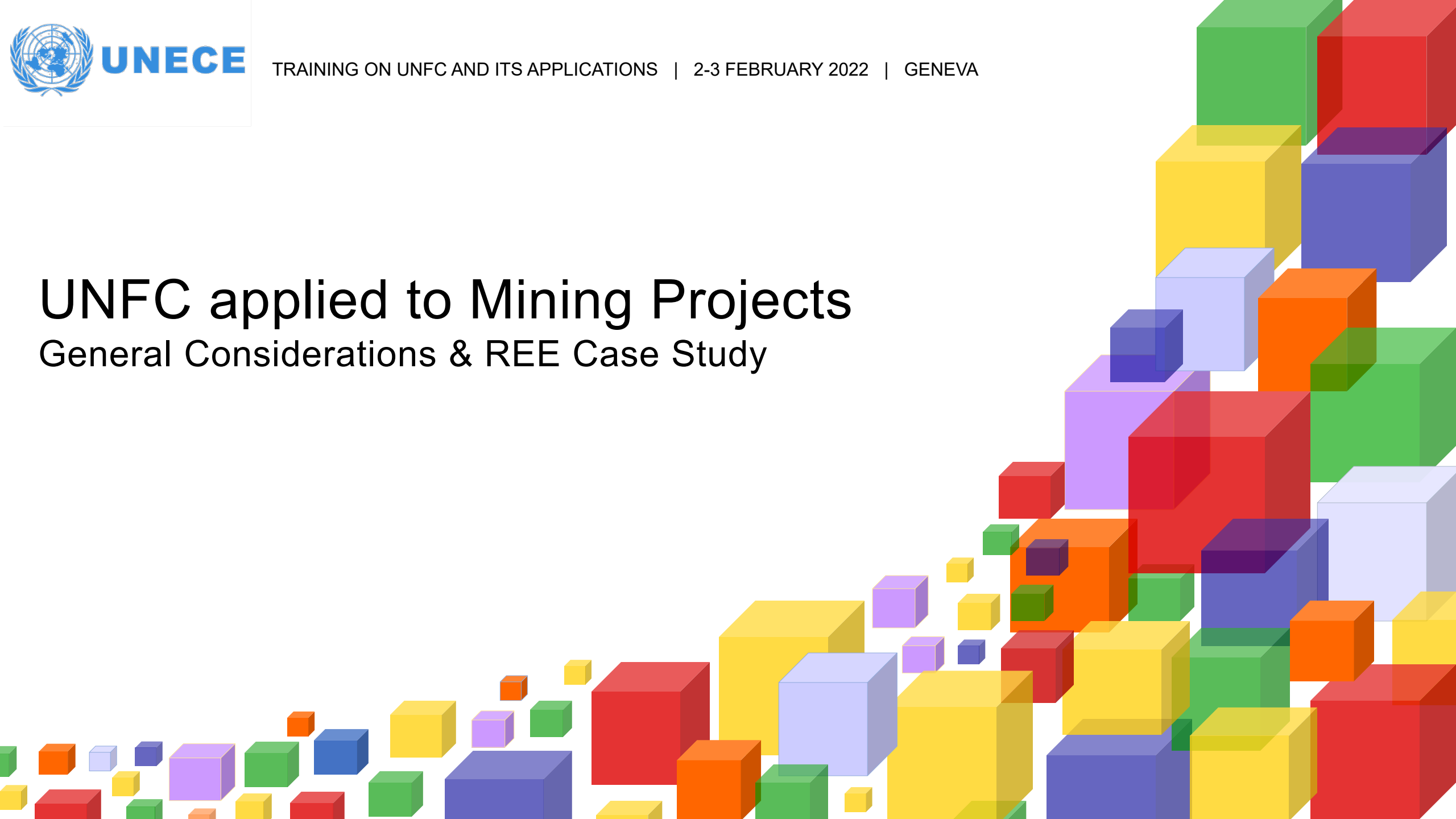




TRAINING ON UNFC AND ITS APPLICATIONS | 2-3 FEBRUARY 2022 | GENEVA

UNFC applied to Mining Projects

General Considerations & REE Case Study

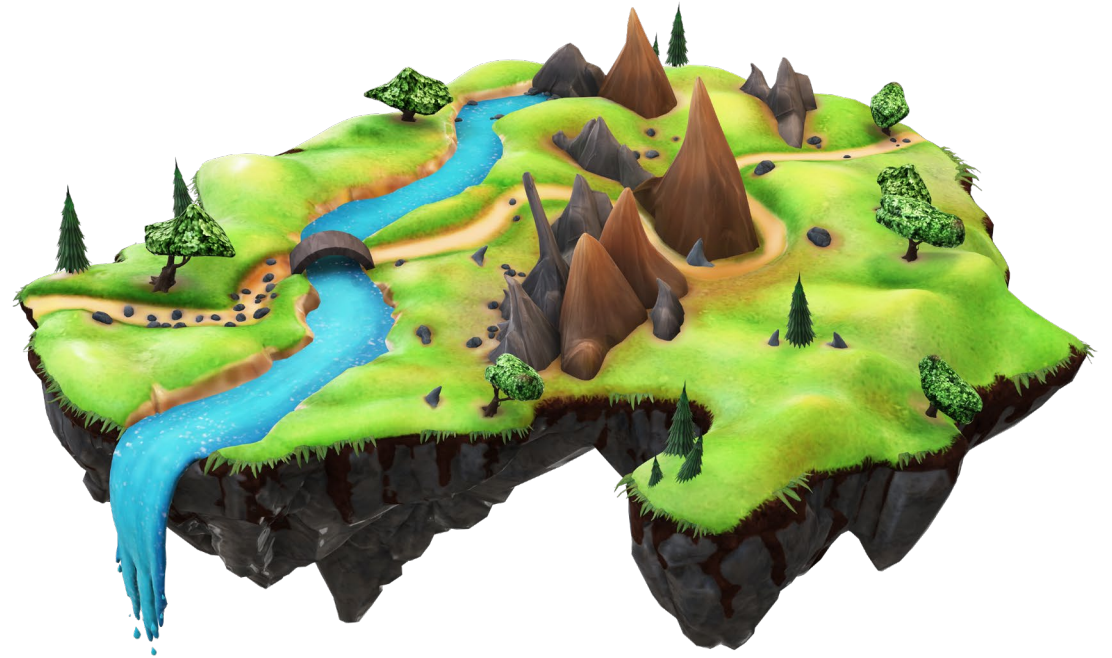


Objectives

- UNFC general mining considerations
- Some E, F and G axis considerations
- A brief case study.

Alignment to SDGs

- To classify mineral projects, including metal ores, technical minerals, evaporites, aggregates