$$\min_{UP_{supply},EL_{invs},UP_{exports}} \quad UP_{supply} \cdot UP_{fuelcst} + \sum_{ELp} EL_{invs}(ELp) \cdot EL_{capital}(ELp) - UP_{exports} \cdot UP_{intlprice} \tag{1}$$

s.t.

$$EL_{dem} - \sum_{ELp} EL_{op}(ELp) \leq 0 \tag{1.1}$$

$$EL_{op}(ELp) - EL_{invs}(ELp) \leq 0 \tag{1.2}$$

$$UP_{supply} \leq UP_{fuelsupmax} \tag{1.3}$$

$$\sum_{ELp} EL_{op}(ELp) \cdot EL_{fuelburn}(ELp) - EL_{UPconsump} \leq 0 \tag{1.4}$$

$$EL_{UPconsump} + UP_{exports} - UP_{supply} \leq 0 \tag{1.5}$$

$$EL_{op}(ELp) \geq 0, EL_{invs}(ELp) \geq 0, UP_{exports} \geq 0$$

$$\min_{UP_{supply},UP_{exports}} \quad UP_{supply} \cdot UP_{fuelcst} - UP_{exports} \cdot UP_{intlprice} - EL_{UPconsump} \cdot EL_{fuelprice} \tag{2}$$

s.t.

$$EL_{UPconsump} + UP_{exports} - UP_{supply} \leq 0 \tag{2.1}$$

$$UP_{supply} - UP_{fuelsupmax} \leq 0 \tag{2.2}$$

$$UP_{exports} \geq 0, UP_{supply} \geq 0$$

$$\min_{EL_{invs},EL_{UPconsump}} \quad \sum_{ELp} EL_{invs}(ELp) \cdot EL_{capital} + EL_{UPconsump} \cdot EL_{fuelprice} \tag{3}$$

s.t.

$$\sum_{ELp} EL_{op}(ELp) \cdot EL_{fuelburn}(ELp) - EL_{UPconsump} \leq 0 \tag{3.1}$$

$$EL_{dem} - \sum_{ELp} EL_{op}(ELp) \leq 0 \tag{3.2}$$

$$EL_{op}(ELp) - EL_{invs}(ELp) \leq 0 \tag{3.3}$$

$$EL_{invs} \geq 0, EL_{UPconsump} \geq 0, EL_{op} \geq 0$$

$$EL_{dem} - \sum_{ELp} EL_{op}(ELp) \leq 0 \qquad \perp \qquad DEL_{sup}$$

$$EL_{UPconsump} + UP_{exports} - UP_{supply} \leq 0 \qquad \perp \qquad DUP_{dem} \tag{2.1}$$

$$EL_{fuelprice} = \begin{cases} DUP_{dem}, & \text{in the deregulated competitive market.} \\ UP_{AP}, & \text{in the market with administered prices.} \end{cases} \tag{3.4}$$