Python for Accounting Applications

Applications of ESG Data Analytics with Python

Min-Yuh Day, Ph.D,
Professor

Institute of Information Management, **National Taipei University**

https://web.ntpu.edu.tw/~myday

2024-12-18

Syllabus

Week   Date   Subject/Topics

1 2024/09/11 Introduction to Python for Accounting Applications

2 2024/09/18 Python Programming and Data Science

3 2024/09/25 Foundations of Python Programming

4 2024/10/02 Data Structures

5 2024/10/09 Control Logic and Loops

6 2024/10/16 Functions and Modules; Files and Exception Handling

7 2024/10/23 Data Analytics and Visualization with Python

8 2024/10/30 ~~Midterm Project Report~~ (Self-Learning)

Syllabus

Week   Date   Subject/Topics

9   2024/11/06 Self-Learning

10 2024/11/13 Midterm Project Report

11 2024/11/20 Obtaining Data From the Web with Python;
              Statistical Analysis with Python

12 2024/11/27 Machine Learning with Python

13 2024/12/04 Text Analytics with Generative AI and Python

14 2024/12/11 Applications of Accounting Data Analytics with Python

15 2024/12/18 Applications of ESG Data Analytics with Python

16 2024/12/25 Final Project Report

# Applications of ESG Data Analytics with Python

Outline

- **Data Science and Sustainability**

- **Data Collection and Analysis for Sustainability**

- **Implementing Data-Driven Sustainability Strategies**

Sherry Madera (2024),
Navigating Sustainability Data: How Organizations can use ESG Data to Secure Their Future, Kogan Page
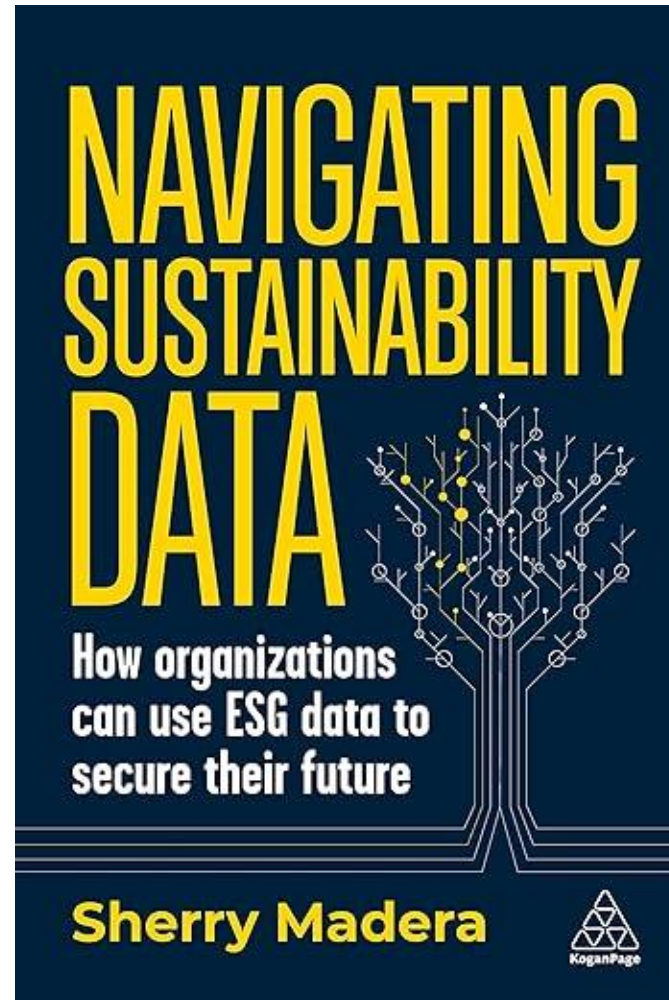
雪莉．馬德拉 (Sherry Madera) (顏敏竹 譯) (2024), 駕馭ESG數據 (Navigating Sustainability Data), 財團法人中國生產力中心
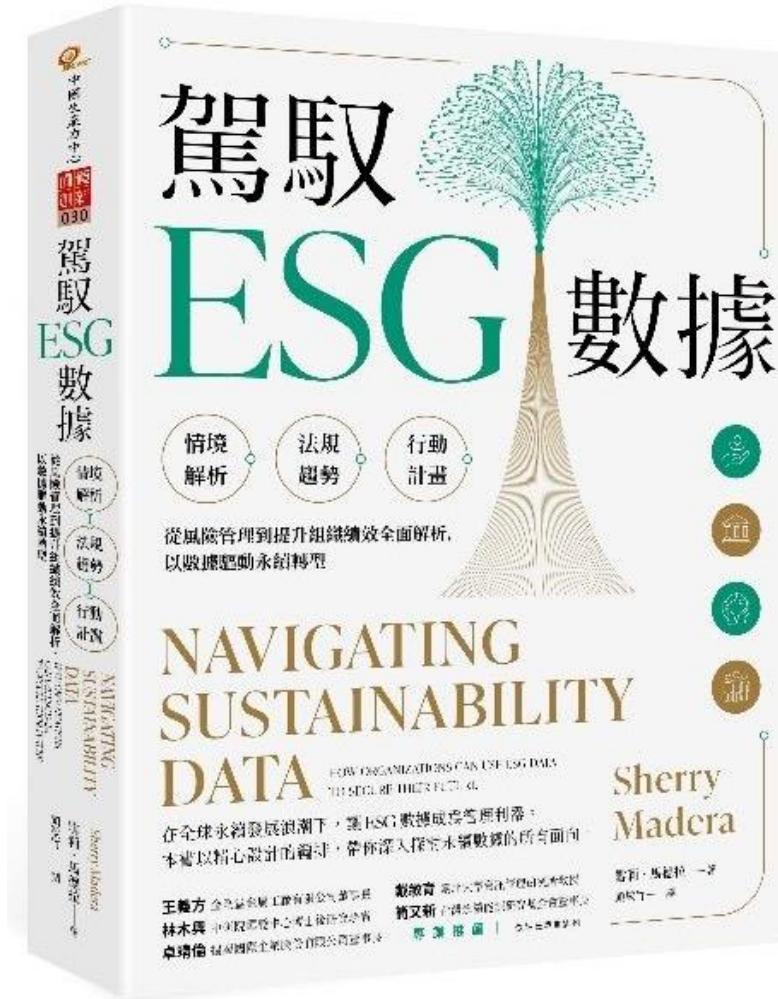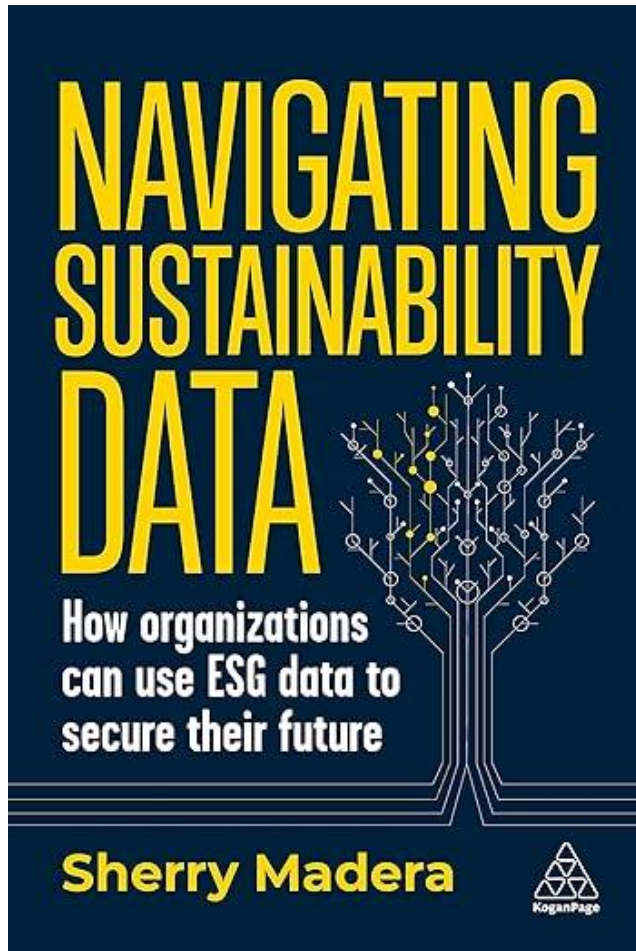
專業推薦：
王義方
　（金全益金屬工廠有限公司董事長）
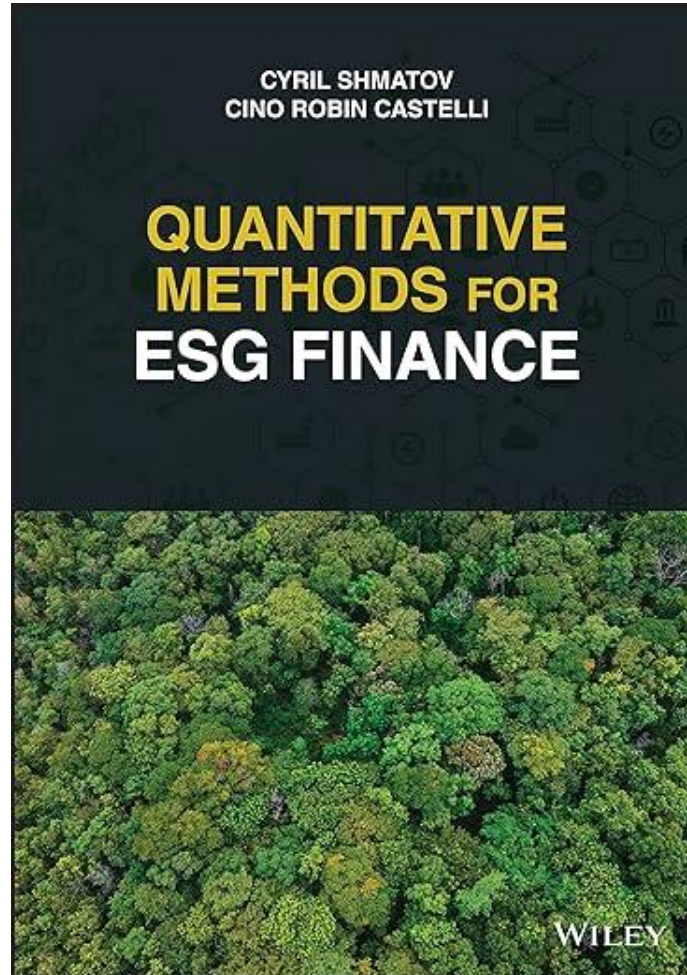林木興
　（中研院環變中心博士後研究學者）
卓靖倫
　（揚秦國際企業股份有限公司董事長）
戴敏育
　（國立臺北大學資訊管理研究所教授）
簡又新
　（台灣永續能源研究基金會董事長）

Cino Robin Castelli, Cyril Shmatov (2022), Quantitative Methods for ESG Finance, Wiley

Simon Thompson (2023),
Green and Sustainable Finance:
Principles and Practice in Banking, Investment and Insurance,
2nd Edition, Kogan Page.
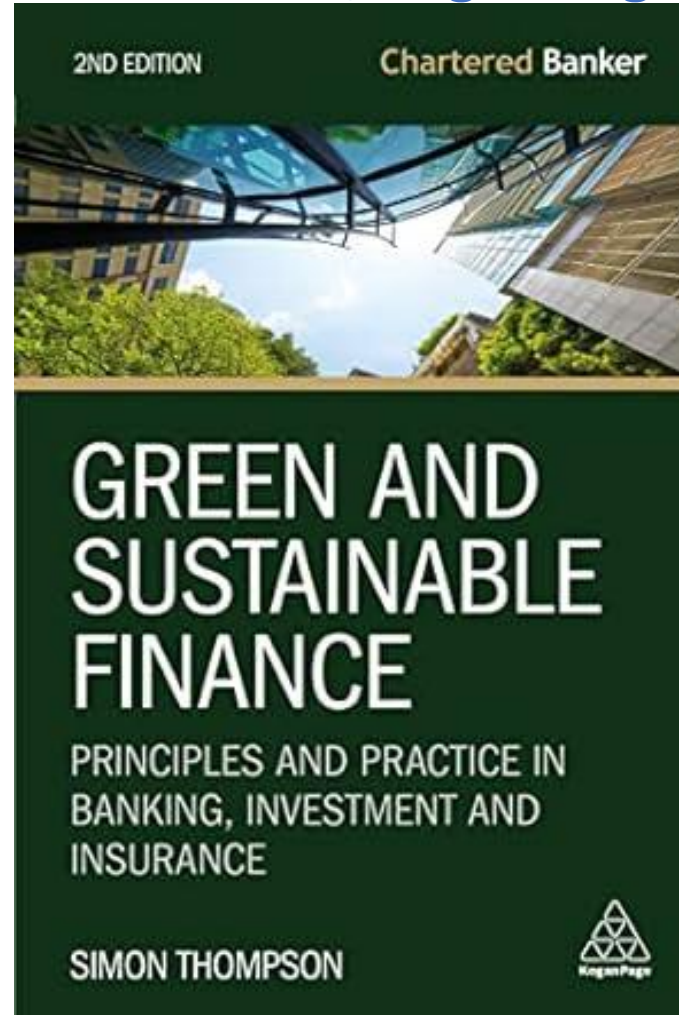
Chrissa Pagitsas (2023),
Chief Sustainability Officers At Work:
How CSOs Build Successful Sustainability and ESG Strategies,
Apress.
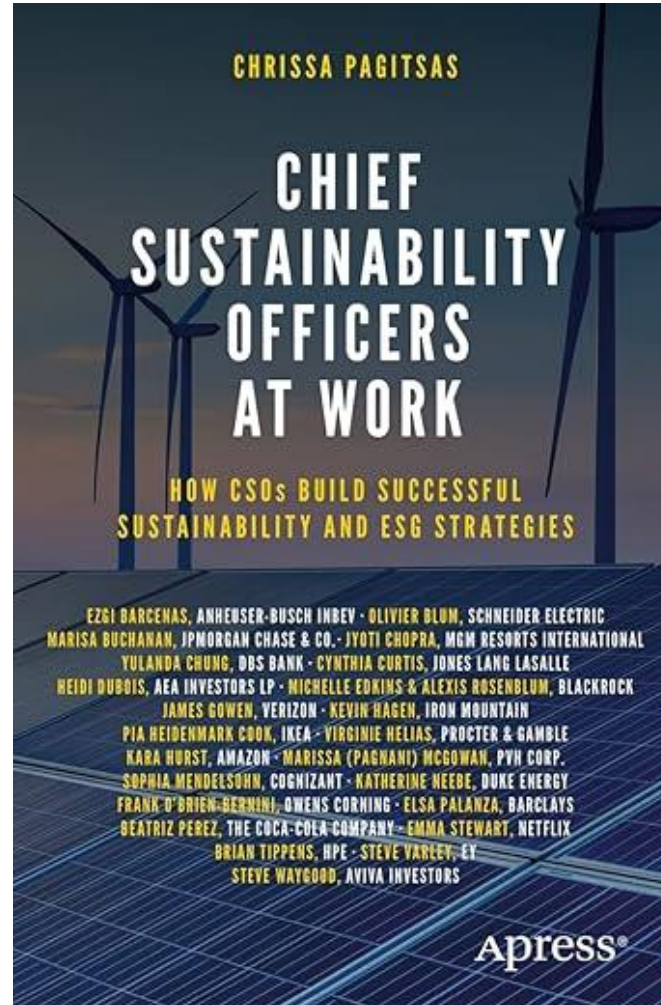
Sustainability and ESG Data Analytics

