XVI
JORNADAS TÉCNICAS
ANIET
08 NOV. 2023

Os Projetos Europeus DIGIECOQUARRY e ROTATE: Digitalização, pegada ambiental e circularidade para a indústria Extrativa

CÉSAR LUACES FRADES

Diretor-Geral da ANEFA - Associação Nacional de Fabricantes de Áridos e da FDA - Federação de Áridos de Espanha

DEQ

DIGIECOQUARRY

INNOVATIVE DIGITAL SUSTAINABLE
AGGREGATES SYSTEMS

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101003750

WHAT IS DEQ?

DIGIECOQUARRY aims to design, develop and validate in **5 pilot environments an Innovative Quarrying System** (IQS) comprising sensors, processes, tools and methods for data capture, processing and sharing to provide **integrated digitalised, automatic and real-time process** control for **aggregates quarries**.

Health & Safety and Security
Upgraded H&S and Security conditions for workers, avoiding their exposure to dangerous operations through automated and controlled processes.

Efficiency, Selectivity and Profitability
Enhanced Selectivity and Efficiency of the aggregates sites, thus increasing the profitability of the processes, ensuring long-term operational sustainability and viability.

Environmental Impact
Maximised Sustainability and Resource Efficiency by reducing emissions, improving the management of water and fostering a sustainable supply of Raw Materials.

Social Acceptance
Improved social acceptance through the communication with policy makers, citizens and relevant actors to get them involved in the value chain

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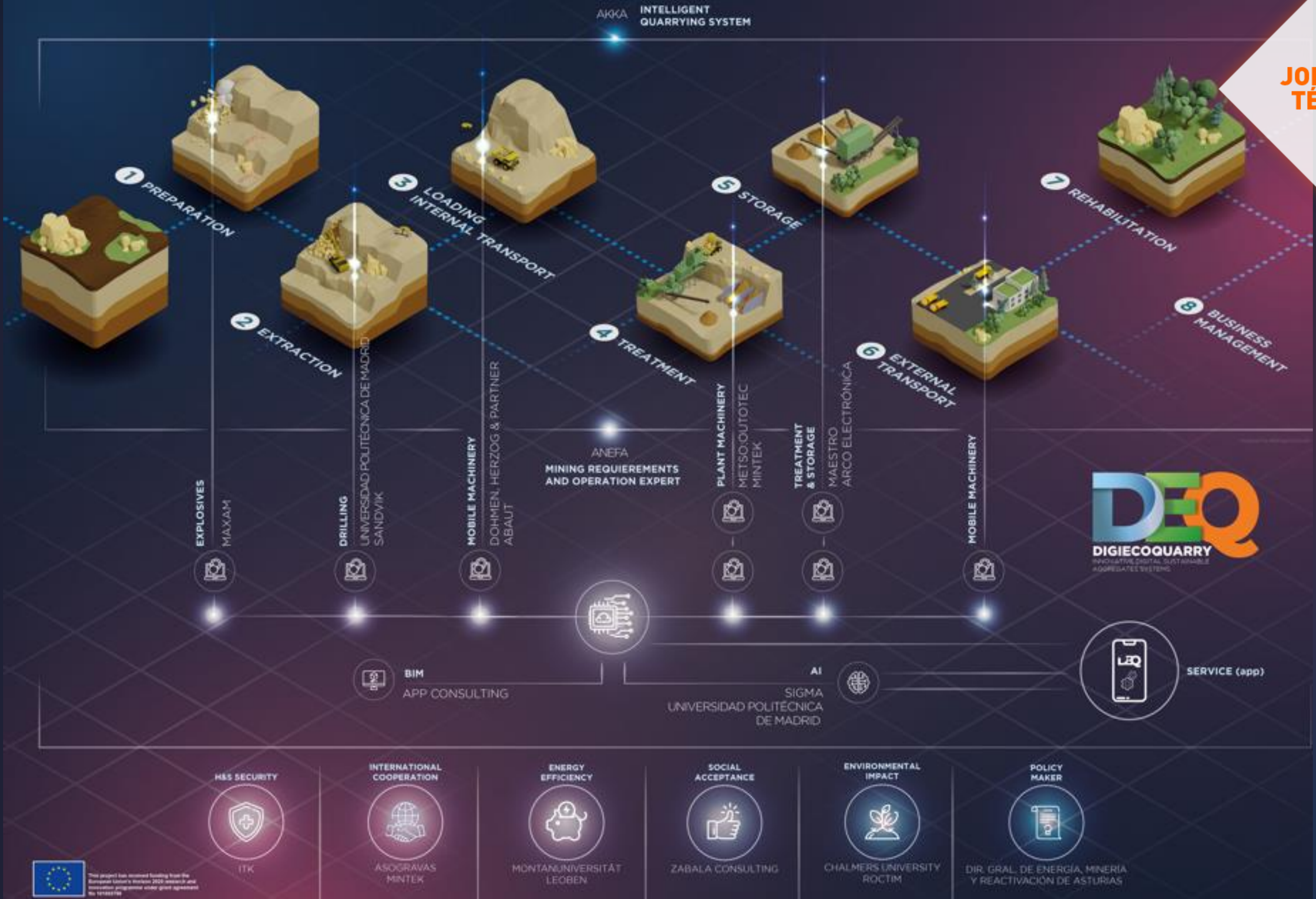


AKKA **INTELLIGENT QUARRYING SYSTEM**

1 PREPARATION
2 EXTRACTION
3 LOADING INTERNAL TRANSPORT
4 TREATMENT
5 STORAGE
6 EXTERNAL TRANSPORT
7 REHABILITATION
8 BUSINESS MANAGEMENT

EXPLOSIVES
MAXAM

DRILLING
UNIVERSIDAD POLITÉCNICA DE MADRID
SANDVIK

MOBILE MACHINERY
DOHMEN, HERZOG & PARTNER
ABAUT

ANEFA
MINING REQUIEREMENTS AND OPERATION EXPERT

PLANT MACHINERY
METSO:OUTOTEC
MINTEK

TREATMENT & STORAGE
MAESTRO
ARCO ELECTRÓNICA

MOBILE MACHINERY

DIGIECOQUARRY
INNOVATIVE DIGITAL SUSTAINABLE AGGREGATES SYSTEMS

BIM
APP CONSULTING

AI
SIGMA
UNIVERSIDAD POLITÉCNICA DE MADRID

SERVICE (app)

H&S SECURITY
ITK

INTERNATIONAL COOPERATION
ASOGRAVAS
MINTEK

ENERGY EFFICIENCY
MONTANUNIVERSITÄT LEOBEN

SOCIAL ACCEPTANCE
ZABALA CONSULTING

ENVIRONMENTAL IMPACT
CHALMERS UNIVERSITY
ROCTIM

POLICY MAKER
DIR. GRAL. DE ENERGÍA, MINERÍA Y REACTIVACIÓN DE ASTURIAS

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No [illegible]

OUR CONSORTIUM

CONSORTIUM PARTNERS: 25 organisations. 23 from 8 different EU countries + 2 international partners

QUARRYING INDUSTRY

- AGREPOR AGREGADOS - EXTRACÇÃO DE INERTES
- CRONENBERGER STEININDUSTRIE FRANZ TRICHES
- HOLCIM AGGREGATI CALCESTRUZZI
- GRANULATS VICAT
- HANSON HISPANIA
- ASOCIACIÓN NACIONAL DE EMPRESARIOS FABRICANTES DE ÁRIDOS
- UNIVERSIDAD POLITECNICA DE MADRID
- MONTANUNIVERSITAET LEOBEN
- DOHMEN, HERZOG & PARTNER
- MAXAMCORP INTERNATIONAL
- METSO:OUTOTEC
- MA-ESTRO
- ARCO ELECTRÓNICA
- CHALMERS TEKNISKA HOEGSKOLA
- abaut
- MINTEK
- ITK ENGINEERING GMBH
- ROCTIM -AB
- SANDVIK MINING AND ROCK TECHNOLOGY

TECHNOLOGY EXPERTS

- AKKA HIGH TECH
- APP CONSULTORIA DE GESTIÓN DE PROYECTOS
- SIGMA TECHNOLOGIES

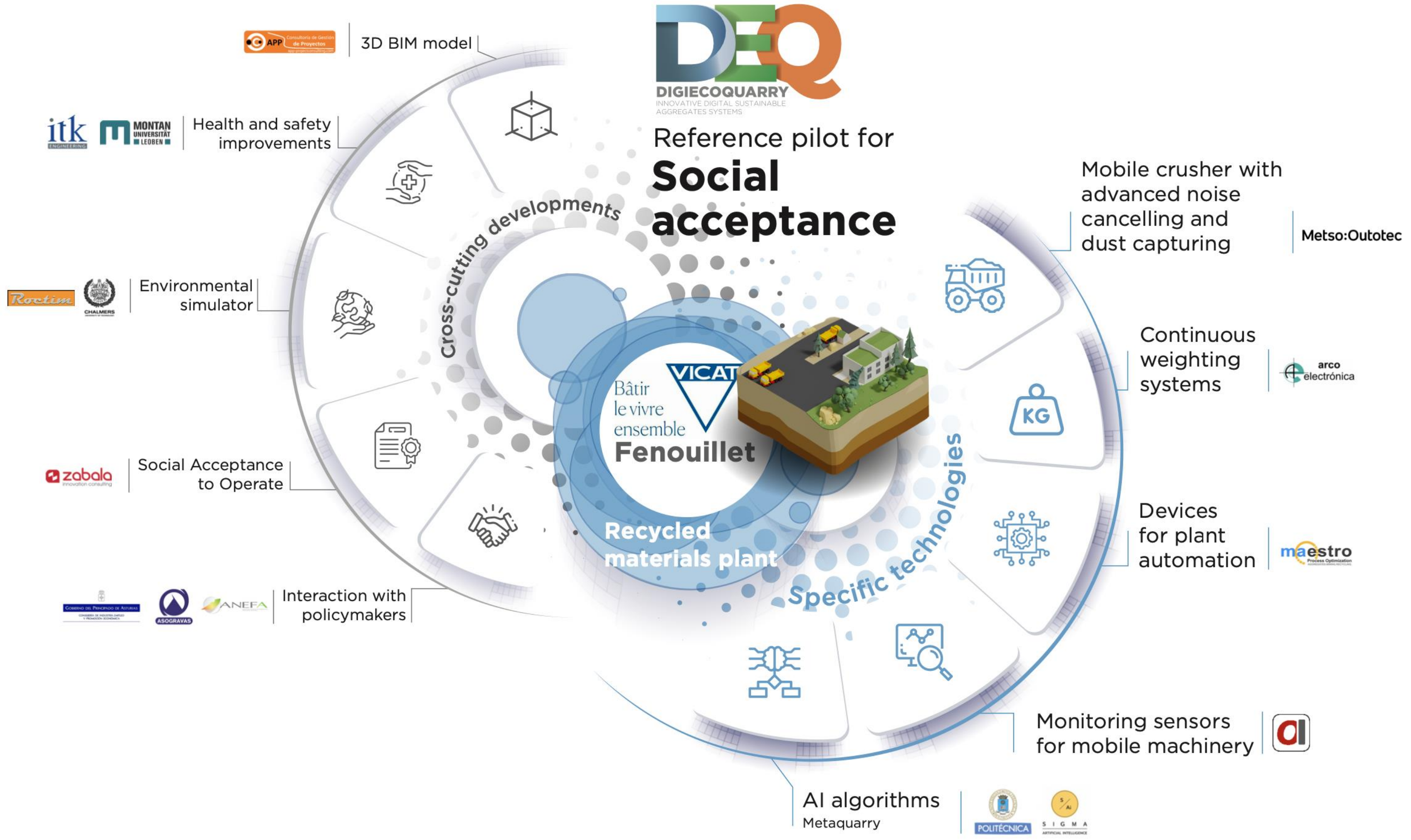
RELEVANT STAKEHOLDERS

- ZABALA INNOVATION CONSULTING
- DIRECCIÓN GENERAL DE MINERÍA Y ENERGÍA DEL PRINCIPADO DE ASTURIAS
- ASOCIACIÓN COLOMBIANA DE PRODUCTORES DE AGREGADOS PÉTREOS

INTERNATIONAL ADVISORY BOARD

- GAIN
- AGGREGATES BUSINESS
- EuroGeoSurveys – The Geological Surveys of Europe
- Hanson HeidelbergCement Group
- IUCN
- MIRO
- UEPG Aggregates Europe
- CEMEX
- dst

OUR PILOTS - FENOUILLET



DIGIECOQUARRY
INNOVATIVE DIGITAL SUSTAINABLE AGGREGATES SYSTEMS

Reference pilot for
Social acceptance

Cross-cutting developments

- 3D BIM model
- Health and safety improvements
- Environmental simulator
- Social Acceptance to Operate
- Interaction with policymakers

VICAT
Bâtir le vivre ensemble
Fenouillet
Recycled materials plant

Specific technologies

- Mobile crusher with advanced noise cancelling and dust capturing — Metso:Outotec
- Continuous weighting systems — arco electrónica
- Devices for plant automation — maestro
- Monitoring sensors for mobile machinery
- AI algorithms
  Metaquarry

