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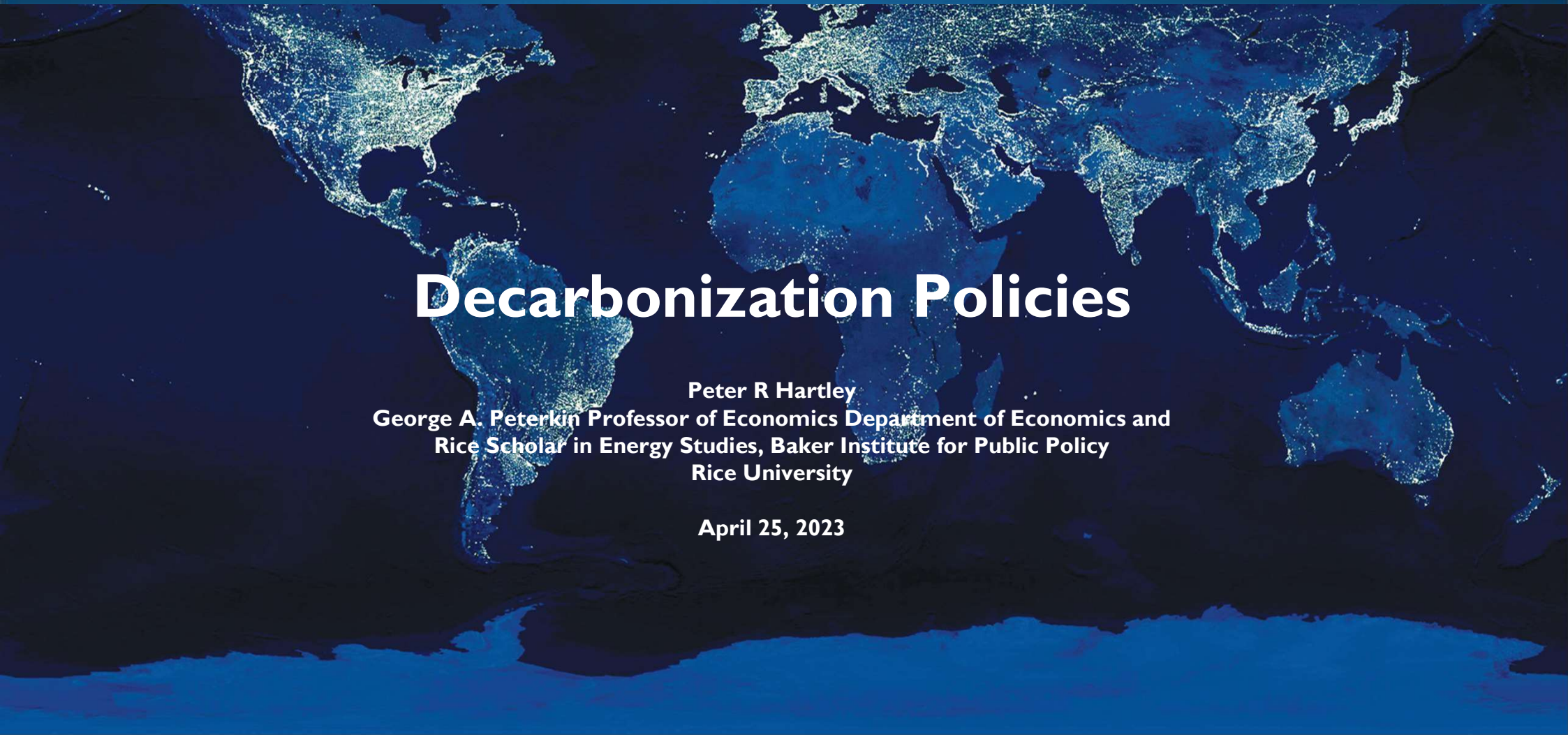

Decarbonization Policies

Peter R Hartley
George A. Peterkin Professor of Economics Department of Economics and
Rice Scholar in Energy Studies, Baker Institute for Public Policy
Rice University

