PROSYS™ Maximize Your Plant.

Optimization and Carbon Caps

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NPRA

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Introduction

- **ProSys, Inc.**
  - Process Controls Consultants
  - Basic/Advanced Controls, Alarm Management, DCS upgrades, HMI

Introduction

- **Carbon Cap and Trade**
- **Carbon Capture and Sequestration**
- **Impacts of Requirements on Refining**

Waxman-Markey Bill (HR 2454)

- **American Clean Energy and Security Act of 2009**
- **Passed by the U.S. House**
- **Placed on Senate calendar**

Terms

"CO_2 equivalent" (CO_2e)

- Measure of greenhouse potential
- Includes CO_2, CH_4, and other gases

"Allowance"

- The right to emit a metric ton of CO_2e without penalty

"Offset credit"

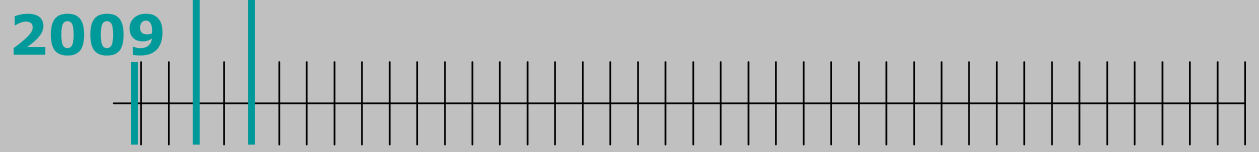
- A financial instrument representing CO_2e removed or prevented

HR 2454

- **Limited CO_2e allowances**
- **Penalty = 2× allowance price**

2012: Limits begin for most industries

2014: Limits begin for refineries



Refinery Allowances Required

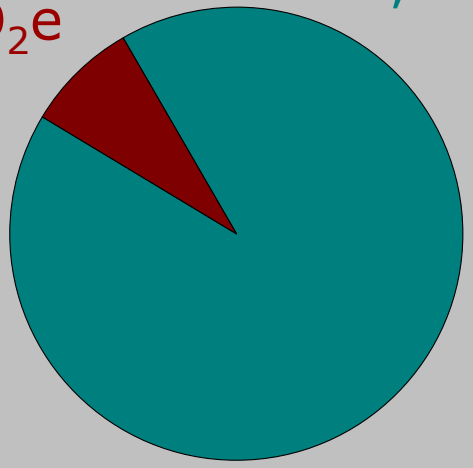
≈ 2,650 Million tons CO_2e per year (2006)

Refinery emissions

215 Million tons CO_2e

Fuel products

2,437 Million tons CO_2e



Allowances Allocated to Refineries

Allocated at no cost

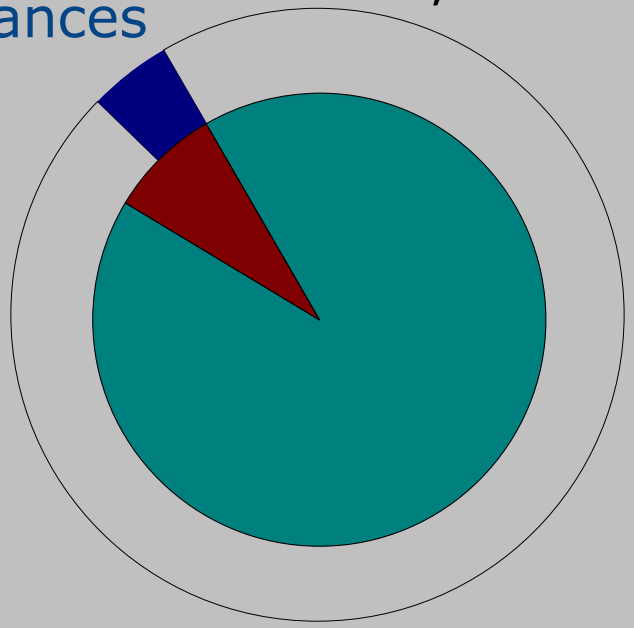
115 Million allowances

(2014)

