10. Financial Assumptions

10.1 Introduction and Summary

This chapter presents the financial assumptions used in the EPA 2023 Reference Case. EPA 2023 Reference models a diverse set of generation and emission control technologies, each of which requires financing and incorporates updates to reflect The Tax Cuts and Jobs Act of 2017.[81] The capital charge rate converts the capital cost for each investment into a stream of levelized annual payments that ensures recovery of all costs associated with capital investment, including recovery of and return on invested capital and income taxes. The discount rate is used to convert all dollars to present values, and IPM minimizes the present value of annual system costs. The discount rate is set equal to the weighted average costs of capital. The primary purpose of this chapter is to describe the methodological approach to quantifying the discount and capital charge rates in the EPA Platform 2023 Reference Case.

10.2 Introduction to Risk

The cost of capital is the level of return investors expect to receive for alternative investments of comparable risk. Investors will only provide capital if the return on the investment is equal to or greater than the return available to them for alternative investments of comparable risk. Accordingly, the long-run average return required to secure investment resources is proportional to risk. There are several dimensions to risk that are relevant to power sector operations, including:

- **Market Structure –**The risk of an investment in the power sector is heavily dependent on whether the wholesale power market is regulated or deregulated. The risks are higher in a deregulated market compared to a traditionally regulated utility market. Slightly more than half of U.S. generation capacity is deregulated (operated by Independent Power Producers (IPPs), or 'merchants').[82] IPPs often sell power into spot markets supplemented by near-term hedges. In contrast, regulated plants sell primarily to franchised customers at regulated rates, an arrangement that significantly mitigates uncertainty and, therefore, risk.[83]

- **Technology** - The selection of new technology investment options is partially driven by the risk profile of these technology investments. For instance, in a deregulated merchant market, an investment in a peaking combustion turbine is likely to be much riskier than an investment in a combined cycle unit. This is because a combustion turbine operates as a peaking unit and can generate revenues only in times of high demand or via capacity payments, while a combined cycle unit is able to generate revenues over a much larger number of hours in a year from the energy markets as well as via capacity payments. An investor in a combined cycle unit, therefore, would require a lower return due to a more diversified stream of revenue and receive a lower risk premium than an investor in a combustion turbine, all else equal.

- **Leverage** - There are financial risks related to the extent of leverage. Reliance on debt over equity in financing a project increases the risk of insolvency. This dynamic applies to all industries, power included.[84]

- **Financing Structure** – Lastly, there are also financing structure risks (e.g., corporate vs. project financing), also referred to as non-recourse financing. There are no clear risk implications from

[81] The Tax Cuts and Jobs Act of 2017, Pub.L. 115-97.

[82] According to EIA Form 860 2019, the current capacity mix is 58% utility and 42% merchant by MW.

[83] There is a potential third category of risk, where IPPs enter into long-term (e.g., ten years or longer), known-price contracts with credit worthy counterparties (e.g., traditionally regulated utilities). With a guaranteed, longer-term price, the risk profile of this segment of the IPP fleet is similar enough to be treated as regulated plants.

[84] We use the terms debt and leverage interchangeably.

the structure alone, but rather, this element interacts with other dimensions of risks, making considerations of leverage, technology, and market structure more important.

- **Systemic** – Systemic risk is when financial performance correlates with overall market and macro-economic conditions such that investment returns are poor when market and economic conditions are poor, and vice versa. For example, if investors are less likely to earn recovery of and on investments during recessions, then these risks are systemic and increase required expected rates of return. This emphasis on correlated market risk is based on the Capital Asset Pricing Model (CAPM), which is used to produce key financial assumptions for EPA 2023 Reference Case. Other risks are handled in the cash flows and are treated as non-correlated with the market.

10.2.1 Deregulation - Market Structure Risks

As noted, the power sector in North America can be divided into the traditional regulated sector (also known as the cost of service or utility sector) and the deregulated merchant sector (also known as competitive, merchant, deregulated,[85] or IPP sector).