and solid energy minerals such as coal and others in alignment with the Sustainable Development Goals (SDGs).
- To adapt the classification system to the projects in an environment of sustainable, and innovative technologies and advanced resource management tools.





Mineral products

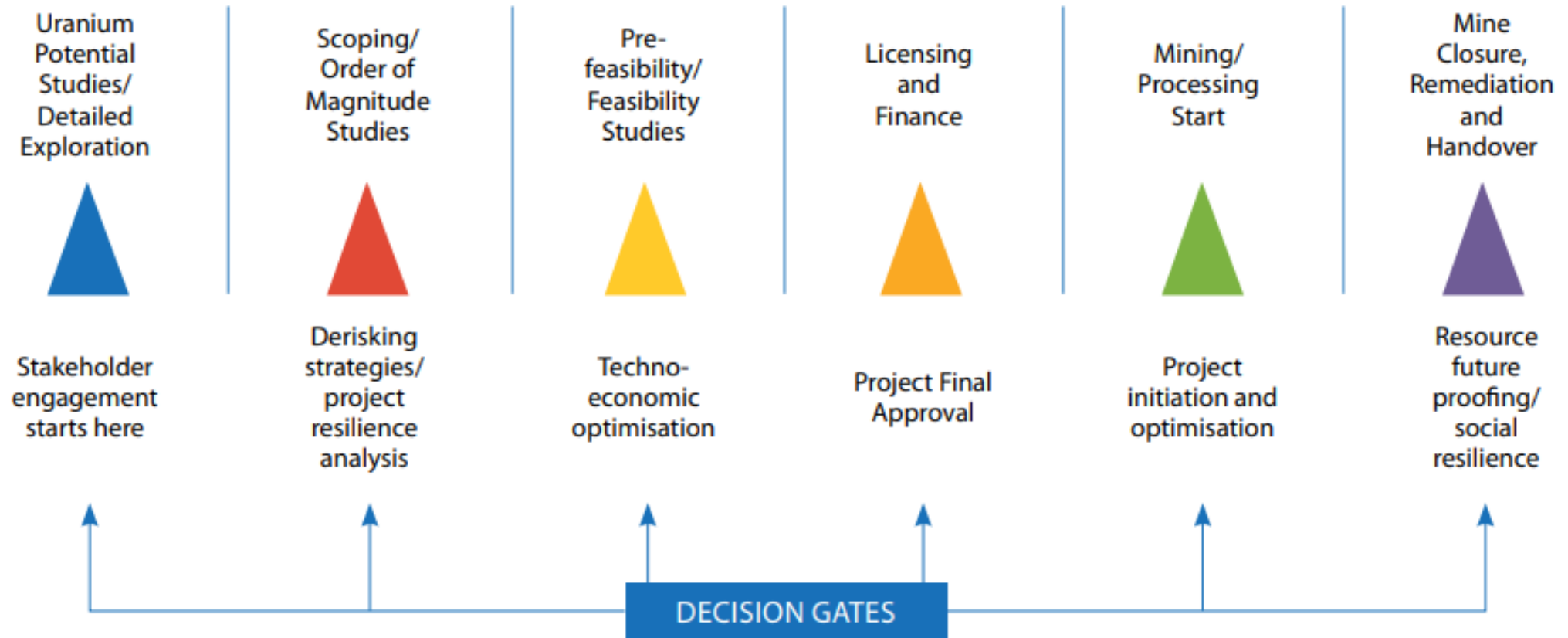
- Mined or produced ores, Co-products
- Beneficiated ores
- Processed ore concentrates
- By-products.