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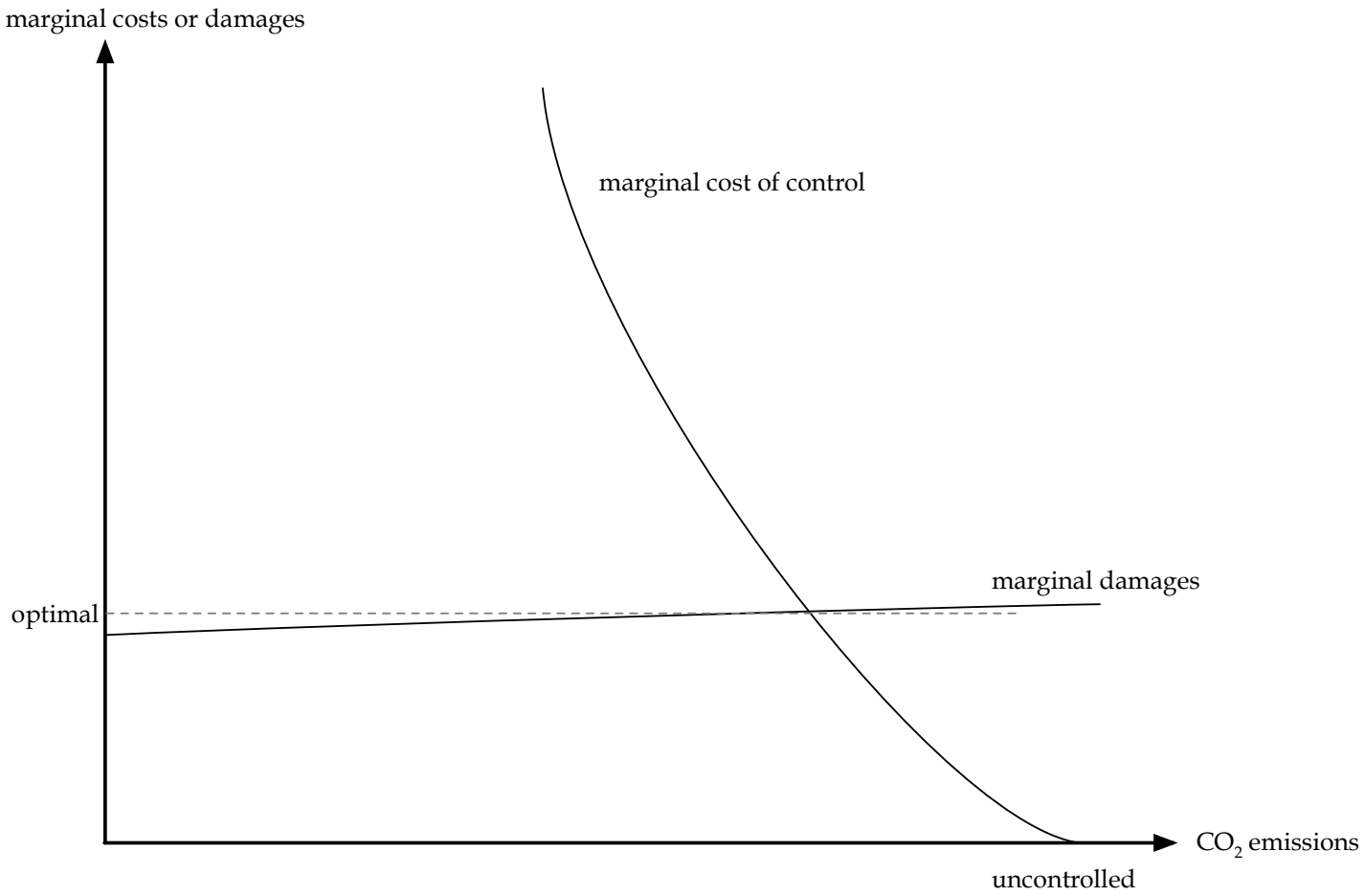
Conceptual framework



