McKinsey&Company

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Integrated Planning of Petrochemical Networks

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McKinsey's Supply Chain Management Practice is active in a wide range of sectors

Today's topic

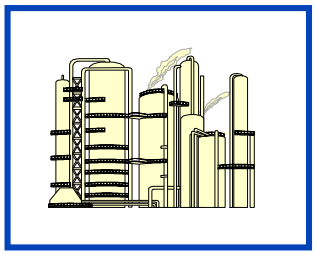
Consumer	 Packaged goods	 Fashion	 Retail
High Tech	 Computer and telecom	 Consumer electronics	 Aerospace and defense
Automotive & Assembly	 OEMs	 Auto-motive suppliers	 White goods
Pharma & Health	 Pharma	 Medical devices	 Hospitals
Process	 Metals	 Paper	 Petroleum and chemicals

Focus on top management-relevant supply chain management issues

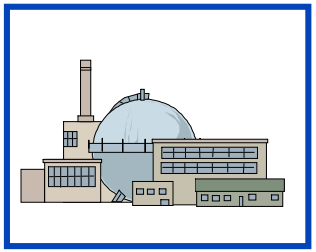
Source: McKinsey

The petroleum value chain

Production

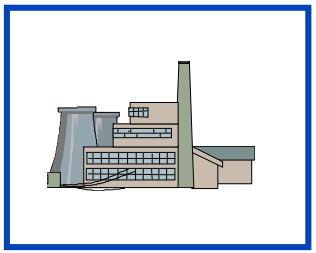


Refining



Petrochemistry

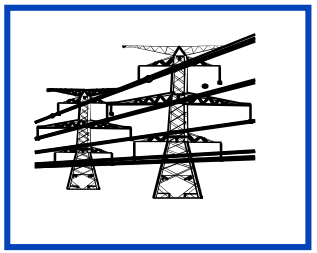
Primary distribution



Power generation

Petrochemical distribution

Fuel distribution



Power distribution

Petro-chemical products

Fuels

Electricity

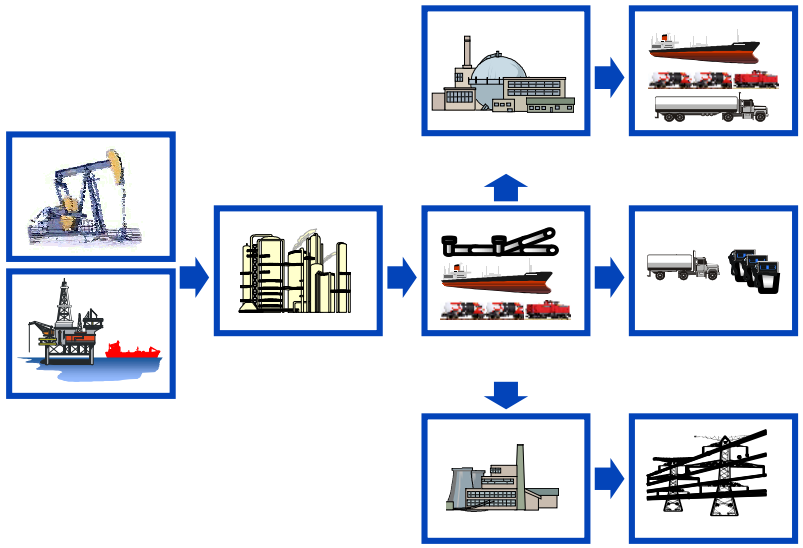
Source: McKinsey

The petroleum value chain is a rewarding area for supply chain optimization

Sources of value

- Facilities costing up to USD 2.5 billion to be optimally utilized
- Variability of feedstock grades, availability and prices
- Variability of product demand and prices
- Logistics may account for up to 50% of product cost