Refiners need to obtain

2,535 Million allowances

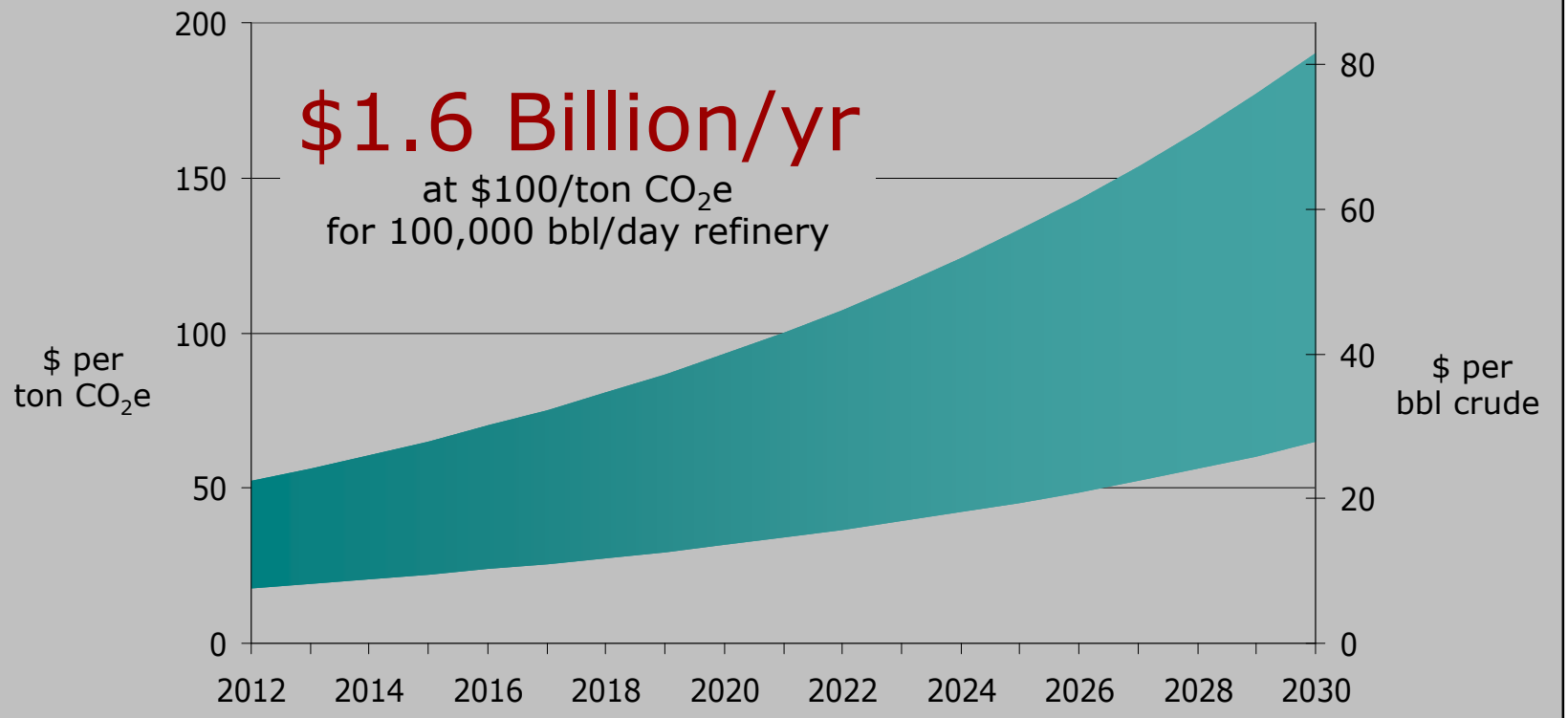
(2014)



What's a Refiner to Do?

- **Pay for allowances and offsets**
- **Reduce emissions**
  - Optimize processes
  - Capital investment; optimize again
- **Capture CO_2**
- **Capture and optimize**

Purchasing More Allowances



Source: Energy Information Administration, "Energy Market and Economic Impacts of H.R. 2454"

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Receiving a Larger Allocation