Equimarginal principle

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- To minimize emission reduction costs:
  - The marginal costs of each method in active use should be equal
  - *Each emitter* should use, and have the same incentive to invent, lowest cost methods of emission reduction, including sequestration
  - Requires all emitters should face the same costs of control
- Externality from CO_2 accumulation is *global*, but there are geographic dimensions to:
  - Changing climates (plural)
  - Climate vulnerabilities
  - Costs of control
- Energy use in high population developing countries will dominate coming decades
  - Carbon leakage

Economic instruments vs. command & control

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- C&C tends to "lock in" existing technology as a single "solution"
  - Economic instruments encourage least cost control and invention of new technologies
- Command & control (C&C) involves governments "picking winners"
  - Economic instruments (net emission taxes and permits) are technology neutral
  - C&C encourages wasteful lobbying expenditure
- Market instruments are more compatible with pro-competitive energy market reforms
  - Decentralized markets are more effective at revealing information about control costs

Emission taxes versus permits

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- Marginal damages and marginal costs of control are imperfectly known and changing
  - Flatter MD than MC implies efficient net emission *cost* is less variable than *quantity*
    - Taxes on net emissions involve lower expected losses than permits
    - A stable emission price is more compatible with investment in long-lived assets
  - Emission reductions are a *risky investment* requiring a risk adjusted discount rate
    - Delaying emission control is an *option* whose value is increased by uncertainty
- "Double dividend" favors taxes unless permits are auctioned rather than given away
- Giving permits away ("grandfathering") also favors incumbent technologies and firms

Desirable *non-emission* attributes of energy sources

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- Affordability – cost of delivered energy to consumers
- Energy security – stability and predictability of energy supply and prices
- Controllability – inflexibility of demand requires more flexibility of supply
- Reliability – exogenous supply fluctuations require flexible alternative supply
- Storability – eliminating supply/demand imbalances over time
- Transportability – eliminating spatial supply/demand imbalances
- Convenience – available on demand in many locations, low time cost to access, safe
- Usability – energy comes in many forms, and some are uniquely suited to some uses
- Non-emission externalities – visual, noise, wildlife, land, water, minerals, disposal

Effective alternative to fossil fuels?

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- Need energy technology that can displace fossil fuels *at scale and without compulsion*
- There is time for needed R&D:
  - The *least sensitive* GCM are most consistent with the evidence
  - RCP 8.5, touted as "business as usual," is in fact extremely unrealistic
- New nuclear technologies hold greatest promise
  - Energy density matters – cost and impacts *per unit of energy produced*
  - Process heat and manufactured gaseous, liquid or solid fuels
  - Fewer problems than renewables with mineral requirements, transmission, network stability, compatibility with current wholesale electricity markets
  - New nuclear can solve safety, proliferation, regulation and affordability concerns
- The "valley of death" for new energy technologies
- Natural gas, energy storage and short-run versus long-run transition

What else can be done?

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- Self-protection policies such as:
  - Building dykes or levees to protect vulnerable coastlines or floodplains
  - Building dams to help protect against flooding and droughts
  - Improving evacuation procedures ahead of threatening weather events
  - Improving weather forecasts to give better warnings to take precautions
  - Improving urban drainage systems and mitigating urban heat island antecedents
  - Burying power lines to make them more resilient to storms
  - Changing building codes to increase structural integrity
  - Removing inducements to build on vulnerable flood plains or coasts
  - Developing crops more resilient to weather extremes
- These defend against adverse weather *whether or not* distributions of those events change
- They can be tailored to address local vulnerabilities and do not require agreement of others

What else can be done?

