The Power of the Mine

A TRANSFORMATIVE OPPORTUNITY FOR SUB-SAHARAN AFRICA

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ESMAP
Energy Sector Management Assistance Program

SAFETE
South African Fund for African Energy, Transport and Extractive Industries

Africa Region
sustainable development

SSA'S POWER DEFICIT IS CRIPPLING DESPITE HUGE ENERGY RESOURCES

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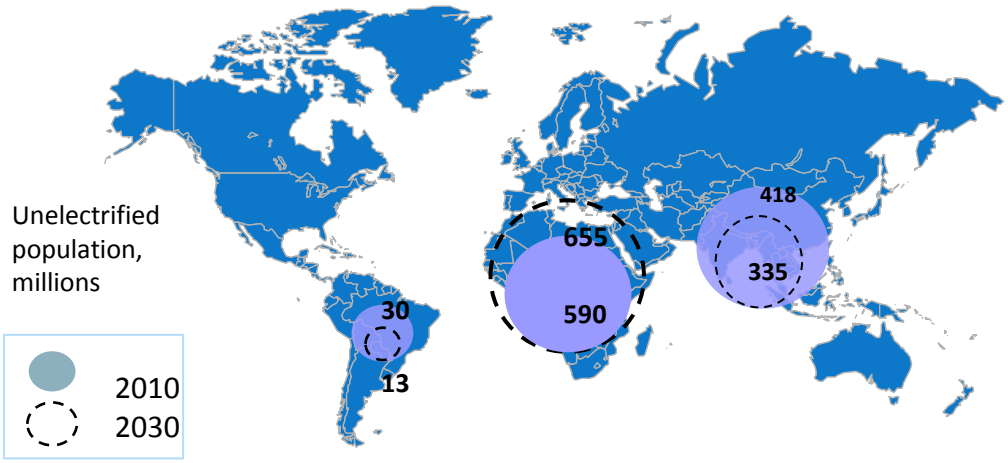
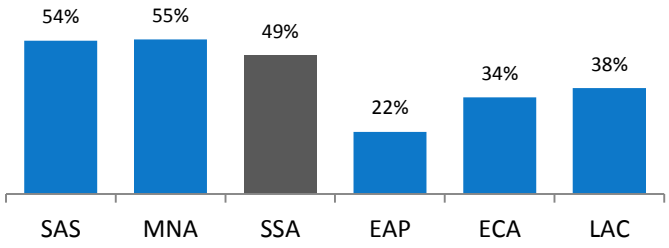
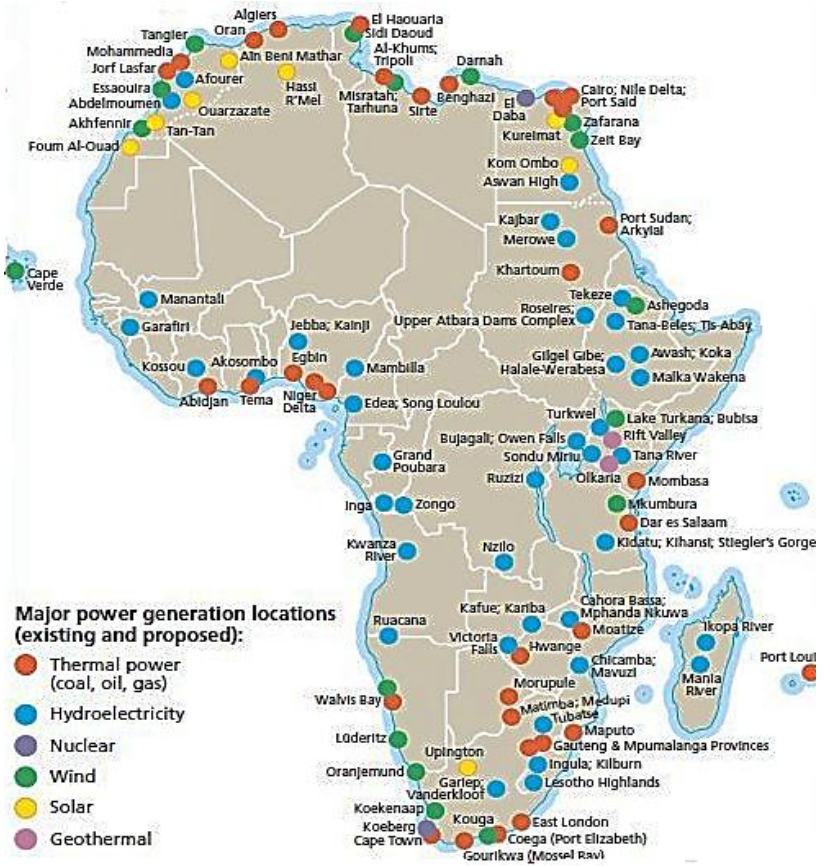


By 2030, 990 million people will be without electricity, with 655 million in SSA

Share of firms identifying electricity as a major constraint (%)



