



# THE WORLD OF RAW MATERIALS 2050

Future Scenarios for the World of Raw Materials in 2050



## **Foresight 2050...**

Three future scenarios for the world of raw materials in 2050  
for policy, industry, research and society

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## Introduction and Background: The INTRAW Project

The admission of China to the World Trade Organisation, in December 2001, started a structural change in industrial markets. China's meteoric rise had an impact on global supply chains. Today with the integration of India, China and other industrialising countries (e.g. Brazil, Turkey and Mexico), into the world economy, these countries account for more than half of the world's population and are claiming an increasing share of raw materials. This means that Europe, the United States of America and Japan are now increasingly competing with other nations for a share in the global supply of mineral raw materials.

Over the last decade, the European Union has become increasingly aware that securing a reliable, fair and sustainable supply of raw materials is important for sustaining its industrial base, an essential building block of the EU's growth and competitiveness. As a result, since 2008, ensuring fair access to mineral raw materials on global markets has been one of the European Commission's priorities. The Horizon 2020 funded project "International Cooperation on Raw Materials" (INTRAW, [www.intraw.eu](http://www.intraw.eu)) runs during the period 2015-2018, with the objective of mapping best practices and boosting cooperation opportunities in relation to the entire raw materials value chain with technologically advanced non-EU reference countries (Australia, Canada, Japan, South Africa, and the United States) facing similar global challenges.

INTRAW has a long-term vision but raw materials policies, strategies and priorities are in constant state of flux in response to political and economic changes. The interconnectedness of these issues at an international level adds one more dimension to an already complex raw material supply system. This requires continuous adaptation of international cooperation frameworks to address emerging issues efficiently.

This challenge is tackled by the development and establishment (by INTRAW) of the International Raw Materials Observatory, a definitive source of raw materials intelligence, operating internationally, that will remain active after completion of INTRAW project itself.

The International Raw Materials Observatory will advance international cooperation mechanisms on mineral raw materials, as defined in thematic action plans addressing research and innovation, education and outreach, industry and trade, and recycling, management and substitution of critical raw materials. These plans will convert best practices of the reference countries to the European context, having consideration of the EU framework, key success factors (for the implementation of best practices) and constraints applied by the future scenarios. Considering that actions highly depend on potential future developments (and future developments can be influenced by actions), the scenario method was selected as an appropriate foresight methodology for developing 3 alternative future scenarios for raw materials in 2050. These provide a baseline set of potential future developments in the Action Plans. Within this brochure, the reader will gain insights into the methodology applied and into the main characteristics of each of the three future scenarios.

We wish you a good journey into the world of raw materials 2050!



Vitor Correa  
Project Coordinator INTRAW  
September 2017



Scenario 1:

# SUSTAINABILITY ALLIANCE

A new generation puts sustainability above everything else to keep deposits for future generations.

political leaders form an alliance to push reforms that focus on increasing sustainability



there is only green mining and a reduced consumption of primary raw materials



environment-friendly way of producing with the aid of green technologies



increased use of high tech for exploration and extraction



substantial progress in re-use, recycling and substitution of materials



## **SOCIETY**

An entire generation has grown up to be environmentally aware and has developed a sustainable lifestyle, assimilating practices which are not based on the ownership of tangible products. Companies sell usage and service rather than products. Corporate planning aligns commercial objectives with sustainability goals. The overall public perception of mining tends to be negative, based on historical disasters.

Despite this situation, the society understands the need for minerals and mining, and accepts the need for the production of primary minerals until substitution technologies have reached a new level of maturity. Manufactured products have to carry a label that specifies the origin of the materials used. Consumers highly prefer locally produced goods and services.

## **TECHNOLOGY**

Only high-tech and low impact mining is tolerated. Mining at new frontiers is a sensitive issue, tolerated by the public, but under continuous scrutiny by decision makers and environmental organisations. New technologies allow for more accurate exploration and new mines are opened, some in rather remote, uninhabited or deep locations and in extreme conditions. Efficient processes along the whole raw materials value chain can be observed combined with new levels of safety and security solutions. A bigger portion of innovation efforts is focused on resource efficiency, extended product lifetimes and waste reduction. New technologies are developed that accommodate the demand for raw materials from the perspective of the circular economy. Recycling at the atomic level is the ambitious goal. Sophisticated monitoring, prevention and mitigation technologies are being deployed. Mine remediation is given priority.

**Sustainability Alliance Scenario:** In 2050, the circular economy has become the norm in the advanced economies. A new generation of political leaders has pushed forward a series of reforms that focus on increasing sustainability, not only in the raw materials industry. Almost every product is produced in an environmentally friendly way with the aid of green technologies. The civil society puts sustainability above everything else to keep deposits for future generations.

