POLICY DIALOGUE ON NATURAL RESOURCE-BASED DEVELOPMENT

WORK STREAM 1: SHARED VALUE CREATION AND LOCAL DEVELOPMENT

"HOW TO" EXAMPLES FOR THE ON-LINE COMPENDIUM OF PRACTICES

This document contains draft versions of three examples that are intended to be included in the Compendium of Practices to support the implementation of the guidance document on Collaborative Strategies for In-Country Shared Value Creation: Framework for Extractive Projects.

The examples are submitted for discussion and possible validation during Session 4 of the Eighth Plenary Meeting of the Policy Dialogue on Natural Resource-based Development on 16 June 2017.

The Compendium of Practices is an online living tool, and will be continuously updated with new examples as they are developed and validated.

EXAMPLE 1

HOW CAN SOLAR ENERGY SUPPORT MORE EFFICIENT ENHANCED OIL RECOVERY?

Framework Step:

STEP 4 – Support and contribute to innovation leading to new products and services

4. B *What can extractives industries do?*

- Leverage extractives sector operations to increase use of renewable energy, as appropriate. This could be done for example by either linking production to renewable energy (e.g. making use of solar and wind power to reduce the contribution of fossil fuels and green-house gases to mineral and oil & gas production, while reducing high electricity costs associated with the use of decentralised diesel generators) or by developing green supply chains (e.g. mining rare earths and supporting local manufacturing of magnets for wind turbines to provide clean energy or mining lithium to manufacture electric batteries for incorporation into green products).
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Tags: *In addition to the Framework step(s) that they fall under, examples will also be tagged by crosscutting issues. Please select all applicable tags.*

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☐ local supplier participation and development, including SMEs
☐ marginalised groups (women, indigenous people)
☐ skills development and upgrading
☐ access to credit
X shared infrastructure (transport, water, power)
☐ technology transfer
X innovation
X economic diversification
☐ Other: _____

Problem Statement:

Petroleum Development Oman uses natural gas in Enhanced Oil Recovery (EOR) to heat water into steam, which is then pumped into oil wells in order to increase the viscosity of heavy oil and increase production. However, this relies on substantial quantities of natural gas – EOR accounts for more than 20% of the country's natural gas use, an amount that will grow as EOR is increasingly relied upon to keep oil production up. At the same time, there is also increased domestic demand for natural gas for power generation, desalination and industrial applications to support the diversification of the economy.

Parties Involved:

- Oman Ministry of Oil and Gas
- Petroleum Development Oman (PDO) (Government of Oman (60%), the Shell Group (34%), Total (4%) and Partex (2%)
- GlassPoint (a solar energy company)

Common ground:

PDO wanted to find a more economical means of Enhanced Oil Recovery (EOR) that would free up natural gas to be used in other sectors of the economy, such as power generation and industrial applications, in line with the priorities set out by the government of Oman.

Actions taken*:*

PDO partnered with GlassPoint, a California-based company, to develop a thermal solar-based EOR solution. Thermal solar projects harness the sun's heat, using it to transform water into steam that can be used in EOR to increase oil production. GlassPoint's approach consists of parabolic troughs that concentrate sunlight to heat up metal tubs containing water, converting it to steam. The troughs are situated in large glasshouse structures, to protect them from the elements. The steam is then injected into mature oil fields to heat heavy oil and allow its extraction. The glasshouse structures protect the thermal solar systems from the elements, allowing them to be lighter and simpler in construction, and consequently cheaper. Because sand and dust building up on the outside of the structures has a negative impact on solar intensity, an automatic cleaning system washes the buildings overnight with water, while they are non-operational. Most of the water is captured and reused. This is especially important considering Oman's arid environment.

PDO and GlassPoint's pilot project in Amal entered operation in December 2012. Generating 7 megawatts of thermal energy (MWth), which is converted into 50 tons of emissions-free steam per day, the project came in on time and on budget, and has exceeded performance targets. Production at the Amal field has increased to nearly record levels.