Sustainability and ESG Data Analytics

Data Science for Sustainability and ESG: Transforming Decision-Making for a Better Future

Data Science for Sustainability and ESG: Foundations & Frameworks

Data Science for Sustainability and ESG

Data Science for Sustainability and ESG

- **Data Science and Sustainability**
- **Data Collection and Analysis for Sustainability**
- **Implementing Data-Driven Sustainability Strategies**

Fundamentals of Data Science

- **Definition of Data Science:**
  - **Interdisciplinary field using scientific methods, processes, algorithms and systems to extract knowledge and insights from structured and unstructured data.**
- **Key components:**
  - **Statistics, Machine Learning, Data Engineering**

Data Science Process

1. Business Understanding
2. Data Understanding
3. Data Preparation
4. Modeling
5. Evaluation
6. Deployment

Data Science Essential tools

- **Python**
- **R**
- **SQL**
- **Tableau**
- **Power BI**

Sustainability and ESG

- **Sustainability: Meeting present needs without compromising future generations**

- **ESG: Environmental, Social, and Governance**
  - **Environmental: Climate change, resource depletion, waste, pollution, deforestation**
  - **Social: Human rights, labor standards, workplace safety, community relations**
  - **Governance: Board diversity, executive compensation, ethics, transparency**

Sustainability and ESG: Business case

- **Risk management**
- **Cost savings**
- **Innovation**
- **Brand value**
- **Investor attraction**

Intersection of Data Science with Sustainability and ESG

- **Data-driven decision making for sustainability initiatives**
- **Predictive analytics for environmental impact**
- **Machine learning for optimizing resource usage**
- **Big data analysis for social impact assessment**
- **AI-powered governance risk management**

The Interconnectedness of Data, Sustainability & ESG

- **Sustainability encompasses environmental, social, and governance concerns.**

- **ESG provides a framework for measuring and reporting sustainability performance.**

- **Data science offers the tools to collect, analyze, and use ESG data for decision-making.**
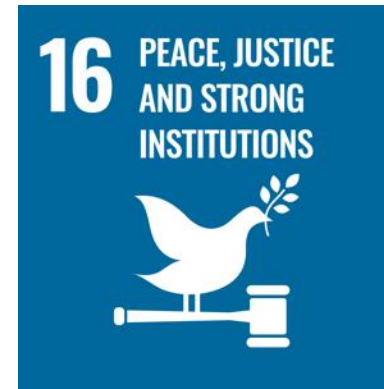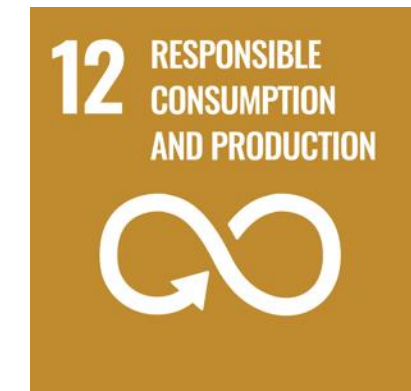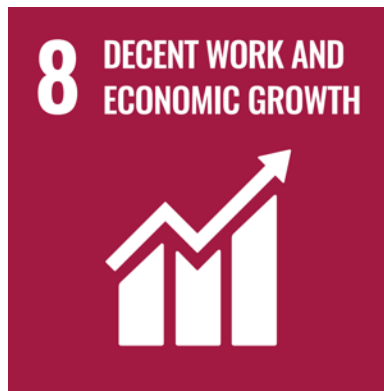
ESG:

Environmental

Social

Governance

Sustainable Development Goals (SDGs)

Sustainable Development Goals (SDGs) and 5P

Partnership

Peace

Prosperity

People

Planet
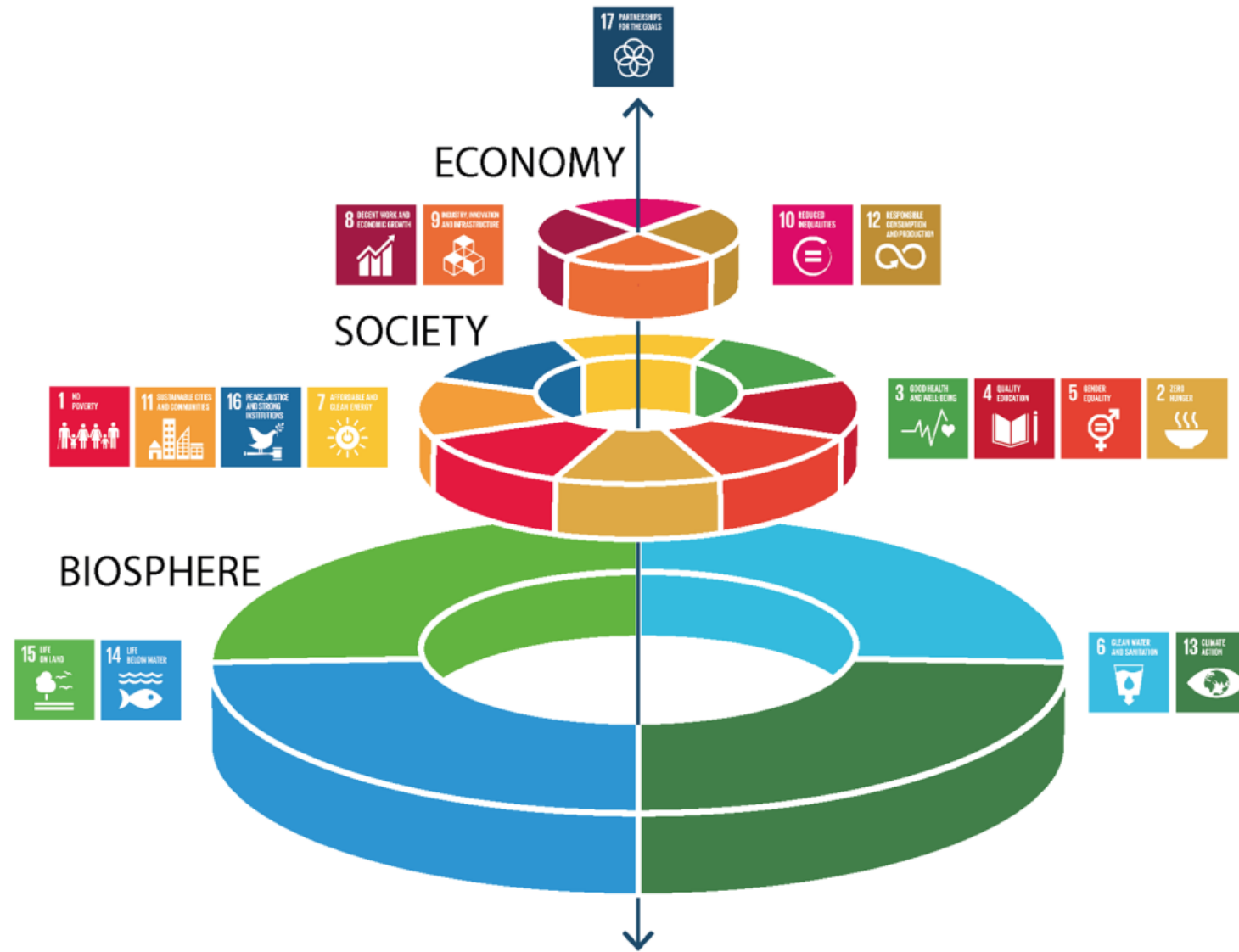
ESG to 17 SDGs

ESG to 17 SDGs

Environment · Social · Governance

- 1: End Poverty
- 2: Zero Hunger
- 3: Good Health and Well-Being
- 4: Quality Education
- 5: Gender Equality
- 6: Clean Water and Sanitation
- 7: Affordable and Clean Energy
- 8: Decent Work and Economic Growth
- 9: Industry, Innovation, and Infrastructure
- 10: Reduced Inequalities
- 11: Sustainable Cities and Communities
- 12: Responsible Consumption and Production
- 13: Climate Action
- 14: Life Below Water
- 15: Life on Land
- 16: Peace, Justice, and Strong Institutions
- 17: Partnerships for the Goals
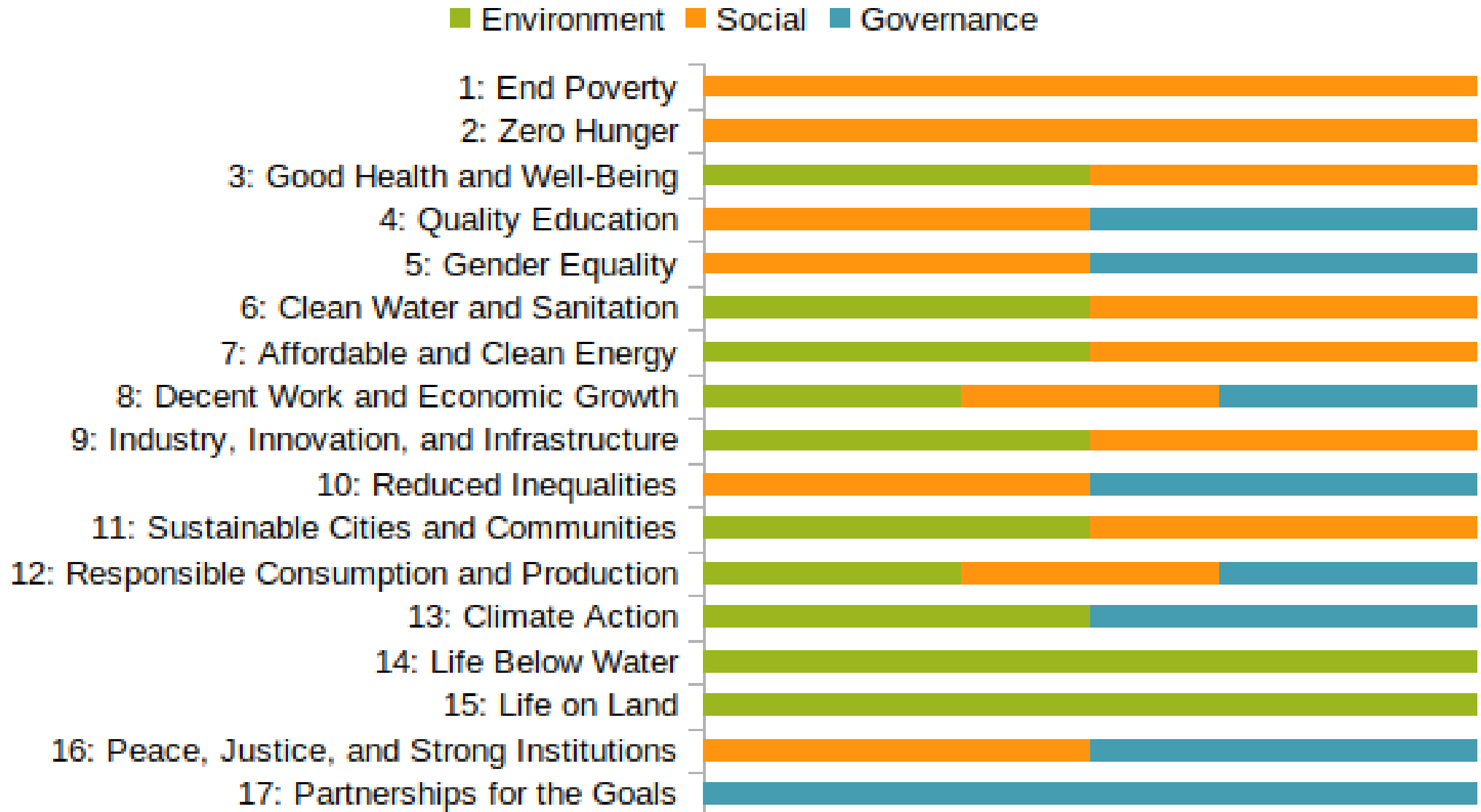
Data Collection and Analysis for Sustainability