Petroleum value chain



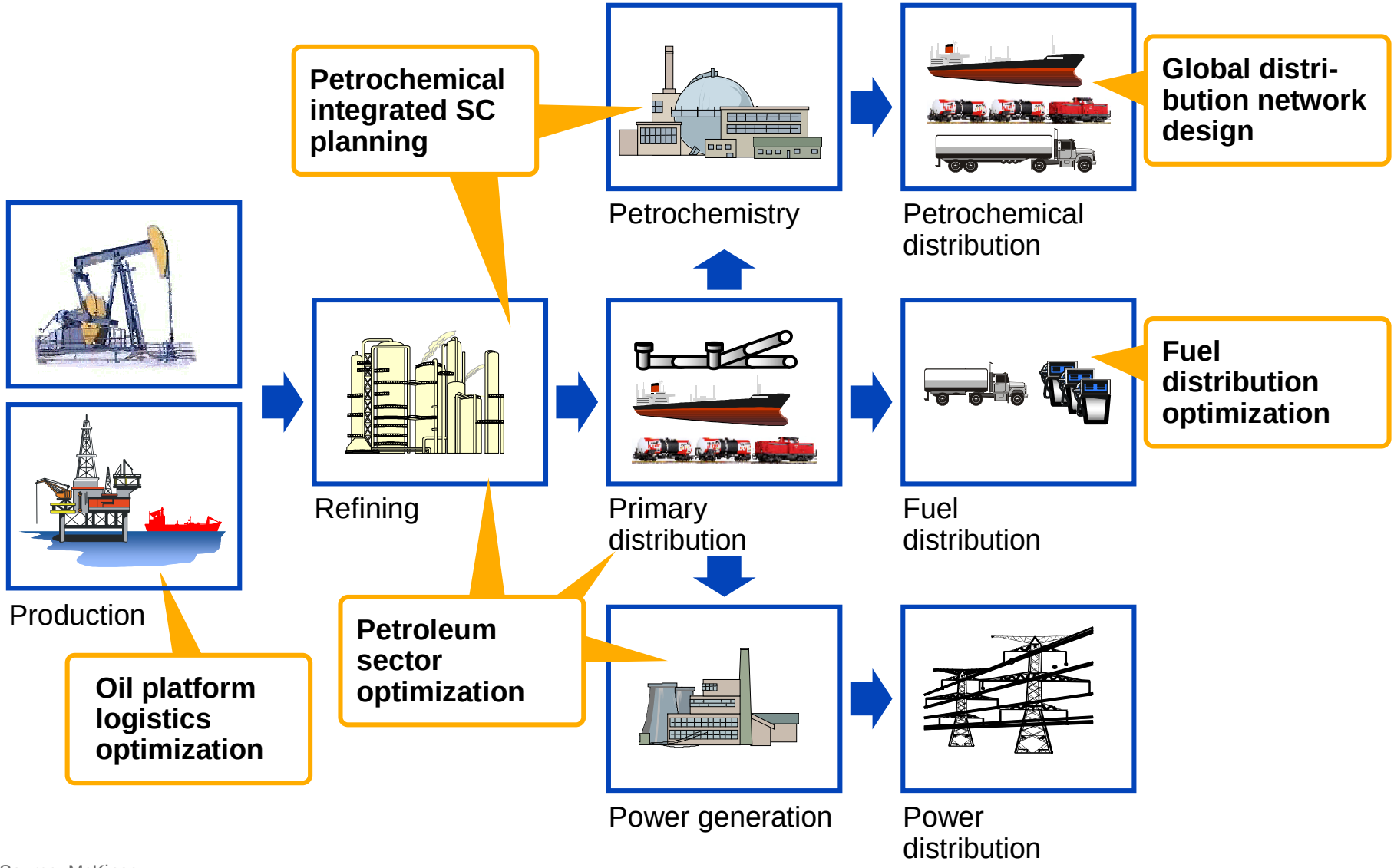
Organizational potentials

Huge complexity historically led to fragmented organization and optimization

Integrated optimization is a major value lever for petroleum supply chains

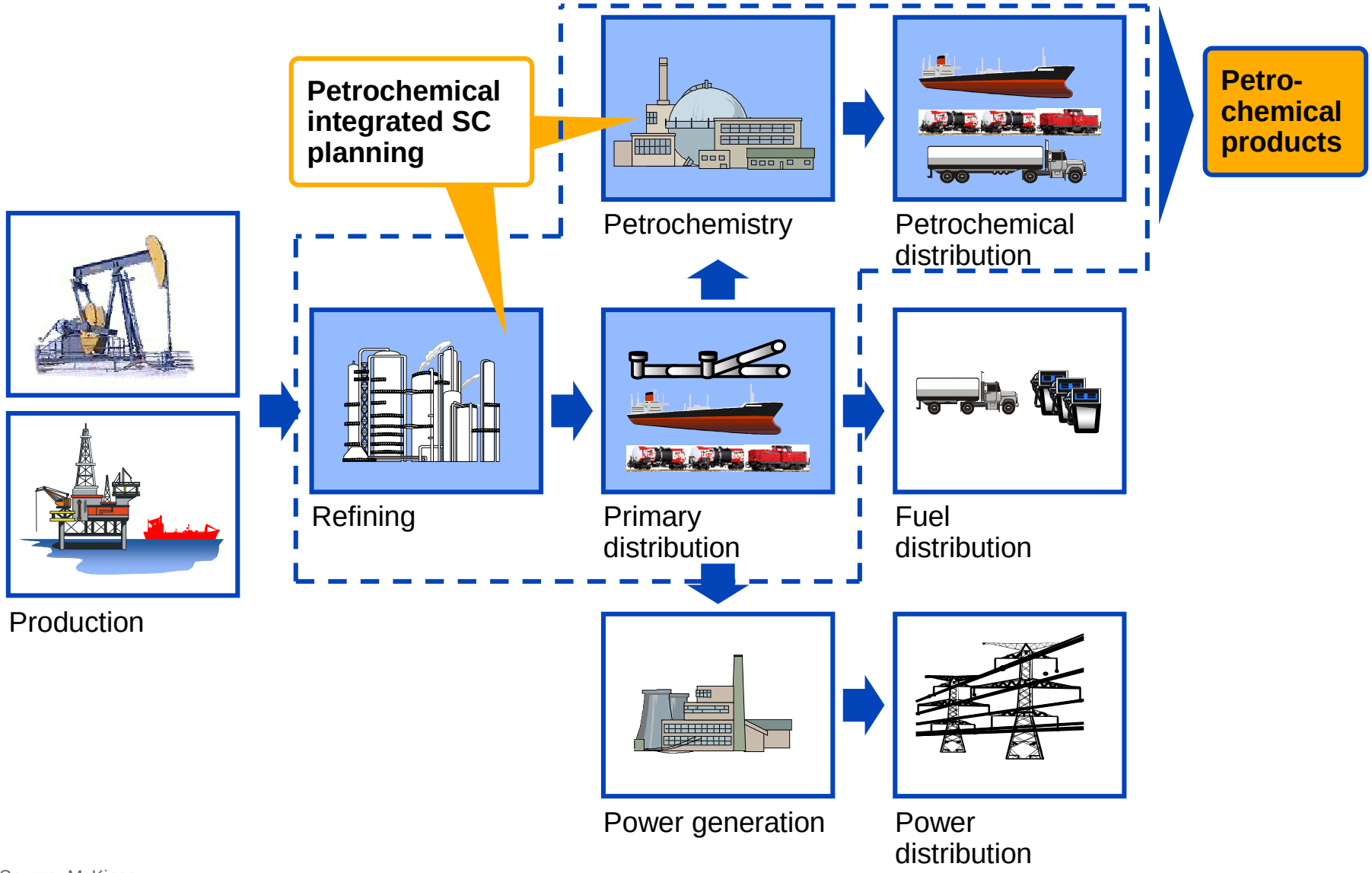
Source: McKinsey

McKinsey optimization applications in the petroleum value chain



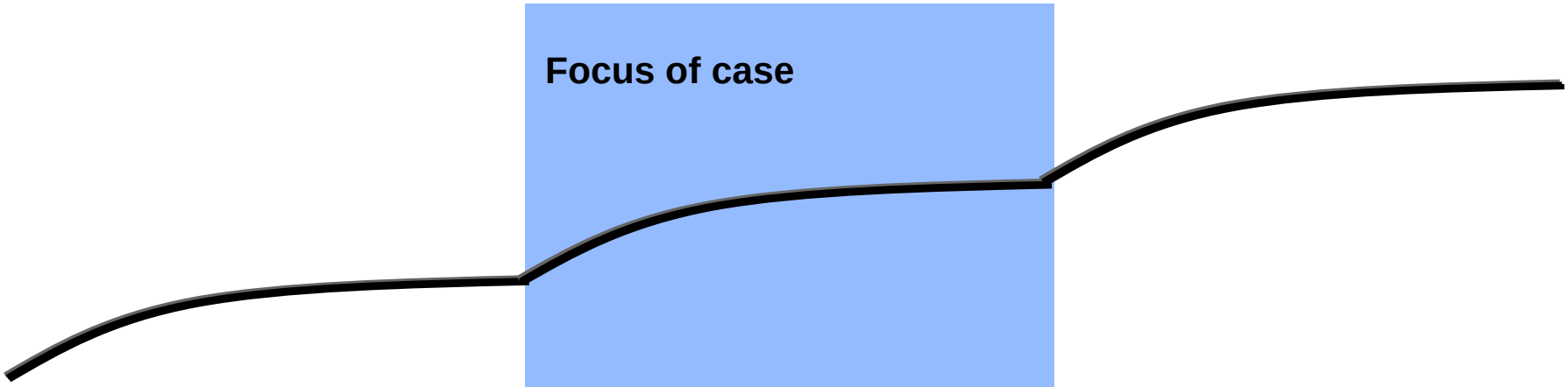
Source: McKinsey

Example 1 – integrated petrochemical supply chain optimization



Source: McKinsey

