Purdue – Mexico Sustainability Center

2nd. Workshop

The role of Sustainability in Technology Management for Pemex Downstream projects

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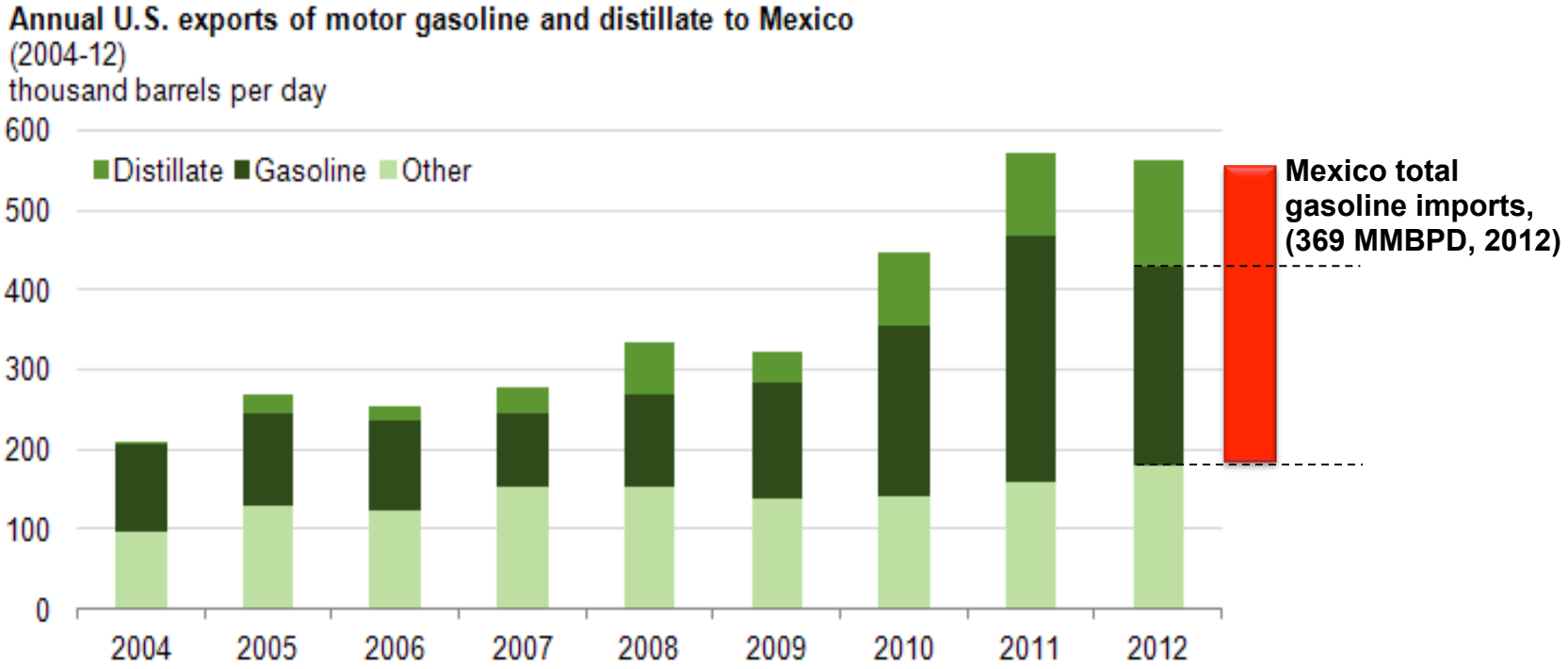
Content

- An Overview of the Refining Market in Mexico
- Bases for Technology Selection Models
- Model Build-up, Applications and Results
- A Long-Term Vision for Sustainability in Industry

Pemex-Refinación has underway major projects for the reconfiguration of its Refining Facilities as to improve distillates yield through Delayed Coking of the residue.

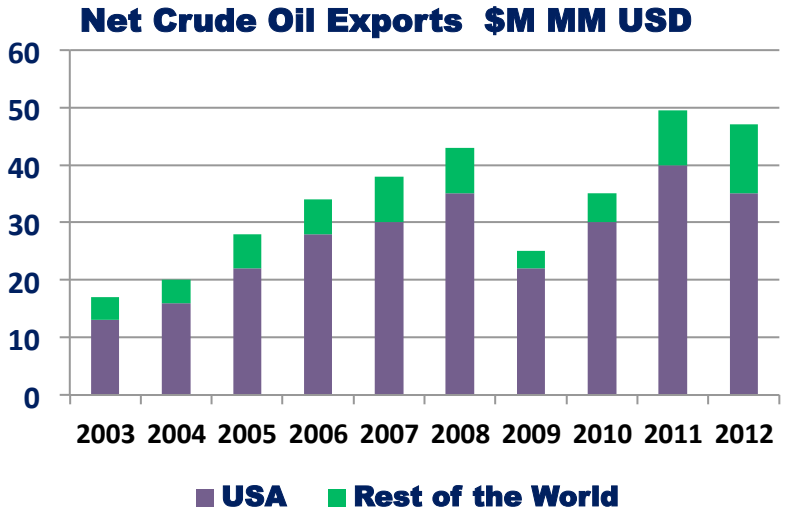
Technology Selection for these projects has been carried out by IMP for the Salamanca, Tula and Salina Cruz Refineries. Sustainability has been introduced as a major selection criteria.

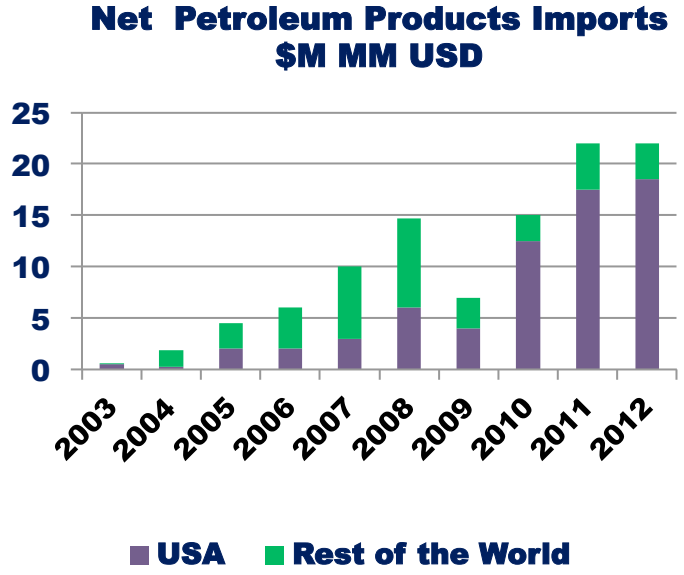
Strong interdependency occurs between USA and Mexico in the Gasoline Market

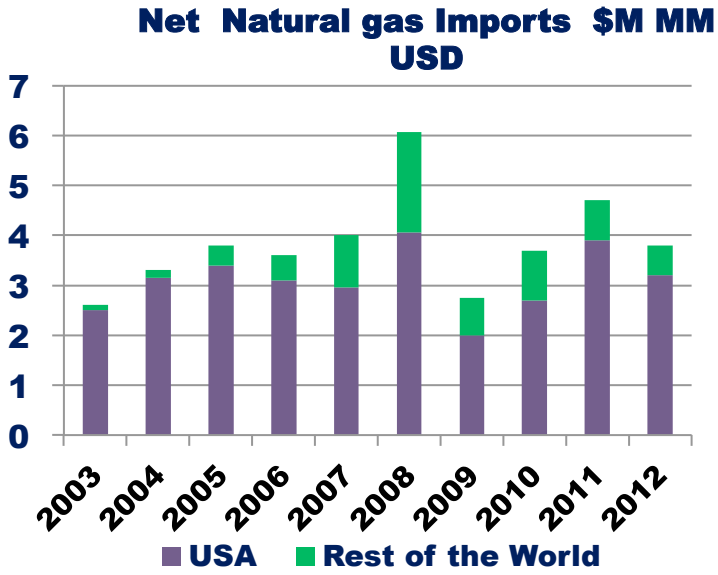


Source: EIA, 2012.