Data Collection and Analysis for Sustainability

- **Types of sustainability data and collection methods**

- **Data quality, preparation, and analysis techniques**

- **Case studies of data-driven sustainability initiatives**

Types of Data Relevant to Sustainability and ESG

- **Environmental**: GHG emissions, energy usage, water consumption, waste generation
- **Social**: Employee demographics, health and safety incidents, community engagement metrics
- **Governance**: Board composition, executive compensation, ethical violations
- **Financial**: ESG-related investments, sustainable product revenues, carbon pricing

Understanding ESG Data

- **Quantitative data: Measurable metrics (e.g., carbon emissions, employee diversity)**
- **Qualitative data: Text-based information (e.g., policies, news articles)**
- **Structured data: Organized in databases**
- **Unstructured data: Requires processing (e.g., social media)**

Challenges of ESG Data

- **Lack of standardization:**
  - **Different reporting frameworks and metrics**
- **Reliability:**
  - **Concerns about "greenwashing" and accuracy**
- **Availability:**
  - **Data gaps, especially for smaller companies and certain sectors**

Data Collection Methods and Sources

- **Internal:**
  - **ERP systems, HR databases, facility management systems**
- **External:**
  - **Government databases, NGO reports, industry benchmarks**

Data Collection Methods and Sources

- **IoT and sensor data**
  - **Smart meters, environmental sensors**
- **Satellite and geospatial data**
  - **Land use changes, deforestation monitoring**
- **Social media and web scraping**
  - **Brand sentiment, consumer trends**
- **Surveys and stakeholder engagement**
  - **Employee satisfaction, community feedback**

Data Quality and Preparation

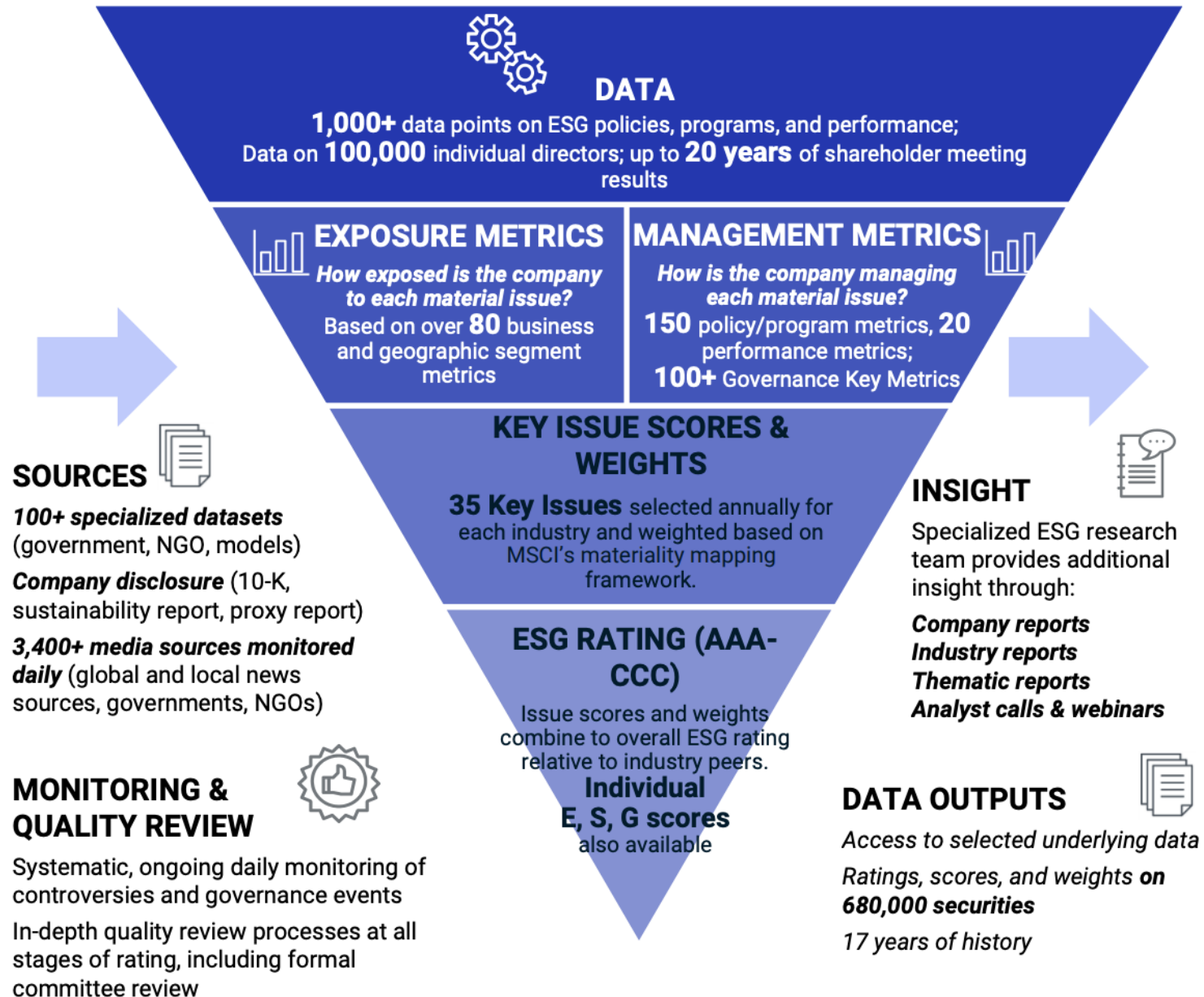- **Ensuring data accuracy:**
  - **Validation checks, cross-referencing**
- **Data cleaning:**
  - **Handling outliers, formatting inconsistencies**
- **Addressing missing data:**
  - **Imputation techniques, understanding data gaps**
- **Data integration:**
  - **Combining multiple sources, resolving conflicts**
- **Standardization:**
  - **Aligning with industry standards (e.g., GRI, SASB)**

Data Analysis Techniques for Sustainability

- **Descriptive analytics:**
  - **KPI tracking, trend analysis**
- **Diagnostic analytics:**
  - **Root cause analysis of sustainability issues**
- **Predictive analytics:**
  - **Forecasting future sustainability performance**
- **Prescriptive analytics:**
  - **Optimization of resource allocation**
- **Machine learning applications:**
  - **Anomaly detection, pattern recognition in sustainability data**

MSCI ESG Rating Framework

DATA

1,000+ data points on ESG policies, programs, and performance; Data on **100,000** individual directors; up to **20 years** of shareholder meeting results

EXPOSURE METRICS

How exposed is the company to each material issue? Based on over **80** business and geographic segment metrics

MANAGEMENT METRICS

How is the company managing each material issue? **150** policy/program metrics, **20** performance metrics; **100+** Governance Key Metrics

KEY ISSUE SCORES & WEIGHTS

35 Key Issues selected annually for each industry and weighted based on MSCI's materiality mapping framework.

ESG RATING (AAA-CCC)

Issue scores and weights combine to overall ESG rating relative to industry peers. **Individual E, S, G scores** also available

SOURCES

100+ specialized datasets (government, NGO, models)

Company disclosure (10-K, sustainability report, proxy report)

3,400+ media sources monitored daily (global and local news sources, governments, NGOs)

MONITORING & QUALITY REVIEW

Systematic, ongoing daily monitoring of controversies and governance events

In-depth quality review processes at all stages of rating, including formal committee review

INSIGHT

Specialized ESG research team provides additional insight through:

Company reports
Industry reports
Thematic reports
Analyst calls & webinars

DATA OUTPUTS

Access to selected underlying data

Ratings, scores, and weights **on 680,000 securities**

17 years of history

MSCI ESG Key Issue Hierarchy

3 Pillars	10 Themes	35 ESG Key Issues	
Environment	Climate Change	Carbon Emissions	Financing Environmental Impact
		Product Carbon Footprint	Climate Change Vulnerability
	Natural Capital	Water Stress	Raw Material Sourcing
		Biodiversity & Land Use	
	Pollution & Waste	Toxic Emissions & Waste	Electronic Waste
		Packaging Material & Waste	
	Environmental Opportunities	Opportunities in Clean Tech	Opportunities in Renewable Energy
		Opportunities in Green Building	
Social	Human Capital	Labor Management	Human Capital Development
		Health & Safety	Supply Chain Labor Standards
	Product Liability	Product Safety & Quality	Privacy & Data Security
		Chemical Safety	Responsible Investment
		Consumer Financial Protection	Health & Demographic Risk
	Stakeholder Opposition	Controversial Sourcing	
		Community Relations	
	Social Opportunities	Access to Communications	Access to Health Care
		Access to Finance	Opportunities in Nutrition & Health
Governance	Corporate Governance	Ownership & Control	Pay
		Board	Accounting
	Corporate Behavior	Business Ethics	
		Tax Transparency	

Data Preparation & Cleaning: Preparing ESG Data for Analysis

- **Handling missing values:**
  - **Imputation, deletion, etc.**
- **Detecting and addressing outliers.**
- **Ensuring data consistency (formatting, units).**
- **Feature engineering:**
  - **Creating new metrics based on raw ESG data.**

Exploratory Data Analysis (EDA) & Visualization:
Uncovering Patterns in ESG Data

- **Exploratory Data Analysis (EDA)**
  - **Using statistical summaries and visualizations.**
- **Identifying trends, correlations, and unusual patterns in ESG data.**
- **Storytelling with data:**
  - **Effective visualizations for ESG insights.**

ESG Predictive Modeling: Forecasting with ESG Data

- **Regression**
  - **Predicting continuous ESG outcomes (e.g., emissions)**
- **Classification:**
  - **Categorizing companies (e.g., high/low ESG risk)**
- **Time Series:**
  - **Forecasting ESG metrics over time.**

Natural Language Processing (NLP) for Sentiment Analysis: Sentiment Analysis for ESG Insights

- **Natural Language Processing (NLP):**
  - **Enabling computers to understand human language.**
- **Sentiment analysis:**
  - **Determining the emotional tone of text (positive, negative, neutral)**
- **Applications for ESG:**
  - **Tracking public opinion, identifying ESG risks and opportunities.**

Analyzing Sustainability Reports

- **Company sustainability report**
- **Identify which framework was used, key ESG metrics, areas of strength and weakness**
  - **How the company presents its ESG data and whether it aligns with the ESG key framework identified**

ESG Key Frameworks

- **Global Reporting Initiative (GRI):**
  - **Comprehensive sustainability standards**
- **Sustainability Accounting Standards Board (SASB):**
  - **Industry-specific metrics**
- **UN Sustainable Development Goals (SDGs):**
  - **Global goals for 2030**

Case Studies:
Data-Driven Sustainability Initiatives

- **Carbon footprint reduction:**

  - **Using ML to optimize logistics routes**

- **Supply chain optimization:**

  - **Predictive analytics for sustainable sourcing**

- **Energy efficiency improvement:**

  - **IoT-driven smart building management**

- **Diversity and inclusion analysis:**

  - **NLP on job descriptions and employee feedback**

GRI (Global Report Initiative)

CDP (Carbon Disclosure Project)

SASB (Sustainability Accounting Standards Board)

https://sasb.org/

49

ISSB (International Sustainability Standards Board)

TCFD
(Task Force on Climate-related Financial Disclosures)

IFRS

https://www.ifrs.org/sustainability/tcfd/

ABOUT US | IFRS ACCOUNTING | IFRS SUSTAINABILITY

Home > ISSB and TCFD

ISSB and TCFD

The Financial Stability Board has announced that the work of the TCFD has been completed, with the ISSB's Standards marking the 'culmination of the work of the TCFD'.

Companies applying IFRS S1 *General Requirements for Disclosure of Sustainability-related Financial Information* and IFRS S2 *Climate-related Disclosures* will meet the TCFD recommendations as the recommendations are fully incorporated into the ISSB's Standards.

Companies can continue to use the TCFD recommendations should they choose to do so, and some companies may still be required to use the TCFD recommendations. Using the recommendations is a good entry point for companies as they move to use the ISSB's Standards.

The IFRS Foundation has published a comparison of the requirements in IFRS S2 and the TCFD recommendations.

