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# Saving energy by replacing compressed air with localized hydropower systems: a 'half level' model approach

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Eskom's electricity supply constraint has focused attention on the need to save energy. One method of saving energy in the mining industry is to replace compressed air with high-pressure water hydraulics (hydropower) as an energy delivery medium to operations.

Localized hydropower systems (in contrast to either centralized or microhydropower systems) consists of modular, mineworthy, constant-pressure, positive-displacement pumps that serve one or more half levels via a local, small-bore reticulation system. This method of delivering energy is suitable for powering either new or existing mines and reduces the dependence on compressed air.

This paper examines the range of issues that affect changing from air to hydropower. Benefits for safety, health, environment and implementation are considered. It quantifies the efficiency, performance, power, energy, water consumption and costs for air, hydropower and electric handheld drilling. Refuge bays are discussed and a comprehensive range of hydropowered ancillary equipment is presented.

Finally, it is concluded that significant safety, health, environment, energy, cost and performance improvements are offered by hydropower. In addition, it opens the door for appropriate mechanization using simple hydropowered rigs that offer further gains.

## Introduction

In South Africa, hard-rock, narrow-reef, dipping-tabular orebody mining produced 59% of the R175 billion mining revenue generated in 2006<sup>1</sup>. This was predominantly mined using handheld, compressed air drills. On a deep-level gold mine, air compressors typically consume at least 25% the total energy required, compared with up to 40% on a large, shallow platinum mine<sup>2</sup>. Given the Eskom electricity supply constraint and significant energy price increases, alternative, more energy efficient technologies need to be considered.

This paper examines the use of high-pressure water-hydraulic (i.e. hydropower) as an alternative energy delivery medium to compressed air. In particular, a modular approach called 'localized hydropower', suitable for both new and existing mines, is proposed. The implications of replacing compressed air are considered under the following headings:

- Safety, health and environment
- Energy efficiency
- Drill performance and drilling requirements
- Water consumption and management
- Capital and operating costs
- Reticulation options: centralized, localized and microhydropower systems
- Pressure generation
- Ancillary equipment
- Refuge bays
- Key success factors
- Drill rig opportunity
- Technology maturity

Finally, these issues are discussed and a conclusion is drawn.

## Hydropowered mining

### Safety, health and environment

Hydropower has many built-in safety features, resulting in the safe reticulation and use of high-pressure water to power mines, save energy and improve the environment.

This has been demonstrated on the four centralized hydropowered mines and on numerous microhydropower sites.

Excess-flow control valves such as hose-fuses and safety isolation valves (SIVs) have been used widely for many years to isolate and safely minimize the release of energy in the event of a hose or pipe failure. The staple-lock hose-and-manifold system has also demonstrated ease of use and safety, ensuring that no hose or device can be installed without having upstream protection. The design of valve and piping systems is well understood and done in accordance with ANSI B31.3.

High-pressure water offers no electrocution or spark risk, and as a hydraulic medium, water is inexpensive, non-toxic, well understood and is already in wide use for dust suppression and cooling.

Hydropowered equipment is generally quiet. Water drills are faster than air drills and thus reduce the operator's noise exposure. With the correct hearing protection, handheld hydropower drilling meets the 2013 legislated noise requirements<sup>3</sup>. If fitted to drill rigs, noise exposure for the operator is further reduced.

Hydropower provides excellent local cooling if the water is cool. Indeed, this was one of the ideas behind the concept of hydropower: use water to deliver both ‘coolth’ and energy to the users at the face where it is required.

Unlike air drills, hydropower emits no airborne grease or unhealthy oil mist and does not contaminate the footwall or ore. Furthermore, the absence of fogging leaves visibility unimpaired and this enhances safety.

Dust suppression with hydropowered drilling is effective.

**Energy efficiency**

The relative effectiveness of various energy delivery mediums to deliver energy to the rock is shown in Figure 1 below.