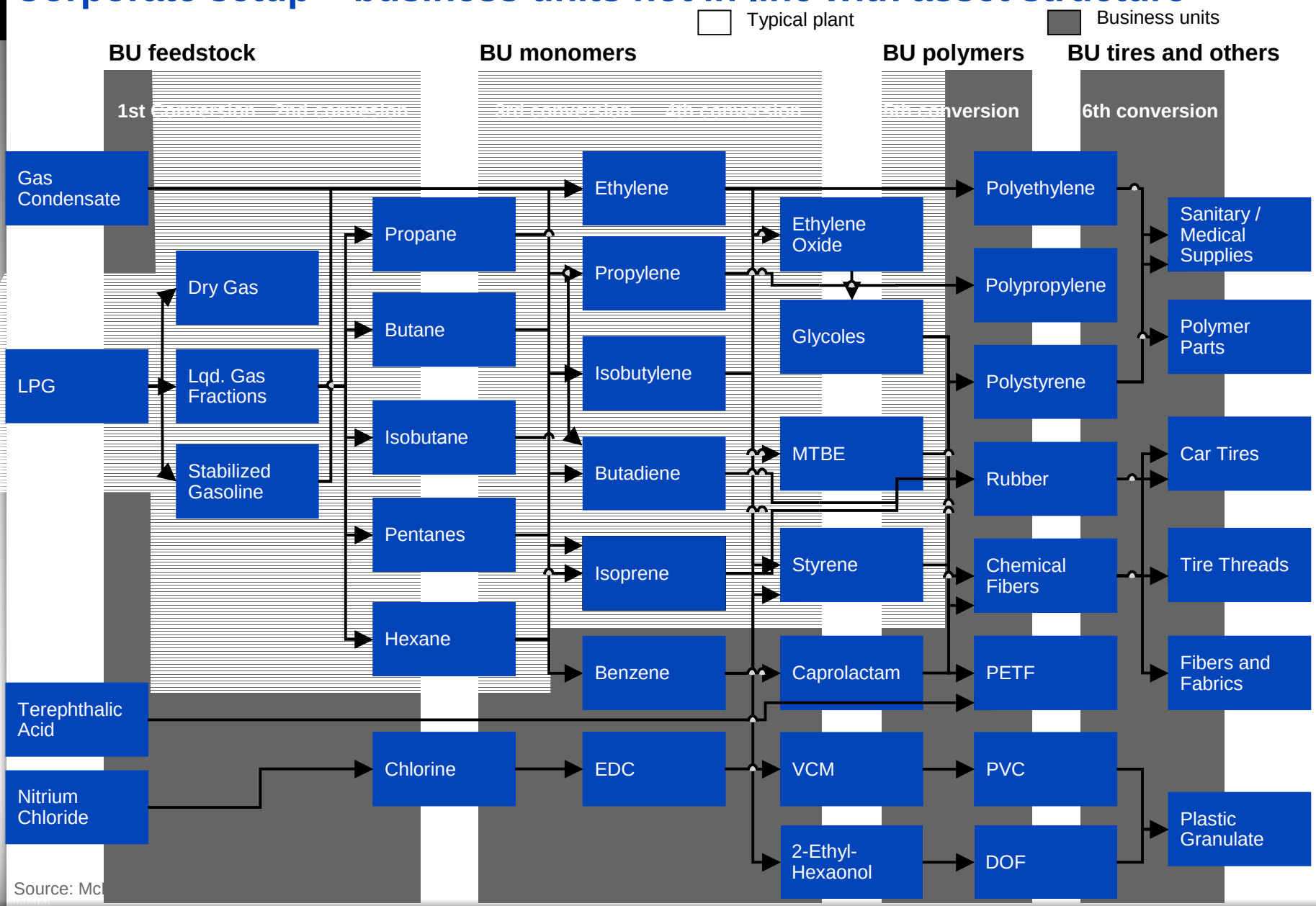
Scope of integrated supply chain planning case



Optimize footprint	Optimize flows	Optimize processes
• Make-or-buy decisions (what to build) • Major investment decisions (e.g., where to build)	• Decisions on production alternatives (what to produce, which unit or process to use) • Market decisions (sell or convert, to whom to sell, from whom to buy)	• Process fine-tuning (e.g., optimize electricity and catalyst use) • Minor investments (e.g., install new compressor)

