

# Modeling and Management of Distributed PV Generation, Storage, and Grid

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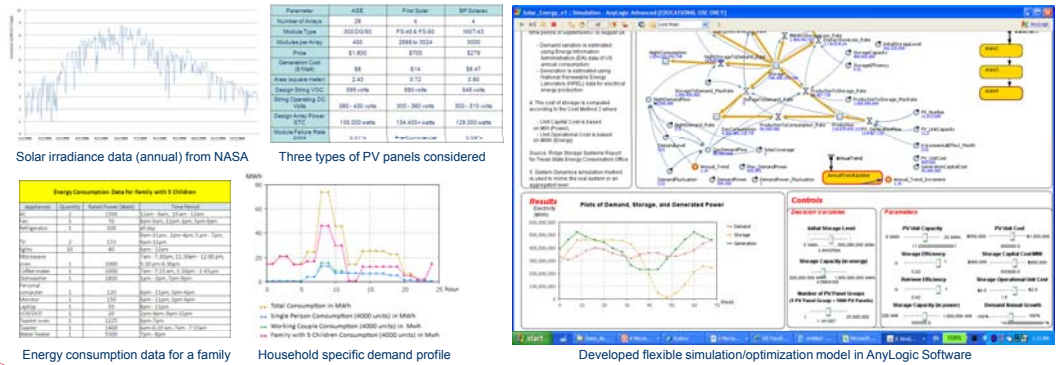
## 1. Central Issues to be Addressed

- To **reduce carbon dioxide** created from traditional fossil fuels when burnt and **make our environment healthier**, providing an energy share from **renewable sources** (e.g. sunshine, wind, water, bio-fuel) is critical.
- Major **challenges** associated with solar (of focus of this research) generation
  - Geographically distributed and uncontrollable (dependent on the changing weather)
  - Storage units are additionally required (save energy for night (short-term); save energy for peak season (long-term))
  - Interface with grid, smart-grid (emerging), and other sources (fossil, wind, water, bio-fuel)
- Research Goal:** design and develop **integrated simulation and optimization models**, which will allow us to 1) obtain a robust and most economical mixture of various generation **capacities** as well as storage capacities while meeting reliability requirements against fluctuating demand profiles and weather conditions and 2) evaluate various **operational decisions** (e.g. store energy vs. sell it to the grid).

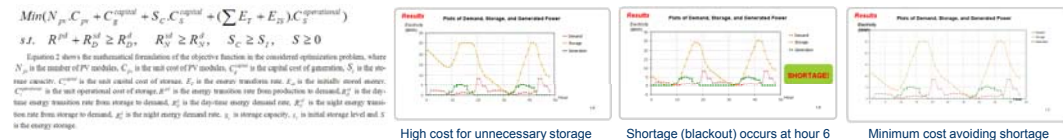
## 2. Scenarios and Modeling Considerations

- Electricity consumption in the entire US (capacity planning) (**Level 1**)
  - Given **weekly US electricity demand** (from Energy Information Administration (EIA)) and solar irradiance data (from NASA), weekly power generation and storage are concerned (**PV is the only source**)
  - Not necessarily to be located at a single facility; we focus on the **total amounts of generation and storage** (transmission capacity is implicitly considered)
  - Goal: Find an optimum (**minimum cost**) capacities given projected demand profiles; **decision variables** (the number of PV panels; Storage capacity; Initial energy level to be stored)
- A region in Tucson (1100 house) (capacity planning)
  - Level 2** (generation is based on TEP Springerville site; empirical/aggregated consumption)
  - Level 3** (generation is based on TEP Springerville site; consumption of individual house (agent-based modeling))
- Perspective of utility company (including grid) (operational decisions) (11000 house) (**Level 4**)
- Different sectors of load (**Level 5**) -- residential, industrial, commercial, transportation
- Can be extended to other renewable sources (**solar**; wind; bio-fuel; hydro) or storage technologies (**CAES**; **super-capacitor**; batteries)

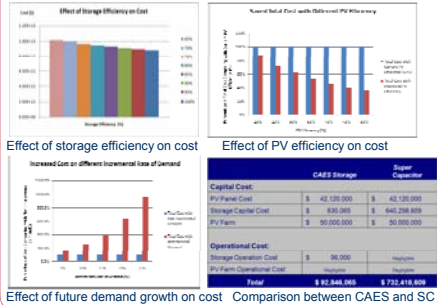
## 3. Data and Simulation Models



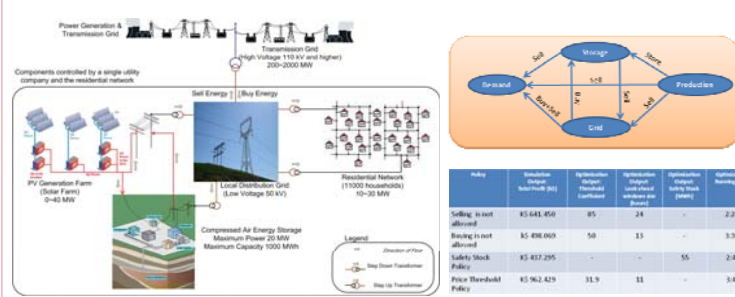
## 4. Optimization and Its Impact



## 5. Experimental Results



## 6. Extension to Operational Decisions (Grid)



## 7. Students

- Esfand Mazhari (SIE)
- Jiayun Zhao (SIE)
- Nurcin Celik (SIE)
- Seungho Lee (SIE)

## 8. Future Works

- Smart-grid and intelligent grid
- Sensor network and SCADA for monitoring/control demand, generation, storage
- Extension to other renewable sources (wind, bio-fuel, hydro)