Based on the success of the pilot project, construction began in 2015 on the Miraah project. The PDO funded Miraah has a cost of 600 million USD and is 100 times larger than the pilot project, rated at 1,021 MWth, one the largest solar plant on the planet. Spread out over a total of 36 glasshouses, the buildings are being constructed sequentially in clusters of four over a three square kilometre area. The project enters steam production in 2017, with progressively more steam units coming online. According to GlassPoint, the vast majority of the materials for the project are being sourced locally, and construction is being handled by local firms. Omani engineers are thus also getting experience in constructing solar powered EOR plants, and with solar projects more broadly.

Obstacles:

- Thermal solar-based EOR is an emerging technology, and while the pilot project was successful, it may be challenging to increase the scale 100 fold.
- The innovative nature of the technology may also create challenges for local construction firms and material suppliers, who need to develop proficiency with new techniques.

Enabling factors:

- The State General Reserve Fund (SGRF), Oman's largest sovereign wealth fund administered by the Ministry of Finance, is a major shareholder in GlassPoint. In 2014, SGRF led a US$53 million investment in GlassPoint along with Royal Dutch Shell and other investors to accelerate the deployment of solar EOR in Oman and throughout the region.
- The pilot project feeds its steam directly into the existing EOR steam infrastructure at the Amal West oil field. The ability to integrate the project directly into the existing conventional system saved time and money. The Miraah project is also being directly integrated into the existing system.

Lessons Learned:

- This is a real world example of a cost-effective application of solar technology that reduces emissions from the production of heavy oil and frees natural gas to be used in other applications.
- It accomplishes multiple goals: extracting oil in a more energy efficient manner, allowing natural gas to support the diversification of the economy, and developing local expertise in a new technology that has broad regional and global applications across the oil sector.
- The business case for the technology is partially due to Oman's geography – a high degree of solar radiation year-round means that substantial amounts of steam can be generated.

EXAMPLE 2

HOW CAN MINING CATALYSE THE DEPLOYMENT OF OFF-GRID SOLAR ENERGY?

Framework Step:

STEP 1 - Adopt a comprehensive long-term vision and implementation strategy to build competitive and diversified economies and create in-country shared value out of natural resources.

1 A. *What can host governments do:*

- Develop sustainable options for energy production and consumption, also assessing trade-offs and combined use of renewable and non-renewable resources.

STEP 3 – Unlocking opportunities for in-country shared value creation

3.2 Shared infrastructure

3.2.1 Shared power

3.2.1.B *What can extractives industries do?*

Where there is no grid or the grid is too remote so that grid-supplied electricity is more expensive or excessively unreliable compared with self-supply:

- Develop electricity self-supply plans that align with government's plans for electrification and local contexts.
- Enable a sustainable strategy for leveraging extractives sector energy generation, by assessing the feasibility of renewable energy power generation options.
- In consultation with donors, governments, and utilities, assess the feasibility of installing a renewable energy-based mini grid instead of isolated generators and explore implementation and cost-sharing arrangements.

STEP 4 – Support and contribute to innovation leading to new products and services

4. B *What can extractives industries do?*

- Leverage extractives sector operations to increase use of renewable energy, as appropriate. This could be done for example by either linking production to renewable energy (e.g. making use of solar and wind power to reduce the contribution of fossil fuels and green-house gases to mineral and oil & gas production, while reducing high electricity costs associated with the use of decentralised diesel generators) or by developing green supply chains (e.g. mining rare earths and supporting local manufacturing of magnets for wind turbines to provide clean energy or mining lithium to manufacture electric batteries for incorporation into green products).

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☐ technology transfer
X innovation
X economic diversification
☐ Other: _____

Problem Statement:
Mining projects require substantial energy, and remote areas of Australia are off-grid and rely on trucked-in diesel fuel, leading to high costs.

Parties Involved:

- Government of Australia
- Australian Renewable Energy Agency, ARENA (recoupable funding)
- Sandfire Resources NL (mine owner)
- Neoen (project owner and equity provider)
- Clean Energy Finance Corporation (debt finance)
- Juwi (Project developer, EPC and O&M contractor)
- KPS Power Generation (diesel power station owner and operator)

Common ground:
Sandfire Resources NL had an interest in reducing its energy costs and increasing reliability of power supply, while the Australian government had an interest in supporting the development of renewable energy projects that could be further deployed to supply power to remote communities.

