



DUNDEE SUSTAINABLE TECHNOLOGIES

CLEVR
PROCESS™

GLASSLOCK
PROCESS™

Novel Metallurgical Processes for the Mining Industry

Company Overview

Dundee Sustainable Technologies (DST) is engaged in the commercialization of environment-friendly technologies for the treatment of materials in the mining industry.

- » **Invested \$45 million** developing its processes
- » Technologies **successfully demonstrated** and ready for commercialization
- » **46 patents** in 16 countries



DUNDEE RESOURCES





Industry Challenges

Environmental

- » Cyanide
 - Jurisdictions have banned or restricted cyanide
- » Arsenic
 - Industry is turning to deposits with greater concentration of arsenic
 - Few facilities currently treat high arsenic material
 - Industry requires a permanent arsenic disposal process

Metallurgical

- » Gold recovery from refractory ores
- » Base metals, tellurium or organic carbon in gold ores



DST Solutions

CLEVRPROCESS™

- » Cyanide-free gold extraction
- » No liquid effluents
- » Refractory ores

GLASSLOCKPROCESS™

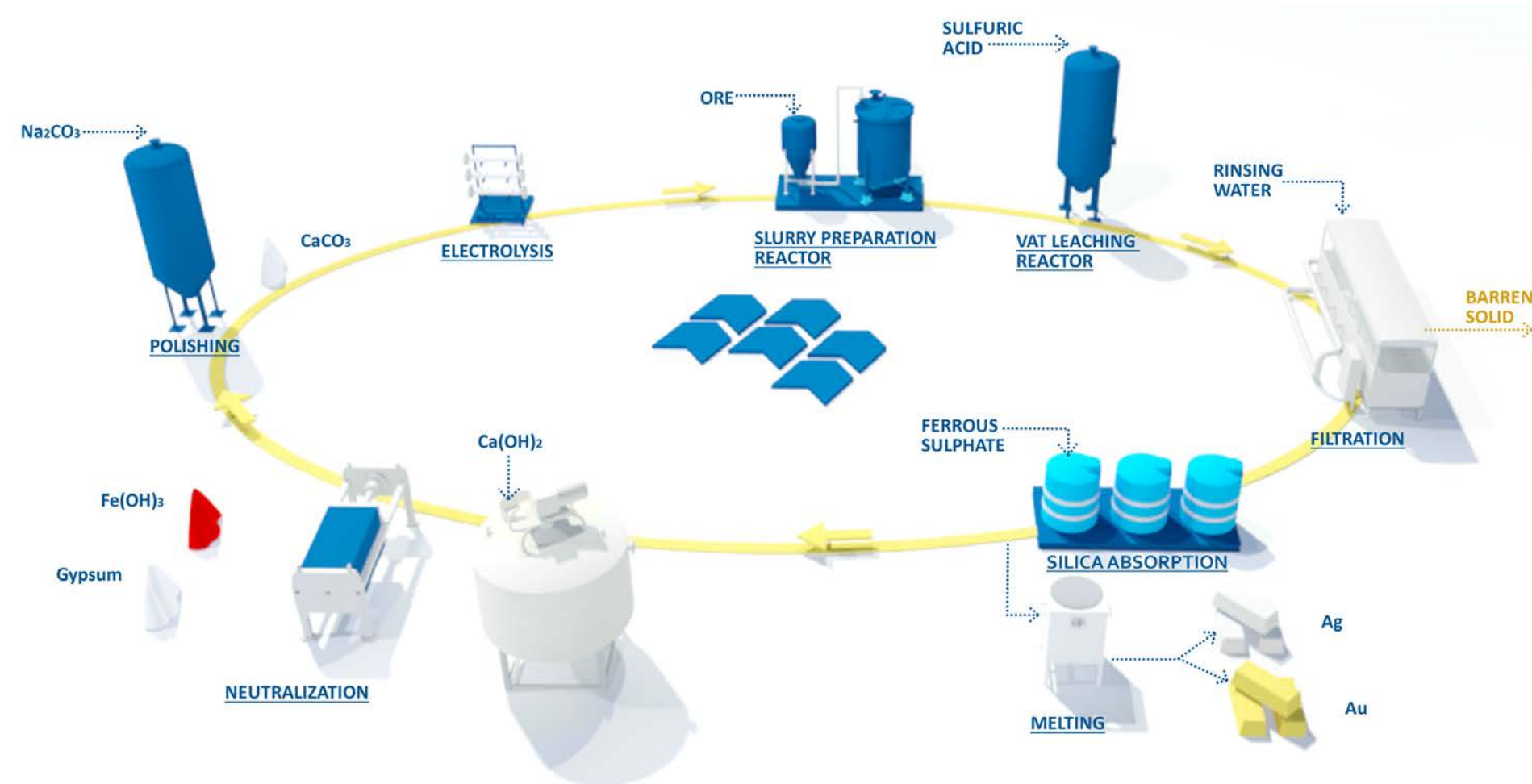
- » Arsenic stabilisation
- » Allows access to complex ores
- » Permanent disposal solution



