



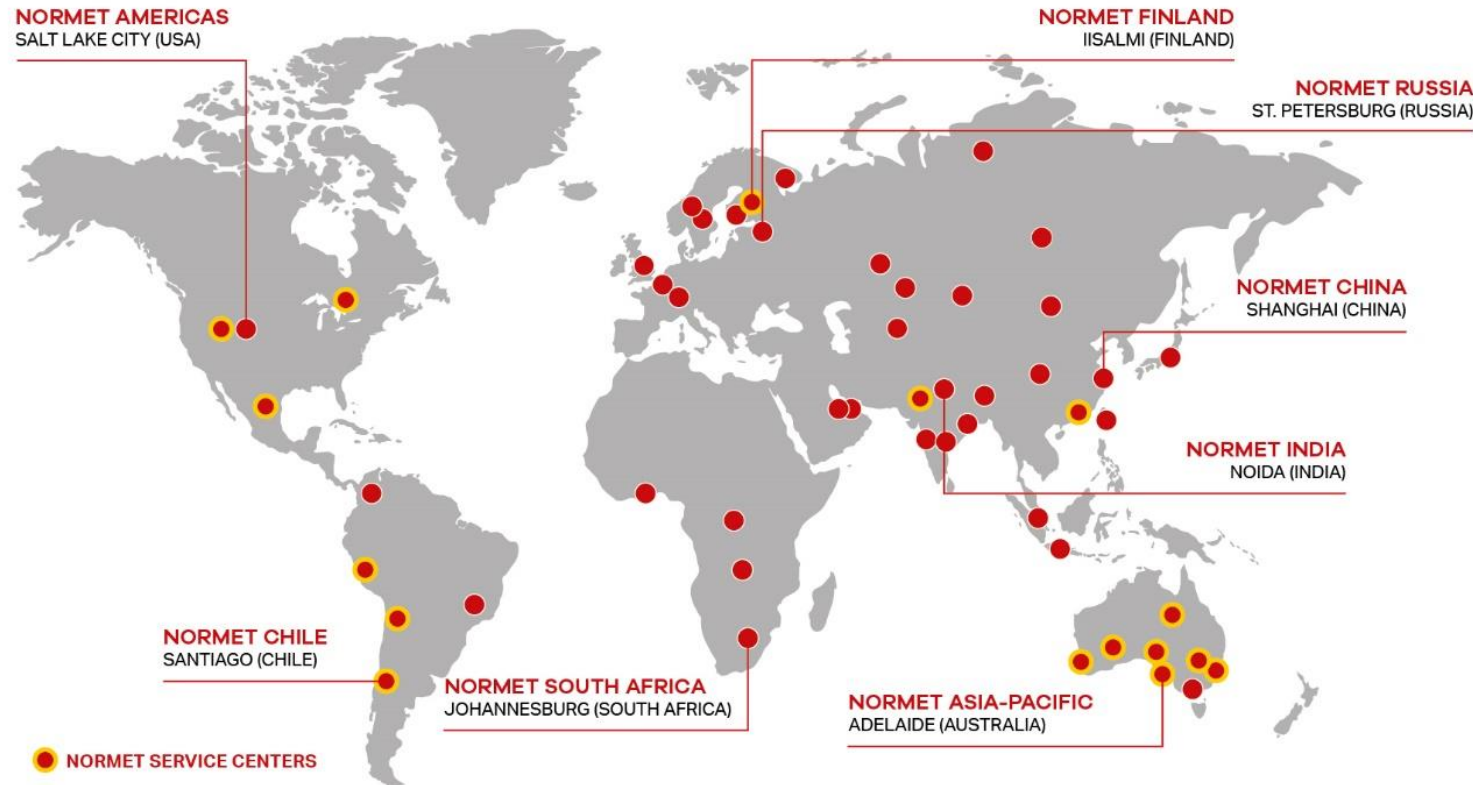
Sustainable Solution for Sprayed Concrete in Underground project

Sourish Nanda

DEFINING THE FUTURE UNDERGROUND

normet

AS GLOBAL AS POSSIBLE AS LOCAL AS NECESSARY



NORTH AMERICA
Canada
Mexico
USA

SOUTH AMERICA
Brazil
Chile
Colombia
Peru

EUROPE
Finland
France
Norway
Russia
Sweden
Switzerland
United Kingdom

AFRICA
Democratic Republic of Congo
Ghana
South Africa
Zambia

ASIA
China
Hong Kong
India
Indonesia
Japan
Kazakhstan
Mongolia

Qatar
Russia
Singapore
Taiwan
United Arab Emirates
Uzbekistan

AUSTRALASIA
Australia

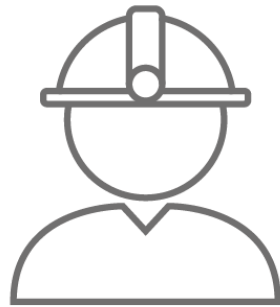
Normet has manufacturing facilities in:

- Finland
- Norway
- Sweden
- United Kingdom
- Switzerland
- Indonesia
- Taiwan
- India
- Australia
- USA
- Mexico
- Chile

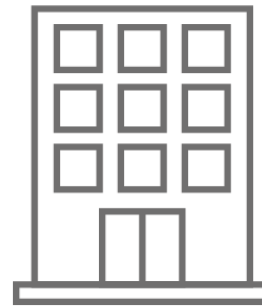
NORMET **IN NUMBERS**



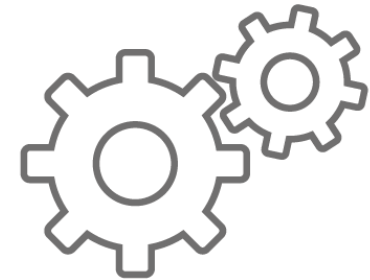
**60 YEARS OF
EXPERIENCE**



**~ 1 600
EXPERTS**



**~ 50
OFFICES**



**~ 14 000
MANUFACTURED
MACHINES**

NORMET HISTORY



1962
Normet was founded
(Peltosalmen
Konepaja)

1972
Normet starts making
mining machines and
becomes Normet Oy



~1975
First explosives (anfo)
charging machine
PK1300



~1979
First dumper,
PK 3000

1983
Normet's 1st
spraying machine
Normet RBY 800



1985
First emulsion
charger

1989
First scaling machine



1990
Development of
tunnelling equipment
offering

1991
Multimec slide on and
off cassette system



1995
Himec the lifting
offering for tunnelling



2005
Normet Service

2008
NorSmart CAN
control system



2010
Acquisition of TAM
International
Basis for the construction
chemical business

2013
Acquisition of Dynamic
Rock Support AS
Basis for the rock reinforcement
business



2019
SmartDrive & other
new technologies
launch at Bauma

2022
Acquisitions:
Aliva
Garock
Rambooms



Normet Supports numerous major tunnel projects worldwide




We believe project success is through early involvement and partnerships



The right underground equipment for the project



Through shared development, selection of the right construction chemical solutions



Local and reliable quality production and logistics – Chemicals and Equipment Spares



(An often integrated) Competent site support team



So, how can our industry help?