Actions taken*:*
Sandfire Resources NL's DeGrussa copper mine is located about 900 km north of Perth, in a remote area without access to the electricity grid. The mine was powered initially by an on-site 20 megawatt diesel generation station that requires substantial amounts of diesel fuel to be trucked to the site. In order to reduce the use of diesel fuel and lower both costs and emissions, Sandfire decided to employ the use of a large solar power generation (10.6 megawatts) and storage (6 megawatts) facility. It is one of the largest integrated off-grid solar and storage facility on a mining site in the world.

Renewable energy firm Juwi partnered with construction firm OTOC to construct the project, which is owned and operated by the French renewable energy firm Neoen. Construction began in June 2015 and the project was commissioned in May 2016. Sandfire has guaranteed that they will purchase power from the plant for at least the next 5.5 years, which is the current expected operating life of the mine, although there is potential for further discoveries to extend the life of the mine. The recoupment

of ARENA's costs is subject to the mine's life being extended.

The diesel generation is fully integrated with the hybrid plant. During the day, power is largely drawn from the solar panels, with the battery acting to make up for short term drops due to cloud cover. During this time, some percentage of the power is still supplied by the diesel power generators. During the night, the diesel generators provide full power. A possibility is envisaged that the battery will be used during night time to help smoothing out fluctuations and support system reliability. In total, it will result in an offset of over 20% of the mine's annual diesel fuel use.

The project is intended to be a world-leading example that increases confidence and drives further advancements in the use of renewable energy at mine sites. The project's knowledge sharing plan aims to release operational performance data summaries to assist mining companies evaluate the risks of renewable energy integration into diesel power plants. It also aims to illustrate the potential diesel and cost savings achievable by renewable energy in a mining setting and analyse the cost curve and key events that could enable high penetration solar PV opportunities to be economically deployed in Australia without subsidies. This will help drive down first-of-a-kind costs and change perceptions about the risks associated with high penetration and critical load off-grid projects. Components for the project were sourced from a variety of countries, including Australia, China, South Korea, New Zealand, USA, Vietnam, and Estonia.

Obstacles:

- Different companies with different expertise had to collaborate closely together in order to integrate new solar PV and battery storage technology into the existing diesel power generation set-up (KPS Power Generation) in a way that enhanced reliability at the mine (Sandfire Resources NL).
- The remote location of the mine meant that materials needed to be brought together from substantial distances and that proper resource management was key to ensuring Health and Safety as well as reasonable productivity.
- There were design challenges in terms of combining diesel and solar, especially in a context where the existing diesel assets already physically formed part of the mining production site.
- Based upon the above, given the project complexity and significant schedule constraint (7 months), implementation of the project needed to be coordinated with a high level of transparency between all stakeholders to avoid further communications challenges. Neoen ensured that appropriate meetings were set up on a daily, weekly and monthly basis.
- Project management support, both directly and through engineers working for the mining company, was heavier than on "typical" projects in order to ensure proper coordination and early detection of potential issues.

Enabling factors:

- The project was supported by repayable finance options from two Australian federal government agencies - the Australian Renewable Energy Agency which provided almost 21 million AUD in a recoupable grant, while the Clean Energy Finance Corporation provided 15 million AUD in debt finance. ARENA also worked with the project proponents to deliver relevant and timely knowledge to the market.
- Location played an important role - the region of Australia that the DeGrussa mine is situated in has high levels of solar irradiation, providing strong potential for solar power generation. At the same time, its remote location meant that it was off-grid, raising the costs of transporting diesel.

Lessons Learned:

- The mining sector can provide a springboard to test new energy technologies that can potentially supply power to off-grid communities. New technologies tend to be expensive, and communities in off-grid areas often lack the funds to trial them. The cooperation between the project proponents and ARENA supported the implementation of a new technology that could potentially be of great benefit to off-grid communities who are currently reliant on diesel fuel. By implementing it in a commercial operation, the technology can be subject to rigorous and long-term study to assess viability and understand how it can be used in other off-grid contexts.

EXAMPLE 3

HOW CAN THE MINING SECTOR DRIVE GROWTH IN GRID-CONNECTED RENEWABLE ENERGY IN CHILE?

