



Wrapping it up:

What are the pieces at the top of the heap

Carbon Markets – Taxes

Richard B. Rood

734-647-3530

rbrood@umich.edu

LECTURE NUMBER ??

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Some news

- Thursday, April 19, will be the day of the projects. Will allocate 1 hour for each.
 - Room 1024 Dana
 - I have the room from 9-12
 - Would like for you to present it as if you were presenting it to a “policy maker”
 - Facts, analysis, recommendations
- This afternoon, 5:00, 1040 Dana, Peter Gleick
 - Water resources and climate change



Some more

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- Christopher Poulsen Assistant Professor
Geological Sciences and AOSS
3:30 — 4:30 p.m.
AOSS Auditorium
2246 Space Research Building
Late Paleozoic Deglaciation and Climate Instability
 - Meet with Tony and Doug Team on Tuesday or Wednesday.



Thinking and putting it together

- Does the Pacala and Socolow Model provide a good starting point?
- What do you think is different about the climate change problem now than 1 year ago?



Thinking and putting it together

- My last question - what would be at the top of the list if you were to do something. Advocate something.
 - Efficiency
 - Tax // valuation of carbon
 - National RPS
 - Infrastructure for regulation
 - CO2 vs other gases
 - corrupts the market
 - International effort for large-scale baseload energy
 - Agree on some limit (550)
 - Long-term policy commitment (stability)



Intrigues with the idea of infrastructure

- Infrastructure to support what?
- Inertia of the installed infrastructure
 - What does this imply for developing nations



Thinking and putting it together

- My last question - what are the factors that might elevate development of policy
 - National security (relation to international instability)
 - Money
 - Heritage to children and grandchildren
 - -----
 - Water
 - Arable land
 - -----
 - Public Health
 - Agriculture



Taxes vs Carbon Market

- Taxes
 - Set price – uncertain emissions
 - What is the real value of carbon
 - Money in the coffers of the government
 - Political viability
 - Ease of implementation
 - Infrastructure?
- Carbon market
 - Economy wide cap – impact is known. (or at least objective is known)
 - Set emissions – uncertain price
 - Value of carbon is determined
 - Appeals to business community
 - Political viability
 - Money in the hands of the private sector
 - Difficulty of implementation
 - Infrastructure?