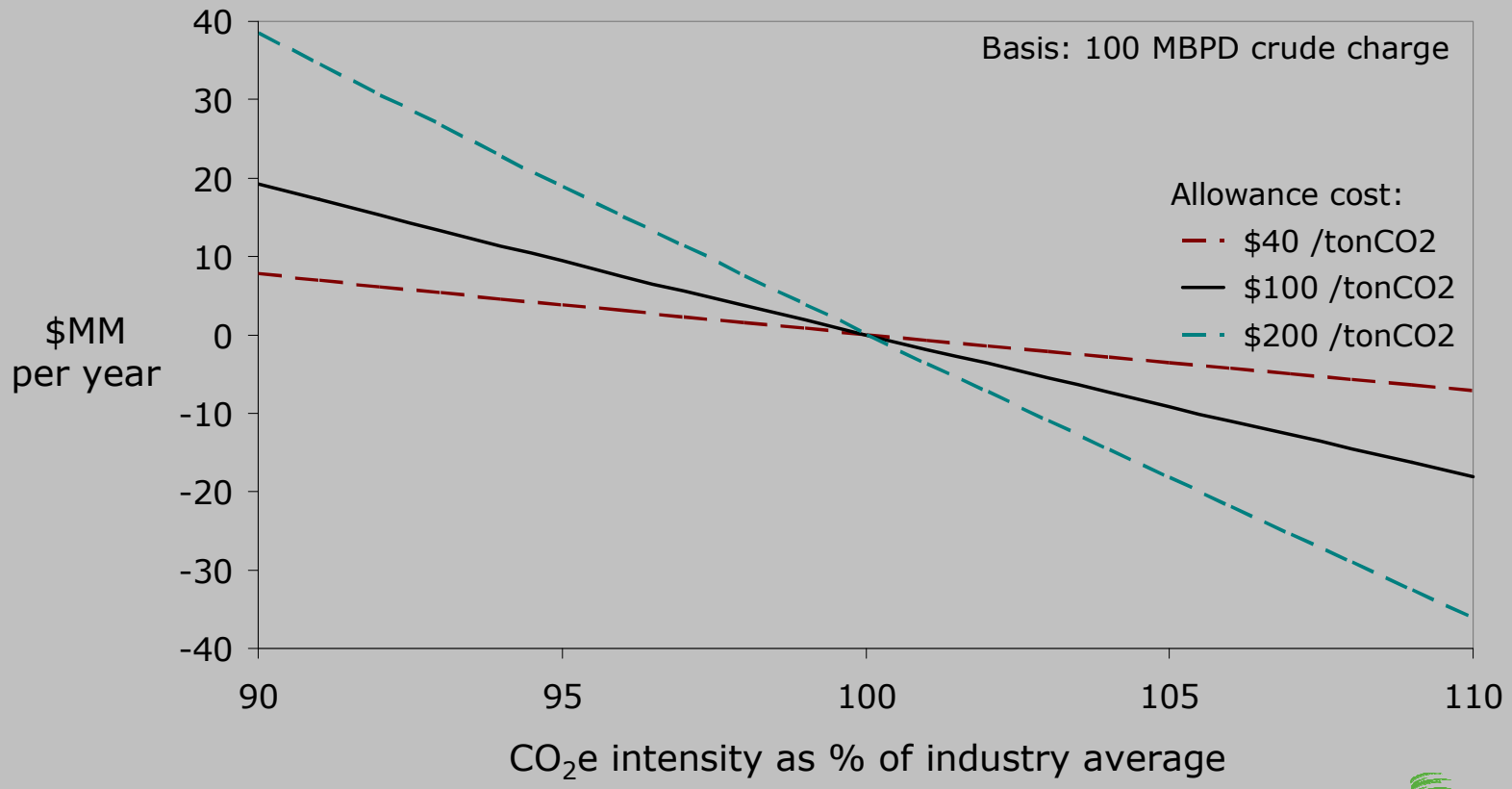
Among refiners, allowances distributed based on:

- **Quantity of fuel produced**
- **Intensity**

$$\frac{CO_2e \text{ emitted} + CO_2e \text{ from electricity}}{\text{Fuel production}}$$

Efficient refiners **receive more** allowances and **require fewer**

Value or Cost of CO_2 Intensity



Achieving Efficiency Improvements

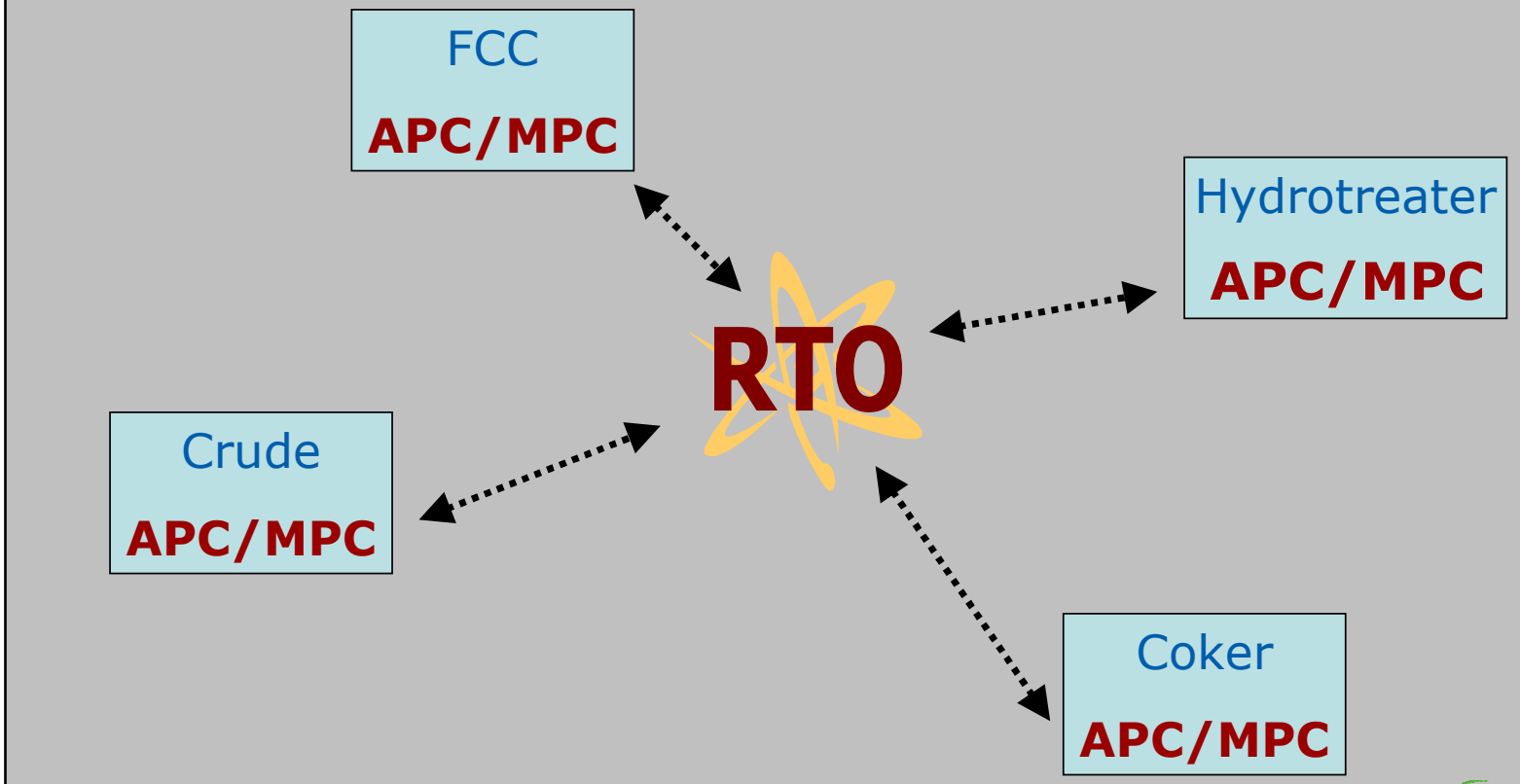
- **Historically, APC and MPC have been cost-effective methods to increase efficiency**
- **APC/MPC provide handles to respond to changing economic conditions**
- **Allow units to operate closer to limits**