Traditional Regulated

The traditional regulated market structure is typical of the vertically integrated utilities whose investments are approved through a regulatory process, and the investment is provided a regulated rate of return, provided the utility's investments are deemed prudent. In this form of market structure, returns include the return on the original investment plus a return on invested capital that is administratively determined. Returns are affected by market conditions due to regulatory lag and other imperfections in the process, but overall regulated investments are less exposed to the market than deregulated investments, all else equal.

Deregulated Merchant

In a deregulated merchant market structure, investments bear a greater degree of market risk, as the price at which they can sell electricity is dependent on what the short-term commodity and financial hedge markets will bear. Return on investment in this form of market structure is not only dependent on the state of the economy, but also on commodity prices, capital investment cycles, and remaining price-related regulation (e.g., FERC price caps on capacity prices). The capital investment cycle can create a boom-and-bust cycle, which imparts risk or uncertainty in the sector that can be highly correlated with overall macroeconomic trends. The operating cash flows from investments in this sector are more volatile as compared to the traditional regulated sector and, hence, carry more business or market risk.[86]

Overall, there is ample supporting evidence for the theoretical claim that deregulated investments are more risky than utility investments. For example:

- All three large publicly traded IPPs[87] are rated as sub-investment grade,[88] while all utilities are investment grade.

[85] Wholesale generators cannot be economically unregulated; they can be Exempt Wholesale Generator ("EWG") subject to FERC jurisdiction. The moniker of deregulated is used to convey greater market risk relative to regulated utility plants.

[86] In this documentation, the terms merchant financing, deregulated, IPP, non-utility and merchant refer to this type of market structure.

[87] Dynegy Inc. Calpine Corp. and NRG Energy Inc are the three IPP's whose ratings were B2, Ba3 and Ba3 in 2016.

[88] Below minimum investment grade.

- All major IPPs have gone bankrupt over the last 20 years.[89]
- Estimates of beta, a measure of risk using CAPM, leverage, debt costs, and weighted average cost of capital, consistently produce higher risk for deregulated power plants.

10.3 Federal Income Tax Law Changes

EPA 2023 Reference Case incorporates updates to reflect The Tax Cuts and Jobs Act of 2017. The four most significant changes in the federal corporate income tax code are:

- **Rate**—The corporate tax rate is lowered 14 percentage points from 35% to 21%. The 21% rate is in place starting in 2018 and remains in place indefinitely. The lower tax rate decreases capital charges in all periods and sectors, all else held equal. When state income taxes are included, the average rate decreases 13.1 percentage points, from 39.2% to 26.1%. This applies to both sectors, utility and IPP.
- **Depreciation** – The new tax law expands near-term bonus depreciation (also referred to as expensing) for the IPP sector only until 2027; the utility sector is unaffected.
- **Interest Expense** – The new law lowers tax deductibility of interest expense for the IPP sector, which continues indefinitely; the utility sector is unaffected.
- **Net Operating Losses** – The new law limits the use of Net Operating Losses (NOL) to offset taxable income. This applies to all sectors, utility, and IPP.

Other important features of the new tax law include:

- **Annual Variation of Provisions** - The legislation specifies permanent changes (tax rate and NOL usage limit) applying to both sectors, utility, and IPP. The legislation also applies temporary changes that vary year-by-year through 2027 (depreciation and tax deductibility of interest) (See Table 10-1), applying to the IPP sector only. This creates different capital charge rates for each year through 2027. We calculate these parameters for IPM run years 2023, 2025, and 2028 and thereafter. This set covers a wide range of financing conditions even though we do not estimate every year.

[89] Dynegy, Calpine, and NRG were bankrupt – i.e., the three large public IPPs were bankrupt. Also, Mirant (major IPP), Boston Generating (IPP), EFH (utility with large IPP component), and FES (utility with large IPP component) have been or are bankrupt.