The key result from this comparison is that compressed air is very much less efficient than all other energy delivery mediums. Even if the ‘after leaks’ factor on the air drilling is removed, compressed air still delivers less than 1/5 the energy of the alternatives.

To consider properly the total energy required, the comparison should include the energy to generate the pressure and to pump the water out of the mine. This is shown in Figure 2 for a localized hydropower system on a half level in a platinum mine.

Furthermore, the energy efficiency of hydropower reduces overall mine electrical demand and can create carbon credits under the clean development mechanism (CDM).

**Drill performance and drilling requirements**

Hydropowered drilling is faster than handheld air drilling at 450 kPa (4.5 bar) and air drilling is faster than electric drilling. Typical penetration rates are shown in Figure 3. Drilling in hard quartzite will be slower than in norite. Electric drilling penetration rates of 0.23 m/min have been reported at Tau Tona<sup>5</sup>.

The following drilling requirements have to be considered if compressed air is to be removed:

- Stope face drilling
- Gully advance drilling
- Stope roof bolting (where applicable)
- Stope preconditioning (where applicable)
- Raise and ledge development including roof bolting
- Ore pass development
- Flat-end development including roof bolting

DRILLING: % ENERGY DELIVERD TO FACE	EFFICIENCY OF COMPRESSOR OR PUMP	RETICULATION PRESSURE OR VOLTAGE DROP	ENERGY LEFT AFTER LEAKS	EFFICIENCY OF DRILL	OVERALL EFFICIENCY
Compressed air	58%	x 75%	x 18%	x 24%	= 2%
Oil electro-hydraulic	80%	x 80%	x 100%	x 36%	= 23%
Hydropower--pumped	85%	x 80%	x 95%	x 31%	= 20%
Hydropower--gravity	96%	x 89%	x 90%	x 31%	= 24%
Electric drill	100%	x 90%	x 100%	x 35%	= 31%

Figure 1. Relative effectiveness of energy delivered to the face for various energy delivery mediums used in drilling,<sup>4</sup>

- Long-anchor drilling
- Cover drilling
- Core drilling.

Figure 4 shows that there are hydropowered options for all drilling requirements.

**Water consumption and management**

The half level model shows that when drilling, hydropower drills demand a higher instantaneous water flow rate than either air or electric drills. (See the top row in Figure 5). However, the total amount of water used by hydropower drills is only about twice the amount used by either air or electric drills: 0.31 ton water per ton rock for hydro compared with about 0.17 ton water per ton rock for air and electric. This is because (a) more of the slower drills air and electric drills are required, and (b), these use water for the entire shift period, not just when drilling. (The Sulzer ADDS air drill and the Seco S215 AWS drill, like hydropowered drills, shut the water off when not drilling. The electric drill, however, requires water for cooling of the motor and this may flow for the entire shift or longer.)

ENERGY USAGE (MWh) HALF LEVEL MODEL	H/held air drill (S215)	H/held hydro drill	H/held elec drill
Input energy for drilling (MWh)	12.00	0.87	0.29
De-watering pump energy per shift (MWh)	0.42	0.76	0.39
Total energy per shift (MWh)	12.42	1.63	0.68
Energy per year (MWh)	4535	451	187
Annual cost of electricity at R0.25 per kWh (R millions)	1.13	0.11	0.05
Electricity cost saving per year compared with compressed air (R millions)	0.00	1.05	1.09
Energy saving relative to compressed air	0%	90%	96%

Assumptions: Input energy is into compressor for air, into hydro pump for hydro and into drill for electric drill. (The compressed air calculation conservatively ignores leaks and wastage. These losses can be many times the actual energy used by the air drills.) The dewatering energy calculation assumes a 1 100 m pumping lift and 70% efficient dewatering pumps and includes only drilling water. Air compressors are assumed to run every hour for every day of the year. Hydro pump and electric drills only run when drilling.

