MOST-$H_2$

Novel metal organic framework
adsorbents for efficient storage of hydrogen

# PROSPECTIVE SOCIAL LIFE CYCLE ASSESSMENT OF EMERGING TECHNOLOGIES

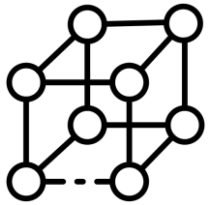
## SLCA CONFERENCE - 30.05.2024

LOAY RADWAN, ANDREAS CIROTH, CONRAD SPINDLER

# MOST-H2

- Collaboration between 16 partners across Europe to develop and validate an innovative, **low cost cryo-adsorptive hydrogen storage system**
- The main focus is on developing **monolithic Metal-Organic Framework (MOF)** adsorbents with an optimal combination of **volumetric and gravimetric H2 storage capacity** and a small environmental footprint
- The outcomes will contribute to establishing **hydrogen as widespread energy carrier** – a key priority for the EU in becoming climate-neutral

## OBJECTIVES



New Materials


H2 Storage

Application

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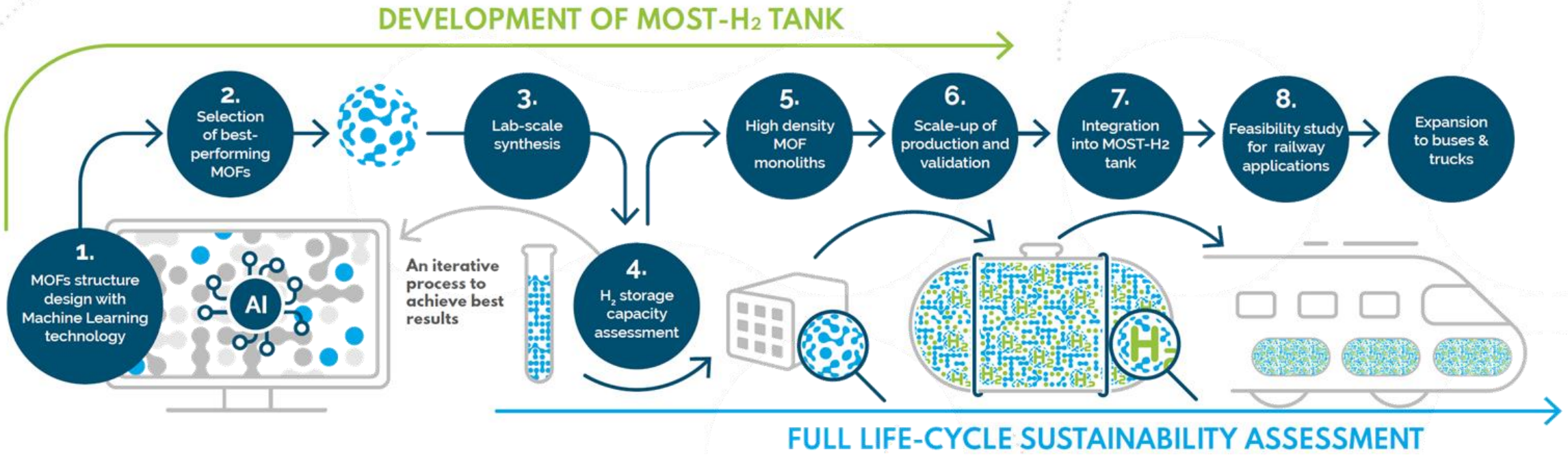
# MOST-H2