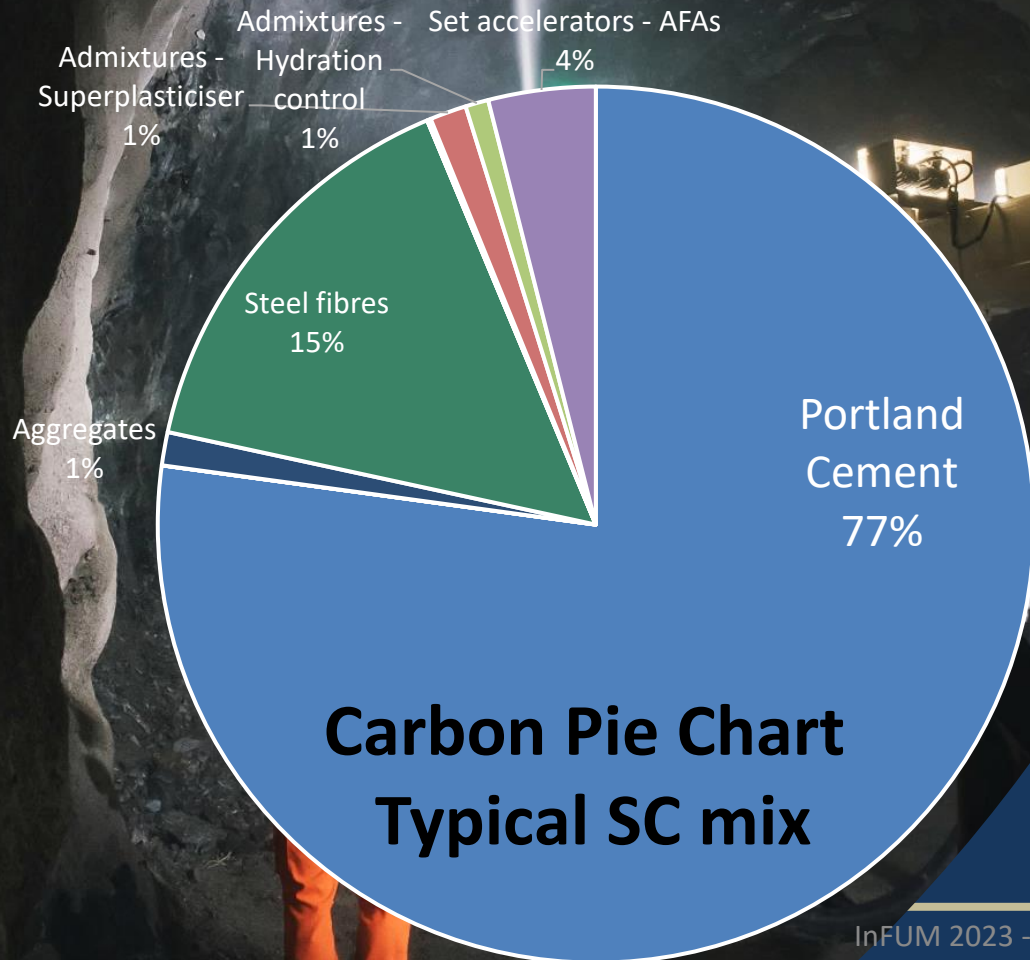
**1 tonne of cement =
>1 tonne of CO₂**

CO₂

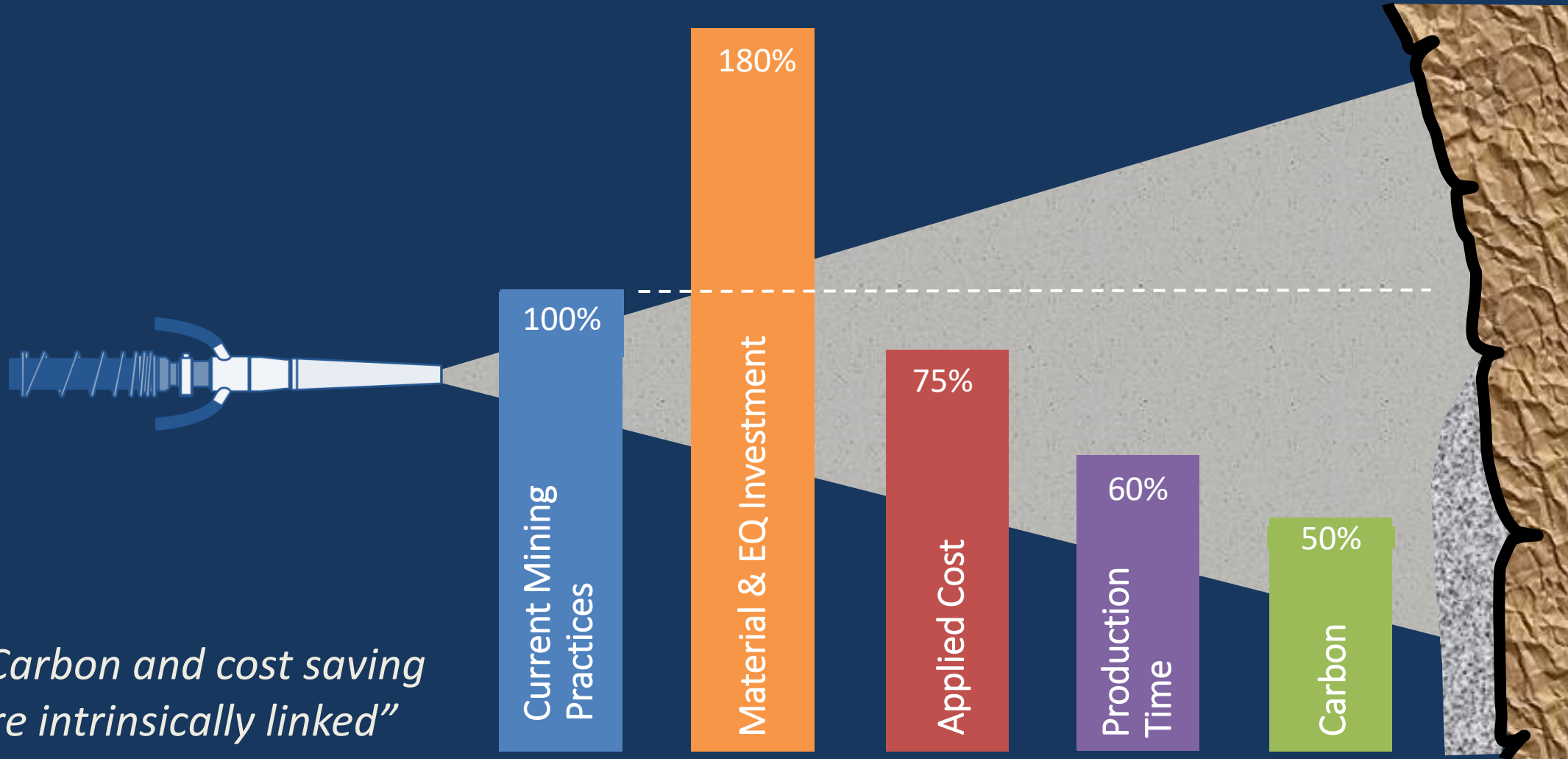
**SUSTAINABLE SPRAYED
CONCRETE PROCESSES**

Sprayed concrete is quite carbon rich!