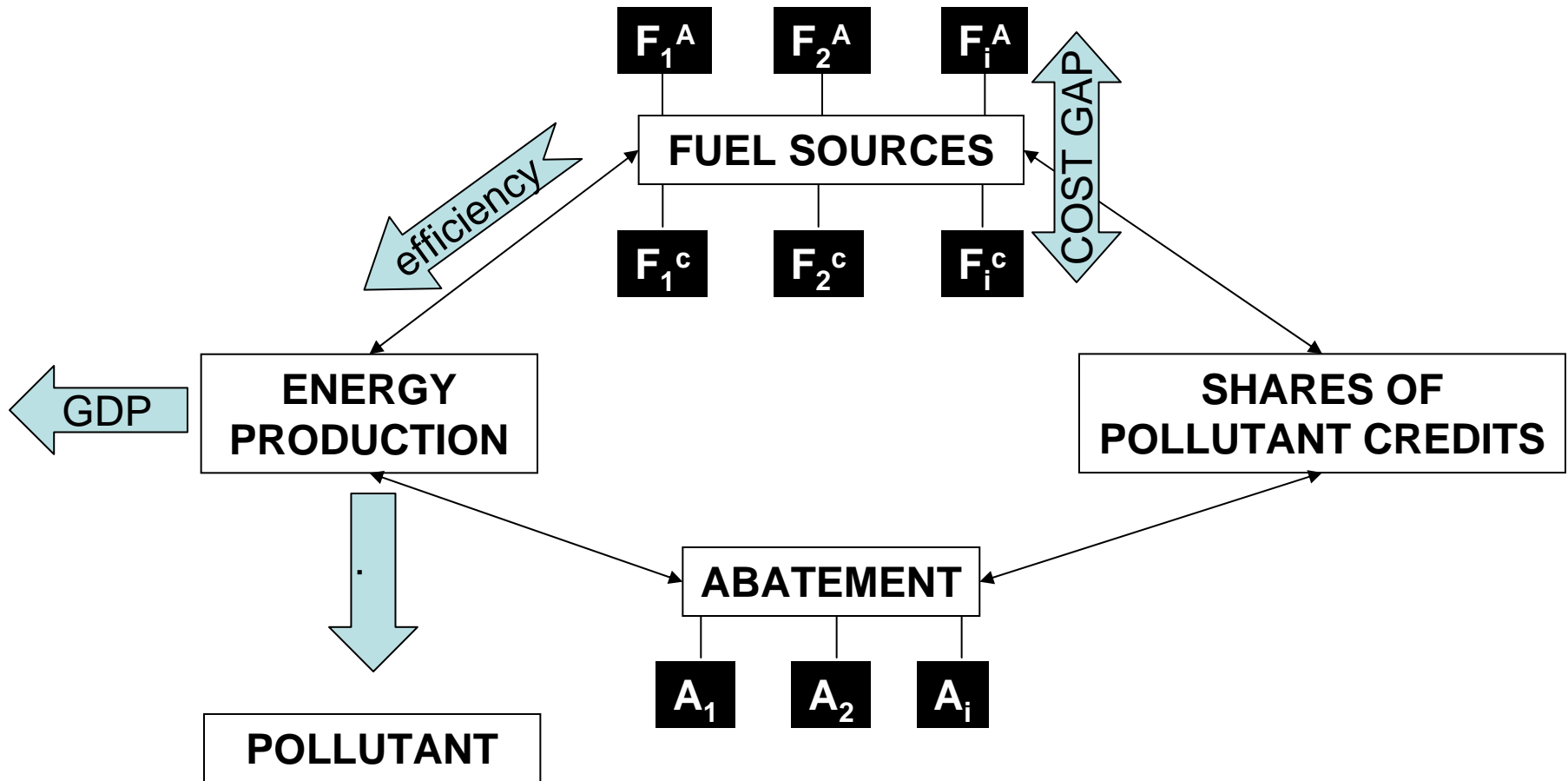


Connections between taxes and carbon market

- Incentives for development of abatement technologies
- Incentives for development of alternative fuels sources
- Over come capital costs to install alternative fuel capabilities
- Taxes
 - A way to insert the cost at the granularity of the population
 - A way to promote development of projects to reduce reliance on cars
 - A way to insert conservation into the equation