Related Information

IFRS Foundation welcomes culmination of TCFD work and transfer of TCFD monitoring responsibilities to ISSB from 2024

Comparison: IFRS S2 Climate-related Disclosures with the TCFD Recommendations

Resource: Making the transition from TCFD to ISSB

IFRS Sustainability Standards Navigator

https://www.fsb-tcfd.org/

Implementing Data-Driven Sustainability Strategies

Implementing
Data-Driven Sustainability Strategies

- **Setting science-based targets and integrating metrics into operations**

- **Advanced analytics for sustainability strategy**

- **Overcoming challenges and future trends in data science for sustainability**

Setting Science-Based Sustainability Targets

- **Science-based targets:**
  - **Emissions reduction goals aligned with Paris Agreement**
- **Using historical data and projections to set realistic targets**
- **Aligning with Sustainable Development Goals (SDGs)**
- **Case study:**
  - **Unilever's science-based targets and progress tracking**

Integrating Sustainability Metrics into Business Operations

- **Embedding ESG KPIs in performance management**
- **Developing sustainability scorecards and dashboards**
- **Data-driven decision making for sustainability**
- **Challenges: Data silos, resistance to change**
- **Best practices: Cross-functional teams, executive sponsorship**

Advanced Analytics for Sustainability Strategy

- **Scenario analysis for climate risk assessment**
- **AI for optimizing energy consumption in real-time**
- **Predictive modeling for supply chain sustainability risks**
- **NLP for analyzing sustainability-related news and social media**

Communicating ESG Performance to Stakeholders

- **Comprehensive sustainability reporting (GRI, SASB standards)**
- **Data visualization: Infographics, interactive dashboards**
- **Real-time sustainability performance portals**
- **Addressing data privacy in sustainability communication**

Overcoming Challenges in Data-Driven Sustainability

- **Improving data quality and standardization**
- **Change management strategies for adoption**
- **Ethical data collection and use in sustainability**
- **Staying compliant with evolving ESG regulations**

Data-Driven Sustainable Investing: Building ESG-Conscious Portfolios

- **ESG investing:**
  - **Considering environmental, social, and governance factors in investment decisions.**
- **Performance of ESG-focused funds vs. traditional funds.**
- **Building ESG portfolios:**
  - **Screening, index funds, impact investing.**

ESG Risk Assessment and Mitigation: Managing ESG Risks for Resilience

- **Identifying ESG risks across the supply chain (environmental impact, labor practices).**

- **Using data to quantify potential financial consequences of ESG risks.**

- **Developing strategies to mitigate ESG risks.**

- **Integrating ESG risk monitoring into decision-making for greater resilience.**

Driving Corporate Sustainability:
Data-Powered Sustainability Transformations

- **Setting data-driven ESG targets and tracking progress.**
- **Utilizing dashboards and analytics for real-time ESG insights.**
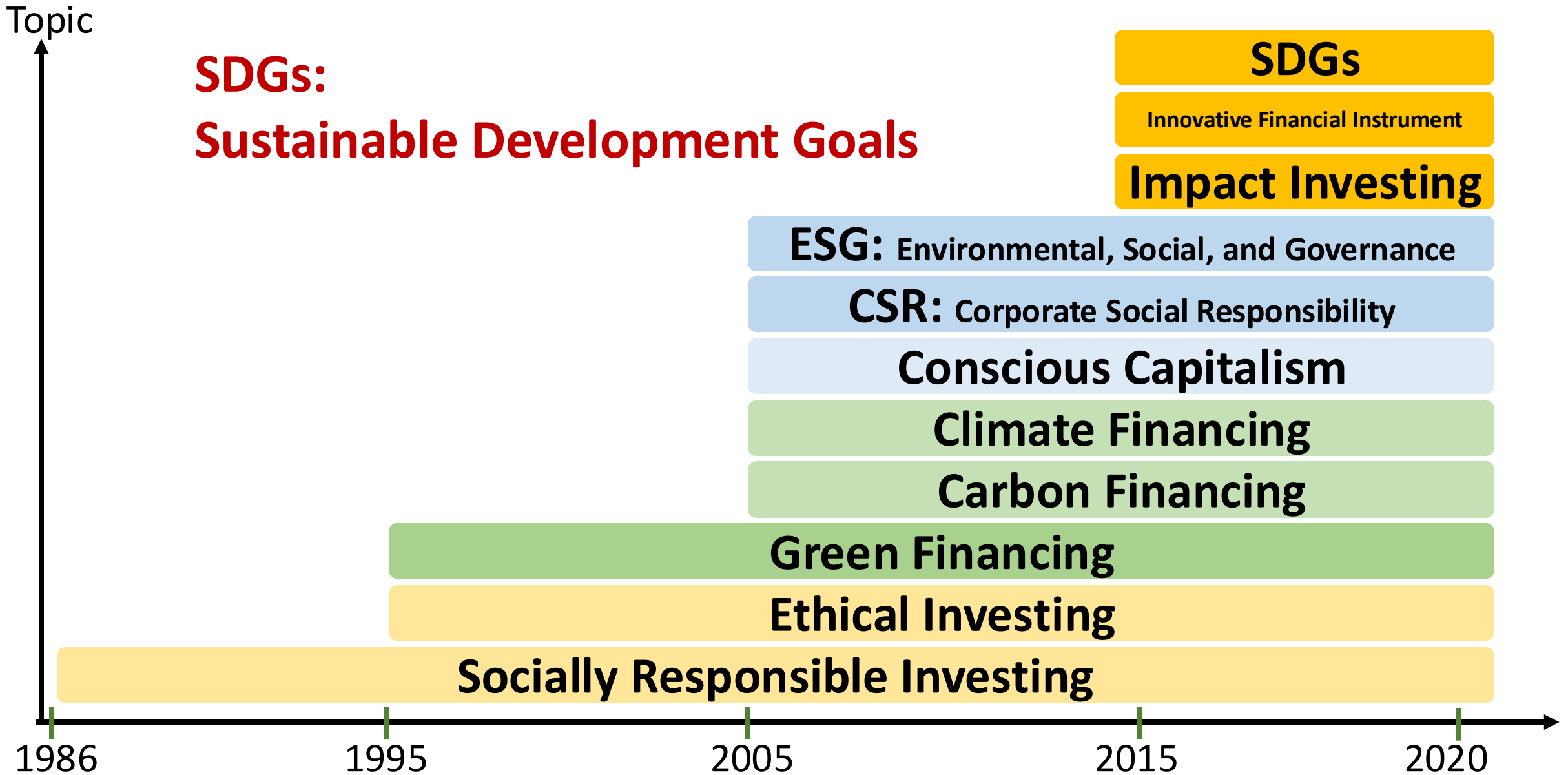- **Engaging stakeholders through transparent ESG reporting.**

The Future of Data-Driven ESG: A Sustainable Future Powered by Data

- **Emerging trends in ESG data and analytics**
  - **e.g., AI for ESG insights**
- **The potential of data to drive progress towards global sustainability goals.**
- **The role of data scientists in shaping ethical and equitable ESG practices.**
- **Be part of the ESG Data Science solution.**

Future Trends in Data Science for Sustainability

- **Blockchain for transparent, sustainable supply chains**
- **Digital twins for environmental impact simulation**
- **Edge computing for real-time sustainability management**
- **Quantum computing for complex climate modeling**
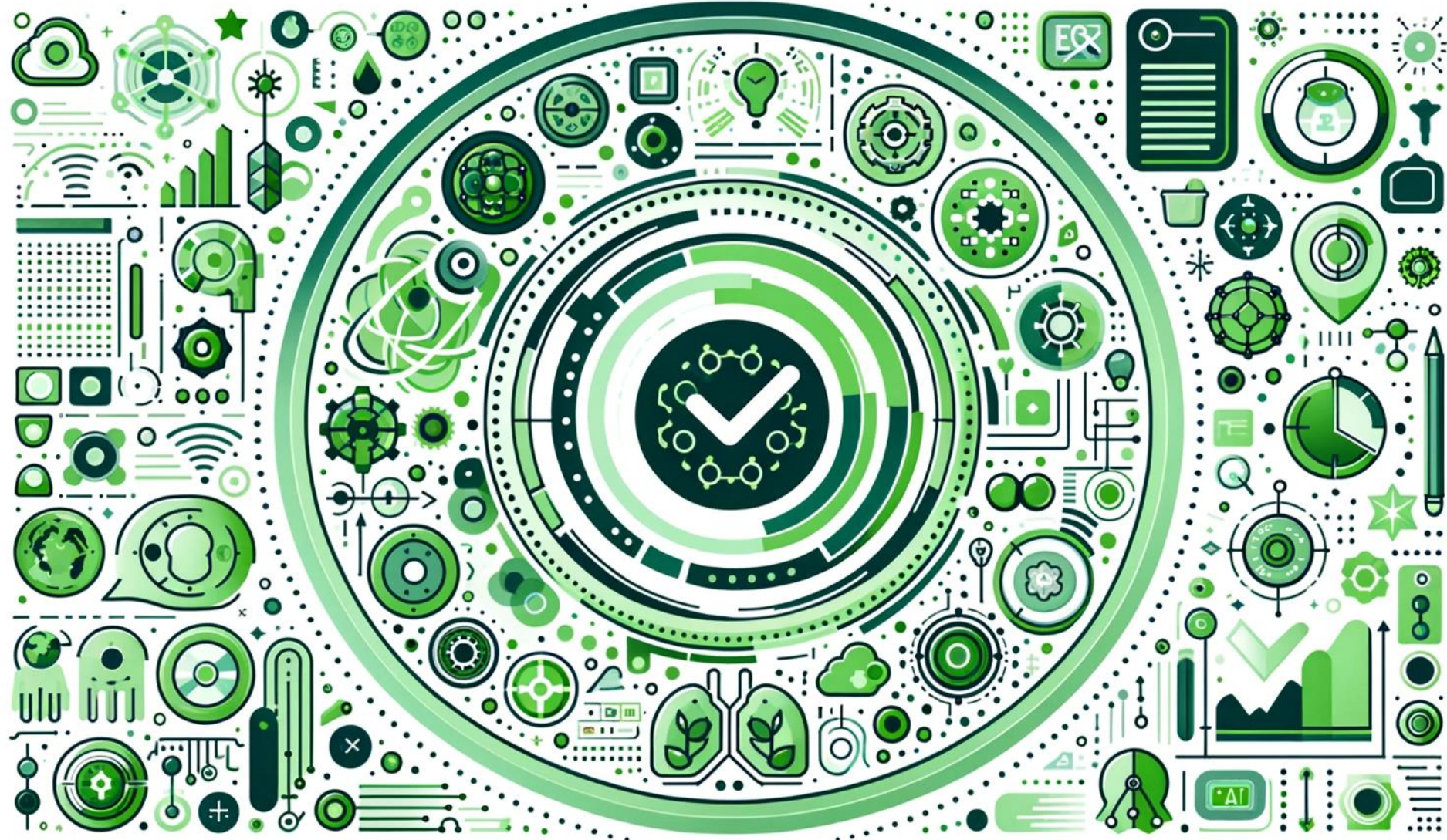
Evolution of **Sustainable Finance** Research

Topic

SDGs:
Sustainable Development Goals

SDGs

Innovative Financial Instrument

Impact Investing

ESG: Environmental, Social, and Governance

CSR: Corporate Social Responsibility

Conscious Capitalism

Climate Financing

Carbon Financing

Green Financing

Ethical Investing

Socially Responsible Investing
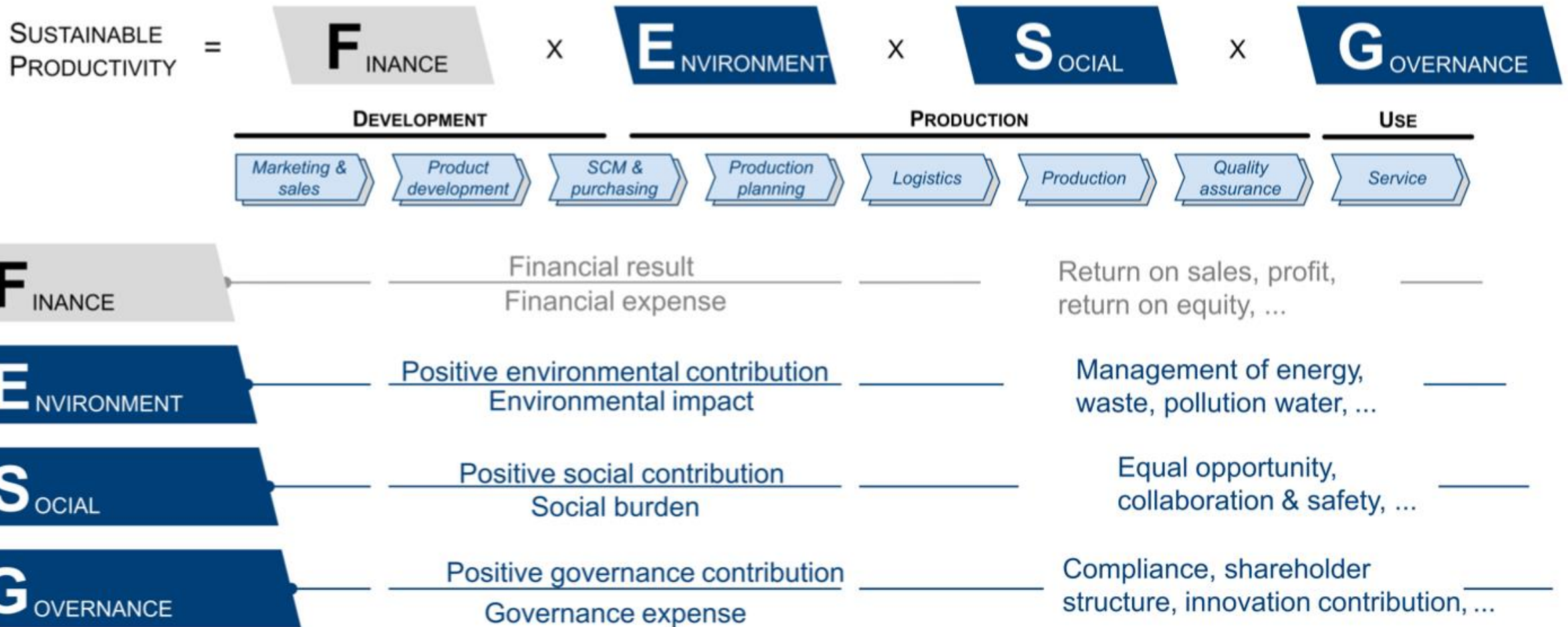
1986   1995   2005   2015   2020

