ease the transition to low carbon regimes for specific populations, and to help protect trade exposed economic sectors (ICMM 2013).

Carbon tariffs

As a carbon tax applied to domestic industries has the potential to create a competitive advantage for imports from jurisdictions without carbon taxation, some economists have recommended a carbon tariff or carbon import tax be applied. While there are considerable logistical challenges with regard to assessing each import's carbon footprint, current estimates suggest that carbon tariffs significantly improve the effectiveness of carbon taxation and emissions reduction policies (Larch and Wanner 2017). Particularly within the mining industry, given the relatively high-level of environmental disclosure, estimating a per ton or per ounce GHG emissions is not difficult. As such carbon tariffs applied to imports of metals and mineral concentrates present a good option for mineral-producing regions.

Export taxes

Export taxes (e.g., a tax on the exportation of a mineral concentrate) can be used to encourage value add refining and manufacturing where feasible within the host country. Export restrictions, such as the export quotas that China applied to its rare earth minerals in 2010, are common within mining and the resource sector more broadly, where they are twice as likely as compared to other sectors. "More than one-third of all notified export restrictions are in resource sectors."(Ruta and Venables 2012) However, China ran afoul of World Trade Organization (WTO) requirements which place limits on the use of certain forms of export restrictions, and dropped its rare earth export quotas in 2015 (Wu and Salzman 2013). Export taxes, however are generally permitted under WTO regulations and as such present a better option for encouraging in-country value-add activities such as further refining or even manufacturing where possible.

SECTOR-TARGETED SUBSIDIES

Industrial policies commonly include the provision of general subsidies to sectors that governments specifically target in order to stimulate economic growth. These subsidies include general financial subsidies (e.g., tax credits and low-interest loans), RE subsidies, and research and development (R&D) subsidies to encourage innovation in a specific industry. While many countries' INDC contain commitments to transition to RE sources, few specify how that transition is to be achieved. Many countries that support green growth through NDCs also subsidize fossil fuels, thus sending perverse signals to the market. For example, mining companies that operate in countries where fossil fuels are subsidized will likely find it challenging to propose to their shareholders to invest in

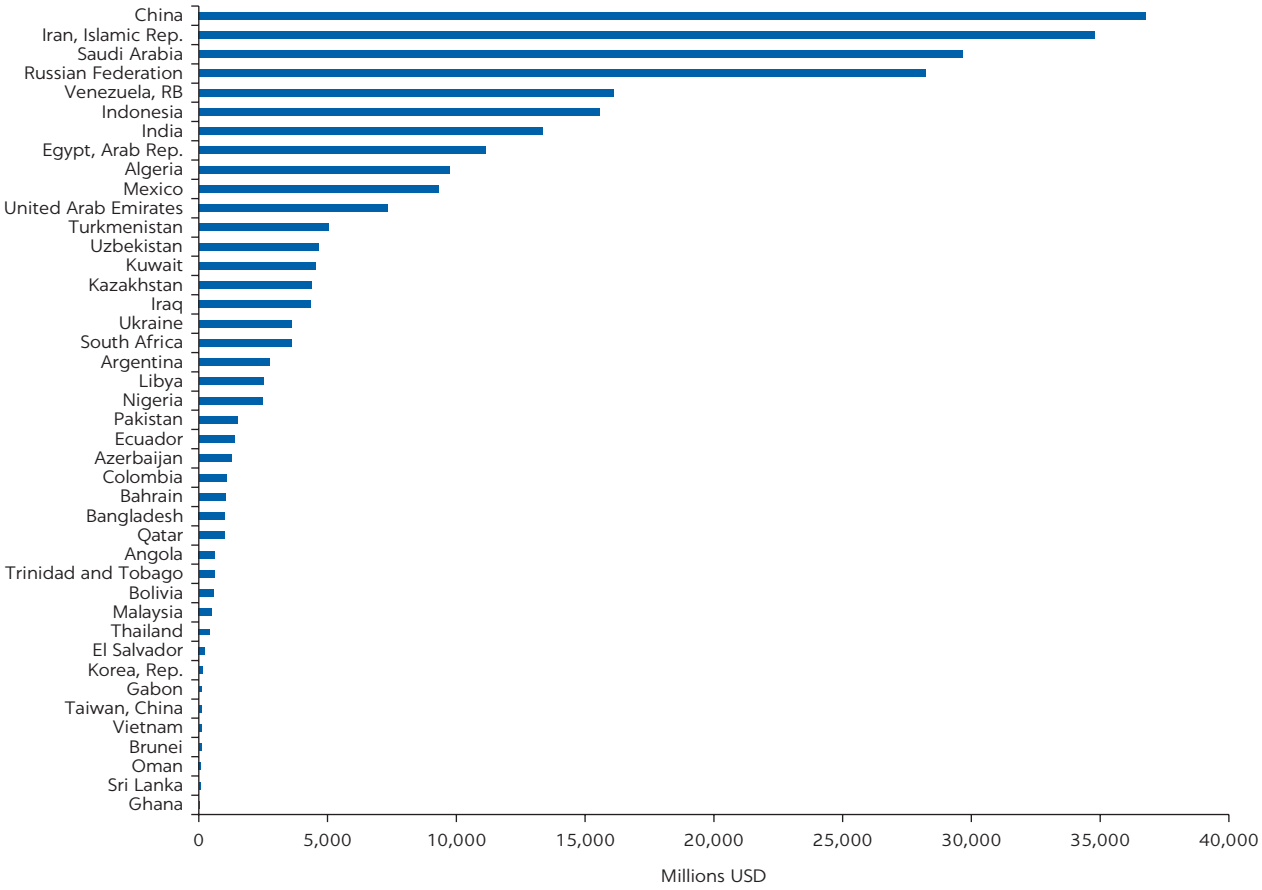
RE (figure 2.1). Ghana however has included phasing out some fossil fuel subsidies in their INDC.

Renewable energy subsidies

One particular type of green growth focused subsidy is a feed-in tariff (FIT) for RE. A FIT generally consists of a series of policies taken to provide a long-term financial incentive for generation of RE. An example of a FIT would be the provision of a guaranteed price for RE supplied to the grid through a long-term contract. The contract price for the energy provided is typically higher than the market price for energy supplied from nonrenewable sources, helping to encourage investment and innovation (Rickerson et al. 2012). FITs support the mining industry's transition toward low-carbon extraction and processing in two ways. One, they increase the likelihood that the available grid energy will have a lower emissions profile and hence lower the operation's scope 2 emissions. Two, they create an economic incentive for mining companies themselves, or in partnership, to develop RE supply that they can sell back to the grid under conditions of surplus. Ghana, for instance, has used its INDC to express its desire to

FIGURE 2.1

Fossil fuel subsidies by country (2016)



Source: International Energy Agency 2017.

adopt a FIT—in addition to the nation's committing in its INDC to a national energy policy, a national RE act, and a national RE fund, it has included a commitment to set up a feed-in-tariff for RE technologies.

Supporting R&D

In *Climate Investment Opportunities in Emerging Markets*, the IFC noted that government funding alone cannot address climate change challenges, but rather governments must strategically target efforts that can encourage or facilitate private sector investment (IFC 2016). Government funding can support the development of innovative, new climate-sensitive technologies at the early stages, where they may not yet be economically feasible for the private sector to utilize. An example is provided in box 2.3.

According to the International Renewable Energy Agency (IRENA), thanks in part to government support at the early stage of variable generation RE technology, the cost of electricity from solar and wind power technologies could fall by at least 26 percent and as much as 59 percent between 2015 and 2025 (IRENA 2016). Between 2010 and 2017 alone the levelized cost of energy (LCOE) fell for installed solar PV plants by 68 percent and LCOE for onshore wind fell by 22 percent (IRENA 2018). Given the current cost competitive environment, governments have started to reduce their level of intervention. To this end, climate change mitigation efforts described in INDCs often include programs to build capacity, encourage R&D, and facilitate technology transfer. The necessarily local nature of understanding and working toward mitigating climate change impacts aligns well with much of the long-term planning required for mine development and closure. For instance, usually mining companies are required to return their mine sites to acceptable end use states, for example, to reclaim, revegetate, and preserve biodiversity and water quality. However, effectively planning to revegetate an area decades into the future requires an understanding of what the future climate will be like, to understand what plant species

BOX 2.3

Supporting carbon capture and storage research

The Norwegian government is proposing to provide funding to a full-scale Carbon Capture and Storage (CCS) project at the Brevik cement plant. The result would be 400,000 tons a year of CO_2 captured from cement production and stored in depleted oil and gas fields in the North Sea (AkerSolutions 2015).