https://most-h2.eu/

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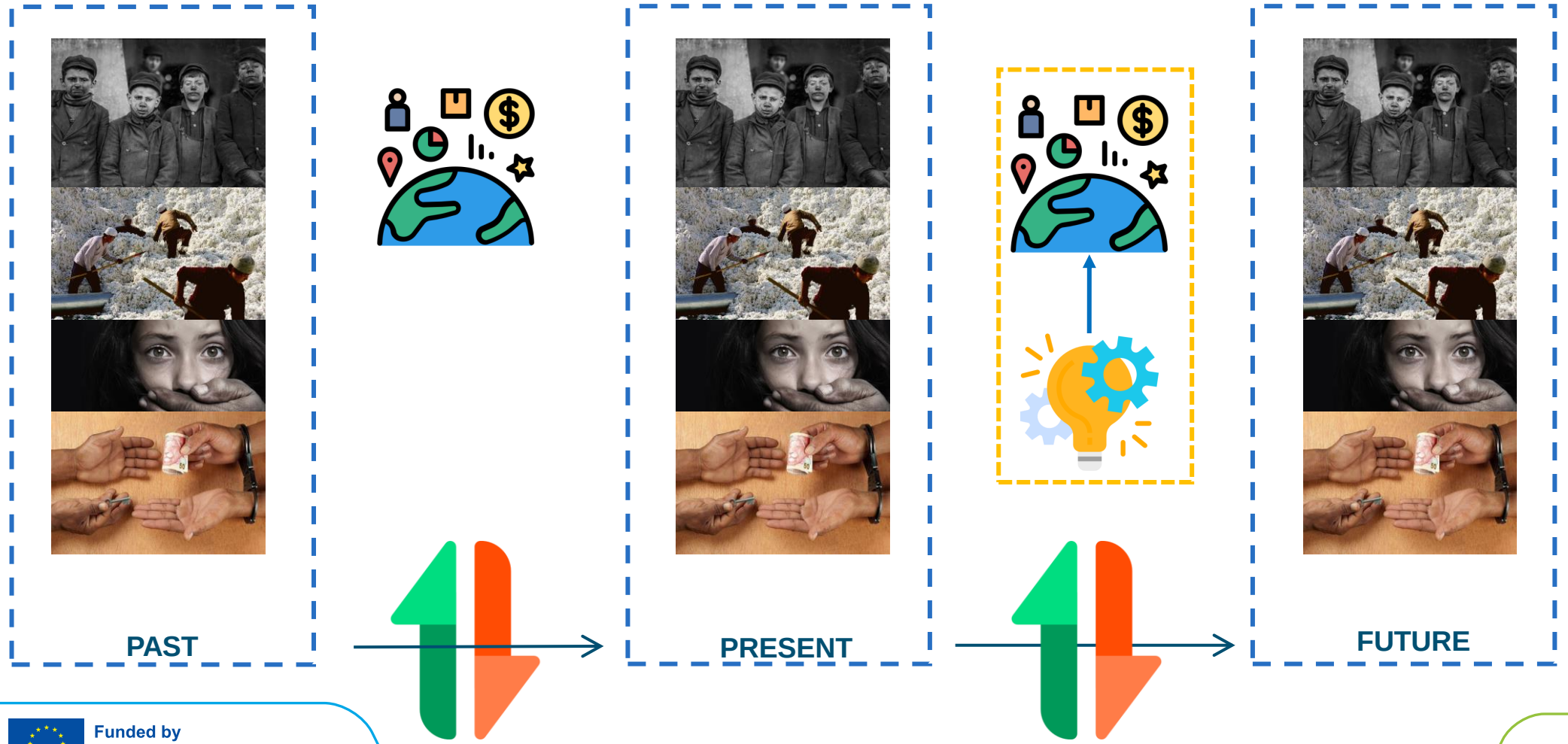
# PROSPECTIVE SOCIAL LIFE CYCLE ASSESSMENT