Table 10-1 Summary Tax Changes

Parameter	Previous	2023[90]	2025	2028 and Later
Marginal Tax Rate - Federal	35	21	21	21
Maximum NOL (Net Operating Loss) Carry Forward Usage	No limit. All losses in excess of income are carried forward and usable immediately.	Carry Forward cannot exceed 80% of Taxable Income	Carry Forward cannot exceed 80% of Taxable Income	Carry Forward cannot exceed 80% of Taxable Income
Tax Deductibility of Interest Expense	100%[91]	30% of EBIT; Utilities MACRS	30% of EBIT; Utilities MACRS	30% of EBIT; Utilities MACRS
Bonus Depreciation[92]	0[93]	IPP 80%[94]; Utilities 0%	IPP 40%[95]; Utilities 0%	0

- **Utilities Versus IPPs** – As noted, the legislation treats utilities and IPPs differently. The new tax code exempts utilities from changes in tax deductibility of interest and accelerated depreciation. The financing assumptions used in IPM modeling are a blend (weighted average) of the utility and IPP average. The weighting is 60% utility and 40% IPP, and hence, the greatest weight is on the least affected sector. This partly mitigates the impacts of the changes.

- **Capital Charge Rates**—We calculate the capital charge rates for utilities and IPPs and then take the weighted average of the resulting capital charge rates. The legislation, combined with the IPM model's ability to vary capital charge rates by run year, allows us to calculate the blended average for specific run years.

- **Discount Rates**—The discount rate equals the weighted average after-tax cost of capital (WACC) and is affected by the change in the corporate income tax rate only. The discount rate is invariant over time, sectors, and technologies. Therefore, the calculation methodology for the discount rate used in IPM is unchanged.

10.4 Calculation of the Financial Discount Rate

10.4.1 Introduction to Discount Rate Calculations

A discount rate is used to translate future cash flows into current dollars by considering factors such as expected inflation and the ability to earn interest, which make one dollar tomorrow worth less than one dollar today. The discount rate allows intertemporal trade-offs and represents the risk-adjusted time value of money.[96]

[90] IPM run years in the near term are 2023, 2025, and 2028.

[91] No limit except losses in excess of income can be carried forward. The losses were limited to first few years.

[92] Referred to as expensing. If depreciation exceeds income in first year, it can be carried forward to succeeding years up to 80% of EBITDA.

[93] Bonus depreciation was available but only in the period before IPM runs, and only for new equipment.

[94] For thermal power plants coming online in 2023, the 100% would apply only to costs incurred through end of 2022. We are hence assuming practically all capital costs are incurred prior to 2023.

[95] Remaining basis depreciated at MACRS schedule.

[96] The discount rate is the inverse of compound interest or return rate; the existence of interest, especially compound interest creates an opportunity cost for not having dollars immediately available. Thus, future dollars need to be discounted to be comparable to immediately available dollars.

The discount rate adopted for modeling investment behavior should reflect the time preference of money or the rate at which investors are willing to sacrifice present consumption for future consumption. The return on private investment represents the opportunity cost of money and is commonly used as an appropriate approximation of a discount rate.[97]

The real discount rate for all expenditures (capital, fuel, variable operations and maintenance, and fixed operations and maintenance costs) in the EPA 2023 Reference Case is 3.76%.[98]

10.4.2 Summary of Results

The tables below summarize the key financial assumptions for the EPA 2023 Reference Case. Throughout the chapter, these values and the attendant methodological approaches are described.

Table 10-2 Financial Assumptions for Utility and Merchant Cases

EPA 2023 Reference Case - Utility WACC using daily beta for 2016-2020	
Parameters	**Value**
Risk-free rate	2.73 %[99]
Market premium	7.15 %[100]
Equity size premium	−0.01 %[101]
Levered beta[102]	0.72
Debt/total value[103]	0.58
Cost of debt	3.50 %[104]
Debt beta	0.00
Unlevered beta[105]	0.36
Target debt/total value[106]	0.50
Relevered beta	0.62

[97] For a perspective on the legal basis for utilities having the right to have the opportunity to earn such returns under certain conditions such as prudent operations, see *Bluefield Water Works and Improvement Co. v Public Service Comm'n 262 US 679, 692 (1923).* See also *Federal Power Comm'n versus Hope Natural Gas Co., 320 US 591, 603 (1944).*

[98] This rate is based on the weighted average after tax cost of capital (WACC), which reflects two weightings. First, it reflects an assumption that 60% of the investments are made by a regulated utility and 40% are made by a merchant investor (also referred to as a hybrid). Second, it assumes a mix of plant types - 55% renewable and 45% gas thermal. This weighting reflects the profile of builds over 2015-2019 of renewable and natural gas-fired units. The financial data used to estimate this rate is primarily from 2016–2020. The EPA 2023 Reference Case uses 2022 (2022$) as its real dollar baseline and assumes 1.76% general inflation. Hence, the nominal discount rate is 5.59%.