Similarly, researchers at the University of British Columbia have been demonstrating the capacity of certain types of mine wastes to sequester large amounts of carbon dioxide. Funded by Canada's Natural Science and Engineering Research Council, Carbon Management Canada, the governments of British Columbia and Yukon, and Environment Canada, this research could lead to net carbon negative mining operations where mine wastes capture up to eight times the volume of carbon dioxide used to produce them.

Companies, such as Canada's Carbon Engineering, are seeking to economically develop CCS, which for now requires government support as global carbon markets develop and consolidate to address the costs of carbon pollution that are currently externalized in most economies.[a]

a. Carbon Engineering, http://carbonengineering.com/.

will thrive. Much of this research is aligned with commitments to explore more sustainable (i.e., less energy and water intensive) forms of agriculture such as contained in the INDC's of Mongolia, Zambia, and Peru.

SHARED DATA INFRASTRUCTURE

While large mining companies have an abundance of data regarding their operations and the environmental and geological environments they operate in, smaller junior mining or exploration companies, that conduct much of the initial work in identifying and assessing the potential for mineral development, are not. Similarly, in order to collectively draw reliable and defensible conclusions from such information requires a level of data sharing and comparability that currently does not exist, apart from a few notable leading practices below. Providing this information with increasing consistency and transparency will serve to enable some of the transformative trends seen in other industries where innovative solutions to challenging problems can be sourced collectively and more efficiently.

Climate forecasting

Mining projects in jurisdictions around the world are continually being exposed to more frequent, acute, and chronic climate hazards, including extreme weather events, sea level rise and long term changes in water scarcity. The absence of sufficient climate data tracking, monitoring and analysis, presents an obstacle to mining companies attempting to implement effective early-warning systems, learn from historic climate events, or create probabilistic estimations of how often these events may occur again in the future. Historically, governments, as part of their environmental programs and mandates have had the sole responsibility of funding, establishing and maintaining climate and environmental data monitoring networks. Over the last several decades, recognizing the indispensable value of observation data, gaps in the coverage of existing government maintained networks and deficiencies in the accuracy and reliability of instruments, mining companies, among many other private sector companies and institutions have taken it upon themselves to supplement and broaden existing climate and environmental observation data networks.

However, in addition to collecting observation data, governments have also traditionally held sole responsibility for funding climate research and specifically for developing climate models to create future projections of climate under multiple scenarios: Australia and Canada are examples of government-led climate data collection (box 2.4). These government agencies, whether by funding academic research or by directly collecting data and developing climate models for their regions, have largely been responsible for developing climate models, forecasts and impacts. Though small private sector agencies and academic research consortiums have worked to modify and develop more local-scale climate models, no mining companies across the globe, or the private sector more broadly, have effectively developed their own models and projections. As mining companies increasingly seek to understand their exposure to climate change they are incorporating climate risks and scenario planning into their existing risk management procedures and mine design. To do this effectively, reliable climate models and projections

BOX 2.4

Climate data: Australia's and Canada's approach

Under the National Climate Change and Resilience Adaptation Strategy, Australia has adopted measures to provide climate adaption information and guidance to assist businesses and communities, allowing them to be best prepared to manage risks. Between 2008 and 2018, the Australian government invested $56.3 million in the National Climate Change Adaptation Research Facility (NCCARF) to provide "comprehensive regional-level data (to the public) that projects future climate change." The Australian government also provides an online tool called CoastAdapt that specifically addresses climate risks in coastal zones and the Climate Related Adaptation from Terrain Evaluation Results (CRATER) which provides "semi-quantitative information" to coal miners and communities that will assist strategic planning to reduce the potential impacts of climate change on operations.[a]

In Canada, Natural Resources Canada (NRCAN) supports greater public understanding of climate change challenges through the Adaptation to Climate Change program and blog. This program shares climate information through an online portal that seeks to "increase the climate resilience of Canadian communities and industry." For example, sharing information on future flooding potential in the lower mainland of British Columbia. Another example is the SmartICE program. Conducted in coordination with the Nunatsiavut Government in northern Canada, SmartICE uses satellites and local knowledge to measure sea-ice and coastal conditions in real-time.[b]

a. Australian Government Department of Environment and Energy, National Climate Change Adaptation Research Facility. Retrieved from https://coastadapt.com.au/tools.
b. Natural Resources Canada. Impacts and Adaptation: Equipping Canadians to Adapt to Climate Change. https://www.nrcan.gc.ca/environment/impacts-adaptation10761.

developed by government agencies are increasingly important. Moreover, since many users have a limited understanding of the science behind climate models and projections, they rely on government agencies to identify limitations, uncertainties and to communicate the overall applicability of these models. Recognizing this responsibility and the challenges in developing climate models and climate projections, government agencies and climate research consortiums across the globe collaborate to develop a suite of models instead of offering simply one set of models for their regions. The Coupled Model Intercomparison project initiated by World Climate Research Programme in 1995 is one result of this. The project aims to provide an ensemble of climate model projections from up to 30 unique climate research centers across the globe, standardize climate change projections, interpretations and formulations, and provide a spread of potential future climate scenarios to limit the systemic bias of individual climate models and projections. Governments across the globe are relying on these kinds of ensembles to add confidence around the individual models they are developing and to broaden their applicability. Chile's INDC, for instance, includes a commitment to create "forecast models that Chile can share and distribute nationally and internationally, both through individual efforts and jointly with other countries determined to take action." The broad reach of this initiative demonstrates clearly why climate modelling and risk assessment needs to be grounded in global initiatives that foster comparability and consistency.

Geological inventories and national survey

One of the economically simplest and most effective ways to support a country's mineral sector is through the development of robust geological inventories through investment in a national geological service with trained professionals. The World Bank, in *The Growing Role of Minerals and Metals for a Low Carbon Future* (2017), notes that there is a significant gap in the data and geological inventories of many developing countries, particularly in Africa, Latin America, and Asia. The United States, the European Union, and Japan have nationally funded programs that track access to, and the availability of, critical and rare earth metals that supply clean energy technologies. As no such institutional capacity was evident in developing countries, the report concludes that "capacity in this area is critical for resource-rich developing countries to best benefit from economic growth."(World Bank 2017) It is important to understand here why such information is key to developing a minerals-based green economy. Geological and geographical information is necessary to plan where and how mineral development can take place in a socially and environmentally sustainable manner. This information helps jurisdictions develop an understanding of what types of minerals exist in sufficient quantities to be economically extracted—including those critical to building RE capacity. Accurate geological inventory information, used in concert with policies such as export taxes can help build in-country cleantech value chains. Lastly, such geological information can help feed more innovative databases that unlock the potential of secondary raw materials in what is termed as a "circular economy." This is the experience of a consortium of national geological services within the EU, who have launched a database of available materials, from various sources, including mining waste (see box 2.5) (Huisman et al. 2016). The potential for the exploitation and reuse of mining wastes, reduces reliance on the energy and water intensive processes of primary resource extraction, and presents an opportunity for a country or jurisdiction to develop a waste-recycling value chain.

BOX 2.5

Mapping secondary mineral deposits

The Prospecting Secondary Raw Materials in the Urban Mine and Mining Wastes (ProSUM) project in the European Union has created a database of precious and base metals and critical raw materials available for "urban mining" from scrap vehicles, spent batteries, waste electronic and electrical equipment, and mining wastes. The 2017 Global E-waste Monitor notes that electronics such as smartphones contain up to 40 different critical raw materials, often in very high concentrations and that mining discarded electronics produces 80 percent less carbon dioxide emissions per unit of gold compared with many primary mining operations.

Source: United Nations University 2018.

Water management and hydrological databases

Governments have a responsibility to ensure reliable access to potable water resources for the public. The mining sector, depending on the mineral resource, typically requires large volumes of water for mineral extraction and processing. Water competition between different industrial and domestic users (e.g., between mining and agricultural operations) and across national and subnational borders, can present a significant source of social conflict. With such a shared resource, it is essential that jurisdictions work with the private sector, and other organizations, to protect water quality and quantity throughout operations.

Given that water issues bring together the diverse interests of numerous water user groups within a region or a nation, transparent and effective water management is critical for green growth and sound environmental and social development. A lack of regional hydrological information presents challenges to the effective management of water resources. The potential for overconsumption presents threats to the availability of existing water resources whereas excessively conservative limits could result in unnecessarily and even detrimental restrictions on growth and development (Toledano and Roorda 2014).

Box 2.6 outlines some good international examples of when jurisdictions and international non-government entities have taken the lead in tracking and forecasting local, regional, and global precipitation and seasonal cycles.