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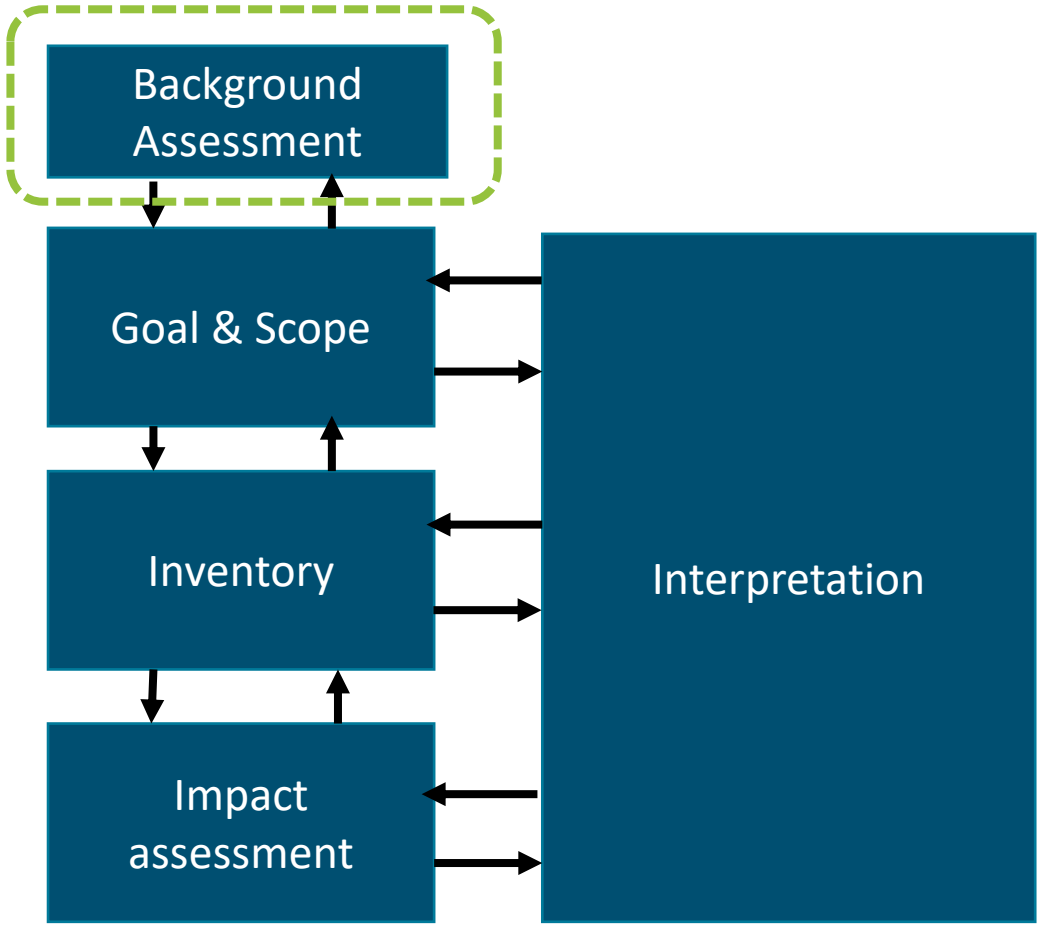
# PROSPECTIVE SLCA METHODOLOGY




ISO14044 Framework

## BACKGROUND ASSESSMENT

- Defining the **technology** and its **objectives**, potential advantages and disadvantages, future developments, conditions for the technology to thrive, etc..
- Collecting data on the **markets and sectors** relevant to the emerging technology including, historical trends, any alternative technologies being developed, etc..
- Collecting data on the **technology developers and management,** history of management, what falls within the operational boundaries, etc..

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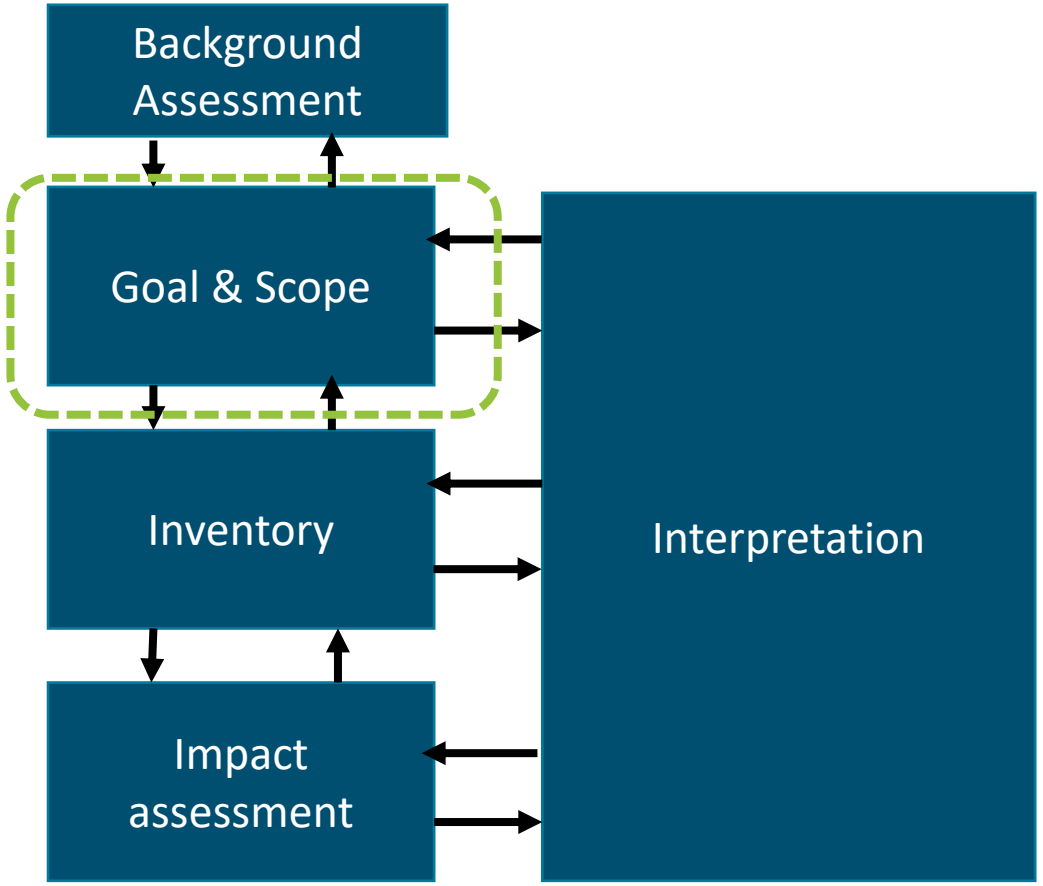
# PROSPECTIVE SLCA METHODOLOGY