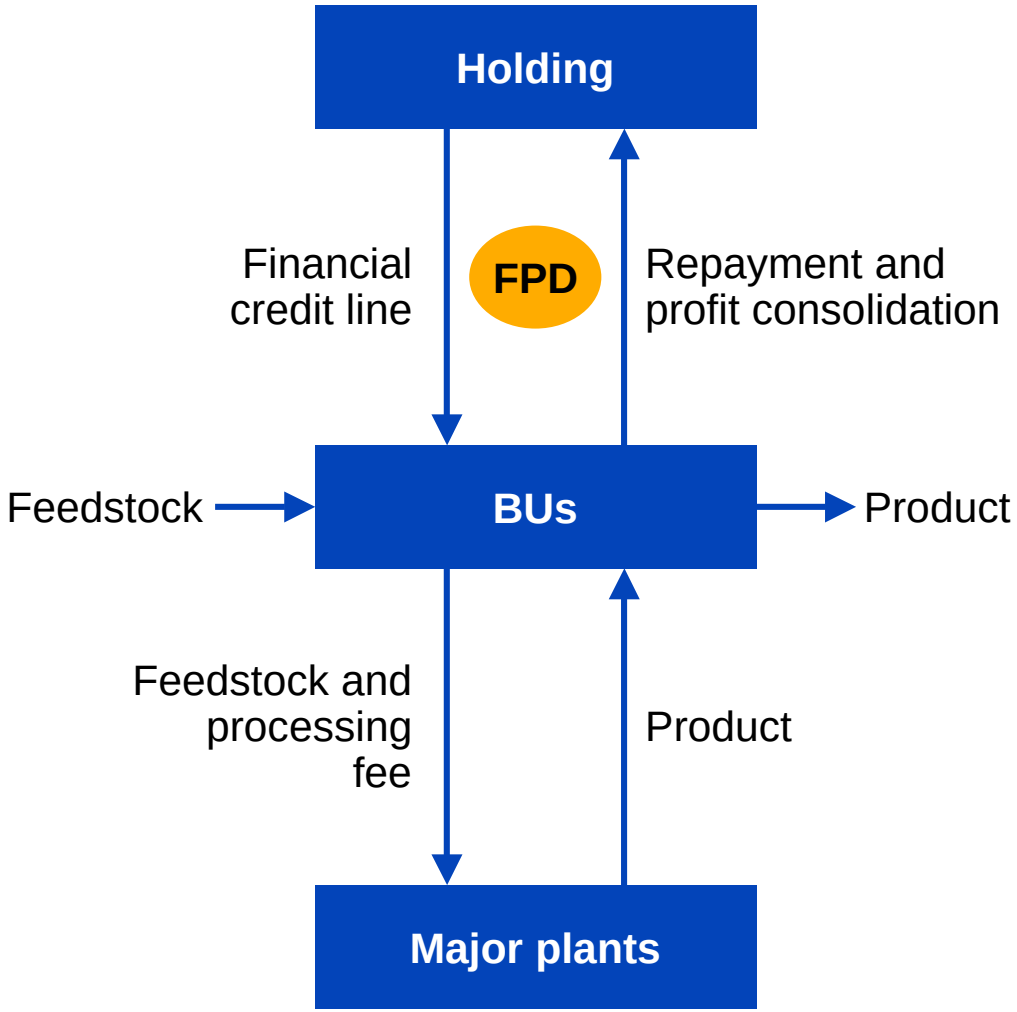
Source: McKinsey

Corporate setup – business units not in line with asset structure



Source: Mc

The Financial Planning Department (FDP) acted as arbiter between BUs



Planning process

1. **BUs** make a very detailed plan of what to buy, produce, and sell. These plans are optimized manually according to current transfer prices and processing fees
2. **FPD** sets transfer prices and processing fees once a year
3. **FPD** puts together unified production and sales plan by ironing out conflicts between business units (according to "self-cost list")
4. **BUs** execute unified feedstock, production and sales plans

Source: McKinsey

Integrated planning vs. reorganization into profit centers

Situation

- Monopolist position in many products and intermediates
- Lack of a real liquid market for many intermediates

Complication

- BU profit centers cut along large blocks of the value chain not effective, since transfer prices are unrealistic in the absence of usable market prices

Solution 1: Integrated planning

- \+ "Real" optimum obtainable
- − Bureaucratic complexity

Solution 2: Decentralization

- − Insufficient transparency and rule of law
- \+ Self-organizing market model

Source: McKinsey

Decision – integrated planning for all product flows

Scope of product flows to optimize

Purchasing

Transport – raw materials

Production

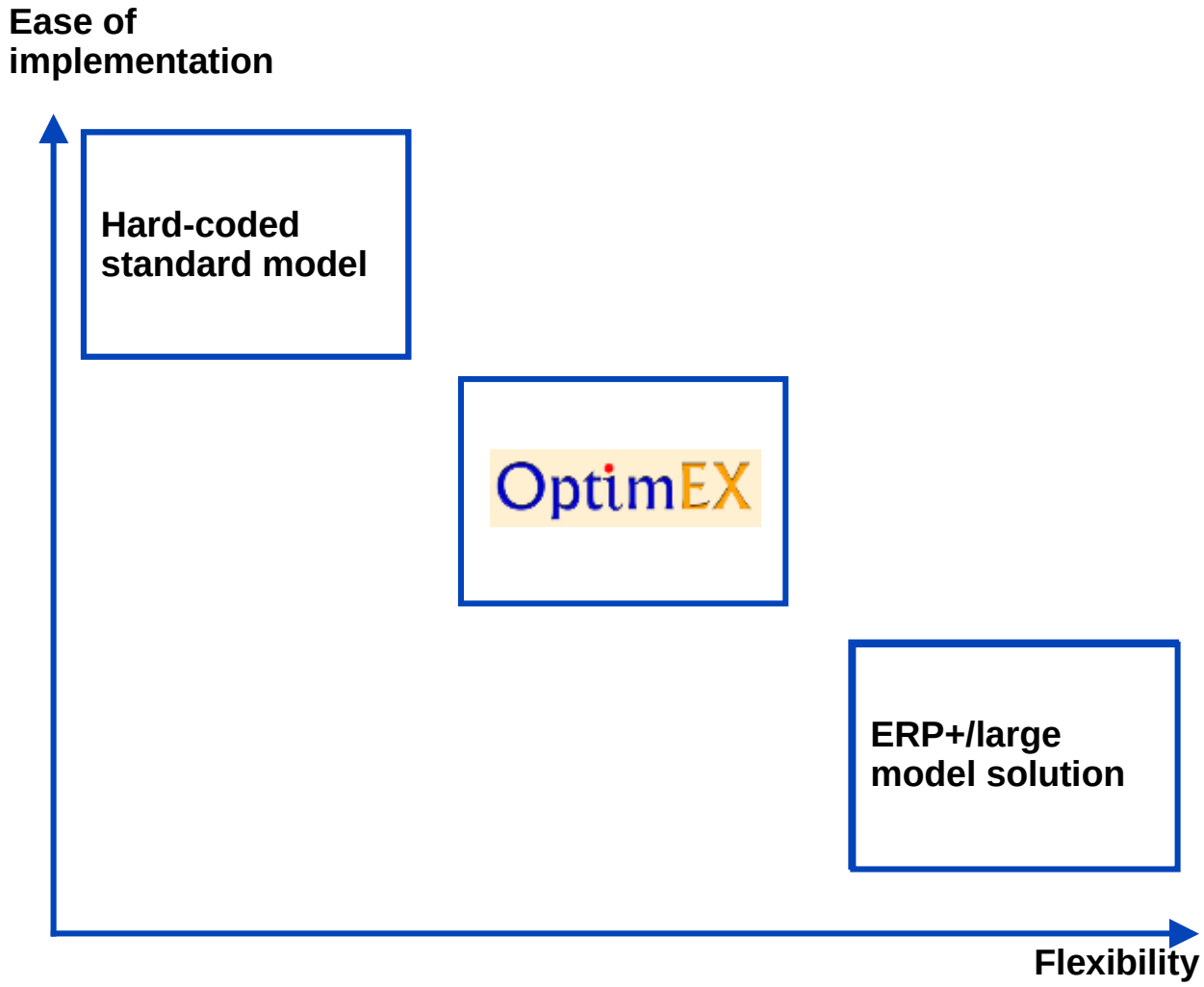
Transport – products

Sales

Optimization across the entire value chain to find a global optimum for the integrated system