Hydro potential: 400GW
Geothermal potential: 16GW
Natural Gas reserves: 329 tcf



SSA'S MINING INDUSTRY COULD BE AN OPPORTUNITY TO UNLOCK THESE RESOURCES

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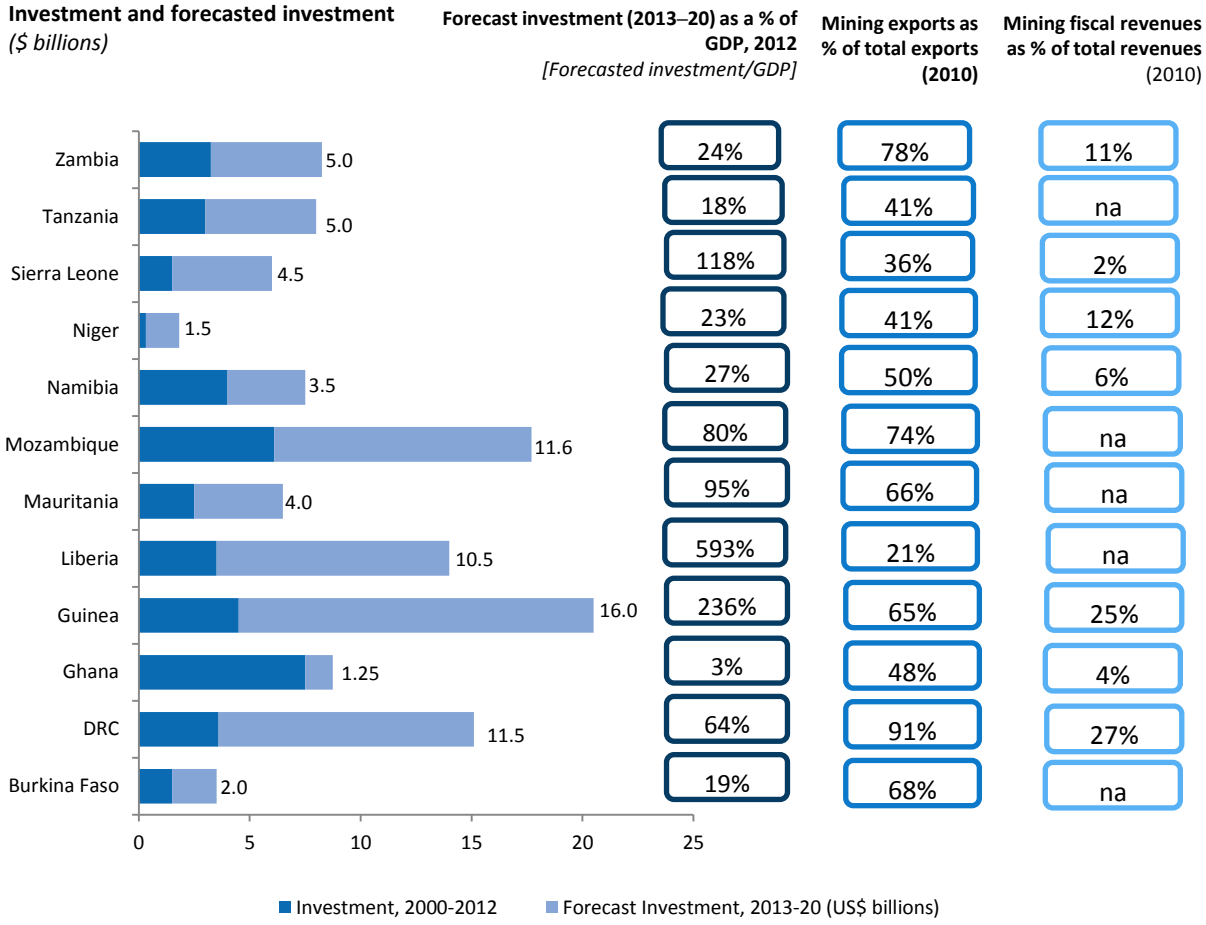


Mining development

Opportunity for exports

+

Domestic use for growth

+

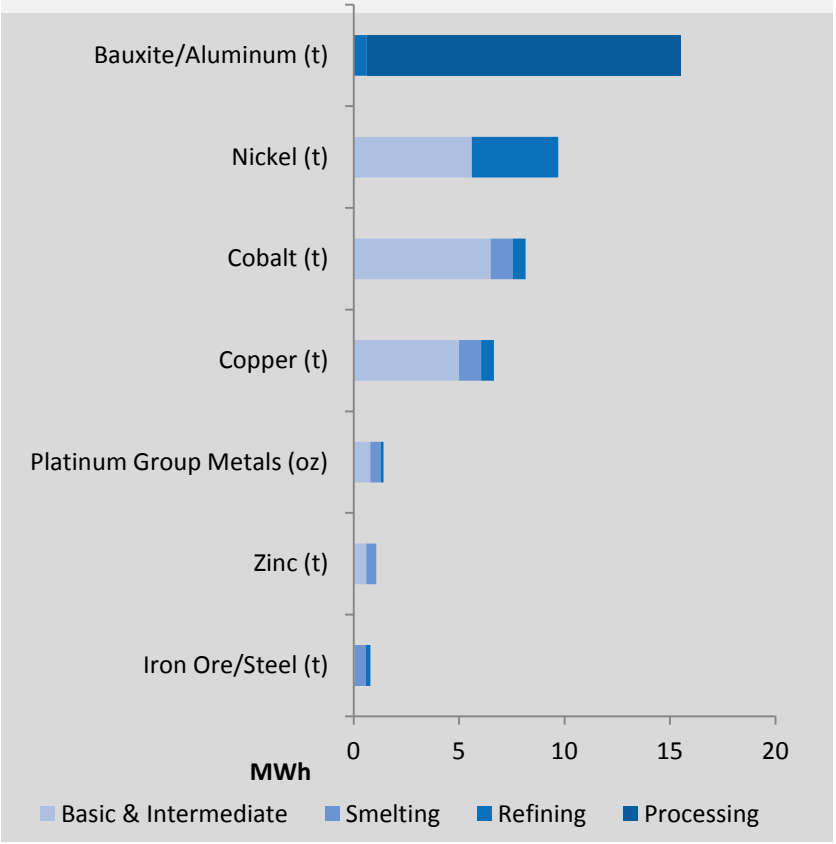
Anchor for economic and infrastructure development

SSA is largely unexplored - absolute amount of spending on exploration increased by more than 700% between 2000 and 2012

POWER IS A CRITICAL INPUT TO MINING PROCESSES

Power needs depend on the type of mineral but even more on the amount of processing

Aluminum smelting is by far the most power-intensive mining activity



Power cost is a substantial component of operating cost (rarely below 10 percent)

	Medium-size operation			
Mineral	Annual production (t)	Required power capacity, MW (maximum beneficiation)	Electricity costs as % of operating costs (maximum beneficiation) 10 cents/ kWh	20 cents/ kWh
Bauxite	2 million	177	29	45
Aluminum	200,000	443	117	234
Coal	10 million	53	10	18
Cobalt	20,000	23		
Copper	100,000	95	15	26
Diamonds	0.6	3		
Gold (open pit)	12	45	9	17
Gold (underground)	12	80	16	28
Ilmenite	300,000	15	15	26
Iron ore/steel	3 million	338	16	28
Manganese	50,000	121	11	20
Nickel	30,000	42	10	18
Platinum Group Metals	5.6	41	14	25
Uranium	1,814	46	30	46
Zinc	200,000	31	8	15

This study reviews the potential and challenges of power-mining integration

Landscape analysis

Why?