CLEVR PROCESS™

DST's Industrial Plant
Thetford Mines, Qc

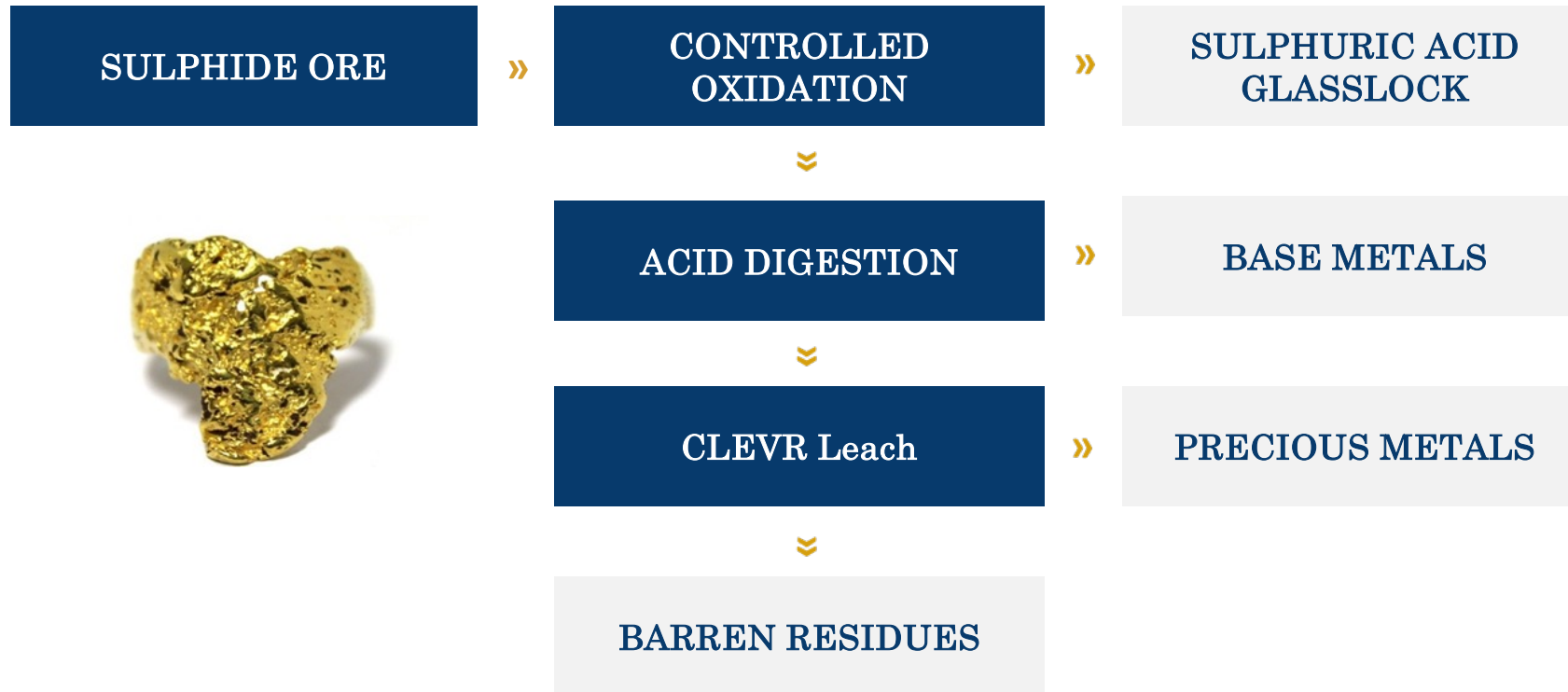
CLEVR Process – Closed Loop Circuit



ISO 14034:2016
Environmental Management
– Environmental Technology
Verification (ETV)



CLEVR Process – Overview



eWaste – Local Processing

Leveraging DST's Thetford Mines Plant

- » Electronic waste represent a new product stream for the application of CLEVR



CLEVRPROCESS™



CLEVR Process – Commercial Drivers

- » Increased **Gold Recovery**
- » Chemistry, **Cyanide-free** gold extraction
- » Efficiency, **2-hour** Reaction time

Process Costs

- » 150 tpd up to **15,000 tpd** ROM Plant Designs
- » Competitive OPEX
- » Competitive CAPEX, **Reduced Plant Footprint**



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DST's Industrial Plant
Namibia, Africa