Generative AI and LLMs for Sustainability and ESG Data Analytics

Generative AI for ESG Rating and Reporting Generation

Sustainable Productivity: Finance ESG

Sustainable Resilient Manufacturing ESG

Source: Huang, Ziqi, Yang Shen, Jiayi Li, Marcel Fey, and Christian Brecher (2021). "A survey on AI-driven digital twins in Industry 4.0: Smart manufacturing and advanced robotics." Sensors 21, no. 19: 6340.
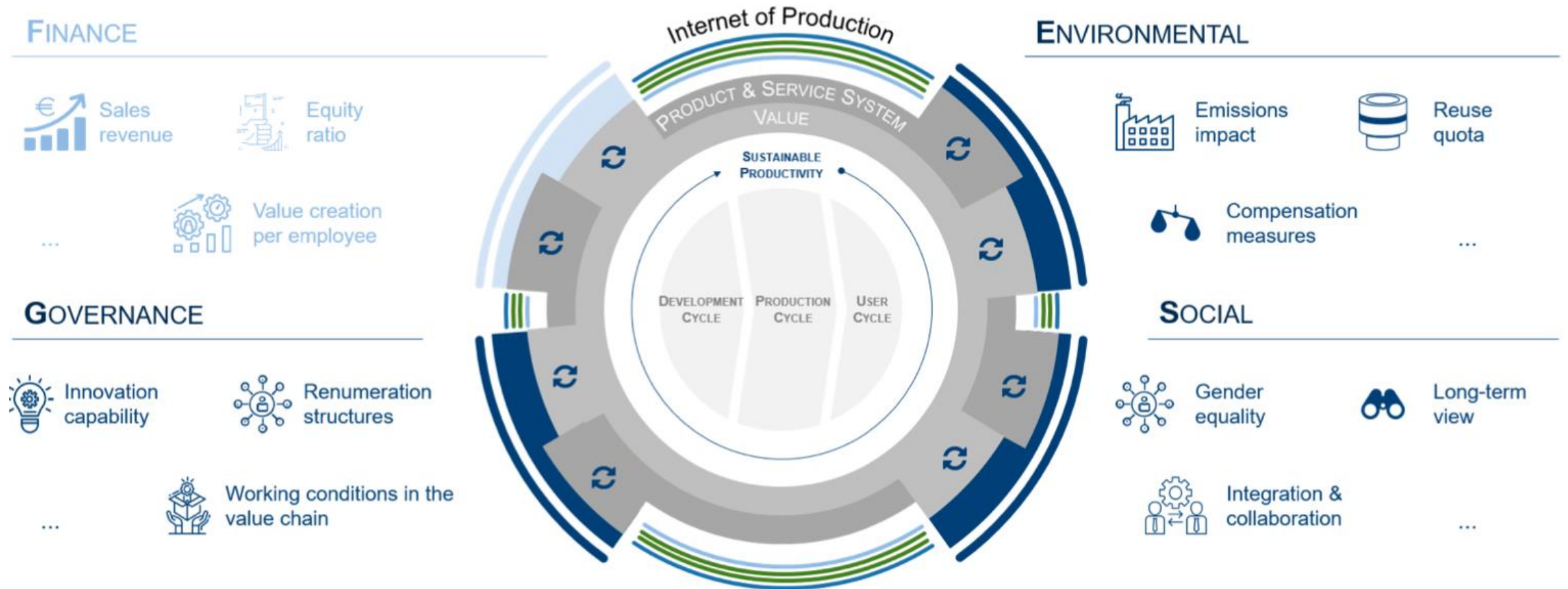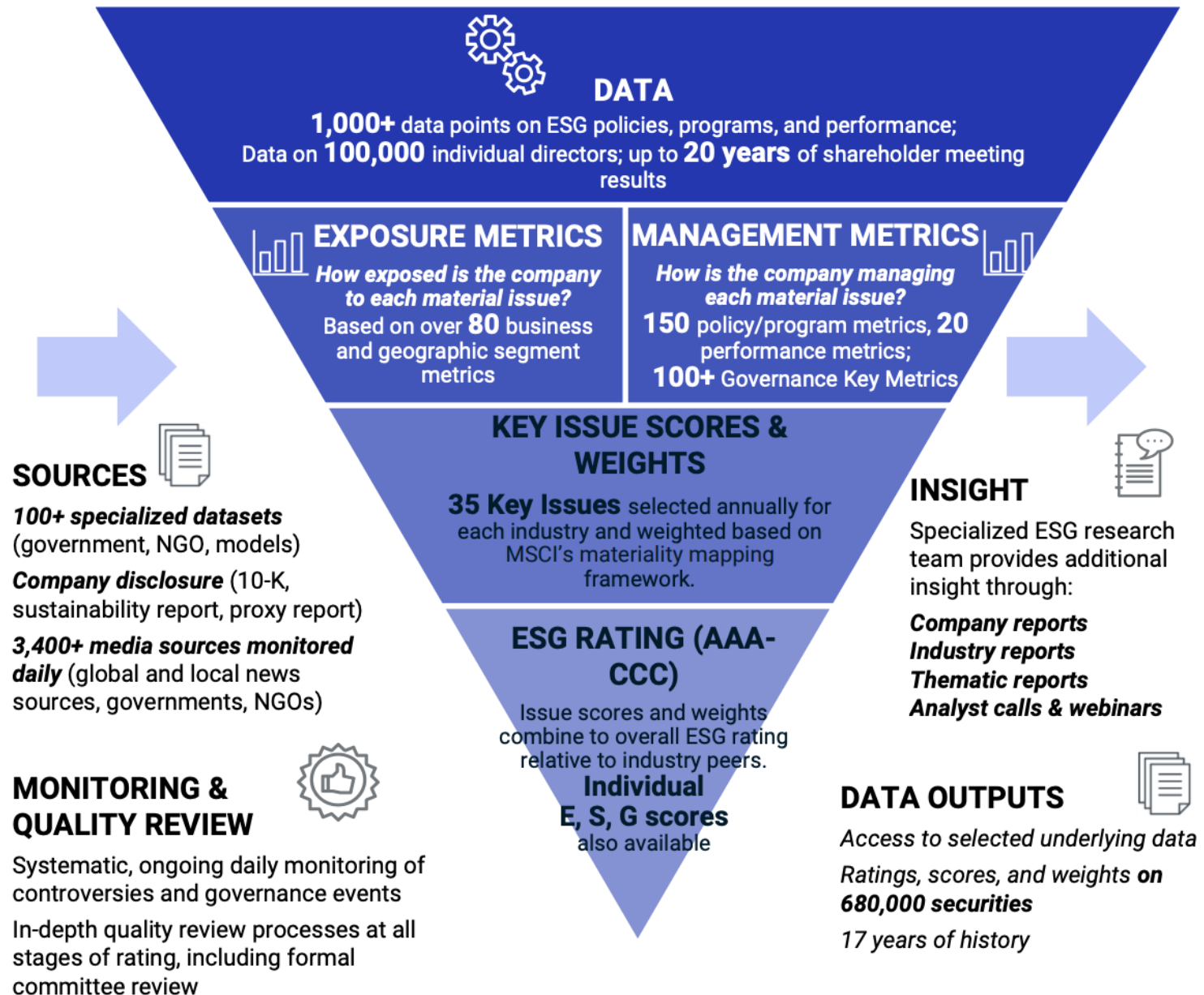
ESG Indexes

- **MSCI ESG Index**

- **Dow Jones Sustainability Indices (DJSI)**

- **FTSE ESG Index**

MSCI ESG Rating Framework

DATA
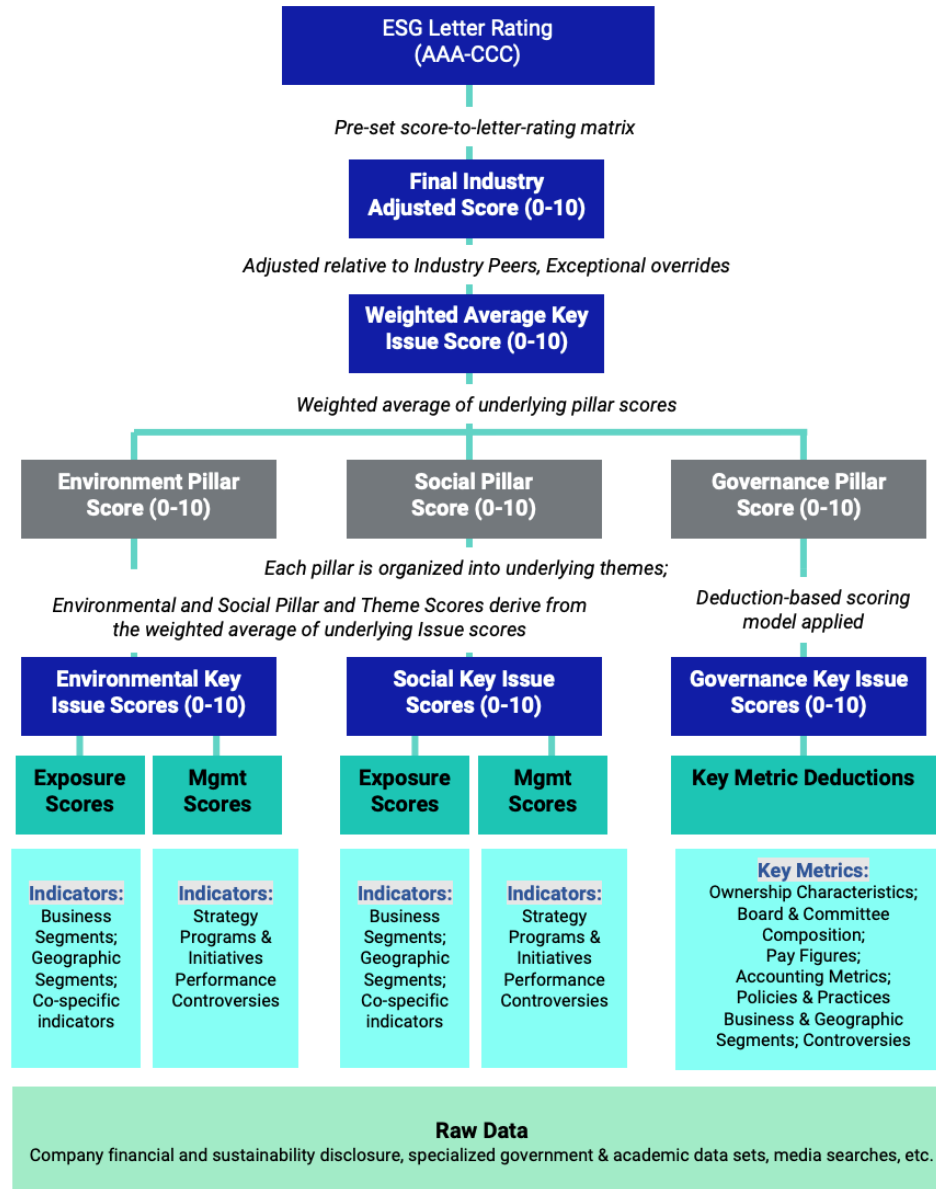**1,000+** data points on ESG policies, programs, and performance; Data on **100,000** individual directors; up to **20 years** of shareholder meeting results

EXPOSURE METRICS
How exposed is the company to each material issue?
Based on over **80** business and geographic segment metrics

MANAGEMENT METRICS
How is the company managing each material issue?
150 policy/program metrics, **20** performance metrics; **100+** Governance Key Metrics

KEY ISSUE SCORES & WEIGHTS
35 Key Issues selected annually for each industry and weighted based on MSCI's materiality mapping framework.