Toulouse, France

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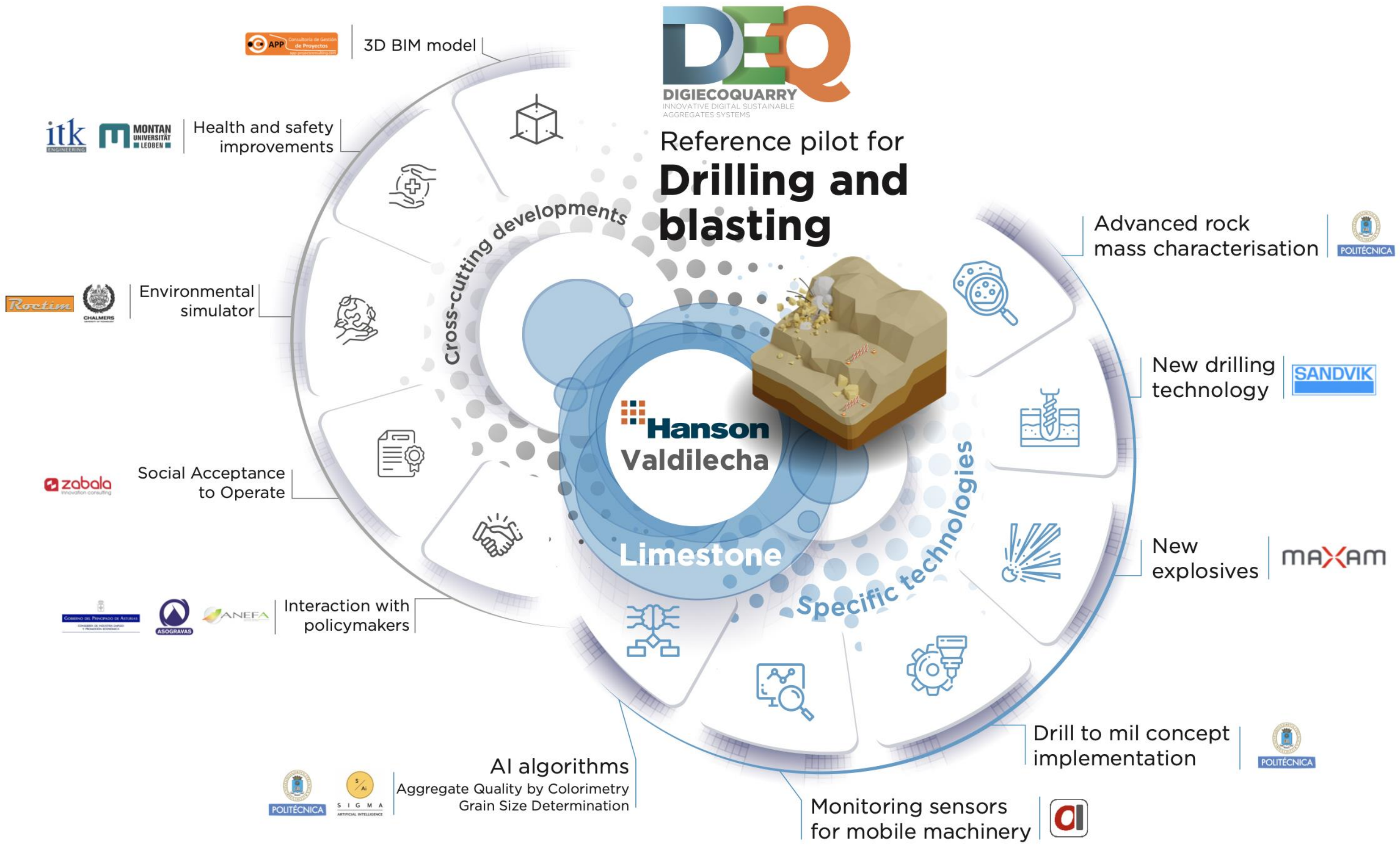
OUR PILOTS - VALDILECHA



DIGIECOQUARRY
INNOVATIVE DIGITAL SUSTAINABLE AGGREGATES SYSTEMS

Reference pilot for
Drilling and blasting

Hanson Valdilecha

Limestone

Cross-cutting developments

- 3D BIM model
- Health and safety improvements
- Environmental simulator
- Social Acceptance to Operate
- Interaction with policymakers

Specific technologies

- Advanced rock mass characterisation
- New drilling technology
- New explosives
- Drill to mil concept implementation
- Monitoring sensors for mobile machinery
- AI algorithms
  - Aggregate Quality by Colorimetry
  - Grain Size Determination

APP
itk
MONTAN UNIVERSITÄT LEOBEN
Roctim
CHALMERS
zabala
ASOGRAVAS
ANEFA
POLITÉCNICA
SANDVIK
MAXAM
POLITÉCNICA
SIGMA
POLITÉCNICA

Madrid, Spain

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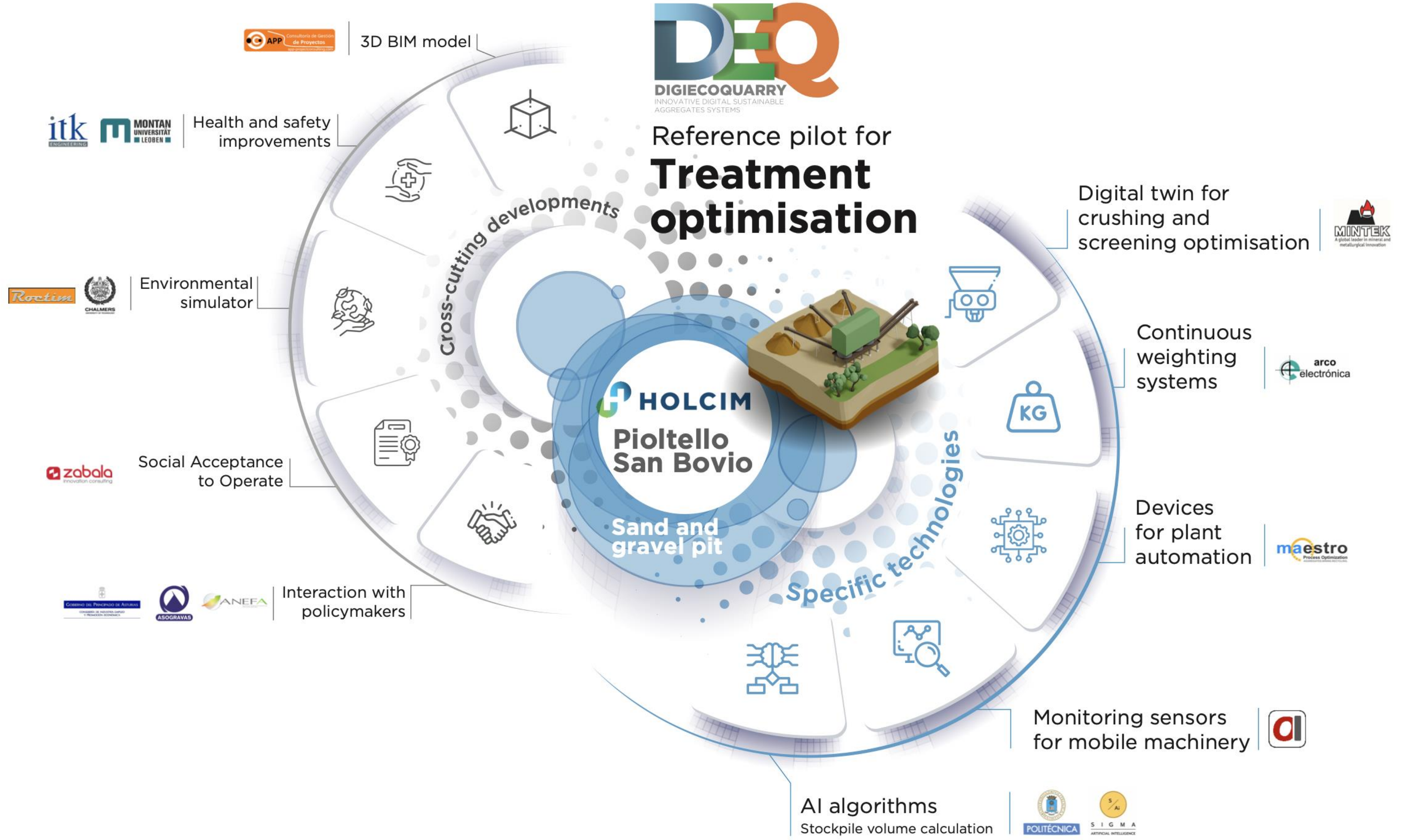
OUR PILOTS - PIOLTELLO


DIGIECOQUARRY
INNOVATIVE DIGITAL SUSTAINABLE AGGREGATES SYSTEMS
Cross-cutting developments
Specific technologies
HOLCIM
KG
APP
itk
MONTAN UNIVERSITÄT LEOBEN
Roctim
CHALMERS
zabala
ASOGRAVAS
ANEFA
MINTEK
arco electrónica
maestro
POLITÉCNICA
SIGMA

Reference pilot for
Treatment optimisation

Pioltello San Bovio

Sand and gravel pit

3D BIM model

Health and safety improvements

Environmental simulator

Social Acceptance to Operate

Interaction with policymakers

Digital twin for crushing and screening optimisation

Continuous weighting systems

Devices for plant automation

Monitoring sensors for mobile machinery

AI algorithms
Stockpile volume calculation

Milan, Italy

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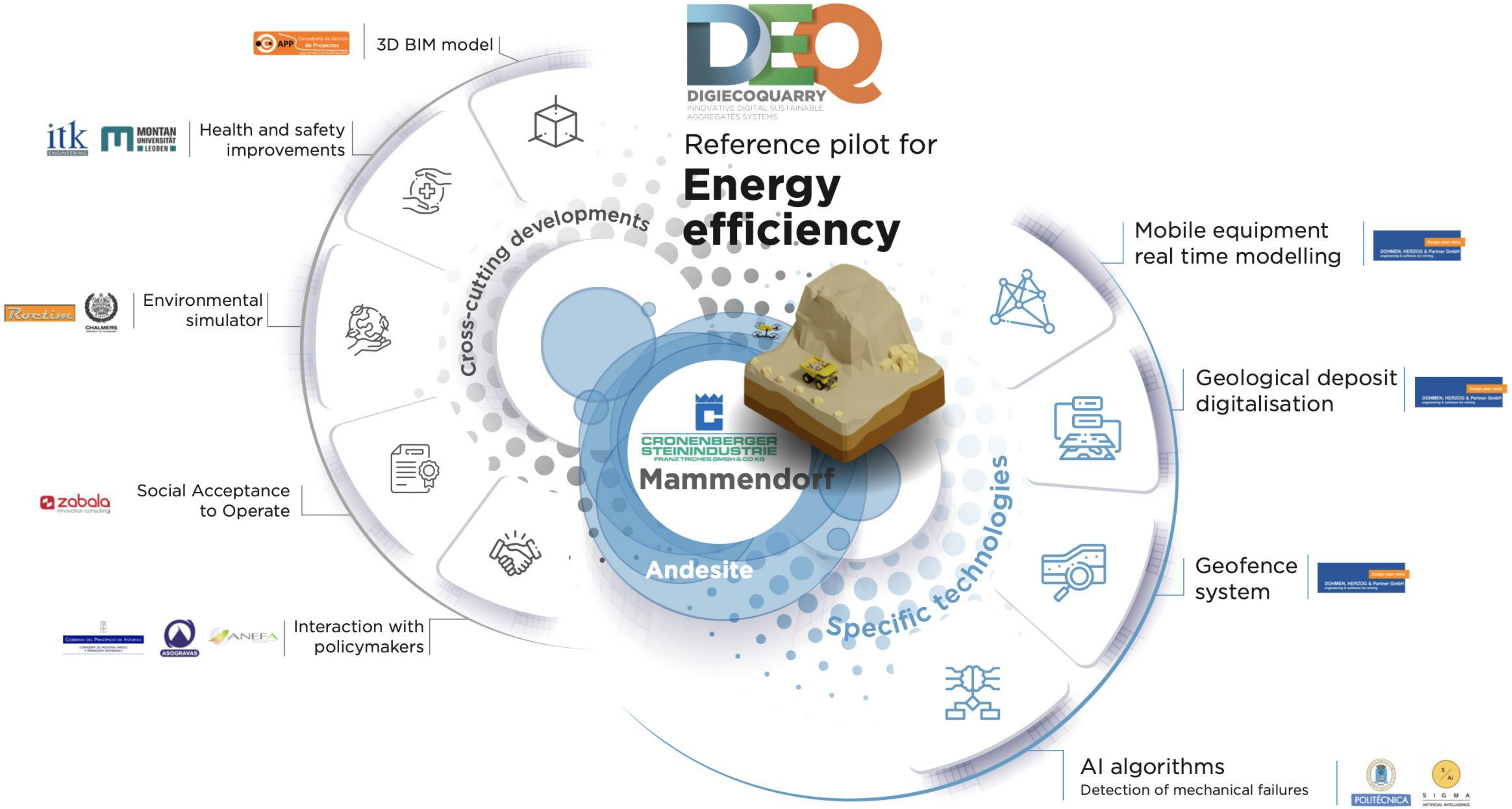
OUR PILOTS - MAMMENDORF



DIGIECOQUARRY
INNOVATIVE DIGITAL SUSTAINABLE AGGREGATES SYSTEMS

Reference pilot for
Energy efficiency

- 3D BIM model
- Health and safety improvements
- Environmental simulator
- Social Acceptance to Operate
- Interaction with policymakers
- Mobile equipment real time modelling
- Geological deposit digitalisation
- Geofence system
- AI algorithms
  Detection of mechanical failures

Cross-cutting developments
Specific technologies
CRONENBERGER STEININDUSTRIE
FRANZ TRICHES GMBH & CO KG
Mammendorf
Andesite