Dollar Value for Mexican Crude Oil Exports and Derivatives and Natural Gas Imports







Source: EIA, May 13, 2013

The Mexico Refining Scenario

1. **Population and GDP growth drive fuels demand growth**
   - Growth at 3% average over the last few years
   - Growth forecasts have historically been underestimated

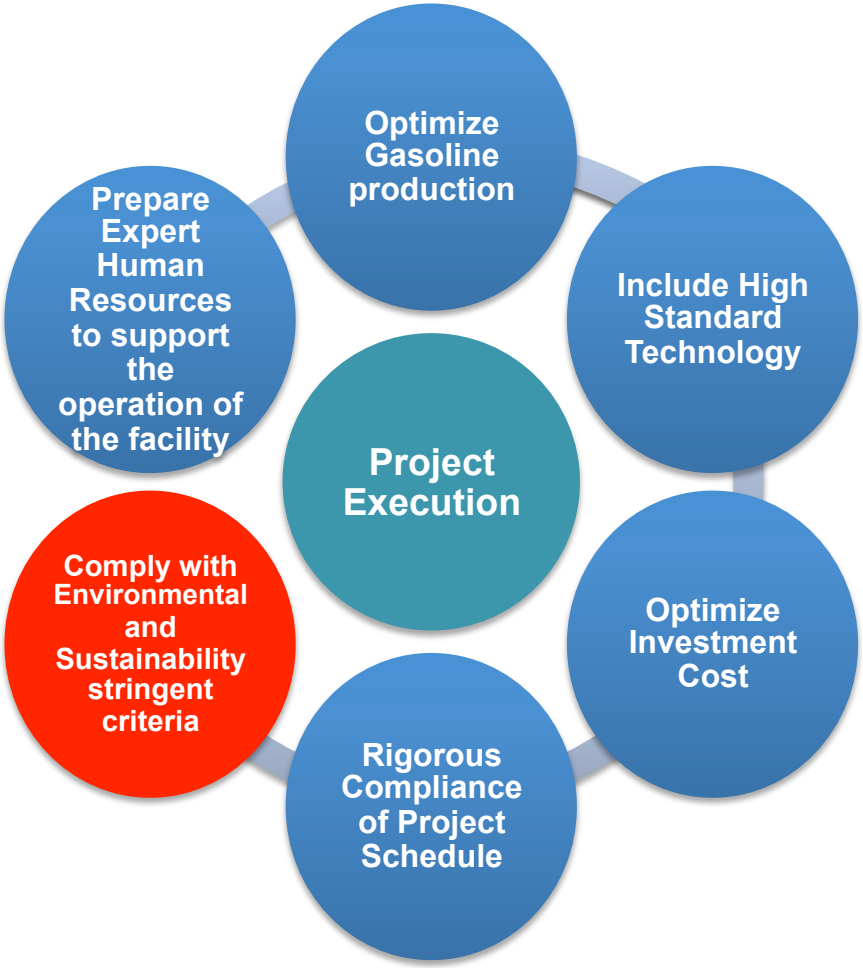
2. **Mexico has become a major derivatives importer**
   (almost 50% of its current gasoline demand)

3. **Major wave of product quality improvement sweeping the country**
   - Low-sulfur transport fuels
   - Other quality improvements (aromatic and benzene reduction, etc.)

4. **Major investments required to meet production and quality goals**
   - Over 1.0 MM BPD of new capacity and expansions over various stages of development

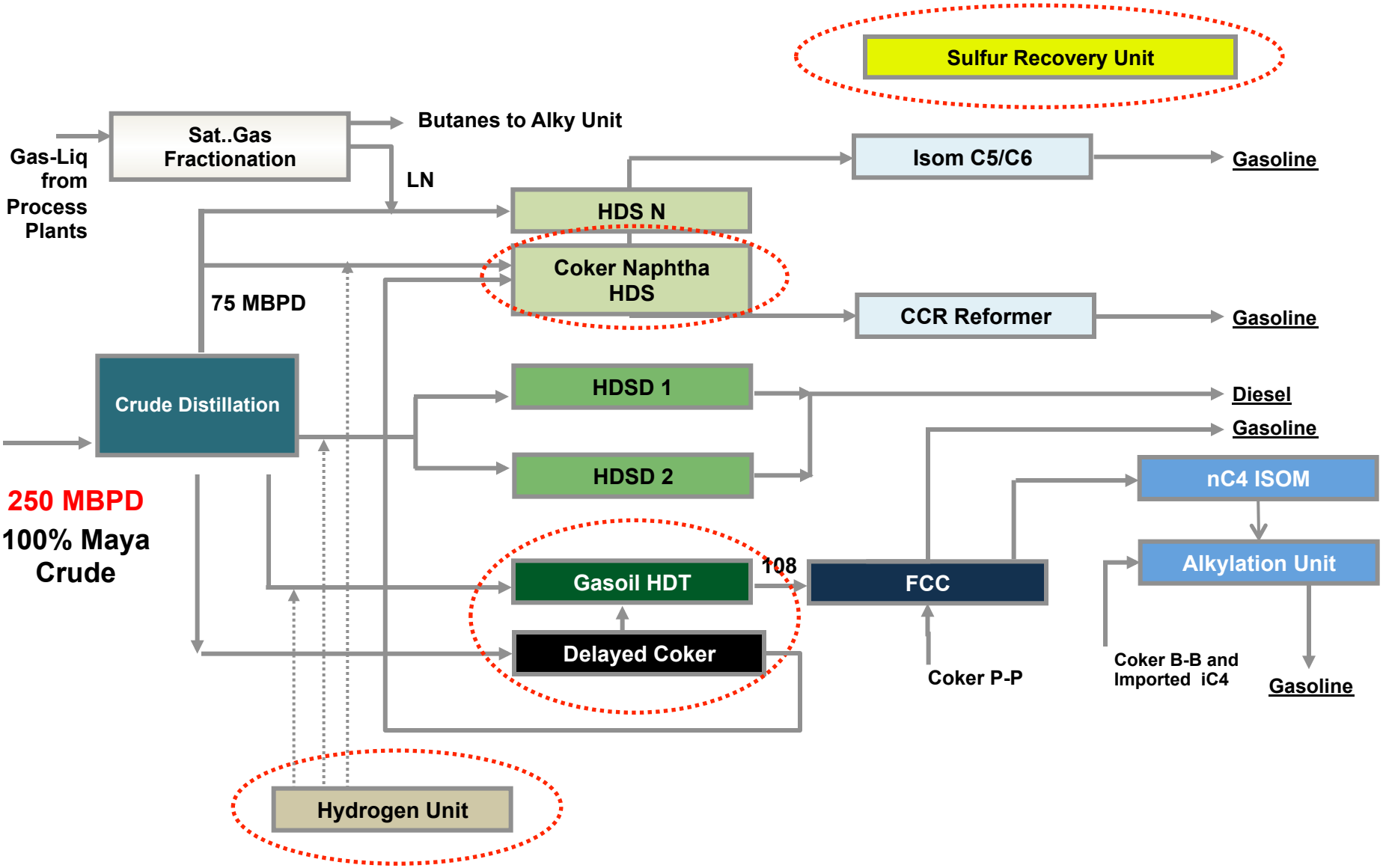
5. **How long will the supply-demand gap last?**

