Financial Attractiveness of Solar Photovoltaic Feed-In Tariffs in the United States

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Abstract

Feed-in tariffs (FITs) are policies that guarantee renewable energy producers fixed payments for electricity over long-term contracts. This study asks whether solar photovoltaic (PV) investments under U.S. FIT programs are financially competitive relative to common investment benchmarks, since a PV investment is only truly attractive when it meets or exceeds these benchmarks. This question matters because policymakers rely on FITs to promote renewable energy deployment. Using solar cost data from the International Renewable Energy Agency (IRENA) and FIT program data from Database of State Incentives for Renewables and Efficiency (DSIRE), I calculated the Levelized Cost of Energy(LCOE), and Internal Rate of Return (IRR). Results show that although declining costs have made recent projects profitable, IRRs remain below benchmark levels, indicating FIT programs are not financially attractive. These findings highlight that effective FIT design is essential for policymakers seeking to promote renewable energy investment.

1. Introduction

As governments seek to reduce carbon emissions and expand renewable electricity generation, feed-in tariffs (FITs) have become a widely used policy tool for promoting renewable energy investment. A feed-in tariff guarantees renewable energy producers a fixed payment for electricity over a long-term contract, typically 15 to 20 years, reducing revenue uncertainty and improving project stability. This structure is particularly important for solar photovoltaic (PV) systems, which have historically required policy support due to high upfront capital costs and uncertain market returns.

For example, Germany's early renewable policies in 1990 and its 2000 Renewable Energy Act guaranteed long-term payments for solar electricity, enabling rapid expansion of PV capacity that would not have occurred under market conditions alone(Suck, 2002). Similarly, between 1998 and 2008, specific feed-in tariff programs such as Germany's Renewable Energy Act (EEG), Spain's Royal Decree FIT system, and Italy's Conto Energia directly drove rapid solar and wind capacity growth, while over 80 countries worldwide adopted similar policies as solar remained too capital-intensive and risky for private investors(Jenner et al., n.d.). Without guaranteed revenues, banks and investors were often unwilling to finance these projects due to long payback periods and uncertain returns, demonstrating why FIT structures were essential for making solar PV investment possible.

Existing research finds that FITs can accelerate renewable energy deployment, but their effectiveness depends on policy design. Farrell argues that FITs outperform fragmented U.S. policies by providing long-term price certainty, protecting producers from market price fluctuations and reducing investment risk(Farrell, n.d.). This is particularly important because the expansion of renewable energy, such as wind, can drive electricity prices down, reducing revenue for generators. By locking in stable prices, FITs reduce this risk and make investment more predictable, encouraging greater participation and lowering overall system costs. Jenner et al. (2013) further show that tariff size, contract duration, and digression rates shape investment outcomes, while Alolo et al. (2020) find that FITs only increase investment when tariff levels align with production costs(Alolo et al., 2020; Jenner et al., n.d.).

These findings highlight that effective FIT design must account for key financial variables, including production costs, market electricity prices, and broader economic conditions such as interest rates. If tariffs are set too low, projects remain unprofitable; if they do not adjust to market conditions, revenues become uncertain. Shcherbakova further shows that FITs only improve investment when they generate predictable financial returns within supportive financial systems(Shcherbakova, 2025). Together, this research suggests that FIT effectiveness depends on how policies are structured.

However, most studies focus on broad outcomes such as renewable capacity growth or emissions reductions rather than financial attractiveness (Lyeonov et al., 2019; Suck, 2015). This study instead examines whether solar photovoltaic (PV) investments under U.S. FIT programs are financially competitive relative to common investment benchmarks, since a project is only truly attractive if it meets or exceeds these benchmarks.

This question is important because a policy may successfully increase renewable deployment while still offering returns that are too low to attract sustained private investment. To address this, this study analyzes five U.S. FIT programs with distinct pricing structures and contract designs: California's Renewable Market Adjusting Tariff (ReMAT), the Los Angeles Department of Water and Power (LADWP) FIT, the Northern Indiana Public Service Company (NIPSCO) FIT, the PSEG Long Island Commercial Solar PV FIT, and Marin Clean Energy (MCE) FIT. These programs differ in tariff pricing (fixed vs. auction-based), contract length (15–20 years), and eligibility requirements, allowing for a direct comparison of how design influences financial outcomes(Rickerson et al., 2008). They were selected because they represent some of the few active and well-documented FIT systems in the United States, where many programs have expired or been replaced, enabling a more consistent comparison than across international markets.