- High amounts of Portland Cement
- Steel girders and mesh
- Always applying more thickness than the design requirement
- Rebound from spraying
- Un-used batched concrete
- Diesel powered tunneling equipment



Invest in low carbon technology to make significant savings



“Carbon and cost saving are intrinsically linked”

A Holistic Approach

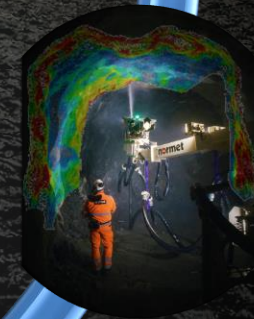
Sustainable
Sprayed
Concrete



Lower carbon, higher performing sprayed concrete



Lower carbon tunnelling equipment



Efficiency using digital technology



Improving sustainable practices

Low Carbon Sprayed Concrete

Sustainable
Sprayed
Concrete



Lower carbon, higher performing sprayed concrete



Lower carbon tunnelling equipment



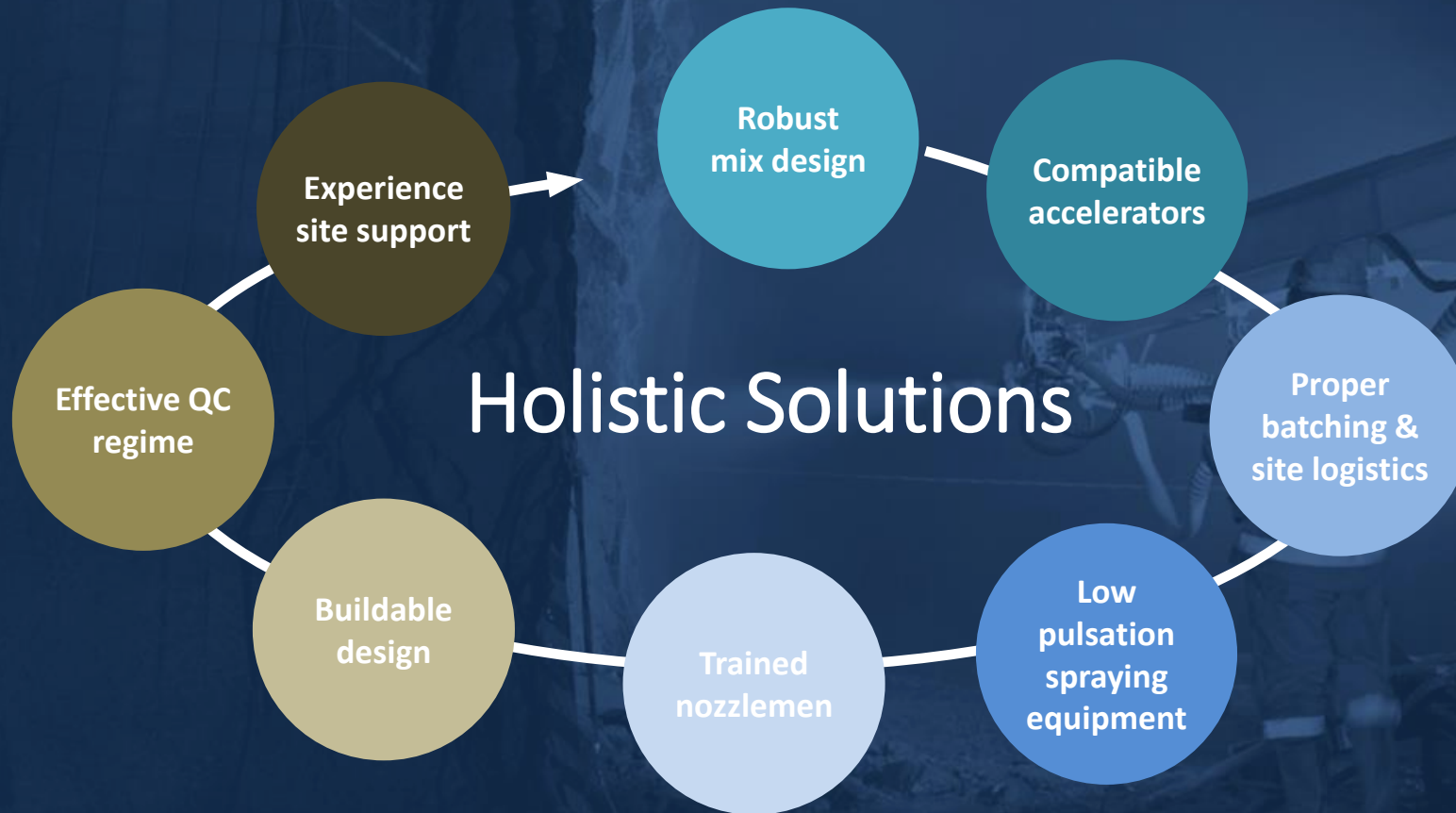
Efficiency using digital technology



Improving sustainable practices

Sprayed concrete is concrete

You need to take a holistic approach



SUSTAINABLE TUNNEL OFFERING - MATERIALS

BUILD CLEVER



-50% Build Clever (Design)

-70% Build Efficiently & Safely (Construction)

-80% Build for a Lifetime (Planning and Operation)