Figure 2. Total energy usage for drilling and dewatering a half level designed to produce 13 100 tpm using different drilling methods

DRILL AND HAMMER PERFORMANCE	H/held air drill @ 450 kPa (S215)	H/held Hydro drill	Hydro drifter	Hydro ITH hammer	H/held electric drill
Hole dia. (mm)	34	36	43	115	34
Penetration rate in Norite (m/min)	0.28	0.65	1.00	0.50	0.13
Penetration rate in UG2 reef (m/min)	0.40	>1.0	n/a	n/a	0.30
Input Power * (kW)	9.2	13.8	33.6	52.5	2.2
Pecussive Power (kW)	2.1	4.1	9.9	20.0	0.7

\*This is the power at the supply hose or cable. This excludes inefficiencies in the generation or distribution of the power

Figure 3. Drill and hammer performances in norite and UG2 Reef. The penetration rates used in this calculation will vary with rock type, bit, etc., but are intended to show the relative performances of the different machines. (Note: ITH = in-the-hole)

	Stope face	Gully	Stope roofbolt	Pre-conditioning	Raise development	Ore-pass	Flat end dev	Long anchor	Cover	Core
H/held air drill	yes	yes	yes	yes	yes	*	yes			
Air drifter (e.g. S36)						yes	yes			
H/held hydro drill	yes	yes	yes	yes	yes	*	yes			
Rig mounted hydro drill	yes		yes	yes	yes		yes			
Hydro drifter						yes	yes	yes		
Hydro ITH hammer						yes			yes	#
Drifter oil-hydraulic	yes	yes	yes	yes	yes	yes	yes	yes		
H/held electric drill	yes	yes	#	#	#	*	#			
Diamond drill									yes	yes

\*Handheld dev. of ore passes is considered high risk  
#Limited and/or slow

Figure 4. Drilling machine options. ‘yes’ indicates that the drill is suitable for the application. (Note: ITH = in-the-hole)

DRILL OPTIONS DRILLING WATER USAGE HALF LEVEL MODEL	H/held air drill (\$215)	H/held hydro drill	H/held elec drill
Water flow rate per drill excl. wastage (l/s)	0.18	1.00	0.12
Water per day (ML/day)	0.10	0.18	0.09
Water per 23 day month (ML/mnth)	2.3	4.1	2.1
TON WATER / TON REEF	0.17	0.31	0.16

Assumptions: 13,100 tpm production. Air and electric drills consume water for 6 hours per shift. Hydro drills only use water when drilling

Figure 5. Estimated water consumption for drilling

The key point here is that hydropower drilling, despite higher peak flows, consumes modest volumes of water despite perceptions to the contrary.

The drilling water consumptions calculated in the half level model are typically lower than are actually used in most mines. Most of the additional water consumed is wastage (e.g. valves unnecessarily left open, leaks, etc.) and unnecessarily increases mine dewatering costs.

If additional cooling water is necessary, then this water consumption should be viewed as part of the overall refrigeration plan.

Water jet cleaning, if used, will produce an additional 0.4 ton/ton given two jets operating at an average 2 l/s for 3 hours cleaning 100 tons reef.

In all mines using water, dirty water management systems are required and should include the following:

- Pick the water up at the earliest possible opportunity and put it in a pipe. This can be done with an inexpensive, simple, ‘no-moving-parts’ jet pump. Other options, such as up-dip scraping, are also feasible
- Always design ore pass box front chutes to have drainage slots, remote operation and to have powerful closing actions. The law demands compliance with SABS 0208, which assumes that the ore pass is full of water/mud/rock
- Where applicable, use on-level recirculation and local water treatment to reduce pumping costs.

The use of jet pumps to ‘suck up’ water in the strike gully at the bottom of the stope panel is known as ‘dry hydropower’, not because there is no water on the stope footwall, but because the water is sucked up and put into a pipe at the earliest possible time. This avoids excess water or mud in the raise and orepass. Once in a pipe the water can gravitate down the raise and either feed directly into the dirty water pipe or into the vertical spindle pump (VSP) sump.