APC/MPC: New Objectives

- **Combustion: CO_2e/heat ratio**
  - Include electrical power and steam
- **Process: CO_2e/throughput ratio**
  - Question old assumptions about process limits

No longer about maximizing throughput

Levels of Optimization



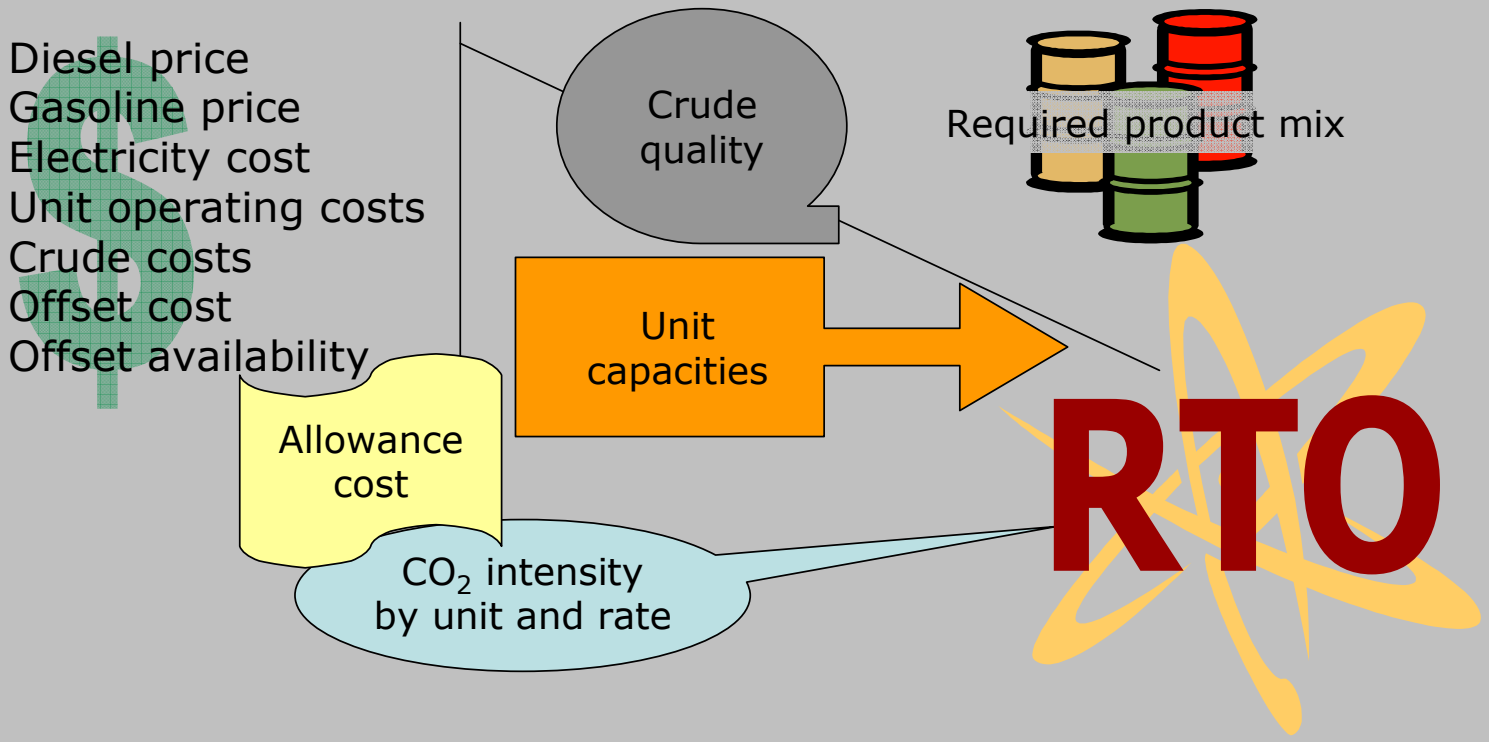
Real-Time Optimization (RTO)