Bases for Downstream Project Execution

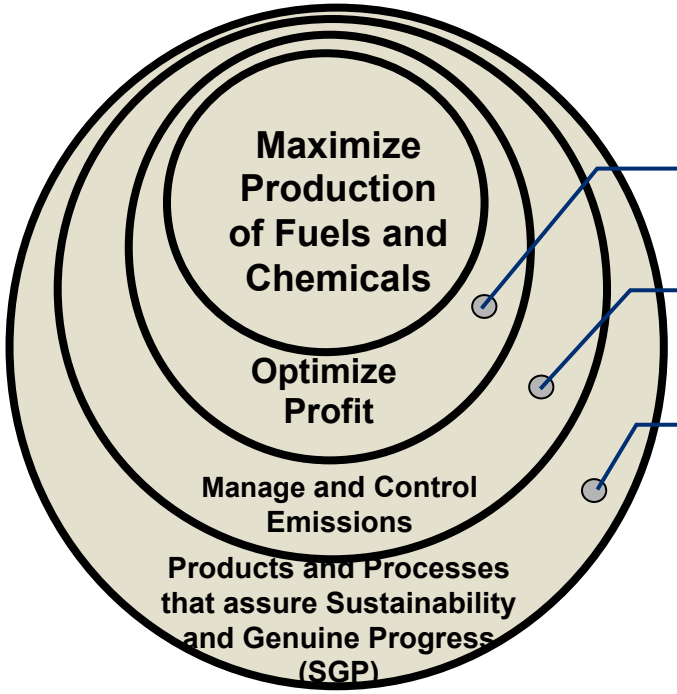


Conceptual Process Scheme for Reconfiguration

Bottom of the Barrel Approach



An Onion Model for the Evolution of Industrial Development

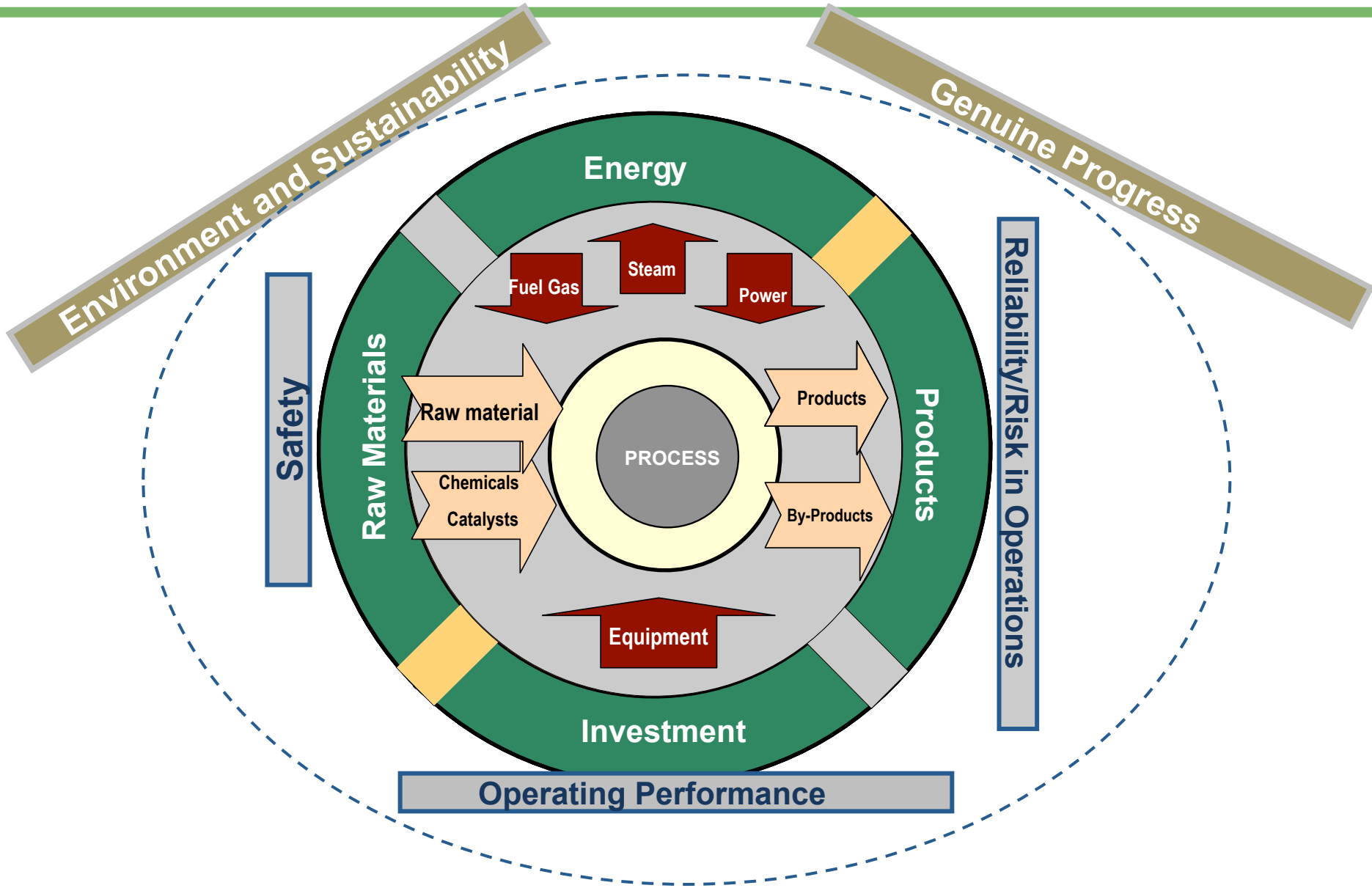


Economical Constrains

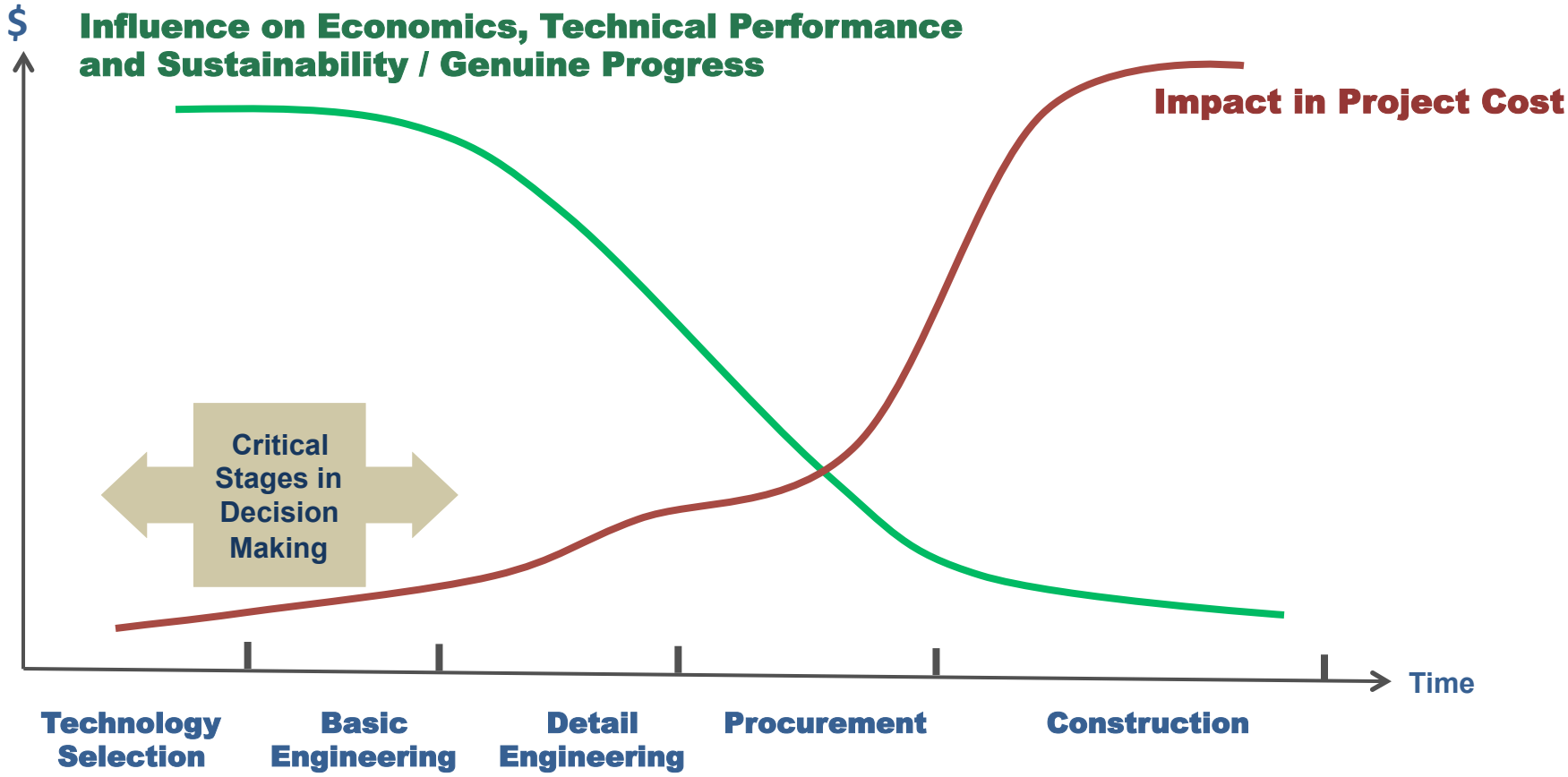
Environmental Constrains

Sustainability and Social Constrains for Genuine Progress

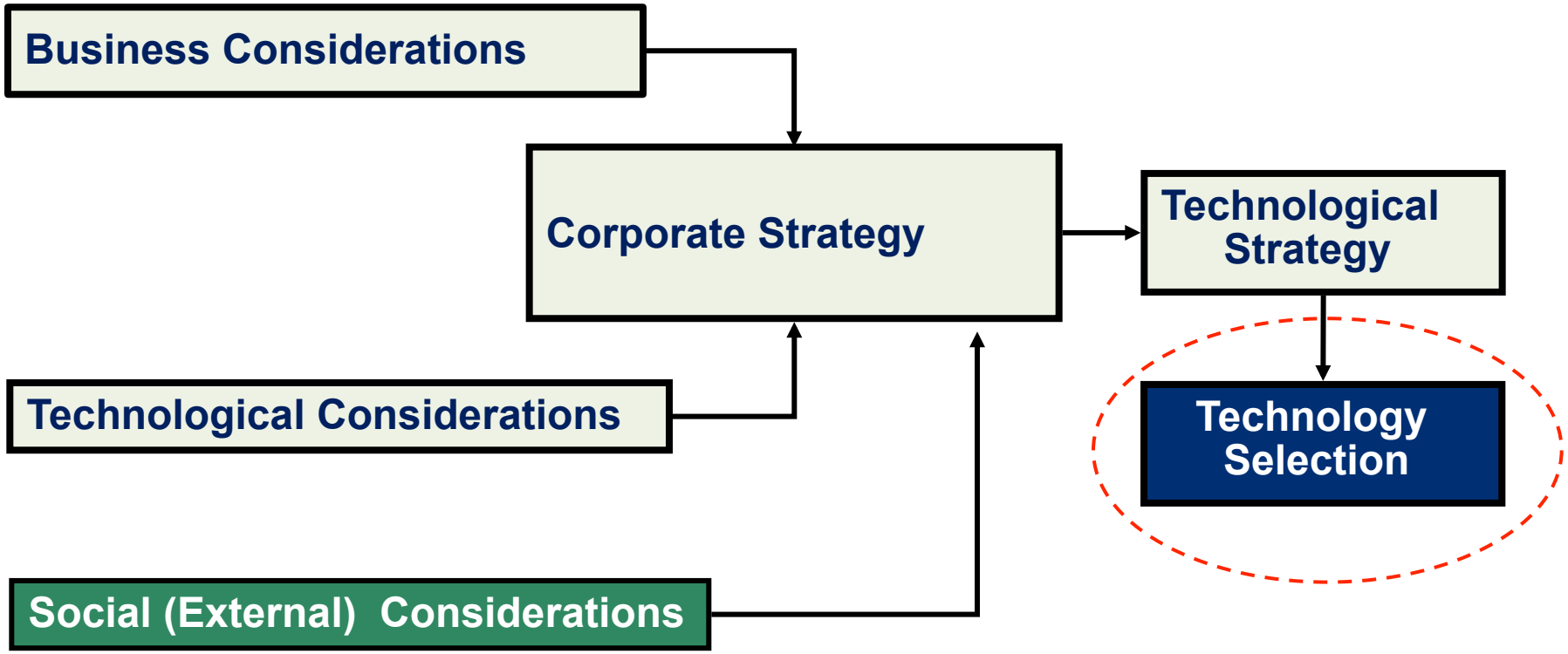
A Refining Unit as an open System- Economical Cell