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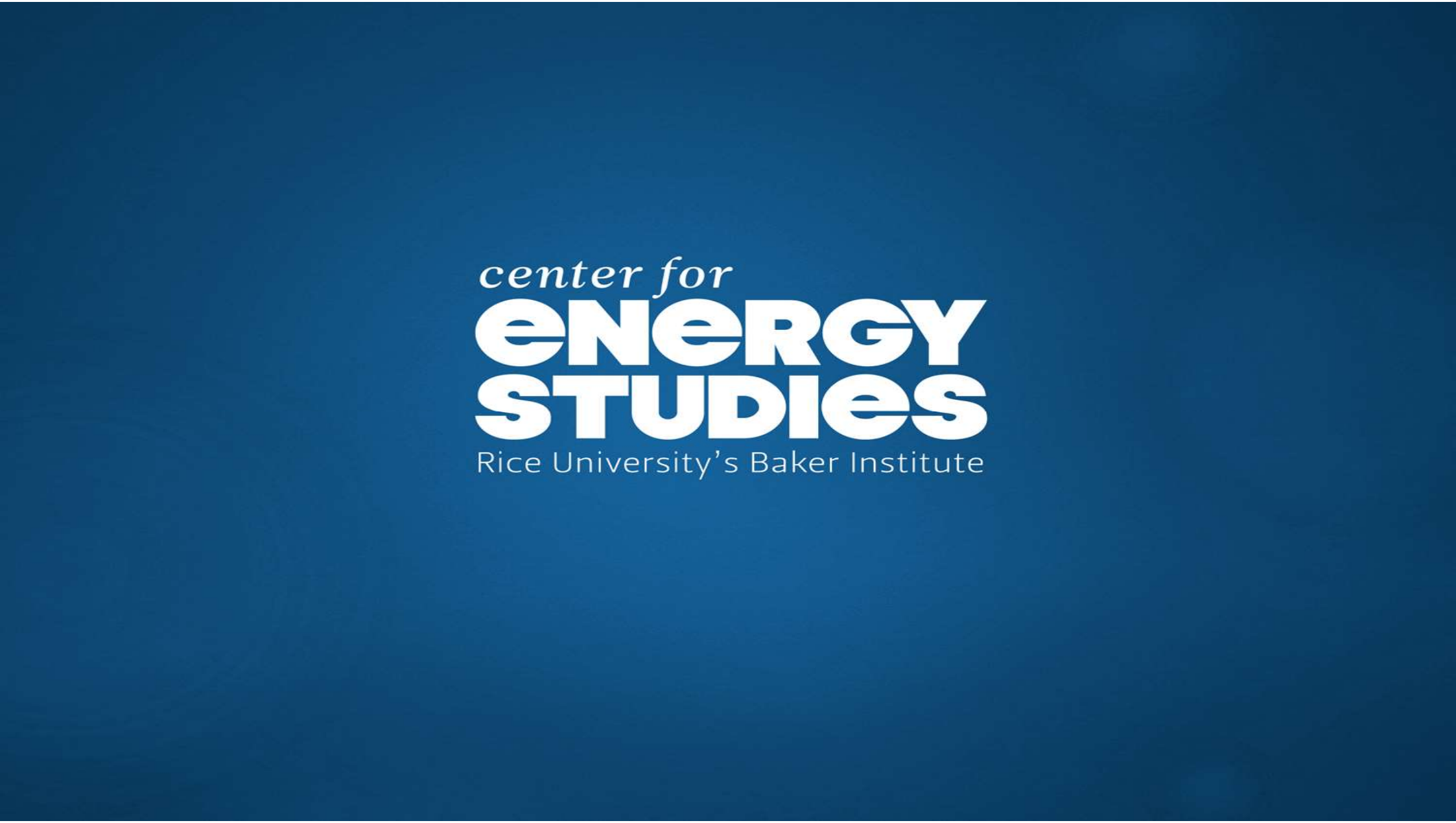
- Self-insurance policies such as:
  - Better disaster relief including improved cooperation between different jurisdictions
  - Better training and equipping of volunteer rescue services
  - Improved emergency medical facilities
  - Improved civil reconstruction capability
- They can also reduce costs of other disasters unrelated to adverse weather or sea level rise
  - Earthquakes
  - Tsunamis
  - Volcanic eruptions
  - Terrorist attacks
  - Major industrial accidents
- This would raise their benefit/cost ratios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