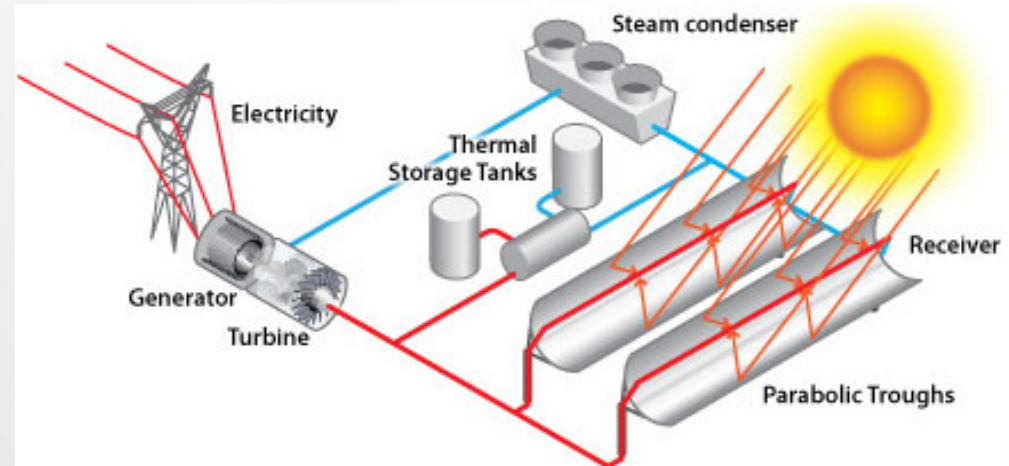


Dynamic Optimization of Energy Systems with Storage – Kody Powell w/ Dr. Thomas Edgar

- Energy storage – shift times of production/consumption
- Hybrid plant operation
- Solar thermal used as case study



- Dynamic optimization
 - Requires forecasting ahead
 - Energy availability
 - Consumer demand
 - Can control to minimize energy usage, maximize profit, etc.

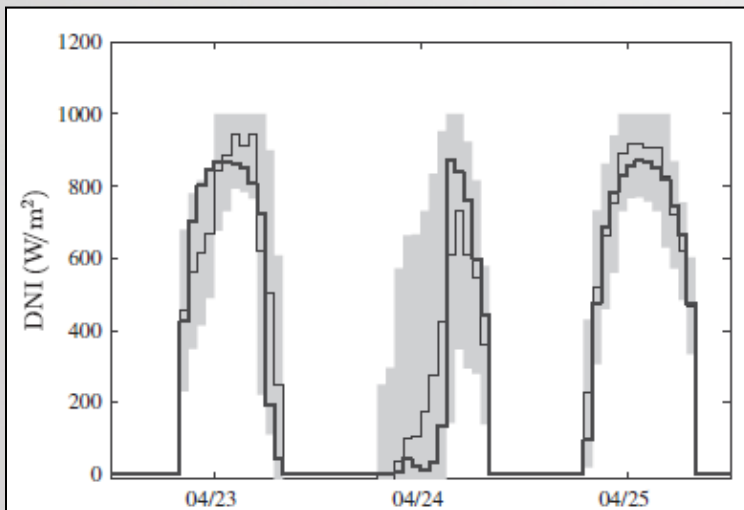


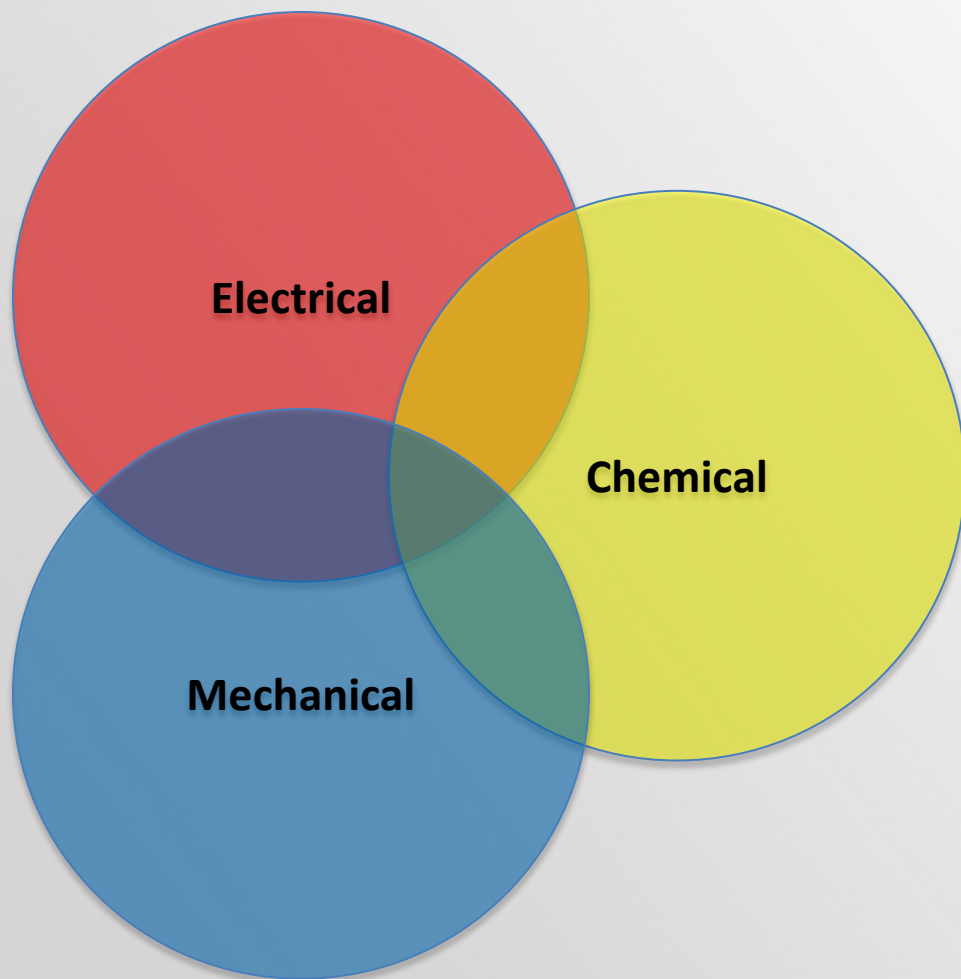
Image from: Marquez, R. and Coimbra, C. F. M., Forecasting of global and direct solar irradiance using stochastic learning methods, ground experiments and the NWS database. *Solar Energy*. Volume 85. 2011

Preliminary Results

- **64% more solar energy harvested on cloudy day**
- **Can make solar thermal more economical technology**
- **Apply to other systems**
 - Combined heat and power
 - Electric grid with storage
 - Microgrid
- **Demand forecasting needed**

	Solar Energy Collected (MWh)	Energy Collected/ Total Incident Energy (%)
Sunny Day		
Standard Control	18.02	76.8%
Dynamic Optimization	18.59	79.2%
Partly Cloudy Day		
Standard Control	14.60	75.8%
Dynamic Optimization	15.83	81.1%
Mostly Cloudy Day		
Standard Control	4.75	52.1%
Dynamic Optimization	7.80	85.4%

Education and the Benefit of IGERT



IGERT

- Interact with many disciplines
- Opportunities for collaboration

Education

- Classes in Chem E, Mech E, Aerospace, EE
- Topics: energy, control, optimization, modeling, policy