BOX 2.6

Good practice in water management and hydrological databases

The Water Accounting Framework in Australia was specifically developed for the mining sector and seeks to share water metrics as well as best practices for water management to reduce negative operational impacts as well as protect community needs. Spurred by assistance from the World Bank, IFC, AusAid, and others, the Mongolian government adopted a similar system, called the Voluntary Code of Practice. It is worth noting that this type of public-private coordination takes many years to mature, the Water Accounting Framework developed after 6 years of work and the Voluntary Code of Practice required three years to be fully adopted and implemented.[a]

Water Resource Data Gathering and Forecasting: In 2015, the World Resources Institute, a global research non-profit organization, launched its Aqueduct Water Stress project. This huge task utilized existing water data and forecasted water stress in 126 countries out to 2040. It measures total annual water fall and water withdrawals (municipal, industrial, and agricultural) and hopes to help inform water management policy development, especially in high risk water stress areas. Open sources like this can play a role in sharing information widely that can help ensure sufficient resources are available for the public and also for industrial uses (World Resources Institute 2015).

Water Recycling: While mining companies continue to seek ways to reduce water usage through increased efficiencies and improved management, there is often no getting around the fact that some operations (like gold and copper mining) need a significant amount of water. When these operations occur in water scarce regions there is potential for confrontation with communities. There is also potential for mutually beneficial gains. One example of this can be seen in Peru. The Cerro Verde copper mine was seeking to expand its operations in the already water scarce region near the city of Arequipa.

continued

Box 2.6, *continued*

After consultations with the surrounding local, municipal, state, and national government stakeholders, the company decided to build, finance, and operate a waste water treatment plant. In the agreement, the mine would get a guaranteed volume of treated water for operations, add a certain amount of treated water to the Rio Chili (improving water quality), and provide a certain amount of clean drinking water to the city of Arequipa. With growing demand, the waste water treatment plant is planning to expand. The company is also working to support greater water efficiency amongst farmers (switching to sprinkler and drip irrigation systems) as well as improving agricultural output while supporting the transition to less water intensive crops, such as avocados (Fraser 2017).

In this example, there is a clear tradeoff, where the mining company has to invest in non-operational projects and continue to maintain this facility, but it also gets the social acceptance to develop as well as the amount of water it needs to expand its operations. This is a good example of when the private sector can leverage its capital to support government sustainability efforts. Moreover, this speaks to the forward-looking potential of developing and sustaining a green value chain in the community—in this example there was sufficient demand to expand the facility. Should that demand persist past the useful life of the mine, or should the community and Cerro Verde agree that the facility is more efficiently managed by the local water utility or a private operator, it presents the opportunity for growth in local water sector businesses, jobs, and skills.

Planning for water reclamation: International best practices demand that water management plans be included as part of the environmental permitting process before a project even begins. These plans usually indicate where water resources are being supplied from, how much is needed, as well as where waste water will be stored, and how it will be treated and/or disposed. In different parts of the world, water scarcity requires special attention to ensure water resources are not polluted or otherwise removed from the water cycle. The eMalahleni Water Reclamation project in South Africa is a good example of how jurisdictions can collaborate with the mining industry to realize water savings (Rickerson et al. 2012).

a. Mineral Council of Australia. Retrieved from http://www.minerals.org.au/water-accounting-framework-australian-minerals-industry.

CLIMATE-SENSITIVE STANDARDS

Standards provide a critical tool to slow the accelerating hazards of climate change and can provide the framework for implementation of a climate-action plan. They ensure that stakeholders are making fair comparisons when analyzing performance and provide some certainty to investors concerned about the economic and financial risks climate change presents.

Renewable portfolio and energy efficiency standards

Renewable portfolio standards (RPS) are regulatory mandates that support increased production of renewables. Standards set a minimum amount for annual production of RE. In Michigan, USA, the 2016 Clean, Renewable and Efficient Energy Act requires that electric providers increase their supply of renewables from 10 percent in 2015 to 15 percent in 2021, with an interim requirement of 12.5 percent in 2019 and 2020.[4] In the United States, state-level RPS have driven the development of RE.

Public policy support for the integration of RE and greater energy efficiency (EE) has been crucial in reducing the use of diesel in power generation and trucks for transporting it, especially to projects located in remote locations. Jurisdictions can adopt policies that encourage RE integration and EE—a trend toward the incorporation of RE into their operations already seems to have taken hold in the mining industry (Fitch Solutions 2018). Governments could incentivize elements of the RE technology portfolio most appropriate to their physical environment or having the greatest promise given they nation's market dynamics, and facilitate mining companies' incorporation of those technologies. Further, governments can reduce the barriers to entry by pursuing integrated resource planning with respect to their electrical grids, encouraging utilities to accommodate intermittent energy sources onto the grid, and building electricity storage capabilities. For EE, policy efforts could include establishing new mandatory standards, providing financial incentives (such as in South Africa where tax incentives are provided for the application of EE measures [Montmasson-Clair 2017]), and supporting the development of a domestic energy services company sector (see box 2.7).

Planning for mine closure and reclamation

Most mining companies are required to include decommissioning and reclamation plans as part of the permitting and licensing process. However, changing climate conditions may require additional measures at the end of a mines life to ensure that waste products are safely disposed of or stored and that there is reduced chance for subsidence. Climate conditions could also be different at the conclusion of a project, so an updated strategy may be required, particularly

BOX 2.7

Encouraging renewables and energy efficiency in mining: Canada and Chile

Natural Resources Canada has a program that provides funding for companies seeking to implement ISO 50001 energy management systems. This program has successfully incentivized numerous mines to undertake energy management system and generate new partnerships with utilities providers (Natural Resources Canada). For example, New Gold's New Afton mine was highlighted by BC Hydro, the primary power utility in British Columbia, for their implementation of ISO 50001. In recent years, numerous associations and industry coalitions have worked to support mining company efforts to complete direct power purchase agreements with developers and utilities or to integrate on-site RE solutions (BC Hydro 2016).

Chile is an example of a country that has legislated policies that require greater integration of renewable energy (or non-conventional renewable energy; NCRE) into its mining operations. Since having these clean energy policies in place since 2013, NCRE has increased from 4 percent to 14 percent, and it has been led largely by the private sector. The mining industry in the remote Atacama Desert region has integrated solar and wind into their operations, sometimes co-located with diesel generators, successfully reducing carbon emissions, but not addressing persistent high prices. Challenges remain in reducing the cost of renewable energy and connecting the solar resources of the northern grid with the rest of Chile. However, this is a strong example of a situation in which a jurisdiction pushes clean energy policies and the private sector responds.[a]

a. https://www.bloomberg.com/news/features/2018-08-07/these-massive-renewable-energy-projects-are-powering-chilean-mines.

when mine planning for the post-closure landscape requires an understanding of climate nuance and how it impacts vegetation that is best suited to the post closure structure and hydrological regime. Furthermore, with proper planning, former mine sites could provide an opportunity for climate friendly usages, such as pump-storage hydroelectric power generation and wind farms. At the moment, this is a gap in public policy thinking, although there are some examples worth noting as described in the following box 2.8 on climate considerations in mine closure.

Resilient infrastructure standards

Jurisdictions can introduce standards to ensure that new infrastructure and retrofits for projects in extreme environments are built in a manner that ensures stability and safety within a changing environment. For example, the Canadian Standards Association has announced new standards that it is developing in northern Canada, with support from Aboriginal Affairs and Northern Development Canada (AANDC), that identifies the best way to build new infrastructure that is less susceptible to degrading permafrost (Flynn et al. 2018).

BOX 2.8

Climate considerations in mine closure

In the Northwest Territories, **Canada**, government approval is required before mine decommissioning is allowed. This creates an opportunity for regulators to include climate change aspects into closure processes. Companies are required to provide bonds that will be recouped upon the completion of their contract, thus incentivizing compliance. The United States also requires bonds as part of the permitting and licensing processes to ensure some funding is available if a mine is abandoned and needs to be decommissioned. This could be an opportunity to include climate change measures into the process in the U.S. as well. A specific example of where this is happening is in Queensland, Australia, where climate change projections indicate the state is likely to become warmer with less rainfall—and thus less groundwater with a greater frequency of extreme rainfall events. In response, the Queensland government used climate models to develop mine closure rehabilitation criteria—for instance, the model showed that stormwater diversions and banks on recontoured rehabilitated landforms, if constructed to currently accepted mine closure completion criteria, would likely fail within 30 years and with the likelihood of failure steadily increasing thereafter. The use of proactive climate modeling allowed for closure criteria to be sustainable in the face of likely climate realities.

In **Ireland**, the closure of the Lisheen Mine, conducted in cooperation with the Environmental Protection Agency of Ireland and the Tipperary County Council, is often held up as a good example of adopting best practices for mine closure and land reclamation. The closure of the lead and zinc mine after almost two decades of operations featured years of planning to address waste tailings and water disposal while protecting the surrounding area water supply and biodiversity. The mine left behind a 36 MW wind farm for the local community and also led a land rehabilitation effort, a portion of which will become the future site of Ireland's National Bioeconomy Campus. The goal of this government supported project is to "create significant employment opportunities." While this mine closure was not directly motivated by mitigating climate change challenges, it provides an example of multiple climate-sensitive strategies that could be adopted more widely (Lisheen Mine 2016).