Source: McKinsey

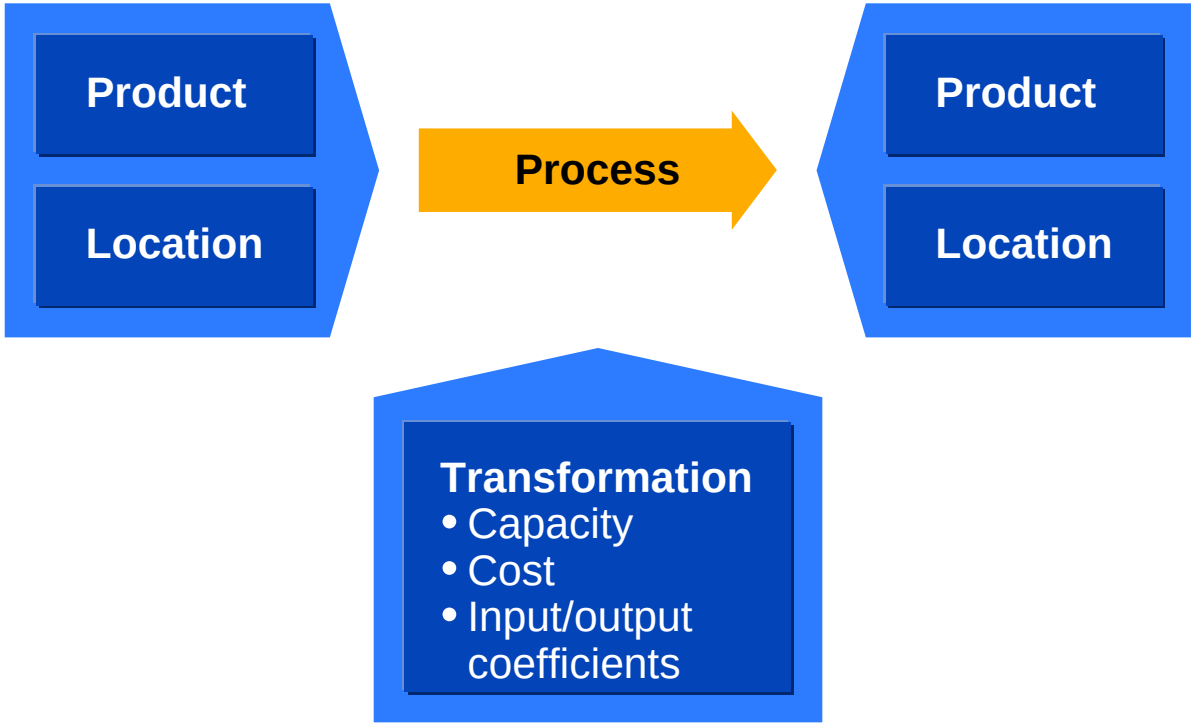
McKinsey proprietary OptimEX solution was developed as a trade-off between ease of implementation and flexibility



Source: McKinsey

Approach – model representation tailored to the problem on hand

CENTRAL MATHEMATICAL SCHEME



Source: McKinsey

Mapping each business process to the mathematical scheme

Purchasing

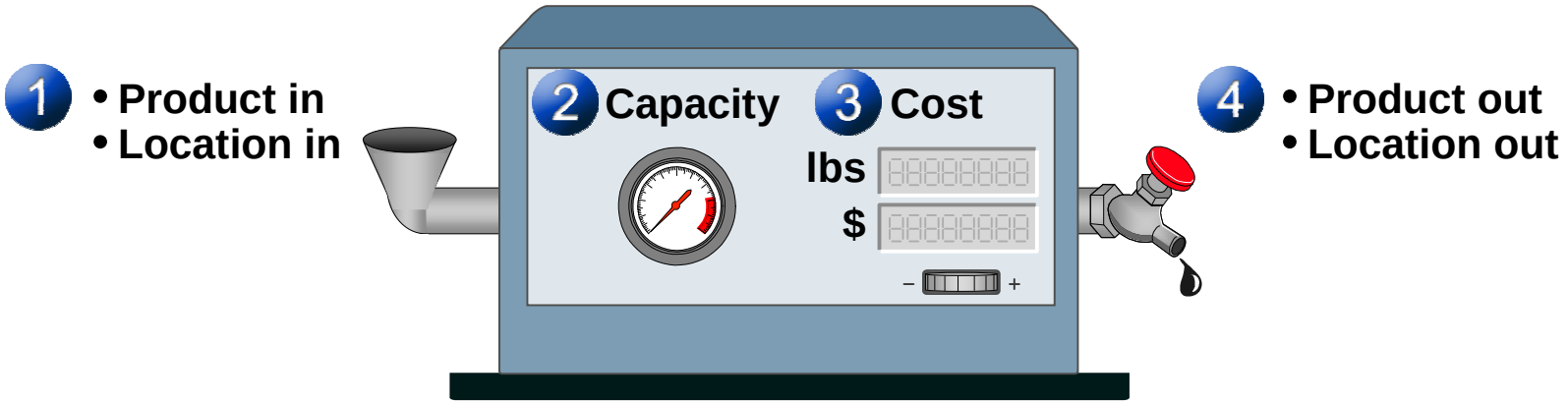
Transport

Production

Transport

Sales

Representation according to one identical scheme in OptimEX

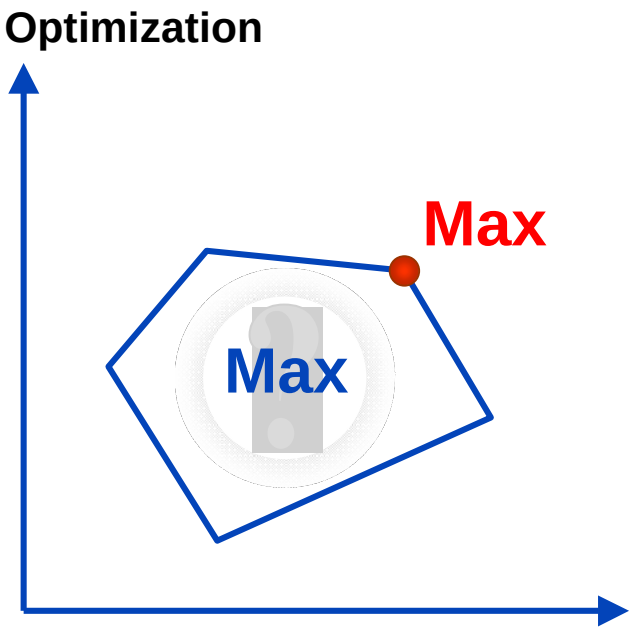


Source: McKinsey

Input and output of the model

Input

- Demand curves
  - Export markets
  - Domestic market
- Supply curves
- Production
  - Variable cost
  - Capacities
  - Coefficients
- Transport routes and tariffs