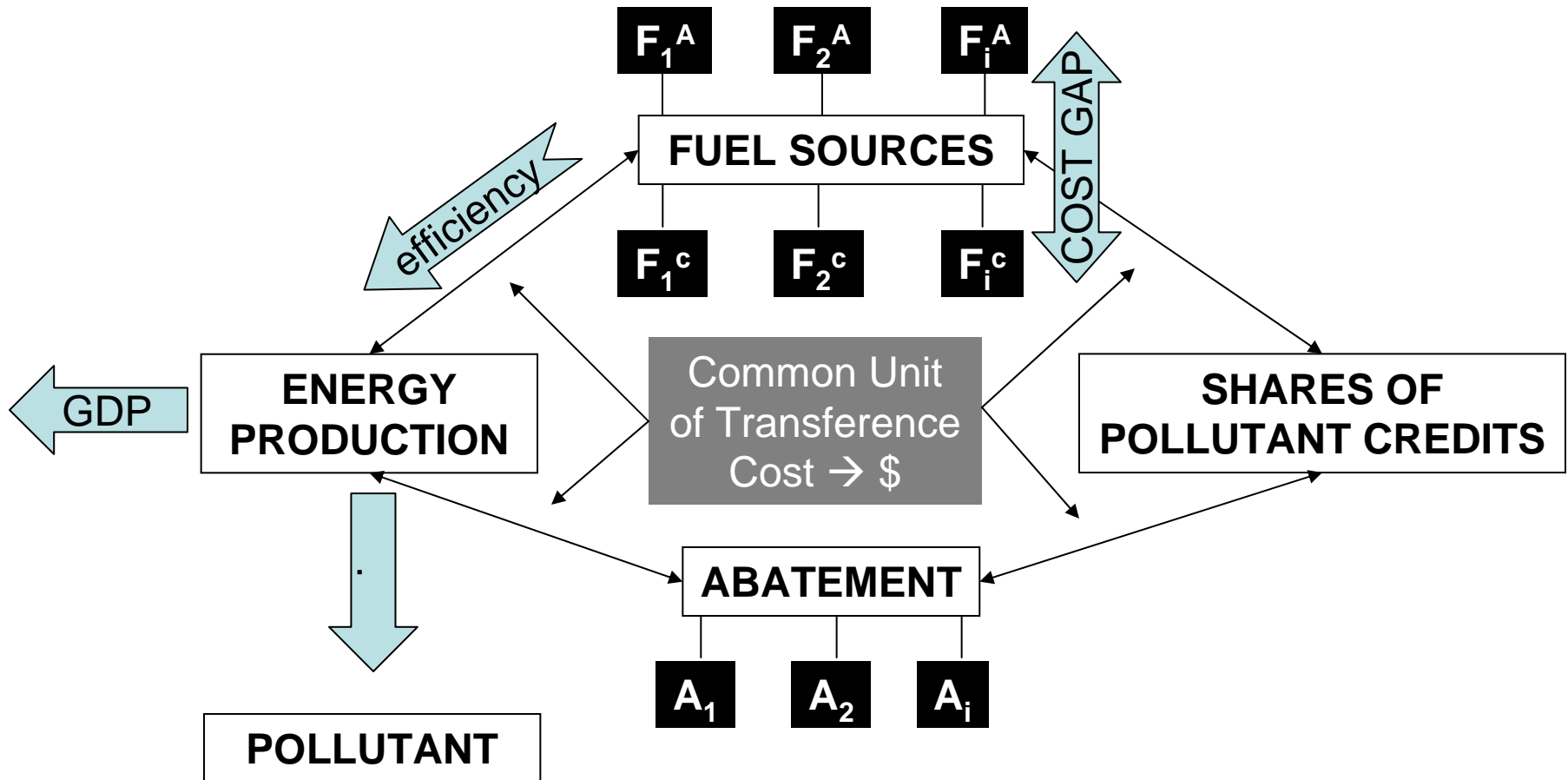


Elements of environmental pollutant market



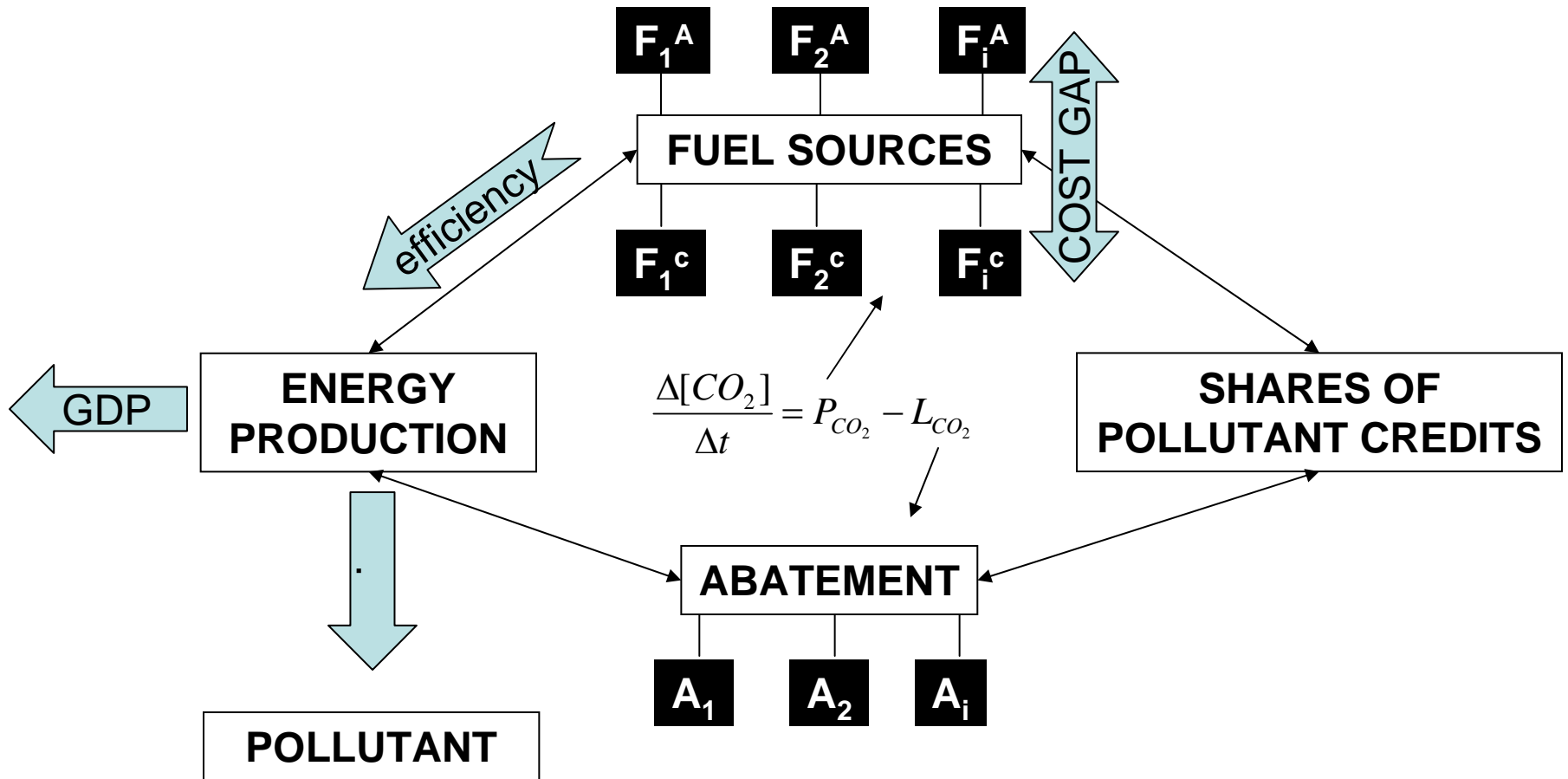


Elements of environmental pollutant market



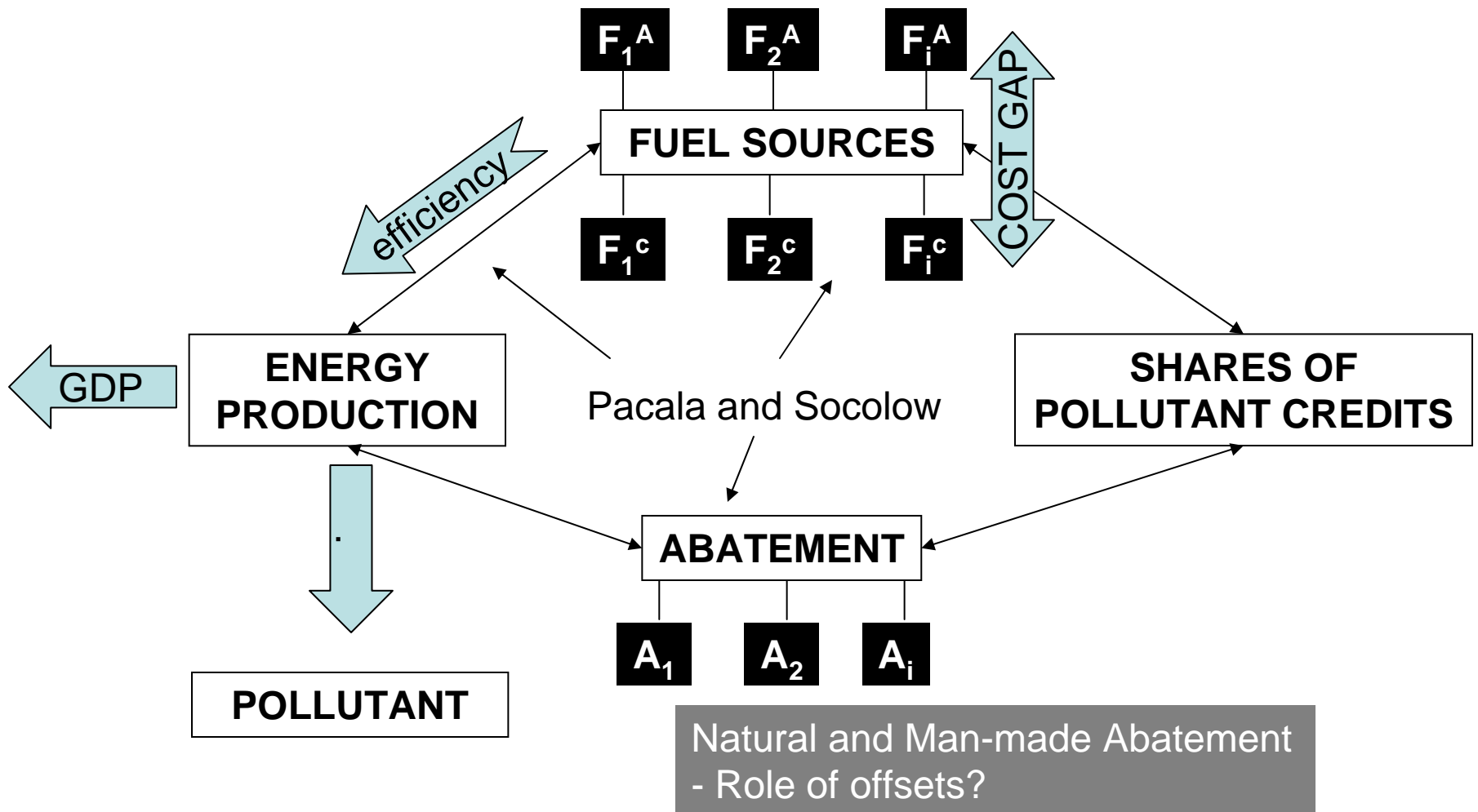


Elements of environmental pollutant market





Elements of environmental pollutant market





Thinking and putting it together

- What do you think is different about the climate change problem now than 1 year ago?



Thinking and putting it together

- Does the Pacala and Socolow Model provide a good starting point?

