

## Feed-In Tariffs

## Discussion of

Couture, Toby, and Yves Gagnon. "An analysis of feed-in tariff remuneration models: Implications for renewable energy investment." Energy policy 38.2 (2010): 955-965

# Main Points

- ▶ Discussion of Feed In tariffs.
- ▶ This is a way of compensating types of generation you want to encourage.
- ▶ Other Alternatives:
  - ▶ Net Metering (Small Scale)
  - ▶ Renewable Portfolio Standards (Utility Scale)
  - ▶ Power Purchase Agreement (General Term)
- ▶ Implicit is mandatory purchase of generated power.

# Net Metering

Visualize a rooftop PV system.

- ▶ You generate electricity
- ▶ If you use more than you generate only get charged for the excess.
- ▶ If you generate more than you use, the excess is subtracted from your bill at the rate you are charged.
- ▶ Most people don't use power (evening) when they generate it (day).

# Renewable Portfolio Standards (RPS)

Standard for a utility to have  $x\%$  of generation come from renewable sources.

- ▶ Premium for renewable and minimum standards achieve same result.
- ▶ RPS hides the cost while the premium makes it specific.

## Simple Static Calc 4 example

$$\begin{aligned} \min_{b,g} & f(b) + n(g) \\ \text{s.t.} & b + g = L \end{aligned} \tag{1}$$

- ▶  $b$  = brown electricity
- ▶  $g$  = green electricity
- ▶  $f$  and  $n$  = cost of generating brown and green energy.
- ▶  $L$  = amount you need.

## With RPS

$$\begin{aligned} \min_{b,g} \quad & f(b) + n(g) \\ \text{s.t.} \quad & b + g = L \\ & \frac{g}{b + g} \geq R \end{aligned} \tag{2}$$

- ▶  $R$  is required fraction that is green.
- ▶ RPS is a constraint

## With Feed-In Tariff

$$\begin{array}{ll} \min_{b,g} & f(b) + n(g) - rg \\ \text{s.t.} & b + g = L \end{array} \quad (3)$$

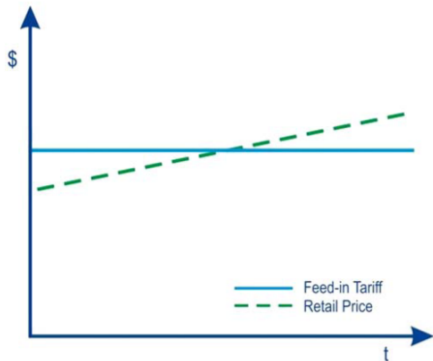
- ▶ Subsidized Feed-In tariffs lowers net cost of producing green energy.
- ▶  $r$  is the per unit subsidy
- ▶ There is always a feed-in tariff that give you your desired proportion of green energy,  $R$ , and vice-versa.



## Key Considerations in Feed-in tariff

- ▶ Uncertainty nominal price
- ▶ Uncertainty real price
- ▶ Variability in profit
- ▶ Incentives to invest in cost minimizing way.

# Fixed Price

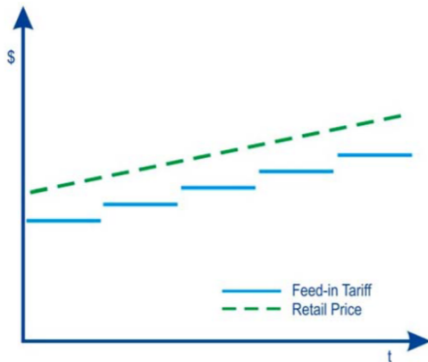


**Fig. 1.** Fixed price model for FIT policy design.

## Fixed Price

- ▶ Uncertainty nominal price: Known with certainty
- ▶ Uncertainty real price: Inflation is unknown
- ▶ Variability in profit: Future costs are unknown
- ▶ Incentives to invest in cost minimizing way: Very hard to pick the right price. Once established, strong incentives to reduce operating costs.

# Fixed Price with Inflation

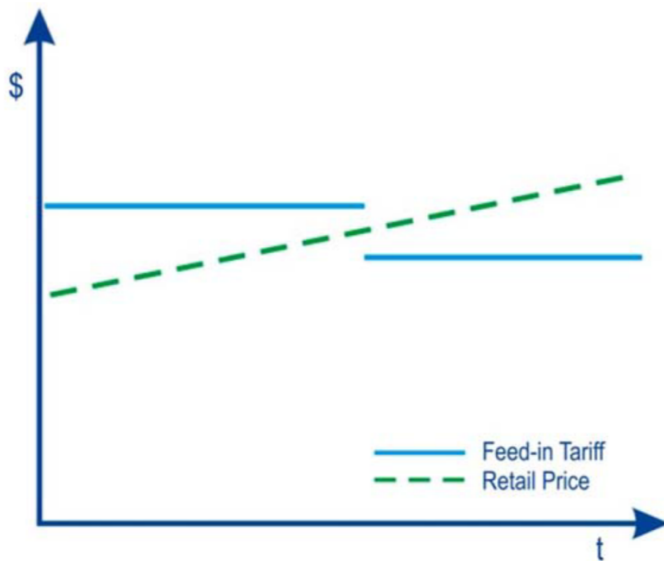


**Fig. 2.** Fixed price model with full or partial inflation adjustment.

## Fixed Price with Inflation

- ▶ Uncertainty nominal price: Known with certainty in next time period.
- ▶ Uncertainty real price: Inflation included in price. (Note that is commonly lagged inflation.)
- ▶ Variability in profit: Future costs are unknown.
- ▶ Incentives to invest in cost minimizing way: Very hard to pick the right price. Once established, strong incentives to reduce operating costs.