Output

- Sales plan by product
- Purchasing plan by raw material
- Utilization for every production unit
- Optimal transportation routes
- P&L forecast
- Report of major bottlenecks

Source: McKinsey

Optimization of feedstock allocation and sales channels – sample output

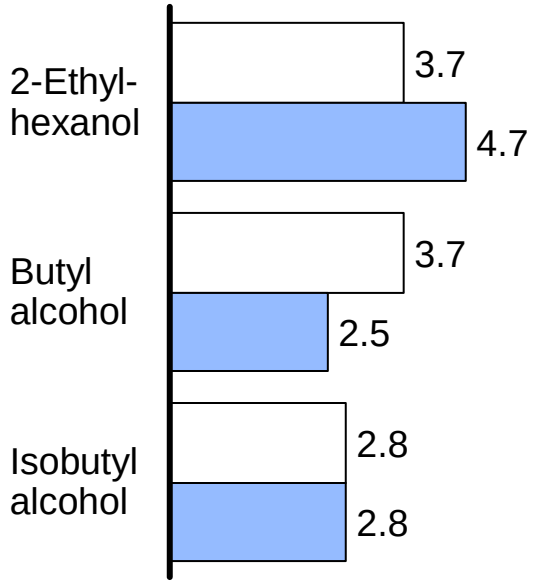
Thousand tons/month

Optimum plan
- Increase production and export of 2-EH
- Reduce production of butyl-alcohols (no export)
- Increase domestic sales of isobutyl-alcohols

Effect
- xx million USD

Feedstock allocation

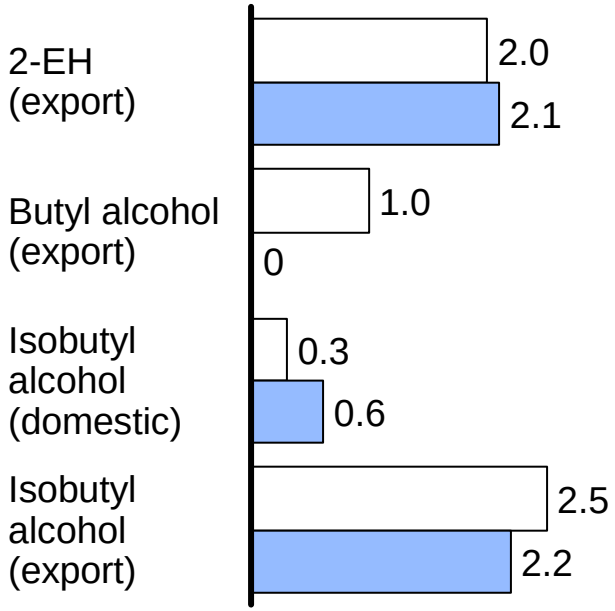
Conversion of propylene



- Reallocation of propylene to 2-EH instead of butyl alcohol
- No change in production of isobutyl alcohol

Sales channels

Sales volumes



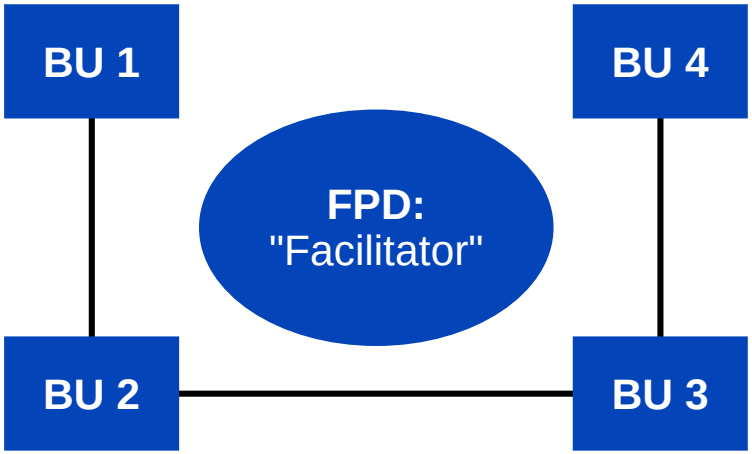
- Discontinuation of unprofitable butyl alcohol exports
- Reallocation of isobutyl alcohols to domestic buyers instead of export

Source: McKinsey

Organizational implications of integrated planning – example: shift of influence from BUs to central planning

Major lines of communication

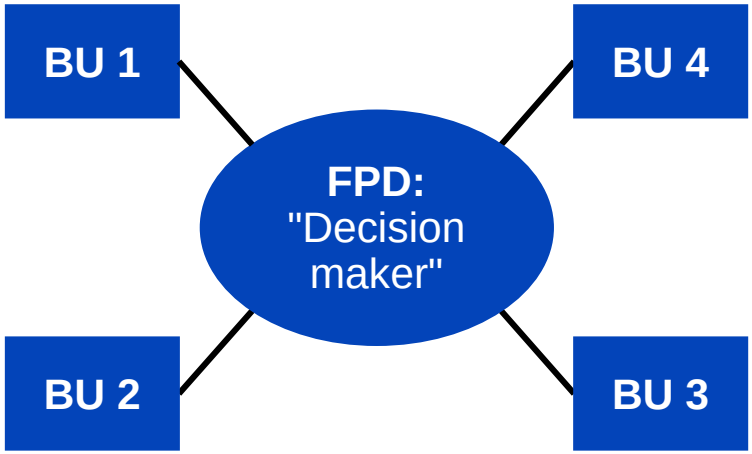
Before



Role of BUs in planning
- Set production volumes and sales volumes
- Coordinate with upstream BUs

Role of FPD
- Iron out details in product balance
- Set transfer prices and processing fees to equalize BU profits

After



Role of BUs in planning
- Supply data on production assets, product, and feedstock markets
- Verify feasibility of central plan

Role of FPD
- Dictate all purchasing, transport, production, and sales volumes

Source: McKinsey

Key implementation challenges

	Explanation	Mitigation plan
Internal political opposition	• Central plan may help one business unit and hurt another (e.g., by selling an intermediate product instead of further conversion)	• Organize business units as cost centers to incentivize them to fulfil a central plan with minimum cost
Insufficient degrees of freedom	• Profit potential of central planning depends on a sufficient number of alternatives (the more, the better) • Sales and purchasing departments must work particularly hard to seek out new buyers and sellers	• Incentivize sales and purchasing departments to submit a higher number of realistic bids and offers (some of which will not be used)
Poor quality of input data	• Model is particularly sensitive to low-quality input data concerning – Demand and supply curves – Capacities and technical constraints – Input data manipulation	• Set up active input data controlling – Comparison of submitted data with realized actuals – Clear consequences for submission of low-quality data

Be aware of "one-size-fits-all" solutions! Organizational integrated planning issues, trade-offs and concrete measures always have to be thoroughly analyzed case by case!