ISO14044 Framework

## GOAL & SCOPE

- Define the **future year** of assessment
- Specify the **global and system assumptions**
- Classify the selected subcategories and indicators

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# GLOBAL AND SYSTEM ASSUMPTIONS

It important to clearly define the **global assumptions** upon which the study is taking place

e.g: there will be no recessions or geopolitical conflicts, no pandemic or **globally disruptive events**

Similarly, it important to clearly define the **specific system assumptions** relevant to the **technology** and the product system

e.g: there will be no emerging alternative raw materials, or other **major technological disruption**

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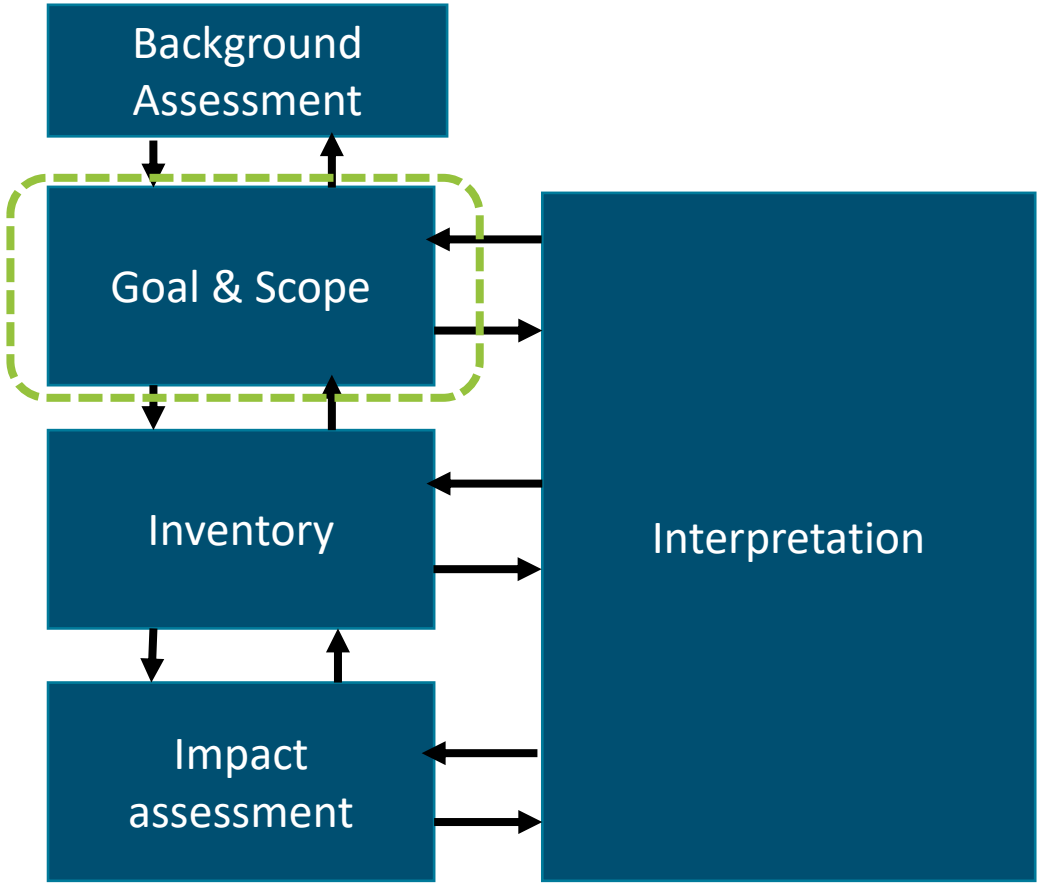
# PROSPECTIVE SLCA METHODOLOGY