Mining methods

- Surface Mining (Open Pit Mining, Quarrying)
- Subsurface Mining (Room & Pillar, Longwall, Slope Mining and others)
- Placer Mining (Trenching, Dredging)
- In-situ Recovery (ISR) (or In-situ Leaching (ISL) or Borehole Mining)
- Solution Mining/Brine Mining.

Mining Lifecycle



Foreseeable future

The period of time that a Project can make a reasonable projection of the occurrence of future conditions, events or other factors that determine the environmental-socio-economic viability or technical feasibility of a Project.

Reasonable expectations E1

Reasonable prospects E2, E3

Reasonable time frame

General Considerations

- Distinction between potentially produced quantities and undeveloped quantities (F1-2 or F4 ?)
- Minerals product (raw ore, beneficiated material, processed ore ? Primary product/Co-product/By-product?)
- Reference point (Mine head, Processing plant etc.)
- Avoidance of double counting (Inclusive? Exclusive, i.e Resources inclusive of Reserves?)

Mineral Resources and Mineral Reserve estimates are shown on a 100% basis for each mine. The Measured and Indicated Mineral Resource estimates are inclusive of those Mineral Resource estimates modified to produce the Mineral Reserve estimates. All estimates are prepared as at June 30, 2021.

- Units - Reporting shall use SI units.

Contained Metal					
Cu	Zn	Pb	Au	Ag	Ni
kt	kt	kt	Moz	Moz	kt

Resource/Reserve indicator	Millions of dry metric tonnes	Copper (%)	Uranium oxide (kg/t)	Gold (g/t)	Silver (g/t)
Proved reserve	221	1.97	0.59	0.73	3.99
Probable reserve	253	1.77	0.61	0.79	3.91
Total reserve	473	1.86	0.60	0.76	3.95

Mineral project studies

- **Scoping study/Order of magnitude studies/Pre-evaluation:** First economic study carried out with minimum requirements and by comparison with similar existing operations, more advanced projects, or using general cost curves. (Estimates +/- 85%)
- **Pre-feasibility study:** Economic study based on more specific data for the actual deposit. (Estimates +/- 50%)
- **Feasibility study:** Final detailed study at the end of which a decision to proceed with or defer construction can be taken. (Estimates +/- 15 %)