Water management and mud rushes are issues in all mines that use water and are not peculiar to hydropower. Failure to correctly manage water will result in mud and local flooding in any mine. This is particularly important in the sinking and early production phase of a mine before permanent dewatering facilities are in place.

**Capital and operating costs**

The half level model shows that localized hydropowered mining is less expensive than either compressed air or electric drilling. This concurs with several propriety studies by respected independent mining consultants (e.g. Turgis Consulting).

The results of a half level model in a platinum mine are summarized in a bar chart in Figure 7. This model is for handheld drilling in 5 stope panels, a raise and a development end. Capital costs are amortized over the life of the equipment and added to the maintenance costs.



Figure 6. A ‘dry hydropower’ jet pump in a gully lifting water from the footwall and pumping it to a pipe

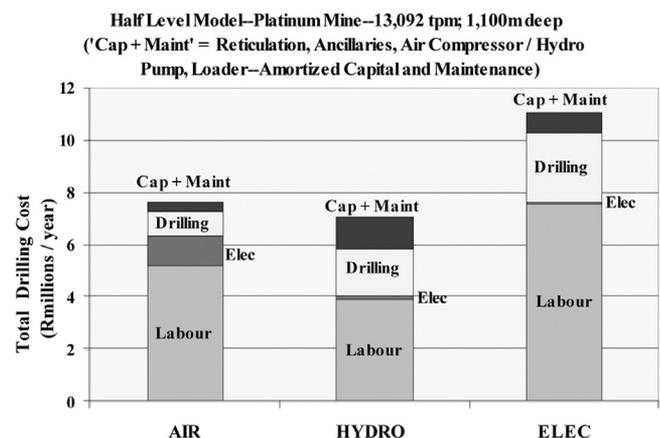


Figure 7. Estimate of capital and operating costs for a half level localized hydropower system

Electric drills have thus far shown themselves to be most suited to drilling holes about a one metre long in the stopes. The longer holes required for raises and flat ends have generally been drilled with other drills. If compressed air is to be removed from the mine, then hydropower is more suited to drilling the longer holes required for development.

**Reticulation options**

Centralized hydropower systems like Northam Platinum, Tau Lekoa, Kloof 4# and Beatrix 3# typically have a large flow rate capacity (200 to 400 l/s) and are initially capital intensive due to the large-bore high-pressure piping. Of these four systems, two are pure gravity while two are gravity plus a surface booster pump. At the other extreme are micro hydropower systems (2 to 10 l/s), which only require small bore piping (50 NB and less) and supply a network typically less than 0.5 km long.

In between these extremes, is a new localized hydropower system (20 to 40 l/s), which is also pump fed and has a network of small-bore piping (80 NB and smaller) less than about 1 km long. Such a system would power a half level. The emergence of localized hydropower fills a gap and permits the retrofitting of hydropower into a conventional compressed air mine. This means that hydropower can now be installed in any operation: new or existing; large, medium or small. This flexibility addresses the misconception that hydropower technology is suitable only to either large centralized systems or microsystems.

**Pressure generation**

Any pump suitable for generating hydropower pressures in either localized or microhydropower systems should be:

- Efficient
- Matched in size to the flow and pressure duty
- Able to vary delivery to meet the varying demand from mining i.e. controllable from zero to 100%
- Mineworthy in a hot, humid, dusty, fume-laden atmosphere and able to tolerate mine water of variable quality, dirt loading and suction pressure
- Reliable and maintainable (preferably on a service exchange basis)
- Compact and easy to transport and reposition as mining moves forward
- Cost-effective.

The constant-pressure, positive-displacement pump emerges from Figure 9 as the most suitable type for localized hydropower, followed by conventional plunger pumps. Centrifugal pumps are more suited to larger systems from 70 l/s upwards.

The constant-pressure pump is under development and should be available in 2009.