- **Process optimization model incorporating intra-day adjustments**
- **Capable of modeling interactions among units**

Real-Time Optimization (RTO)

- **Optimize over refinery as a whole**
  - Throttle use of carbon-intensive processes
  - Consider effects of turn-downs on carbon intensity
  - Find most profitable way to achieve product slate

Lots of Variables



RTO Outputs

- **Writes values to MPC/APC**
  - Targets
    - Unit product rates
    - Unit operating parameters
    - Product parameters
  - Steady-state gain adjustments

Real-Time Optimization (RTO)

RTO can:

Bias forecasts

Follow market trends

Set medium-term refinery targets

What's a Refiner to Do?

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Reduce CO_2 – Capital Investment

- **Additional heat exchange capacity**
- **Additional reactor volume, reduce severity**
- **Waste heat recovery; economizers**
- **Compressor improvements**
- **Cogen units**
- **Variable-frequency drives**

Capital investment increases optimization opportunity

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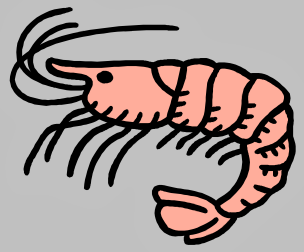
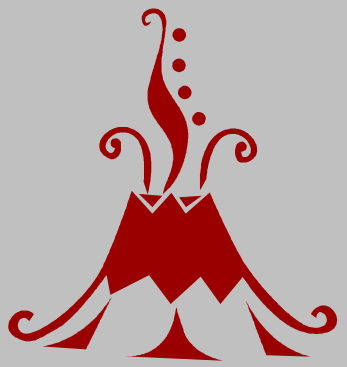
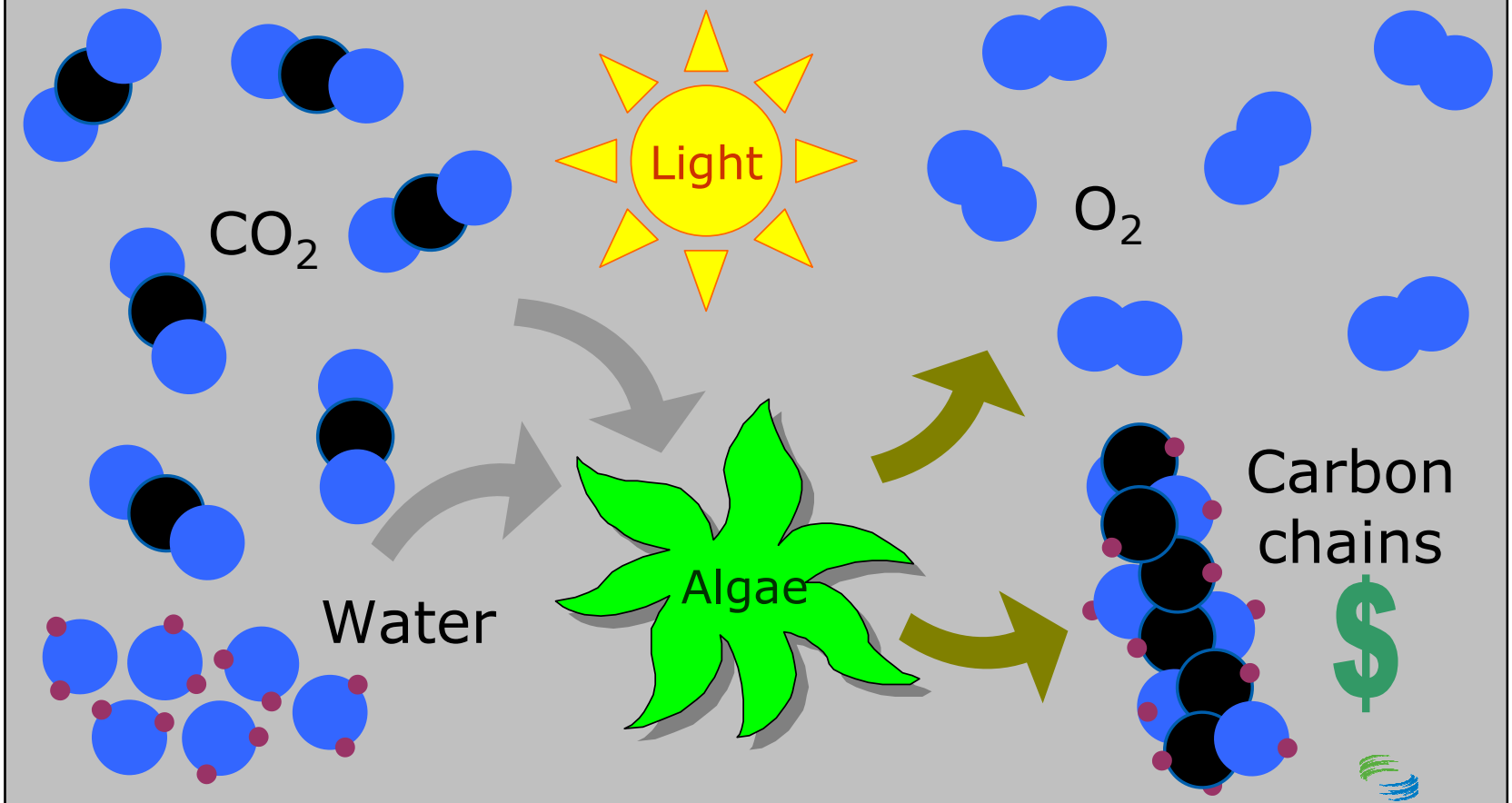
CO_2 Capture & Sequestration (CCS)