## **ECONOMY**

The change towards sustainability was principally enabled by falling prices for secondary raw material making recycled materials more attractive relative to primary extracted material. A truly circular economy has become reality in many aspects. Advanced western economies help to raise the mining standards in developing countries. Efficient and environmentally friendly trade is the overall goal. Strong independent institutions reduce the risk of raw material black markets. The shift towards green technologies generated its own economic growth, as spendings in research and innovation increased to develop green technologies.

Mining companies want to benefit from the boom in secondary raw materials. Some of them acquire recycling companies, others have turned into vertically integrated raw material companies. Green technologies, in turn, require raw materials which are thus regarded as critical.

## **POLICY**

Given the emergence of severe environmental problems, the biggest economies have come to a tipping point. Starting with the ratification of the climate change agreement by the U.S. and China in 2022, a political consensus was reached that a new, distinctly green approach was needed. Sustainable development is a must and all governments agree to place sustainability above growth and profit. Concerted actions by governments and industry incentivized the shift towards more sustainable approaches to provide and use raw materials. In 2050, hydro-carbons are mainly used as raw materials, not as a source of energy anymore.

The changes have encompassed a transformation of other industries, too. Agriculture, the energy sector, logistics, infrastructure, etc. needed to be transformed to provide sufficient resources for a growing world population in a sustainable manner.



# Scenario 2: **UNLIMITED TRADE**

Increased global consumption leads to raw materials growth.

increased demand for raw materials due to growing consumption



integration of processing industry



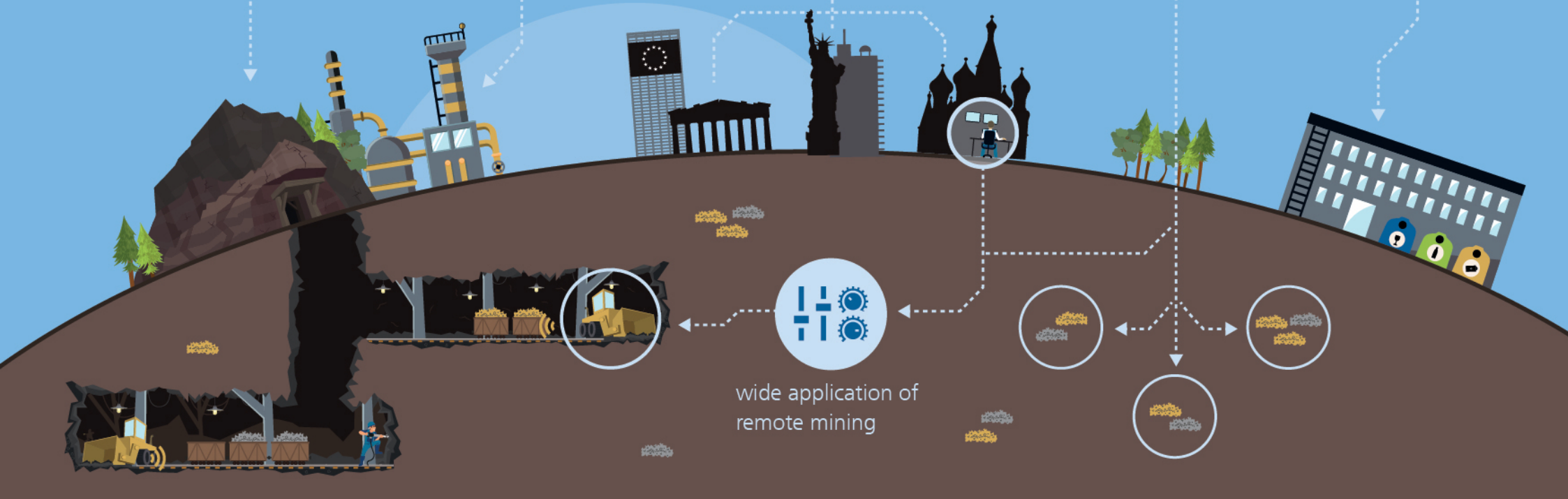
international cooperation and elimination of trade barriers



increased use of high tech for exploration and extraction



recycling gains importance



wide application of remote mining

## **SOCIETY**

The mining industry and governments have invested heavily into shaping the public perception of mining. People now have a much more positive picture than some decades ago, mainly due to a better understanding of the contribution of mining to sustainable development. The absence of significant mining accidents and the implementation of higher environmental standards (e.g. reduction of energy consumption, less pollution) has contributed to increased acceptance.

Student interest in mining increases. Mining is regarded as a diverse and high-tech industry, requiring advanced skills in geology, engineering and business. In the advanced, resource-rich countries it is not the blue-collar workers that dominate mining anymore.