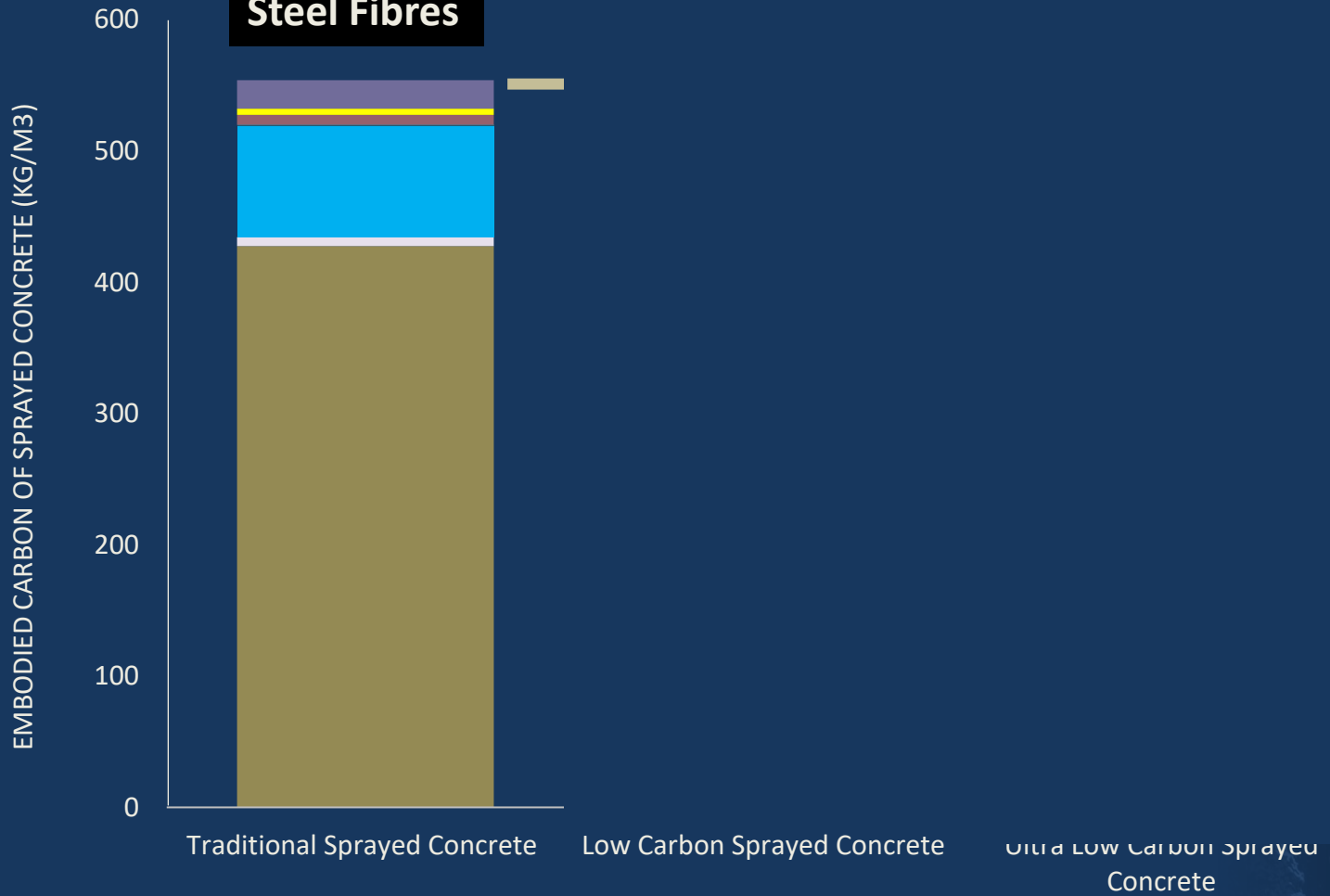
Towards Net Zero

CARBON REDUCTION
TOWARDS NET ZERO

Normet supporting the

Low and Ultra Low Carbon SCL Mixes

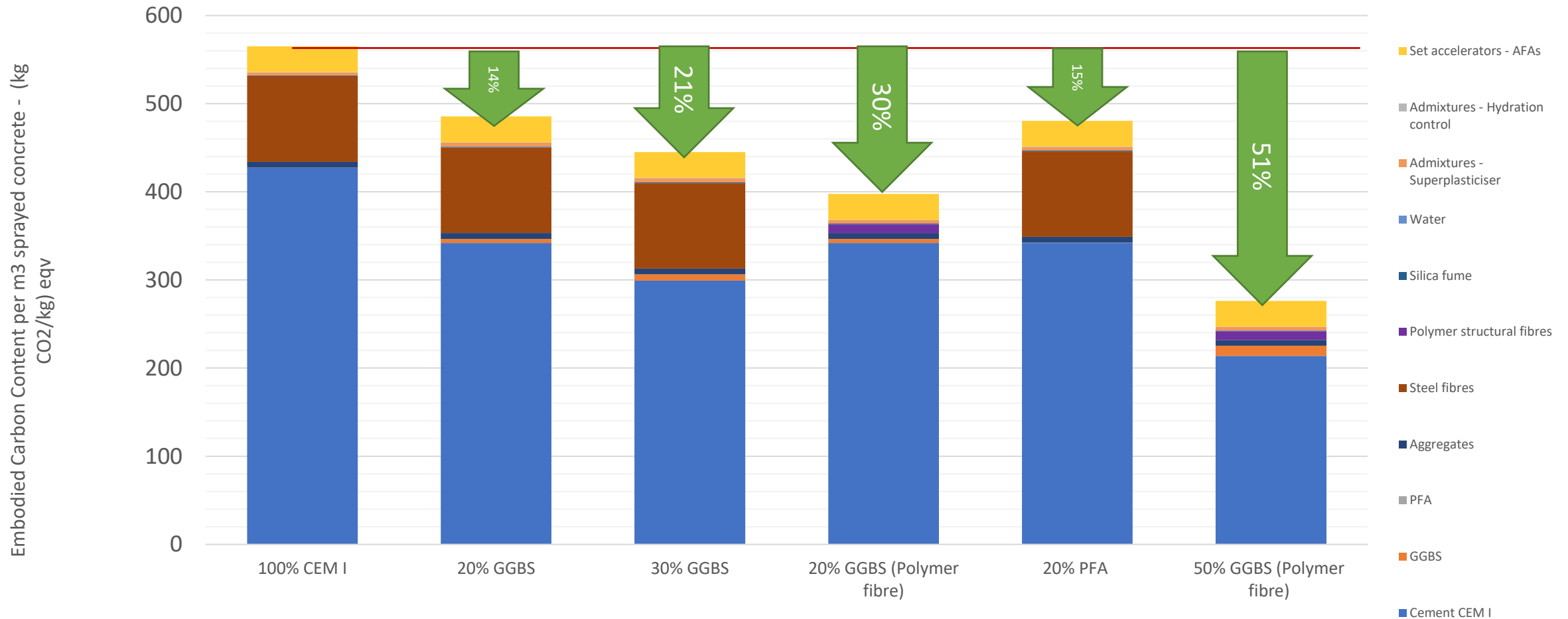
**100% CEM I
Steel Fibres**



- Set accelerators - AFAs
- Admixtures - Hydration control
- Admixtures - Superplasticiser
- Silica fume
- Struct Polymer Fibres
- Steel fibres
- Aggregates
- GGBS
- Cement CEM I

Recent low carbon sprayed concrete trials

Embodied carbon reduction



Cemex-Normet Dry Silo Mortar (DSM) Partnership – Lower Carbon Mixes

This year we have developed lower carbon mixes:

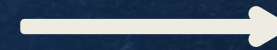
- CEM I with 40% GGBS replacement
- CEM II A-L mixes
- Now working on CEM II A-L plus 20% GGBS
- We can replace steel fibres with much lower cost and carbon structural polymer fibres