**Ancillary equipment**

It is not possible to remove compressed air from a mine if alternative equipment is not available to carry out the operations powered by compressed air. The list below illustrates that a comprehensive range of equipment exists. The main South African suppliers include Cemo Pumps, HPE, MME, Novatek, Sulzer and Trucking and Engineering. Sweden's Wassara is an ITH hammer supplier. The author is aware of several other suppliers about to enter this market.

1. Anfo-loader: hydrocompressor with hopper, anti-static hose and lance.

2. Blast-hole cleaner with lance for flushing and de-watering blast-holes.
3. Box-front chutes: hydropowered with slots and remote control with fail-safe self-closing on loss of power.
4. Cannon: Ekskalibur water cannon for stope cleaning.

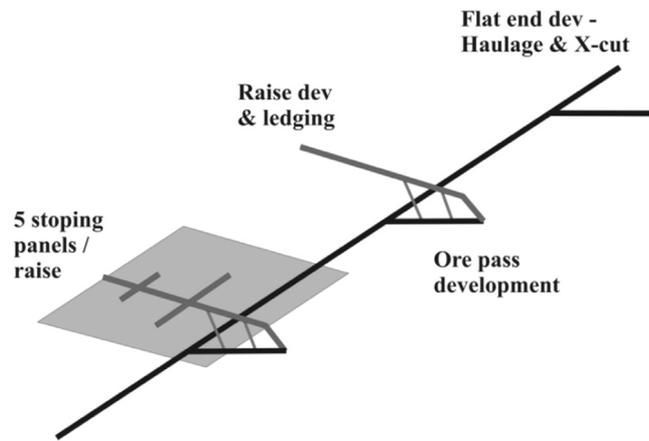


Figure 8. A typical half level layout. (Note: This is not to be confused with the term 'half level' meaning an inter-level between two levels)

HYDRO PUMP-- POSITIVE DISPLACEMENT OPTIONS	Positive displacement (Constant pressure type)	Positive displacement (Plunger type)
	Efficiency	87-90%
Pressure	Any	Any
Flow	Any	Any
Capacity control	Built in	Unloader; VSD &/or
Mineworthiness	Good	Good
Dirt tolerance	Good	Moderate
Suction pressure	Flexible	Flexible

HYDRO PUMP-- CENTRIFUGAL OPTIONS	Centrifugal Multistage (Mine de-watering type)	Centrifugal Multistage (Boiler feed pump)	Centrifugal Pitot (Rotojet)	Centrifugal (Tangent type)
	Efficiency	75%	70 - 80%	40 -60%
Pressure	< 12 MPa	> 12 MPa	14 MPa	14 MPa
Flow	>70 l/s	>20 l/s	5-40 l/s	5-40 l/s
Capacity control	VSD &/or by-pass	Built in	Built in	Built in
Mineworthiness	Good	Poor*	Good	Poor*
Dirt tolerance	Adequate	Poor	Good	Poor
Suction pressure	Can be critical	Flexible	Flexible	Critical

Figure 9. (a) Positive-displacement hydropump options, (b) Centrifugal hydropump options