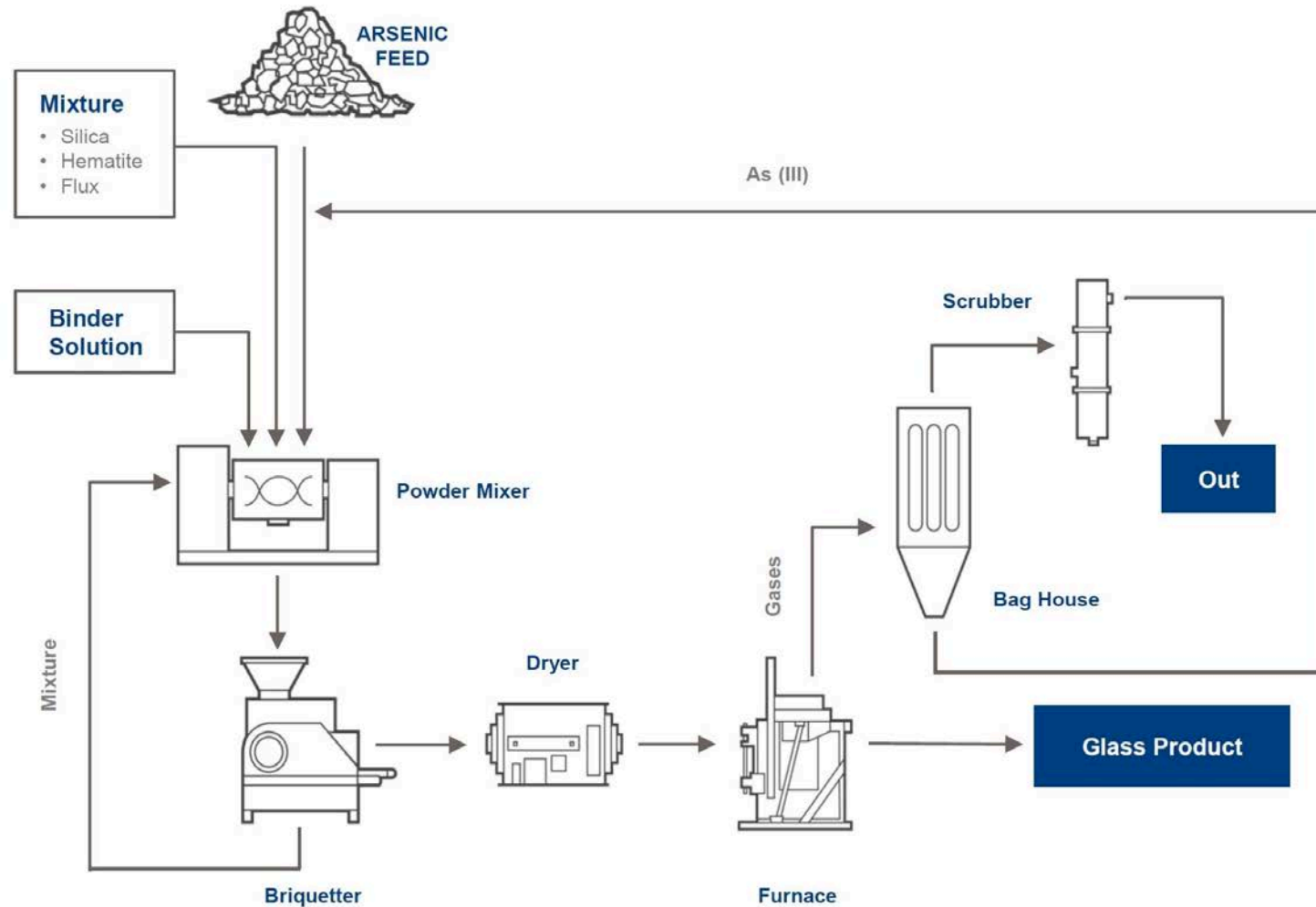


GlassLock Process – Arsenic Stabilization

- » Stabilization by vitrification
- » Intermediate compound that can sustain vitrification temperature
- » Produces glass with over >15% As
- » EPA's TCLP (5 ppm) Compliant
- » Widely available reagents / equipment



GlassLock Process – Circuit



Arsenic Glass Product

Glass Samples & TCLP

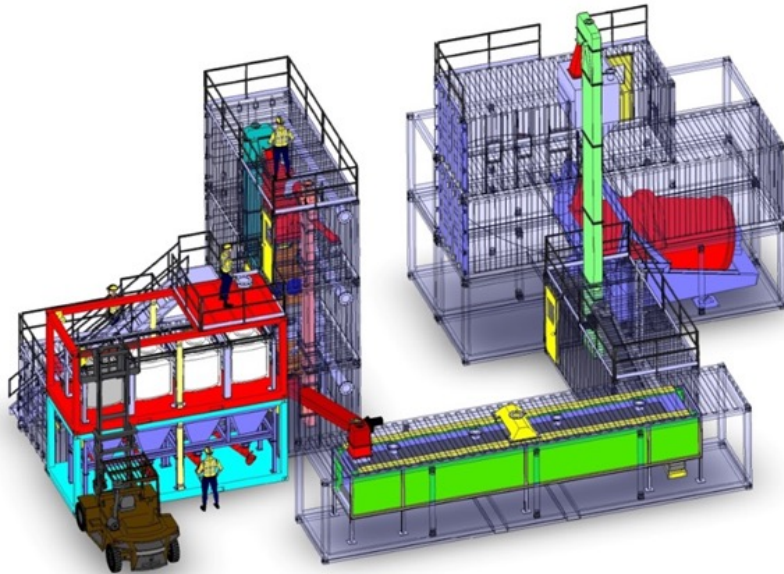
	Sample 1	Sample 2
As (%)	17.5 %	18.1 %
TCLP		
As (mg /L)	1.79	1.95

- » Glass density: 2.7
- » Amorphous/single phase silica matrix
- » Contaminants such as **Sb**, **Cd**, **Bi**, **Te** and **Pb** present in the dusts would also be encapsulated within the glass product.



Industrial Demonstration Plant – African Smelter

Plant constructed by DST and shipped to an operating base metal smelting facility. Designed to stabilise up to **1,600 tonnes per year of arsenical dusts** and produce **4,000 per year of glass product**.