- To establish demand for power from mining since 2000 and project to 2020 (*high probability and low probability*)
- To create a typology of power-sourcing arrangements of mines

What has been done?

Africa Power-Mining Database, 2013—a database of 455 mining projects in 28 Sub-Saharan countries with value of the ore reserve assessed to be more than $250 million

Case-study analysis

Why?

- To do a deep dive for eight mineral rich economies at different levels of power-mining synergies to explore win-win scenarios
- To analyze barriers to realizing integration scenarios

What has been done?

Cameroon, Democratic Republic of Congo, Ghana, Guinea, Mauritania, Mozambique, Tanzania, and Zambia are the case study countries

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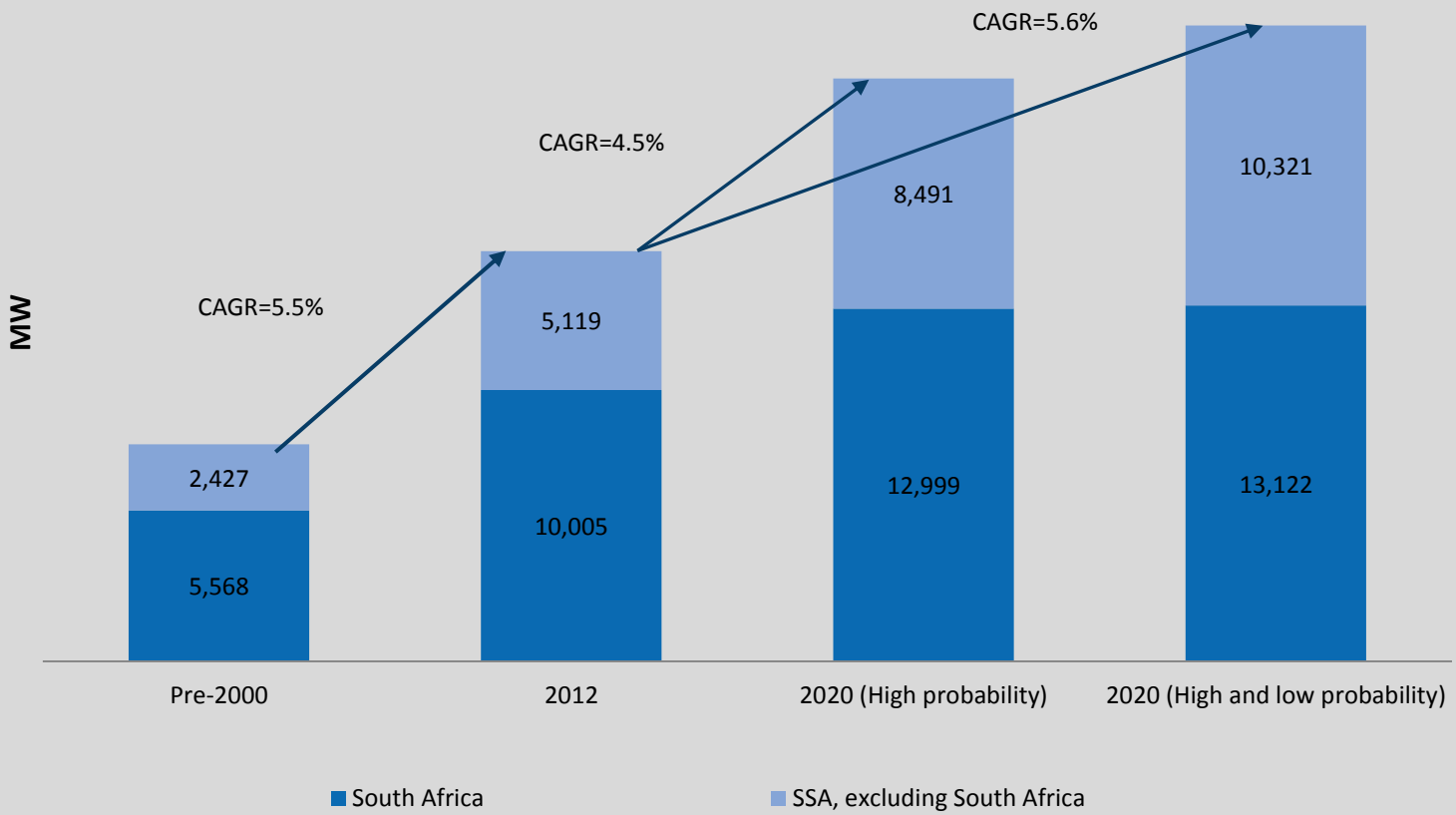
THE OPPORTUNITY – POTENTIAL OF POWER-MINING INTEGRATION

MINING DEMAND FOR POWER CAN BE UP TO 23 GW IN 2020

Growth rate of power demand from mining: 2012-2020
South Africa = 3.5%
SSA, excluding South Africa = 9.2%