Magdeburg, Germany

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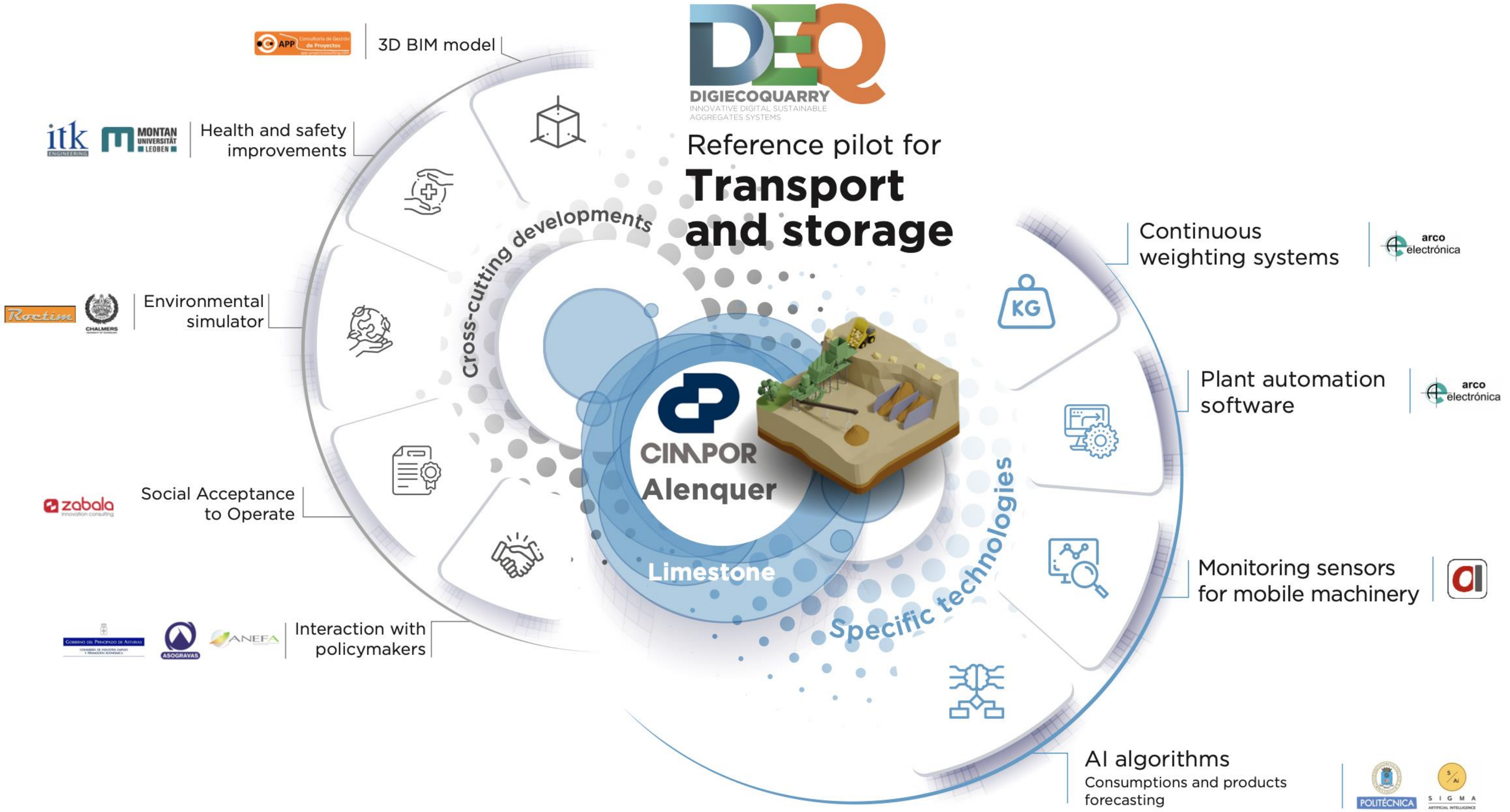
OUR PILOTS - ALENQUER


DIGIECOQUARRY
INNOVATIVE DIGITAL SUSTAINABLE AGGREGATES SYSTEMS
Cross-cutting developments
Specific technologies
CIMPOR
Alenquer
Limestone
KG

Reference pilot for
Transport and storage

- 3D BIM model
- Health and safety improvements
- Environmental simulator
- Social Acceptance to Operate
- Interaction with policymakers

- Continuous weighting systems
- Plant automation software
- Monitoring sensors for mobile machinery
- AI algorithms
  Consumptions and products forecasting

Lisbon, Portugal

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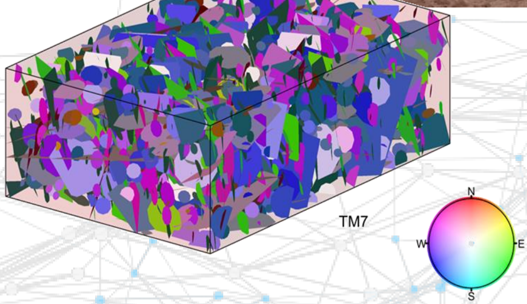
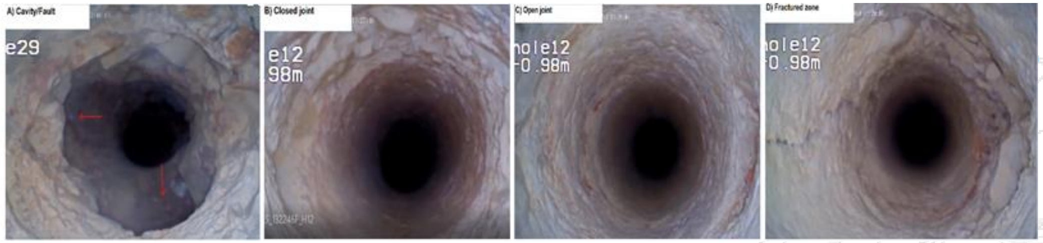
OUTCOMES – Extraction

1 MWD ANALYSIS FOR ADVANCED ROCK MASS STRUCTURAL RECOGNITION

- Especially large discontinuities and cavities.
- With a drill rig with navigation system and an add-on to record the penetration rate.
- Borehole logging with an endoscope camera for calibration of MWD-based model.
- Novel procedure to obtain DFN models using non-parametric directional-linear statistics




A) Cavity/Fault
B) Closed joint
C) Open joint
D) Fractured zone
e29
e12
98m
hole12
-0.98m
hole12
-0.98m

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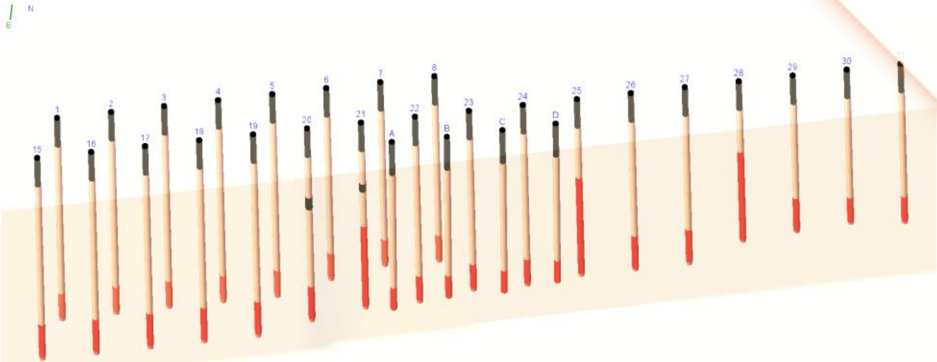
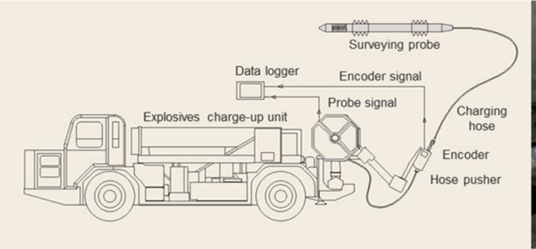
OUTCOMES – Extraction

2 FULL DIGITALIZATION AND CONNECTIVITY OF BLASTING



- Smart product and system implementation to vary explosive density instantaneously.
- Blasts designed and carried out with different explosive density in the hole.
- Automatic retrieving system with height measurement of the hose to ensure the adequate explosive density at the desired heigh.


Surveying probe
Data logger
Encoder signal
Probe signal
Explosives charge-up unit
Charging hose
Encoder
Hose pusher

Handheld PC
Surveying Probe

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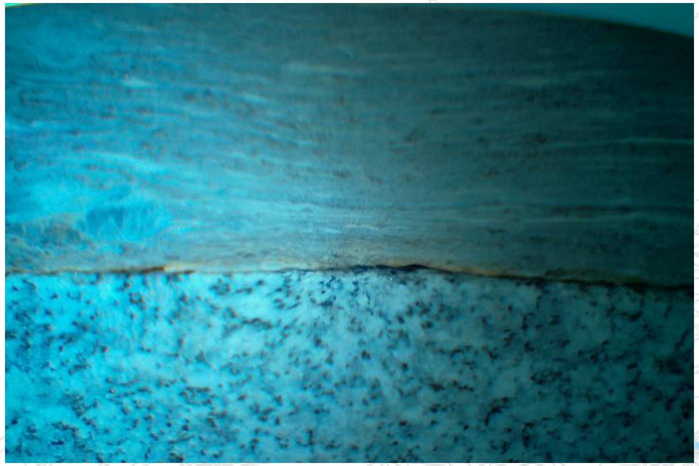
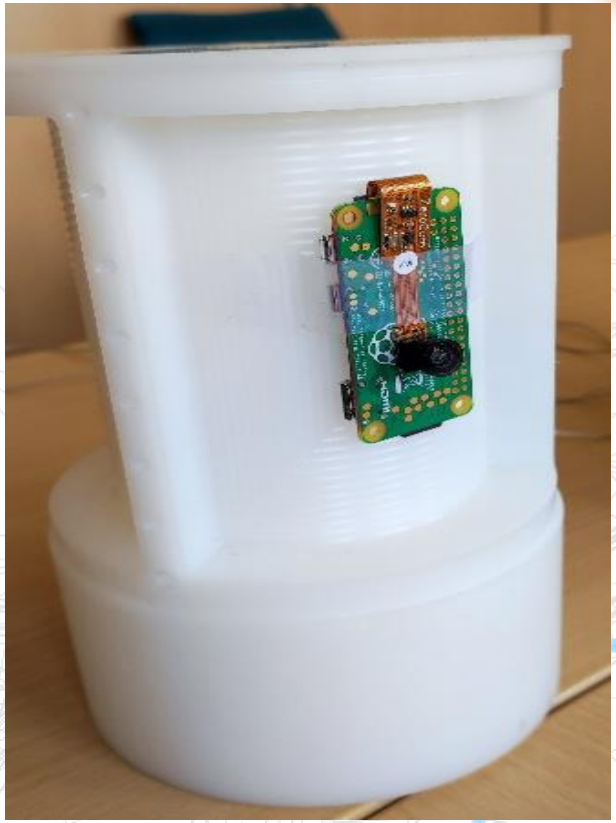
OUTCOMES – Extraction

3 VIRTUAL CORING WHILE DRILLING PROTOTYPE

- Construction of a prototype of virtual coring while drilling.
- First test results under lab conditions.
- System to take images of the blasthole walls when drilling is finished, and the rods are pulled out

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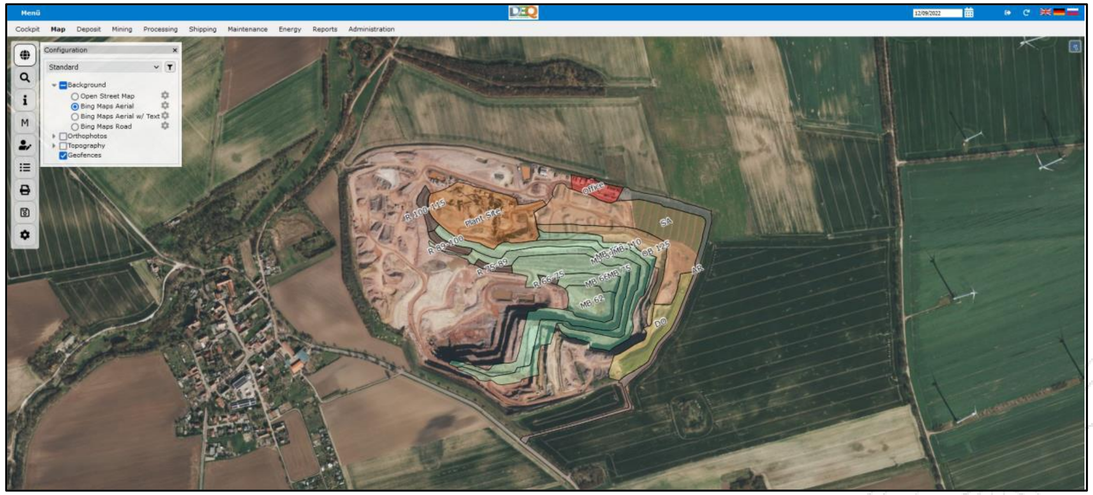
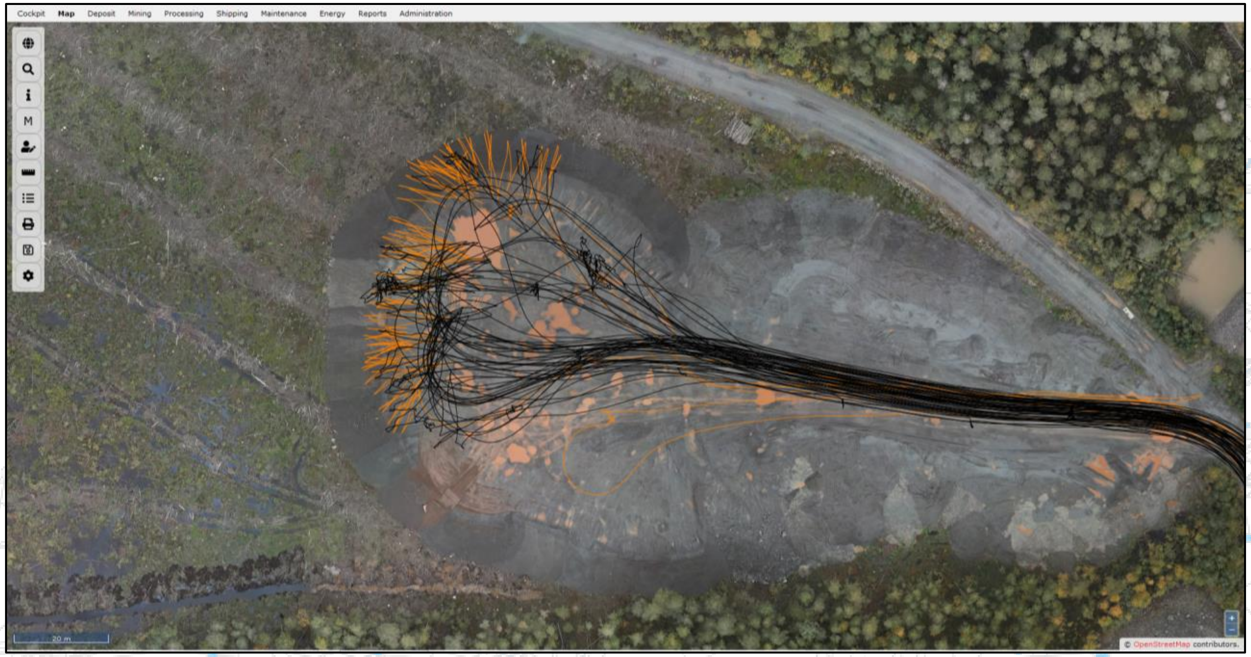
OUTCOMES – Loading and hauling