Impact of decision making during a refinery project execution

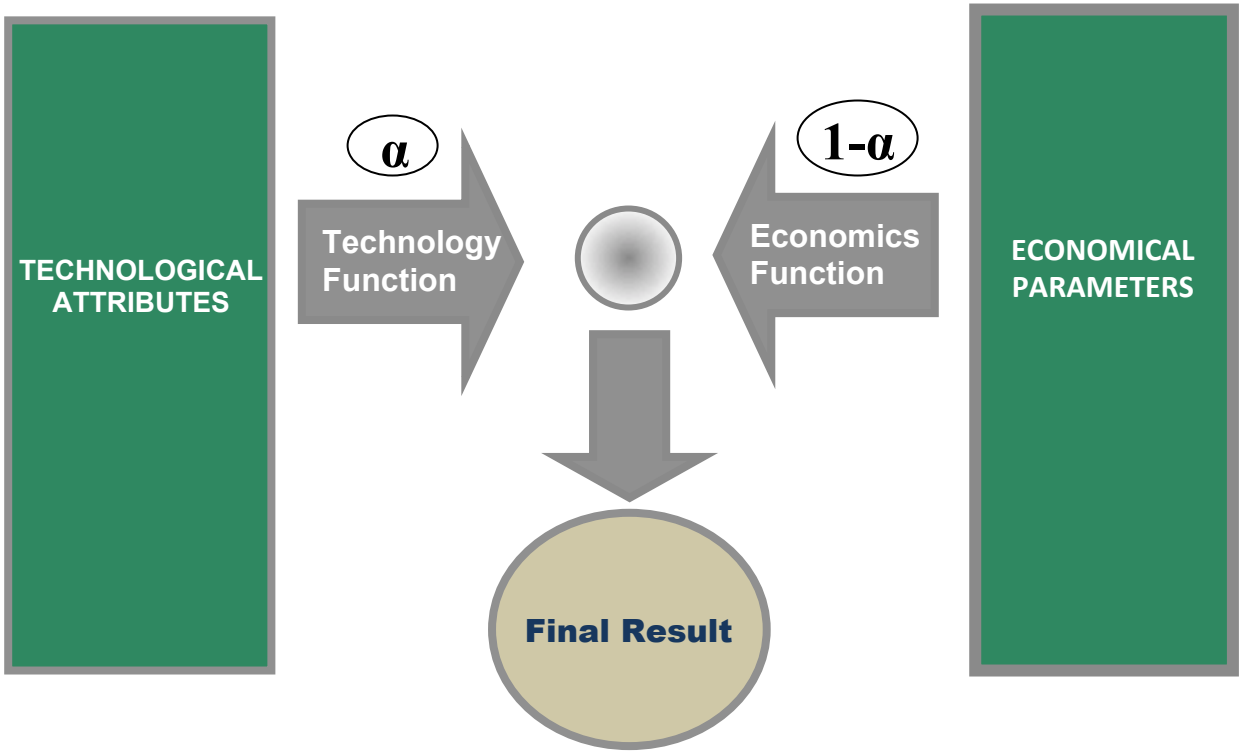


A change in the conception of the Technological Strategy



IMP Technology Selection Model

IMP has developed a semi-quantitaive model for downstream process technology selection



The challenge is how to introduce a quantitative measure of sustainability in this "classical" approach

Where does Metrics Fit In?

- **Translate strategy into goals and targets**
- **Track and evaluate performance**
- **Support decision-making**
- **Communicate results**
- **Reflect organizational capacity for change**
- **Inform strategy**
- **Produce insights - task group learning**

… so Technology Selection requires Metrics

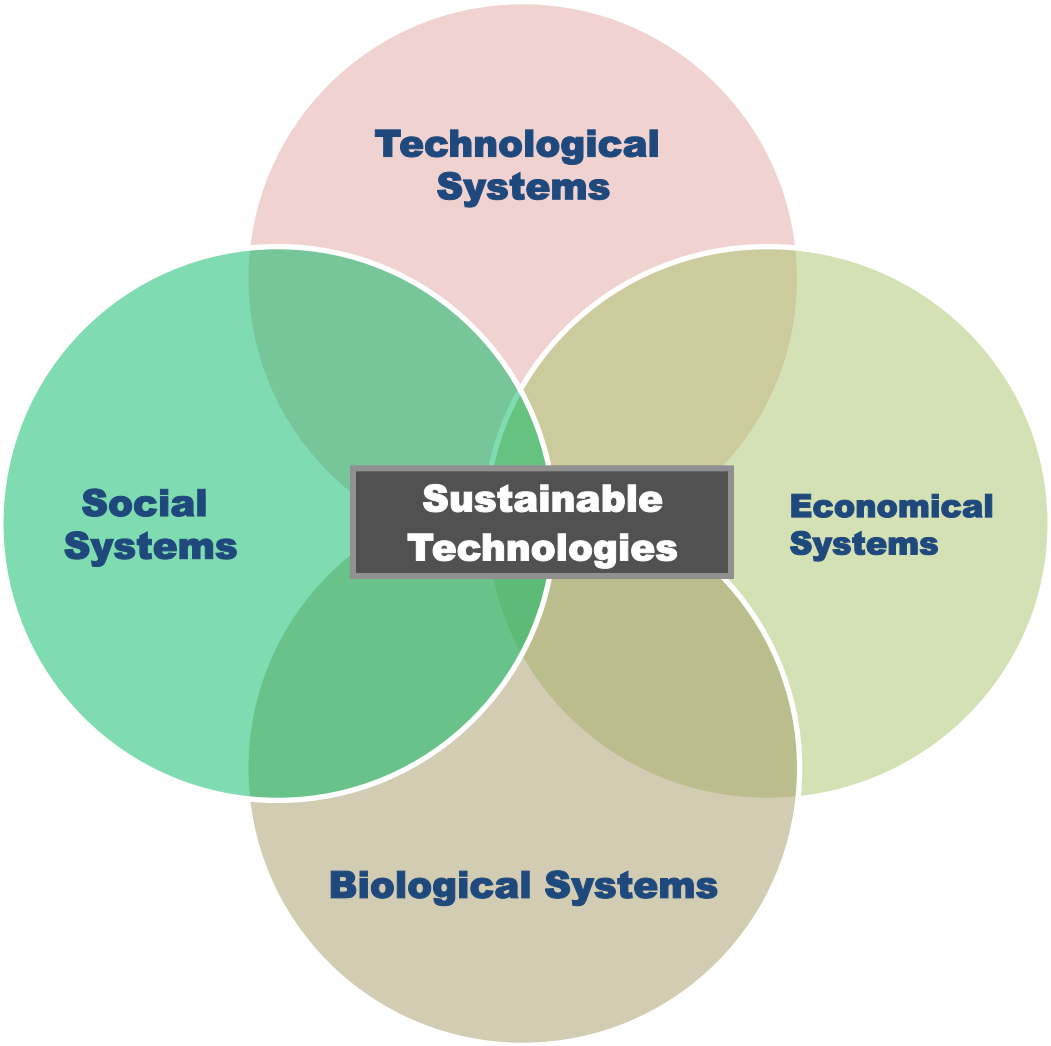
Questions for the inclusion of a new technology

1. What is the benefit (cost-effectiveness) for our system?
2. How long will the benefit last?
3. What is the impact on our system (short and long term)?

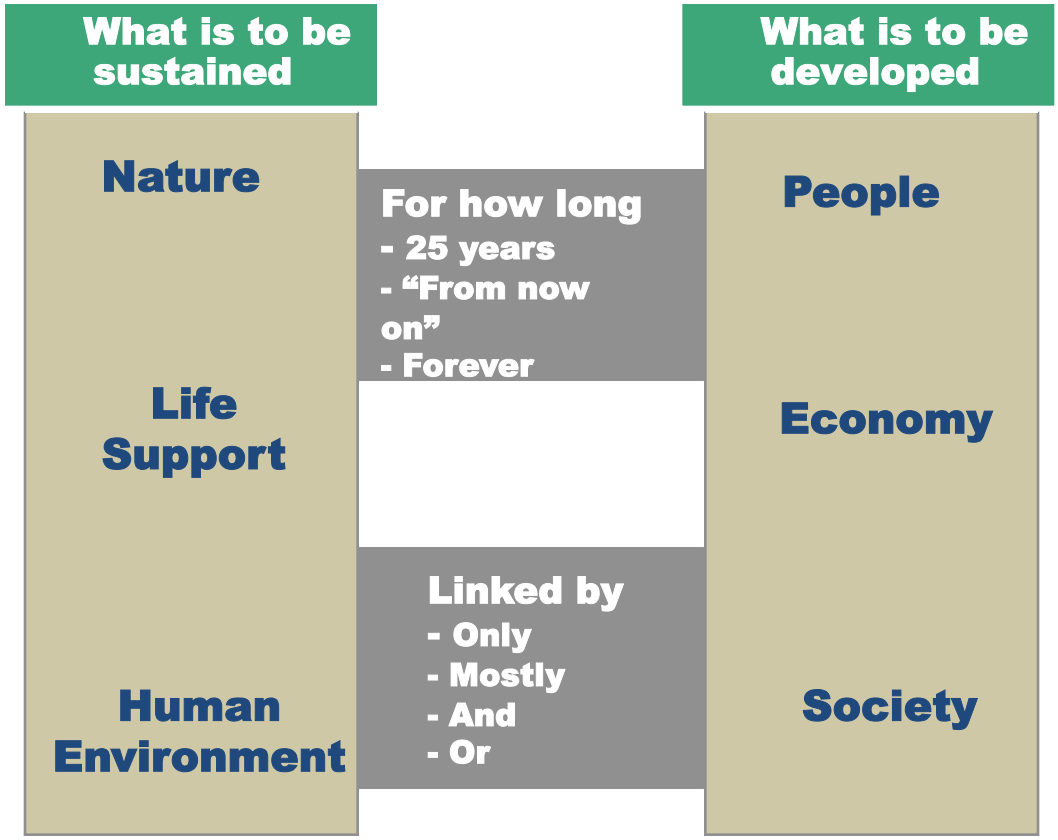
4. What is the cost to the “outside” (externalities)?
5. Is the benefit to society a real move to progress?

