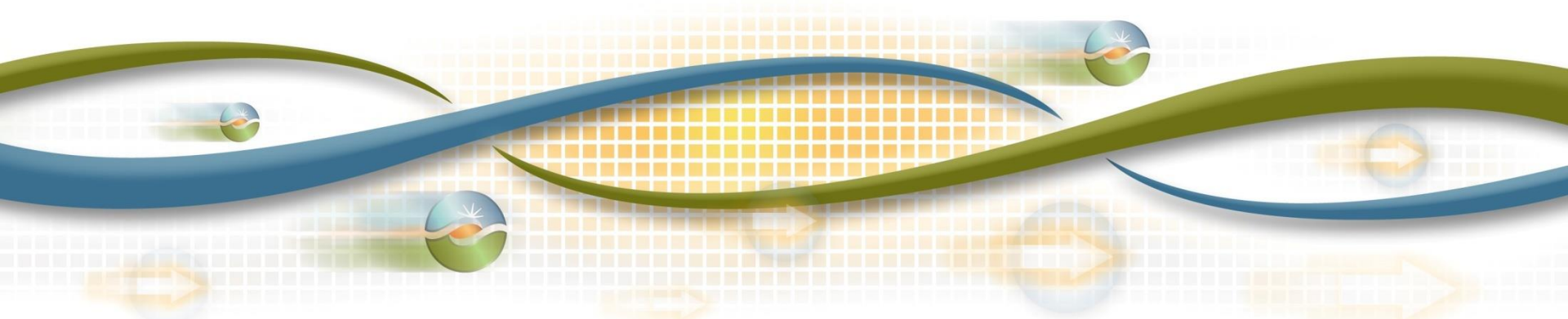
California ISO

Multi-State Generator (MSG) Model

George Angelidis, Ph.D.
Principal
Power Systems Technology Development
January 27, 2017

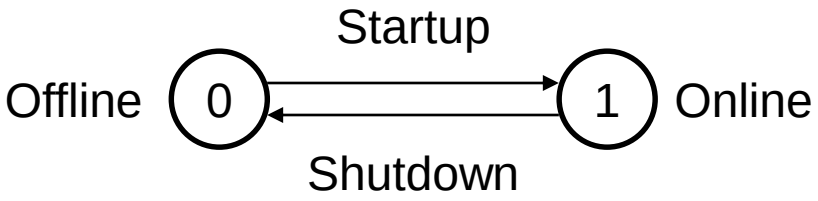


What is a MSG?

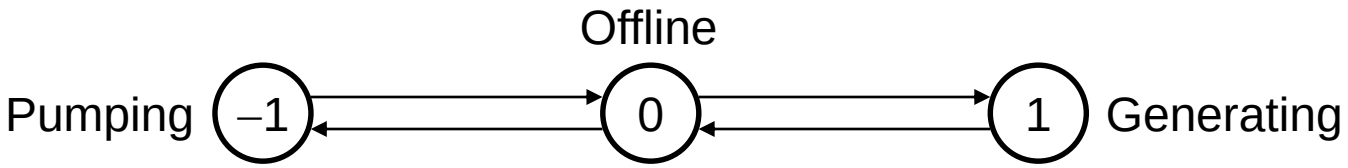
- MSG is a generating resource that can operate in different distinct operating states
  - Each operating state has its own physical characteristics
    - Minimum/maximum capacity, ramp rate, startup capability
  - Each operating state has its own inter-temporal constraints
    - Minimum Up/Down (in-state/out-of-state)Time, Maximum Daily Startups (in-state transitions)
  - Permissible state transitions
    - Startup Time or State Transition Time

MSG is an expansion of the standard Generating Resource model

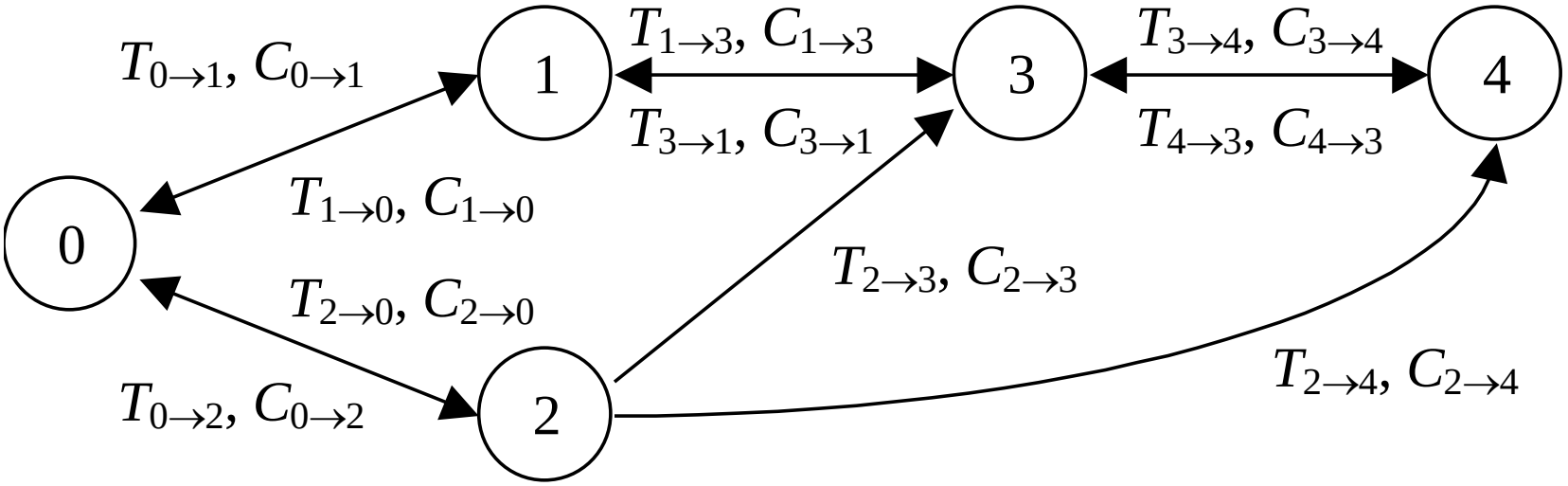
- Generating Resource



- Pumped-Storage Hydro



MSG has multiple online states



$T_{i\to j}$: State Transition Time from state i to state j

$C_{i\to j}$: State Transition Cost from state i to state j

MSG advantages

- Each state has each own bids and constraints
  - Accurate cost for overlapping configurations
  - State Transition Costs are considered
  - More optimal unit commitment and dispatch
  - Feasible dispatch
- Simpler implementation with lower performance cost
  - No need for dynamic ramp rates
  - No need for Forbidden Operating Ranges

MSG Implementation

- Bidding rules
  - Self-commitment must specify state
  - Self-schedule at physical resource level
  - Energy bids must allow downward transitions and shutdown without gaps
- Optimization
  - Binary variable for each state
  - Ancillary services awards are preserved on state transitions
  - Telemetry indicating operating state