1 GEOLOGICAL DEPOSIT MODELLING

- Survey data.
- Geological information (borehole database).
- Operational mobile equipment data.


Menü
Cockpit
Map
Deposit
Mining
Processing
Shipping
Maintenance
Energy
Reports
Administration
Configuration
Standard
Background
○ Open Street Map
● Bing Maps Aerial
○ Bing Maps Aerial w/ Text
○ Bing Maps Road
☐ Orthophotos
☐ Topography
☑ Geofences
R 100-115
Plant Site
Office


Cockpit
Map
Deposit
Mining
Processing
Shipping
Maintenance
Energy
Reports
Administration
20 m
© OpenStreetMap contributors.

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OUTCOMES – Loading and hauling

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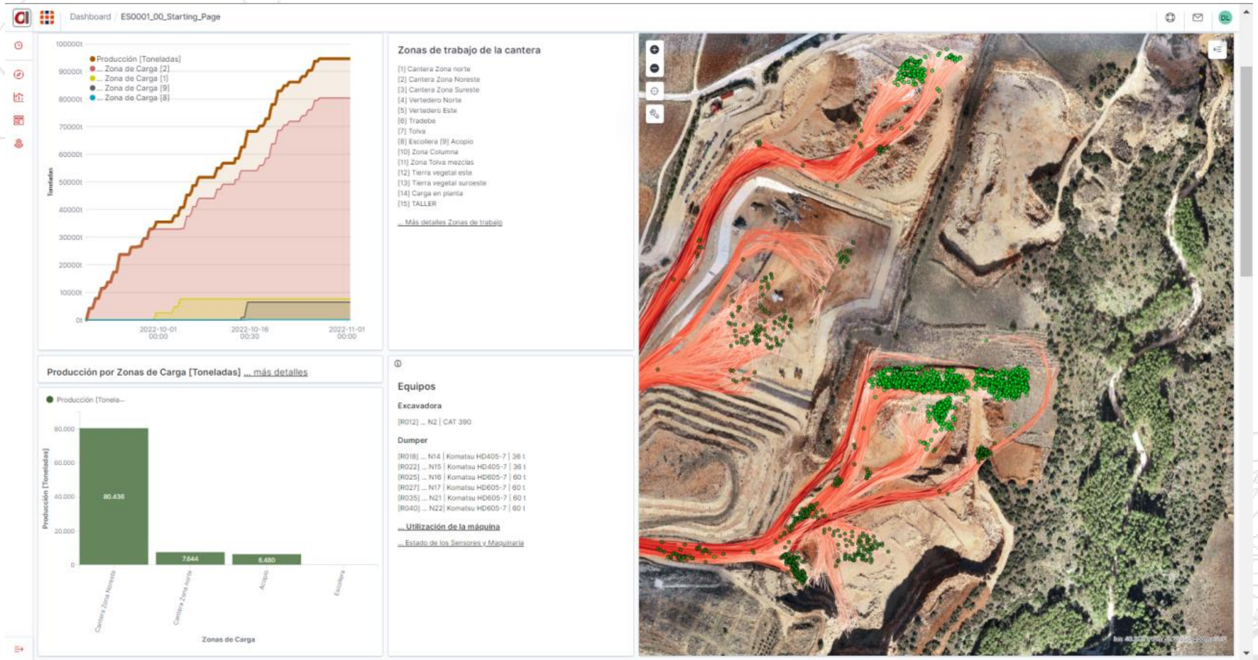
2 MONITORING SENSORS FOR MOBILE MACHINERY

Information related to the production, mass flow, fleet efficiency, working hours, starting of the operations, number of machines per shift, idle times


Dashboard / ES0001_00_Starting_Page

Producción [Toneladas]
... Zona de Carga [2]
... Zona de Carga [1]
... Zona de Carga [9]
... Zona de Carga [8]
Toneladas
1000000t
900000t
800000t
700000t
600000t
500000t
400000t
300000t
200000t
100000t
0t
2022-10-01 00:00
2022-10-16 00:30
2022-11-01 00:00

Zonas de trabajo de la cantera

[1] Cantera Zona norte
[2] Cantera Zona Noreste
[3] Cantera Zona Sureste
[4] Vertedero Norte
[5] Vertedero Este
[6] Tradebe
[7] Tolva
[8] Escollera [9] Acopio
[10] Zona Columna
[11] Zona Tolva mezclas
[12] Tierra vegetal este
[13] Tierra vegetal suroeste
[14] Carga en planta
[15] TALLER

... Más detalles Zonas de trabajo

Producción por Zonas de Carga [Toneladas] ... más detalles

Producción [Tonela...
Producción [Toneladas]
80.000
60.000
40.000
20.000
0
80.436
7.644
6.480
Cantera Zona Noreste
Cantera Zona norte
Acopio
Escollera
Zonas de Carga

Equipos

Excavadora

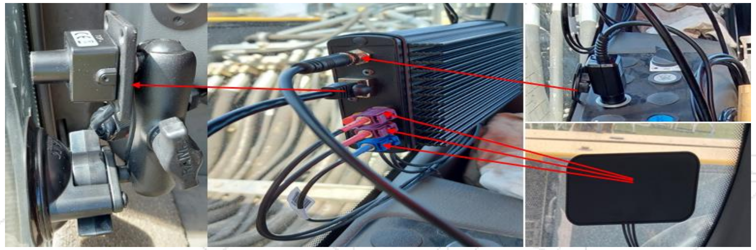
[R012] ... N2 | CAT 390

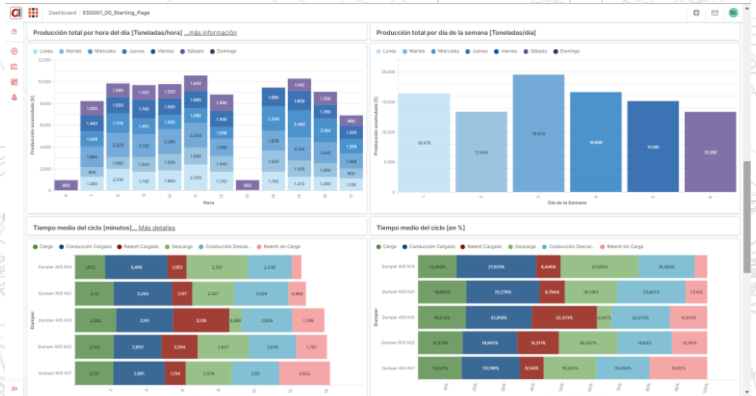
Dumper

[R018] ... N14 | Komatsu HD405-7 | 36 t
[R022] ... N15 | Komatsu HD405-7 | 36 t
[R025] ... N16 | Komatsu HD605-7 | 60 t
[R027] ... N17 | Komatsu HD605-7 | 60 t
[R035] ... N21 | Komatsu HD605-7 | 60 t
[R040] ... N22 | Komatsu HD605-7 | 60 t

... Utilización de la máquina

... Estado de los Sensores y Maquinaria




Dashboard / ES0001_00_Starting_Page

Producción total por hora del día [Toneladas/hora] ... más información
Producción total por día de la semana [Toneladas/día]
Lunes
Martes
Miércoles
Jueves
Viernes
Sábado
Domingo
Hora
Día de la Semana
Tiempo medio del ciclo [minutos] ... Más detalles
Tiempo medio del ciclo [en %]
Carga
Conducción Cargado
Ralentí Cargado
Descarga
Conducción Descar...
Ralentí sin Carga
Dumper

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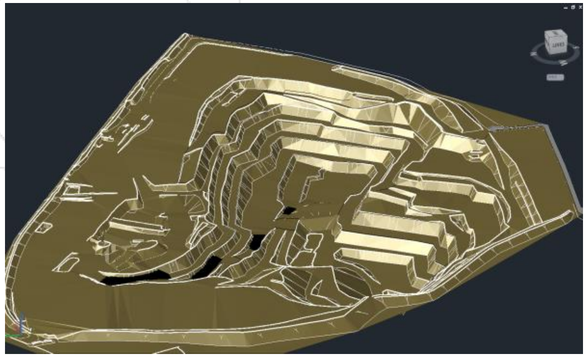
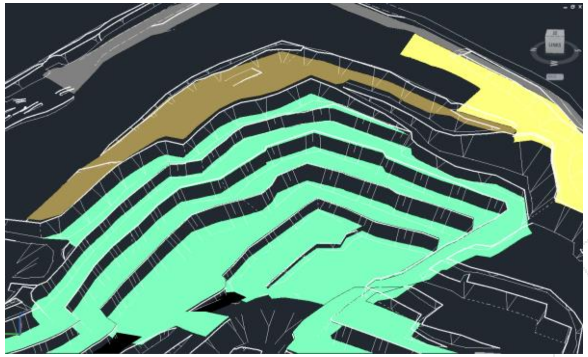
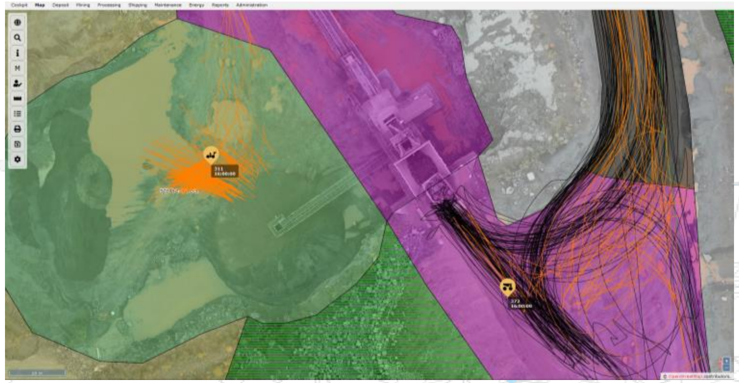
OUTCOMES – Loading and hauling

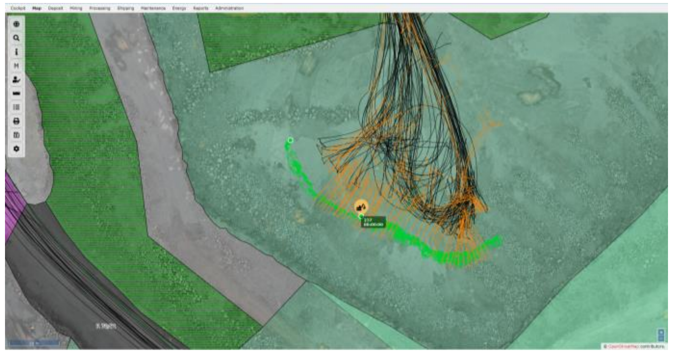
3 3D DYNAMIC GEOFENCE SYSTEM

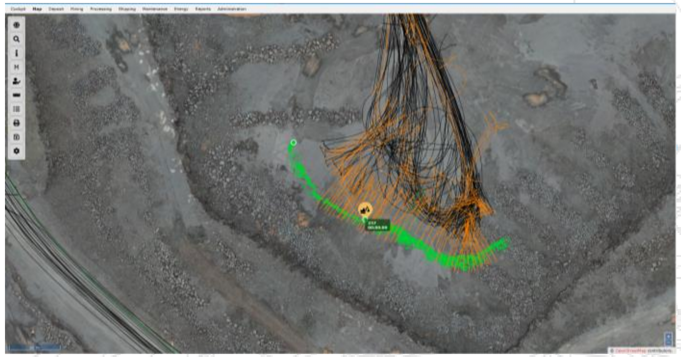
Analysis of the position of the machine to automatically monitor its activity and perform material tracking inside the quarry.

