

6 EPEC

 Name

 Learning objectives

- Define equilibrium problems with equilibrium constraints (EPEC)
- Formulate and solve EPECs using diagonalization

 Bibliography

- Basic reading:
 - Wogrin, S. Generation expansion planning in electricity markets with bilevel mathematical programming techniques, PhD dissertation, 2013.
 - Gabriel, S., Conejo, A., Fuller, D., Hobbs, B., and Ruiz, C. Complementarity modeling in energy markets. Springer, 2012 (chapter 7).
- Further reading:
 - S. Wogrin, J. Barquin, and E. Centeno. Capacity expansion equilibria in liberalized electricity markets: An EPEC approach. IEEE Transactions on Power Systems, 28(2):1531-1539, 2013.



Capacity expansion of several power producers

In example 5-2 we formulated a bilevel problem to determine the optimal capacity $\bar{x}_g$ of one power producer. However, other power producers may also increase the capacity of their units. Discuss how to formulate a model to determine the optimal capacity expansion decisions of two power producers assuming they make these decisions simultaneously.



📌 Example 6-1: Diagonalization method for capacity expansion of several producers

Write down all the steps of the diagonalization algorithm to solve the capacity expansion model of two power producers g_1 and g_2 .

Solving Example 6-1 with GAMS (Example6-1.gms)

Solve the problem formulated in Example 6-1 using GAMS and provide the optimal capacities for g_1 and g_2 if each unit is owned by a different power producer for the following data: $i_{g_1} = \$50000/\text{MWyear}$, $i_{g_2} = \$40000/\text{MWyear}$, $\bar{X}_{g_1} = \bar{X}_{g_2} = 1000\text{MW}$, $\hat{x}_{g_1} = \hat{x}_{g_2} = 1\text{MW}$.

Unit	$\underline{x}_g$	$\bar{x}_g$	c_g	Demand steps	t_w	d_w
g_1	0	?	5	w_1	2920	325
g_2	0	?	7	w_2	2920	575
g_3	0	400	10	w_3	2920	750
g_4	0	400	15			

Example6-2.gms

Use the code of example 5-3 or 5-4 to determine the optimal capacities of g_1 and g_2 if these units are owned by the same power producer.

Example6-3.gms

Modify the code of example 1-3 to determine the optimal capacities of g_1 and g_2 in order to minimize the production and investment costs (central planner perspective).

📌 Compare capacity expansion decisions

Fill in the following table with the optimal capacity expansion decisions obtained in the previous examples and comment on the results.

Unit	Monopoly	Competition	Central planner
g_1			
g_2			