ISO14044 Framework

## GOAL & SCOPE

- Define the **future year** of assessment
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# CLASSIFICATION OF THE SOCIAL SUBCATEGORIES AND INDICATORS

**Context-based indicators**

- These indicators are influenced by regional and national conditions. Their future state depends on the evolving regional and national circumstances, which in turn are shaped **by various driving factors**

**Management-based indicators**

- These indicators are influenced by management and operations. They **may be excluded from the scope** or assumed to remain similar to the present situation unless justified otherwise

**Technology-based indicators**

- These indicators are influenced by emerging technology. They can be **assessed qualitatively**, based on the specifics of the technology and the impacts of comparable proxy technologies

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# CLASSIFICATION OF THE SOCIAL SUBCATEGORIES AND INDICATORS


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# MAPPING OUT KEY DRIVING FACTORS


Mapped **driving social factors** in a network to assess their influence on each other and identify the **most influential ones**

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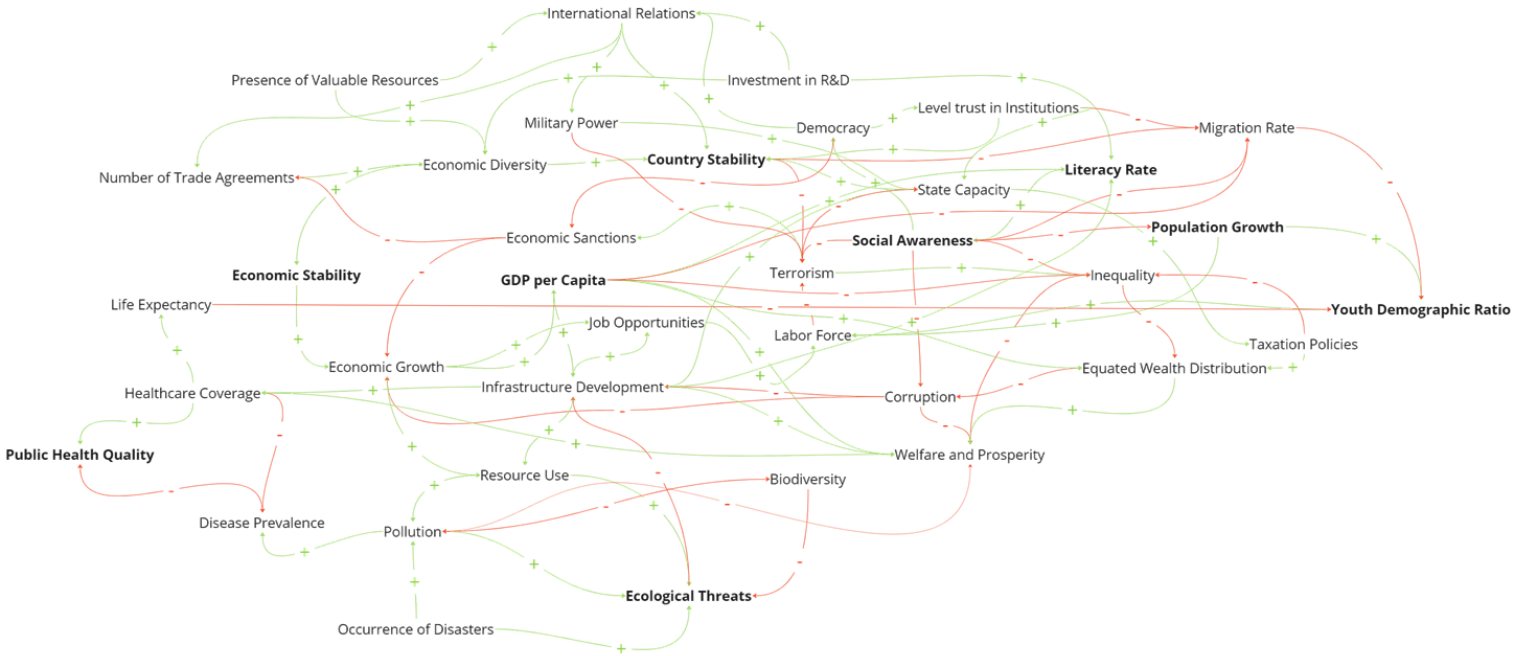
# MAPPING OUT KEY DRIVING FACTORS