BOX 2.9

West African Coastal Areas Management Program

The West African Coastal Areas Management Program (WACA), financed by the World Bank, targets all 17 West African countries, providing access to technical expertise and finance to support resilient infrastructure. The financial package includes a credit of $120 million and a grant of $70 million from the World Bank's International Development Association and a grant of $20.25 million from the Global Environment Facility.[a]

a. West Africa Coastal Areas Management Program (WACA), http://www.worldbank.org/en/programs/west-africa-coastal-areas-management-program.

Similarly, outside of Canada and in developing regions like West Africa, policymakers will have to address and make smart investments in resilient infrastructure to support mining operations in coastal areas. In West Africa coastal erosion and flooding is currently affecting 500,000 people a year, and in some areas the coastline is eroding by 20 meters or more a year.[5] For mining operations in coastal regions, such climate impacts can be devastating. For example the Ensham mine in Queensland, consisted of six thermal coal open pit mines, inclusive of administration, workshop, and workforce accommodation facilities; a coal processing plant; a rail loop; and a train-loading facility. An unprecedented flood from the Theresa Creek and Nogoa River caused a halt in production, $100 million in submerged equipment, destroyed internal haul roads and light vehicle access roads, and evacuated employees—without accounting for the longer term impacts.[6] With rising potential for such climate-related risks, policies that drive resiliency in the construction or retrofitting of infrastructure are becoming more prominent, including in donors' supported operations as shown in box 2.9.

NOTES

1. Note: CRM are external to the benchmark minerals for the purposes of this report but are included at a cursory level due to their growing economic importance and severe supply chain constraints.
2. Cement Sustainability Initiative, https://www.wbcsd.org/Sector-Projects/Cement-Sustainability-Initiative.
3. Teck, https://www.teck.com/news/stories/2019/uniting-thought-leaders-to-tackle-climate-change.
4. Michigan Department of Licensing and Regulatory Affairs, Public Service Commission. Retrieved from https://www.michigan.gov/mpsc/0,4639,7-159-16393---,00.html
5. West Africa Coastal Areas Management Program (WACA). Retrieved from http://www.worldbank.org/en/programs/west-africa-coastal-areas-management-program
6. West Africa Coastal Areas Management Program (WACA). Retrieved from http://www.worldbank.org/en/programs/west-africa-coastal-areas-management-program

3 Regulating Local Content

While not generally considered an industrial policy mechanism, jurisdictions can optimize the ability of the green industrial policies outlined above to generate new green domestic economic value chains by establishing *complementary policies* that incentivize the inclusion of domestic components, labor, or other services (i.e., local content policies) in climate-related capital projects in which mining companies engage. Within the context of these broader policies, like renewable portfolio standards, carbon taxes, and rigorous water management policies, the establishment of smart local content regulations can supercharge the development of, for instance, of a domestic renewable energy industry, and a skilled an knowledgeable water sector work force. Local content policies in this scenario would commit the mining industry, already motivated to invest in projects that would provide it with captive renewable energy, or water treatment plants, to find local contractors and labor that can help them deliver.

That being said, the key to the establishment of local content policies is that they be *smart*. Heavy handed mandates for local content can have the effect of chilling investment in the country, and as such any envisioned beneficial impact on the local economy may never transpire. As such, when a country is considering the establishment of local content policies, a careful balancing exercise must be conducted. Some considerations include:

- **Landed cost of competing components:** Will mandatory local content inclusion increase the costs of supply such that miners decide to forgo a green project altogether?
- **Local skills and education:** is the local workforce sufficiently educated and trained such that contracting with local firms does not pose an undue burden on miners?
- **Incentives:** Local content regulation can often work better when paired with an additional benefit. Brazil's development bank (BNDES), for instance, makes project financing available only after the inclusion of a threshold level of local content.

The options for governments to address local content and employment fall into two categories, demand-side and supply-side. Aspects of each are outlined in the table 3.1 below.

As noted above, there are international examples of these approaches, all of them with mixed results. Box 3.1 describes Chile's approach to local content for green growth. However, based on this report's consideration of the literature, mining jurisdictions do not seem to integrate green growth considerations in their sectoral local value creation and employment strategies, which appears as a missed opportunity.

Nevertheless, local content requirements can be viewed as discriminatory and subject to challenge under the General Agreement on Tariffs and Trade (GATT). In December 2012, the World Trade Organisation (WTO) issued panel report that found that Ontario, Canada's Local Content Requirement scheme for supporting domestic renewable energy producers violates the WTO's non-discrimination principle enshrined in the GATT and the WTO Agreement on Trade-Related Investment Measures (TRIMS).[1] Box 3.2 outlines South Africa's approach to enhancing local content in the mining sector.

TABLE 3.1 Options for increased local content and employment

DEMAND-SIDE POLICY OPTIONS	SUPPLY-SIDE POLICY OPTIONS
• Targeted percentages for local procurement of goods and services • Target list of types of goods and services to be locally sourced • Requirements to provide a local procurement plan • Preferential treatment to local suppliers to the extent feasible • Targeted percentages for local / national workforce participation (including at different levels of management) • Requirements to provide on-the-job training or other skills development • Community development agreements	• Supplier development programs • Building suppliers' networks and facilitating engagements • Providing access to finance • Setting up suppliers' portals • Partnerships / collaboration with technical and vocational institutions • Energy oversupply obligation

Source: IGF 2018.

BOX 3.1

Encouraging local content in Chile

One example of a potential local content green growth best practice can be found in Chile, where the government and academic institutions have partnered with BHP to setup supplier development programs and trainings to strengthen local supplier capacity, encouraging projects that focus on innovative solutions to mining project challenges, such as access to water and energy. As such programs stimulate local capacity development, they create efficiencies and horizontal linkages between industries that benefit future participants. The value of such stimulus includes economic diversification away from reliance on initial extractive operations and economic vitality post mine closure.

Source: IGF 2018.

BOX 3.2

Creation of local value chains in South Africa

South Africa's revised 2017 Mining Charter requires 70 per cent procurement of mining goods and 80 per cent procurement of services from Black Economic Empowerment (BEE) entities. It also requires that 100 per cent of analysis of mineral samples be done by South African-based companies. Policies such as these have been identified as drivers in the development of mining value chains in South Africa, such as platinum group metals used in clean technology (e.g., hydrogen fuel cell catalysts). As forward, backward, and horizontal linkages are developed among local businesses, industrial ecosystems emerge that support further development and innovation, particularly where supported by other sectors such as government or academia. An example of this is South Africa's Northern Cape Manganese Leadership Forum established by mining companies South32, Kumba Iron Ore, and others to form economic clusters of sustainable businesses and services and achieve the desired economic development goals of the region.

Source: IGF 2018.

NOTE

1. Panel Report, Canada—Renewable Energy Measures, WT/DS412/R, WT/DS426/R 19 December 2012 Para 7.26

4 Jurisdictions: Sample Selection

Building off the above identified climate-sensitive policy areas, a short list was developed of jurisdictions that exhibit one or more of these climate leading characteristics. From these, reference jurisdictions were chosen based on a set of criteria, including the presence of climate-sensitive policies/strategies that are being implemented, the risk of water scarcity, the presence of local value creation policies, the investment attractiveness and mineral resource potential, and the presence of one of the five benchmark minerals/metals. A detailed description of the criteria and scoring is presented in appendix A. Ultimately, in order to tie these jurisdictional efforts to previous reports and provide a holistic picture of the sector, the jurisdictions chosen include the development of one of each benchmark metal/mineral (iron ore, copper, gold, aggregate/cement) and one example is devoted to a critical raw material (lithium).

Jurisdictions were evaluated based on their potential for mining and natural resources, their climate-sensitive public policies, and whether they existed in an emerging market. The final assessments—reflected above—are composite scores garnered from a series of open-source evaluation categories such as the jurisdictions risk of water scarcity by 2040 and the jurisdictions emissions reduction policy. These are fully detailed in appendix A. This evaluation process, based on publicly available information and expert and industry consultation, revealed a series of leading jurisdictions. Note that, due to the nexus of Australia's strong policy climate and world-class mineral resources, multiple cases were analyzed, including an analysis of provincial policies covering Queensland and South Australia.