ESG RATING (AAA-CCC)
Issue scores and weights combine to overall ESG rating relative to industry peers.
Individual E, S, G scores also available

SOURCES
100+ specialized datasets (government, NGO, models)
Company disclosure (10-K, sustainability report, proxy report)
3,400+ media sources monitored daily (global and local news sources, governments, NGOs)

MONITORING & QUALITY REVIEW
Systematic, ongoing daily monitoring of controversies and governance events
In-depth quality review processes at all stages of rating, including formal committee review

INSIGHT
Specialized ESG research team provides additional insight through:
Company reports
Industry reports
Thematic reports
Analyst calls & webinars

DATA OUTPUTS
Access to selected underlying data
Ratings, scores, and weights **on 680,000 securities**
17 years of history

MSCI ESG Key Issue Hierarchy

3 Pillars	10 Themes	35 ESG Key Issues	
Environment	Climate Change	Carbon Emissions	Financing Environmental Impact
		Product Carbon Footprint	Climate Change Vulnerability
	Natural Capital	Water Stress	Raw Material Sourcing
		Biodiversity & Land Use	
	Pollution & Waste	Toxic Emissions & Waste	Electronic Waste
		Packaging Material & Waste	
	Environmental Opportunities	Opportunities in Clean Tech	Opportunities in Renewable Energy
		Opportunities in Green Building	
Social	Human Capital	Labor Management	Human Capital Development
		Health & Safety	Supply Chain Labor Standards
	Product Liability	Product Safety & Quality	Privacy & Data Security
		Chemical Safety	Responsible Investment
		Consumer Financial Protection	Health & Demographic Risk
	Stakeholder Opposition	Controversial Sourcing	
		Community Relations	
	Social Opportunities	Access to Communications	Access to Health Care
		Access to Finance	Opportunities in Nutrition & Health
Governance	Corporate Governance	Ownership & Control	Pay
		Board	Accounting
	Corporate Behavior	Business Ethics	
		Tax Transparency	

MSCI Governance Model Structure

72
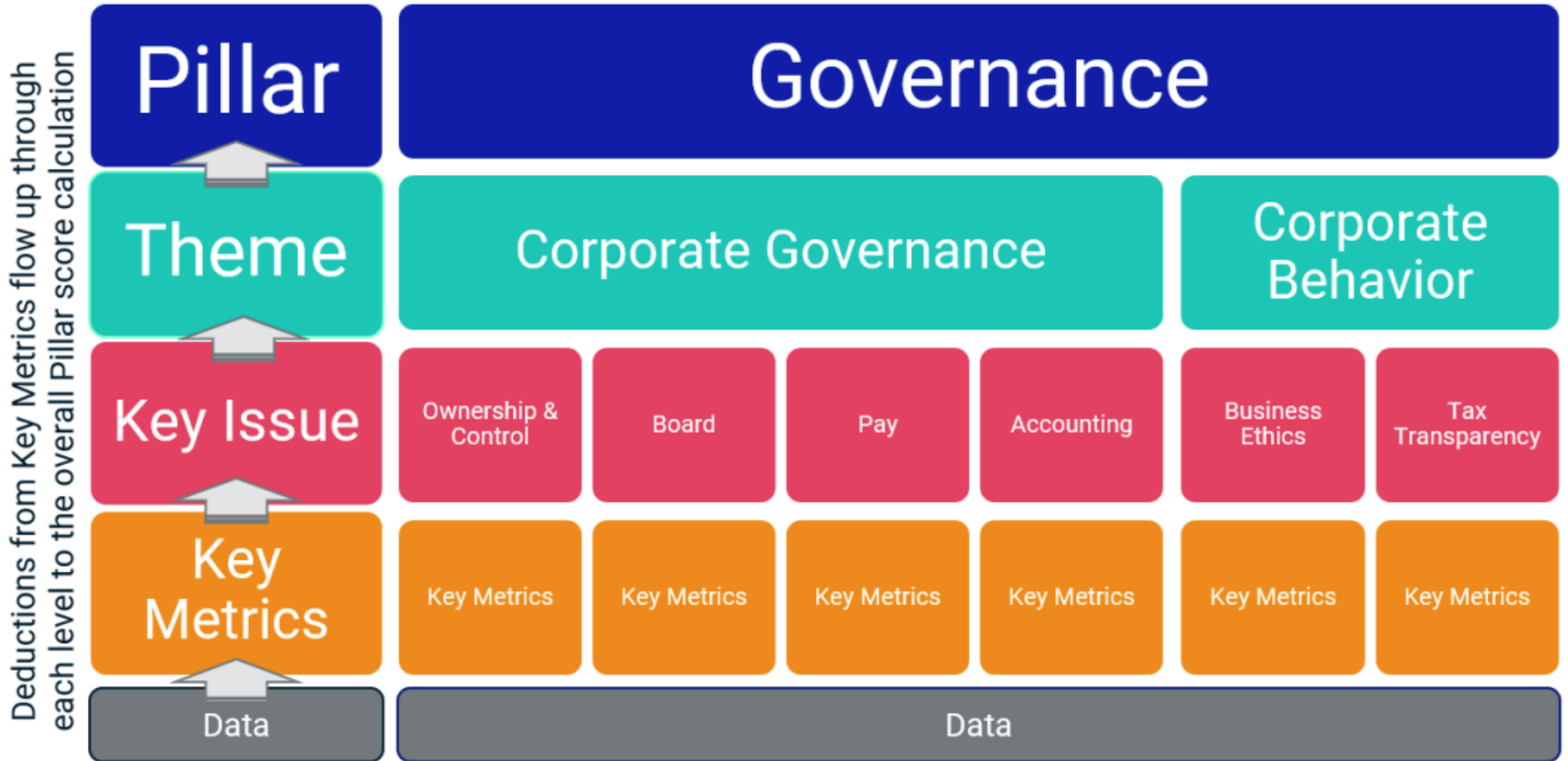
MSCI Hierarchy of ESG Scores

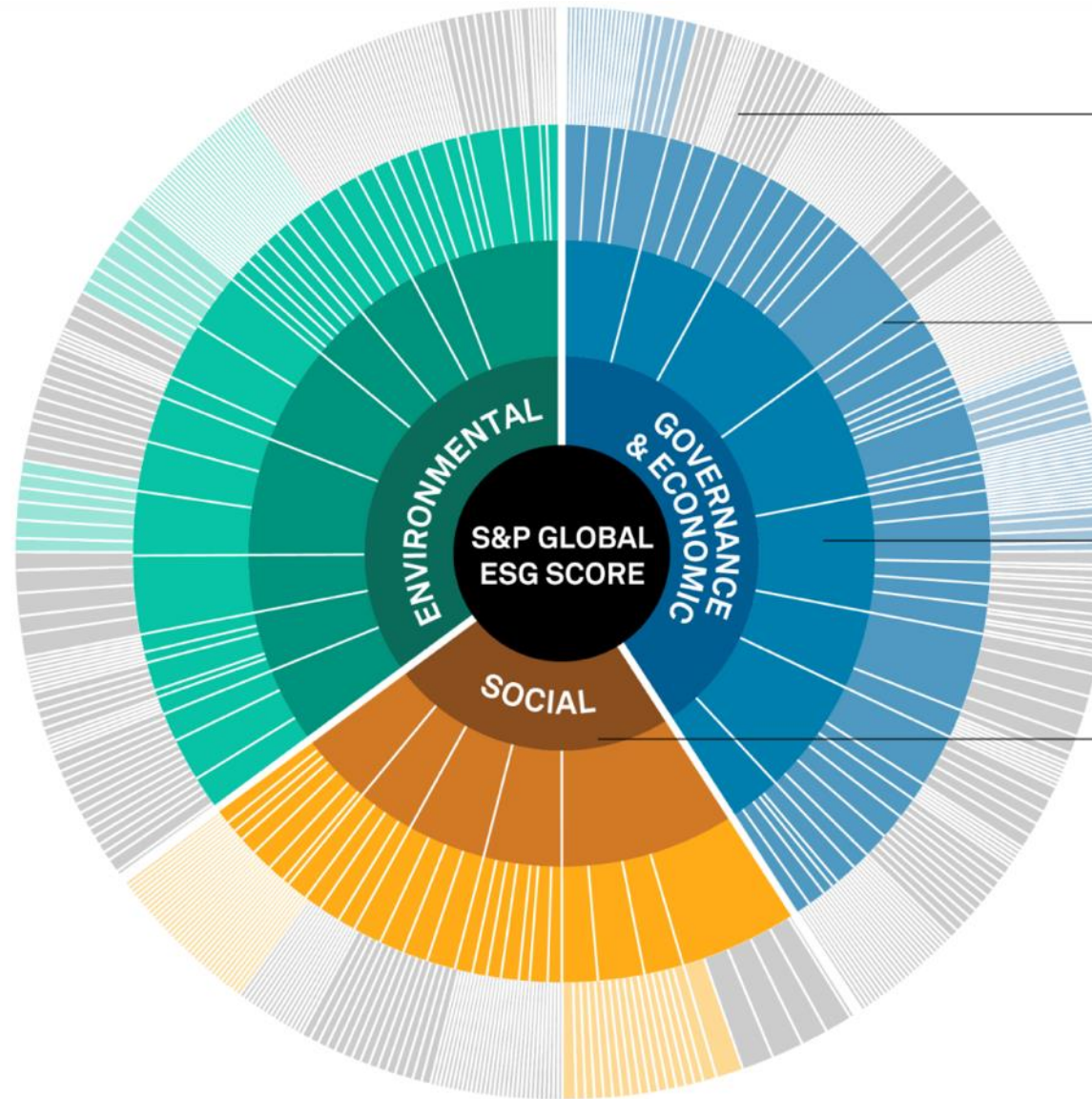Source: https://www.msci.com/documents/1296102/21901542/ESG-Ratings-Methodology-Exec-Summary.pdf

DJSI S&P Global ESG Score

8,000
Companies

90%
Global market capitalization

340,000+
Current Research Universe and Active Securities

ENVIRONMENTAL

GOVERNANCE & ECONOMIC

S&P GLOBAL ESG SCORE

SOCIAL

Approx.
1,000
Datapoints

Assessed values, text, checkboxes, documents

Sources: Web-based questionnaire and company documents

130+
Questions

Weighted data point scores

Up to 50% industry-specific

Ave.
30+
Criteria scores

Weighted question scores

61 industry specific approaches, with tailored questions, criteria and related weightings

3
Dimension scores

Weighted criteria scores

Adjusted for corporate ESG controversies where applicable

1
S&P Global ESG Score

Sum of weighted dimension scores

FTSE Russell ESG Ratings

Sustainalytics ESG Risk Ratings

Analyst-based approach

Sustainalytics' ESG Risk Ratings measure a company's exposure to industry-specific material ESG risks and how well a company is managing those risks.

Negligible	Low	Medium	High	Severe
0 - 10	10 - 20	20 - 30	30 - 40	40+

Machine-based approach
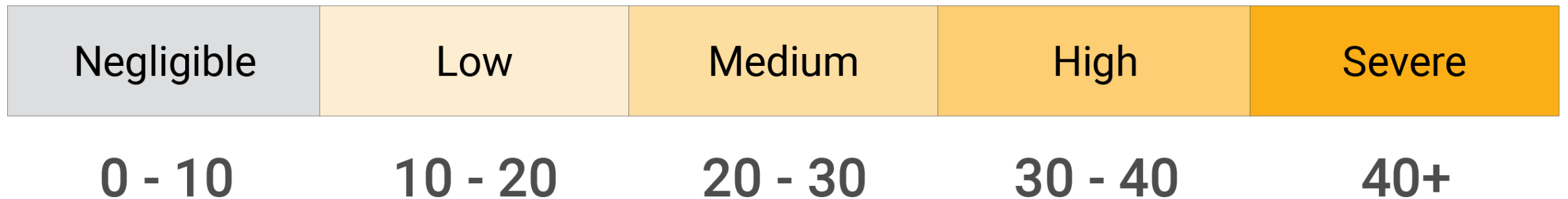
Truvalue
ESG Ranks

國立臺北大學
National Taipei University

- **Truvalue Labs** applies **AI** to analyze over **100,000 sources** and uncover **ESG risks** and opportunities hidden in **unstructured text**.

- The ESG Ranks data service produces an overall company rank based on industry percentile leveraging the **26 ESG categories** defined by the **Sustainability Accounting Standards Board (SASB)**.

- The data feed covers 20,000+ companies with more than 13 years of history.

| Laggard | Below Average | Average | Above Average | Leader |
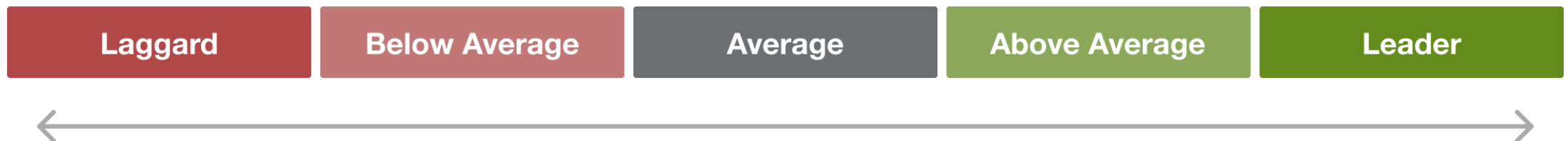
Analyst-driven vs. AI-driven ESG

Sustainalytics

Truvalue Labs

Analyst-driven ESG research
Derives ratings in a structured data model

Collect data → Process data → Analyze data → Generate score/rating

DATA MINERS & TECHNOLOGY

ANALYSTS

Analyst role at the end of the process allows subjectivity to color results

AI-driven ESG research
Derives signals from unstructured data

Develop algorithms → Extract signals → Analyze data → Generate score/rating

ANALYSTS & ENGINEERS

TECHNOLOGY

Analyst expertise at the beginning of the process produces consistent results

Analyst based ESG Research

AI based ESG Research

Analyst Based ESG Research

| Collect Data | Process Data | Analyze Data | Generate score rating |

Raw data sources and tools — Collect Data

Analysts — Process Data, Analyze Data, Generate score rating

Applying AI to ESG Research

| Develop algorithms | Extract signals | Analyze data and uncover material impact | Review and determine investment decision |

Analysts and Engineers — Develop algorithms

Technology — Extract signals, Analyze data and uncover material impact

Analysts — Review and determine investment decision

It would take an analyst over 5 years to do what our AI can in 1 week

Combining analysts with AI creates gives you the full picture
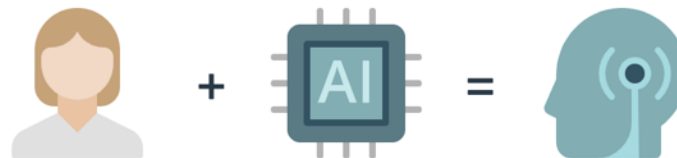
ESG ANALYTICS
Invest where it matters.