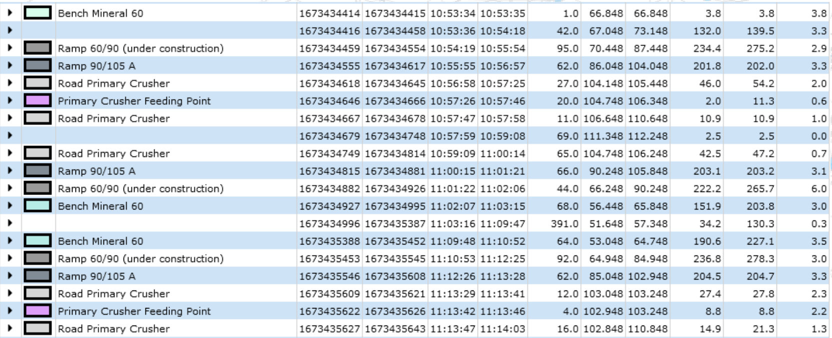












▶	🟩	Bench Mineral 60	1673434414	1673434415	10:53:34	10:53:35	1.0	66.848	66.848	3.8	3.8	3.8
▶			1673434416	1673434458	10:53:36	10:54:18	42.0	67.048	73.148	132.0	139.5	3.3
▶	⬛	Ramp 60/90 (under construction)	1673434459	1673434554	10:54:19	10:55:54	95.0	70.448	87.448	234.4	275.2	2.9
▶	⬛	Ramp 90/105 A	1673434555	1673434617	10:55:55	10:56:57	62.0	86.048	104.048	201.8	202.0	3.3
▶	⬜	Road Primary Crusher	1673434618	1673434645	10:56:58	10:57:25	27.0	104.148	105.448	46.0	54.2	2.0
▶	🟪	Primary Crusher Feeding Point	1673434646	1673434666	10:57:26	10:57:46	20.0	104.748	106.348	2.0	11.3	0.6
▶	⬜	Road Primary Crusher	1673434667	1673434678	10:57:47	10:57:58	11.0	106.648	110.648	10.9	10.9	1.0
▶			1673434679	1673434748	10:57:59	10:59:08	69.0	111.348	112.248	2.5	2.5	0.0
▶	⬜	Road Primary Crusher	1673434749	1673434814	10:59:09	11:00:14	65.0	104.748	106.248	42.5	47.2	0.7
▶	⬛	Ramp 90/105 A	1673434815	1673434881	11:00:15	11:01:21	66.0	90.248	105.848	203.1	203.2	3.1
▶	⬛	Ramp 60/90 (under construction)	1673434882	1673434926	11:01:22	11:02:06	44.0	66.248	90.248	222.2	265.7	6.0
▶	🟩	Bench Mineral 60	1673434927	1673434995	11:02:07	11:03:15	68.0	56.448	65.848	151.9	203.8	3.0
▶			1673434996	1673435387	11:03:16	11:09:47	391.0	51.648	57.348	34.2	130.3	0.3
▶	🟩	Bench Mineral 60	1673435388	1673435452	11:09:48	11:10:52	64.0	53.048	64.748	190.6	227.1	3.5
▶	⬛	Ramp 60/90 (under construction)	1673435453	1673435545	11:10:53	11:12:25	92.0	64.948	84.948	236.8	278.3	3.0
▶	⬛	Ramp 90/105 A	1673435546	1673435608	11:12:26	11:13:28	62.0	85.048	102.948	204.5	204.7	3.3
▶	⬜	Road Primary Crusher	1673435609	1673435621	11:13:29	11:13:41	12.0	103.048	103.248	27.4	27.8	2.3
▶	🟪	Primary Crusher Feeding Point	1673435622	1673435626	11:13:42	11:13:46	4.0	102.948	103.248	8.8	8.8	2.2
▶	⬜	Road Primary Crusher	1673435627	1673435643	11:13:47	11:14:03	16.0	102.848	110.848	14.9	21.3	1.3

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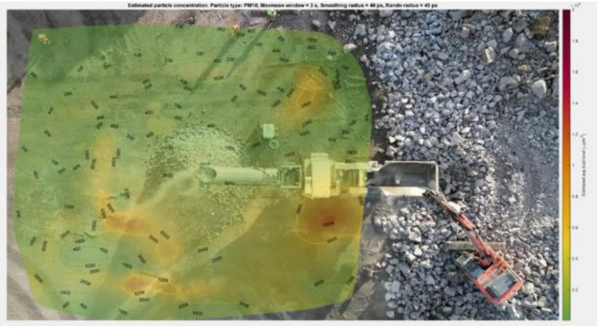
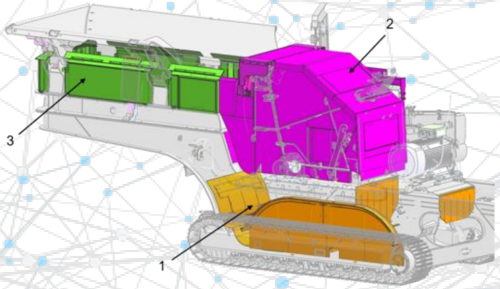
OUTCOMES – Treatment and processing

1 INNOVATIVE MOBILE CRUSHER

Equipped with electric/hybrid power train with auxiliary systems for reduced noise and dust generation.


Estimated particle concentration. Particle type: PM10, Movmean window = 3 s, Smoothing radius = 40 px, Randn radius = 45 px



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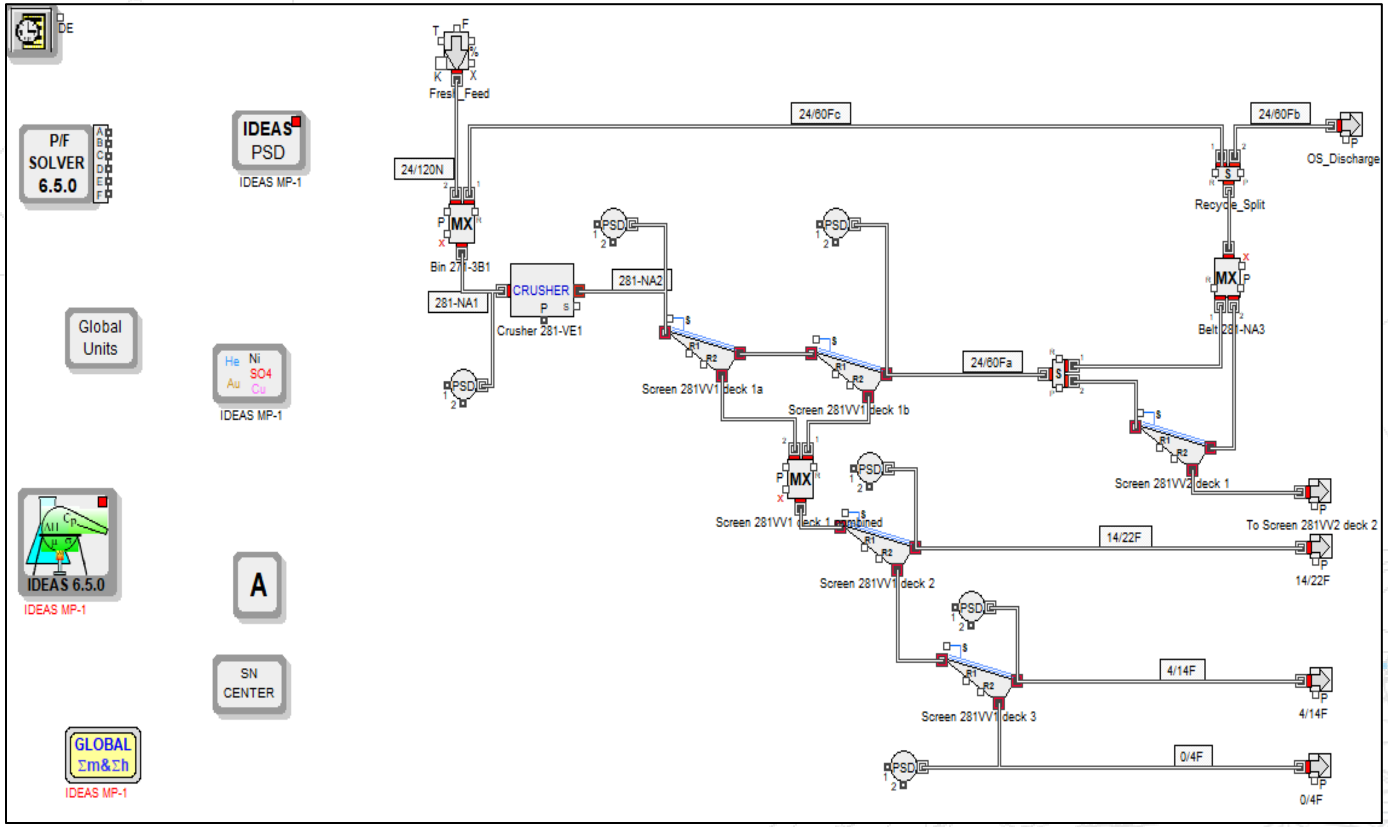
OUTCOMES – Treatment and processing

2 BREAKAGE AND SCREENING MODELS AND DIGITAL TWIN


DE
P/F SOLVER 6.5.0
IDEAS PSD
IDEAS MP-1
Global Units
He Ni Au SO4 Cu
IDEAS MP-1
IDEAS 6.5.0
IDEAS MP-1
A
SN CENTER
GLOBAL Σm&Σh
IDEAS MP-1
Fresh_Feed
24/120N
MX
Bin 271-3B1
281-NA1
CRUSHER
Crusher 281-VE1
281-NA2
PSD
Screen 281VV1 deck 1a
Screen 281VV1 deck 1b
24/60Fc
24/60Fb
OS_Discharge
Recycle_Split
MX
Belt 281-NA3
24/60Fa
Screen 281VV2 deck 1
To Screen 281VV2 deck 2
MX
Screen 281VV1 deck 1 combined
Screen 281VV1 deck 2
14/22F
14/22F
Screen 281VV1 deck 3
4/14F
4/14F
0/4F
0/4F

- High-resolution models for crushing and screening optimisation.
- Accounting for the feed rate and Particle Size Distribution (PSD) of the fed material as well as crusher gap size, classification factor and speed.
- Prediction of a more optimal set of operating parameters, without manipulating the physical plant with trial-and-error adjustments.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101003750

OUTCOMES – Treatment and processing

3 AUTONOMOUS WEIGHTING SYSTEMS

Control and measurement of:

- Instantaneous flow.
- Instantaneous, accumulated and total production.
- Conveyor speed.

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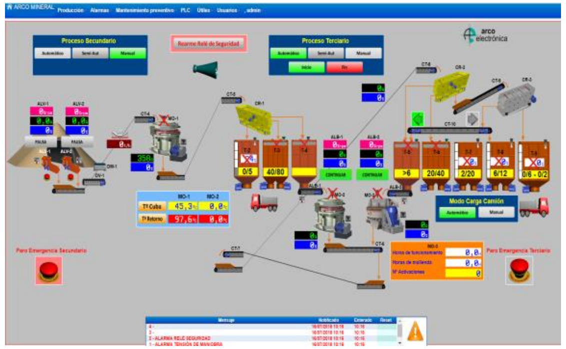
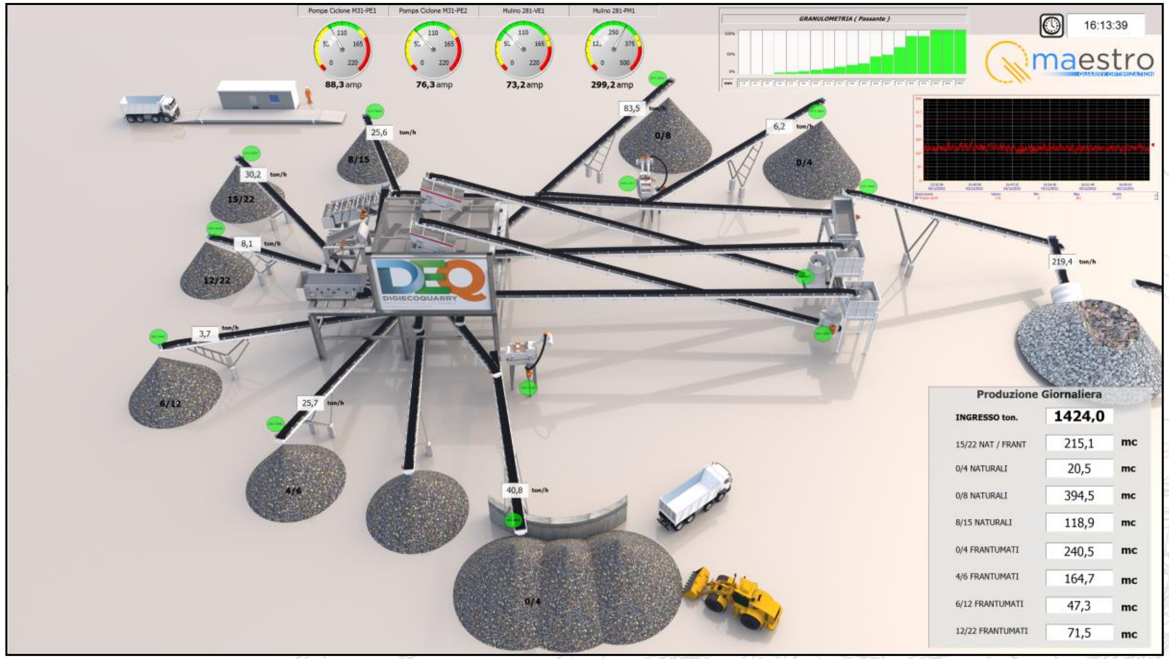
OUTCOMES – Treatment and processing