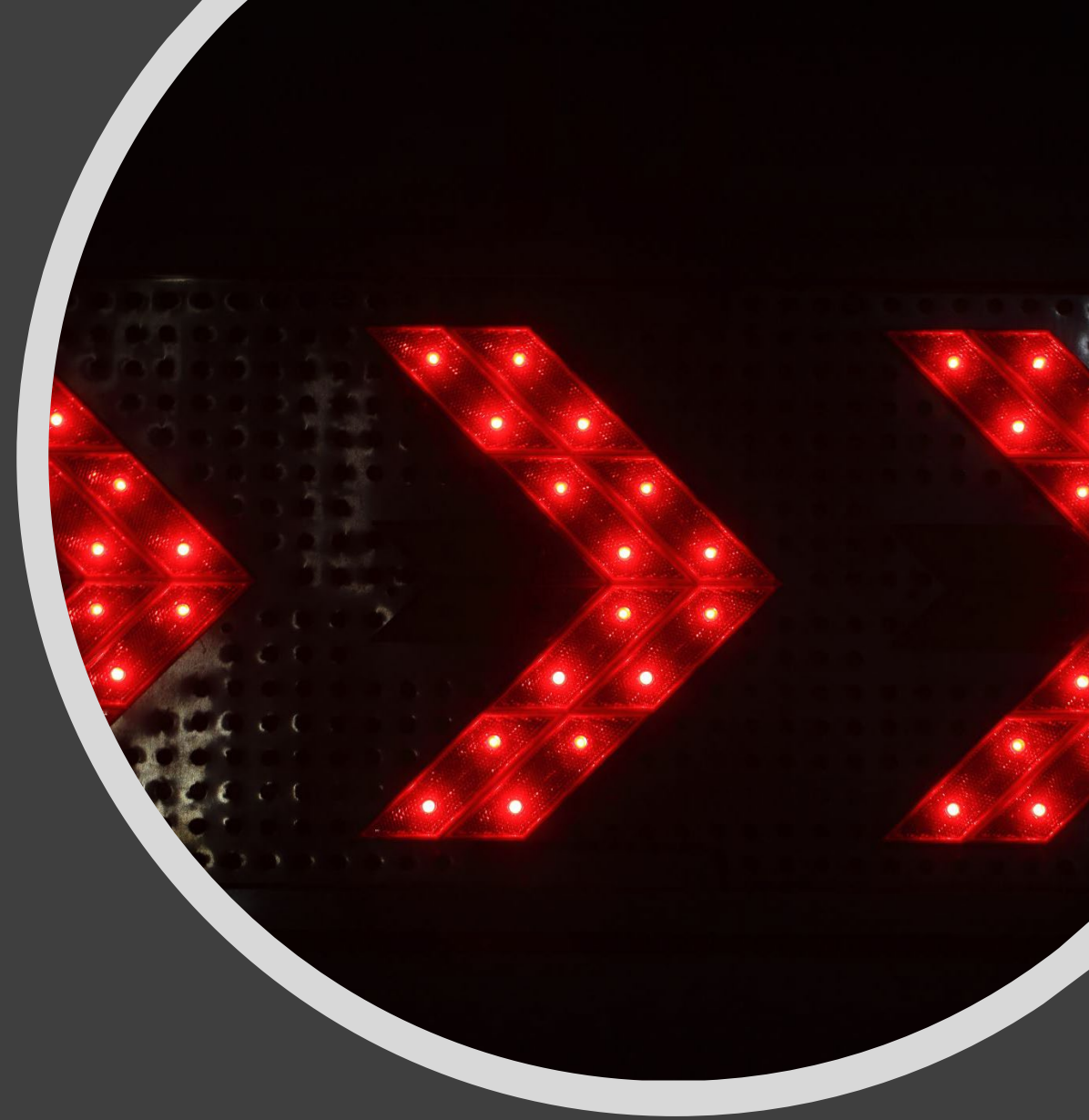
Detailed studies 1/2

- To designate a project as F1, sufficiently detailed studies have to be completed
- The feasibility study usually entails definition of the ore body and design of a method for recovering the material
- Minimum quantities required for E1F1 project depend on the number of years the project is expected to run, so that the project can pay back the capital and bring in some returns on the investment.
- Further economics will change if additional by- and co-products are extracted



Detailed studies 2/2

- The feasibility study must accurately and completely describe the proposed project.
- The capital, operating, and decommissioning costs are estimated and compared with the projected revenue generated by the sale of the product.
- To properly conduct this assessment, it is important to do a preliminary environmental baseline study and to estimate the potential impacts of the project on the local environment.
- Coupled with this is the need to examine the regulatory requirements that may be imposed upon the development.