ESG Analytics: NLP Taxonomy
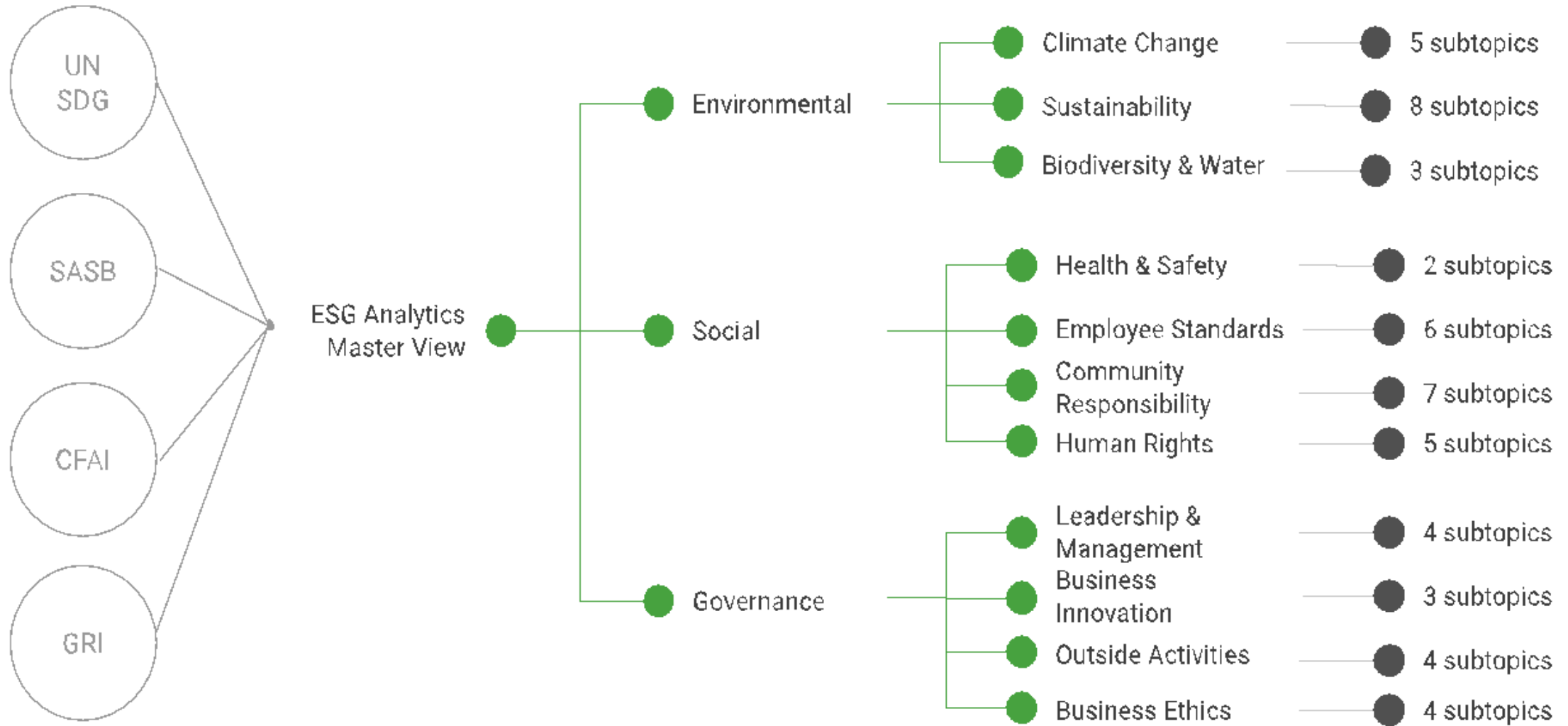
Top ESG Reporting Software

Environmental, Social and Governance (ESG) Reporting software or **Sustainability software** helps organizations manage their operational data, evaluate their impact on the environment and provide reporting to perform audits.
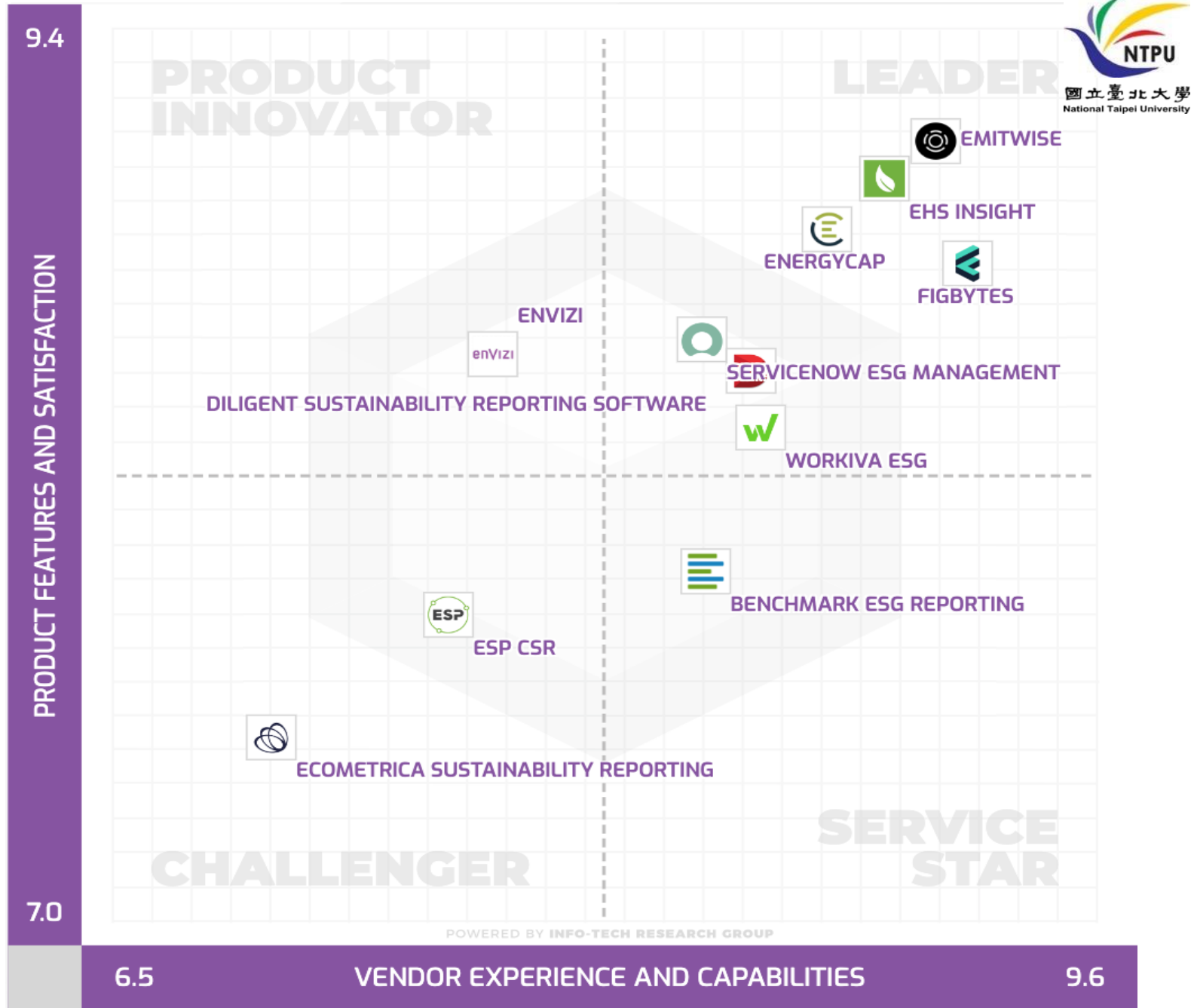
ESG Data Analysis and Visualization

```python
# ESG Data Analysis and Visualization
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
from datetime import datetime
import random

# Generate synthetic data
np.random.seed(0)
data = {
    'company': ['Company A', 'Company B', 'Company C', 'Company D', 'Company E'],
    'emissions': np.random.randint(10000, 50000, 5),
    'diversity': np.random.uniform(0.2, 0.9, 5),
    'employee_satisfaction': np.random.uniform(60, 90, 5),
    'waste_type': ['Plastic', 'Organic', 'Electronic', 'Metal', 'Other'],
    'waste_amount': np.random.randint(100, 500, 5)
}
df = pd.DataFrame(data)
```

ESG Data Analysis and Visualization

```python
# Separate DataFrame for time series and correlation
time_series_data = pd.DataFrame({
    'year': np.repeat(np.arange(2018, 2023), 5),
    'company': np.tile(['Company A', 'Company B', 'Company C', 'Company
    D', 'Company E'], 5),
    'energy_use': np.random.randint(1000, 5000, 25)
})

# Simulating correlation data with a slight positive trend
diversity = np.linspace(0.2, 0.9, 100)
np.random.shuffle(diversity)
employee_satisfaction = 60 + (diversity - 0.2) * 150
employee_satisfaction += np.random.normal(0, 5, 100)

correlation_data = pd.DataFrame({
    'diversity': diversity,
    'employee_satisfaction': employee_satisfaction
})
```

ESG Data Analysis and Visualization

```python
# Save DataFrame to CSV
df.to_csv('ESG_Dataset.csv', index=False)

# Calculate statistics for each company
statistics = df.describe()
statistics = statistics.applymap(lambda x: format(x, '.4f'))
print(statistics)
statistics.to_csv('Company_ESG_Statistics.csv')
```

	emissions	diversity	employee_satisfaction	waste_amount
count	5.0000	5.0000	5.0000	5.0000
mean	31447.6000	0.4085	77.1504	345.6000
std	11667.5748	0.1099	7.0841	94.8093
min	12732.0000	0.2397	70.1219	215.0000
25%	30757.0000	0.3909	71.7835	297.0000
50%	31243.0000	0.4083	74.3993	343.0000
75%	40403.0000	0.4691	84.3651	435.0000
max	42103.0000	0.5344	85.0824	438.0000

ESG Data Analysis and Visualization

```python
# Create visualizations and save them at 300 dpi
# Bar Chart for Emissions
plt.figure(figsize=(8, 4))
plt.bar(df['company'], df['emissions'], color='skyblue')
plt.xlabel('Company')
plt.ylabel('Emissions (Tonnes)')
plt.title('ESG Comparison of Company Emissions')
plt.show()
plt.savefig('ESG Company_Emissions.jpg', format='jpg', dpi=300)
```
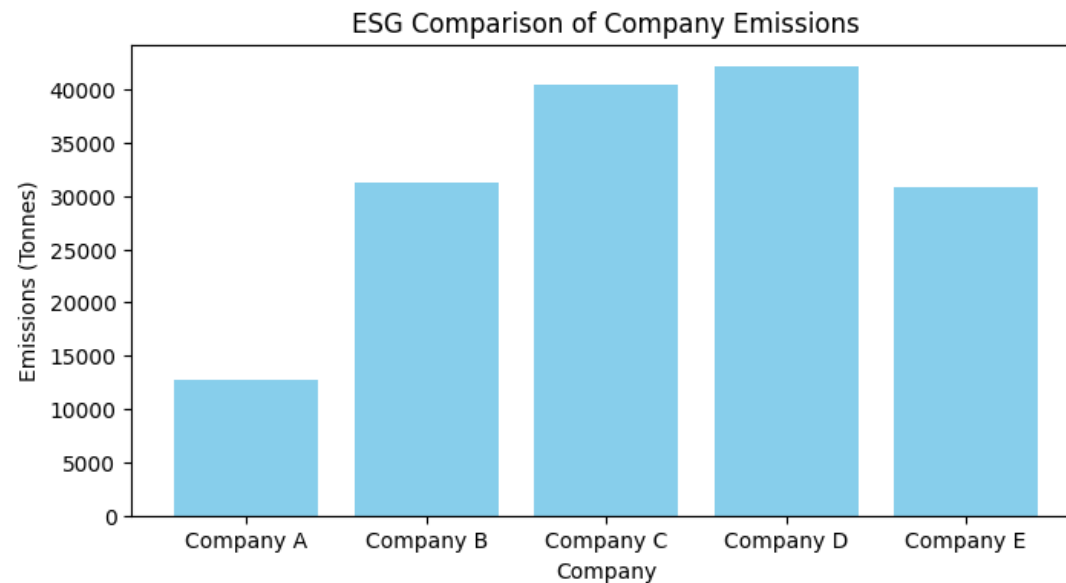
ESG Data Analysis and Visualization

```python
# Line Chart for Energy Use
plt.figure(figsize=(8, 4))
for company in time_series_data['company'].unique():
    company_data = time_series_data[time_series_data['company'] ==
    company]
    company_data = company_data.sort_values(by='year')
    plt.plot(company_data['year'], company_data['energy_use'],
    marker='o', linestyle='-', label=company)
plt.xlabel('Year')
plt.ylabel('Energy Use (kWh)')
plt.title("ESG Companies' Energy Use Over Time")
plt.xticks(company_data['year'].unique()) # Ensuring only whole years
are marked
plt.legend()
plt.grid(True)
plt.show()
```

