Optimal Pigouvian Taxation

A coal-fired power plant releases air pollution into the atmosphere for every unit of electricity produced. The inverse demand function is $P_d = 20 - 0.5Q$, which represents the marginal benefit where Q is the quantity consumed when consumers pay price P_d. The inverse supply curve for coal-fired electricity is $P_s = 5 + Q$, which represents the marginal private cost curve when the power plant produces Q units. The marginal damage from emissions is given by $MD = 3.5Q$, which describes the cost of greenhouse gas emissions and local air pollution when the industry generates Q units of coal-fired electricity.

(a) Illustrate the market for the coal-fired electricity with a supply/demand graph. Be sure to draw the curves for demand, supply, marginal damage, and social marginal cost.

(b) What is the private market equilibrium?

(c) What is the socially optimal/efficient quantity of coal-fired electricity?

(d) How large is the deadweight loss from this negative production externality?

(e) A corrective tax has the effect of "internalizing the externality." How large should the (constant) per-unit corrective tax be in order to induce the market quantity to be socially optimal/efficient? Draw the firm's supply curve with the new tax on your graph in part (a). What is the consumer price paid and the supplier price received with the optimal corrective tax?

(b)

$$\begin{aligned} 20 - 0.5Q &= 5 + Q \\ 15 &= 1.5Q \\ Q &= 10 \\ P &= 15 \end{aligned}$$

(c)

$$\begin{aligned} 20 - 0.5Q &= 5 + Q + 3.5Q \\ 15 &= 5Q \\ Q &= 3 \\ P &= 17.5 \end{aligned}$$