The methodology uses solar PV cost data from the International Renewable Energy Agency (IRENA), including capital cost, levelized cost of electricity (LCOE), and capacity factor estimates for 2010 and 2023(Renewable Power Generation Costs in 2023, n.d.). FIT payment rates and contract terms are obtained from the Database of State Incentives for Renewables and Efficiency (DSIRE)(*Database of State Incentives for Renewables & Efficiency®*, n.d.). Using these inputs, annual project cash flows are constructed based on fixed FIT payments and estimated electricity generation. Financial performance is evaluated using the internal rate of return (IRR), calculated as the discount rate that sets the net present value of these cash flows equal to zero, and compared to a 7% stock market benchmark.

The results show that declining solar PV costs have improved the financial performance of FIT-supported projects over time. In earlier years, particularly between 2010 and 2017, FIT payment rates were often below the levelized cost of energy (LCOE), meaning the guaranteed price did not cover costs and projects were financially unattractive. By 2023, however, falling costs allowed several programs to generate positive returns. Despite this improvement, all programs still produce IRRs below the 7% benchmark, indicating limited competitiveness with traditional investments (see Figure 1). Among the programs analyzed, the PSEG Long Island Commercial Solar PV FIT generates the highest returns, followed by the higher-priced LADWP tariffs.

Overall, this paper demonstrates that the financial effectiveness of feed-in tariffs depends not only on whether they make renewable energy projects viable, but on whether they generate returns that can compete with alternative investments. This distinction is critical for policymakers seeking to design FIT programs that attract long-term private capital while supporting renewable energy deployment.

3. Methodology and Data

This study evaluates the financial attractiveness of several U.S. feed-in tariff (FIT) programs for solar photovoltaic (PV) investment by constructing a discounted cash flow model in Google Sheets. The model simulates the lifetime revenue and costs of a representative solar PV system under each FIT program and calculates the internal rate of return (IRR) as the primary measure of financial performance.

Data Sources

Solar PV cost and performance data were obtained from the International Renewable Energy Agency (*Renewable Power Generation Costs in 2023*). Specifically, the analysis uses capital cost (USD/kW) and capacity factor (%) estimates for 2010 and 2023. For solar PV, capital costs declined from $5,310/kW in 2010 to $758/kW in 2023 (in 2023 dollars), while capacity factors increased from 14% to 16%. These values are used to estimate total system cost and annual electricity generation.

Feed-in tariff program data were collected from the Database of State Incentives for Renewables and Efficiency (DSIRE). For each program (ReMAT, LADWP, NIPSCO, PSEG Long Island, and MCE FIT+), the model incorporates:

- Fixed tariff price ($/MWh or $/kWh)
- Contract length (typically 15 or 20 years)
- Program structure (fixed price vs. auction-based)

Model Construction

A discounted cash flow model was constructed in Google Sheets to simulate the financial performance of a representative solar PV system under each feed-in tariff (FIT) program. The model uses IRENA cost and capacity factor data along with FIT pricing and contract terms from DSIRE to calculate annual revenues and costs.

For each program, the initial investment is based on the installed cost per kilowatt from IRENA (2023 values). Annual electricity generation is estimated using a fixed capacity factor and total hours per year:

$$\text{Annual Energy} = \text{System Capacity} \times \text{Capacity Factor} \times 8760$$

Annual revenue is calculated by multiplying electricity generation by the FIT tariff price. A constant annual operating and maintenance (O&M) cost is subtracted to determine net cash flow. These net cash flows are projected over the full contract length (15–20 years), and each year's cash flow is discounted to calculate IRR.

Internal Rate of Return (IRR)

Financial performance is evaluated using the internal rate of return (IRR), calculated as:

$$0 = \sum_{t=0}^{T} \frac{Ct}{(1+IRR)^{t}}$$

where Ct represents net cash flow in year t, and T is the contract length. IRR represents the discount rate at which the present value of all project cash flows equals zero.