[99] Represents 10-year historical average (2011- June 2020) on a 20-year treasury bond. See discussion of risk-free rate and market premium. The 5-year average (2016–June 2020) on a 20-year T bond is 2.45%. The 5-year (2016–June 2020) and 10-year (2011–June 2020) averages for the 30-year bond are 2.66% and 2.99% respectively.

[100] Represents the long horizon expected equity risk premium based on differences between S&P 500 total returns and long-term government bond income returns from 1926–2020 (Duff and Phelps 2020).

[101] Size Premiums according to size groupings taken from Duff & Phelps 2020 Valuation. Equity Size Premium is based on weighted average of each company's Equity Size Premium, weighted by each company's Market capitalization level.

[102] Levered betas were calculated using 5 years (2016–June 2020) and in a sensitivity case discussed separately later 10 years (2011–June 2020) of historical stock price data. Daily returns were used in the current analysis. In the previous case, weekly returns for 5 years (2016-2020) were used.

[103] Debt/total value ratio is the simple average of net debt to equity ratio for the past 5 years.

[104] Cost of debt is based on 5-year (2016–June 2020) weighted average of debt yields for 18 utilities. The weights assigned are equity share of each utility.

[105] Calculated using Hamada equation.

[106] Target debt/total value for utility case is based on historical 5 years of average D/E for utilities

EPA 2023 Reference Case - Utility WACC using daily beta for 2016-2020	
Cost of equity (with size premium) [107]	7.17 %
WACC	4.88 %
EPA 2023 Reference Case - Merchant WACC using 55% Target Debt	
Parameters	**Value**
Risk-free rate	2.73 %
Market premium	7.15 %
Equity size premium	0.89 %[108]
Levered beta[109]	1.04
Debt/total value[110]	0.64
Cost of debt[111]	6.27 %
Debt beta[112]	0.00
Unlevered beta[113]	0.45
Target debt/ total value[114]	0.55
Relevered beta	0.86
Cost of equity (with size premium) [115]	9.74%
WACC	6.65%

Table 10-3 Weighted Average Cost of Capital in the EPA 2023 Reference Case

Utility Share	Utility WACC	Merchant Share	Merchant WACC	Weighted Average Nominal WACC	Inflation	Weighted Average Real WACC
60%	4.88%	40%	6.65%	5.59%	1.76%	3.76%

10.5 Discount Rate Components

The discount rate is a function of the following parameters:

- Capital structure (share of equity and debt)
- Post-tax cost of debt
- Post-tax cost of equity

[107] Cost of Equity represents the simple average cost of equity derived from Risk-Free Rate, Market Premium, Relevered Beta, and Target D/E value.

[108] Size Premiums according to size groupings taken from Duff & Phelps 2020 Valuation Handbook. Equity Size Premium is based on weighted average of each company's Equity Size Premium, weighted by each company's equity capitalization level.

[109] Levered betas were calculated using five years (2016-June 2020) of historical stock price data. Weekly returns were used in the analysis.

[110] Debt/total value for merchant case is calculated as simple average of the 5-year total debt to total value for each IPP.

[111] Cost of debt is based on historical 5-year weighted average of yields to maturity on outstanding debt.

[112] Debt Beta was previously used as Dynegy was in the process of bankruptcy.

[113] Calculated using Hamada equation. In merchant case, it was modified slightly to include the riskiness of debt.

[114] The capitalization structure (debt to equity (D/E)) for merchant financings is assumed to be 55/45.