Sprayed concrete without cement is another development - Geopolymers

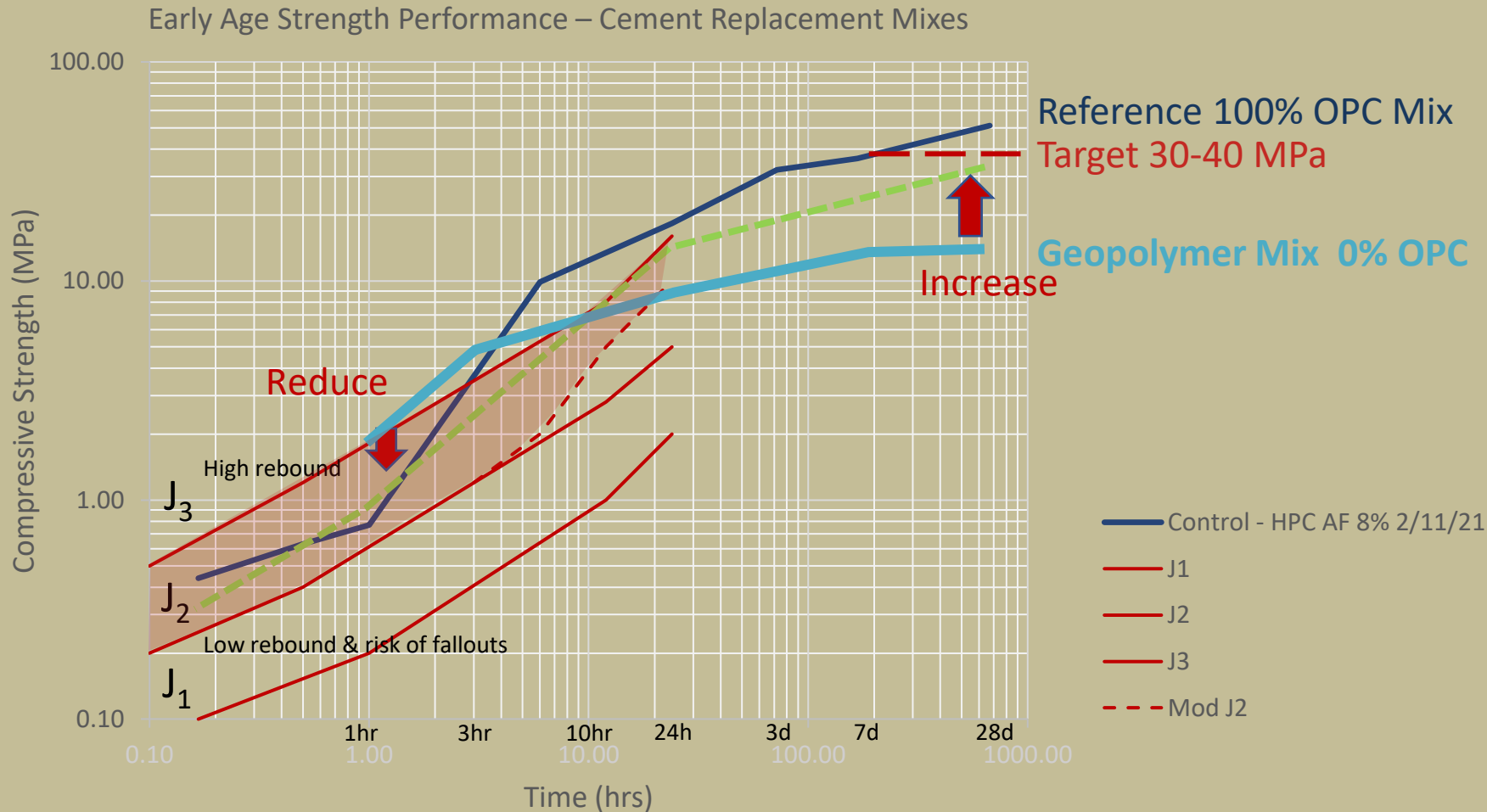
- Portland cement has many challenges
- Geopolymers offer some notable advantages
- Formed by chemical activation of sodium silicate + low calcium flyash + Blast Furnace slag
- Several advantages
 - Eco-friendly - 80% reduction in CO₂ footprint compared to Portland Cement
 - Very durable – low shrinkage, low porosity, fire resistant, chemically stable



Cooling



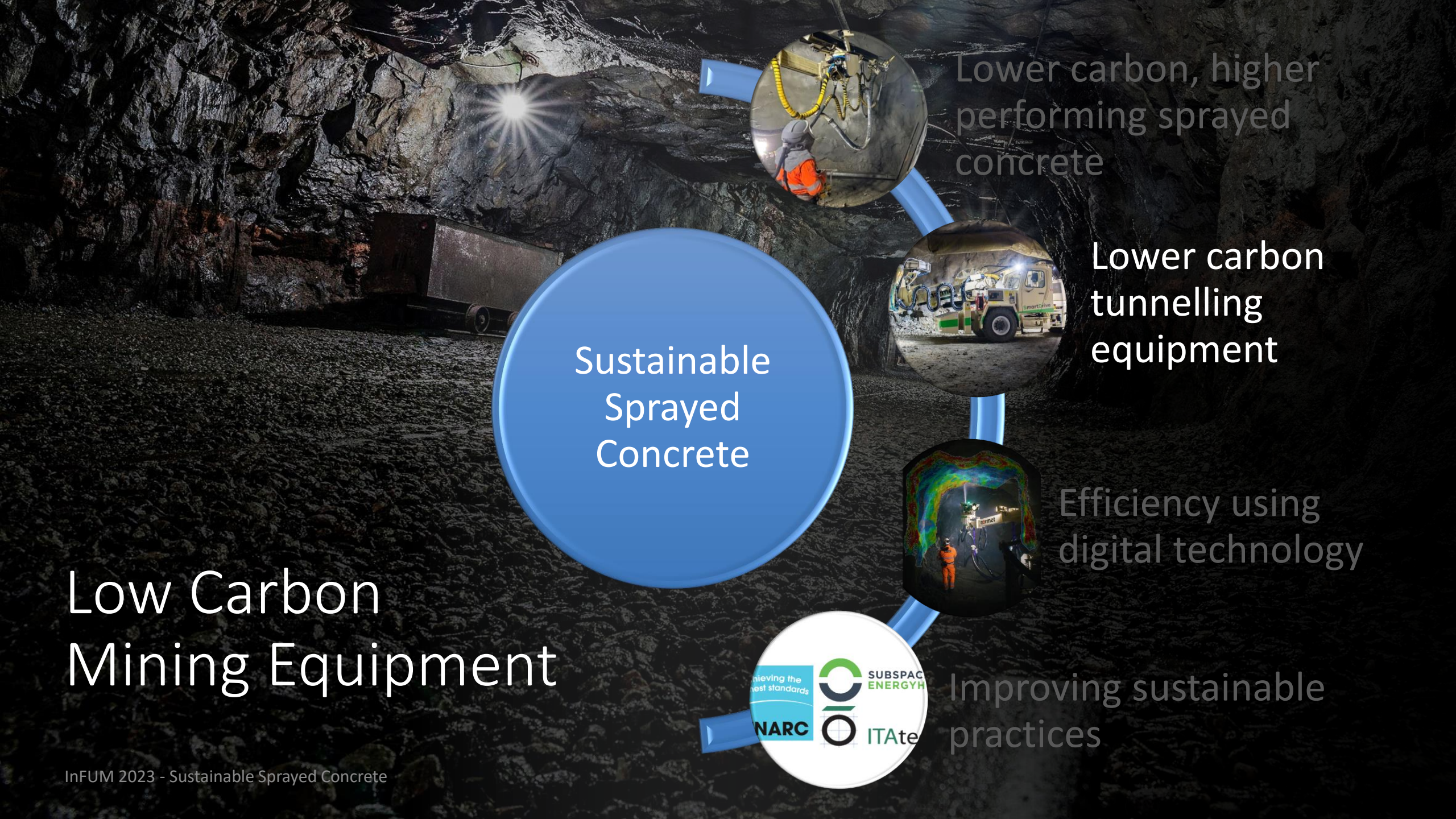
Performance needed with Geopolymer SC



- We have very good early strengths 2MPa @ 1hr
- But we can reduce early age strength
- As we need to gain improvements in long term strength