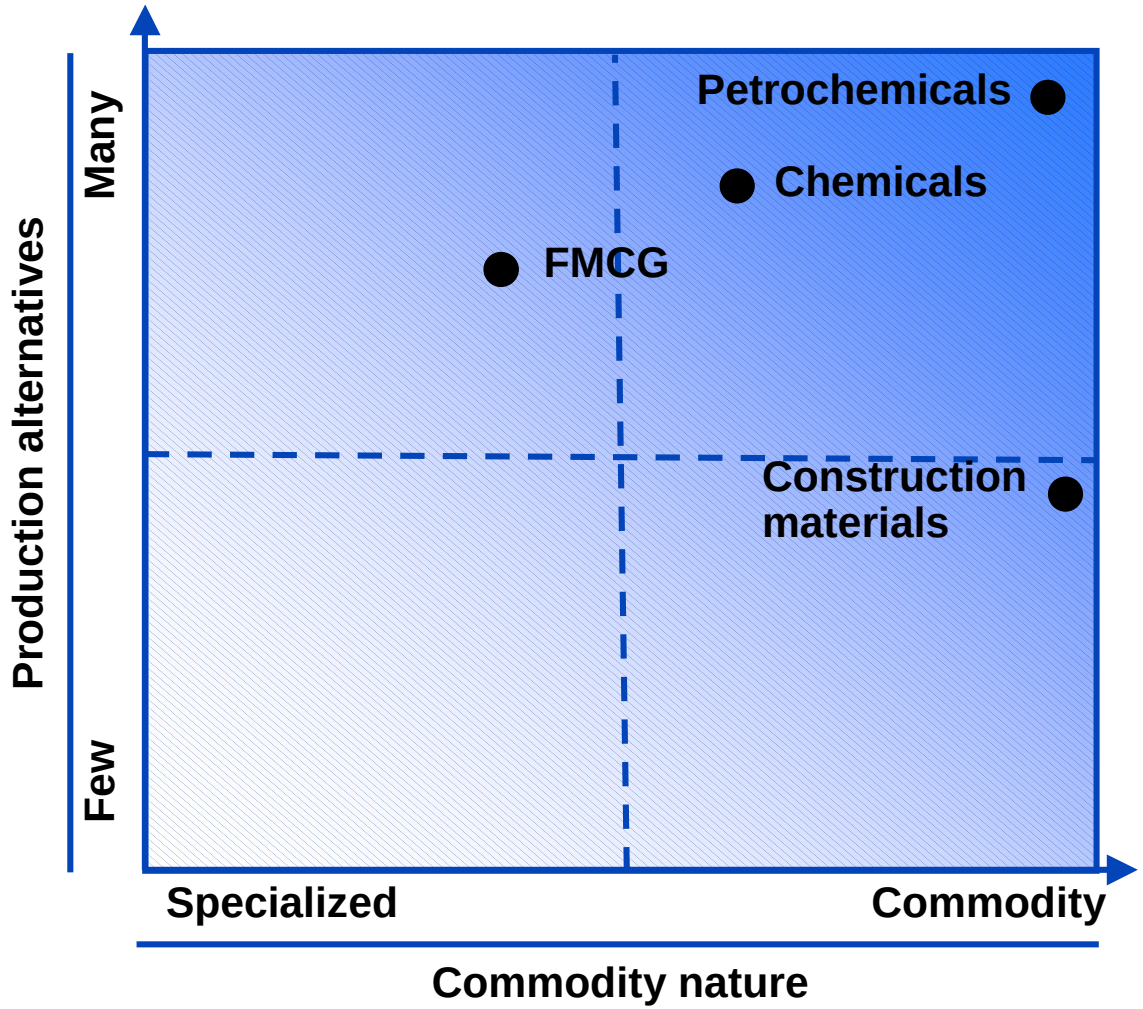
Source: McKinsey

OptimEX is a good base for optimization approaches in other appropriate industries