E-axis SDG scoring 1/2

- Direct, indirect and induced high skilled and well-paying jobs (SDG 1)
- Support to sustainable food production (SDG 2)
- Support to the health infrastructure and improving public health by reducing the pollution levels (SDG 3)
- Support to science and technology education (SDG 4)
- Energy access to enhance labour emancipation and reduce jobs involving drudgery, which disproportionately affects women (SDG 5)
- Clean water and sanitation, including support to desalination (SDG 6)
- Support to the green energy transition (SDG 7)

E-axis SDG scoring 2/3

- Support to a diverse range of jobs, including various engineers, technicians, and other specialists (SDG 8)
- Enabling mining and processing facilities to operate at greater safety and performance levels (SDG 9)
- Engaging stakeholders including indigenous and marginalised groups (SDG 10)
- Support to urban development and improving e-mobility (SDG 11)
- Improving resource efficiency (SDG 12)
- Support to decarbonization of mineral cycle (SDG 13)
- Preventing ocean acidification or other chemical emissions (SDG 14)
- Enhancing biodiversity (SDG 15)

E-axis SDG scoring 3/3

- Supporting the development of strong national institutions committed to human rights (SDG 16)
- Partnerships with governments, industry, non-governmental organizations (NGOs), and educational institutes (SDG 17).



F axis Feasibility Scoring 1/2

Mining method (e.g. underground, open pit) and mining technique (e.g. drill and blast, continuous mining)

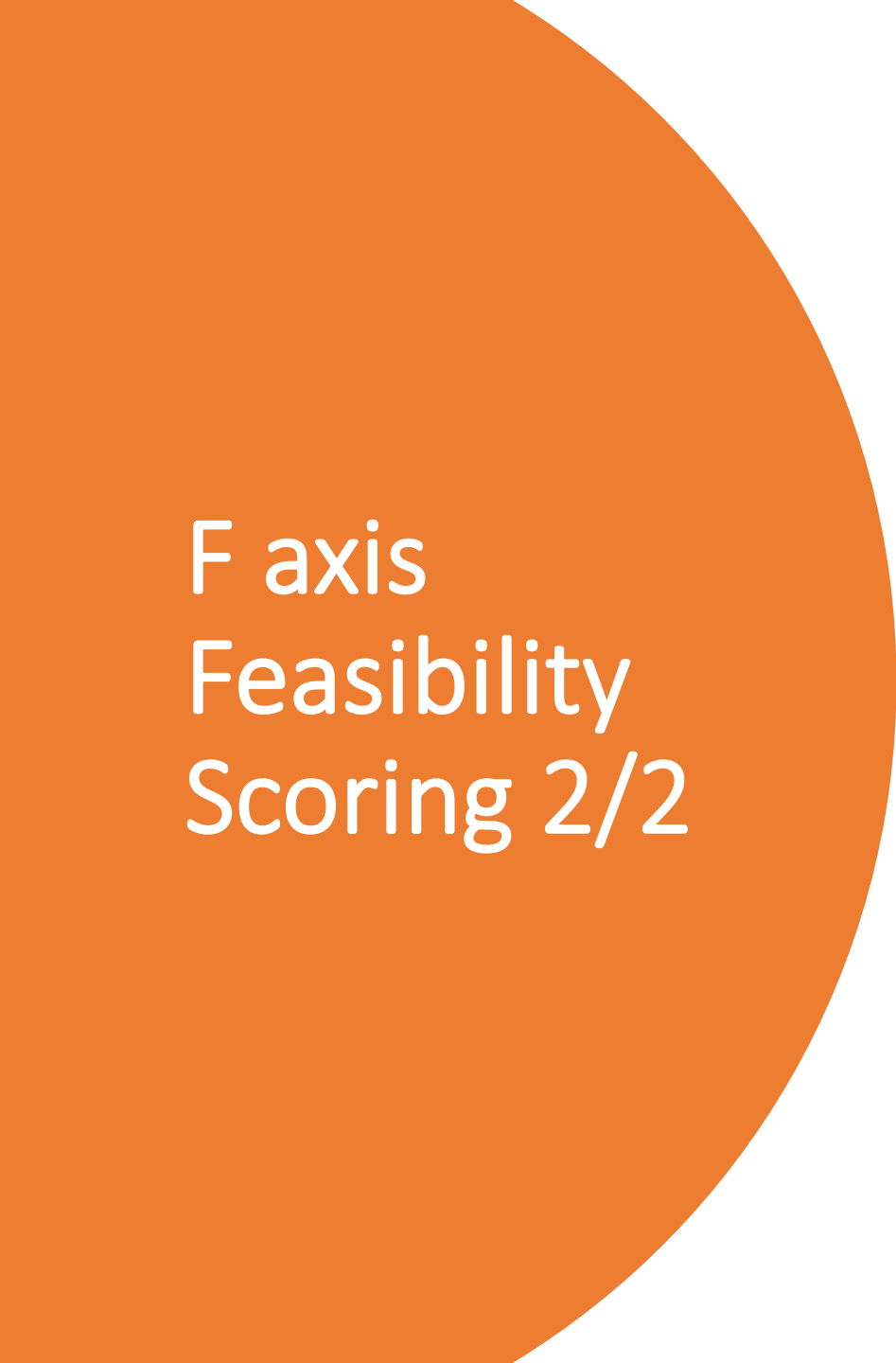
Rock mechanical conditions of the site

Volume - masses relation of volume streams, density of relevant rock types

Processing method (incl. chemistry, required grain size for processing etc.)

