Solar energy uptake and energy efficiency in mineral extraction and beneficiation industry: A review

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Introduction

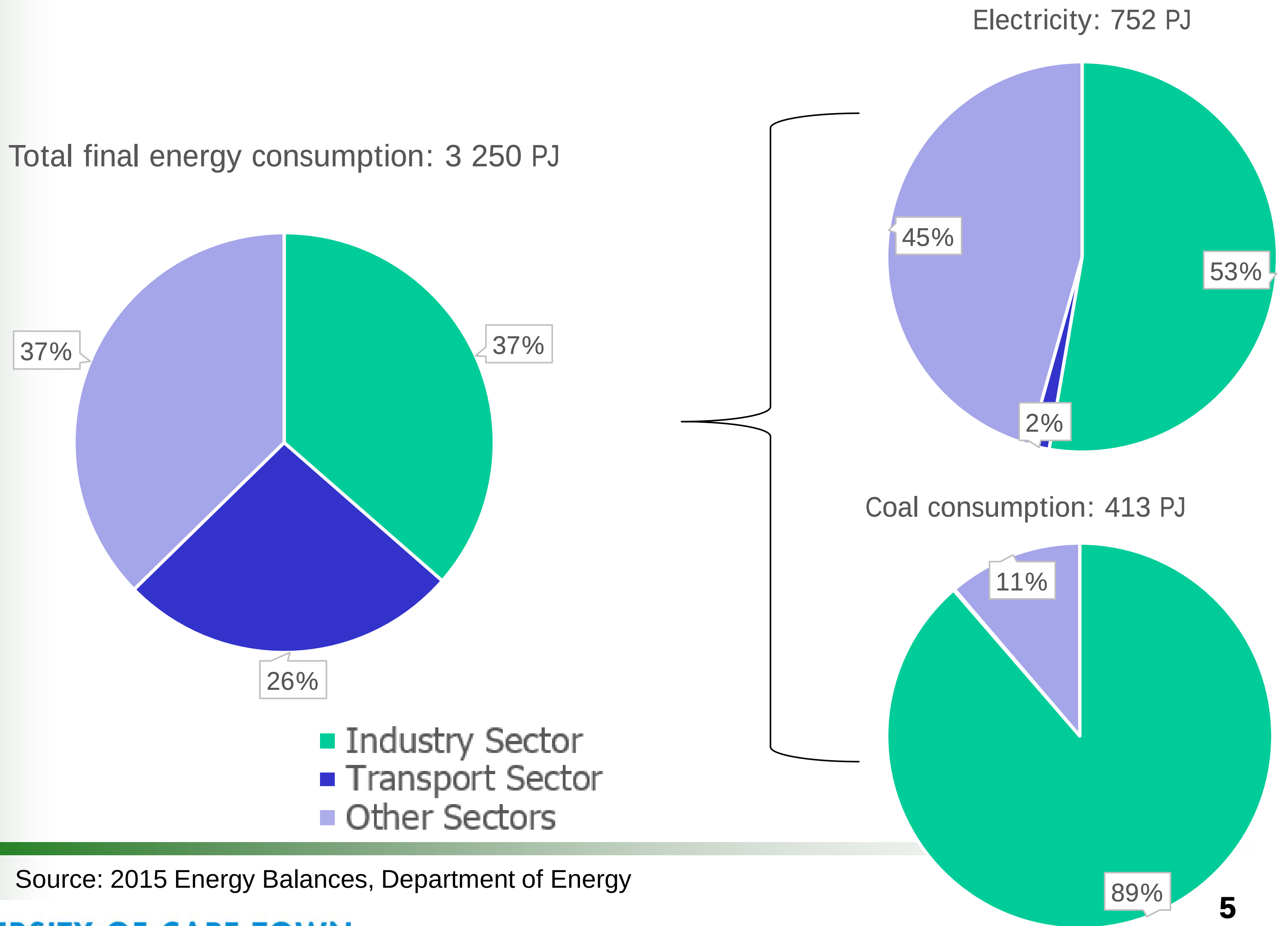
“A study by (Kluczek and Olszewski, 2017) has shown that the adoption of many **energy efficiency** measures represents a driver for increasing industrial process performance due to related **economic costs** and significant **environmental impacts**, which this industry can take advantage of to mitigate their **energy intensive** processes”