4 SOFTWARE FOR PRODUCTION CONTROL

Communication of sensors, electrical components and SCADA to automatically register and monitor all production data

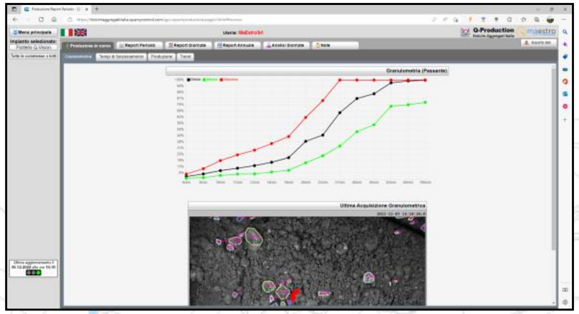

ARCO MINERAL Producción Alarmas Mantenimiento preventivo PLC Útiles Usuarios
Proceso Secundario
Automático Semi-Aut Manual
Proceso Terciario
Automático Semi-Aut Manual
arco electrónica
0/5
40/80
20/40
2/20
6/12
0/6 - 0/2
Modo Carga Camión
Paro Emergencia Secundario
Paro Emergencia Terciario

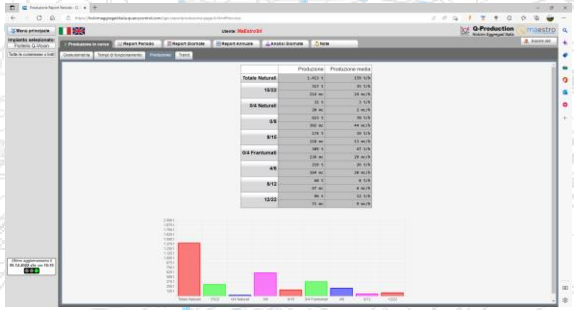
Mass flow measurements, grain size distribution after buffer stockpile


Pompa Ciclone M31-PE1
Pompa Ciclone M31-PE2
Mulino 281-VE1
Mulino 281-FM1
88,3 amp
76,3 amp
73,2 amp
299,2 amp
GRANULOMETRIA (Passante)
16:13:39
maestro
25,6 ton/h
30,2 ton/h
8,1 ton/h
3,7 ton/h
25,7 ton/h
40,8 ton/h
83,5 ton/h
6,2 ton/h
219,4 ton/h
8/15
15/22
12/22
6/12
4/6
0/4
0/8
0/4
DEQ DIGIECOQUARRY

Produzione Giornaliera

INGRESSO ton.	1424,0	
15/22 NAT / FRANT	215,1	mc
0/4 NATURALI	20,5	mc
0/8 NATURALI	394,5	mc
8/15 NATURALI	118,9	mc
0/4 FRANTUMATI	240,5	mc
4/6 FRANTUMATI	164,7	mc
6/12 FRANTUMATI	47,3	mc
12/22 FRANTUMATI	71,5	mc


Q-Production
maestro
Granulometria (Passante)
Ultima Acquisizione Granulometrica


Q-Production
maestro
Produzione
Produzione media

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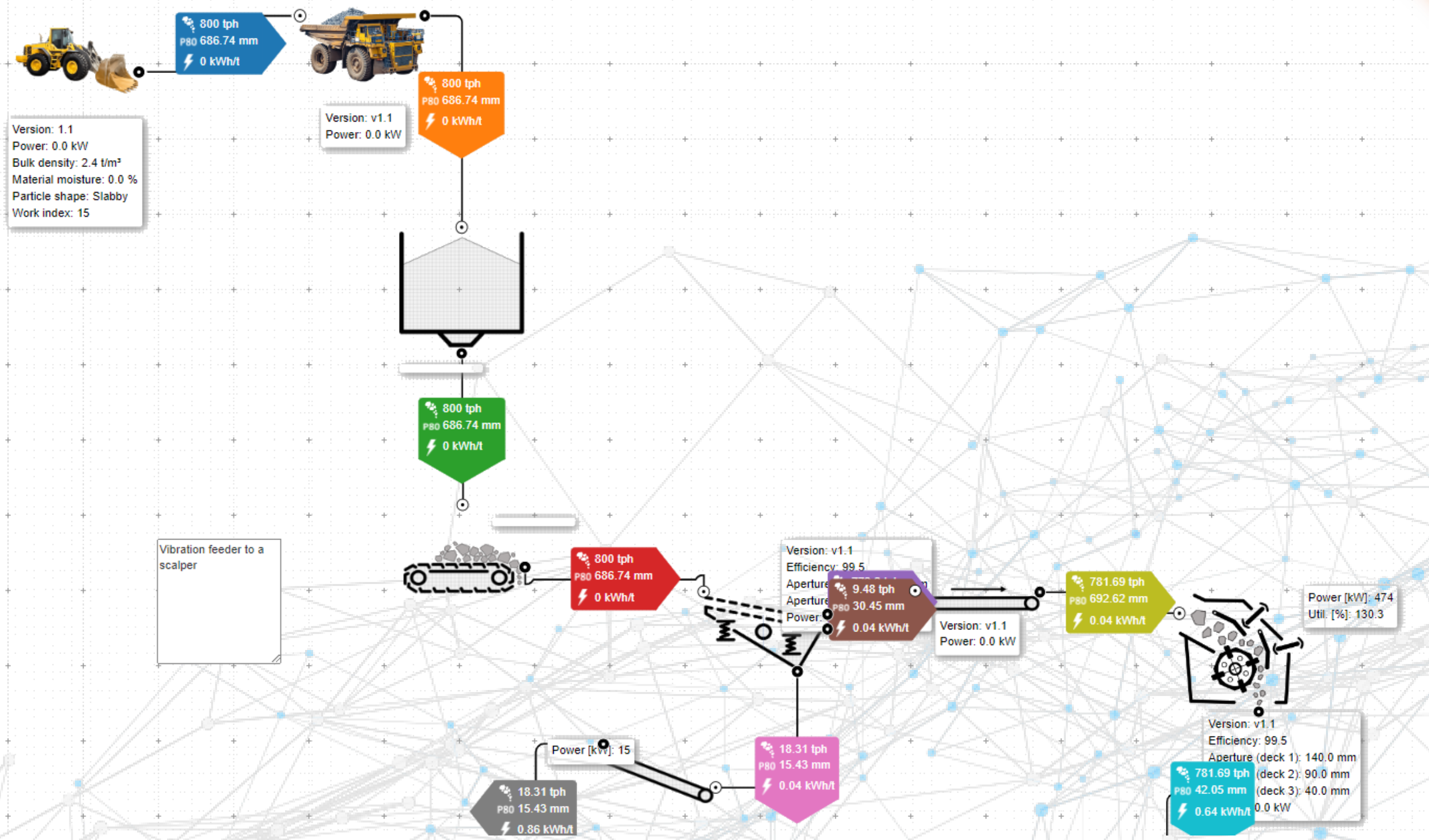
OUTCOMES - Environment

1 ENVIRONMENTAL SYSTEM EVALUATION AND SIMULATION

- Quantification of the environmental impact of the site.
- Identification of the best practices.
- Reduction of the environmental impact and energy consumption, while improving efficiency in all the processes.



Version: 1.1
Power: 0.0 kW
Bulk density: 2.4 t/m³
Material moisture: 0.0 %
Particle shape: Slabby
Work index: 15

Version: v1.1
Power: 0.0 kW

Vibration feeder to a scalper

Version: v1.1
Efficiency: 99.5
Aperture
Aperture
Power:

Version: v1.1
Power: 0.0 kW

Power [kW]: 474
Util. [%]: 130.3

Version: v1.1
Efficiency: 99.5
Aperture (deck 1): 140.0 mm
(deck 2): 90.0 mm
(deck 3): 40.0 mm
0.0 kW

Power [kW]: 15

800 tph
P80 686.74 mm
0 kWh/t
800 tph
P80 686.74 mm
0 kWh/t
800 tph
P80 686.74 mm
0 kWh/t
800 tph
P80 686.74 mm
0 kWh/t
9.48 tph
P80 30.45 mm
0.04 kWh/t
781.69 tph
P80 692.62 mm
0.04 kWh/t
18.31 tph
P80 15.43 mm
0.04 kWh/t
18.31 tph
P80 15.43 mm
0.86 kWh/t
781.69 tph
P80 42.05 mm
0.64 kWh/t

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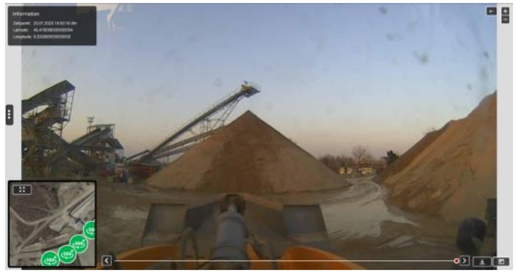
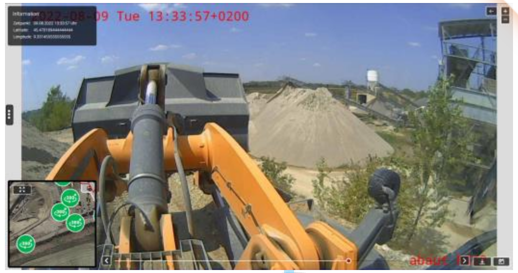
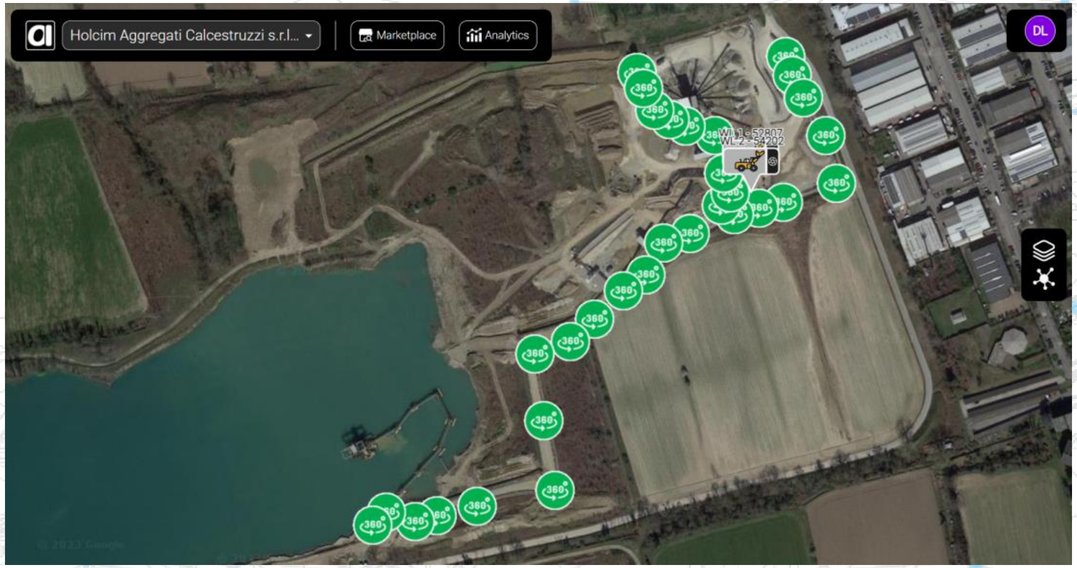
OUTCOMES – H&S

1 RECOGNITION SYSTEM FOR WORKERS NEARBY MOBILE MACHINERY AND H&S SYSTEMS FOR MOBILE EQUIPMENT

- Identification of the worker in the surrounding machines.
- Location and time of the picture.
- Possibility to include the picture in site according to its location.
- Speed of the machine in the moment of the recognition.