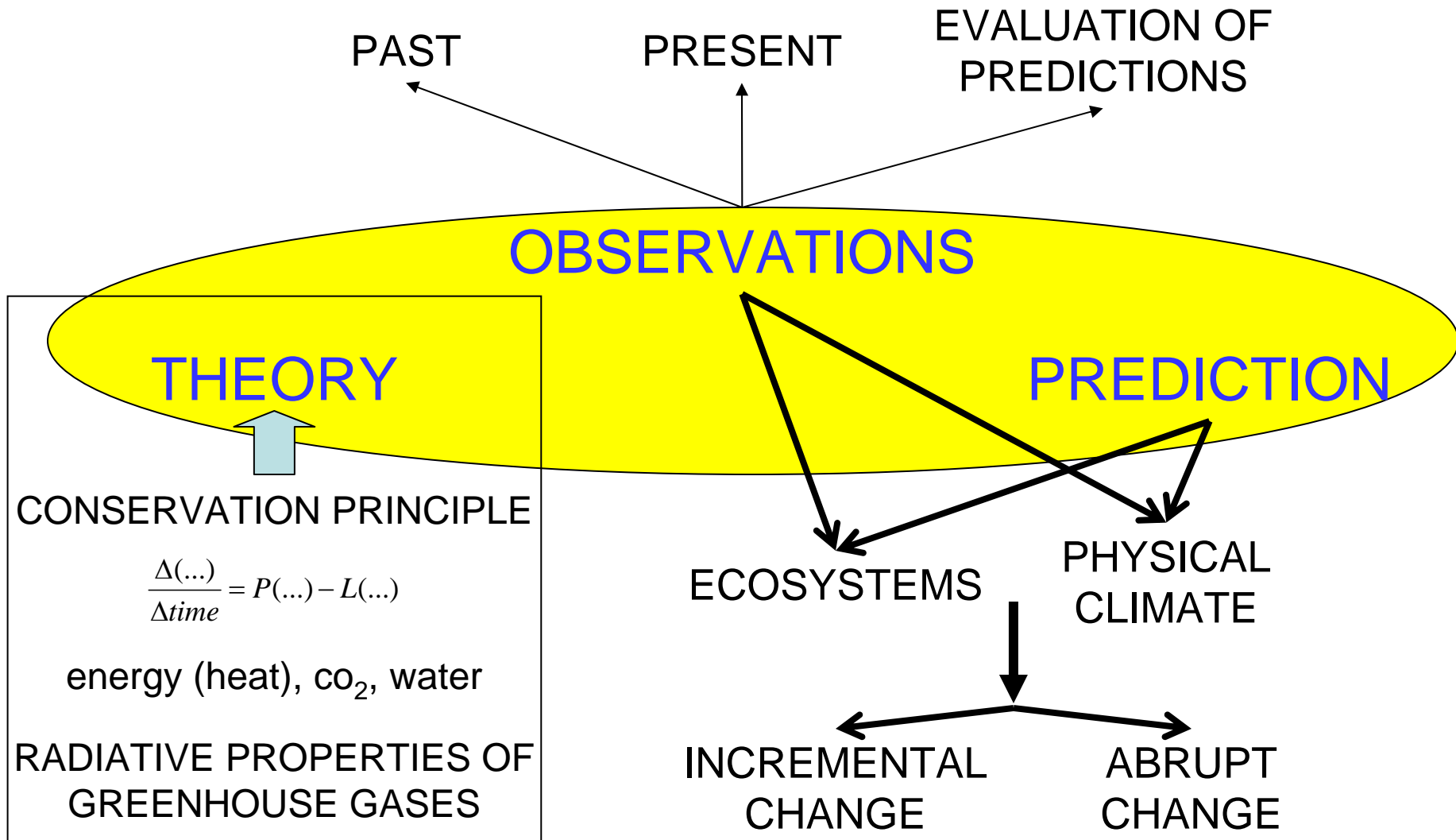


Rood personal thoughts

- Role of public opinion
- Role of policy
- Are we overly fixated with the carbon market?
- What's different
 - Election?
 - IPCC report?
 - Massachusetts vs EPA giving litigation a foundation?
 - Observations
 - State and local development of policy
 - Influence of business



SCIENTIFIC INVESTIGATION OF CLIMATE





SCIENTIFIC INVESTIGATION OF CLIMATE

- ISSUES

- Long time scale of changes and impacts
- Long time scale of consequences of actions
- Water, water, water
- Uncertainty of what society will do, emissions, air quality, ... is greater than the uncertainty due to quantification of climate change
 - Is there something that will change the sign of warming?
 - What are the unknown, unknowns?
 - Transitions and phase changes
- (Fast) melting of ice