TABLE 4.1 Selection of reference jurisdictions

JURISDICTION	MINING AND RESOURCE POTENTIAL	CLIMATE SMART PUBLIC POLICY	EMERGING MARKET	CUMULATIVE
Chile	4	4	1	9
Australia	4	5	0	9
South Australia	4	5	0	9
Western Australia	4	5	0	9
Queensland Australia	4	5	0	9
Kazakhstan	4	3	1	8
South Africa	4	3	1	8
China	2	4	1	7
Alaska (United States)	4	2	0	6
Mongolia	2	3	1	6
Peru	4	1	1	6
Canada	4	4	0	8
British Columbia (Canada)	2	4	0	6
Indonesia	4	1	1	6
Alberta (Canada)	1	4	0	5

5 Climate-Sensitive Policies in a Select Group of Jurisdictions

AUSTRALIA: WEATHER AND CLIMATE CHANGE FORECASTING AND PLANNING

Australia is one of the most experienced mining jurisdictions globally. Its mining sector represents eight percent of its economic output and 57 percent of its exports and it is the top global producer and reserve holder of iron ore, which has been identified as one of this study's benchmark minerals and metals. Through experience and investment, Australia has, and continues to, address mining sector challenges, including those associated with climate change. Australia is one of the most at-risk countries from a climate perspective, according to Germanwatch, a global climate change research organization. It is within the top third of countries at risk for negative impacts (both economic and social, such as loss of life) from climate change, especially regarding the impact of changing weather patterns.

Temperatures in Australia have been rising. Heat waves are intensifying, and wild fire season is increasingly longer across large parts of the country. Rainfall is changing, with longer dry seasons in the north and increased precipitation in the south, and sea levels are rising while waters are warming. These types of changes create new challenges for various industries, including mining, agriculture, and fishing as well as coastal communities. Specifically, in the mining sector, projects often operate on timelines that are 30 years or less. The potential implication is that, beyond initial work done on project lifespan planning, there is little understanding of weather trends nor is there any incentive to retain information after the project is completed.

For this reason, conducting long-term and ongoing research as well as maintaining databases and responding to public concerns in often changing circumstances is uniquely the provenance of the government. Publicly developed and shared information on climate change trends and forecasts can help all companies and communities to be aware of these issues, without having to invest that capital themselves. Weather and climate forecasting can assist in predicting seasonal trends (such as increased rainfall or water shortages) as well as the frequency and intensity of extreme weather events specific to a location. Ultimately, government efforts along these lines can reduce risk and future costs in supporting a company's ability to plan for scenario's ahead of time, rather than be forced to adjust, at a potentially significant cost (including to reputation) when a situation presents itself later.

The potential green growth impacts from this policy trend includes:

- Water intensive industries can plan to operate when the resource is most available or develop strategies to mitigate water scarcity.
- Mining companies can utilize the information early in the project planning and development process to build infrastructure, such as retaining walls for waste containment and access roads, to the appropriate specifications to limit the potential for operations to be negatively impacted as well as limited impacts on air and water quality.
- Companies can use the tools to better inform their mine closure and land reclamation strategies, not to mention their technical approaches to building retention walls and waste materials pits.
- Support the creation of green jobs in the public or private sector. Government funding of academic and research institutions can also create opportunities for individuals to work and be educated on climate change sciences.

The Australian government recognizes the potential green growth benefits of supporting weather and climate change forecasting and planning. This is clear from its investment of $56.3 million between 2008 and 2018 in the National Climate Change Adaptation Research Facility (NCCARF). The NCCARF provides "comprehensive regional-level data (to the public) that projects future climate change" (Government of Australia 2007). The Australian government also developed an online tool called CoastAdapt (https://coastadapt.com.au/tools) that specifically addresses climate risks in coastal zones and the Climate Related Adaptation from Terrain Evaluation Results (CRATER) which provides "semi-quantitative information" to coal miners and communities that will assist strategic planning to reduce the potential impacts of climate change on operations (Hodgkinson, Grigorescu, and Alehossein 2013). The government further supports the Commonwealth Science and Industrial Research Organization (CSIRO) which works with various Australian government entities and academic institutions to ensure that climate change is included in policy planning at all levels.

Australia's exploration and pursuit of a green economy through initiatives such as its investment in NCCARF appears to be a strategy that will pay off in the long run. According to researchers at CSIRO, Australia's government scientific research agency, the country's brightest economic scenarios were associated with stronger international action on climate change. CSIRO also pointed to particularly positive scenarios assuming the successful deployment, development, and exported technology from Australia's carbon capture and storage sector.

QUEENSLAND: WATER RESOURCE MANAGEMENT

Queensland is the second largest Australian province by land mass– and produces numerous metals and minerals in large quantities. According to a 2017 report, Queensland produced almost 11 percent of global bauxite, 8.4 percent of global lead, 4.4 percent of global zinc, and 3.5 percent of total global silver production (Government of Queensland 2017). As well, the province holds significant copper reserves, producing 1.3 percent of total copper production in the same time period—but only accounting for one-third of total Australian production, such is the dominance of Western Australia on the global marketplace (Government of Queensland 2017). All of this makes Queensland the most populous Australian province that holds significant mineral production capabilities on the continent—making it a prime location for examining climate-sensitive policies at the provincial level.

Water scarcity is an increasingly significant challenge for operators in the mining sector. The critical need for access to potable water by communities as well as its essential role in many mining sector operations necessitates special consideration by all stakeholders. Similar to weather and climate change forecasting and planning, improving the collection, retention, and dissemination of water access trends as well as sharing leading practices for mitigation and adaptation should fall within the responsibility of governments. That said, a key difference is that forecasting weather patterns and extreme climate events often entails a large regional focus, while addressing water resource issues tend to require a more local and community based approach.

Mining companies usually establish water access and management plans before they begin operations, but, again, these projects are only for a certain, limited period of time. Unless regulations and policies are in place, there is no immediate economic incentive for industry to consider water needs after its operations have ceased. Public policy that requires the sharing of information on leading water management practices could broadly protect water resources in the medium-term, and also supports the building of social acceptance of the trade-off between economic development and access to water.

The potential green growth impacts from this policy trend includes:

- Proper planning can allow for sufficient water resources to be shared by all entities and best practices can be followed to protect its quality.
- Adopted conservation and protection efforts in water scarce regions ensure resources are not depleted too precipitously and that proper procedures are followed to allow access by multiple users.
- Mining companies can reduce costs and increase project efficiencies by utilizing existing information on previous water management issues in a specific location as well as benefiting from local community experiences and knowledge.

To address the challenges from water scarcity in the mining sector, the Australian government, the University of Queensland, and the Minerals Council of Australia (MCA) industry association coordinated to develop the Water Accounting Framework that would apply specifically to water accounting in the mining and metals industry. Adopted in 2011, after 6 years of development, the framework is a repository of data and information on water resource issues throughout the country as well as best practices for measuring, monitoring, and reporting on water use (ground water, surface water, and sea water).[1] Previously, mining companies developed their own processes and standards, but now all MCA industry members abide by the same standard procedures. BHP Billiton, for instance specifically references its compliance with the Water Accounting Framework in its annual Water Report. It is in part due to Queensland's concerted effort to monitor and ensure water health that BHP, along with peers such as AngloAmerican and Glencore, joined the government and other partners in the Fitzroy Partnership for River Health, which releases annual report cards on the health of the Fitzroy River Basin.[2] The report cards track whether current water management strategies are proving successful in maintaining the health of the entire ecosystem.

The government of Queensland, Australia also relies on the independent Office of Groundwater Impact Assessments (OGIA) to regulate water usage by the mining industry in its province, especially regarding Cumulative Management Areas (CMA), which means there are multiple entities utilizing water from the same source. Through coordination with industry, local communities and other stakeholder government agencies, OGIA develops an Underground Water Impacts Report (UWIR) that includes a prediction of impacts on water levels in aquifers, a water monitoring program, a spring impact management strategy, and assigns responsibilities to individual resource tenure holders to undertake water management activities in the area. The UWIR is then released to the public for comment before being finalized.[3]

These efforts dovetail nicely with Queensland's stated objective to develop the jobs and skills necessary to create a sustainable water sector over the next 30 years. Specifically, the Queensland Government published a 30-year water sector strategy in 2014, in which the fifth strategic priority is to develop a skilled labor force to "respond to the challenges of the future, deliver services and secure economies of scale" (Government of Queensland 2014). The priority includes among other activities creating competency frameworks for water sector professionals and developing business skill programs.

SOUTH AUSTRALIA: FACILITATING GRID INTEGRATION OF RENEWABLE ENERGY

The South Australia mining sector contributes over three percent to the provinces GDP and includes production of copper, gold, and iron. While the sector does not make up a large portion of the provincial economy, it does represent a potential opportunity for public officials that are focusing on improving economic growth, reducing unemployment, and could be combined with another targeted growth area, supporting renewable energy integration and industry development.

The mining sector often requires large amounts of energy. This can be a challenge, especially when mining projects are in remote areas. The solution is often transporting in heavy fuel oil, like diesel, to run generators. While the cost of this fuel is expensive and getting it to the project site can be logistically challenging, the mining industry must pursue these measures because there are limited other economically feasible options to obtain reliable energy for its operations.