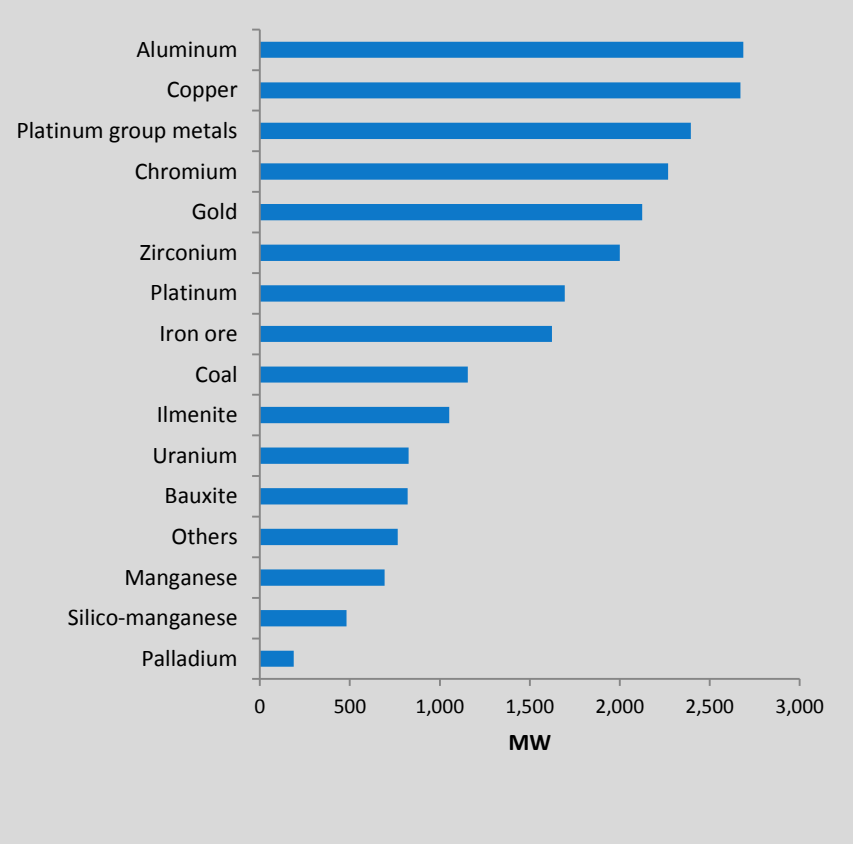
Mining demand for power over time

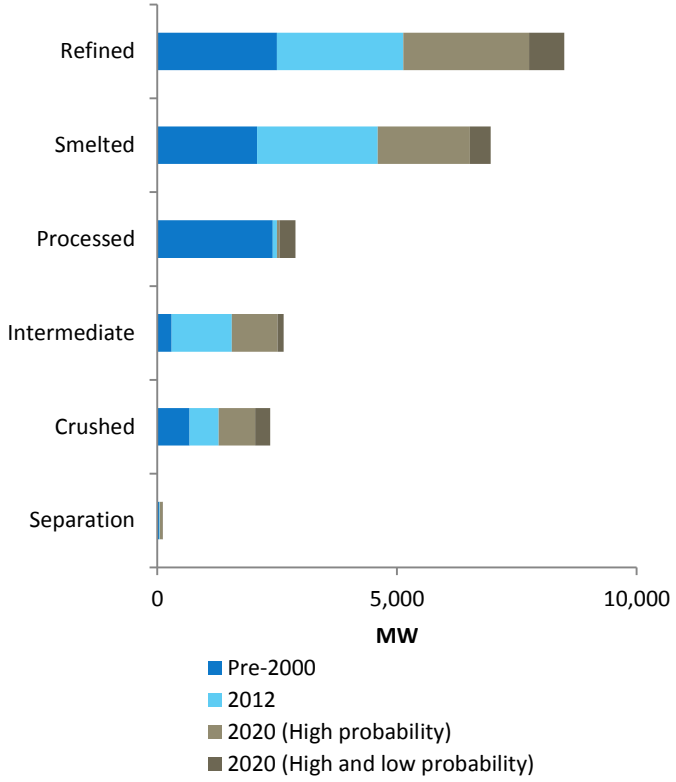


Note: CAGR=Compound Annual Growth Rate

A FEW MINERALS AND STAGE OF BENEFICIATION WILL DETERMINE POWER DEMAND FROM MINING

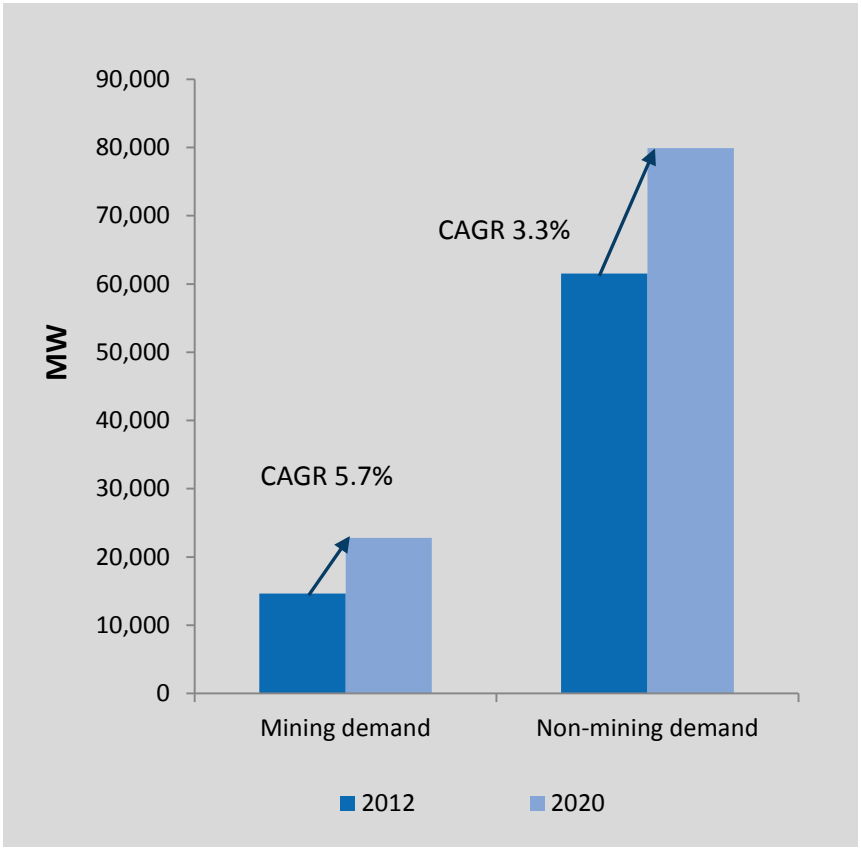
Iron ore and PGM will experience the largest increase in power demand
Refining and smelting together are almost two-thirds of the total power demand