Framework Step:

STEP 3 – Unlocking opportunities for in-country shared value creation
3.2 Shared infrastructure
3.2.1 Shared power
3.2.1.B *What can extractives industries do?*

- Enable a sustainable strategy for leveraging extractives sector energy generation, by assessing the feasibility of renewable energy power generation options.
- In consultation with donors, governments, and utilities, assess the feasibility of installing a renewable energy-based mini grid instead of isolated generators and explore implementation and cost-sharing arrangements.

3.2.1.C. *Host governments and extractives industries can work together to:*

- Undertake early discussions regarding power infrastructure needs and plans to determine if there are synergies, efficiencies and other opportunities for shared value creation with respect to power generation and distribution. This includes developing strategies for situations where there is no ready access to the electricity grid.

STEP 4 – Support and contribute to innovation leading to new products and services
4. B *What can extractives industries do?*

- Leverage extractives sector operations to increase use of renewable energy, as appropriate. This could be done for example by either linking production to renewable energy (e.g. making use of solar and wind power to reduce the contribution of fossil fuels and green-house gases to mineral and oil & gas production, while reducing high electricity costs associated with the use of decentralised diesel generators) or by developing green supply chains (e.g. mining rare earths and supporting local manufacturing of magnets for wind turbines to provide clean energy or mining lithium to manufacture electric batteries for incorporation into green products).

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Problem Statement:
Due to a reliance on imported fuel, Chile's electricity generation is expensive relative to neighbouring countries, negatively impacting the competitiveness of the mining industry and national economy as a whole.

Parties Involved:

- Chilean Ministry of Energy
- Chilean Ministry of Mining
- Collahuasi (Chile-based mining company owned by Anglo American plc (44%), Glencore (44%) and Japan Collahuasi Resources B.V. (12%))
- SolarPack (Spain-based solar energy company)

Common ground:
Collahuasi wanted to reduce its dependence on expensive electricity generated from coal, oil and gas and test the market to see if renewable energy was capable of supporting their mining operations in northern Chile. The government of Chile wanted to bring more renewable energy to the grid and take advantage of the country's solar potential to reduce dependency on fuel imports.

Actions taken*:*
Copper mining is a major industry in Chile and it requires substantial amounts of energy. However, electricity rates in Chile are relatively high - over the past decade prices have doubled, hitting $100 per megawatt hour in August 2015, twice as much as in neighbouring copper producer Peru. While Peru has the advantage of domestic hydropower and natural gas reserves, Chile has had to rely on imported fuel for its power sector.

The confluence of high energy prices, declining costs for solar photovoltaic (PV) technology and wind turbines, and high wind levels as well as world-leading levels of solar irradiation in northern Atacama Desert have created rich potential for renewable energy in Chile for both industrial and consumer use. Although the north is relatively sparsely populated compared to the south, it is the centre of Chile's mining activity, including the Collahuasi copper mine.

In 2012, Collahuasi put out a power tender specifically for renewable energy to test the economic potential of renewables in its mining operations. As Collahuasi's copper mine is grid-connected, renewables would be competing in terms of price against conventional fossil fuel powered sources. Mining poses special challenges for the use of renewable energy, as it requires consistent (flat) power supply, while renewable energy tends to vary in production rates throughout the day. However, Collahuasi's leadership was attracted by the price stability it offered compared to power that depended on imported fuel. It also had environmental benefits in terms of lowered overall carbon emissions.

Collahuasi signed a 20-year power purchasing agreement with SolarPack, a Spanish renewable energy developer. The project was viable without public support. Power is provided by the Pozo Almonte II and III plants, which Codelco uses as well. SolarPack built the plants and is responsible for their operation and maintenance, while the government coordinator, formally the Centre for Economic Dispatching of the Interconnected System of the North, is responsible for managing dispatch. The development of the plants was supported by loans (equity) provided by the Inter-American Development Bank (IDB), and financing was provided by the Canadian Climate Fund for the Private Sector in the Americas (established by the Canadian government and managed by IDB). The loans were provided at market rates, which at the time were quite high; the economics for solar projects in Chile have subsequently become much better as prices and interest rates have declined. The plants were built without subsidies from the government. The solar PV plants have been operating since early 2014. They have a total power generation capacity of 25 MW, sufficient to meet 13% of Collahuasi's power demand.