Public policy and support for integrating renewable energy onto the grid can help mitigate the costs to industry and reduce the dependency on hydrocarbons. Eliminating hydrocarbons completely in many cases, at least initially, may be unrealistic—due to the variability of energy production and the increased operational cost to the grid of integrating unpredictable supply—but power sector policies that introduce cleaner energy sources, support mining sector efforts to reduce costs, and maintain operational capabilities can meet multiple green growth objectives. Furthermore, smart public policies combined with recent innovations in battery storage technology, could provide even greater green growth benefits, reducing emissions and providing reliable electricity. Another opportunity for green growth includes the potential to leverage innovative clean energy solutions to develop local training and technical skills to manage and service the systems once completed.

In 2016, for instance, South Australia was experiencing recurring power outages due to over extension of the grid. The government, responding to a challenge from Tesla CEO Elon Musk, pursued an approach that would solve its power sector issues in a sustainable manner. The province contracted Tesla to build a 100 MW battery that would provide 129 MWh to 30,000 homes for 8 hours or 60,000 homes for 6 hours. The project, which was completed in 2017 for $50 million, was activated just in time for the energy intensive summer season (Tesla 2017). It stores energy from the Hornsdale Wind Farm and provides generation to the region during peak times, reduces variability and helped solve the regions power shortages. The implications for the mining sector are manifold—especially in terms of securing access to low cost clean energy over the long term. With South Australia making such a commitment to energy storage, it has increased its capacity to sustain more variable generation clean energy technology onto its grid. A concerted approach to increase grid-connected energy storage can potentially enable mining operations to make investments in wind or solar either through direct on-site installation or through the execution of direct power purchase agreements with off-site grid-connected plants. In the on-site example, the mine might be incentivized to sell excess energy to the grid, and the grid that much more capable of handling the intermittency of that supply. In the off-site example, the mine operator can invest in a very large plant with the *intent* of selling excess supply to the grid.

Other provinces have contracted or are seeking battery storage to support power supply in their jurisdictions. For example, the Australian Renewable Energy Agency (ARENA) is co-funding a similar project in Victoria, except instead of wind power, it is storing and balancing solar.[4] Other companies are

starting to compete with Tesla to build these large lithium batteries and bringing low carbon solutions to energy challenges in Australia and around the world.

One example of where South Australia's commitment to energy storage as a technology has contributed to the development of its economy and creation of local value includes the subsidies the government announced for home battery systems in September 2018. After investing more than AU$71 million in battery system subsidies—at about AU$6,000 a customer—German company Sonnen announced Australia as the "world's biggest market" to-be, and its plans to set up an energy storage manufacturing facility in the province, creating 430 new green jobs.[5] A greater commitment to batteries/energy storage can lead to a country being able to integrate more renewables—a space that the mining industry is increasingly relying on to reduce their climate footprint.

CHILE: RENEWABLE ENERGY DEVELOPMENT

Chile is the largest copper producing country in the world and holds the largest reserves. Copper is a benchmark metal for this project because global demand for copper is unlikely to decrease as it makes up a major component of power sector infrastructure and energy demand is growing, especially in the emerging economies. Chile ranks seventh on the Fraser Institute Annual Survey of Mining companies with attractive investment environments and mineral resource potential. The copper industry is very energy intensive, and the cost and access of electricity are major challenges to mining companies operating in the remote regions of northern Chile.

National policies that aim to support the integration of renewable energy into the grid and ease the ability of companies to access their own off-grid energy supplies can play a role in spurring green growth and facilitating cleaner more efficient industrial operations, including in the mining sector. Governments must help facilitate this transition, including with incentives, to help utilities and power sector entities adjust to variable and intermittent renewable energy resources. This also includes strategy planning and targeted efforts to build out transmission and other necessary infrastructure development as well as regulatory support. These efforts could help create the framework and provide more opportunities for renewable energy producers.

Renewable energy can help mining companies reduce high priced diesel energy costs while adopting the more energy intensive efforts of extracting lower grade ore. In some places, electricity prices for off-grid renewables could still remain high and the lack of connectivity to the main grid may reduce the incentive of new renewable projects due to limited potential for off-takers.

Governments could augment their support for renewable energy development by encouraging local clean energy sector labor development. Efforts in support of this green industrial growth could be pursued through domestic training programs and targeted financial support. Furthermore, renewable energy could generate follow-on local value creation from domestic support services to setup, maintain, and operate equipment.

Chile has a long mining history and large ongoing mining operations. These major operations, especially in the northern Atacama Desert region, are in remote and challenging locations, especially when it comes to accessing affordable electricity. In 2013, the Chilean government signed into law a bill which mandated that utilities source 20 percent of their electricity from

"non-conventional" renewable energy (NCRE) by 2025 (SolarServer Global Solar Industry Website 2013). The law called for the creation of an annual bidding process for utilities to purchase electricity from NCRE sources and attempted to reduce estimated permitting time significantly. By 2017, NCRE and renewables accounted for 15 percent of Chile's total energy (ACERA 2017). Encouraged by the government and seeking a way to reduce costs from diesel power generation, many mining companies in the north have begun to source significant amounts of their power needs from new renewable energy projects through direct take-or-pay power purchase agreements or built their own.

For example, Codelco's Gabriela Mistral project receives almost 100 percent of its power from the large Pampa Elvira solar project, 2,620 solar panels that generates 54,000 MWh of energy a year.[6] Another example is Minera Los Pelambres, a subsidiary of Antofagasta Minerals, which sources 20 percent of its power needs from the 115 MW El Arrayán wind power plant and a co-located natural gas or diesel generation. Under the power purchase agreement, the remaining power is sold into the Chilean spot market.[7] The next step is connecting the north to the rest of the country with an 1,865-mile transmission line that has been announced by the government.

The economic boost Chile has been able to generate by prioritizing and crafting policies that support the development of the renewable energy sector has been well founded based on economic analyses the government has commissioned. Specifically, the Natural Resources Defense Council (NRDC) in partnership with the Chilean Renewable Energy association published a study titled "The Economic Benefits of Non-Conventional Renewable Energy in Chile" in which they found that over the next 15 years, a future with greater renewables deployment would add an incremental $1.6 billion to the Chilean economy and 7,769 more jobs than the baseline scenario (NRDC and ACERA 2013). In terms of the implications for the mining industry, Marcelo Mena-Carrasco, the Minister of the Environment in Chile published an Op-Ed in 2017 in which he indicated new mines are installed with *at least* 40 percent of their electricity needs provided through solar or wind energy contracts (Mena-Carrasco 2017).

SOUTH AFRICA: WASTE WATER TREATMENT

South Africa is an emerging economy with significant gold resources. It is the sixth largest global producer of gold and holds the second largest amount of reserves. Mining and minerals make up eight percent of GDP (2017) and gold accounts for more than one third of exports. With an already established resource base and mining sector, ranked within the top third of the Fraser Institute Annual Survey of Mining companies with attractive investment environments, and estimated reserves worth $2.5 trillion, the mining sector will continue to play a role in South Africa for many years to come (Bodley et al. 2013). South Africa also ranks high for risk of water scarcity and will need to manage its resources effectively while simultaneously seeking investment into its mining sector.

South Africa

As water scarcity in many global locations increasingly impacts the feasibility of mining projects and existing/growing demand

continues from other industries and communities, governments must adopt policies that balance these competing priorities. Government policy can play a role in mandating water management planning and encouraging the adoption of technologies and techniques that ensure sufficient resources are available and reduce the amount of water needed in the mining process. Public policy can also play a role in processing water for usage that would otherwise be disposed of or removed from the water cycle.

Treating waste water maximizes resources for usage in the mining process, and bolsters the social acceptance of mining operations by lessening the negative impacts of competition for resources. Potential green growth impacts can be realized by cost savings for Companies that reuse their processed waste water for operations. Furthermore, waste water treatment processes can produce byproducts that can potentially be used in other industries, such as construction, and agriculture, as well as households.

When Anglo American closed a South African coal mine in 2008, it faced a large number of legislative requirements in order to ensure the sustainability of local water resources as set by the Department of Mineral Resources (DMR). To comply with these regulations, after completing operations, Anglo American set up a reclamation plant in South Africa that uses a High Recovery Precipitating Reverse Osmosis process to produce potable water from contaminated mine water. In close collaboration with DMR and other South African government entities, the project includes the creation of overlapping quality control and management processes to provide fresh drinkable water to thousands of people.

The waste water treatment facility successfully recycles polluted water and reduces the communities need to extract scarce fresh water from underground formations. This reduces stress on the naturally existing fresh water and allows for more sustainable water resource management.