6. What is the metrics to answer all the above questions?

The Global Approach for Sustainable Technologies

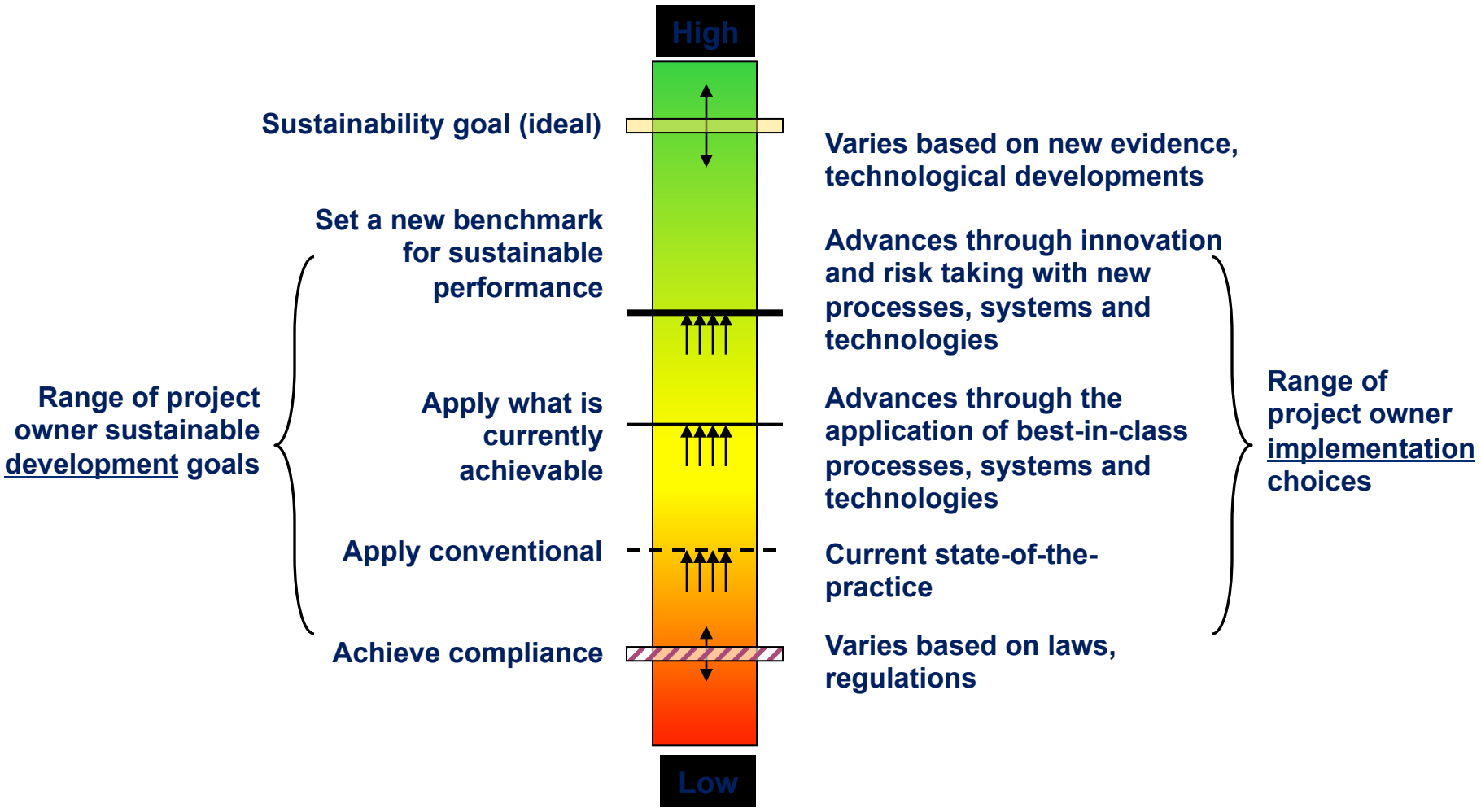


Common Concerns[1]

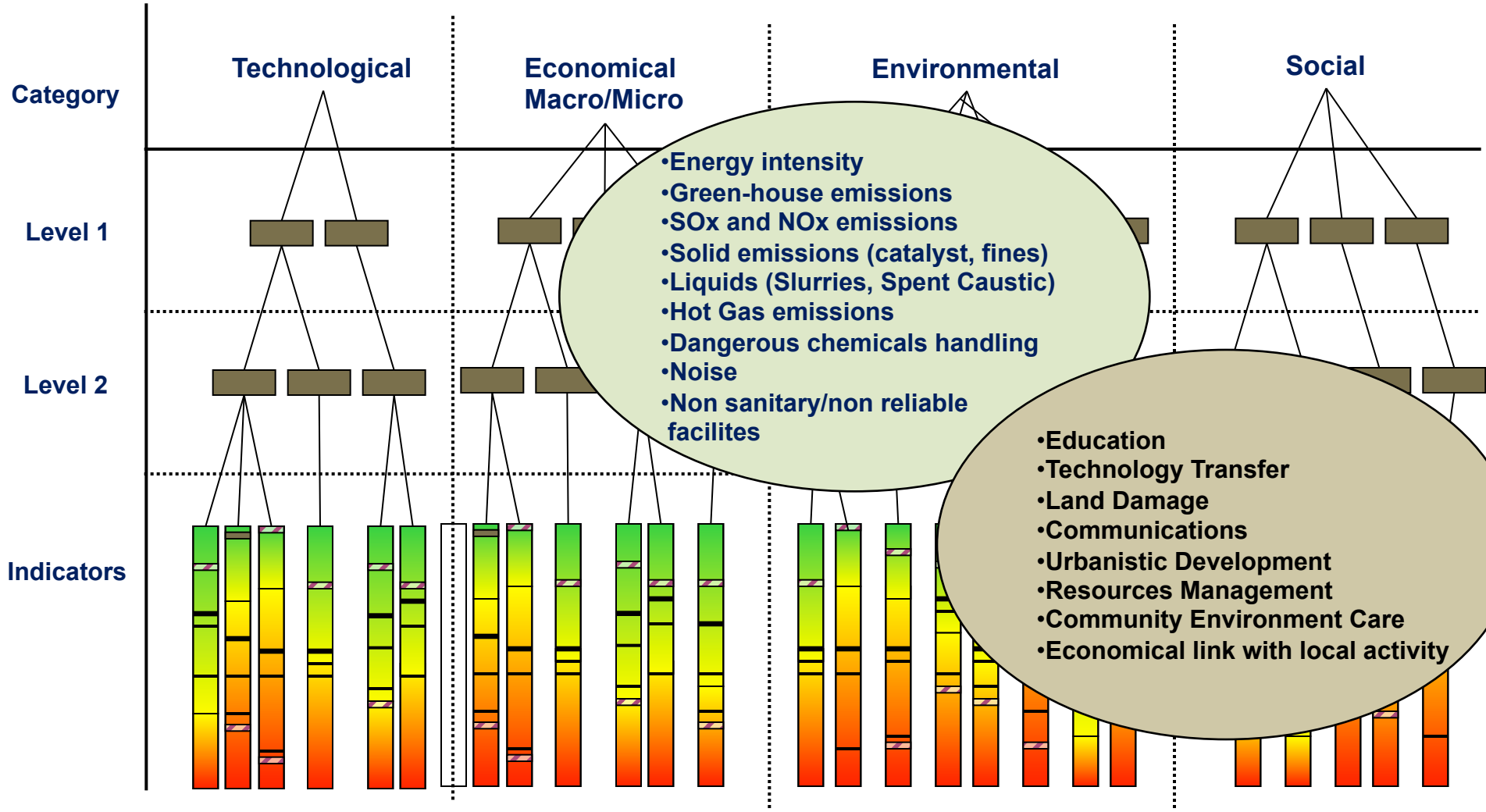


(1) Our Common Journey. A Transition towards Sustainability. National Academy of Science, USA, 2006