NORMET INNOVATION - MINI LAB SPRAYER





Sustainable Sprayed Concrete



Lower carbon, higher performing sprayed concrete



Lower carbon tunnelling equipment



Efficiency using digital technology

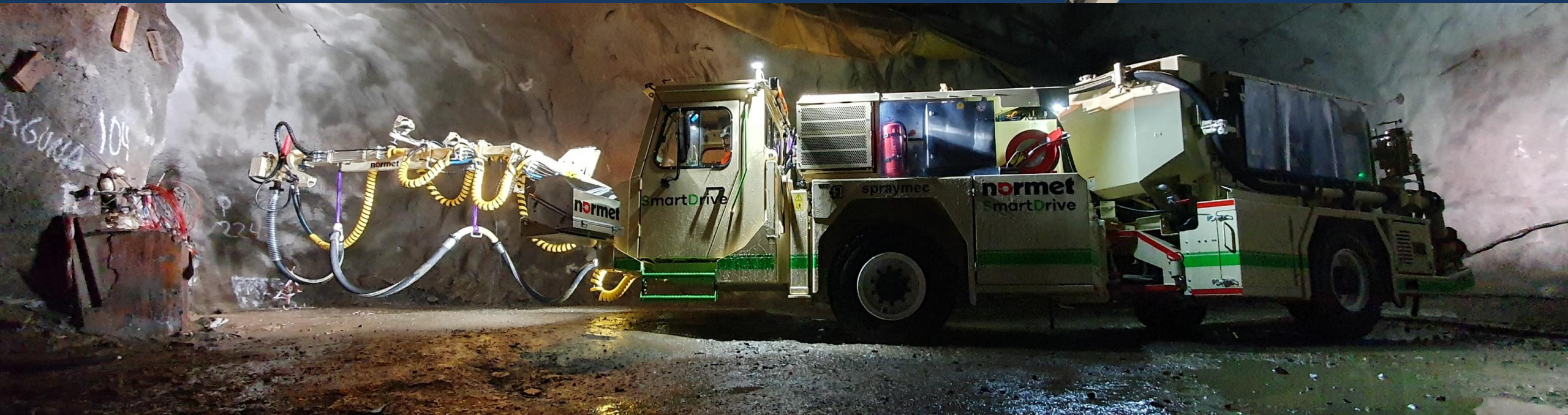
Low Carbon Mining Equipment



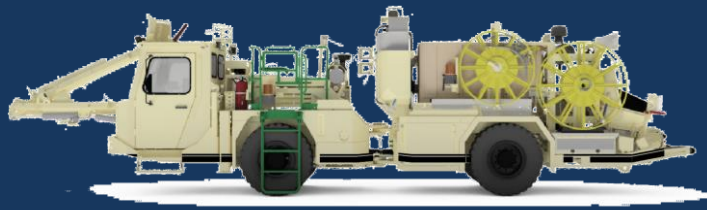
Improving sustainable practices

Automated Battery Electric Drive Sprayer

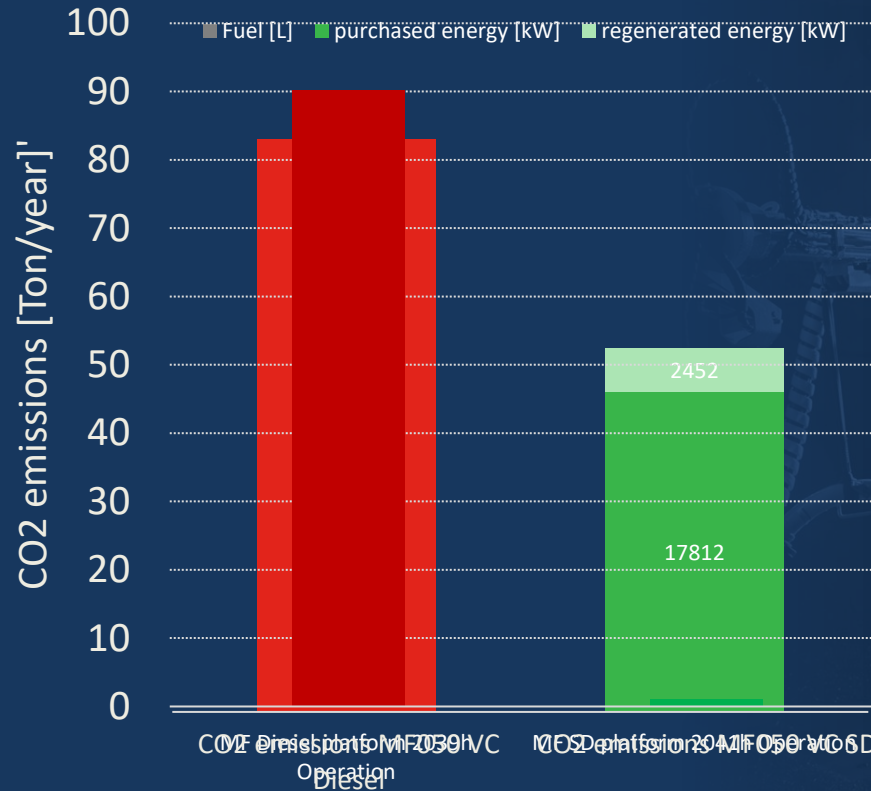
- Electric vehicles are coming onto the market, but slowly!
- Replacing diesel power trains – clean energy
- Reduced CO₂ emissions through power from renewable energy sources
- Smart spraying technologies