*..." Various options were investigated – Vitrification was the most viable option"
- owner*

GlassLock Namibia Plant



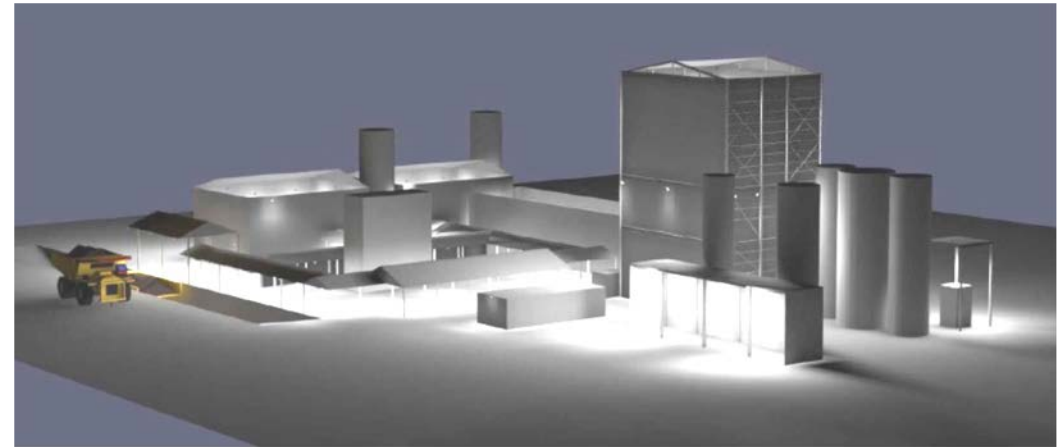
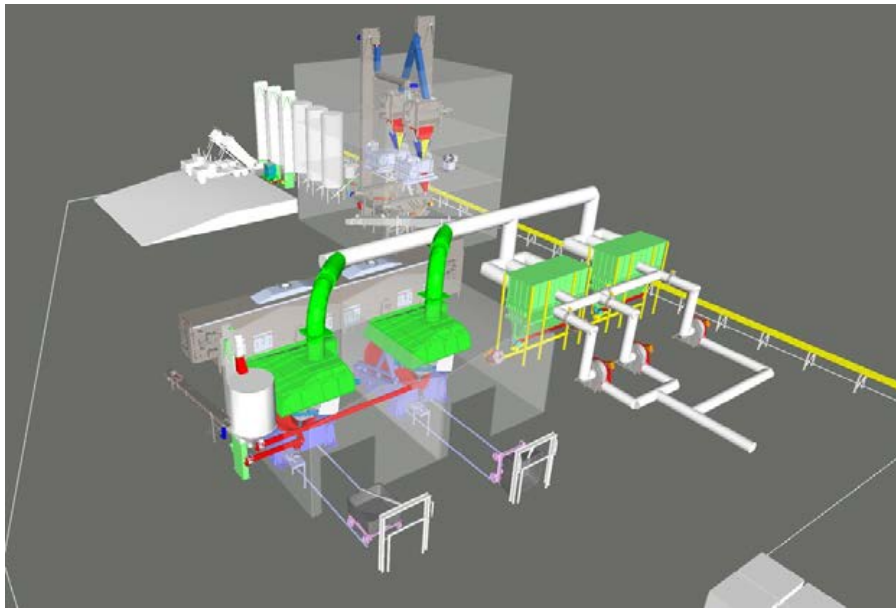
Glass Product Handling and Transport



Arsenical glass product handling & transport by truck to a determined disposal site

