ECON 4930 Spring 2011
Hydropower economics
Lecture 7

Lecturer:

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Self-sufficiency of electricity supply

- Impact of lobby groups
- If one wants cheap electricity one must build so much capacity that there is enough electricity at the price one wants
  - Willoch, K. (1985): “El-forsyningen foran store oppgaver” [Electricity supply faces great challenges], *Fossekallen* 31(7), 4-5.

Trade between countries (regions)

- Consider two countries (regions) linked by an interconnector, home country and abroad
- Loss on the interconnector is disregarded
- Trade during a period is the net flow, i.e., either import or export
- The price of electricity abroad is exogenous
- Money is a new good in our partial model
- Trade income (expenditure) is just added (subtracted from) to the social value of electricity consumption

The social planning problem with trade constraint

$$\max \quad \sum_{t=1}^{T} [\int_{z=0}^{x_t} p_t(z)\,dz + p_t^{XI} e_t^{XI}]$$

subject to

$$x_t = e_t^H - e_t^{XI}$$

$$R_t \le R_{t-1} + w_t - e_t^H$$

$$R_t \le \overline{R}$$

$$-\overline{e}^{XI} \le e_t^{XI} \le \overline{e}^{XI}$$

$x_t, e_t^H, R_t \ge 0$, e_t^{XI} unconstrained in sign

$T, w_t, R_o, \overline{R}, p_t^{XI}, \overline{e}^{XI}$ given, R_T free, $t = 1,..,T$

The Lagrangian function

$$L = \sum_{t=1}^{T} \left(\int_{z=0}^{e_t^H - e_t^{XI}} p_t(z)\,dz + p_t^{XI} e_t^{XI} \right)$$

$$- \sum_{t=1}^{T} \lambda_t (R_t - R_{t-1} - w_t + e_t^H)$$

$$- \sum_{t=1}^{T} \gamma_t (R_t - \overline{R})$$

$$- \sum_{t=1}^{T} \alpha_t (e_t^{XI} - \overline{e}^{XI})$$

$$- \sum_{t=1}^{T} \beta_t (-e_t^{XI} - \overline{e}^{XI})$$

The Kuhn – Tucker conditions

$$\frac{\partial L}{\partial e_t^H} = p_t(e_t^H - e_t^{XI}) - \lambda_t \leq 0 \quad (= 0 \text{ for } e_t^H > 0)$$

$$\frac{\partial L}{\partial e_t^{XI}} = -p_t(e_t^H - e_t^{XI}) + p_t^{XI} - \alpha_t + \beta_t = 0$$

$$\frac{\partial L}{\partial R_t} = -\lambda_t + \lambda_{t+1} - \gamma_t \leq 0 \; (= 0 \text{ for } R_t > 0)$$

$$\lambda_t \geq 0 \; (= 0 \text{ for } R_t < R_{t-1} + w_t - e_t^H)$$

$$\gamma_t \geq 0 \; (= 0 \text{ for } R_t < \overline{R})$$

$$\alpha_t \geq 0 \; (= 0 \text{ for } e_t^{XI} < \overline{e}^{XI}) \; (e_t^{XI} > 0)$$

$$\beta_t \geq 0 \; (= 0 \text{ for } -e_t^{XI} < \overline{e}^{XI}) \; (e_t^{XI} < 0) \;,\; t = 1,..,T$$

Enerhy bathtub diagram for two periods