Obstacles:

- Collahuasi was one of the first mining companies in Chile to try to source some of its energy from renewable generation. At the time, the Chilean market was not yet mature, and there was unfamiliarity with renewable energy technology, as well as uncertainty in terms of costs and the capacity of supply.
- Solar energy costs were also relatively high compared to current costs – over time, the technology has become cheaper, and there is greater expertise around installation.

Enabling factors:

- Collahuasi's leadership were strongly supportive of moving towards renewable energy, and took the challenge of implementing it seriously by bringing in engineers with expertise in renewable energy.
- There was a strong business case for it, with relatively high energy costs (due to Chile's reliance on imported fuel) and Chile's strong environmental potential for renewable energy (world-leading levels of solar irradiation).

Unlike many countries who are looking to support the growth of the renewable energy sector, Chile does not provide any price subsidisation for solar or wind power. Instead, the Chilean government created a an enabling policy environment for renewable energy:

- In 2004 the Chilean government introduced Short Law 1, which stipulated non-discriminatory grid access for renewable power generation. It also removed transmission fees for generators under 9 MW and reduced them significantly for those between 9 and 20 MW. In 2008, the government introduced the Non-Conventional Renewable Energy Law, which set a 5% quota to be met by 2014, increasing annually by 0.5% until 2024. This applied to all

electrical power sales and had price penalties if it was not achieved. This was later revised with Law 20/25, which increased the targets to 20% renewable energy by 2025, with 1% annual increases until 2020, and 1.5% annual increases from 2020 until 2025.

- The Chilean government has also assisted the development of renewable energy projects by providing financial support for pre-investment and feasibility studies through a series of programs, the most recent being the Support for Non-Conventional Renewable Energy Development Programme, introduced in 2012 with a USD 85 million budget. This has since been replaced with a new study called PRAP (Programa de Apoyo a Proyectos Estrategicos en Etapa de Pre Inversion) whose objective is to support pre-investment studies.
- The approach taken by the Chilean government means that renewable energy projects are encouraged to develop, but they are not subsidised, and must be competitive with conventional power sources.

Lessons Learned:

- When Collahuasi contracted SolarPack to construct the Pozo Almonte plant, it was an early adopter of renewable energy in the Chilean mining sector. The prices for development were relatively high, as is the price paid for power. With the more mature market today, prices have come down significantly. This is also supported by improvements in the transmission system. In October 2016, Collahuasi issued a significant new tender for 150 megawatts of renewable energy.
- The confluence of natural potential for renewable energy, government policies that support its adoption in the electrical grid, rising cost pressures on the commodity sector and declining costs of solar PV technology have helped drive the growth in industry.
- Renewables and the extractive sector can have a virtuous relationship, with efficiency gains in the extractive sector spurring spending on renewable energy projects, and the growth in renewable energy production contributing to a higher availability of renewable energy on the grid as a whole.
- Coordination between mining companies and the public sector is also essential to help ensure that opportunities for power development with excess capacity that can be sold back to the grid are taken advantage of.
- By using a Power Purchasing Agreement with SolarPack, Collahuasi outsourced the most technologically challenging aspects of using renewable energy in its operations, simplifying its deployment. Despite declining prices, in their current technology level, renewables are not sufficient to entirely replace baseload generation capacity. However, they have capacity to augment existing power use and reduce the need for fossil fuels or added generation capacity. At a power procurement auction held by the Chilean government in October 2015, all 1,200 GWh of the available contracts went to wind and solar projects, outcompeting proposals for coal plants based on price alone. In part, this was because the government allowed companies to bid in specific time slots. Solar power has a significant advantage if it is only considered on the merits of daytime generation.
- The existing electrical grid infrastructure in Chile is inadequate and strained. It has bottlenecks at certain points that prevent the free flow of power. This means that mining companies and other industrial users in the North are not necessarily able to take advantage of excess power generated by renewables on the grids, thus preventing the power generating companies from recouping their costs and leaving power unused. However, work is underway to unify the two main grids.