Information


Information
2022-08-09 Tue 13:33:57+0200


Holcim Aggregati Calcestruzzi s.r.l...
Marketplace
Analytics
DL
360

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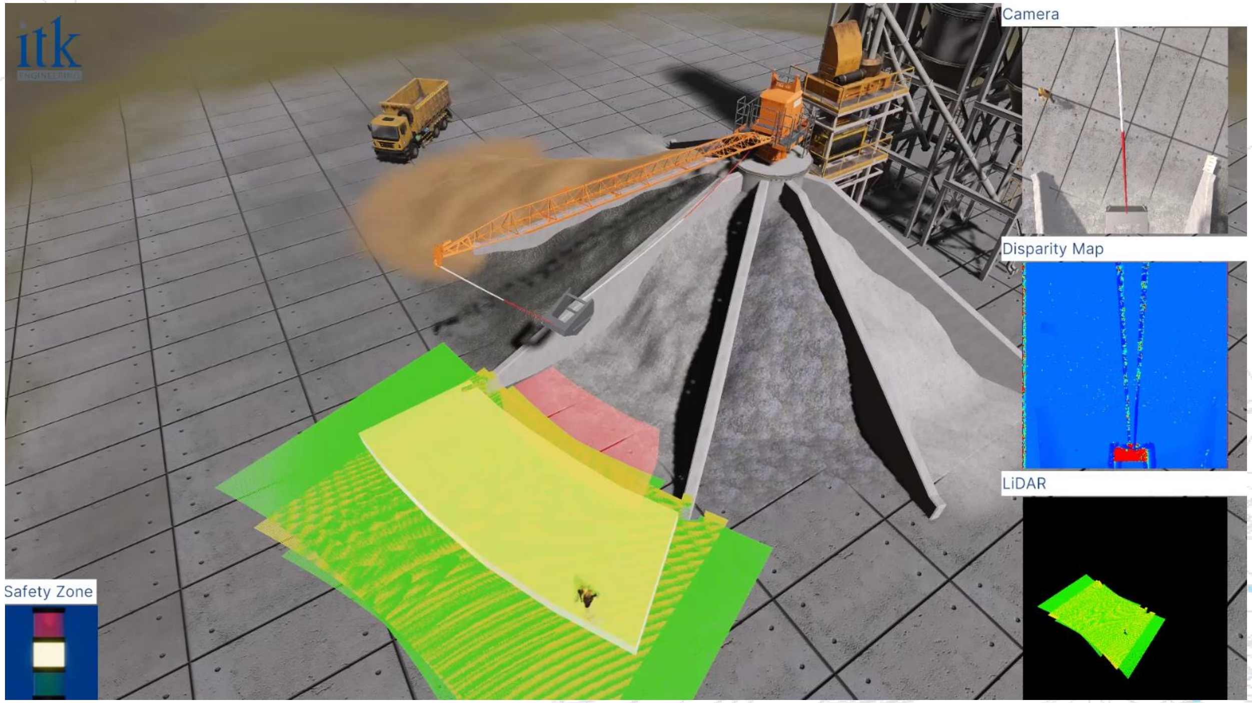
OUTCOMES – H&S

2 H&S SYSTEMS FOR STATIONARY EQUIPMENT

Safeguard system which detects hazardous machine movements by using appropriate sensors.


itk
Camera
Disparity Map
LiDAR
Safety Zone

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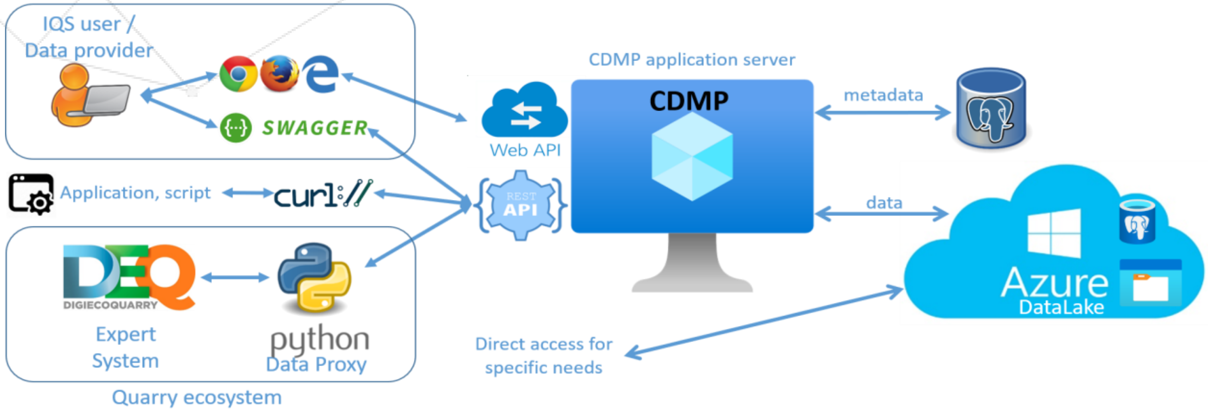
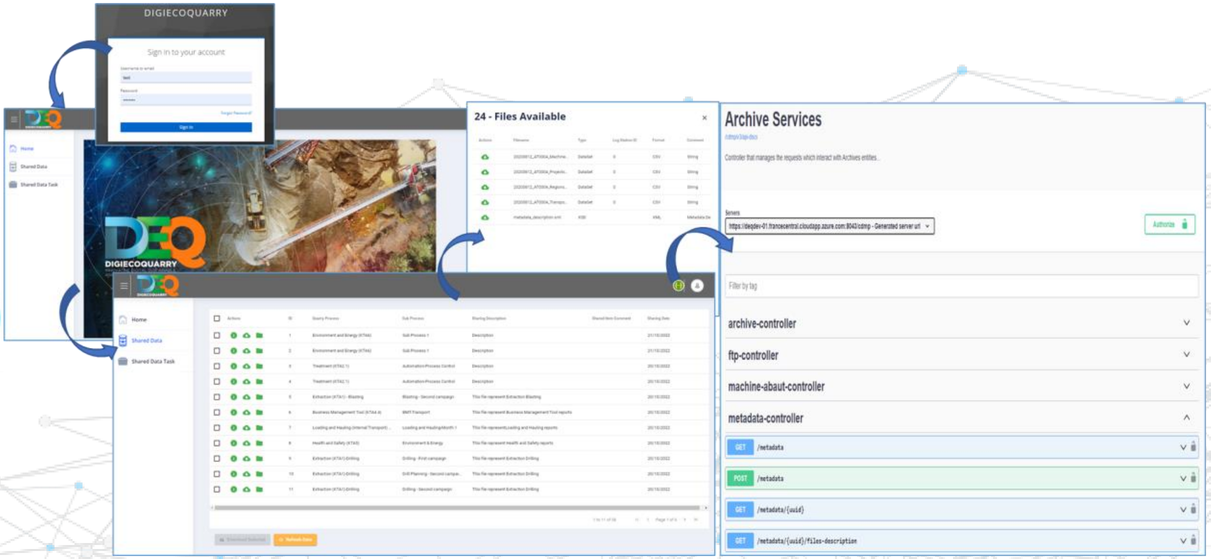
OUTCOMES - Connectivity

1 IQS

A centralised platform using open-source frameworks. It aims to collect and store data from all parts of the quarries and allows partners and suppliers to browse, access and download data.


IQS user /
Data provider
SWAGGER
Application, script
curl://
DEQ
DIGIECOQUARRY
Expert
System
python
Data Proxy
Quarry ecosystem
Web API
REST
API
CDMP application server
CDMP
metadata
data
Azure
DataLake
Direct access for
specific needs


DIGIECOQUARRY
Sign in to your account
24 - Files Available
Home
Shared Data
Shared Data Task
DEQ
DIGIECOQUARRY

Archive Services

archive-controller

ftp-controller

machine-abaut-controller

metadata-controller

GET /metadata

POST /metadata

GET /metadata/{uuid}

GET /metadata/{uuid}/files-description

The data will be associated with metadata -data description- stored in a global database used to fetch and retrieve data.

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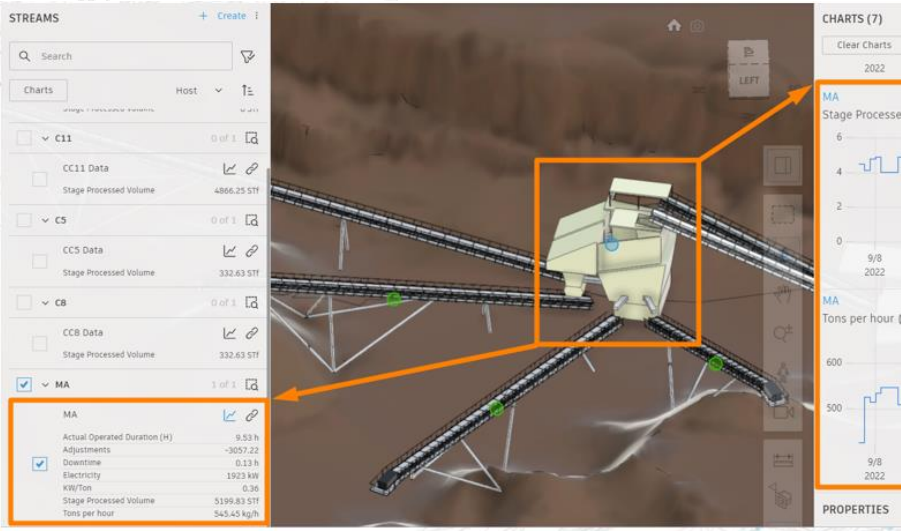
OUTCOMES - Connectivity

2 BIM

Building Information Modelling extends the three primary spatial dimensions (width, height and depth), incorporating information about time (so-called 4D BIM).



STREAMS + Create

Search

Charts Host

☐ C11 0 of 1
☐ CC11 Data
Stage Processed Volume 4866.25 STf

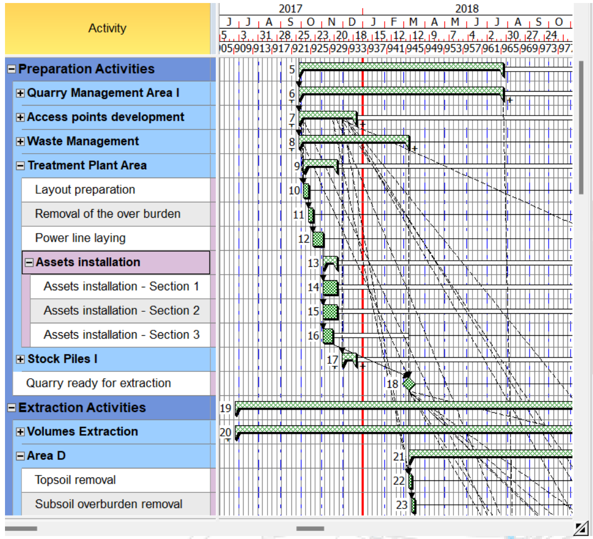
☐ C5 0 of 1
☐ CC5 Data
Stage Processed Volume 332.63 STf

☐ C8 0 of 1
☐ CC8 Data
Stage Processed Volume 332.63 STf

☑ MA 1 of 1
☑ MA

Actual Operated Duration (H)	9.53 h
Adjustments	-3057.22
Downtime	0.13 h
Electricity	1923 kW
KW/Ton	0.36
Stage Processed Volume	5199.83 STf
Tons per hour	545.45 kg/h

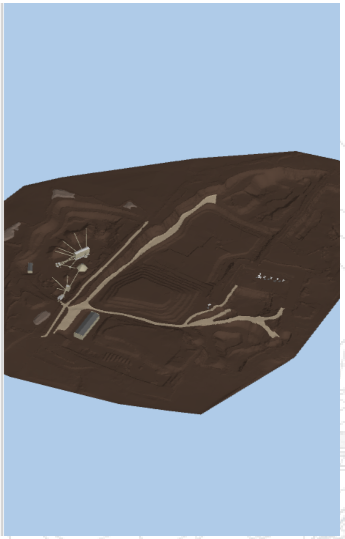
CHARTS (7)
Clear Charts
2022
MA
Stage Processe
6
4
2
0
9/8
2022
MA
Tons per hour
600
500
9/8
2022
PROPERTIES
LEFT



Activity

⊟ Preparation Activities
⊞ Quarry Management Area I
⊞ Access points development
⊞ Waste Management
⊟ Treatment Plant Area
Layout preparation
Removal of the over burden
Power line laying
⊟ Assets installation
Assets installation - Section 1
Assets installation - Section 2
Assets installation - Section 3
⊞ Stock Piles I
Quarry ready for extraction
⊟ Extraction Activities
⊞ Volumes Extraction
⊟ Area D
Topsoil removal
Subsoil overburden removal

2017
2018
J J A S O N D J F M A M J J A S O
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23



- 3D visualisation.
- Clashes/conflicts visualisation.
- Time planning.
- Works execution optimisation.
- Resource and cost optimisation.

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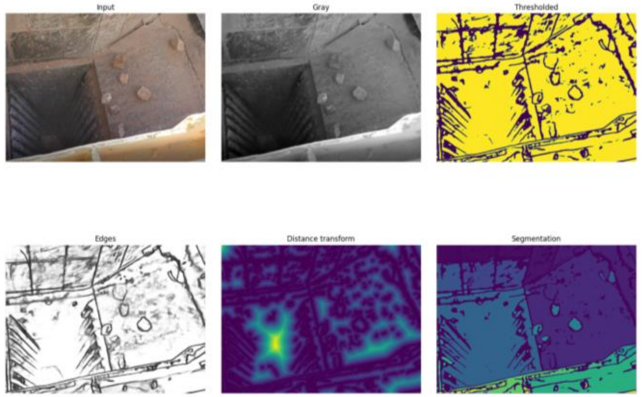
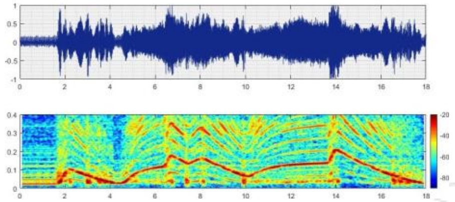
OUTCOMES – Connectivity

3 ARTIFICIAL INTELLIGENCE SERVICES

- Aggregate Quality by Colorimetry
- Grain Size Determination
- Stockpile Volume Calculation
- Anomaly Detection of Mechanical Failures
- NLP Information and Document Search Engine (MetaQuarry)
- Consumptions & Product Forecasting


Input
Gray
Thresholded
Edges
Distance transform
Segmentation



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OUTCOMES – Knowledge and social

1 3 ROADMAPS FOR THE EXTRACTIVE INDUSTRY

2 SOCIAL AWARENESS OF RAW MATERIALS

3 CAPACITY BUILDING PROGRAM

4 EXPLOITATION PLAN FOR DEQ's RESULTS

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DIGIECOQUARRY
INNOVATIVE DIGITAL SUSTAINABLE
AGGREGATES SYSTEMS

FOLLOW US IN SOCIAL MEDIA

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@digiecoquarry

@digi_eco

f Digiecoquarry

YouTube Digiecoquarry

v Digiecoquarry

XVI Jornadas Técnicas ANIET
Porto - Portugal
8 November 2023

XVI
JORNADAS
TÉCNICAS
ANIET
08 NOV. 2023

ROTATE
CIRCULAR ECOLOGICAL ESSENTIAL
& CRITICAL RAW MATERIALS

César Luaces Frades – Director General – ANEFA
Carlos Fernando Forero Bonet – Secretario General Asogravas

