

# ***ENERGY EFFICIENCY AND PRICE REGULATION***

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## **Overview**

This paper examines the incentives embedded across different regulatory regimes – rate of return, price cap and mandated target regulation – for investment in energy efficiency programs at the supplier's end of the network.

As a cost-effective approach to sustainable energy use and greenhouse gas emissions reduction, energy efficiency programs have returned to the forefront of public policy. However, despite their high profile, energy efficiency opportunities have by and large not been materialized. This is particularly the case in the electricity sector where between 20 and 60 per cent of total electricity used could be conserved by cost effective initiatives (Greenstone and Allcott, 2012). Although there are demand side management (DSM) programs that reduce consumption by a kilowatt-hour at a cost lower than the cost of supplying that electricity, they are not widely used (Freeman et al., 2010). There are several reasons why this may be the case. First, electricity suppliers (especially network service providers) need to invest in a range of infrastructure that is required to integrate distributed energy resources, including energy storage technologies, the digital hardware and software for improving transmission and distribution system reliability and security, and the supply-side and customer-side systems needed for full customer connectivity (Lester and Hart, 2012). Second, these firms operate in a regulated environment where prices are usually set by a regulatory agency or government department that may not reward such investments by not considering them prudent or efficient. Finally, investment in energy efficiency may not be recouped if demand for electricity falls in the future or if the regulatory regime changes.

It follows then that electricity suppliers need to be incentivized to undertake energy efficiency investment. Key policies promoting energy efficiency in the electricity sector include taxes, cap-and-trade systems and direct regulation of the firms' operation. Creating incentives for suppliers/distributors to undertake energy efficiency initiatives can be complex as these incentives interact with the form of price regulation. For example, in a context where firms are allowed to recover, via prices, all the costs of supplying electricity to consumers, regulated firms may have little incentive to undertake energy efficiency investment. The interaction between price regulation and incentives for energy efficiency is an important public policy issue and the subject of this paper.

## **Methods**

We pursue the above objective by building a theoretical model of a monopolist who can choose whether or not to undertake an investment in energy efficiency. The investment is not observable by the regulator who can only determine whether the investment has been successful in terms of the level of energy efficiency achieved. More specifically, the firm's choice of effort affects the probability of a successful outcome with a higher effort resulting in a higher probability of achieving a better energy efficiency outcome.

In this setting, regulatory regimes cannot explicitly compensate the firm for the effort it has put into energy efficiency. We explore how different existing regulatory regimes perform in terms of expected amount of energy efficiency and total welfare.

More generally, we provide a full characterisation of the optimal effort, optimal prices (regulated or unregulated) and expected welfare for the different regimes and show the trade-offs between rent extraction and incentives.

## **Results**

The comparison across different regimes is done from an expected welfare perspective and is driven by the size of the cost of effort.

We show that, in equilibrium, the monopolist chooses to exert effort more often under price cap regulation than under no regulation and that she exerts no effort under rate of return regulation. In particular, for sufficiently high

effort cost, the monopolist chooses zero effort under all possible scenarios. In this case, price cap regulation always dominates an unregulated monopolist both set prices ex-ante (that is, prior to the realization of the energy efficiency outcome) and prices are lower under price cap regulation. This particular ranking is of course true for any cost of effort as a regulator could always choose the unregulated monopolist's price if it were to increase welfare.

While we can show that price cap regulation dominates an unregulated monopolist in terms of expected welfare, the comparison between price cap and rate of return regulation, and between rate of return regulation and an unregulated monopolist, is ambiguous and complex. For instance, rate of return regulation performs better than price cap regulation when zero effort is optimal. In this case, it is not necessary to incentivize the firm to exert effort into energy efficiency and rate of return regulation then ensures that profits are ex-post zero whereas under price cap regulation profits are only zero ex-ante so prices are higher to ensure that the firm's participation constraint is satisfied. At the other extreme, when the cost of effort is sufficiently low, price cap regulation always dominates rate of return regulation as it is socially optimal to set an ex-ante price that whilst ensuring that the firm's participation constraint is satisfied, might result in positive (ex-post) profits for the regulated firm. At this price the firm is incentivized to exert effort in energy efficiency. For intermediate values of the cost of effort, the comparison between rate of return and price cap regulation is more complex.

We show, however, that mandated target regulation is always dominated by both price cap and rate of return regulation in terms of expected welfare although it can do better than an unregulated monopolist. The key reason is that mandated target regulation is too coarse and the trade off between providing incentives to invest in energy efficiency and rent extraction is less pronounced than under existing regulatory regimes such as price cap and rate of return regulation.

It follows that the regime which will yield the highest expected welfare will depend on demand, costs and the weight assigned by the regulator to the monopolist's profits in total surplus.

## Conclusions

This paper develops a theoretical model to investigate the relationship between a regulated firm's incentive to invest in energy efficiency and the nature of the regulatory regime. In this paper, the reason for the regulated monopolist not to undertake investment in energy efficiency is not due to her desire to maximise quantity but rather due to the inability of a regulator to commit to reimburse the effort costs given that these are not directly observable. This is another channel through which regulatory regimes can disincentivize regulated firms to invest in energy efficiency – in addition to the issue of decoupling. Price cap, rate of return and mandated targets deal with these lack of incentives in different ways. Rate of return provides no incentive to invest in energy efficiency. Even if successful, the ex-post nature of rate of return regulation ensures that the firm earns zero economic profits. Price cap, in contrast, provides incentives for investment in energy efficiency as the firm is able to capture, in the event that the investment is successful, some of the economic rents. Mandate target regulation also provides incentives to invest in energy efficiency by penalising the firm for not achieving its target.

Our analysis suggests two key messages that might be of relevance to policy makers. First, when the cost of effort to undertake energy efficiency investment is low – that is, when there are existing opportunities that can be pursued at low cost and that are likely result in energy savings – a price cap regime is likely to perform better than a rate of return regulatory regime. Conversely, when the cost of effort is too high, rate of return regulation is welfare superior to price regulation as in this instance it is not optimal for the firm to invest in energy efficiency. Second, mandated target regulation is clearly an inferior policy to stimulate investment in energy efficiency. The key reason is that mandated target regulation is too coarse as an instrument to provide the appropriate incentives to the regulated firm.

## References

- Freeman, L., Intorcio, S., Park, J., March 2010. Implementing energy efficiency: Program delivery comparison study. Iee whitepaper, Institute for Electric Efficiency.
- Greenstone, M., Allcott, H., 2012. Is there an energy efficiency gap? *The Journal of Economic Perspectives* 26 (1), 3.28.
- Lester, R. K., Hart, D. M., 2012. *Unlocking energy innovation: how America can build a low-cost, low-carbon energy system.* MIT Press, Cambridge, Mass.