## **TECHNOLOGY**

To achieve economies of scope, we observe a growing trend towards horizontal and vertical integration. The big mining companies have absorbed a range of suppliers (and their technologies) to enable what was once called "Mine of the Future". Most mines are now partly automated to reduce costs. Sites that were previously considered sub-economic are now found feasible due to advanced technology. Better technology has led to a dramatic reduction of the (relative) need for energy & water. Technology now allows to mine in remote and off-shore locations at reasonable costs.

Significant technological progress also happens in downstream processing technologies and in recycling. Advanced mining technology spreads increasingly fast across borders as good practices are shared. This happens even in less developed countries, where manual labour is relatively cheap.

**Unlimited Trade Scenario:** In 2050, the world of raw materials has experienced steady growth, mainly due to ever-growing consumption. International cooperation and dialogue have created new opportunities to produce and trade raw materials. Access to capital has led to industry integration, technology development and productivity improvements alike. Increased global consumption leads to raw materials growth.

## **ECONOMY**

Advanced economies are able to keep growth rates at 2% due to high levels of consumption. It is a win-win situation for both governments and the mining businesses, as total employment in mining has gone up, too. As capital is available, the extraction of raw materials goes on and new mines are opened. Virtually all countries have introduced more efficient regulatory frameworks that support governmental bodies, industry, local communities and other stakeholders to resolve conflicts and to reach a consensus on establishing new mines in shorter periods of time. Most countries have established stable tax regimes as part of the agreements between governments and the mining industry. Secondary raw materials play an increasingly important role in the provision of raw materials. However, the rate of recycling cannot keep up with the total demand. It has reached a plateau.

## **POLICY**

Stakeholders in the raw materials business have learned from the ups and downs in the raw materials industry, which has experienced a number of shocks in the 2000s and 2010s. The growth of the BRICS states has been amplified by other fast-growing economies (Mexico, Indonesia etc.), which entered the material-intensive development phase. While economic growth is not steady, the total demand for raw materials increases as the world population grows. Under the pressure of large multi-nationals, the world's economic giants (the U.S., China and India) have opted to intensify dialogue and to cooperate rather than to pursue their self-interests only. They foster constructive relationships with countries that possess critical raw materials. Long-term trade agreements secure access to raw materials. Measures have been taken to regulate speculation with raw materials and to increase transparency. For instance, comprehensive inventories for primary and secondary raw materials have been established.



Scenario 3:

## NATIONAL WALLS

Economic standstill gives rise to nationalist politicians and protectionist measures.



countries that abandoned mining have re-started



mining technology development is at a standstill, but some countries have to catch up



little economic growth, mostly boosted by national government



no collaboration across national borders



acceptance of mining (it is a necessity)





## **SOCIETY**

In protectionist, resource-rich countries, mining has become an important job motor. Even countries that almost abandoned mining, have re-started. However, globally speaking, we'll see less mining employees than 30 years ago, due to stagnating demand. Mining has turned into a somewhat dull industry. Mining companies fall from the top 20 most attractive employers list as other industries are much more attractive. Land degradation continues globally at an unsustainable scale but this is met by indifference by society whose primary focus is providing the means for survival.

Society is ageing rapidly. In the EU, migration is limited and strongly controlled by restrictive immigration policies, aimed to protect the national workforce. At the same time, migration pressures increase.

## **TECHNOLOGY**

Mining has always been a conservative industry, but with a few exceptions mining practices are basically the same as 40 years ago. Technologies that are readily available are favoured. High-tech mining and low-tech mining co-exist as countries or blocks of countries pursue their own agendas with regards to the domestic production of raw materials.

Technologies for recycling, reuse & substitution are developed – especially by resource-poor countries, but at a slow pace. Domestic R&D gets a boost. Environmental permitting procedures for mining are mostly a formality, any investment that meets basic environmental criteria and generates employment is approved very quickly.

**National Walls Scenario:** In 2050, the world of raw materials got stuck as social and demographic pressures triggered a long period of economic standstill which lead to a rise of protectionist measures. The absence of leadership and insufficient political will didn't help to improve the situation. Each country fights for its own agenda. There is little progress in mining practices as reforms have stalled and private investments are low. Economic standstill gives rise to nationalist politicians and protectionist measures.

## **ECONOMY**

Global trade has stagnated during the 2030s and 2040s and there is a general sense of global insecurity. There is little and uneven economic development. For most countries, securing access to all required resources is a challenge. Some old alliances are re-established (e.g. USSR) to cope with shortages of raw materials. As demand for commodities stagnates, governments run national economic development programmes to boost their domestic economies. Investors don't know where to invest their money. Growth rates are slow and international investments are risky. Europe still benefits from an inheritance of large amounts of capital from the past. This means that although there are huge differences in the economic performance and the standard of living between the different „European blocks“, Europe is still a nicer place to live in than most other countries - this higher standard of living is strongly protected against external influence.