“Electricity and energy **price increases** have affected the **global competitiveness** of South African minerals extraction and beneficiation operations as this constitutes nothing less than **10% of their operational expenses** (Votteler and Brent, 2016) “

South African Minerals Industry

- SA is one of the major mining countries in the world (EY's Global Mining & Metals Center, 2015),
- As of 2018, the mining and quarrying sector in South Africa has contributed about 8.06 % (SAMI, 2019) to the GDP
- Mineral reserves include precious metals, energy minerals, non-ferrous metals, ferrous and industrial metals and minerals
- Critical to the country's socio-economic development

Energy use in South Africa



Source: 2015 Energy Balances, Department of Energy

Summary of energy balances

Mining and minerals beneficiation

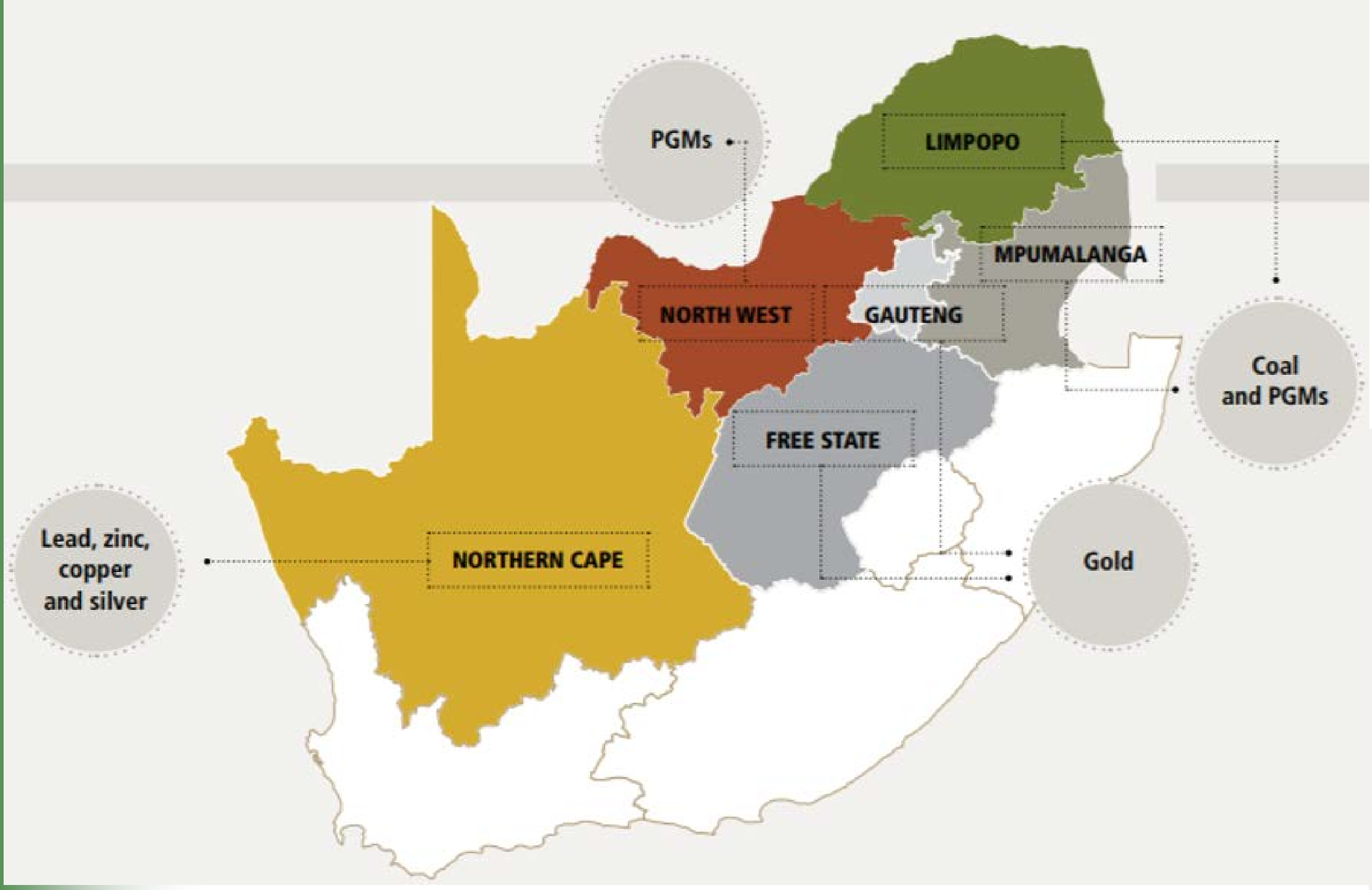