5. Capsule gun for grouting roof bolts and shepherd's crooks.
6. Cementation pump drive: automatic reciprocating cylinder.
7. Chain-hoist: 3 ton.
8. Chainsaw: hydropowered.
9. Cylinders: hydropowered (various sizes, stokes and pressure-ranges).
10. Cylinders: low-pressure water powered to replace air cylinders when air is removed, e.g. box-front chutes.
11. Cylinders: shaft-bottom loading rock skips complete with interlock valves.
12. Development end rig: various types.
13. Diamond-drill drive: turbine motor for cover drilling
14. Drifter: HPE with reversible rotation (under development).
15. Drills: hydropowered, handheld (High-press. 14–18 MPa, medium-press. 10–12 MPa, low-press. 8–10 MPa).
16. Explosive mixers (under development).
17. Fans: hydropowered, which also provide very effective cooling; various sizes.
18. Grout pump for grouting roof bolts and shepherd's crooks.
19. Hammers: in-the-hole.
20. Hydrocompressor for either grout capsules or explosive cartridge blowing.
21. Jet eductor: refuge bay ventilation, cooling, scrubbing and pressurization using low-pressure water (prototype manufactured).
22. Jet pumps: large bore for dam cleaning and shaft-bottom dewatering using pump column head; small bore for dewatering development ends and 'dry hydropower' (versions powered by mine service water are also available).
23. Jetting gun: cleaning stopes (with or without scraper), drains and development ends.
24. Loader: hydropowered, track-bound 100–150 tph hopper loading rate.
25. Long-hole rigs: for ore passes, drain holes, etc.
26. Manifolds, piping and hoses with either quick-connect staple or taper-hub/clamp connections (NW6 to 300 NB).
27. Mesh and lacing rig: single drill boom and mesh roll installation arm (under development).
28. Motors: positive displacement (high torque, low-speed: 750 to 300 Nm) and turbine driven with integral reduction gearboxes.
29. Power packs and pumps.
30. Raise rig: for raise and travelling way development and ledging.
31. Raise transporter: mounted on monorail to provide logistical support for stoping and equipping (able to transport a 2 ton winch).
32. Stope drill rig and jigs: various types available and/or under development.
33. Stope jig: various types.
34. Stope roofbolter: self-standing type with twin stingers and free-standing tripod type.
35. Support roof-bolter rig: single boom unit to support scissors type flat end development rig and twin boom unit for secondary support drilling.

36. Sweeping tool.
37. Universal rig: 2 boom rig for flat end development
38. Ventilator cooling jet.
39. Water-blast for fume and dust suppression in development ends.
40. Watering-down guns: various types.

### Refuge bays

Refuge bays have to be provided with fresh air (oxygen), cooling, a positive pressure, and the exhaled carbon dioxide has to be diluted. In compressed air mines this can be done with compressed air. Where compressed air has not been available, chemical oxygen generators have been installed in purpose, built containers. This is done in Canada and elsewhere.

In mines that have had compressed air, it is possible to use the existing piping to draw air from the surface and deliver it to the refuge bays. This can be done by replacing the compressor with a low-pressure 'blower' on surface and pressurizing the pipe network to a low pressure e.g. 30 to 80 kPa. This will not be energy hungry and is an easy conversion option.

A variation on this use the existing piping is to keep compressed air at full pressure only in the shaft area (where leaks can be managed) and then reduce the pressure supplying the haulage pipe, thus achieving the same result.

Both approaches will necessitate blanking off cross-cut take-offs to avoid wasteful leaks though the old, disused piping.

In new mines the refuge bay can be supplied with a small-bore dedicated air reticulation system.

### Key success factors

Introducing localized hydropower and removing compressed air in an existing mine is a significant technology change and must be addressed as such. Change management is therefore important. Key issues include:

- A strategic commitment by senior management
- Acceptance by operators and organized labour
- A detailed implementation plan
- Training (not just operators, but also senior and middle management)
- Understanding of the differences between air and hydropower (e.g. 'off-collar' drilling due the increased thrust requirements of the more powerful drill)
- Pipe sizing that must meet peak flow demands
- Dirty water management (discussed above)
- Drill, pump and ancillary hydropower equipment maintenance
- Different drill steels, bits, holes sizes, etc. that may affect existing drill patterns and explosive designs
- Logistics requirements (these will be greater than in traditional compressed air mines)
- Electrical reticulation to underground pumps
- Conversion of all other air operated equipment and the selection of ancillary equipment
- Equipment issuing and control (e.g. a stainless steel 'combi valve' is more expensive than a low-pressure, cast iron ball valve and unless controlled will increase operational costs unnecessarily)
- Appropriate incentive schemes
- Selection of the right people (e.g. selecting persons 'stuck in their ways' or unsuited for new challenges will not assist the implementation).