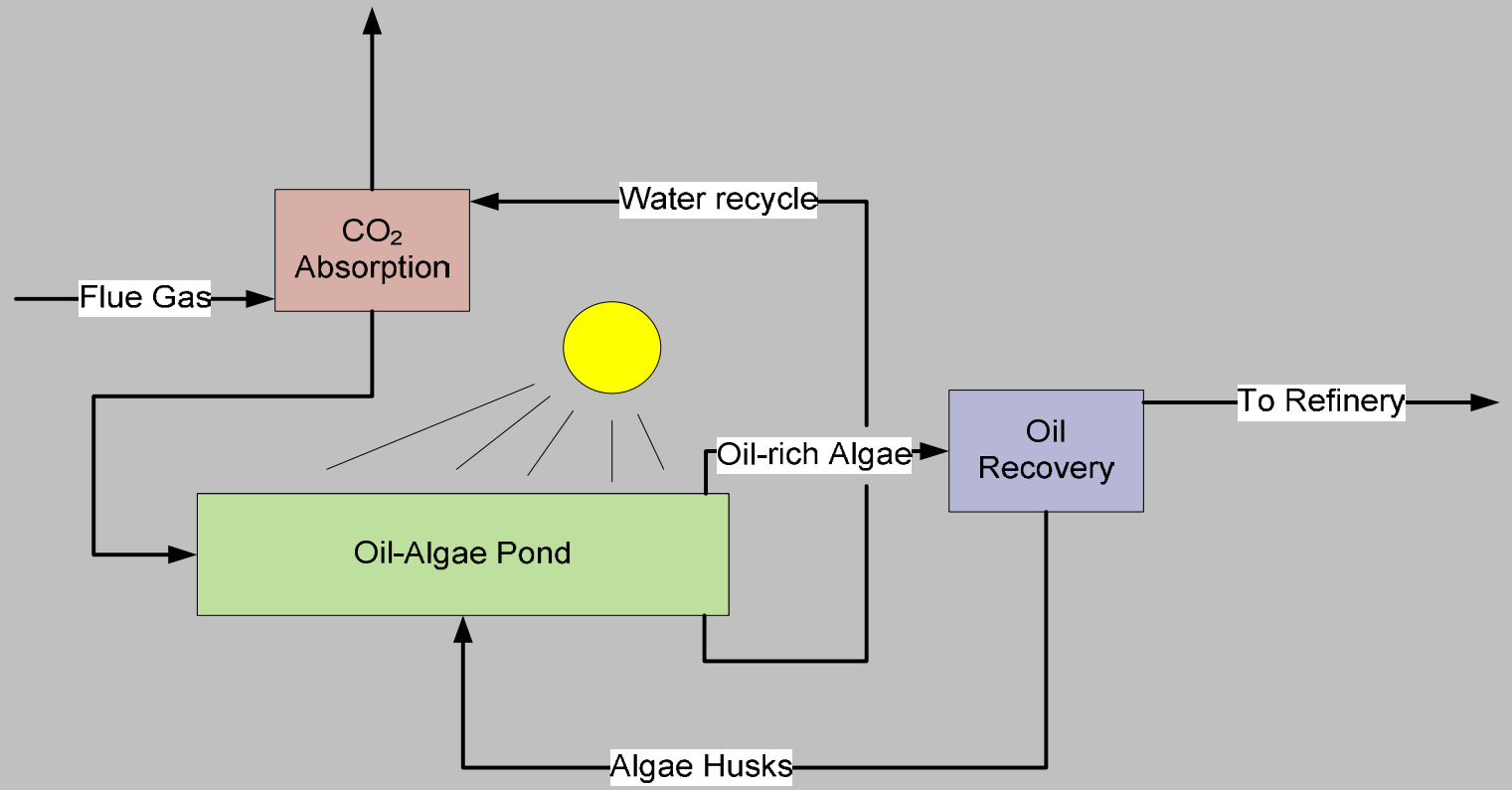
- **Deep sea**
  - Cost of CO_2 transport?
  - Kill marine life?
- **Underground**
  - Permanent? Safe?
- **Oil algae**
  - Land, water, light requirements
  - Potential to create value



