Unit Commitment Optimization model

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Sets

T set of total time from [0,maxTime]- maxTime furthest out to optimize for
P set of plants which we are optimizing for dispatching
R set of time period for when starting up and ramping is possible
(will assume 2-MaxTime inclusive)

Parameters

o_p variable operating cost of plant p
c_p capital (fixed) cost of plant p
e_p environmental cost associated with plant generating electricity at plant p
t_p startup cost (turn on) of plant p
r_p ramp rate percentage of plant p
g_p maximum generating capacity of plant p
m_p minimum generating capacity of plant p
d_t demand at time t for the system

Decision Variables

$x_{p,t}$ generation for plant p at time t
$i_{p,t}$ operation for plant p at time t (1 is operating, 0 is not operating)
$s_{p,r}$ plant p switches on at ramp time r (1 switching on, 0 otherwise)

Optimization Model

Objective

$$\min \quad \sum_{p\in P}\sum_{t\in T}((x_{p,t}(o_p+e_p)+i_{p,t}c_p)+\sum_{r\in R}s_{p,r}t_p) \tag{1}$$

S.t.

$$\sum_{p\in P} x_{p,t} \geq d_t \qquad \forall T \tag{2}$$
$$x_{p,t} \leq g_p i_{p,t} \qquad \forall P,T \tag{3}$$
$$x_{p,t} \geq m_p i_{p,t} \qquad \forall P,T \tag{4}$$
$$x_{p,r} - x_{p,r-1} \leq r_p i_{p,r} + m_p s_{p,r} \qquad \forall P,R \tag{5}$$
$$x_{p,r-1} - x_{p,r} \leq r_p i_{p,r-1} + m_p(i_{p,r-1} - i_{p,r} + s_{p,r}) \qquad \forall P,R \tag{6}$$
$$s_{p,r} \geq 1 - i_{p,r} - i_{p,r-1} \qquad \forall P,R \tag{7}$$
$$x_{p,t} \geq 0 \qquad \forall P,T \tag{8}$$
$$i_{p,t}, s_{p,r} \qquad \in \{0,1\} \tag{9}$$

Objective and Constraint Explanations

1. minimize system operating costs which are: generation variable costs and variable environmental costs, fixed operating costs (can also explore fixed environmental costs which could be interesting to explore), startup costs for each plant in ramping period.

2. cumulative generation from all plants at every single timestep should meet or exceed demand

3. generation from each plant can't exceed its maximum rated nameplate capacity if on

4. generation from each plant must be above its minimum capacity if on

5. generation for each specific plant must abide by its ramping up constraint limits (second addition is allowing greater jumps for minimum operating capacity).

6. generation for each specific plant must abide by its ramping down constraint limits (second addition makes sure constraint only important when turning off)
7. plant is switching on when you go from plant off stage (i = 0) to plant on stage (i = 1)
8. generation must be non negative
9. a generator will either be on (1) or off (0) or switching on (1) or otherwise (0)