Electricity 33%

Coal 40%

Total final energy consumption

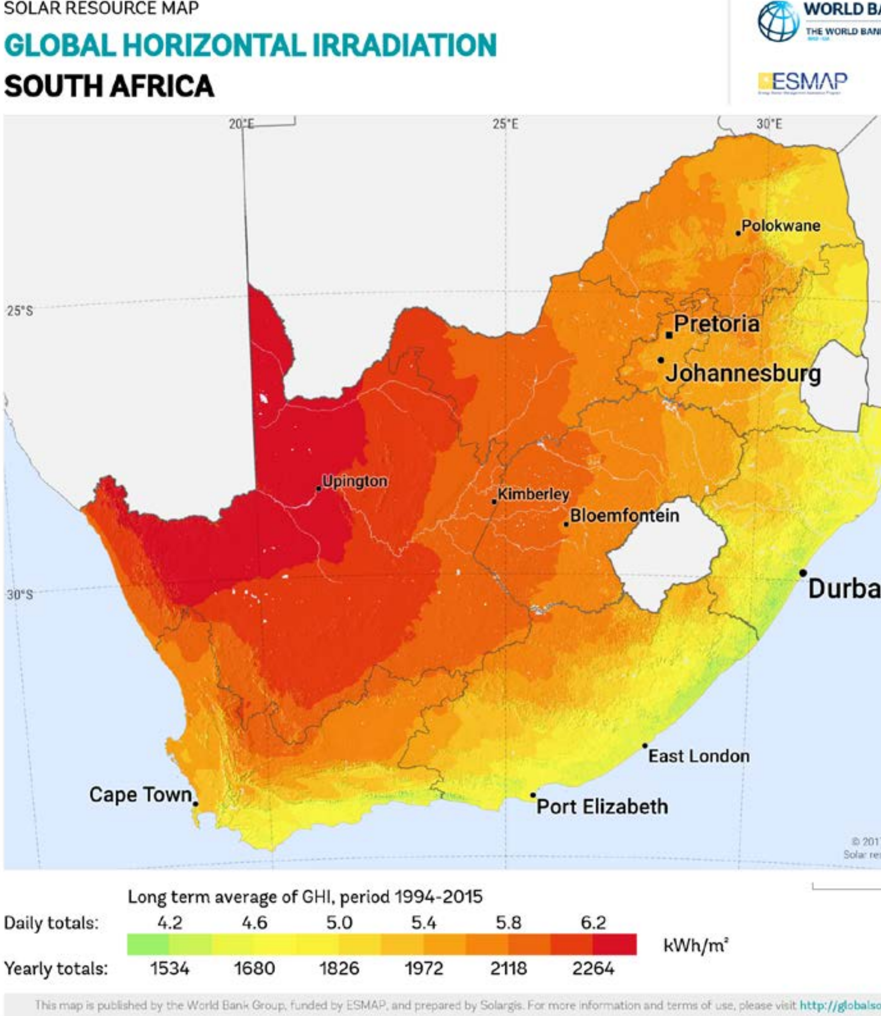
17%

Areas with mineral extraction and beneficiation activity

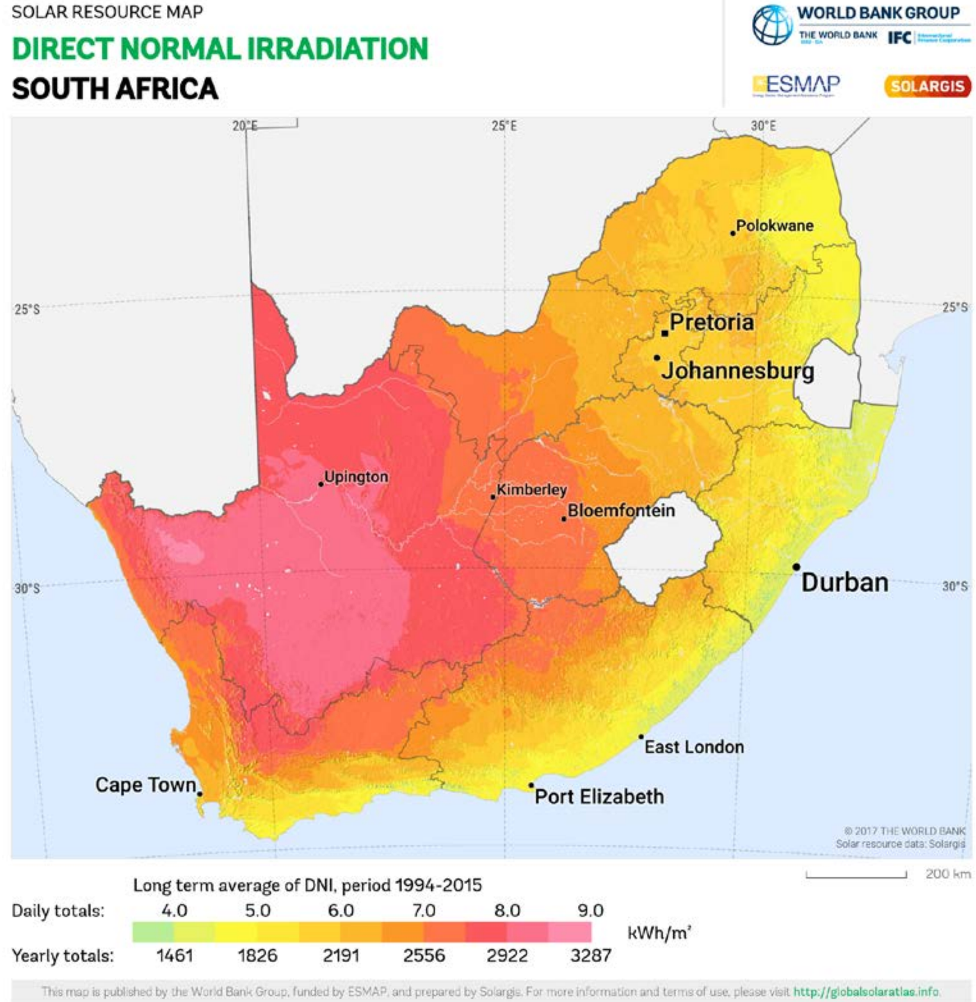


- Gold
- PGM
- Coal
- Diamonds
- Manganese
- Iron Ore
- Copper
- Chromite
- Silver
- Uranium

Source: Chamber of mines



Photovoltaic technologies



Solar thermal technologies

“South Africa has a good **solar resource**, which is a great alternative for **utility scale electric supply** and **process heat** which can be used by the mineral extraction and beneficiation industry

“Moreover, **energy efficiency** presents a **sustainable solution** because for this energy intensive industry, small reductions could provide substantial savings in terms of **energy costs”**

It is also well documented that solar energy presents a **sustainable energy supply option** for the mineral extraction and beneficiation industry, as it is a low carbon energy source”

Literature review

Energy efficiency for minerals processing operations

- Mineral extraction and beneficiation operations are generally a long-term investment, as a result, operations that were designed many years ago seldom have optimal operations (Immink, Louw and Brent, 2018) which are energy efficient
- Due to the rising energy costs, most operations have actively reduced their energy consumption by implementing demand side management interventions and other energy efficiency measures which are not costly, with short term benefits
- (Sbarbaro, Pena and Moran, 2018) have conceded that with increased demand, volatile energy prices, falling ore grades from complex ore bodies, increased energy consumption and increasing concern about the industry’s energy related carbon footprint