Mapped **driving social factors** in a network to assess their influence on each other and identify the **most influential ones**

| Driving Factors | Influence | Observability |
|---|---|---|
| Social Awareness | 3 | 1 |
| Digital skills gap | 2 | 2.5 |
| Economic Diversity | 3 | 2 |
| Cultural Diversity | 1 | 1.5 |
| 70+ factors | - | - |

More than 70 social factors were ranked from 1 (lowest) to 3 (highest) assessing their **influence** and **observability**

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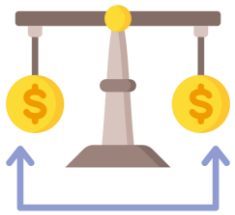
# KEY DRIVING FACTORS


GDP per Capita

Country Stability

Literacy Rate



Economic Stability

Demographics

Public Health

Ecological Threats

**Connectivity**

Assesses the connection of the driving factor to the social indicators 1 (low), 2 (moderate) to 3 (high)

**Sensitivity**

Assesses the sensitivity of social indicator to the driving factor 1 (low), 2 (moderate) to 3 (high)

**Changes in the existing trends**

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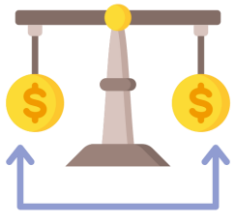
# KEY DRIVING FACTORS


GDP per Capita

Country Stability

Literacy Rate



Economic Stability

Demographics

Public Health

Ecological Threats

| Ratio Type | Range | Final Score |
|---|---|---|
| GR | ≤-2 | -3 |
| GR | -1.5 to -2 | -2 |
| GR | -1 to >-1.5 | -1 |
| GR | -1 | 0 |
| GR | -0.1 to >-1 | -(1+range) |
| GR | 0.1 to <1 | (range-1) |
| GR | 1 | 0 |
| GR | 1 to <1.5 | 1 |
| GR | 1.5 to 2 | 2 |
| GR | ≥2 | 3 |
| MGR | 0 to 1 | 1 |
| MGR | 1 to 2 | 2 |
| MGR | >2 | 3 |

$$\text{GDP Growth Ratio (GR)} = \frac{Predicted\ Growth\ Rate\ (PGR)}{Average\ Historical\ Growth\ Rate\ (AHGR)}$$

*If AHGR < 0 and PGR > 0, then use a modified ratio to reflect the positive turnaround:*

$$\text{Modified Growth Ratio (MGR)} = \frac{PGR - AHGR}{|AHGR|}$$

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# EXAMPLE: STEEL PRODUCTION IN CHINA

| Indicators | Score | Connectivity | Sensitivity | Child Labour (2030) |
|---|---|---|---|---|
| GDP per Capita | 3 | 3 | 3 | +5% |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |

AHGR: 6.59%
PGR: 4.4% annually till 2030
GR Score= 3

China's Economy is Rebounding, But Reforms Are Still Needed

By Diego A. Cerdeiro and Sonali Jain-Chandra

February 3, 2023

**Economic Research: China's Trend Growth To Slow Even As Catchup Continues**

Asia-Pacific Chief Economist: Louis Kuijs
Sector: Economic Research
Tags: APAC, China
Topic: China in Transition

Sources: (imf.org), S&P Global Ratings (spglobal.com)

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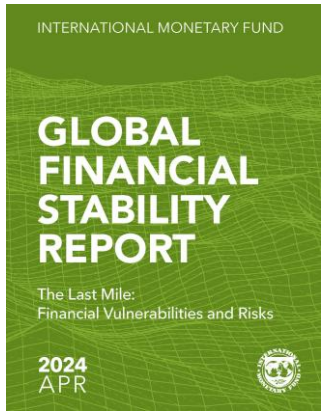
# EXAMPLE: STEEL PRODUCTION IN CHINA

| Indicators | Score | Connectivity | Sensitivity | Child Labour (2030) |
|---|---|---|---|---|
| GDP per Capita | 3 | 3 | 3 | +5% |
| Economic Stability | -1 | 3 | 2 | -2% |
| Public Health Quality | x | 1 | 1 | x |
| Country Stability | x | 3 | 3 | x |
| Literacy Rates | x | 2 | 2 | x |
| Demographics | x | 3 | 1 | x |
| Ecological Threats | x | 1 | 1 | x |
| **TOTAL** | - | - | - | +3% |