[115] Cost of Equity (ROE) represents the simple average cost of equity. In the Merchant ROE, the decrease reflects primarily the lower beta.

The WACC is used as the discount rate and is calculated as follows:[116]

WACC = [Share of Equity * Cost of Equity]
+ [Share of Preferred Stock * Cost of Preferred Stock]
+ [Share of Debt *After Tax Cost of Debt]

The methodology relies on debt and equity (common stock) because preferred stock is generally a small share of capital structures, especially in the IPP sector. Its intermediate status between debt and equity in terms of access to cash flow also tends not to change the weighted average.[117] Typically, net cash flows are used to fund senior debt before subordinated debt, and all debt before equity. Therefore, the risk of equity is higher than debt, and the rates of return reflect this relationship. Notwithstanding, consistent with our use of utility debt that has recourse to the corporation rather than individual assets, we use IPP debt that has recourse to the corporation rather than individual assets because the data are more robust.

10.6 Market Structure: Utility-Merchant Financing Ratio

With two distinct market structures, EPA 2023 Reference Case establishes appropriate weights for regulated and deregulated financial assumptions to produce a single, hybrid set of utility capital charge rates for new units. The EPA 2023 Reference Case uses a weighting of 60:40, regulated to deregulated, based on recent capacity addition shares by market type (see Table 10-4).[118]

Table 10-4 Share of Annual Thermal Capacity Additions by Market

Entity	2015	2016	2017	2018	2019	Total
Regulated	61%	81%	51%	52%	63%	61%
Merchant	39%	19%	49%	48%	37%	39%

10.7 Capital Structure: Debt-Equity Share

10.7.1 Introduction and Shares for Utilities and IPPs

The second step in calculating the discount rate is determining the capital structure, specifically the debt to equity (D/E) or debt to value (D/V) ratio for utility and merchant investments. This is calculated by determining the company's total market value and the market value of its debt and equity. The company's market value is the sum of its debt and equity. We also determined the capital structure for the various technology types.

The target capitalization structure for utilities was assumed to be 50:50, based on the capitalization over the 2016 to 2020 period. The capitalization structure for merchant financings is assumed to be 55/45, reflecting the greater risk inherent to this market.[119]

[116] Sometimes abbreviated as ATWACC. The pretax WACC is higher due to the inclusion of income taxes. Income taxes are included in the capital charges. All references are to the after-tax WACC unless indicated.

[117] Debt generally has first call on cash flows and equity has a residual access.

[118] In contrast to new units, existing coal units can be classified as belonging to a merchant or regulated market structure. Hence, for retrofit investments, the EPA 2023 Reference Case assumption is that coal plants owned by a utility get purely utility financing parameters coal plants owned by merchant companies get purely merchant financing parameters.

[119] The U.S. wide average authorized rate of return on equity, authorized return on rate base, and authorized equity ratio during the 5 years (2012–2016) for 146 utility companies was 9.93%, 7.64%, and 50.22% respectively. According to S&P Global Market Intelligence, the authorized ROE approved for the first half of 2020 was 9.55%. Similarly, S&P Global Market Intelligence give an average authorized ROE of 9.64% in 2019, 9.59% in 2018, 9.63%

10.7.2 Utility and Merchant

The empirical evidence suggests that utility rates of return are based on an average return to the entire rate base for utility financing. Thus, EPA 2023 Reference Case assumes that the required returns for regulated utilities are independent of technology. In contrast, merchant debt capacity is based on market risk and varies by technology.

10.7.3 Merchant by Technology

Assigning merchant technology risk is difficult because there is a lack of publicly traded securities that provide an empirical basis for differentiating between the risks and, hence, financing parameters for different activities.[120] Nevertheless, we assigned merchant technology market risk as follows:

- **Combined Cycles** – The capitalization structure for merchant financing of combined cycles is assumed to be 55/45.

- **Peaking Units** – A peaking unit such as a combustion turbine is estimated to have a capital structure of 40/60. Peaking units have a less diverse and, therefore, more risky revenue stream.