Building off this effort, the South African Minister of the Department of Water Affairs signed up to the World Economic Forum's Water Resources Group 2030. This initiative brings together Coca-Cola, Eskom, Nestle, South African Breweries, Sasol and to set-up a Strategic Water Partnership Network (Department of Water Affairs, South Africa and The 2030 Water Resources Group 2014). This initiative has consists of public-private teams that develop and support water strategies for South Africa's water security.

The eMalahleni Water Reclamation project now successfully provides water to the municipal reserve for 60,000 people and has reduced the percentage of people without access to potable water from 14 to 2 percent. The public-private team that developed the project sought to provide local value creation throughout the process. 700 temporary jobs were created during the construction of the plant (two-thirds of those were local) and 57 permanent employees now staff the facility (almost all local). Furthermore, the waste product from the reclamation process has been used to produce gypsum-based solid bricks to support the building of affordable housing nearby. This created opportunities for community-based enterprises to be established to manufacture and sell these products (Rickerson et al. 2012).

This project has received international attention and is held up as a best practices in ensuring water sustainability and supporting mineral resource development. It is unclear if smaller mining companies could provide the required capital expenditure to develop similar projects, but it underscores the need to consider sustainability during mine closure and work collaboratively with all stakeholders to identify the best path forward.

BRITISH COLUMBIA AND ALBERTA: CARBON PRICING

British Columbia and Alberta are both significant producers of aggregates and concrete. This industry contributes more than $8 billion in annual sales and over 27,000 direct and indirect jobs to the two-provinces economy.[8] As discussed above, cement processes also contribute large amounts of CO_2 into the atmosphere. In Alberta, the minerals sector directly employs approximately 10,000 people. Its sand and gravel production is $289 million.[9] In British Columbia, it's copper production is close to $2 billion and its aggregates bring in over $350 million.[10] In 2008 British Columbia established North America's first carbon tax that applies to the purchase and use of fossil fuels and covers approximately 70 percent of provincial greenhouse gas emissions.[11]

Governments have adopted carbon pricing regimes to encourages reduced emissions and climate impacts by charging entities that emit carbon dioxide. Without public policy, there is little financial incentive for a company to adopt technologies and techniques that reduce the emission of carbon into the atmosphere from industrial processes. These policies must be balanced to ensure domestic industries are not put at a competitive disadvantage.

The establishment of carbon pricing regimes can support green growth impacts in a couple of key ways:

- Support clean energy technology development to help industry reduce costs of penalties under the regime.
- Governments can reinvesting revenue collected from industry in clean industry, climate education, and support for clean energy technology development.

In 2008, British Columbia was the first province in Canada, and the first large government entity in North America, to introduce a broad-based carbon tax. Over the first 7 years since implementation, the tax reduced net emissions by nearly 5 percent while the province's GDP grew by more than 17 percent.[12]

Despite the GDP growth and the successful GHG emission reduction, the government recently revised the pricing strategy out of concern that it would drive up the cost of goods and undercut provincial company competitiveness. The price in British Columbia is set to increase by $5 per ton until 2021, however, portions of the revenues from this increase will be redistributed to assist companies with competitiveness issues and assure good and service affordability.[13] This demonstrates the high-wire calculus that municipalities and governments must engage in when implementing such measures. In order to dramatically reduce carbon emissions with a tax companies who emit large quantities of GHG, a balance must be struck.

Part of this balance involves weighing the possible revenue generated from carbon pricing against the cost of taxing local or provincial businesses. For example, under the Alberta Climate Leadership Plan (CLP), carbon revenues, managed by the Climate Change and Emissions Management Corporations' Emissions Reduction Alberta, carbon price generated revenues are invested in support of the development of climate-friendly technologies, such as renewable

energy and energy efficiency, low carbon research and development, support for climate change programming inside government, and to foster the creation of GHG inventories and adaptation measures.[14] This demonstrates the province's effort to mitigate the possible negative local economic development externalities associated with taxing businesses.

Alberta's pricing strategy accounts for distributing revenue from carbon levies to a variety of initiatives. To prevent carbon costs from being passed directly onto the consumer, Alberta's strategy includes a rebate to households. According to the CLP, over the next 3 years, $5.3 billion, including from carbon revenues, will go toward carbon levy rebates to offset costs associated with the carbon levy ($1.6 billion), to support Alberta's transition away from coal-generated electricity and to cap electricity prices ($680 million), to support energy efficiency projects ($662 million), to support climate leadership initiatives in Indigenous communities ($145 million), funding to support greater public use of transit ($1.3 billion), to support innovation and technology development ($521 million), for climate programming across government ($386 million), and tax relief to businesses ($632 million). Specifically, the CLP tracks domestic employment and skills supported by its investments. Its 2016–17 Progress Report identified 2,790 jobs that were supported by their efforts. As a region with significant coal mining, operating within a national framework committed to phasing out coal-fired electricity by 2030, the CLP seeks to replace this with renewable energy and natural gas development (Government of Alberta 2018).

CRITICAL RAW MATERIALS: LITHIUM IN AUSTRALIA AND BOLIVIA

The future of clean energy and advanced, rechargeable technology is inexorably tied to battery technology. Without batteries, solar power cannot be stored long term, cell phones cannot operate, mini-grids become less viable, and cars may cease to function. Battery and energy storage technology represents the path forward for much of today's most advanced and cleanest technology.

Due to its unique chemical properties, energy density by weight, and ability to conduct an electric charge, lithium is currently—and is projected to remain until at least 2030—a key ingredient in rechargeable battery technology. Australia is currently the largest producer of lithium, together responsible for approximately 50 percent of total global production; and to fully contextualize the potential economic implications of future lithium production for the continent, consider that Macquarie Research has predicted global demand will increase by at a compound rate of 18 percent approximately over the next decade, and that Western Australia alone stands to gain 93,000 jobs and add $56 billion to its GDP by 2025 if it expands lithium and the new energy metals sector beyond just exports (Hastie 2018).

Australia holds approximately 13,000,000 ton in reserve.[15] By comparison, Bolivia has the largest reserves of lithium in the world, holding approximately 39,000,000 tonnes of lithium brine embedded in the Uyuni Salt Flats, and mine infrastructure development is only recently underway.[16] This ostensible Bolivian productive potential represents an opportunity to compare the existing policies of a country with a well-developed enabling environment and historically strong lithium production and a country that has the potential to be one of the top lithium producers of the future in an effort to guide those countries that are not yet strong lithium producers towards climate and development-smart policies.

The role of policy is integral to successfully developing new lithium production as the cornerstone to a local resilient economy. Jurisdictions utilize different extraction approaches (determined by the type of lithium mineralogy) that present different climate challenges. Australia, the current leading global producer of the metal, relies on hard rock extraction that requires blasting, drilling, and other energy-intensive processes to separate lithium from the ore body. Bolivia, Argentina, and Chile, forming what is known as the "Lithium Triangle," by contrast are often only able to rely on brine extraction. This process relies on natural evaporation but requires large pools of lithium brine, precise weather conditions, and an extended time period to produce processable lithium. The brine process also require large quantities of water compared to hard rock mining, straining infrastructure in an already water-stressed environment—a common concern in all four of the selected jurisdictions.

Despite their disparate extraction activities—energy efficient policies in Australia may not translate to lithium mining processes that are extremely energy efficient—there are areas where the policies of proven lithium producers could positively influence the lithium mining countries that are yet to reach peak production. Notably, the water-intensive brine extraction process in countries such as Bolivia which lack a comprehensive water management policy—especially one that engages the mining industry—could benefit from Australia's water management policies and regulations. Western Australia in particular—the heart of Australia's lithium production—has a water management policy crafted explicitly to outline how to comply with water management regulations for the mining sector and is "primarily applicable to new projects." The policy illustrates how mining companies must manage and mitigate water risk while setting specific input and output targets (see box 5.1). This type of government policy, applied across Bolivia or exclusively in those jurisdictions (as it is in Western Australia) that have a strong nexus between water stress and substantial mining activity, could positively shape the entire lithium industry in these countries for decades to come.

This approach would also present a strong case for foreign investment and local value creation. Water is among the chief concerns of both mining companies and the jurisdictions where they operate and there are numerous cases where countries have forcibly shut down mining operations that fail to preserve and protect water resources. Bolivia has an opportunity to mitigate perhaps the top risk to the revenue generated by their own lithium mining operations, the communities that surround them, and the climate at large by adopting strong water management policies like those found in Australia. This not only creates a stable investment environment for companies but contributes to the local economy by preserving a job and tax revenue generating operation in a climate-sensitive manner.