MINING DEMAND FOR POWER CAN BE OVERWHELMING IN A FEW COUNTRIES

Comparison of mining and nonmining demand



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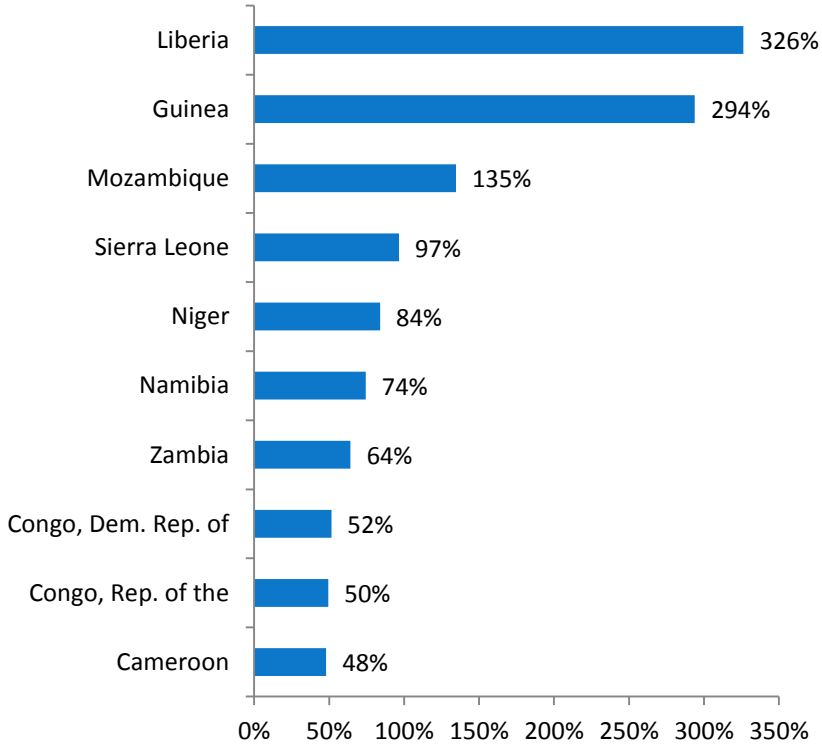

Mining demand as % of total non-mining demand

There are six distinct intermediate power sourcing arrangements

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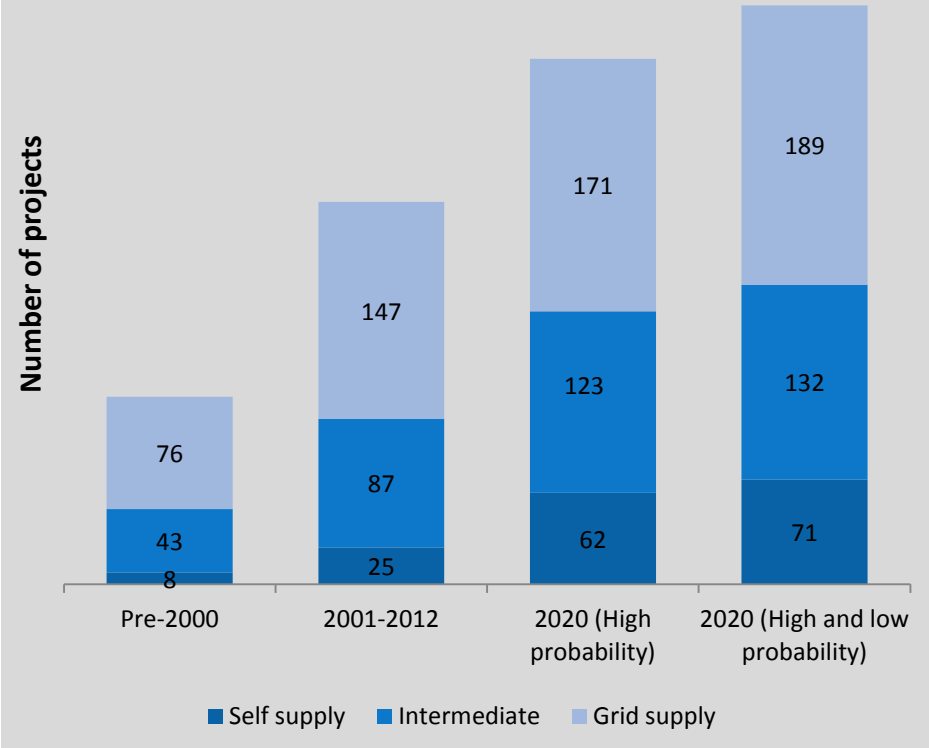
1 ← 2 Intermediate → 3

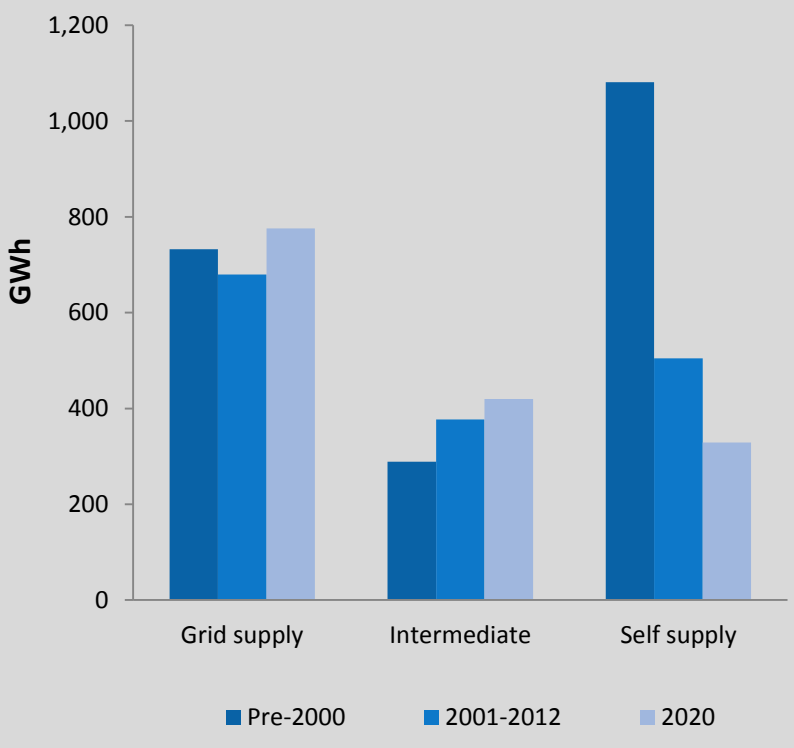
	Self-supply	Self-supply + CSR	Self-supply + sell to the grid	Grid supply + self supply backup	Mines sell collectively to grid	Mines invest in grid	Mines serve as anchor demand for IPP	Grid supply
Description	Mine produces its own power for its own needs	Mine provides power to community through mini-grids or off-grid solutions	Mine produces its own power and sells excess power to the grid	The mine is first connected to the grid and is moving into own-generation when more economical	Coordinated investment by a group of mines, producers, and users in one large power plant off-site connected to the grid	Mine invests with government in new, or in the upgrading of, power assets under different arrangements	Mine buys power from an independent power producer and serves as an anchor customer	Mine does not produce any power, but buys 100% from the grid
Main Generation drivers	Diesel HFO	Diesel HFO	Coal, Gas, Hydro	Diesel HFO	Diesel, HFO, Solar	Hydro, Gas	Any	Any
Presence	Mali and Guinea (hydro) Sierra Leone and Liberia (oil)	Guinea Madagascar	Zimbabwe Mozambique Cameroon	Democratic Republic of Congo Tanzania	Ghana	Niger Democratic Republic of Congo	South Africa	Mozambique Zambia