X= To be assessed


Overview




Sources:
China Overview | World Bank,
The Last Mile: Financial Vulnerabilities and Risks (imf.org)

Improvement of the **current trend** by 2030

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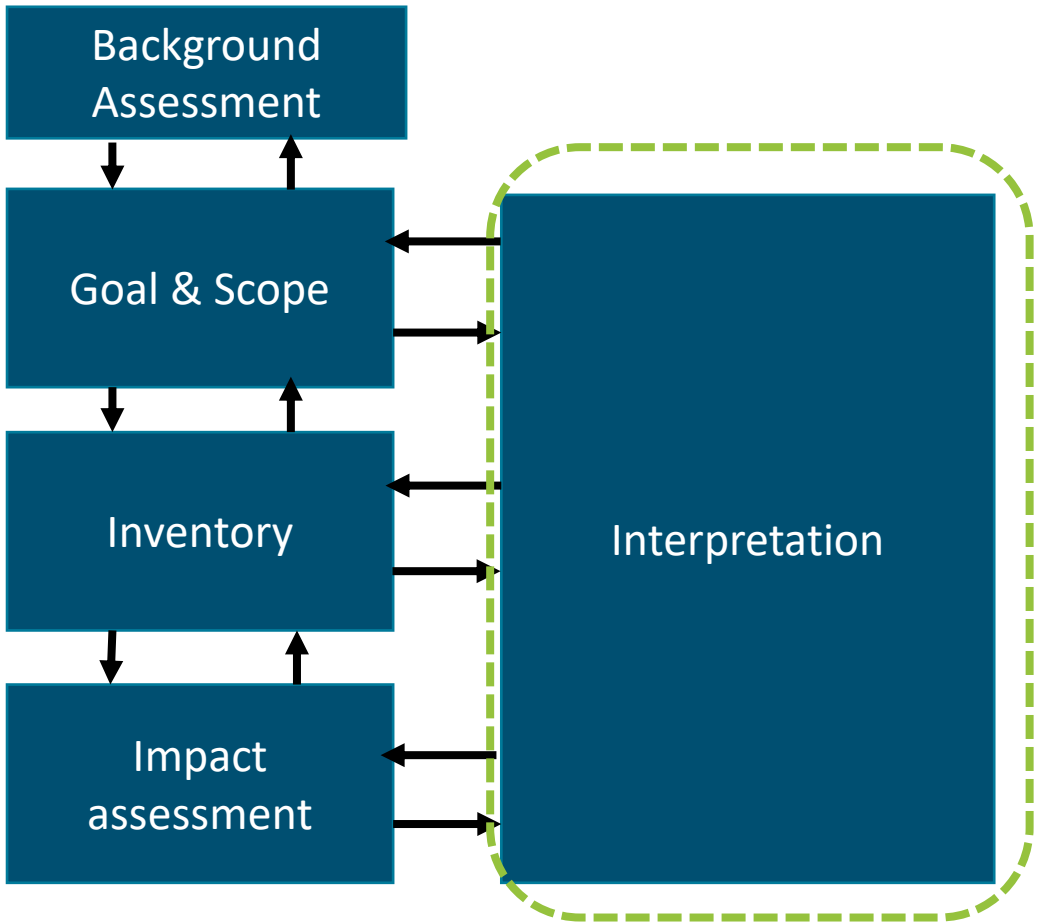
# PROSPECTIVE SLCA METHODOLOGY




ISO14044 Framework

## INTERPRETATION

- It is important to assess **various scenarios** exploring a range of the potential forecasts
- It is important to clarify the **hard facts** from the **speculative ones** at the end of the assessment

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# CONCLUSION & FUTURE STEPS

- It is feasible to **predict the future conditions** of some social indicators based on the historical trends and future forecasts
- Conducting Prospective SLCA of emerging technologies is possible as long as the **assumptions and justifications** are clearly defined
- Establishment of a **concrete mathematical framework** combining the scores of the driving factors along with sensitivity and connectivity based on the historical trends
- Incorporation of **uncertainty assessment** into the methodology
- Integration of the prospective SLCA framework into **existing databases** (e.g. PSILCA)

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# THANK YOU FOR YOUR ATTENTION

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