WATER, WATER, WATER

HUMANS AND ECOSYSTEMS

PHYSICAL CLIMATE

ENERGY PRODUCTION



ABRUPT CLIMATE CHANGE

OCEAN CIRCULATION

OCEAN ACIDIFICATION

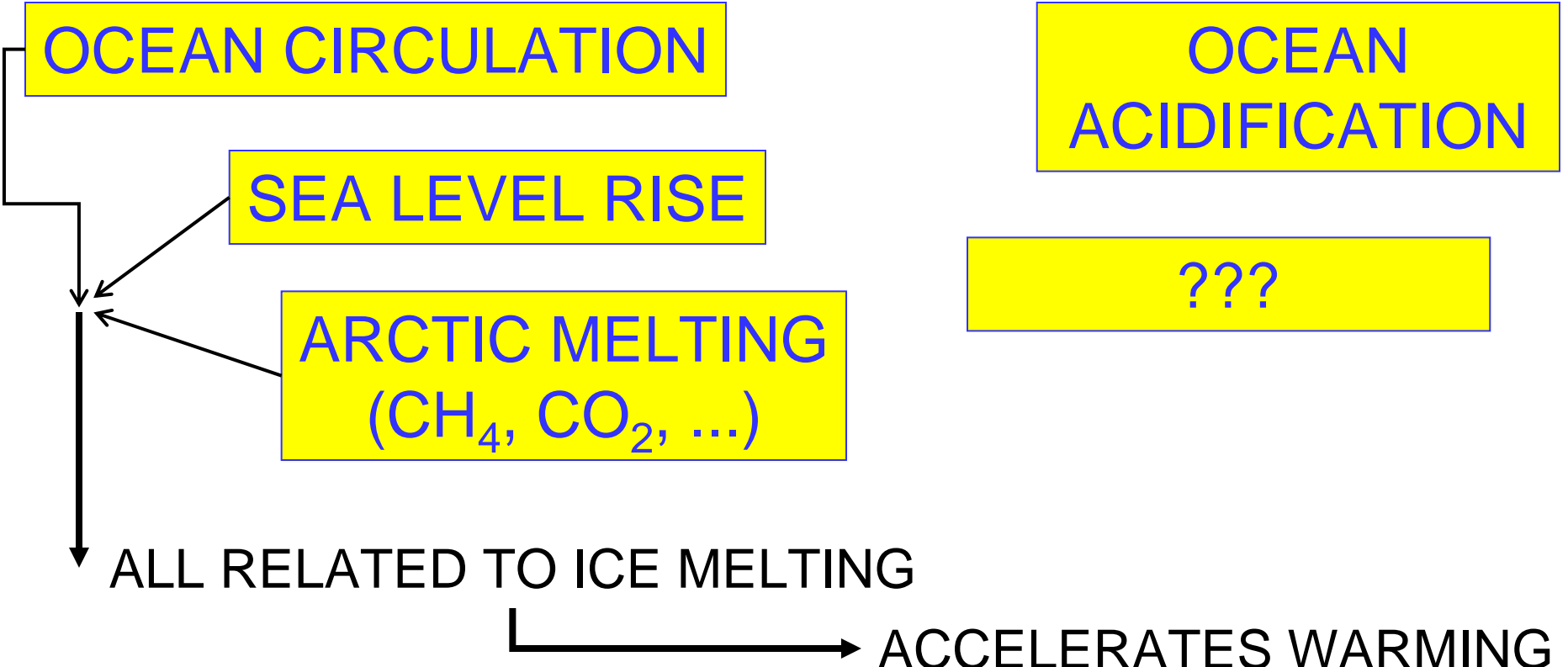
SEA LEVEL RISE

ARCTIC MELTING
(CH₄, CO₂, ...)

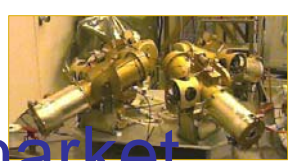
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ALL RELATED TO ICE MELTING

ACCELERATES WARMING







What follows is fluid development of carbon market ideas March April 2007



General results



- **$P < MC$** implies a *buyer* on the market
 - A buyer saves money by purchasing allowances to cover its emissions.
- **$P > MC$** implies a *seller* on the market
 - A seller makes money by undertaking extra abatement and selling its excess allowances.
- These incentives give rise to least-cost abatement.
 - We achieve cost-effective regulation!!!
- The existence of this tension or balance between marginal cost and price of abatement implies that there is a market. There are options



Compliance options



- Compliance options:
 - Without trading: Reduce SO₂ emissions to comply with their quota
 - Install new abatement technology (SO₂ “scrubbers”)
 - Use cleaner fuel sources (e.g., switch to low-sulfur coal)
 - Produce less electricity (typically not considered!)



Sulfur market

Emission Target = **E**

Emission / Unit Used
Cost / Unit



Reduction depends on how much is there per unit mass.
depends on how much power is generated.

Energy produced says how many units of fuel you use.



Where is efficiency?