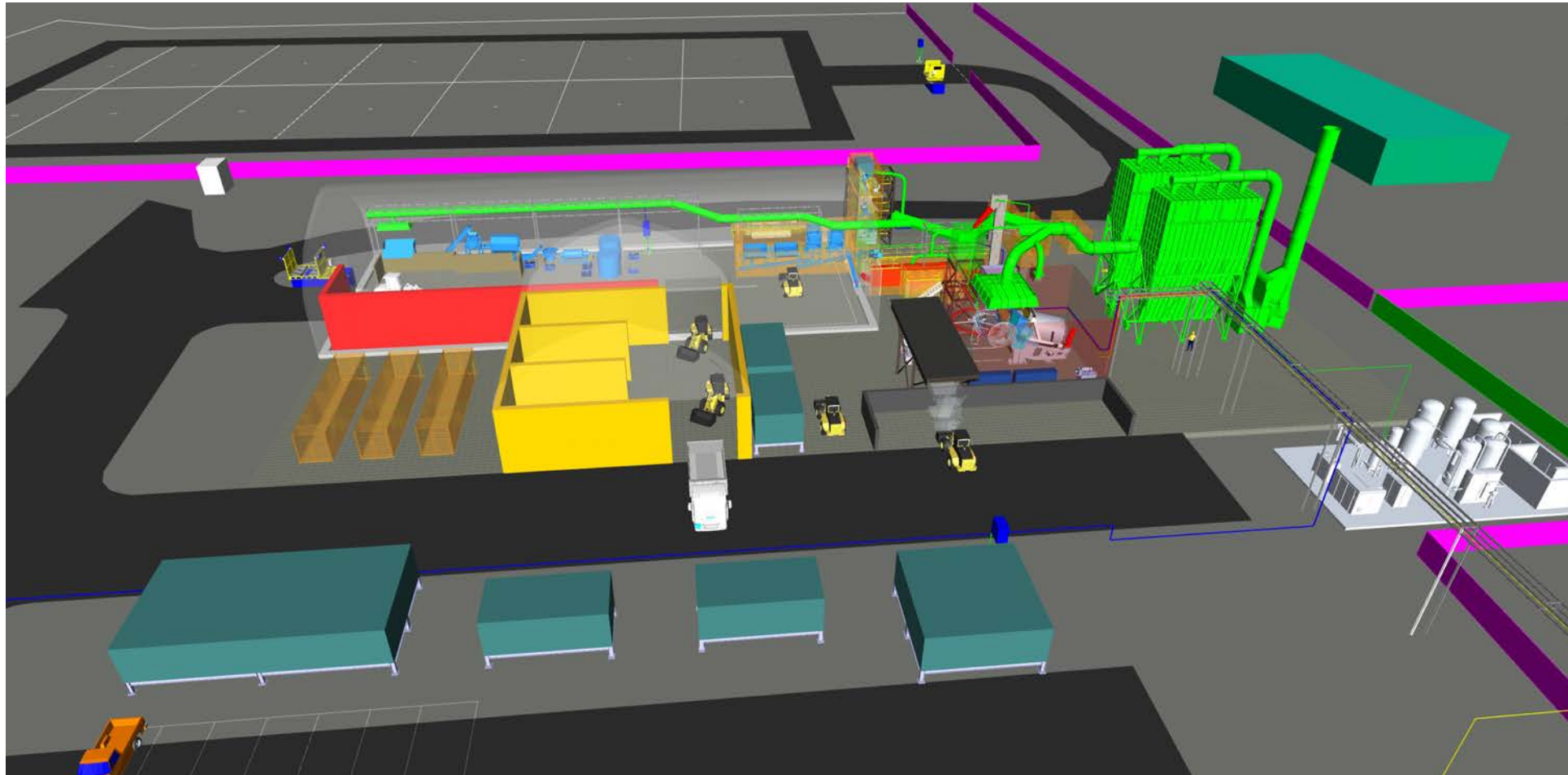
Copper Smelter – Full Scale Implementation

A full-scale plant designed and capable of producing **>150,000 tonnes per year of stable arsenical glass product.**



Designed, Engineered and Delivered by DST in return for **Technology Royalty Payment**

Africa Plant #2 – Overview



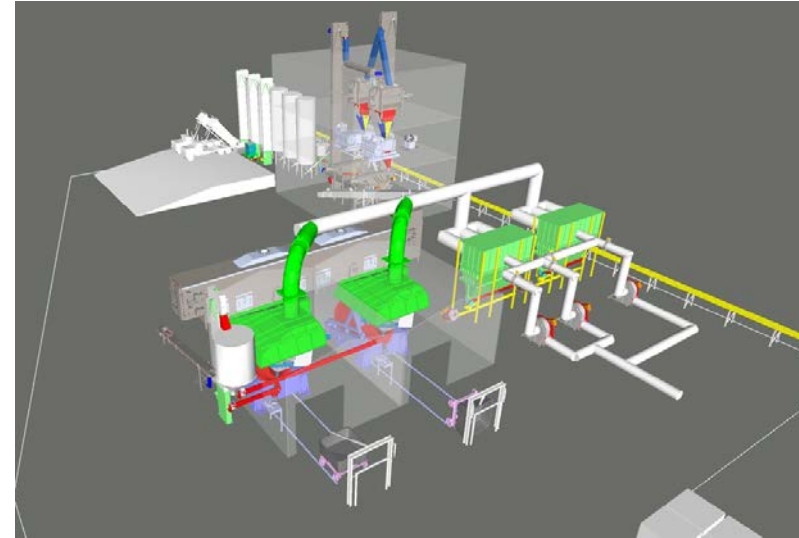
GlassLock Process – Arsenic Stabilization



Demonstration plant

~4,000 TPY of stable arsenical glass product.