BOX 5.1

Western Australia guides its miners through water management

What stands out about Western Australia's (WA) approach to water management is its execution. WA, which has experienced a 90 percent reduction in water inflows between 2010 and 2016, is a notoriously water-stressed region. Having experienced droughts in the region throughout its history, WA has an impressive landscape of water use policies—but in 2013 it got serious about the mining industry, which represents nearly 30 percent of its economy. Noting mining's reliance on water, and its own reliance on mining, WA published guidelines that applied specifically to the sector, which provided a roadmap of sorts of how to navigate the water use policy environment, and ultimately obtain a water license. The guidelines cover the following elements and others, structured in attempt to explain how to obtain a license:

- Exploration for water resources
- Environmental policy
- Water quality
- Cultural policy
- Dewatering and surplus water management
- Mine site operations and closure
- Water use optimization
- Fractured rock resources

Source: Government of Western Australia.

NOTES

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6 Conclusion

Developed and developing economies alike are struggling to find agreement on how to address the challenges presented by climate change. Within their borders, their decision-making is buffeted by entrenched economic interests and a perceived tension between economic growth and climate imperatives. Internationally, a country's climate strategy must be compatible with a new global economic paradigm—featuring governments brokering, scrapping, and rewriting international trade agreements on an unprecedented scale, with the aim of protecting their economic self-interest. This nexus between local and global economic interests and the rising criticality of the climate challenge confronting nations highlights the challenge presented to the world's policymakers to craft a new green industrial policy—one that fosters an economy that can take advantage of emerging climate-related opportunities just as readily as it can respond to emerging climate risks.

It is within this context that this report takes up the mining sector. Given the industry's reputation for cautious investing in response to volatile commodity prices, the mining sector may seem like an imperfect vantage point from which to view the implications of the laws, regulations, and incentives that governments are promulgating in an effort to build a green economy. However, as the supplier for many of the critical inputs for tomorrow's technologies, and with high operating costs that require innovative technology and process reengineering to gain efficiencies, mining, already a traditional driver of economic development globally, is poised to modify its production processes to operate in a new green economy.

Much has been written, in this series of reports and elsewhere, on existing and emerging climate-sensitive innovations in the mining industry: rapid acceleration of adoption of renewable energy sources, increasing automation and electrification, elimination of net water use. What this report strives to demonstrate is the need for a stable and predictable green industrial policy from host countries to enable development and expansion of these technologies. Mining is a high-risk, capital intensive business. While considerable ambition and potential for low-carbon development exists within the commercial mining sector, shareholders of mining companies globally require a demonstrably

prudent investment in climate-sensitive infrastructure. Mineral-rich nations and sub-national jurisdictions play a critical role in signaling to the market that they are open for responsible mineral development by providing the stability and predictability required both for companies looking to invest and to the local communities expected to host (and bear a significant share of the risk from) mineral development projects.

Fortunately, the trends described in this report suggest that governments could design a smart and stable policy framework that incentivizes the mining industry—and other sectors—to invest in climate-sensitive technology, processes, and infrastructure that will not only help achieve climate goals, but will add new green value chains to a country's economy that will allow for sustainable growth over the long term. While the evidence thus far does not yet show that policy-makers design their climate agenda with an explicit objective of generating new industries or green value chains—nor does it show that the mining industry or any other sector makes climate-sensitive investments with the expectation of delivering local value—there does appear to be considerable value in linking the two ambitions. This report has offered examples of where energy and water-related policies can drive mining innovations that drive long term economic rewards. It has also shown that there are other areas that may result in the same benefit, such as export restrictions and investments in data infrastructure. Moreover, there are climate-sensitive policies that put the onus on governments themselves to make investments in areas that are crucial to mining operations, such as coastal infrastructure—which can lead to further sustainability in the sector and continuation of the economic rewards that mining provides.

Despite these potential economic benefits of climate-sensitive policy-making, in many cases the local benefits or economic impacts are not so clear. There will be clear tradeoffs as jurisdictions struggle to calculate the true impact of their decisions. These discussions are not simple and there is not a bright line that highlights policies that are both climate-sensitive and development-smart. There is still progress to be made in this arena, but the jurisdictions outlined in this report demonstrate that it is possible to successfully engage in climate-sensitive policy creation while retaining—or increasing—the ability of companies to drive local economic development. What is certain is the criticality of host countries being able to drive the type of development they require in order to respond to climate change and to compete within a rapidly changing global economy.

Appendix A Selection of Sample Jurisdictions

Table A.1 contains the detailed scoring of each criteria. Table A.2 lists and describes the criteria applied to select the sample jurisdiction for in-depths analysis.

TABLE A.1 Jurisdictions scoring

	MINING AND RESOURCE POTENTIAL		CLIMATE SMART POLICY			EMERGING MARKET	
	BEST PRACTICES/ MINERAL POTENTIAL 2017	BENCHMARK METAL/ MINERAL (NOT INCLUDING AGGREGATE, RARE EARTH, COBALT, OR LITHIUM)	RISK OF WATER SCARCITY BY 2040	EMISSIONS REDUCTION POLICY	EXAMPLES OF MINING SECTOR LVC	EMERGING MARKET	
	SCALE						
COUNTRY	0 (MIN)–2(MAX)	0 (MIN)–2(MAX)	0 (MIN)–2(MAX)	0 (MIN)–2(MAX)	0 (MIN)–1(MAX)	0 (DEVELOPED)-1(EMERGING AND DEVELOPING)	CUMULATIVE SCORE (MAX: 9)
Chile	2	2	2	1	1	1	9
Australia	2	2	2	2	1	0	9
Queensland (Australia)	2	2	2	2	1	0	9
Western Australia	2	2	2	2	1	0	9
Kazakhstan	2	2	2	0	1	1	8
South Africa	2	2	1	1	1	1	8
China	0	2	2	1	1	1	7
Alaska (United States)	2	2	2	0	0	0	6
Mongolia	1	1	2	0	1	1	6
Peru	2	2	1	0	0	1	6
Canada	2	2	1	2	1	0	8
British Columbia (Canada)	0	2	1	2	1	0	6
Indonesia	2	2	1	0	0	1	6
Alberta (Canada)	0	1	1	2	1	0	5

Note: LVC = Local Value Creation.

TABLE A.2 Jurisdictions selection criteria

CATEGORY	DESCRIPTION	SOURCE
Best practices/ mineral potential 2017	This category scores jurisdictions based on where they are on the Frasier Institute Annual Survey of Mining Companies 2017 Best Practices and Mineral Potential list; this list scores on both attractiveness of regulatory regime as well as resource potential; 0–2, with 0 = within the bottom third of the list and 2 = within the top third	Fraser Institute Annual Survey of Mining Companies 2017; Best Practices and Mineral Potential (out of 91 jurisdictions ranked)
Benchmark metal/ mineral	This category is based on a jurisdictions resource potential, with scores going to jurisdictions (usually countries) that are within the top 20 of global producers and/or reserves of benchmark minerals/metals (gold, copper, and iron ore), but does not include aggregate/cement or critical raw materials; subnational jurisdictions are scored high if a significant amount of their revenue is generated from the development of a benchmark mineral/metal; 0–2, with 0 = none and 2 = two or more	USGS 2019 and Gold Hub 2019
Risk of water scarcity by 2040	This category scores jurisdictions based on the risk of water scarcity by 2040, in a business as usual ranking by WRI; Most countries have water management policies/laws that are included in the permitting/licensing process, however, when searching for jurisdictions that have adopted best climate-sensitive practices, it seemed prudent to identify those most at risk for future water scarcity; 0–2, with 0 = not at risk and 2 = within top third of countries ranked;	Risk of Water Scarcity (WRI 2015) by 2040, business as usual (BAU) scenario
Emissions reduction policy	This category scores jurisdictions on whether they have clear and active emissions reduction policies in place, including carbon pricing regimes; 0–2, with 0 = no or not robust, and 2 being yes with carbon pricing	Carbon Pricing Policies (ICMM 2013, Cost of Carbon Pricing)
Examples of mining sector LVC	This category scores jurisdictions on the presence of mining sector local compensation plans that largely focus on supporting value creation locally or nationally (for example, this does not award points to jurisdictions solely based on mandating equity stake in projects or requiring joint ventures with foreign mining companies); 0–1, with 0 = no and 1 = yes	Local Content Policies (IGF July 2018); desktop research
Emerging market	This category scores jurisdictions based on IMF economic rankings; 0–1, 0 = developed countries and 1 = emerging markets	Advanced Economy/Emerging Market and Developing: IMF World Economic Outlook, April 2017

Note: ICMM = International Council on Mining and Minerals; IMF = International Monetary Fund; LVC = Local Value Creation; WRI = World Resources Institute.

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green press INITIATIVE

The green economy entails an approach by nations to adopt economic policies designed to develop climate-sensitive industrial sectors that can drive long-run sustainable economic growth. Any meaningful transition to a new green economy will require the mining sector as a central stakeholder. This is in part due to the significance of the minerals sector to the overall global economy. Minerals make up and will continue to make up the fundamental building blocks of the global economy. This report provides an overview of the policies of countries leading the shift toward a green economy, and the implications of those policies for the mining sector in those countries.

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