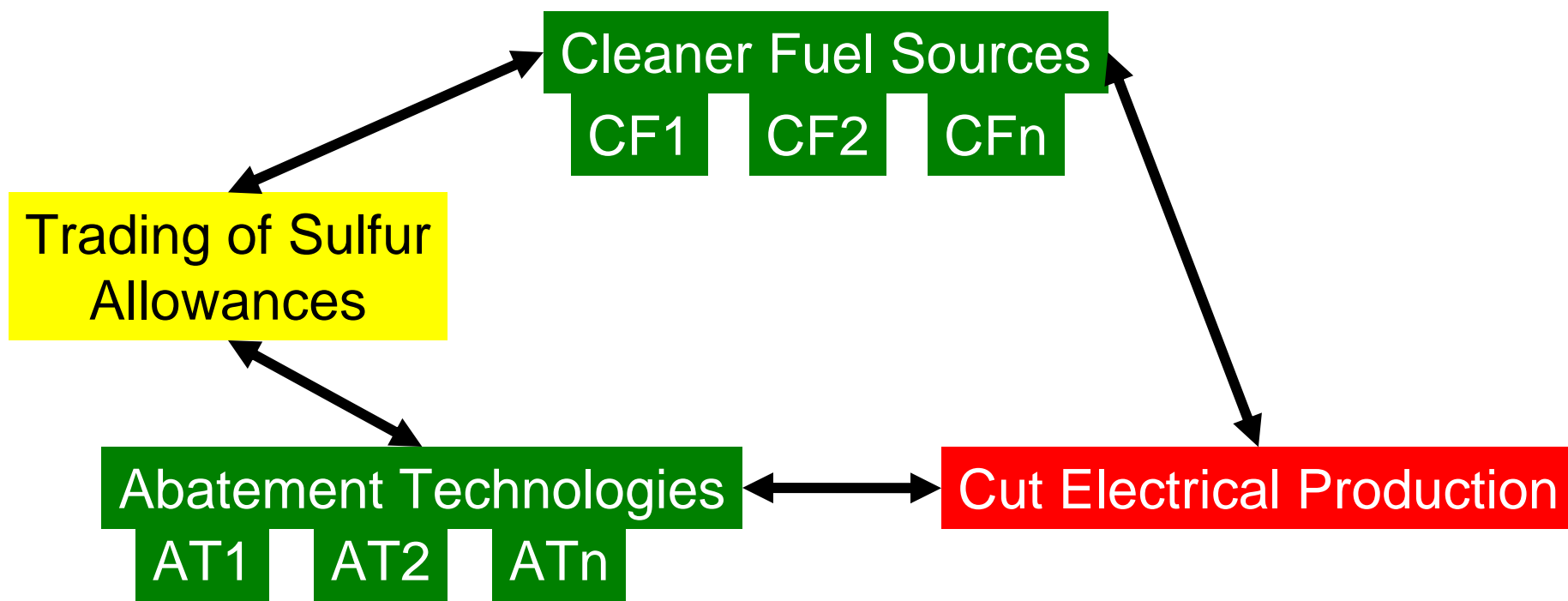


Market components

- Fuel Mass Units
- Buy fuel N units of Mass
- Fuel costs $D/(\text{unit Mass})$
- Energy Production $P / (\text{unit Mass of Fuel})$
 - Fuel efficiency
- Emissions (unit Mass of Fuel)
- Emissions (Unit Energy Production)
- Emission removal
 - proportional to amount?
 - cost to remove per unit mass of emission.
 - Link back to Mass of Fuel
 - Link back to energy production
 - disposal of removed emission
- Total emission
 - Source
 - Sink
- Compare to some emission amount, say a quota.
 - A cost that is associated with the difference from that quota
- Need to identify cost at every step.
 - Different types of cost
 - Total cost.
 - Price that energy is worth
- Market
 - Market implies that there is some sort of balance in this system
- Cost is the unifying thread through the system



Sulfur market



Where is efficiency?



Carbon market

Choices?

Cleaner Fuel Sources

CF1

CF2

CFn

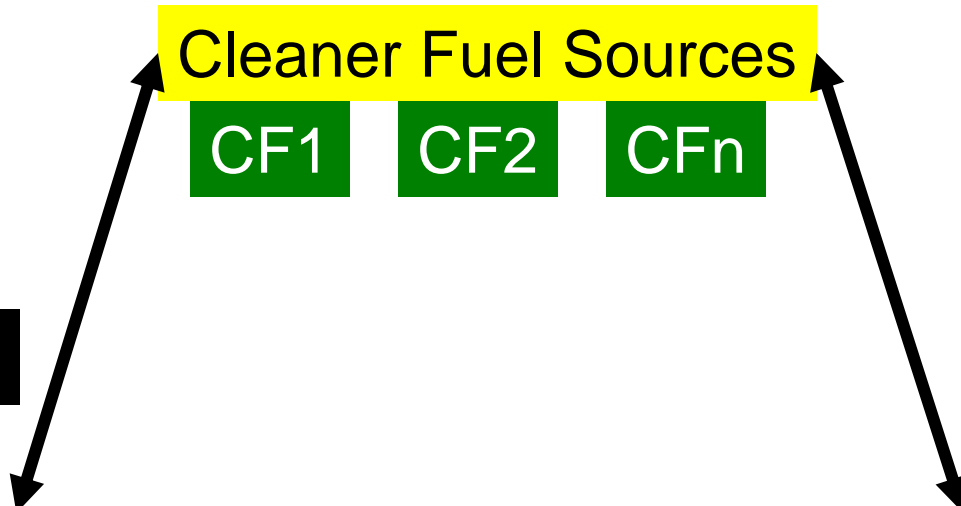
Enhance Sinks?