Sustainability with BEV Spraying Robots – CO₂ EMISSIONS



Diesel Sprayer



- 40-60% less energy
- >95% less CO₂



BEV Sprayer



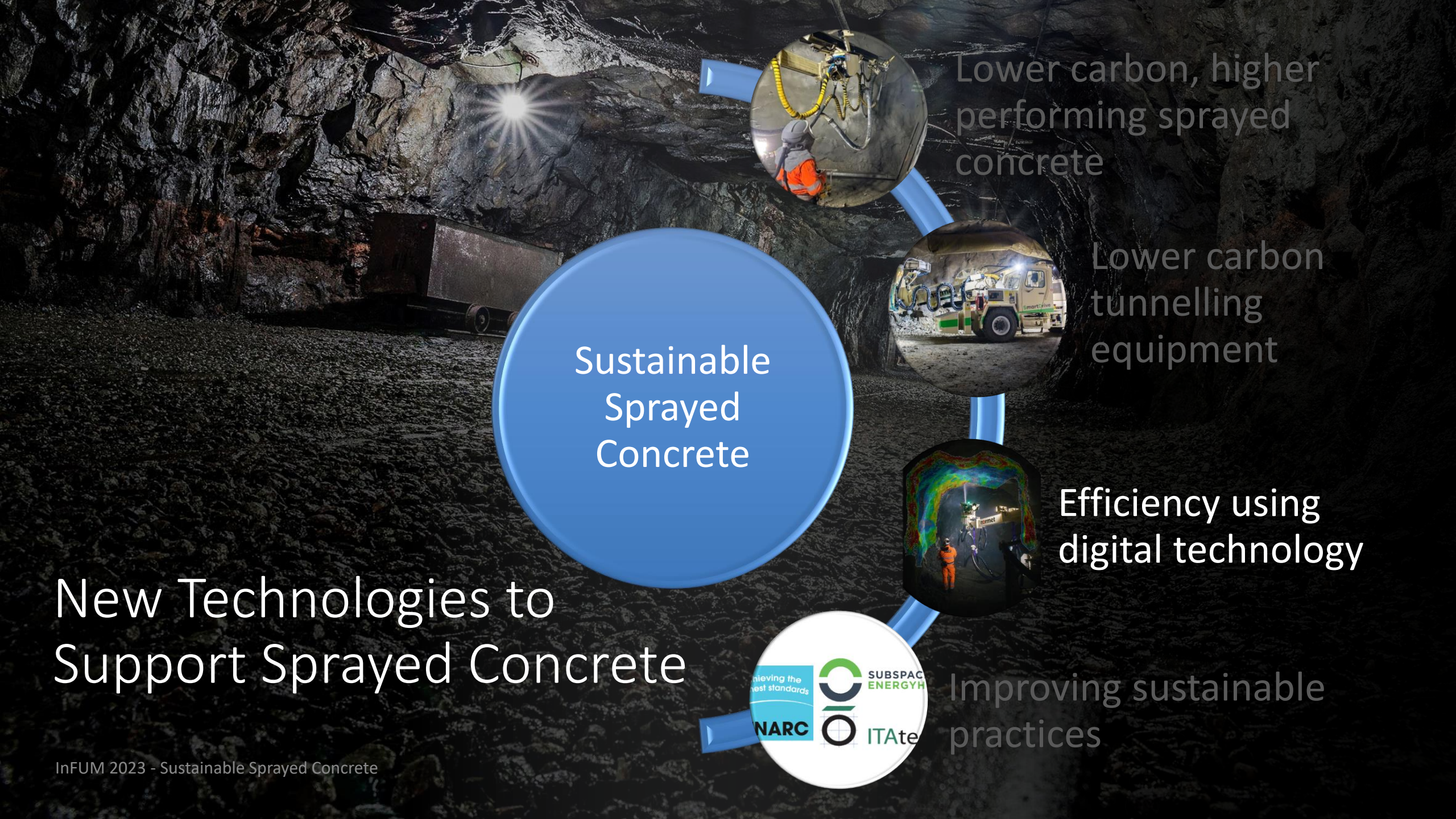
ABSORBS 1 TONNE OF CO₂ IN 100 YEARS

InFUM 2023 - Sustainable Sprayed Concrete

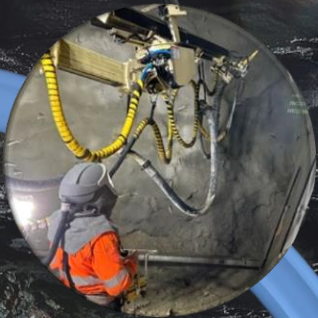
To neutralize 5 years machine lifetime 450 trees and 105 years would be required



*The calculation considers 2 hours driving per shift, 2 shifts per day.



Sustainable Sprayed Concrete



Lower carbon, higher performing sprayed concrete



Lower carbon tunnelling equipment



Efficiency using digital technology



Improving sustainable practices

New Technologies to Support Sprayed Concrete



normet
EFNARC C2
NOZZLEMAN TRAINING
& ACCREDITATION
VR SPRAYED CONCRETE
SIMULATOR

- Develops accurate spraying skills for new nozzle men, and identifies areas for further improvement with experienced operators
- Supports improved safety, efficiency and sustainability of sprayed concrete operations
- Coupled with 4Days on site spraying, the EFNARC C2 route provides nozzle men a recognised, worldwide industry qualification
- Normet's VR Simulator presents an accurate digital twin of the equipment, process and underground environment
- The simulator uses the real NorSmart control system so spraying parameters and nozzle movements are an exact replica
- Portable training package for offices and site set ups
- Now available for your training needs

ANALYSE TRAINING NEEDS SET TRAINING OBJECTIVES TRAINING AND PRACTICE EVALUATION AND REPORT

NORMET'S VR SPRAYED CONCRETE SIMULATOR IS APPROVED BY EFNARC. EFNARC C2 HAS BEEN ESTABLISHED TO CREATE A STANDARDISED QUALIFICATION FRAMEWORK THAT COMBINES BOTH TRAINING AND ASSESSMENT OF NOVICE OPERATORS AND EXPERIENCED NOZZLEMEN (www.efnarc.org/information/efnarcC2). FOR MORE INFORMATION PLEASE CONTACT: PANG DIN DIN@NORMET.COM

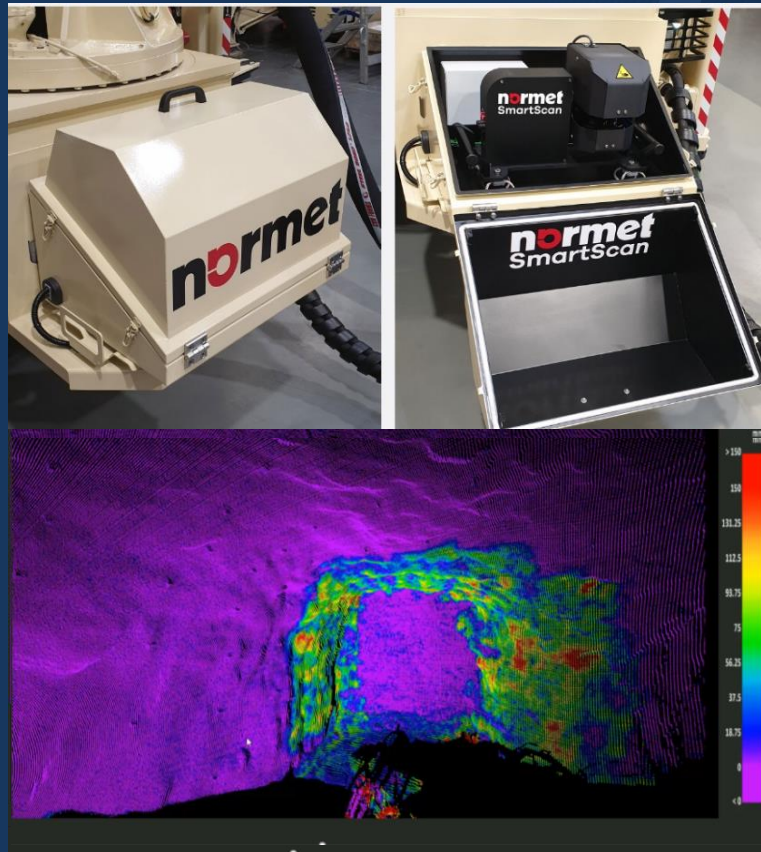
achieving the highest standards
EFNARC

Spraying Simulator training is a useful tool

- Fully EFNARC approved simulator training tool
- For training and now integral to certification process
- Helps get nozzle operator up and running
- Not breaking anything too expensive too soon!
- Up to a 25% improvement in performance . . . Even with experienced nozzle operators
- Stress free learning environment
- Good fit to the new, young generation!

Real time control - SmartScan

Most sprayed concrete linings are between 1.5x and 2.5x theoretical amount!



- Nozzle operator more in control
- Getting it right at the point of application – not later, too late!
- Spraying to profile is coming soon
- Safety - knowing minimum thickness is applied
- Controlling quality and economy
- Remove steel girders/arches as we can spray to profile without them now
- **We can start measuring carbon and start improving!**

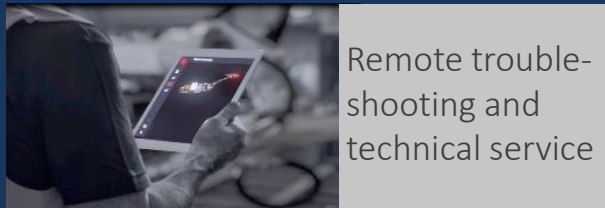
Spraying Process Equipment - Digitalisation