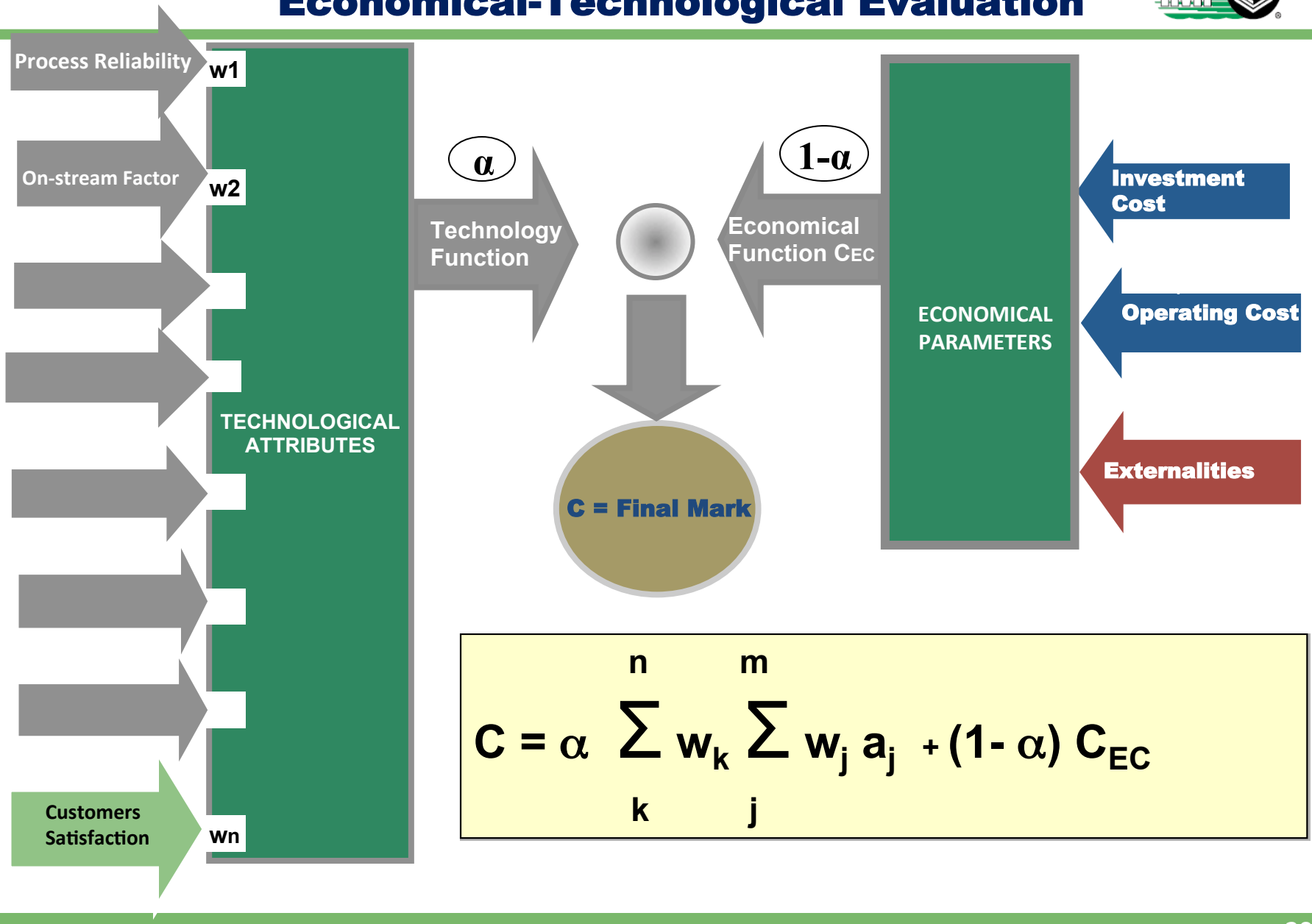
Sustainable Project Goals and Indicators



