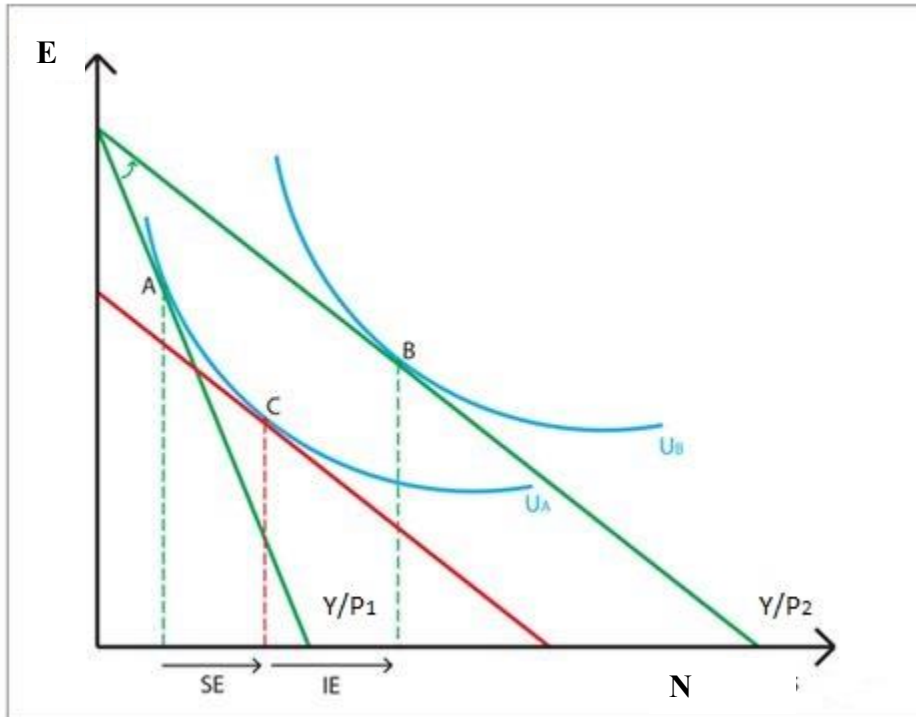


# Study Questions to Accompany International Energy Markets

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## Chapter 16. Modeling Energy Demand

**16.1** Consider a world of energy (E) and other non-energy goods (N). A consumer has a budget constraint (Y) and all of it is spent on either Energy or Non-energy. Now, if the price of Energy drops from  $P_{E1}$  to  $P_{E2}$ , show the income effect (IE) and the substitution effect (SE) as the consumption bundle changes from A to B on a 2 goods preference model. (contributed by Anant)



**16.2** (contributed by Derek) A 20 MW natural gas power plant with a heat rate of 10,000 Btu/kWh faces electricity prices of \$0.10/kWh.

**16.2a** What is the marginal revenue product of natural gas per MMBtu?

**16.2b** How much natural gas does the plant require to generate at full capacity for 1 hour?

**16.2c.** What are the plant's profits during this hour if gas costs \$6/MMBtu?

**16.2d.** Assume that the plant is not operating near capacity and it can employ additional units of labor per hour to increase output. The current wage is \$9/hour. The first unit of labor increases output by 400 kWh, the second by 350 kWh, the third by 300 kWh, and so on; while additional units of energy (MMBtu's) increase output at a constant rate based on the given heat rate (constant marginal revenue product). How many units of labor should the plant employ?

**16.3** (Contributed by Toru Muta) Using World Energy Balances (textbook page 377, Table 16.1), compare the efficiency among Electricity Plant, Combined Heat and Power Plant, Heat Plant and Oil Refinery. Then, discuss what features make the difference in efficiency.

Efficiencies are calculated as below.

(Mtoe, 2011)	<b>Elec Plant</b>	<b>CHP Plant</b>	<b>Heat Plant</b>	<b>Oil Ref</b>
Coal Peat	-2075.4	-180.8	-109.5	
Crude Oil	-41.6		-0.8	-4023.9
Oil Product	-203.8	-25.5	-11.7	3989
Natural Gas	-711.3	-314	-92.9	-0.8
Nuclear	-670.4	-3.6		
Hydro	-300.2			
Ot Renew	-99.8	-1.4	-0.1	
Bio & Waste	-81.1	-42.8	-10.8	
Elec	1725	177.8	-0.3	
Heat	-0.4	153.1	189.7	
Input Total	-4184	-568.1	-226.1	-4024.7
Output Total	1725	330.9	189.7	3989
<b>Efficiency (Out/In)</b>	<b>41%</b>	<b>58%</b>	<b>84%</b>	<b>99%</b>