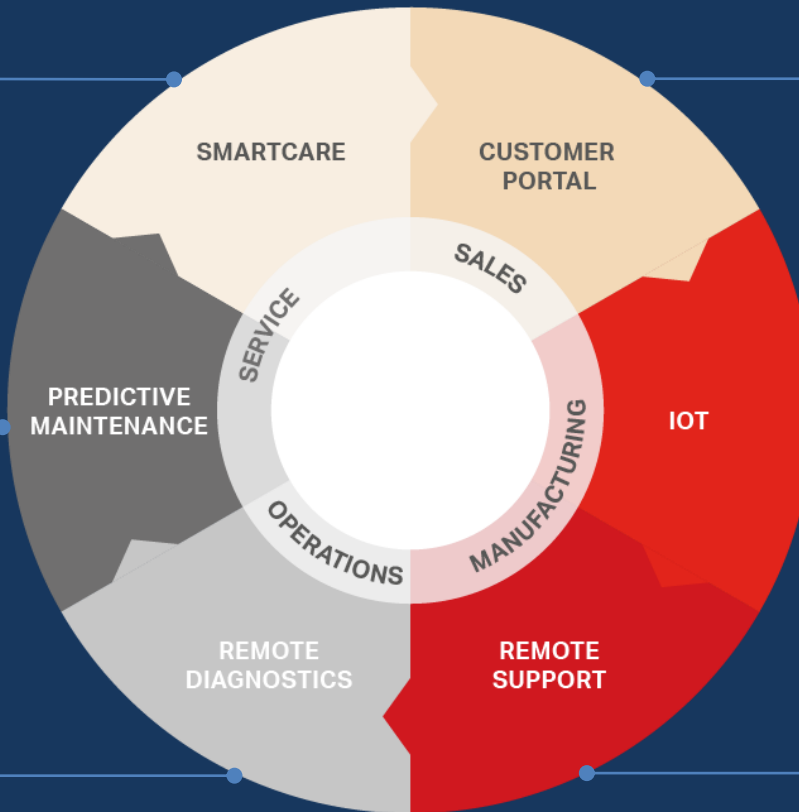
Service history and OEE in one place



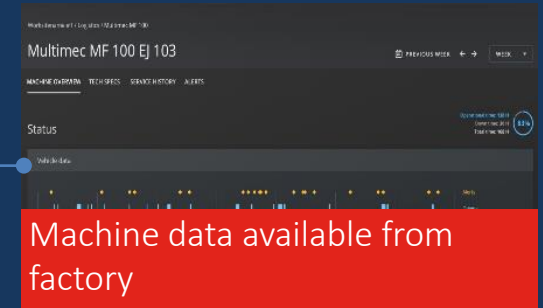
Active predictive maintenance based on machine learning and AI



Remote troubleshooting and technical service



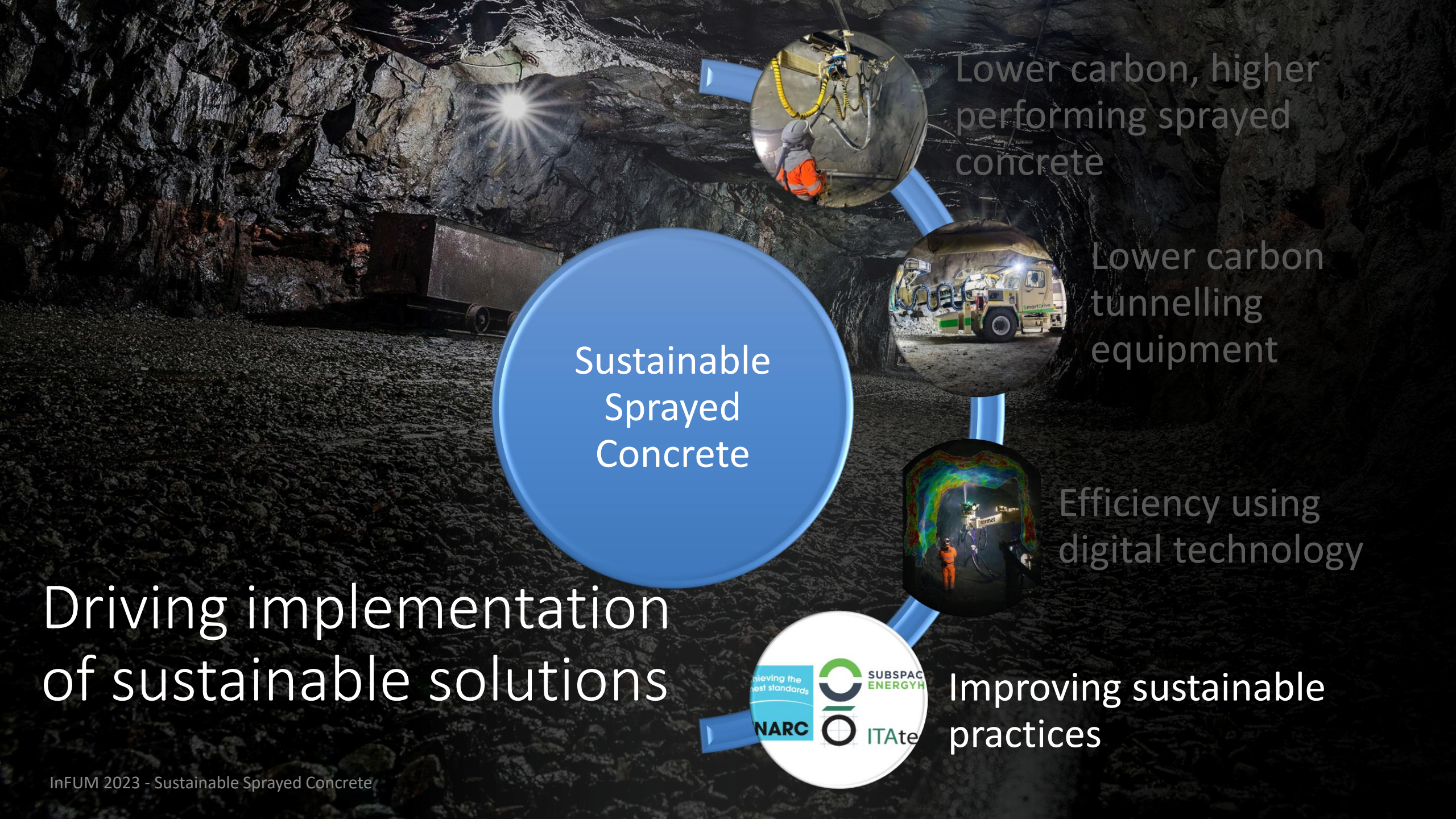
Customer specific configurations and service packages



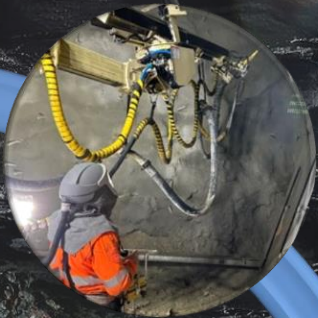
Machine data available from factory



Remote operations support based on real-time information



Sustainable Sprayed Concrete



Lower carbon, higher performing sprayed concrete



Lower carbon tunnelling equipment



Efficiency using digital technology



Improving sustainable practices

Driving implementation of sustainable solutions

We have good standards in our industry

Common standards let everyone work to the same levels of safety and quality



EUROPEAN SPECIFICATION
for
SPRAYED CONCRETE

GUIDELINES
FOR SPECIFIERS AND CONTRACTORS

**CHECKLIST
FOR
SPECIFIERS AND CONTRACTORS**

EUROPEAN SPECIFICATION FOR SPRAYED CONCRETE
EXECUTION OF SPRAYING
(revised version of Section 8)

*Remember Sprayed concrete
is Concrete*