OptimEX application area

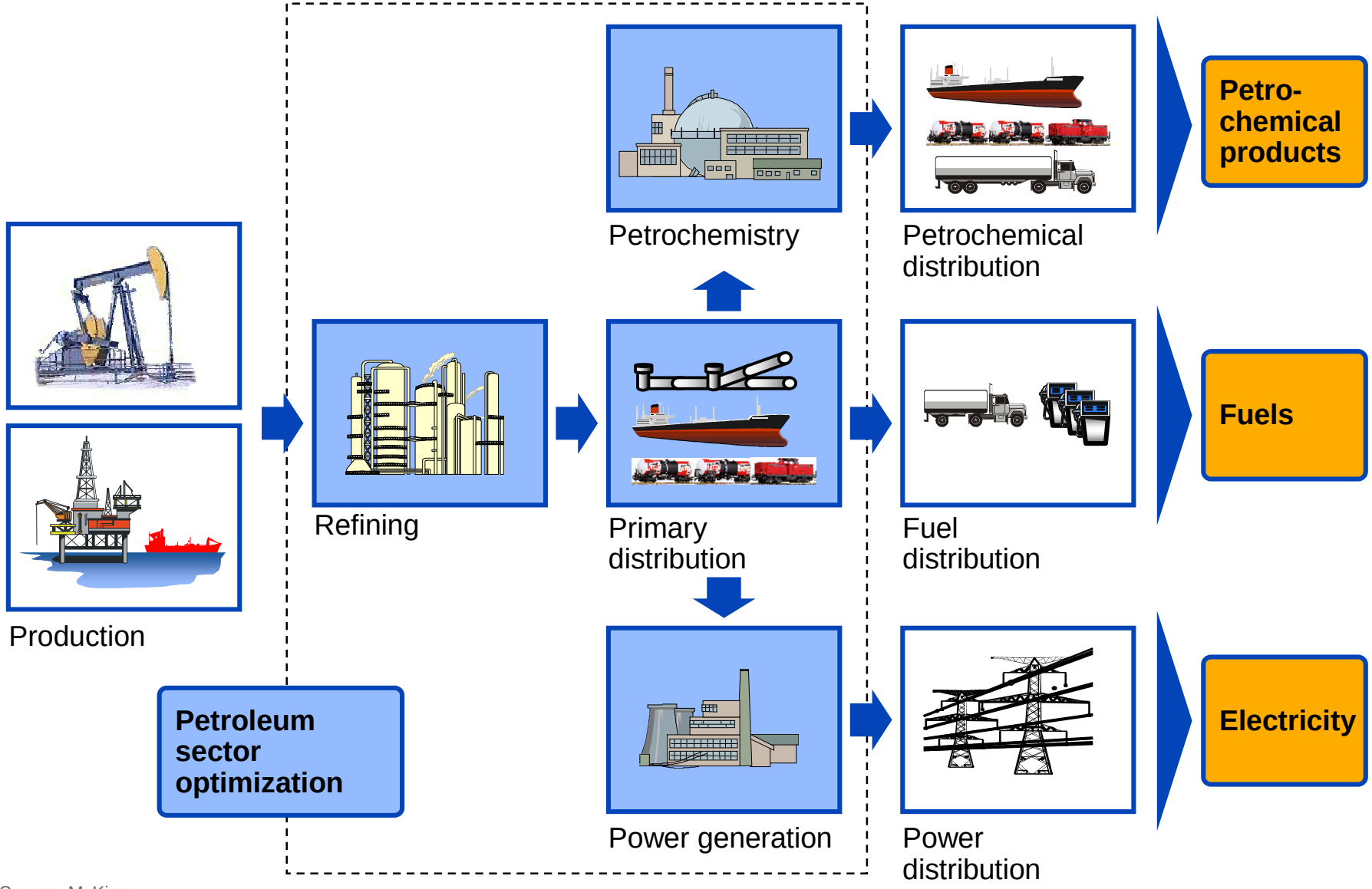
Conditions

- **Production alternatives:** Client is able to switch production from one process or location to another
- **Commodity products:** The products or inputs at different locations are similiar



Source: McKinsey

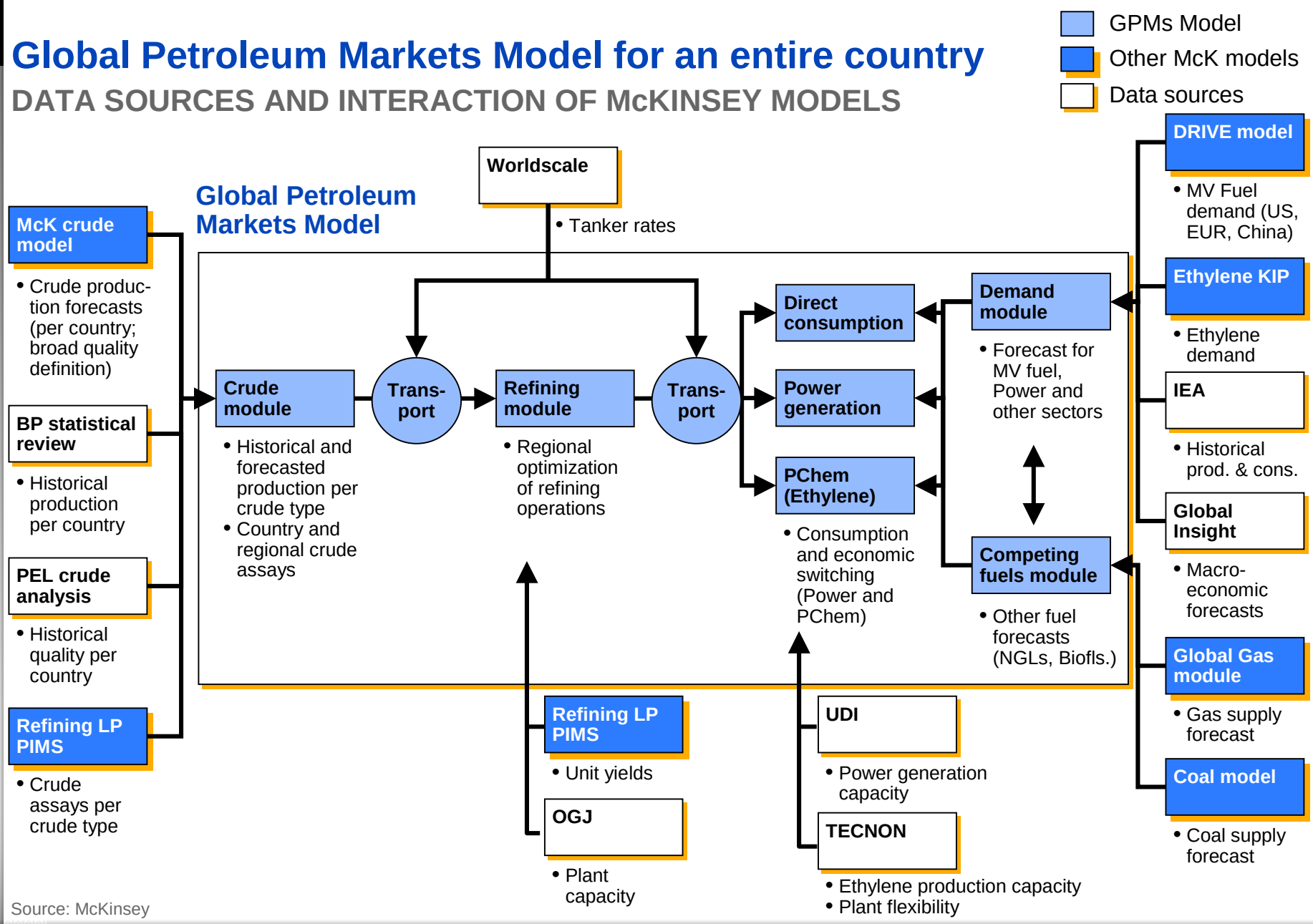
Example 2 – extending optimization scope to an entire economic sector



Source: McKinsey

Global Petroleum Markets Model for an entire country

DATA SOURCES AND INTERACTION OF McKINSEY MODELS



Source: McKinsey

Outlook – key organizational and strategic challenges of petroleum value chain optimization

Market modeling	• Capturing demand and supply volume-price relationships • Utilizing market models for operational planning decisions
Customer service level management	• Understanding relationship between customer service and price • Utilization service/price trade-off in logistics planning decisions
Organizational implementation	• Establishing incentives and responsibilities that support reaching global optimums – while still motivating for local improvement

Source: McKinsey

Thank you!

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Project experience	• SC process optimization in high tech, consumer goods and retail sector • Logistics network design • Global production strategy • Support of more than 250 SC projects worldwide	• Logistics network design • Production network optimization • Forecasting and inventory management • Integrated supply chain master planning in process industry
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Source: McKinsey