- **Coal Units** – A new coal unit is estimated to have a capital structure of 40/60, reflecting higher risk than a combined cycle unit. This is reflected in a lack of proposed new builds, decreases in coal dispatch, financial assessments by other entities such as EIA and NREL indicating greater risk, and greater levels of environmental regulatory risk.

- **Nuclear Units** — A new nuclear unit is estimated to have a capital structure of 40/60. There is a high risk associated with a new IPP nuclear unit. This is supported by: (1) the financial challenges facing existing nuclear units, (2) the very limited recent new nuclear construction, (3) statements by financial institutions, and (4) the lack of ownership of nuclear power plants by pure-play IPP companies. Of the three pure-play companies, only one has partial ownership of a single nuclear power plant. With this one exception, only utilities and affiliates of utilities own nuclear units.

- **Renewable Units** — A new merchant renewable unit is estimated to have a capital structure of 65/35. This is the highest debt share among the major classes of generation options and, therefore, the lowest cost of capital. This is in part because renewables have access to a third source of financing in tax equity. Tax equity receives the tax benefits such as ITC, PTC, and losses available to defray income tax over time by making a payment upfront. These benefits are not transferable to other companies. There is a risk that the tax credits may become less valuable over time (e.g., the company providing the tax equity does not have sufficient taxable income), or the project may not perform and have inadequate operations to generate expected PTC volumes. This risk is less than typical equity since the tax credits and the tax credit value are not subject to as much variation as regular equity. These projects are also easier to hedge because they have zero variable costs, and hence, the annual volume of output is less uncertain, all else equal, and often receive support via power purchase agreements and renewable energy credits. Limits of relying on even greater debt include the scheduled lowering of the PTC and ITC over time and the potential for performance problems.

Table 10-5 Capital Structure Assumptions in the EPA 2023 Reference Case

Technology	Utility	Merchant
Combustion Turbine	50/50	40/60

for 2017, and 9.60% in 2016. In contrast, they state the average earned ROE to be 9.75% for the 12 months ended during the second quarter of 2020, 10.21% in 2019, 10.34% in 2018, 10.00% in 2017.

[120] There were only three major IPP companies with traded equity. This is insufficient to conduct statistical analysis.

Technology	Utility	Merchant
Combined Cycle	50/50	55/45
Coal & Nuclear	50/50	40/60
Renewables	50/50	65/35
Retrofits	50/50	40/60

10.8 Cost of Debt

The third step in calculating the discount rate is to assess the cost of debt.[121] The utility and merchant cost of debt is assumed the same across all technologies.

Table 10-6 Nominal Debt Rates in the EPA 2023 Reference Case

Technology	Utility	Merchant
Combustion Turbine	3.50%	6.27%
Combined Cycle	3.50%	6.27%
Coal & Nuclear	3.50%	6.27%
Renewables	3.50%	6.27%
Retrofits	3.50%	6.27%

10.8.1 Merchant Cost of Debt

The cost of debt for the merchant sector was estimated to be 6.27%. It is calculated by taking a 5-year (2016-2020) weighted average of debt yields from existing company debt with eight or more years to maturity. The weights assigned to each company's debt yields were based on that company's market capitalization. During the most recent 5 years (2016-2020), none of the existing long-term debt exceeded twelve years to maturity; hence, above average yields are based on debt with maturity between eight and twelve years.

[121] Measured as yield to maturity.

10.8.2 Utility Cost of Debt

The cost of debt for the utility sector was estimated to be 3.5%. It is calculated based on the 5-year (2016-2020) average of a set of 18 investment-grade utilities weighted by enterprise value (see Table 10-7).