## Front Loaded



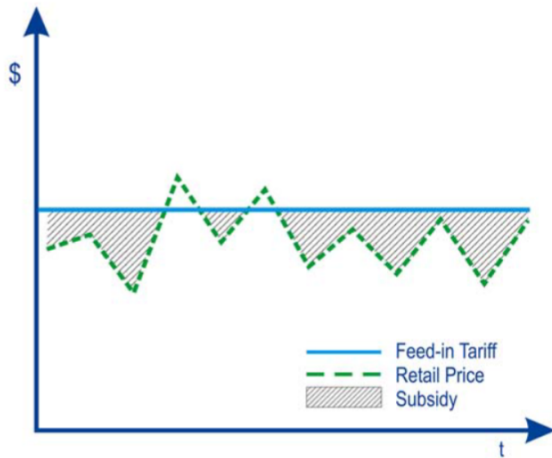
**Fig. 3.** Front-end loaded tariff model.

## Front Loaded

- ▶ Uncertainty nominal price: Known with certainty
- ▶ Uncertainty real price: Inflation is unknown
- ▶ Variability in profit: Future costs are unknown but if costs are inversely correlated with time, reduces uncertainty.
- ▶ Incentives to invest in cost minimizing way: ?

This better tracks the cost pattern, more tax depreciation in early years,

# Spot Market Plus



**Fig. 4.** Spot market gap model.

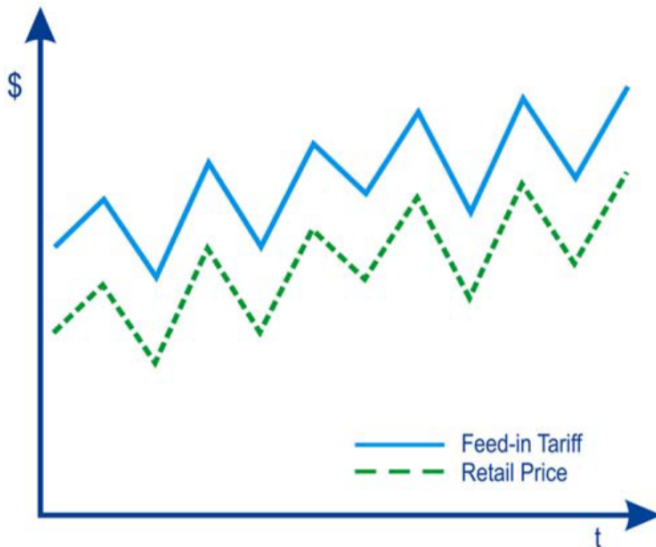


# Spot Market Plus

- ▶ Uncertainty nominal price: Cuts off the downside
- ▶ Uncertainty real price: Similar but does not adjust the floor with inflation.
- ▶ Variability in profit: Reduced uncertainty and allows firms to capture profits when prices are high.
- ▶ Incentives to invest in cost minimizing way: ?

Given that the generator is in an ISO, wholesale markets that are easy to access, this provides strong incentives to invest.

## Premium Price

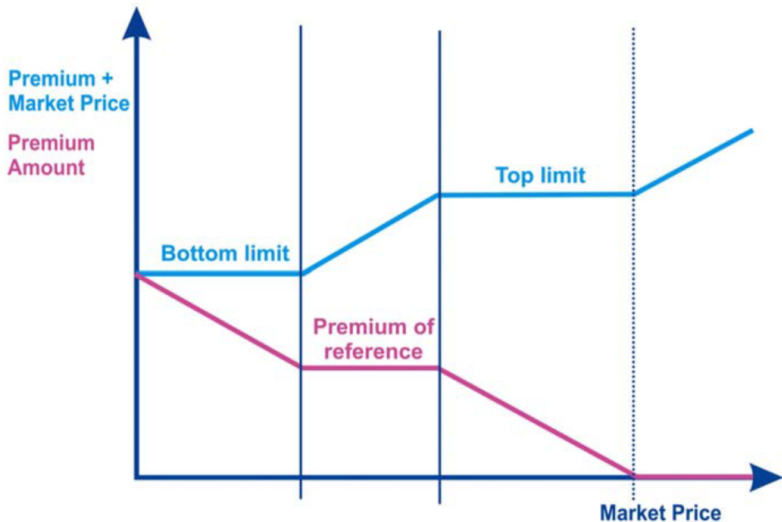


**Fig. 5.** Premium price model.

# Premium Price

- ▶ Same uncertainty in price and profit as market exposure
- ▶ Higher average prices and profits

# Variable Premium

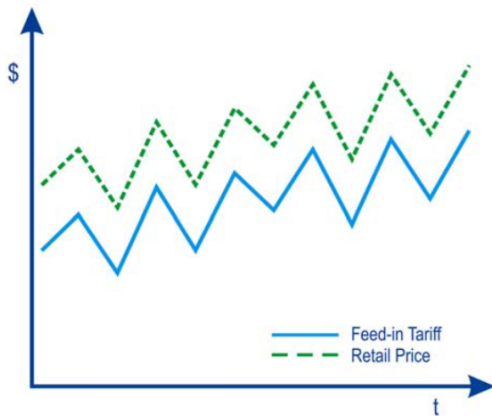


**Fig. 6.** Variable premium FIT policy design.

## Variable Premium

- ▶ Puts a lower and upper bound on the premium price subsidy.

# Percent Retail



**Fig. 7.** Percentage of retail price model.

## Percent Retail

- ▶ Graph is funny but this is a multiplicative version of premium price.