Financial performance is evaluated using the internal rate of return (IRR), defined as the discount rate at which the present value of all project cash flows equals zero. IRR is compared to a 7% benchmark, representing the long-term average return of the stock market, allowing each FIT-supported solar investment to be evaluated relative to an alternative investment. The analysis relies on several simplifying assumptions. First, LCOE values are based on aggregated IRENA data that combine utility-scale and residential systems, which may not perfectly match the specific project types within each FIT program. Second, annual cash flows are assumed to remain constant over time, excluding factors such as panel degradation, inflation, or changes in operating and maintenance costs. Third, a fixed capacity factor is applied across all programs despite geographic variation in solar output. Fourth, projects are assumed to be fully equity-financed, excluding debt, taxes, and subsidies. Finally, FIT payments are assumed to remain constant over the full contract period without policy changes.

If these assumptions are violated, IRR estimates may change significantly: higher actual costs or lower energy output would reduce IRR, while favorable financing or subsidies could increase it; similarly, variability in prices, costs, or policy conditions would introduce uncertainty and potentially lower the reliability of the calculated returns.

4. Figures

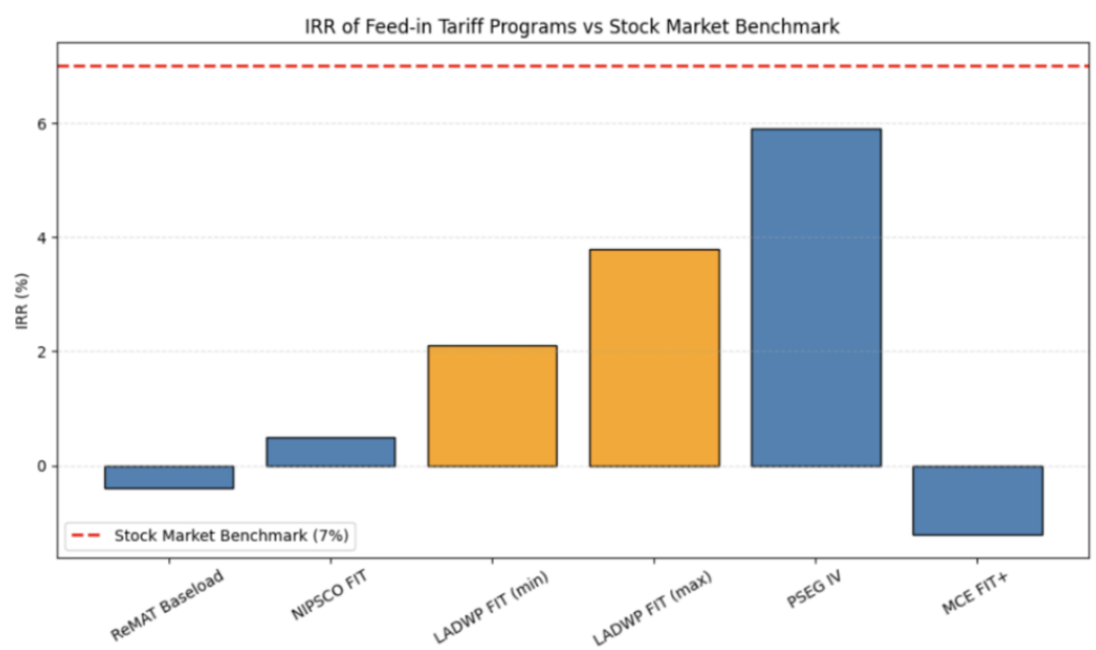

Figure 1. Internal Rate of Return (IRR) of Selected Feed-in Tariff Programs Compared to the Stock Market Benchmark. This figure compares the internal rate of return (IRR) for solar photovoltaic investments under several feed-in tariff (FIT) programs, including ReMAT, NIPSCO FIT, LADWP FIT (minimum and maximum tariff levels), PSEG Long Island FIT, and MCE FIT+. The dashed horizontal line represents a 7% benchmark approximating the long-term average return of the stock market. While some programs generate positive returns, none reach the benchmark level. Among the programs analyzed, the PSEG Long Island Commercial Solar PV FIT provides the highest IRR, followed by LADWP FIT rates.

