COMBINING TARIFFS, INVESTMENT SUBSIDIES AND SOFT LOANS IN A RENEWABLE ELECTRICITY DEPLOYMENT POLICY

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The aim of our paper is to provide insight on the cost-effectiveness of combinations of deployment instruments for the same technology, because until now little attention has been paid to this subject despite tools combinations are very common in several countries (see the paper).
The model developed combines FIT and FIP with subsidies (or soft loans) for a given profitability level, specific technology and type of plant.

Our model is a general framework which allows policy makers to set remuneration levels and combine them with subsidies (or soft loans).
Tariffs and premiums and investment subsidies (case FITs)

In such a case the model is a modified expression of net present value incorporating investment subsidies:

\[ V = pq \sum_{t=1}^{t=T} \left( \frac{1 + \varepsilon}{1 + i} \right)^t + \gamma I - \left[ \gamma I + (1 - \gamma)I + \tau I \sum_{t=1}^{t=T} \left( \frac{1 + \varepsilon}{1 + i} \right)^t \right] \]

- **\( p \)**: amount of the investment subsidy
- **\( q \)**: portion of the initial investment financed by the promoters’ own funds

Terms:

- **\( q_{ACTt} \)**: annual plant production (kWh or MWh)
- **\( I \)**: upfront investments
- **\( t \)**: time (a year), \( t \in [1, T] \)
- **\( T \)**: installation lifetime
- **\( p \)**: initial FIT level
- **\( m \)**: initial O&M costs and some current expenditures.
- **\( i \)**: interest rate (or discount rate)
- **\( \varepsilon \)**: annual rate of tariff revision.
- **\( \tau \)**: \( m/I, 0<\tau<1 \)

All terms are defined in relation to the capacity of the plant (kW).
Tariffs and premiums and investment subsidies (case FITs)

From the known *profitability index* or profit investment ratio \((r)\) of the project,

\[
r = \frac{V}{I}
\]

and setting \(r = r^*\), it is obtained the \(p = f(\gamma)\) function

\[
p = \frac{I(r^* + 1 + \tau K)}{q K} - \frac{I}{q K} \gamma
\]

which is a decreasing straight line
The general expression of feed-in premiums (FIP) is given by,

\[ \rho_t = e_t + \sigma_t \]

where,
- \( \rho_t \) guaranteed price for feeding-in (per kWh or MWh)
- \( e_t \) electricity wholesale market price
- \( \sigma_t \) premium

As before, from the net present value expression and the profitability index, it is obtained the \( \sigma = f(\gamma) \) function

\[ \sigma = \frac{I(r^* + 1 + \tau K)}{qZ} - e - \frac{I}{qZ} \gamma \]

which is also a decreasing straight line.
Tariffs and premiums and investment subsidies (an example)

PV plant: $I=3500\,\text{€/kW}$; $T=30\,\text{years}$; $q=1800\,\text{kWh/kW}$; $i=0.06$; $\varepsilon=0.02$; $r^*=0.04$, $t=0.01$ and $e=0.05\,\text{€/kWh}$.

FITs

FIPs

Above 86% of the upfront Investment, the addition of the wholesale price and the premium lead to an excessive remuneration. Premium should be removed.
The modified expression of net present value incorporating soft loans is,

\[ V = pq \sum_{t=1}^{T} \frac{(1 + \epsilon)^t}{(1 + i)^t} - (1 - \lambda)I + \tau I \sum_{t=1}^{T} \frac{(1 + \epsilon)^t}{(1 + i)^t} + \sum_{t=1}^{T} \frac{\lambda I}{T(1 + i)^t} + \sum_{t=1}^{T} \frac{\lambda I (1 - \frac{t - 1}{T}) i^*}{(1 + i)^t} \]

Part of investment paid in cash by the investors

Portion of the investment financed by a soft loan

O&M and other yearly expenditures

Debt service (payoffs plus interests) in the \( t \)-th period

The soft loan interest is \( i^* = \phi i, 0 \leq \phi < 1 \)

Amortization consists in constant payoffs

Some other assumptions have been established for the sake of simplicity (see paper)
Tariffs and premiums and soft loans (cases FITs and FIPs)

From the profitability index and setting $r=r^*$, it is obtained the $p=f(\lambda, \phi)$ function,

$$p = \frac{I \left[ (1 - \lambda) + \tau K + r^* + \lambda Z \frac{1}{T} + \lambda Wi \phi \right]}{qK}$$

This equation has two degrees of freedom ($\lambda$ and $\phi$). We can calculate,
1) How the changes in the share of the upfront investments paid by a soft loan ($\lambda$) affect the tariff.
2) How the reduction of the interest rate ($0 \leq \phi < 1$), given the subsidized part of the investment, impacts on tariffs ($p$).

The $\sigma=f(\lambda, \phi)$ function in case of FIPs ($\sigma$) is:

$$\sigma = \frac{I \left[ (1 - \lambda) + \tau K + r^* + \lambda Z \frac{1}{T} + \lambda Wi \phi \right]}{qZ} - e$$
Tariffs and premiums and soft loans (general relationship between variables)

Graphical representation of $p=f(\lambda, \varphi)$ and $\sigma=f(\lambda, \varphi)$ surfaces
The financial costs of instrument combinations

We compare the cost of different combinations of FITs and FIPs with investment subsidies, or soft loans. The conclusion is that, given the level of net profitability \( (r^*) \), the different tools combinations do not change the financial costs of the policy. There is simply a temporal distribution of the same amount of financial resources. However, subsidies and soft loans could probably give rise to massive financial requirements at the beginning of such a policy, which could be problematic. In any case, there is not an efficiency conflict between higher short-term costs and lower inter-temporal costs (the overall costs do not change).
Main conclusions

- It has been found out that the policy costs of instrument combinations for a given technology are the same as for the FITs or FIPs-only options, provided that the net profitability and the discount rates do not change.

- The different levels of investment subsidies or soft-loans merely involve inter-temporal distributions of the same amount of policy costs. However, such inter-temporal distributions affect the social acceptability and political feasibility of renewable energy support. In this sense, it should be remembered that the FITs or FIPs-only option lead to a more uniform distribution of the costs of the policy over time.

- In any case, combining deployment measures is not a cost-containment strategy.

- If the aim is to reduce this financial burden of promotional policy, the only way to do so is to induce lower values of the discount and the net profitability rates (assuming that basic technical and economical variables such as $I$, $q$ and $T$, do not change).
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Thanks for your attention

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