Abatement Technologies

Cut Energy Production

Conservation?

Efficiency?





Carbon market

Choices?

Trading of Carbon Allowances

Cleaner Fuel Sources

CF1

CF2

CFn

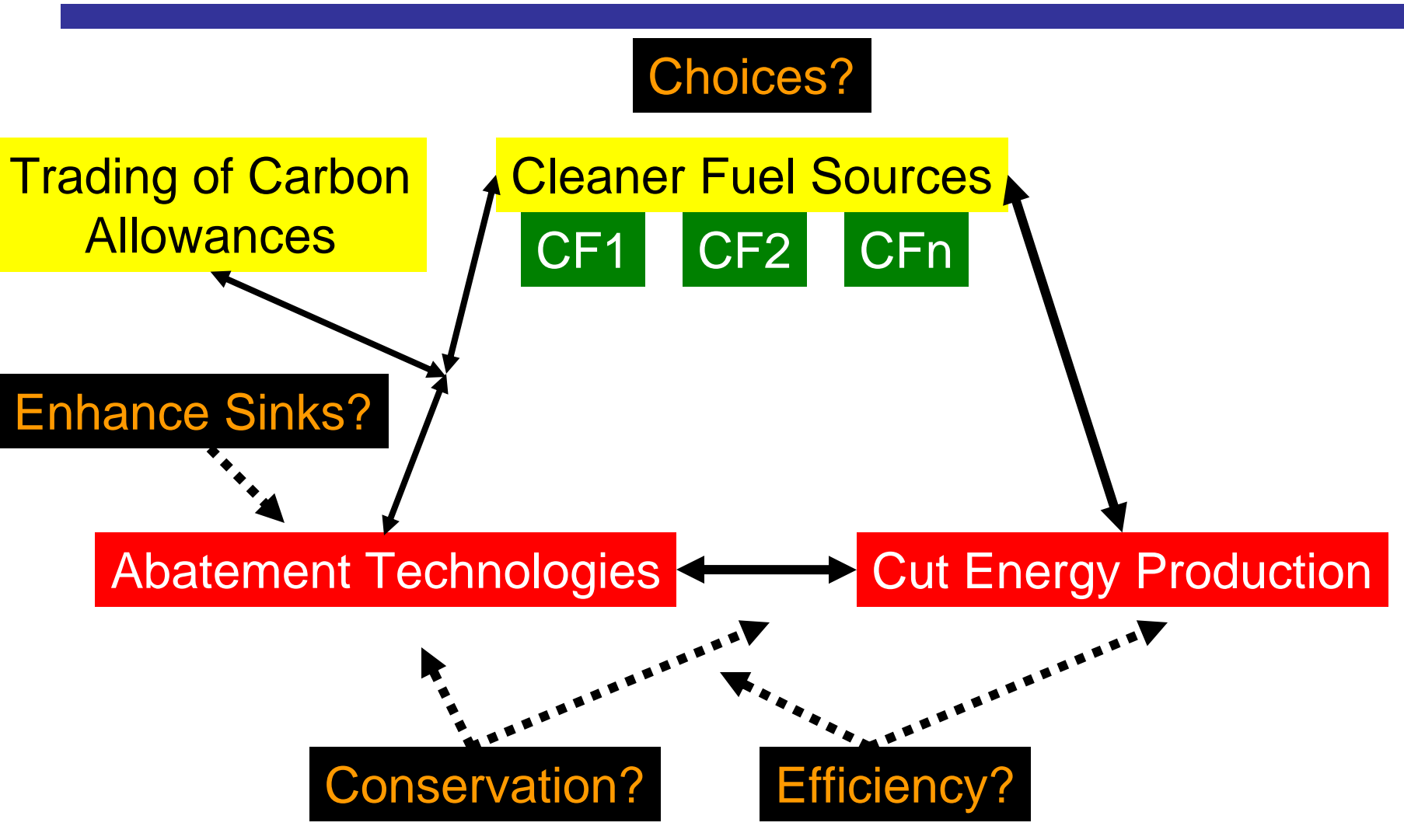
Enhance Sinks?

Abatement Technologies

Cut Energy Production

Conservation?

Efficiency?





Some Market Issues

- What is the role of allowances?
 - Savings relative to what baseline?
- Cost of allowance relative to other choices?
- How do we make a carbon market?