Failure to manage these factors will result in unnecessary delays, reduced production and higher than budgeted costs.

### Drill rig opportunity

If drill rigs are used instead of handheld drilling, then the operator can be moved away from the face and under permanent support out of the 'high risk' zone. This immediately addresses the major fatality causation factors shown in the dotted box enclosing right hand half of Figure 10.

The introduction of simple hydropowered drill rigs in development ends has been demonstrated over the last decade. Stope drill rigs are at an earlier stage of development and have yet to achieve a similar success. Mechanizing stoping is the one of the greatest 'yet-to-be solved' challenges in hard-rock, narrow-reef mining.

The need for mine safety is of paramount importance and for this reason alone mechanization using drill rigs must be pursued.

Mechanization offers many additional benefits that will arise from accurate drilling. These include broken rock of the correct fragmentation, minimum overbreak, a smooth hanging- and footwall, minimum damage that requires additional support, maximum advance, and a straight face that lends itself to repeating the process in the next cycle. For the mine manager, these benefits translate into faster development, and on the reef horizon, more face advance and better grades.

In addition, drill rigs offer the operator a much more attractive job that is far less physically demanding.

The full analysis of the cost-benefit of the various hydropower drill rigs is outside the scope of this paper, but clearly moving from compressed air to hydropower opens the door to this opportunity.

Viewed in this light, the strategic use of localized hydropower can be seen as not only a means of reducing dependence on compressed air, but as an opportunity to prepare for appropriate mechanization using simple hydropower drill rigs.

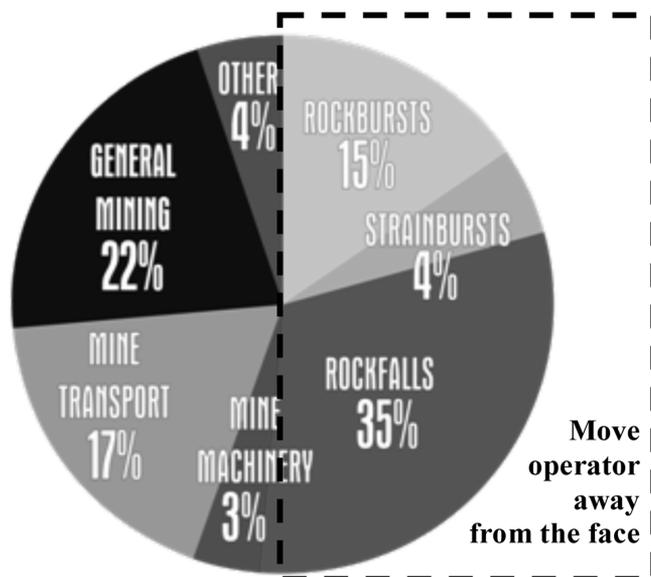


Figure 10. Mine death causation factors<sup>6</sup>

### Technology maturity

Hydropower was conceived in the 1970s as a means of powering and cooling the working area at the face. It has been totally relied on since the 1990s at Northam and subsequently elsewhere. It has seen tremendous growth in the past decade with the development of appropriate mechanization drill rigs and ancillary equipment in 'micro-systems' powered by power packs.

Unlike compressed air technology, which has its roots in the 1871 patent of the pneumatic rock drill, and is at the 'maturity stage' of its life cycle, hydropower technology is in the 'growth stage' of its life cycle.

Hydropower drill life exceeds 500 metres drilled between services at one major mine and this is equivalent to that achieved by standard compressed air drills. The drill maintenance cost per metre drilled has come down substantially in real terms.

Because hydropower is still growing and evolving, there are many areas in which innovation and improvement are possible. These include opportunities for cost reduction due to economies of scale and better engineering designs. There is also a need for better training materials.

Two particular elements that are still under development include the hydropowered drifter and better variable-output pumping systems. These offer a further leap forward when available.

Given the need to reduce dependence on compressed air and the upside that hydropower offers, the relative 'newness' of the technology is not reason enough to dismiss hydropower.