Sustainable Goals and Indicators: Conceptual Model

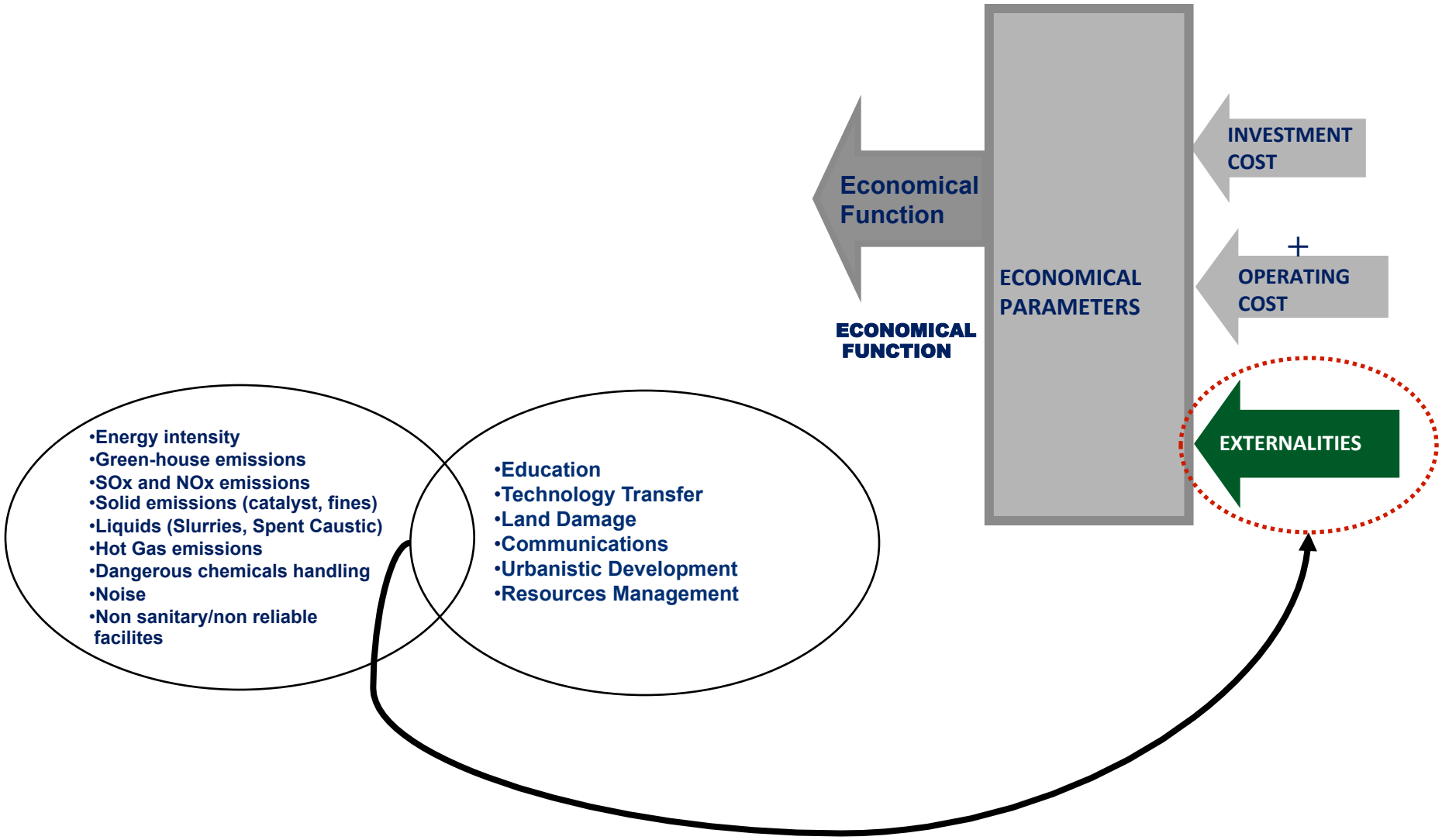


IMP Model
Economical-Technological Evaluation



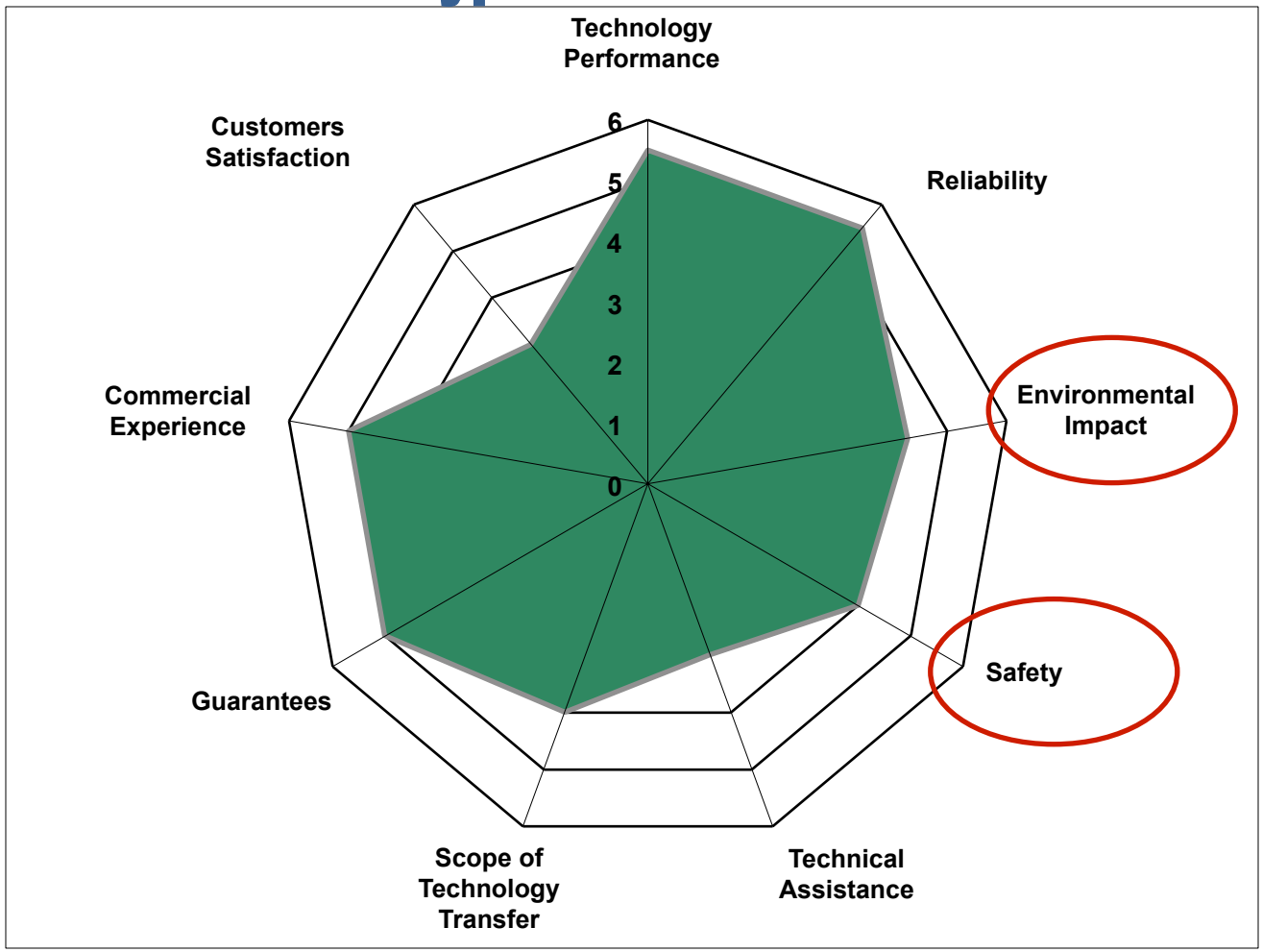
$$C = \alpha \sum_{k}^{n} w_k \sum_{j}^{m} w_j a_j + (1-\alpha) C_{EC}$$

The Impact of SGP Criteria on Metrics



DCU Technology Evaluation
Technical attributes

Typical Results



Results

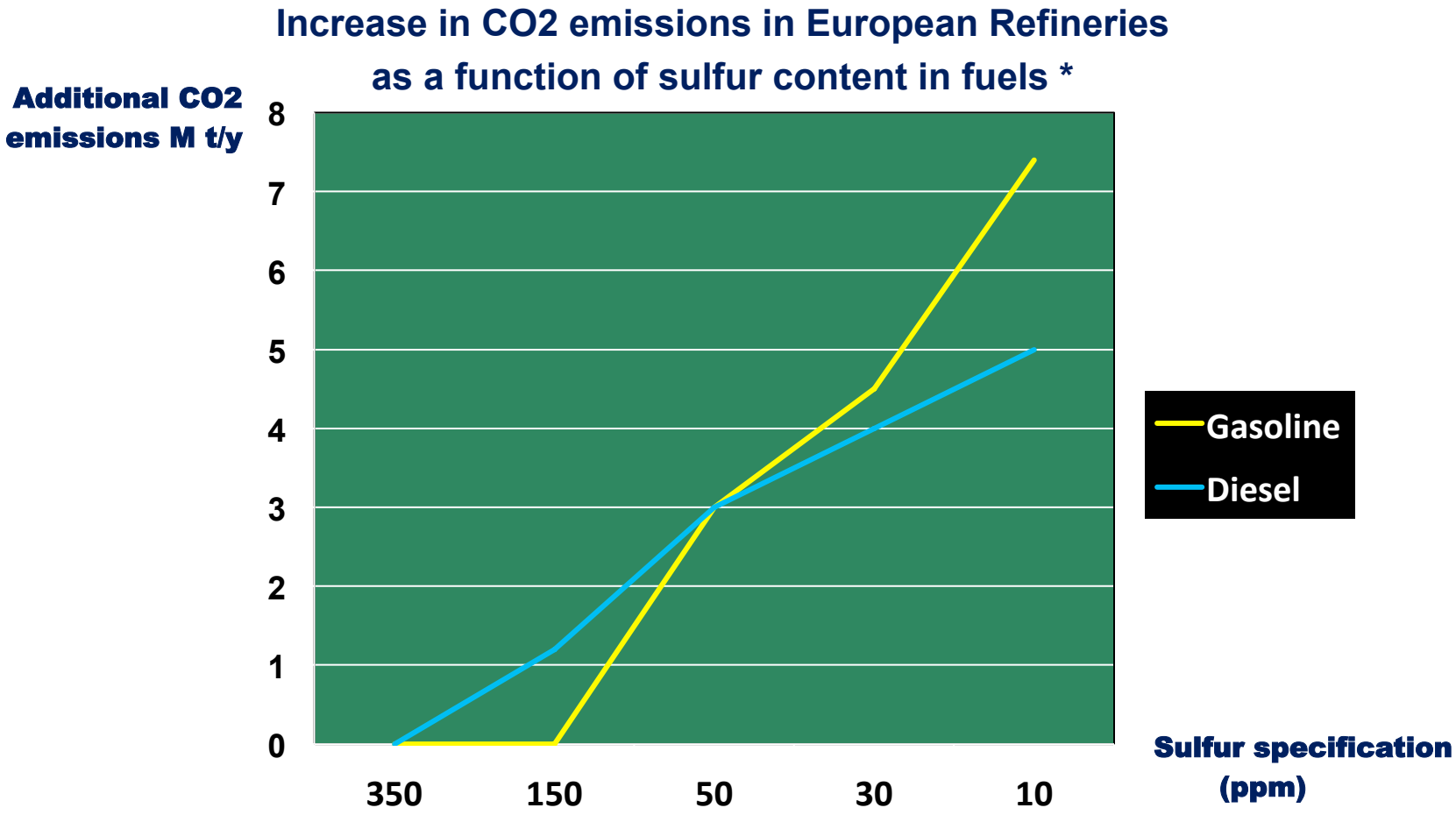
- **Technology Selection for brand-new units at Pemex-Refining has been carried out under low environmental impact and partially under sustainabilty criteria**

- **In different cases environmental and sustainability indicators were critical for technology selection, mainly in high environmental impact facilities**

- **The sustainability culture will remain and increase for future projects**

- **In the future we must go beyond sustainability up to the application of the Genuine Progress Concept**