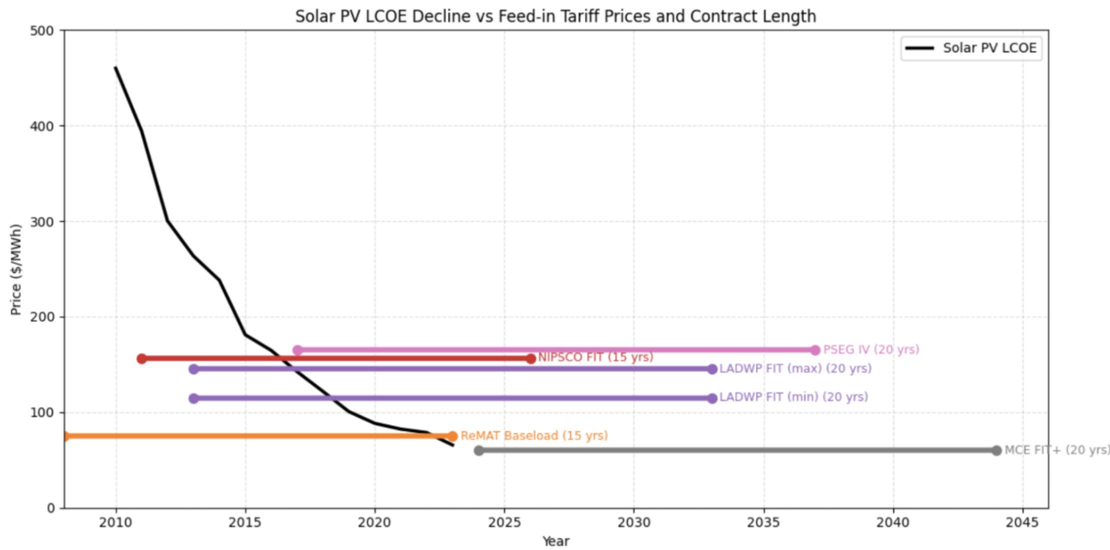

Figure 2: Feed-In Tariff Price Compared to Levelized Cost of Energy. This figure shows the comparison of solar PV levelized cost of electricity (LCOE) and selected U.S. feed-in-tariff(FIT) prices over time. The black line shows solar PV LCOE from IRENA, while the colored horizontal lines show the fixed payment levels and contract durations of individual FIT programs. PSEG IV reflects a 20-year contract from 2017 to 2037 for a specific small-scale solar category, with the tariff price corresponding to that project type. The LADWP minimum and maximum rates are shown in the same color to indicate that they represent a pricing rage within the same FIT program rather than separate policies. This figure is intended to illustrate how declining solar costs affected the profitably of investing in these types of solar projects over time(*Database of State Incentives for Renewables & Efficiency®*, n.d.; *Renewable Power Generation Costs in 2023*, n.d.).

5. Results/Findings

The results show a clear transition in the financial performance of solar photovoltaic (PV) investments under feed-in tariff (FIT) programs, moving from unprofitable to economically viable over time. This shift is driven primarily by the decline in solar PV costs rather than increases in tariff prices, as many FIT tariff rates have, in fact, decreased over time.

The comparison between FIT prices and the levelized cost of electricity (LCOE), the cost per megawatt-hour of producing electricity over the lifetime of the system, illustrates this transition (see Figure 2). In 2010, the LCOE of solar PV was approximately $460/MWh, significantly higher than all available FIT prices. Under these conditions, projects operated at a loss, as even with government-supported FIT payments, revenue from electricity generation remained below LCOE, making investment financially unjustifiable. By 2023, however, the LCOE declined dramatically to approximately $44/MWh, representing nearly a 90% reduction in costs. This decline allowed FIT prices to exceed generation costs, enabling positive cash flow and marking a transition to economic viability.

However, economic viability does not imply strong financial attractiveness. The analysis of the internal rate of return (IRR) shows that although returns improved over time, they remain low across all programs. While IRR values increased from negative levels to slightly positive values by 2023, they remain far below the 7% stock market benchmark (see Figure 1). This suggests that FITs improve the competitiveness of renewable energy investments, but not to the level required to compete fully with broader financial markets.