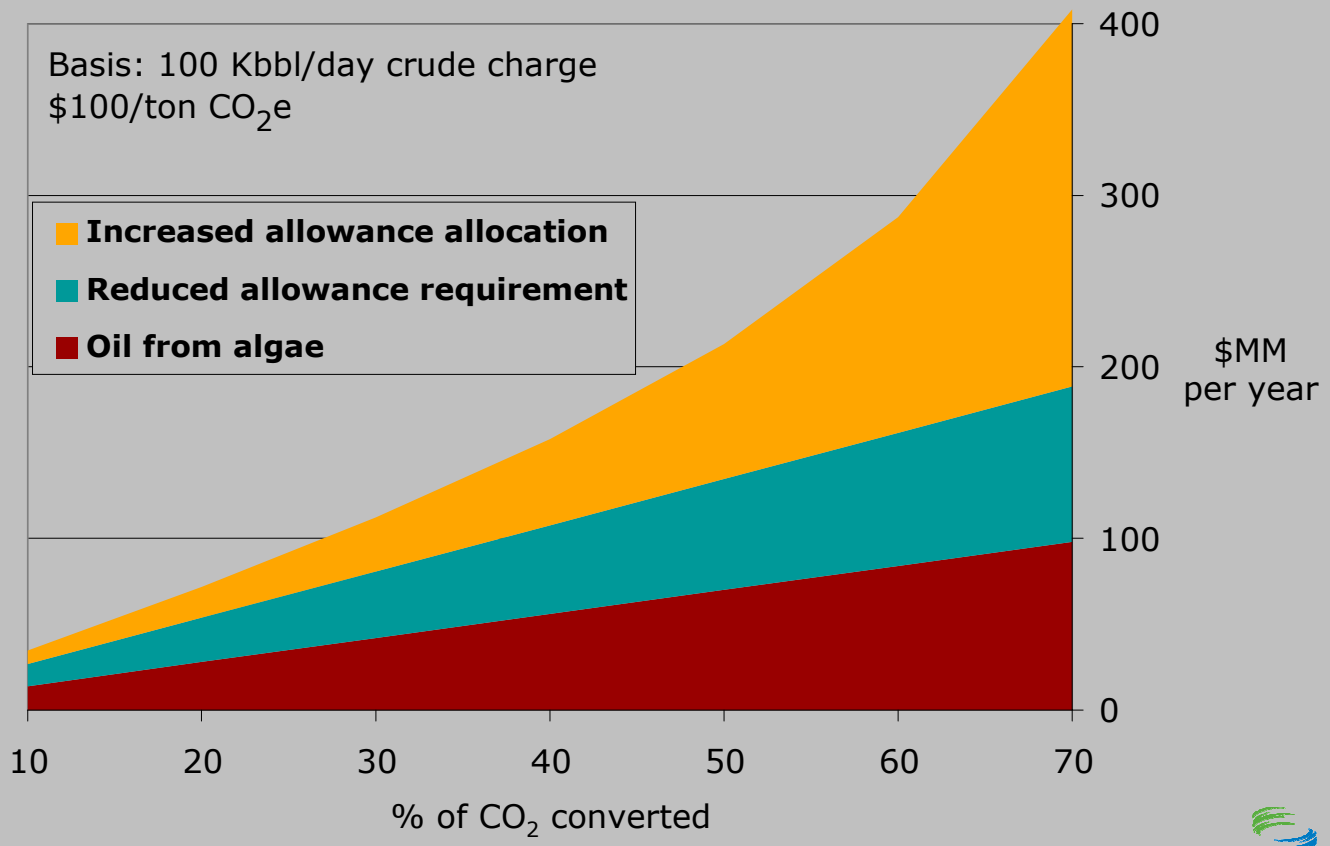
Photosynthesis



Oil Algae in Refining



Value of CO_2 Capture via Oil Algae



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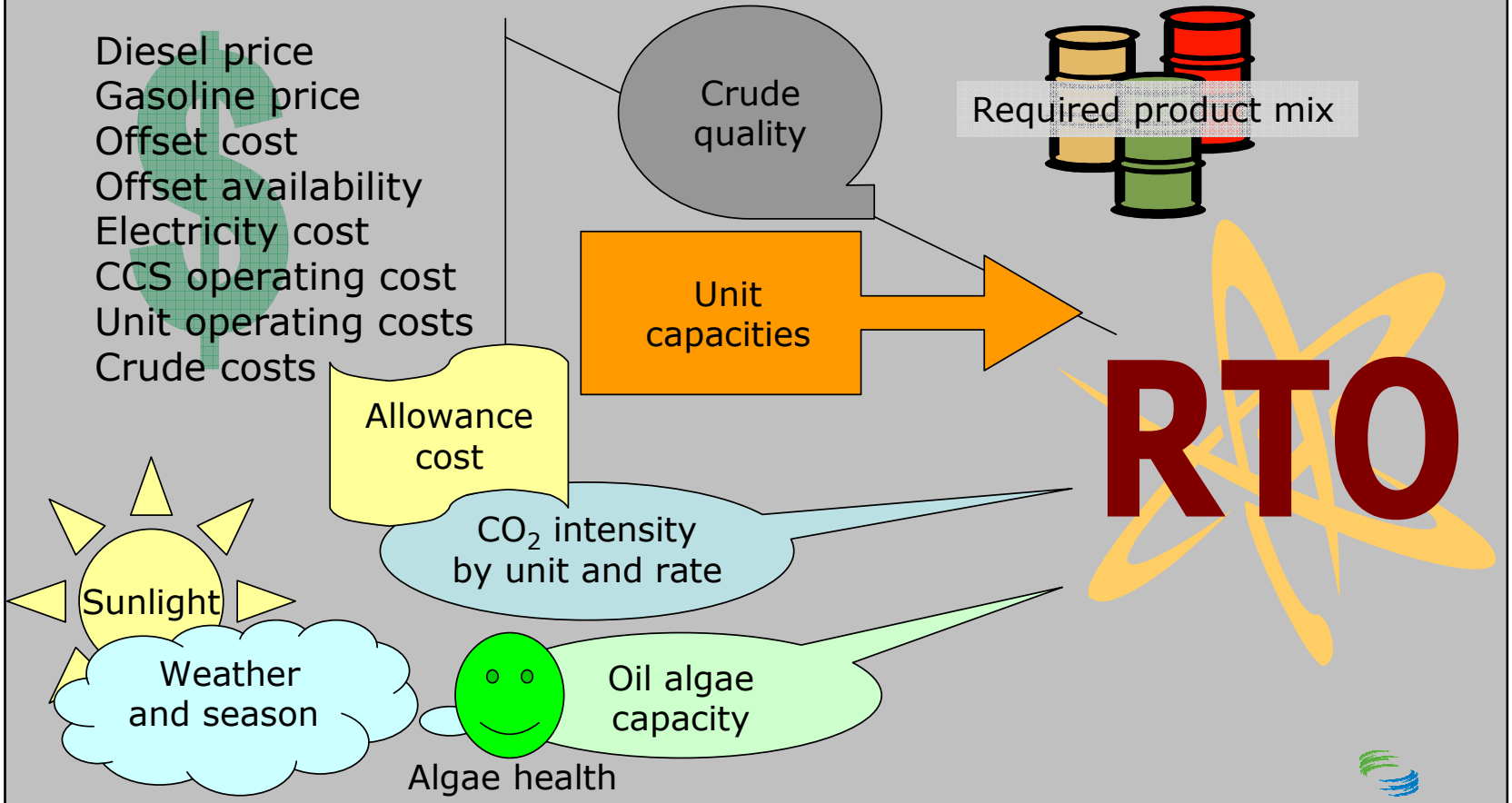
Even More Variables



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    - Unit operating parameters
    - Product parameters
    - Oil algae targets
  - Steady-state gain adjustments

Real-Time Optimization (RTO)

RTO can:

Bias forecasts

Follow market trends

Set medium-term refinery targets

Set shorter-term targets based on algae or sequestration capacity

After CCS and Optimization

- **How long can fuel producers utilize optimization and CCS alone?**
  - About 15 years
  - Year 2024, total allowances available fall to 96% of current emission levels
  - Year 2050 and later, only 22% of current CO_2 emissions will be allowed

After CCS and Optimization

- **Refineries must change to survive**
  - Shift toward non-fuel products
  - New feedstocks (biofuels?)
  - Export more; sell less domestically

Winners and Losers

- **Winners will have captured carbon and optimized effectively**
- **Winners will gain allowances left behind by the losers**

Timeline

- **Today's APC/MPC investments aren't wasted**
- **Rethink future economics of RTO**
- **Investigate CCS technologies**

Conclusion

You don’t need to outrun the bear; you just need to outrun the guy next to you!

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