AVERAGE ENERGY CONSUMPTION IS EXPECTED TO RISE FOR INTERMEDIATE ARRANGEMENTS

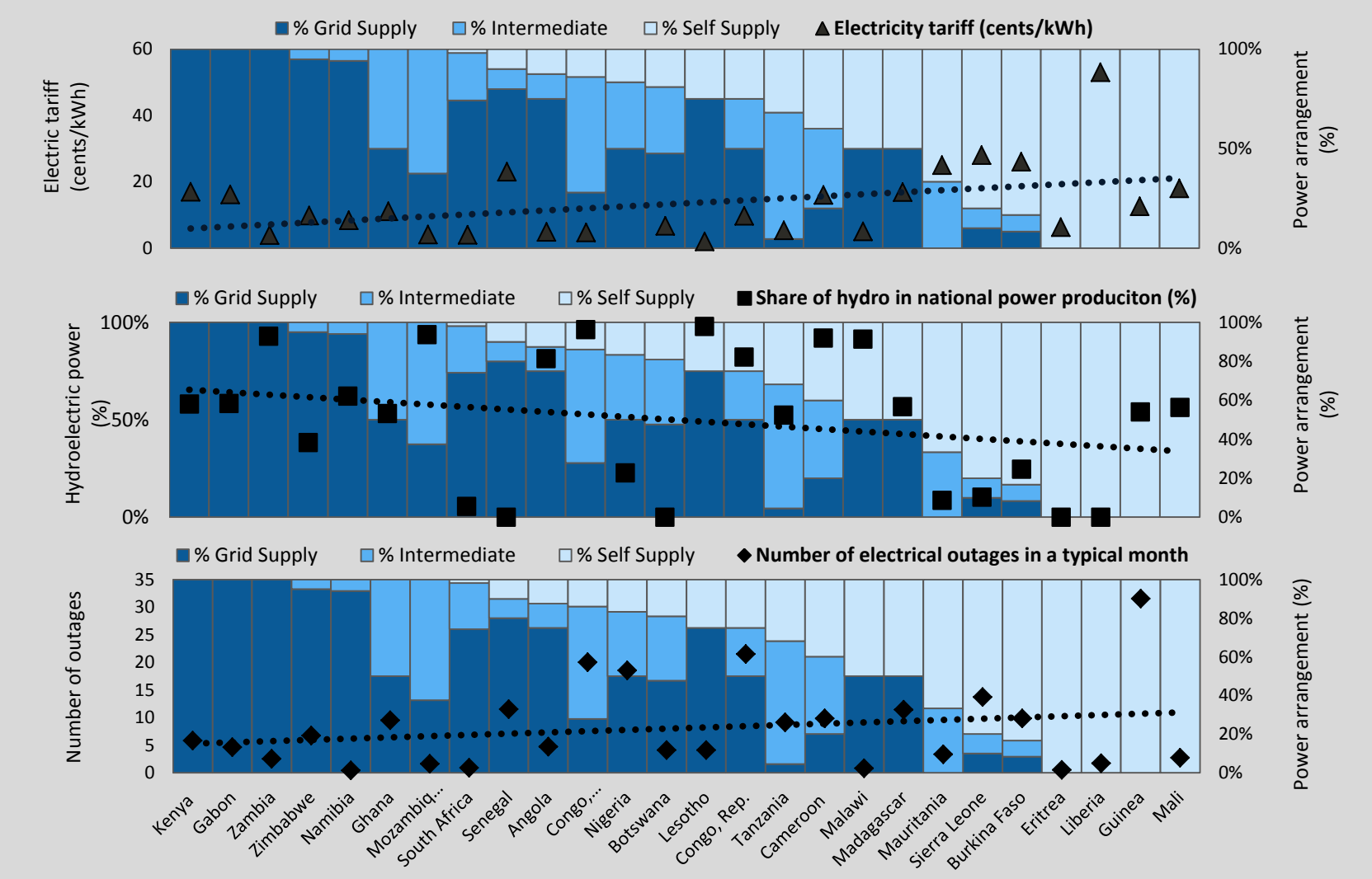
CAGR for the three arrangements (pre-2000 to 2020):
Self-supply – 11.4%
Intermediate – 6.04%
Grid supply – 5.09%



Average annual energy consumption has increased only for Intermediate options



A COMPLEX MIX OF FACTORS - RELIABILITY, FUEL MIX, TARIFFS - DECIDE POWER SOURCING ARRANGEMENT



SELF-SUPPLY IS A LOSS TO UTILITY, MINES—AND THE COUNTRY

Utility	Loss of large customers Loss of an opportunity to use the mines as anchor customers exhibiting economies of scale
Mines	Direct cost of self-supply is generally much higher (offset by continuous supply and consistent product quality)
Country	Weak utility Loss of exports and tax revenues Negative impact on GDP, and reduced employment opportunities

Mines investment in self – supply power infrastructure
2000-2012: $1.3 billion
2013-2020: $1.4 - $ 3.3 billion