The comparison across programs highlights clear differences in financial outcomes. As shown in Figure 1, PSEG Long Island (FIT IV) produces the highest IRR, primarily due to its relatively high tariff price combined with a 20-year contract (2017–2037), which increases total and stable revenue. In contrast, programs such as MCE FIT+ generate weaker returns despite similar contract lengths, demonstrating that tariff price is the dominant factor determining financial performance. Higher tariff prices increase investment incentives by generating larger and more stable cash flows, but they also introduce trade-offs, as these payments are typically funded by taxpayers or ratepayers, increasing system-wide costs and raising the risk of over-subsidization.

These findings also reflect a broader shift in the role of FITs, particularly as market dynamics such as the solar cannibalization effect begin to shape investment outcomes. As solar penetration increases, electricity prices tend to fall during peak generation periods, reducing the revenue solar projects can earn. Historically, FITs were necessary to make solar PV projects feasible at all, given high upfront costs and low market competitiveness. As shown in Figure 2, declining costs have fundamentally changed this dynamic. FITs now play a different role: rather than enabling viability, they primarily shape the attractiveness of these investments relative to alternative opportunities. This evolution highlights the growing importance of policy design, particularly tariff pricing, in determining investor behavior.

Overall, the results suggest that evaluating renewable energy policies requires more than measuring deployment outcomes. While FITs have been effective in supporting solar expansion, their ability to attract sustained private capital depends on whether they can generate returns closer to market benchmarks. Without sufficiently high or well-calibrated tariff prices, FIT programs will continue to rely on policy-driven participation rather than fully competitive financial incentive**s.**

Conclusion

This study evaluates whether feed-in tariff (FIT) programs provide financially attractive conditions for solar photovoltaic (PV) investment and how these returns compare to a 7% stock market benchmark. The analysis shows a clear shift over time: solar PV investments have moved from financially unattractive to economically viable, but they remain uncompetitive relative to traditional market investments.

The primary driver of this transition is the dramatic decline in solar PV costs. As the levelized cost of electricity (LCOE) fell significantly between 2010 and 2023, FIT-supported projects shifted from failing to recover their costs to generating positive net returns. This demonstrates that FIT programs have been effective in supporting renewable energy deployment by ensuring that projects can cover their costs and avoid financial loss.

However, financial viability does not imply financial attractiveness. Even in recent years, internal rate of return (IRR) values remain far below the 7% stock market benchmark, indicating that solar PV investments under FIT programs do not offer returns competitive with alternative investment opportunities. As a result, FITs function more as policy tools to enable deployment than as mechanisms for attracting capital based on strong financial performance.

The comparison across programs highlights the importance of tariff design. Among those analyzed, PSEG Long Island (FIT IV) offers the most favorable conditions due to its higher tariff price and long-term contract structure. This reinforces that tariff price is the primary driver of returns, while contract length mainly reduces risk.

More broadly, the role of FITs is evolving. As solar penetration increases, the cannibalization effect drives down daytime electricity prices, reducing solar revenues while creating opportunities for complementary technologies such as battery storage. This shift makes policy design increasingly important in shaping investment outcomes.

These findings highlight a broader policy challenge. Policymakers must balance three competing objectives: ensuring sufficient investor returns, maintaining affordability for ratepayers, and achieving renewable energy deployment targets. Designing FIT programs that meet all three goals remains difficult, particularly as technology costs continue to evolve.

This study has several limitations. It relies on simplified assumptions, including constant cash flows, fixed capacity factors, and the exclusion of financing structures such as debt, taxes, and subsidies, all of which affect real-world returns. Additionally, the use of aggregated LCOE data and a limited set of U.S. FIT programs may introduce inaccuracies and does not fully capture broader market conditions such as regional prices or policy changes.

Future research could improve this analysis by incorporating project-level data, including location-specific generation and financing structures, and by comparing FITs to alternative policy mechanisms. While FIT programs have supported significant renewable growth, capacity expansion alone does not reflect financial performance. Comparing FITs to alternative policy mechanisms would further clarify how different designs balance deployment outcomes with financial attractiveness.

Overall, FITs have been effective in enabling solar PV deployment, but their current design limits their ability to generate returns competitive with traditional investments. Improving financial attractiveness will be critical for attracting sustained private capital and supporting the long-term energy transition.

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