

# ADVANCED OPTIMIZATION FOR ENERGY PROCESSES

**Nick Sahinidis**

**National Energy Technology Laboratory  
Department of Chemical Engineering  
Carnegie Mellon University  
sahinidis@cmu.edu**



**Energy  
Systems**

**OPTIMIZATION  
Theory  
Algorithms  
Software**

**Biomedical  
Computing**

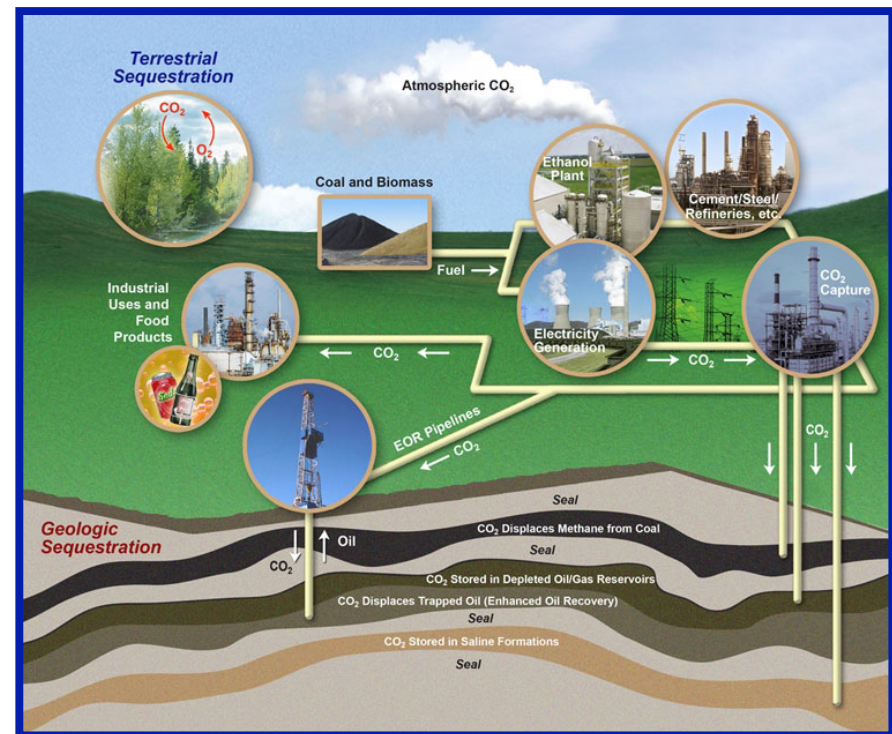
**Computational  
Chemistry**

# MOTIVATION

- **One-third of U.S. CO<sub>2</sub> emissions come from power plants and other point sources**
- **Available carbon capture and sequestration technologies would increase electricity costs**
  - **Pulverized coal plants**
    - » **Currently: 75% increase**
    - » **Goal: < 35% increase**
  - **Integrated gasification combined cycle plants**
    - » **Currently: 35% increase**
    - » **Goal: < 10%**
- **Risk quantification required**

# CARBON CAPTURE AND SEQUESTRATION TECHNOLOGIES

- **Capture**
  - Pre/Post/Oxy-fuel Combustion
  - Absorption, adsorption, membranes, cryogenic distillation, ...
- **Sequestration**
  - Ocean
  - Mineral
  - Geologic
    - Oil/gas reservoirs
    - Saline formations
    - Coal seams
  - ...



[http://www.netl.doe.gov/technologies/carbon\\_seq/index.html](http://www.netl.doe.gov/technologies/carbon_seq/index.html)

# MAJOR GOALS

- **Develop algorithms and software to facilitate optimization of energy processes**
  - **BARON: Global optimization of algebraic NLPs/MINLPs**
  - **Optimization without an algebraic model**
    - » **Simulation-based optimization**
    - » **Derive surrogate algebraic models from simulations; optimize surrogates with algebraic methods**

# PROJECTS AND STUDENTS

- **Optimization of CO<sub>2</sub> capture technologies**
  - Alison Cozad
- **Design of drilling fluids for high P/T**
  - Apurva Samudra
- **Risk assessment for CO<sub>2</sub> sequestration**
  - Yan Zhang