## **POLICY**

The world's biggest economies find it difficult to sustain growth. They focus on solving their own economic and societal problems. Disparities between countries got worse. There is a widespread tendency towards protectionism and trade agreements are breached. We repeatedly observe conflicts related to the access to raw materials. International institutions are weak, they barely manage to settle disputes.

A wave of „neo-colonialism“ can be observed. Environmental policies are in place but often ignored. In this world, the dream of a united Europe is long forgotten. Europe is characterized by a number of blocks of countries that engage in cooperation. There is a free movement of goods (customs union) but the remaining „EU“ institutions are weak, trying to balance the interests of the different geographical alliances.

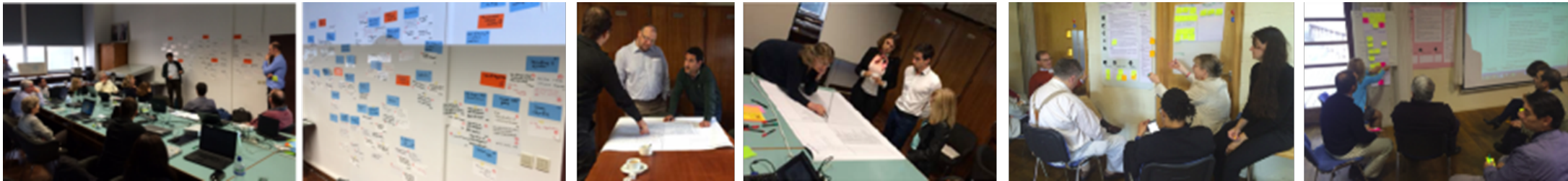
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## The Scenario Development Process

The scenario method is a well-established foresight methodology to support medium to long-term planning in companies, industries and on a policy level. Scenarios are often used to support strategic planning and provide the basis for other methods, for example the development of roadmaps or action plans. In our 2050 foresight exercise, we have asked the question 'What can conceivably happen?' by following a strict sequence of steps that identifies the key elements of a system and projects how these elements will evolve collectively.

The advantage of the scenario method is that it allows for multiple alternative but believable futures. Even if it is not clear what the future will look like in a couple of years, it is possible to take actions today to support desirable futures or to safeguard against the less desirable ones. Within the INTRAW project a process consisting of 5 steps was applied to the development of the three final scenarios, guided and moderated by the Competence Center R&D Management of Fraunhofer IAO.



1. Scoping

2. Identification and selection of descriptors

3. Description of potential future developments

4. Scenario development

5. Transfer

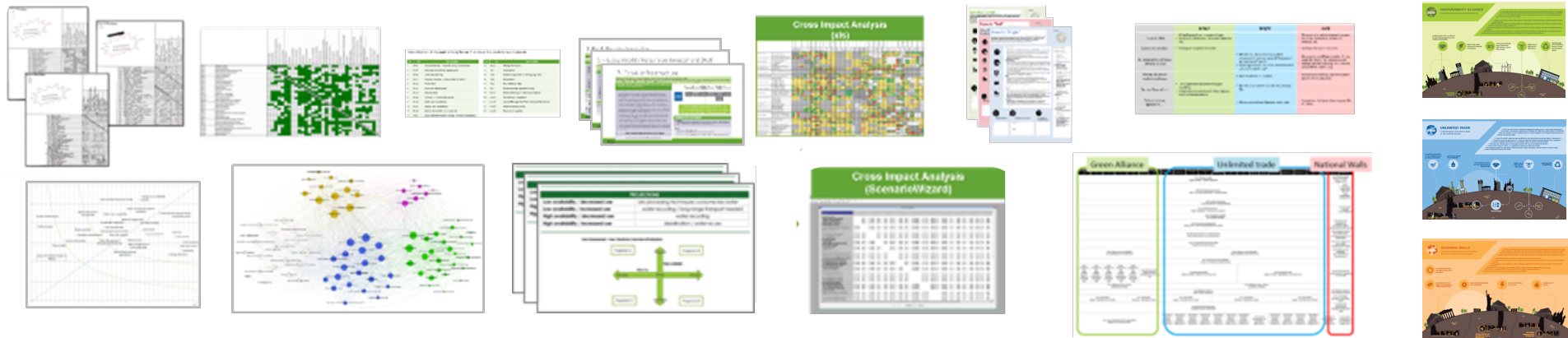
**96**  
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Descriptors

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Raw Scenarios

**3**  
Final Scenarios



# IMPRINT

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<http://s.fhg.de/intraw>

<http://www.intraw.eu/the-world-of-raw-materials-2050/>

Descriptors catalogue is available on request.

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