ESG Data Analysis and Visualization

ESG Companies' Energy Use Over Time
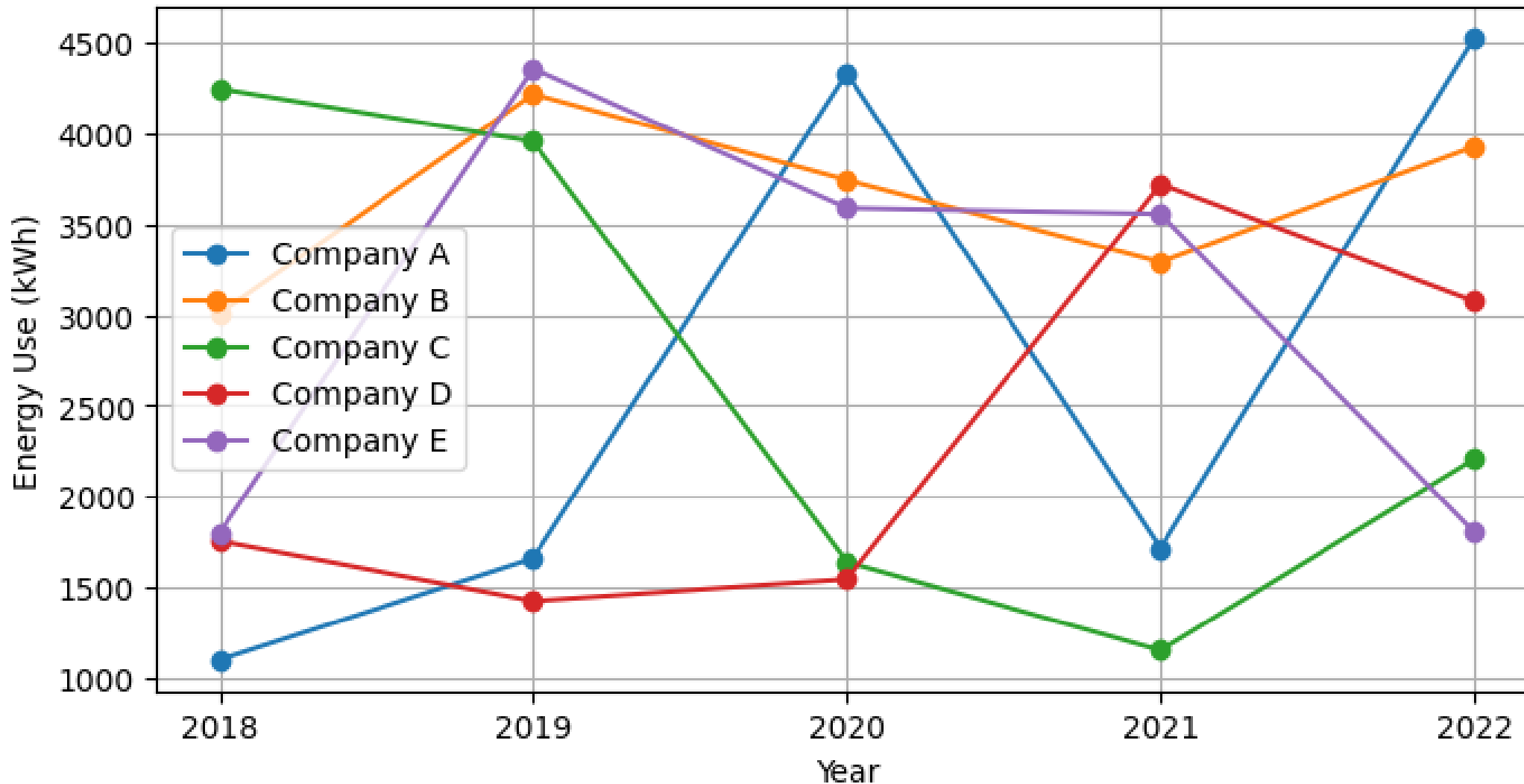
ESG Data Analysis and Visualization

```python
# Scatter Plot for Diversity vs. Satisfaction
plt.figure(figsize=(8, 4))
plt.scatter(correlation_data['diversity'],
correlation_data['employee_satisfaction'], alpha=0.7)
plt.xlabel('Board Diversity (Ratio)')
plt.ylabel('Employee Satisfaction (%)')
plt.title('ESG Correlation Between Board Diversity and Employee
Satisfaction')
plt.grid(True)
plt.show()
plt.savefig('ESG_Diversity_vs_Satisfaction.jpg', format='jpg', dpi=300)
```

ESG Data Analysis and Visualization

ESG Correlation Between Board Diversity and Employee Satisfaction
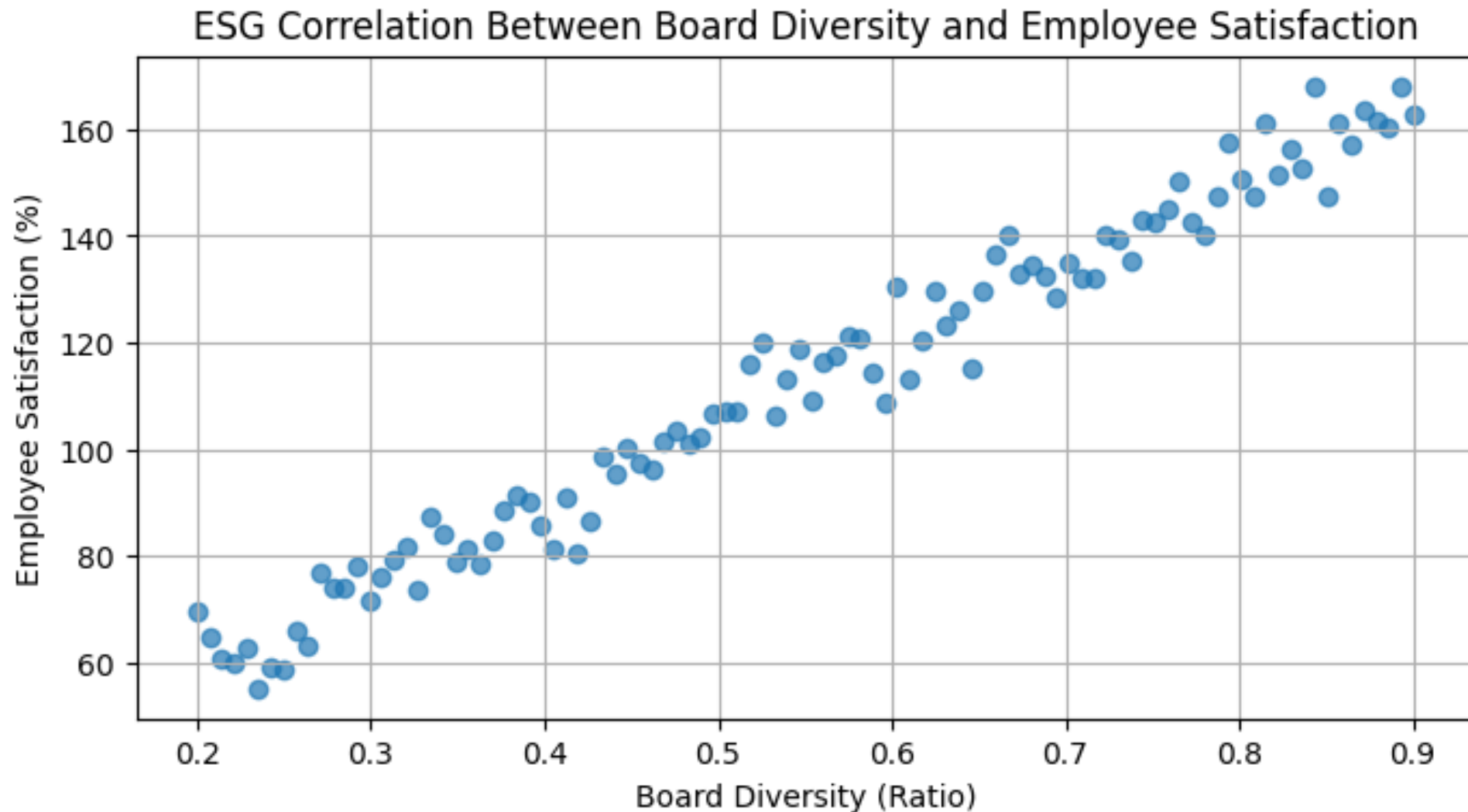
ESG Data Analysis and Visualization

```python
# Pie Chart for Waste Types
plt.figure(figsize=(8, 4))
plt.pie(df['waste_amount'], labels=df['waste_type'], autopct='%1.1f%%',
startangle=140)
plt.title('ESG Waste Types')
plt.axis('equal') # Equal aspect ratio ensures that pie is drawn as a
circle.
plt.show()
plt.savefig('ESG_Waste_Type_Breakdown.jpg', format='jpg', dpi=300)
```

Applications of ESG Data Analytics with Python

ESG Data Analytics

https://www.kaggle.com/datasets/pritish509/s-and-p-500-esg-risk-ratings/data

ESG Data Analytics

ESG_Data_Analytics.ipynb

File   Edit   View   Insert   Runtime   Tools   Help   All changes saved

+ Code   + Text

RAM
Disk

Gemini

```python
#ESG Data Analytics
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns
import plotly.express as px
import plotly.graph_objects as go

from sklearn.model_selection import train_test_split
from sklearn.ensemble import RandomForestRegressor, RandomForestClassifier
from sklearn.metrics import mean_squared_error, accuracy_score, r2_score, precision_score, recall_score, f1_score
from sklearn.linear_model import LinearRegression
from sklearn.tree import DecisionTreeRegressor, DecisionTreeClassifier
from sklearn.neighbors import KNeighborsClassifier
from sklearn.naive_bayes import GaussianNB
from sklearn.cluster import KMeans
from sklearn.preprocessing import StandardScaler, LabelEncoder
from xgboost import XGBRegressor, XGBClassifier
from sklearn.impute import SimpleImputer

import tensorflow as tf
from tensorflow import keras

import warnings
warnings.filterwarnings('ignore')

sns.set_style('whitegrid')  # Set seaborn style for static plots
```

Python in Google Colab (Python101)

https://colab.research.google.com/drive/1FEG6DnGvwfUbeo4zJ1zTunjMqf2RkCrT

https://tinyurl.com/aintpupython101

Summary

- **Data Science and Sustainability**

- **Data Collection and Analysis for Sustainability**

- **Implementing Data-Driven Sustainability Strategies**

References

- Sherry Madera (2024), Navigating Sustainability Data: How Organizations can use ESG Data to Secure Their Future, Kogan Page
- Cino Robin Castelli, Cyril Shmatov (2022), Quantitative Methods for ESG Finance, Wiley
- Simon Thompson (2023), Green and Sustainable Finance: Principles and Practice in Banking, Investment and Insurance, 2nd Edition, Kogan Page.
- Chrissa Pagitsas (2023), Chief Sustainability Officers At Work: How CSOs Build Successful Sustainability and ESG Strategies, Apress.
- Wes McKinney (2022), "Python for Data Analysis: Data Wrangling with pandas, NumPy, and Jupyter", 3rd Edition, O'Reilly Media.
- Aurélien Géron (2023), Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow: Concepts, Tools, and Techniques to Build Intelligent Systems, 3rd Edition, O'Reilly Media.
- Steven D'Ascoli (2022), Artificial Intelligence and Deep Learning with Python: Every Line of Code Explained For Readers New to AI and New to Python, Independently published.
- Stuart Russell and Peter Norvig (2020), Artificial Intelligence: A Modern Approach, 4th Edition, Pearson.
- Cino Robin Castelli, Cyril Shmatov (2022), Quantitative Methods for ESG Finance, Wiley
- Simon Thompson (2023), Green and Sustainable Finance: Principles and Practice in Banking, Investment and Insurance, 2nd Edition, Kogan Page.
- Chrissa Pagitsas (2023), Chief Sustainability Officers At Work: How CSOs Build Successful Sustainability and ESG Strategies, Apress.
- Yihan Cao, Siyu Li, Yixin Liu, Zhiling Yan, Yutong Dai, Philip S. Yu, and Lichao Sun (2023). "A Comprehensive Survey of AI-Generated Content (AIGC): A History of Generative AI from GAN to ChatGPT." arXiv preprint arXiv:2303.04226.
- Min-Yuh Day (2024), Python 101, https://tinyurl.com/aintpupython101