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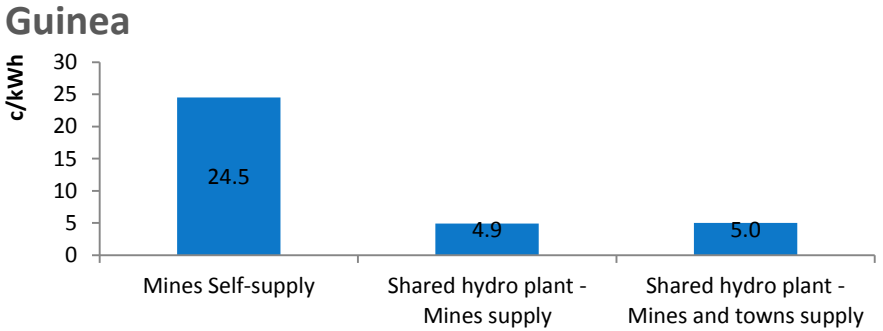
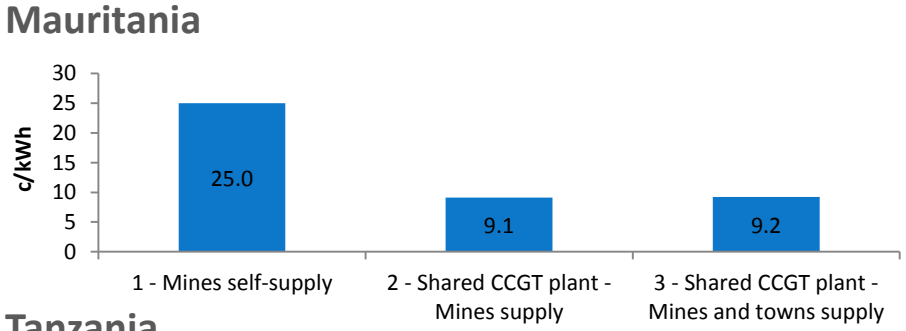
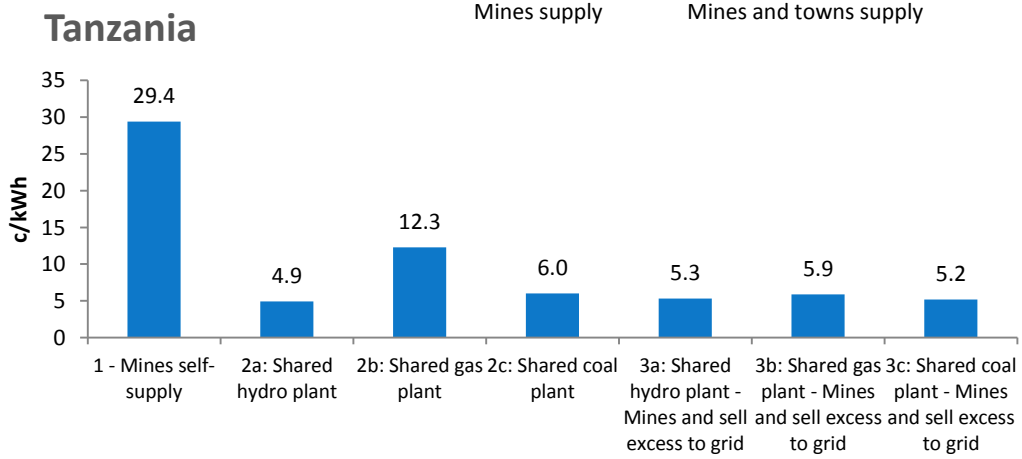
SCENARIOS OF POWER-MINING INTEGRATION – A WIN-WIN

SHARED INFRASTRUCTURE IS LOWEST COST AND BENEFICIAL TO COMMUNITIES

- Three scenarios -
  - Mines self-supply
  - Shared power plant among mines
  - Shared plant also serves neighboring communities (as in Guinea and Mauritania) or sells excess to the grid (as in Tanzania)
- Projects could be developed for a higher capacity to meet the electrification needs of the neighboring communities
- Electrification for community: **Guinea → 5%** of total population and **Mauritania → 4%** of the population)
- Cost savings for mines: Around **$600 million** in **Guinea** and around **$1** billion in **Mauritania**.







SHARED INFRASTRUCTURE CAN PROVIDE THE ANCHOR DEMAND TO DEVELOP REGIONAL PROJECTS

- **Mozambique**
  - Mines produce high-quality coking coal for export, and the discard coal is available for power generation.
  - Additional power generation capacity can be allocated either for the national or regional markets, or for an aluminum smelter.
  - Two scenarios explored:
    - Mines self-supply
    - Mines produce electricity from discard coal to supply to aluminum smelter

- **Cameroon**
  - Innovative framework requires a long-term planning and investment commitment by large power users to developing the country's hydropower resources.
  - The full potential of the hydropower site could be developed by the mine, with the surplus being sold to the grid at cost-recovery tariffs.
  - The surplus could be first absorbed in the domestic market, for later on export to the Central African Power Pool.

Shared infrastructure can provide bankable Public-Private investment opportunities

- At least **$6 billion** in private– public investment opportunities in Guinea, Mauritania, Tanzania, Mozambique
  - Mozambique option – Power plant along with the smelter - $4.5 billion.
  - Guinea option - 300 MW hydro plant – $595 million
  - Mauritania option – 150 MW combined cycle plant – $142 million
  - Tanzania option – 300 MW hydro, coal, gas-fired ~ $400 million
- With a desirable investment climate, potentially viable projects exist for the independent power producers and the governments.

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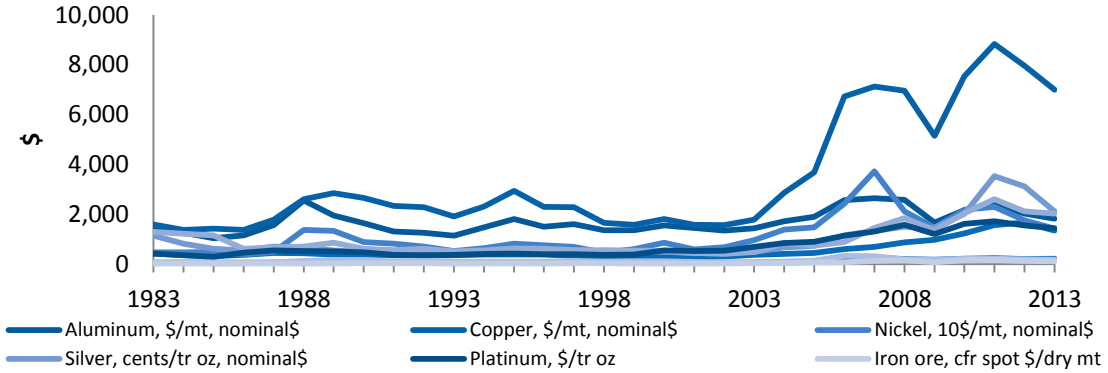
RISKS IN POWER-MINING INTEGTRATION – OPTIONS FOR POLICYMAKERS