Horizon Europe research
and innovation programme
(Nº 101058651)

The need behind R8

Demand for critical and non-critical **Raw Materials** is **increasing** drastically, but **Europe** heavily **relies on** imports from **third countries.**

↓

Ensure access to a secure, diversified, affordable and **sustainable supply.**

Challenges to face:

Health & Safety	Efficiency & profitability	Environment-friendly	Positive social impact

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Consortium

21
partners

9
different EU countries

- Asociación Nacional de Empresarios Fabricantes de Áridos – ANEFA 🇪🇸
- Advanced Mineral Processing 🇪🇸
- AGREPOR – CIMPOR 🇵🇹
- AKKODIS Research 🇫🇷
- Investigación Centro Tecnológico del Mármol, Piedra y Materiales 🇪🇸
- Canteras Industriales 🇪🇸
- Chalmers University of Technology 🇸🇪
- CITEPA 🇫🇷
- Danish Teknologisk Institut 🇩🇰
- Fundación Tormes-EB 🇪🇸
- Gate2Growth 🇩🇰
- Hormisoria 🇪🇸
- Imperial College London 🇬🇧
- LafargeHolcim Francia 🇫🇷
- Metso:Outotec 🇫🇮
- Roctim AB 🇸🇪
- Université de Liège 🇧🇪
- UPM Universidad Politécnica de Madrid 🇪🇸
- Velde Industri AS 🇳🇴
- Vlaamse Instelling Voor Technologisch Onderzoek Nv (VITO) 🇧🇪
- Zabala Innovation Consulting 🇪🇸

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R8TATE
CIRCULAR ECOLOGICAL ESSENTIAL
& CRITICAL RAW MATERIALS

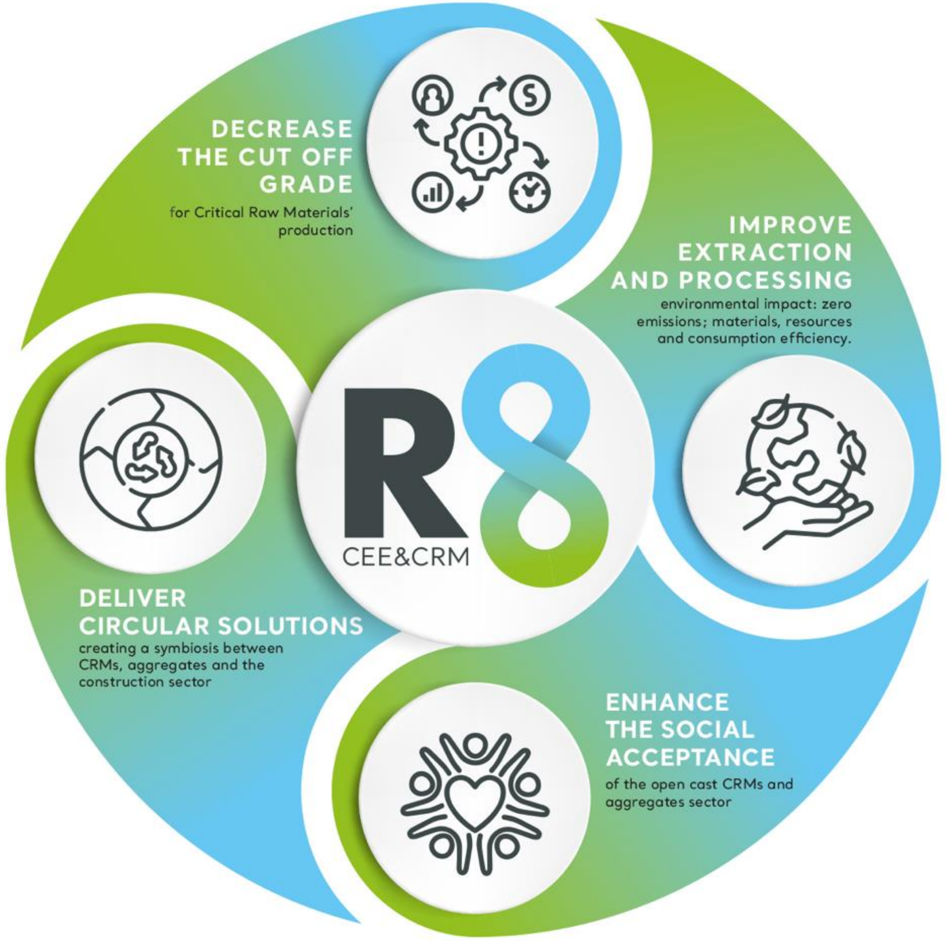
Goals

Extraction and processing improvement
zero emissions, materials, resources and consumption efficiency.

Circularity, industrial **symbiosis** and waste **valorisation**.

Environmental footprint
assessment, management and monitoring.

Social engagement



R8
CEE&CRM

DECREASE THE CUT OFF GRADE
for Critical Raw Materials' production

IMPROVE EXTRACTION AND PROCESSING
environmental impact: zero emissions; materials, resources and consumption efficiency.

ENHANCE THE SOCIAL ACCEPTANCE
of the open cast CRMs and aggregates sector

DELIVER CIRCULAR SOLUTIONS
creating a symbiosis between CRMs, aggregates and the construction sector

ANIET
ASSOCIAÇÃO NACIONAL DA INDÚSTRIA EXTRACTIVA E TRANSFORMADORA

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the European Union

Supporting organisations

INTERNATIONAL ADVISORY BOARD

Panel composed of **extractive industry's relevant stakeholders** which provides **external input**, **guidance**, and **feedback**.

IUCN
euromines
European Agency for Safety and Health at Work
UEPG
Direção-Geral de Energia e Geologia
AGGREGATES BUSINESS
GAIN
UNIVERSIDAD DE GRANADA
CEPCO
Gobierno del Principado de Asturias
ASOGRAVAS
ANIET
ASSOCIAÇÃO NACIONAL DA INDÚSTRIA EXTRACTIVA E TRANSFORMADORA

FOLLOWER PROJECTS STEERING COMMITTEE

Board consisting of diverse **mining projects**. R8 will **gather** their **issues**, **integrate** them into its **core**, and **seek** their **solution**.

SACHTLEBEN MINERALS
Holcim
MYTILINEOS
INFINITY LITHIUM
Ponderosa ÁRIDOS Y HORMIGONES
Strategic Minerals Spain
QUANTUM MINERIA
CRONENBERGER STEININDUSTRIE FRANZ TRICHES GMBH & CO KG
Tolsa
dst
THIESS

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Technologies to be developed

CANTERAS INDUSTRIALES

Celestite

- Increased celestite recovery
- Reuse of celestite tailing
- Sludge super thickener

VELDE

Granite

- Artificial Vision granulometry control
- Residues valorisation for cement and concrete

HORMISORIA

Sand and gravel
Cassiterite, Monazite
Zircon, Ilmenite

- Use and recovery of CRMs
- 3D sludge printing

LAFARGE

Sand and gravel

- Crushability characterisation
- Water treatment

CIMPOR

Limestone

- Energy-efficient mobile crusher w/ dust and noise minimisation
- Crushability characterisation

- Environmental management platform
- Social engagement strategy
- Interaction with policymakers
- Exploitation plan

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Processing solutions

R8TATE
CIRCULAR ECOLOGICAL ESSENTIAL & CRITICAL RAW MATERIALS

FOR CRM OBTENTION

Increased celestite recovery

Combination of spiral technologies and sieves for size separation.

- Suitable fraction of celestite to be detected using spiral technology.
- Dense media methods to be combined with a hydrocyclone for celestite concentration.
- Mix of a Low Intensity Magnetic Separator (LIMS) and a Gravity and Magnetic equipment.
- Recovery processes to be scaled up to a semi-industrial scale.

Sludge super thickener:

Definition of the optimum formulation and quantity of the flocculant.

- Based on the characterisation of the specific flocculant used as a reagent.
- Analysis and optimisation to obtain a malleable sludge easy to reuse and the high fraction of recovered water.
- Processes to be scaled up to the industry.

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Processing solutions

FOR CRM OBTENTION

Development of a technology to recover valuable minerals and CRMs from aggregates sites

All-in-line processing technology to recover the small fraction of CRMs contained in aggregates production lines.

- Adaption and combination of gravimetric equipment, magnetic and electrostatic separation, flotation and leaching systems to recover the preliminary preconcentrate of CRMs in water.
- Characteristics and yield of the equipment to be analysed and tested.
- Enrichment of the resulting CRMs to be considered and studied so to meet the requirements of commercial mineral products.
- Recovery processes to be deployed to a semi-industrial scale.

Funded by the European Union

Efficiency solutions

FOR
COMMON
PROCESSES

Energy-efficient mobile crushing technology with noise and dust minimisation

To improve the overall sustainability of the crushing process.

- Optimised process flow and crusher control to reduce CO2 emissions, noise and dust.
- Minimisation of the generated fines by process control through on-line data.
- Process design be based on preliminary material tests.
- Fine-tuning with machine vision and capacity measurements.

Innovative RM mechanical and crushability characterisation

New energy-based rock crushability testing method for crushing simulation.

- Evaluation of current rock testing techniques and their applicability for crushing simulation to overcome the lack of accuracy in fines prediction.
- Development of an energy-based rock testing method.
- Evaluation of the aforementioned rock test method for different aggregates or by-products.
- Calculation and comparison of process flow charts for tested materials.

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the European Union

Efficiency solutions

FOR COMMON PROCESSES

Advanced Characterisation of Granulometry based on Artificial Vision Systems

To minimise energy requirements and avoid equipment failures.

- Implemented in the crushing stage.
- Automatic detection of the granulometry.
- Monitored, quantified and controlled energy consumption .
- Artificial intelligence, machine learning and cloud computing to improve previous prototypes of AVS tested at laboratory scale.

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Valorisation solutions

FOR
ENHANCED
CIRCULARITY

Advanced treatment of water in front of mine

To improve water management

- Based on matter, water and reagents balance.
- Iterations of the initially defined process diagram to be performed.

Valorisation of aggregate washing residue in cement and concrete development

Batches of aggregates washing residue with different compositions will be tested as:

- Concrete filler.
- Supplementary cementitious material (SCM) after co-calcination.
- Lightweight aggregate.

Valorisation of sludges for 3D printing development.

Aggregates and natural stone sludges for additive manufacturing of cement and concrete.

- Granulometric adaptation and sample preparation.
- Dosage tests and fresh characterization.
- Extrusion and applicability tests.

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the European Union

Valorisation solutions

FOR ENHANCED CIRCULARITY

Valorisation of mine tailings based on geophysics and teledetection development

To enhance mine tailings valorisation

- Geophysical methods teledetection by means of UAV, data acquisition by spectroradiometer, integration of geological/ geophysical data with resource calculation and mine planning software with grade calculations and 3D models.
- All the measurements to be geo-referenced by GPS.

Standardisation, regulation and certification for construction

To improve existing and future standards

- Existing legislation to be analysed and if relevant, recommendations will be elaborated regarding further development of existing standards.
- Development of end-of-waste-criteria: recommendations for further standardisation work.

Funded by the European Union

Monitoring & Assessment

FOR
ENVIRONMENTAL
MANAGEMENT

Mine Closure and Remediation guidelines

Methodology to guide decision-makers regarding M&Q licenses in closure and post-closure actions.

- Geological characterization of the area.
- Mechanical stability of the soil.
- Surface and underground hydrological aspects and acid waste drainage control.
- Contaminated soil management.
- Stabilization and protection of metallurgical waste.
- Reuse of sites and facilities.
- Criteria to develop a geomorphological restoration.
- To be tested in real study cases.

Funded by
the European Union

Monitoring & Assessment

R8TATE
CIRCULAR ECOLOGICAL ESSENTIAL & CRITICAL RAW MATERIALS

FOR ENVIRONMENTAL MANAGEMENT

Environmental Management Platform

A tool for global interoperability of collected data for automatic management decisions support.

- Biodiversity module.
- Process and environmental assessment for resources efficiency module.
- Emission estimation module.
- Environmental risks prediction and management module.
- Energy efficiency module.
- Decision-making module.

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Social and policy aspects

TO RAISE AWARENESS OF RM

Social acceptance and citizen engagement in extractive industries is still one of the pending areas to be fully deployed and understood. It is key to ensure the long-term sustainability of the sites, which includes not only avoiding potential conflicts with local communities but also integrating the extractive activity in the local economy to effectively contribute to local development.

- Promote active participation of the stakeholders in the project.
- Raise social awareness of Raw Materials in EU.
- Develop a plan targeting policy makers.
- Define a Clustering plan to build a collaborative network.
- Ensure transfer of knowledge and cooperation among relevant stakeholders.

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Social aspects

TO EXPLOIT THE PROJECT'S RESULTS

Business plan, exploitation and profitability

To promote ROTATE as a new concept of sustainable mining and quarrying, enabling the sector to establish a new framework for new business strategies based on smart exploitation that will allow the access to currently unavailable RM.

- Exploitation strategy.
- Business plans.
- IPR strategy.
- Cost-benefit analysis.
- Replication analysis for other sites.
- Training of the technologies developed in the project.

Funded by the European Union

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the European Union

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YouTube ROTATE PROJECT

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