### Discussion

Both handheld hydropower and electric drills offer health and environment benefits over compressed air. Noise levels for electric drilling are particularly low, but unlike hydropower drilling, which can cool the local environment, electric drills add heat.

Both handheld hydropower and electric drills are much more efficient than compressed air drills, but hydropower offers superior drilling speed.

Hydropower also offers a complete suite of drilling solutions for all applications across the mine.

Handheld electric drills are primarily suited to short-hole stope drilling until a more powerful unit is available. If compressed air is to be removed from a mine, other drilling solutions are needed for flat-end drilling and ore-pass development. Hydropower is the obvious energy delivery medium for development, thus creating the possibility of a hybrid system: with (a) electric stope drilling (with 'dry hydropower' ancillary equipment) and (b) hydropowered development.

A half level model for platinum mine shows that the overall drilling water consumption for hydropower drills is modest at about 0.31 tons water per ton rock. Compressed air and electric drills consume just over half of this volume.

The relatively new concept of 'dry hydropower', which makes use of jet pumps to 'suck up' water in the strike gully at the bottom of the stope panel and put into a pipe at the earliest possible time, addresses concern about excess water entering ore passes. This concept has also been used in conventional compressed air mines and in electric drilling stopes to keep the rock 'dry' using jet pumps powered by low-pressure mine service water.

Importantly, a simple half level model indicates that hydropower is the most cost-effective energy delivery medium.

Unlike centralized hydropower systems, localized hydropower systems can be installed in new and existing mines. They offer a reduced dependence on compressed air and a means of introducing hydropower gradually on a half level basis. This is turning point in the accessibility of hydropower for conventional mines and has never been a serious consideration previously.

The development of the constant pressure pump (CPP) due in 2009, offers an improvement to the standard plunger pump power pack, which has been in use for many years.

Other concerns about removing compressed air have revolved around refuge bays and ancillary equipment. Both these issues have been addressed and suitable solutions exist. Refuge bays can be supplied with low-pressure air through existing pipes and a comprehensive range of both low- and high-pressure water powered ancillary equipment is available.

The lessons of previous hydropower initiatives, and the current maturity of the technology, reassure those considering hydropower that it is the most appropriate technology choice in the face of the Eskom electricity supply constraint.

Finally, a comprehensive range of simple hydropower drill rigs fitted with high-power rotary percussive devices offer substantial safety and productivity improvements over handheld drilling.

### Conclusion

Localized hydropower is an energy efficient energy delivery medium that can be used to reduce or eliminate dependency on compressed air. If properly implemented, the use of localized hydropower offers, a safe, clean, efficient, powerful, fast, 'single hose', cost-effective, proven alternative to compressed air with significant upsides.

A full suite of ancillary equipment is available to replace existing air powered equipment and solutions exist for refuge bays.

With a drilling water consumption of about 0.31 ton water per ton reef and appropriate dirty water management systems, the 'fear of excess water' can be addressed.

Localized hydropower can be used in a hybrid system with electric stope drills to power ancillary equipment and development drilling.

Importantly, it offers a strategic opportunity to prepare for appropriate mechanization using simple hydropower drill rigs.

Localized hydropower can be incrementally implemented in new and existing mines and, in the process, offers benefits to all stakeholders: shareholders, management, organized labour, Eskom users and the nation.

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### Peter Duncan Fraser

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Peter Fraser is a Professional Engineer and holds Masters degrees in both Mechanical Engineering and Business Administration. He started his career with the Chamber of Mines Research Organization and has been with Hydro Power Equipment (HPE) since 1998 where he heads the Innovation segment. HPE has developed the use of high-pressure water (hydropower) to power mining equipment, to improve the local working environment and to save energy—and in doing this HPE has become the hydropower industry leader. Peter is a member of the SA Institution of Mechanical Engineers and The SA Institution of Mining and Metallurgy.