Metallurgical features (including petrographic studies)

Infrastructure (access to power supply and to market, transport distances and means)

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F axis Feasibility Scoring 2/2

Technical aspects of legal and governmental obligations (licence to operate, prospecting, exploration, mining)

Technical practicability of safety requirements

Available technology for site closure, decommissioning and site remediation

Climatic, temperature aspects especially in projects with seasonally variable frost conditions on site or in any part of the infrastructure

Management and disposal of wastes.

G axis: Recovery factors, losses

- Only recoverable material should be included as G1, G2 and G3
- Depends on mining methodology, processing techniques etc.
- Minimum recovery limits deemed acceptable will also depend on the detailed studies.
- The recovery is calculated for all the processing steps

Mining and milling method	Overall recovery factor (%)
Open-pit mining with conventional milling	80
Underground mining with conventional milling	75
ISL (acid)	75
ISL (alkaline)	70
Heap leaching	70
Block and stope leaching	75
Co-product or by-product	65
Unspecified method	75

Co-product and By-product accounting

- Co-production is where more than one material is present in economic concentrations.
- This is common in base metal ores where typically copper and nickel or zinc, lead and silver are produced from a single ore source.
 - Talvivaara operation produces copper, zinc, nickel and cobalt as products using a heap leach flowsheet.
 - Olympic Dam, which records economic uranium production from what is, primarily, a copper producer.
- By-production is employed for resources where the primary product also contains a secondary and even tertiary product.
- Often, the secondary product is not in itself economic, but its extraction can be facilitated by the primary commodity production process
 - Anglo Gold: Au and U (palaeo quartz-pebble conglomerate)
 - Bingham Canyon: Cu and U (porphyry copper)

Application of the United Nations Framework Classification for Resources

Case studies

Case study

- Application of UNFC to Rare Earth Elements and Thorium Comprehensive Resource Recovery Projects in Argentina
 - Legal framework
 - Comprehensive resource recovery
 - Technical aspects of
 - Carbonatites, veins, altered zones
 - Pegmatites
 - Placers



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REE projects, Argentina

- One project with reasonable potential for commercial recovery
- Significant potential for further development in other projects
- Can be produced as a by- or co-products
- Detailed studies are required for firming up the resources.

<i>Project</i>	<i>UNFC Class</i>	<i>UNFC Sub-class</i>	<i>UNFC Category</i>	<i>Resources</i>
<i>Rodeo de los Molles (REE-U)</i>	Potentially Commercial Project	Development On Hold	E2, F2.2, G2	2,270 tREO 15 tU
			E2, F2.2, G3	117,600 tREO 950 tU
<i>Cordillera Oriental and Puna (REE-Th)</i>	Non Commercial Project	Development Unclassified	E3.2, F2.2, G3	35,300 tREO+Y 23,900 tTh
<i>Ill River (REE-Th)</i>	Additional Quantities In Place	---	E3.3 F4 G4	15,500 tREO 850 tTh
<i>V River (Th)</i>	Additional Quantities In Place	---	E3.3 F4 G4	260 tTh
<i>Rodeo de los Molles (Th)</i>	Exploration Project	---	E3.2 F4 G4	10,000 tTh
<i>Jasimampa (REE-Th)</i>	Exploration Project	---	E3.2, F3, G4	Not Available

<i>Project</i>	<i>UNFC Class</i>	<i>UNFC Sub-class</i>	<i>UNFC Category</i>	<i>Resources</i>
<i>Susques (REE-Th)</i>	Exploration Project	---	E3.2, F3, G4	Not Available
<i>Cachi (REE-Th)</i>	Exploration Project	---	E3.2, F3, G4	Not Available
<i>Cueva del Chacho (REE-Th)</i>	Exploration Project	---	E3.2, F3, G4	Not Available

To Summarize

- Avoid common pitfalls.
- Pay attention to important E,F and G considerations
- Case study: Co-product and by-product accounting.

Thank you!

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UNECE

Date 2-3 | 2 | 2022, Geneva