RISKS TO INTEGRATION REMAIN

Commodities' price	Investments may not materialize - price swings, difficulties in raising capital, optimistic geological assessments, and political instability.
Planning	Different time horizons for planning mining and power investments. Power investments will need other customers who may not materialize.
Joint strategy	Resource pooling and joint strategy among mines is difficult to achieve given the highly competitive environment
Incentives	Little incentive to construct power plants with greater capacity than the mining demand—need for regulatory and commercial incentives and transmission network
CSR	Power supply to local communities is not attractive unless mines integrate that as part of their Corporate Social Responsibility (CSR) or unless they are contractually required to do so
Viable partners	Public utilities are often not a viable partner for the private sector



TRANSMISSION LINKS AND FINANCIAL STATE OF UTILITY ARE COMMON CONSTRAINTS

Constraint	Countries	Remedial policy actions
Inadequate national transmission grid	Cameroon, Democratic Republic of Congo, Guinea, Mauritania, Mozambique, Tanzania, and Zambia	Transmission reinforcement projects
Irregular fuel supplies and water flows	Cameroon and Ghana	Completion of Lom Pangar project Back-feed to West African Gas Pipeline from Jubilee Field;
Weak national utility	Democratic Republic of Congo, Guinea, Mauritania, and Tanzania	Utility and sector capacity building; strengthening regulators and their ability to raise tariffs to commercial viability levels
Rail and port infrastructure lacking for bulk mineral exports	Guinea and Mozambique	Rail and port projects
Regional market and interconnector capacity constraints	Democratic Republic of Congo, Mozambique, and Zambia	Reinforcement of regional market institutions and regional interconnectors

SUGGESTIONS FOR POLICYMAKERS

- **Strengthen power sector finances:** establishing the utility as a viable partner with a stable investment framework and effective regulation is critical
- **Support the operating environment for IPPs:** power sector sufficiently liberalized to allow for IPPs in generation, and encourage private sector to invest in transmission.
- **Integrate mining demand in power sector planning:** only Tanzania and the West Africa Power Pool do so
  - Involve the Ministry of Mining—Cameroon, Mauritania, and Tanzania share the same Ministry
  - Integrate power requirements into Mining Law: Focus on dialogue, not on mandated actions
- **Source expertise:** take a long-term perspective and identify potential synergies, and the actions that will create an attractive enabling environment. Many institutional arrangements are possible; one size does not fit all.
- **Strengthen regulatory mechanisms:** in setting cost recovery tariffs, managing risks and regulating access. Effective regulators enforce contracts and strengthen the utilities.
- **Regular review of mining tariffs:** large mining operations as anchor customers is very promising but approach with caution
  - Do not subsidize mines and be prepared for time when non-mining demands also will want this power
- **Careful drafting of CSR contracts:** develop model concession agreements mandating the provision of electricity within some radius to increase certainty for investors, and enhance the accountability of government as the contract enforcement authority.
- **Use regional platforms:** a regional approach will often be required to fully benefit from new arrangements

THANK YOU!

Questions or comments?

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Background Slides

LEVERAGING POWER-MINING SYNERGIES CAN BE WIN-WIN IN ANY SITUATION

Situations	Opportunity for integration: How can the power sector leverage the mining energy demand?	Cost savings for the mine	Increased welfare for the host state
Grid: Too remote Mine: Builds its own generation ("Self-supply" and "Self- supply and CSR")	Leveraging decentralized energy for rural electrification (off grid or mini-grid)	Save the social license to operate	Accelerate effort of electrification
Grid: Too expensive or too unstable Mine: Builds its own generation ("Self-supply," "Self-supply and sell to the grid," "Mines sell collectively to grid," and "Mines serve as anchor demand for an IPP")	Leveraging for increased generation: - If the mine produces excess and sells back to the grid - If anchor demand for IPPs; if mines build bigger collective power plant	Either additional revenues Or diminished costs of energy needed	Additional sources of generation Cost of generation drops
Grid: Hydro-based (gas-based) and very cheap Mine: Wants to source from the grid ("Grid supply and self-supply backup," "Mines sell collectively to grid," "Mines invest in grid," and "Grid supply")	Leveraging for more robust grid: - If mines participate in upgrading the grid - If mines leverage the idle capacity of emergency generators to alleviate the grid	Stable access to very cheap electricity Opportunity for additional revenues	Utility can gain in efficiency; infrastructure upgrading Avoid saturation of the grid

Supporting Conditions for Power-Mine Integration

Power-Mine Synergy	Supporting Conditions
Mines supplies power to the communities (rural electrification)	Contractual requirement Coordination between mining companies & donors/govts/NGOs Clear framework allocating responsibilities Each party has sufficient capacity Presence of local govt/utility in rural areas Effective demand/willingness to pay
Mines sells excess power to the grid	Liberalized power market with clear legislative & regulatory framework Excess capacity built in at design phase Commercially viable offtake agreement between company & utility Credible state-owned company (if offtaker) Adequate transmission infrastructure Demand for excess power
Mines as an anchor for IPP	Liberalized power market with clear legislative & regulatory framework Sufficient IPP power supply for mining demand and national grid Sufficiently low cost & reliable power supply (relative to self-supply) Power plant and mine on same timetable Investment in transmission infrastructure to supply power to mine Utility is credible partial offtaker of power from IPP
Mines source from grid	Sufficient & reliable national power supply Cost of power low enough to act as disincentive to self-supply but high enough to achieve cost recovery Transmission infrastructure in place or manageable investment Management of mines' power demand so as not to saturate the grid Commercial frameworks provide incentive for mines to participate in infrastructure upgrades & development of power generation capacity

Source: Toledano, Perrine; Sophie Thomashausen; Nicolas Maennling; and Alpa Shah (forthcoming), *A Framework to Approach Shared Use of Mining-Related Infrastructure*, Vale Columbia Center on Sustainable International Investment, New York, New York.