800 TPY of stabilised As



Full-scale plant

>100,000 TPY of stable arsenical glass product.

20,000 TPY of stabilised As

Arsenic Bearing Concentrates – DST Approach

Remove and stabilize the arsenic content from complex mineral concentrates

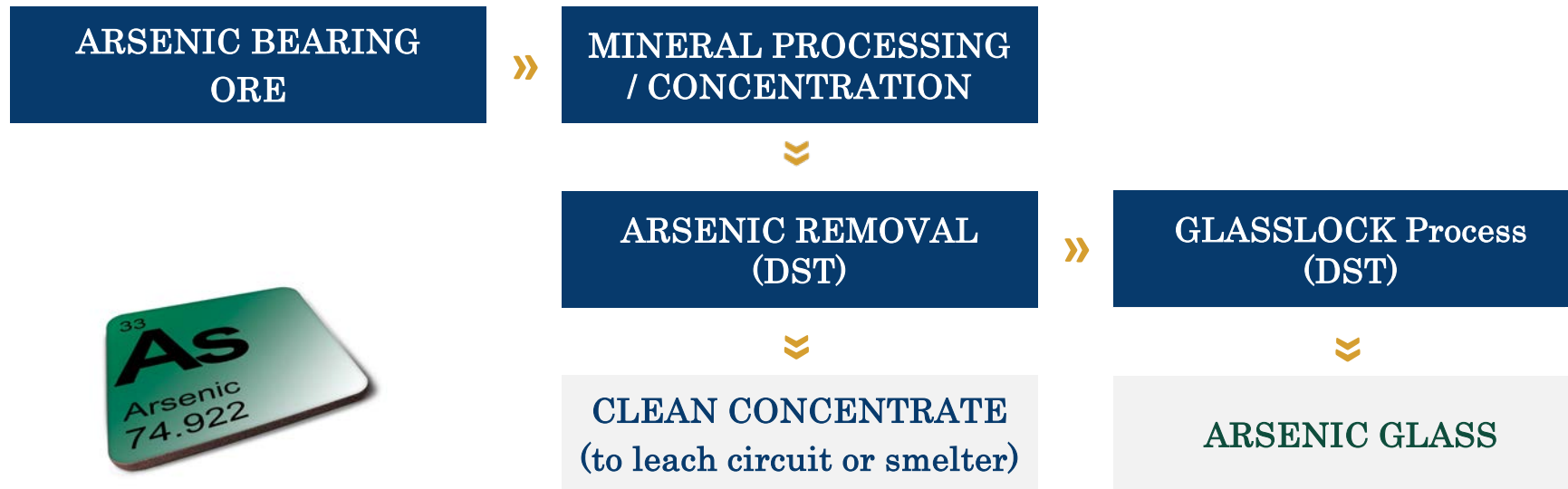


Offset the costs imposed to complex concentrates by smelter penalties or associated to POX operations



Provide a viable outlet for complex concentrates and leverage technology for the acquisition and development of complex deposits

Arsenic Bearing Concentrates – DST Approach





GlassLock Process – Commercial Drivers

- » Product **Stability**, Quality Arsenic Glass Product
- » Process **Flexibility**, Adapts to Feed and Operation
- » **Arsenic Removal**, Unlocks Operations & Opportunities

PROCESS COSTS

- » 1,000 tpa up to **50,000 tpa** treatment Plant Designs
- » Improved OPEX **<US\$1,000 per tonne of As**
- » Advantageous CAPEX & **Alternative Treatment Flowsheet**



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