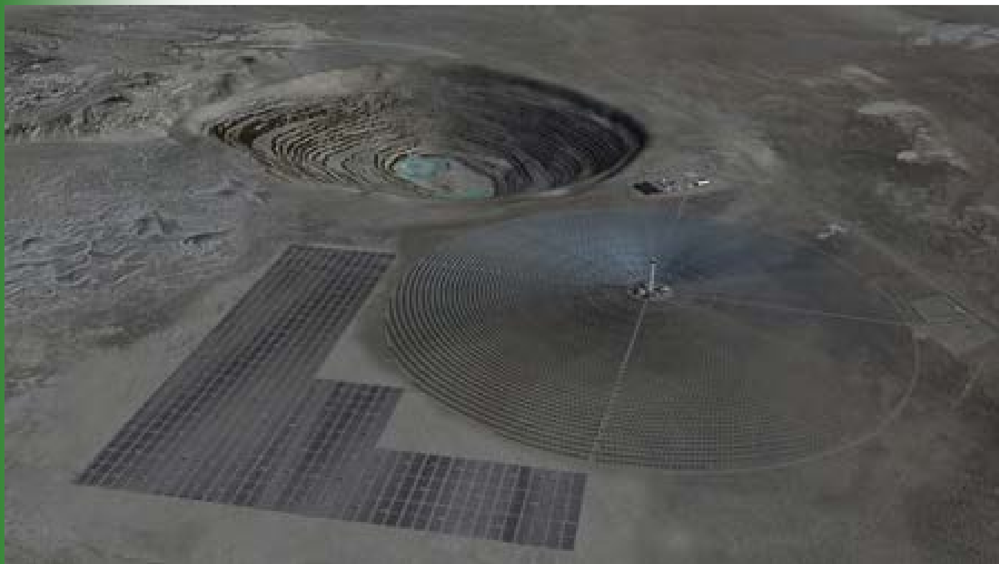
Energy efficiency and solar energy

- Some of the benefits of energy efficiency, as noted by (Levesque, Millar and Paraszczak, 2014) include;
  - Reduced energy consumption which may result in increased profits and enhanced competitiveness
  - Lower energy demand which extend life of current energy sources
  - Lower energy bills will liberate funds which would have been allocated for energy supply
- When these benefits are coupled with the use of solar energy at mineral extraction and beneficiation operations, may result in a resource efficient and decarbonised society

Solar energy: Intermittent

- Energy storage technologies, along with co-ordination mechanisms such as hybridisation, are quickly becoming solutions for the intermittency of the sun
- Conventional fossil based energy source is supplemented or replaced with a renewable energy source, no intervention in the process operation is carried out
- And considering changes in the current operations to suit the availability of the sun and take full advantage of it
- New processes and operations are designed to fully utilise the solar energy potential

Solar energy co-location in Chile



SolarReserve Copiapó plant: Solar tower and solar PV

What the Chileans are currently doing

- Remote mining areas co-locating solar PV and solar thermal technologies
- Increased solar PV installations
- Decarbonising the mining industry

MSc in 2012

- Solar energy in the minerals processing industry: Identifying the first opportunities for solar energy
- Synergies when solar energy technologies are co-located

Atacama dessert: Hybrid CSP with molten salt storage and solar PV

Source: RenewableWorld

“A recent study in the **Chilean copper industry** has shown that if the electricity that is fed from the grid is **exclusively replaced with onsite solar energy technologies** this can lead to a reduction of the global warming potential of copper production by up to **63% and 76% for pyrometallurgical and hydrometallurgical copper production processes** respectively (Moreno-Leiva et al., 2017) “

SA operation: Goldfields

Country	South Africa
Operation name	Gold Fields
Type of resource	Gold
Location of the mine	Off-grid
Type of resource	Solar PV
Generation capacity	40 MW
Output capacity	100 GWh/annum
Government regulatory mechanism	25 years PPA
Diesel saving, L/annum	up to 20%
General mine's energy consumption	500 GWh
GHG emissions reduction	100 000
Project value	N/A

- To date, Gold Fields mine is the only South African operation which has implemented utility scale solar PV onsite at their South Deep mine
- Based on their (RMI, 2017) case study report, the South Deep mine processes approximately 150 000 tons of ore per month, with a peak electricity demand of 60 MW and consumes 500 GWh per annum

Concluding remarks

- Understand the energy consumption for this industry, across the mineral processing value chain
- Appropriate solar energy solutions should be matched with the energy demands of the minerals processing industry
  - The minerals extraction and beneficiation industry have various processes and units which are energy intensive, and not all these processes and units are suitable for solar energy integration
  - As (Chandia et al., 2016) reiterates that each process and unit operation has different needs in terms of temperature and energy, and some of them can be complemented with solar energy
  - For thermal energy requirements, processes such as comminution and solvent extraction operate at ambient temperature. Therefore, there is no need to integrate any solar technology for process heat generation
- Evaluate methods to increase energy efficiency solutions at these operations
- Incentives and regulatory mechanisms should be in place to support minerals processing operations to integrate solar energy technologies and energy efficiency in their operations

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