The Sulfur / Carbon Dioxide emissions



* Marcilly,C., J. of Catalysis, 216, 2003, p. 48

Evolution of the Challenges in Refining Scheme Configurations and Technologies

Challenges

- Cost-Effectiveness
- Environmental Issues
- Heavy Crudes

Revamp Units to maximum capacity

High Severity Hydrotreating

Reformulated gasoline

Bottom of the Barrel processing

Heavy Crudes Processing

Optimal Energy Use

Current Scenario

Heavy Crude Slate Processing

High Gasoline/ diesel demand

Low Residuals demand

Reformulated Environmental Fuels

Operations Profitability

Challenges

- Sustainability
- Genuine Progress

Heavy Crudes Processing

Gas to Liquids

High Efficiency Hydroteating

Bottom of the Barrel Units and Cogeneration

Waste Treatment Units

More olefins and synthetic gasoline

Hydrogen and biofuels production

Future Scenario

Process different crude slate

Crude reserves declination and higher gas availability

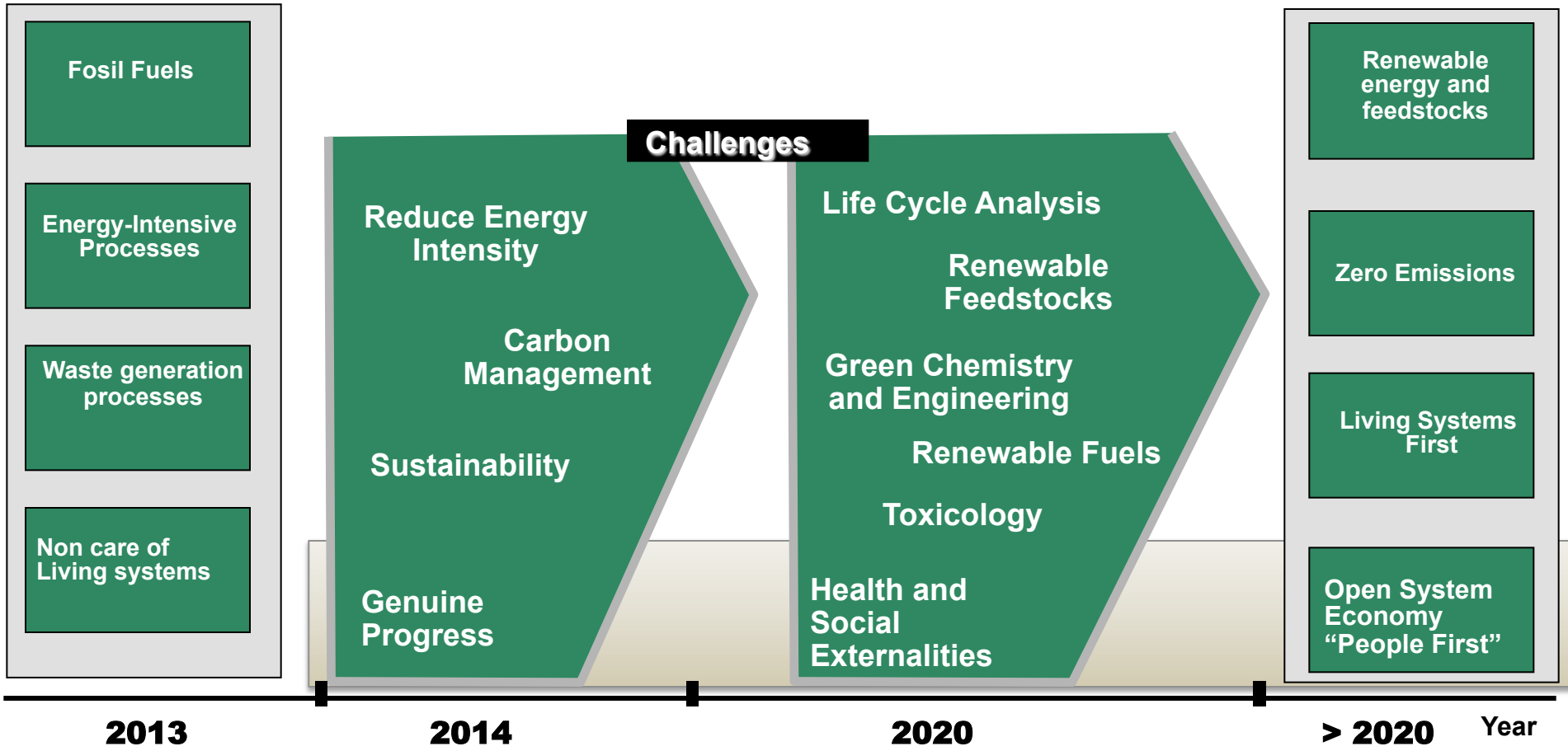
Ultraclean Fuels production (zero emissions)

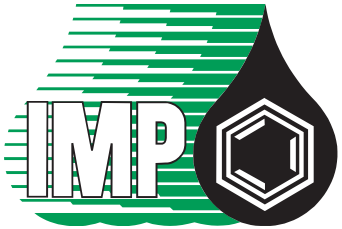
Health and Safety

Externalities included in the economical equation

A Long-Term Vision for Sustainability in Industry

Fosil Fuels + Profit Dominance → **Fosil Fuels Decline + Social Capital Dominance**




IMP

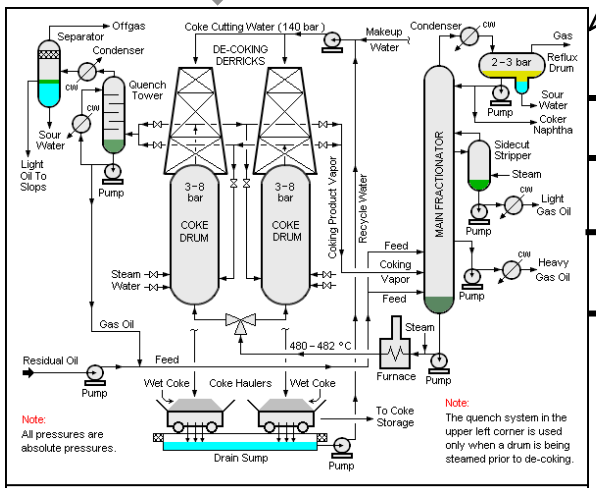
Supporting slides (if required only)

Characteristics of good indicators

- Simplicity
- Relevance
- Validity
- Sensitivity
- Reliability/repeatability
- Aggregation
- Orthogonality

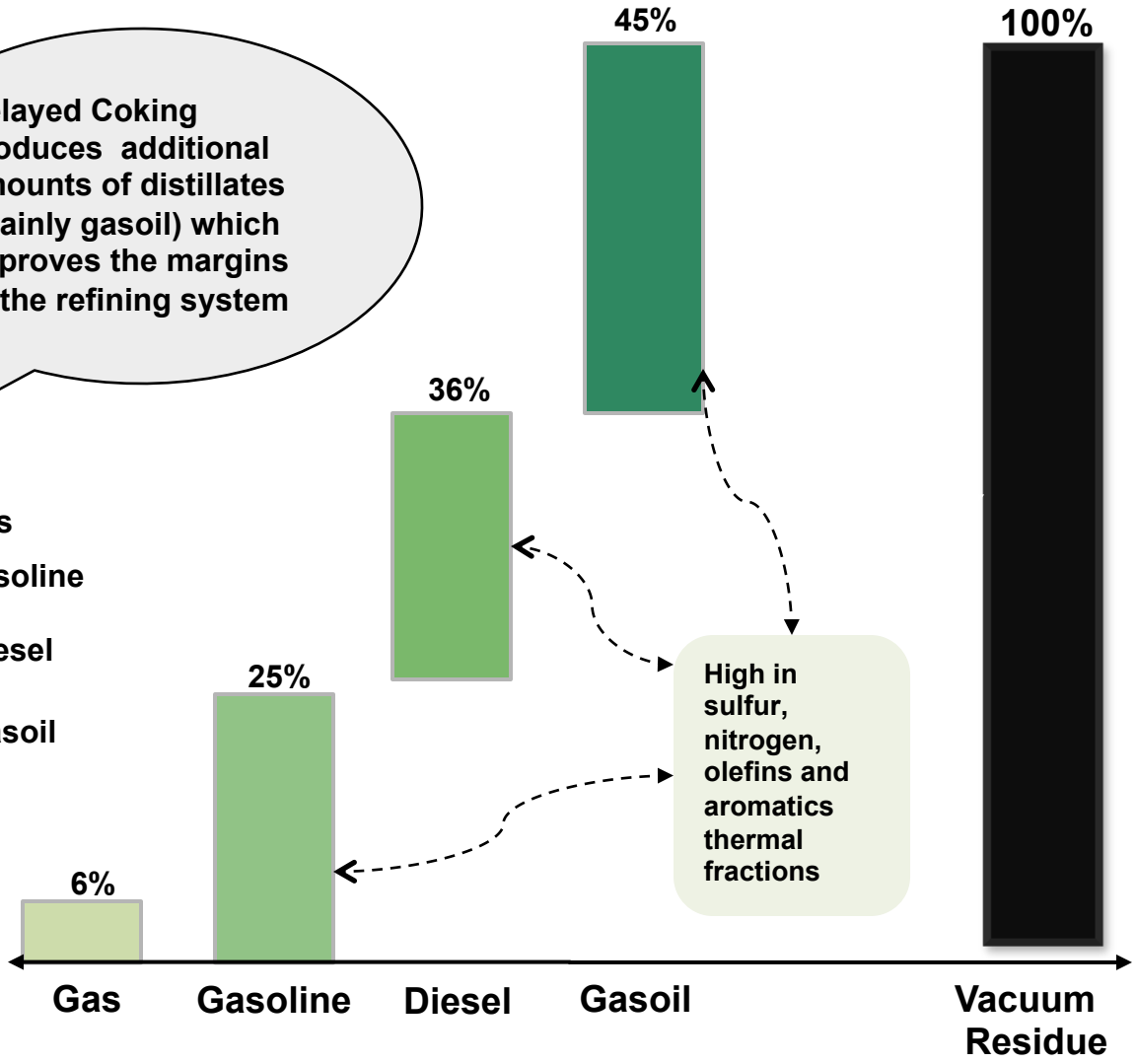
Delayed Coking Unit (DCU)

Vacuum Residue
28% of Crude Oil



Delayed Coking produces additional amounts of distillates (mainly gasoil) which improves the margins of the refining system

- **Gas**
- **Gasoline**
- **Diesel**
- **Gasoil**



Critical Technological Features

1. The Design of the Coker Drums
2. Hardware and Control System for Decoking
3. Automation of the Unit and Reliability of the Systems for the Swing on Coker Drums
4. Thermal and Hydraulic Design of the Fractionation Column
5. Product Yield (HCGO)
6. Coke Handling – Environmental Impact and Safety

Maximize Value (NPV)

The Role of Catalysts in Sustainable Refinery Processing

ENVIRONMENTAL CATALYSTS OUTLOOK

Promote Sustainable Processes and Products

- Conversion or Reuse of Waste Water
- Gas and Liquid Emissions Clean up
- Enviromental-friendly Catalytic Processes

Promote a better use of Resources

- Use of renewable energy
- Reduction of emissions in transport
- Increase efficiency in Resources and Energy use
- Upgrading of Natural Resources

Promote Quality of Life

- Air Quality Improvement
- Soil and Water Remediation
- Reduction of Greenhouse Gases