Table 10-7 Utilities Used to Calculate Cost of Debt

Name
Ameren Corp
American Electric Power Co Inc
Cleco Corporate Holdings LLC
CMS Energy Corp
Empire District Electric Co/The
MGE Energy Inc
Vectren Corp
Evergy Kansas Central Inc
WEC Energy Group Inc
CH Energy Group Inc
Consolidated Edison Inc
Eversource Energy
Southern Co/The
Avista Corp
IDACORP Inc
Pinnacle West Capital Corp
PNM Resources Inc
Xcel Energy Inc

10.9 Return on Equity (ROE)

10.9.1 Introduction and Beta

The final step in calculating the discount rate is the calculation of the required rate of return on equity (ROE). The ROE is calculated using the formula:

ROE = risk free rate + beta x equity risk premium + size premium

The formula is the key finding of the CAPM and reflects that a premium on return is required as investment risk increases, and that premium is proportional to the systemic risk of the investment.[122] Systemic risk is measured by the impact of market returns on the investment's returns and is measured by beta.[123]

[122] The financial literature on CAPM originally did not emphasize the size premium (also referred to as the liquidity premium). It emerged from later findings that the estimated required return was too low for small stocks (i.e., with low equity value).

[123] Beta is the covariance of market and the stock's returns divided by the variance of the market's return.

There are several additional aspects of estimating beta:

- **Time Period** – The most common practice is to use five years of historical returns to estimate beta.

- **Returns** – Daily returns are commonly used to estimate beta except for illiquidly traded stocks when weekly returns are used to avoid underestimating beta. The utility estimates presented use daily data and the IPP estimates used weekly estimates.

- **Unlevered Betas**—It is useful to estimate unlevered betas that eliminate the effects of leverage. This facilitates comparison across investments with different leverage levels and allows recalculation to account for future changes in leverage levels. This recalculation involves a technique known as the Hamada[124] equation.

- **Debt Betas** - When a company is facing financial distress, the debt can become the new equity as part of a corporate reorganization under the federal bankruptcy code. Hence, during the bankruptcy period, the debt trades like equity. There is a technique to adjust the beta by calculating a debt beta. This technique is employed because in past analyses (e.g., 2012–2016), IPP companies were bankrupt.

10.9.2 Risk-Free Rate and Equity Risk Premium

The risk-free rate of return and equity risk premium are market parameters and are not company-specific. They also determine the average market-wide level of returns on equity. Therefore, the average return of the market equals the sum of the risk-free rate of return and equity risk premium.

The EPA estimate uses long-term averages for both the risk-free rate and the market risk premium. This avoids using or giving large weight to the currently depressed risk-free interest rates.

In the current analysis, the EPA used the 10-year Risk-Free rate of 2.73%, based on the 10-year (2011–2020) average of U.S. Treasury 20-year bond rates. Additionally, the Duff and Phelps Long-Term (1926–2020) Market Premium of 7.15% was adopted in this analysis. Thus, the total of the risk-free rate and the market premium is 9.88%. As noted, this sum equals the expected return of the market (i.e., the beta is one).

10.9.3 Beta

Utility betas average 0.72 during the 2016 to 2020 period on a levered basis (see Table 10-8). This estimate is based on daily returns.

Table 10-8 Estimated Annual Levered Beta for S15ELUT Utility Index Based on Daily Returns[125]

Year	Levered Beta
2016–2020	0.72

[124] In corporate finance, Hamada's equation is used to separate the financial risk of a levered firm from its business risk.

[125] S15ELUT Index comprises of 20 utilities. They are: American Electric Power Co Inc, ALLETE Inc, Duke Energy Corp, Eversource Energy, Entergy Corp, Evergy Inc, Edison International, Exelon Corp, FirstEnergy Corp, Hawaiian Electric Industries Inc, IDACORP Inc, Alliant Energy Corp, NextEra Energy Inc, OGE Energy Corp, Pinnacle West Capital Corp, PNM Resources Inc, PPL Corp, Southern Co/The, and Xcel Energy Inc. We have excluded NRG as it is an IPP Company.

IPP levered betas average 1.04 based on weekly returns from 2016–June 2020. After decreasing leverage for IPPs from 64% to 55%, the relevered beta was 0.86. The unlevered betas (i.e., betas without debt impacts) of utilities is 0.33, and of IPPs is 0.45.[126]

10.9.4 Equity Size Premium

It is observed that the long-run returns of smaller, less liquidly traded companies have higher returns than predicted using the market risk premium. Therefore, an equity size of a liquidity premium is added. Based on the 2020 Duff and Phelps Valuation Handbook, there was a significant equity size premium for IPPs of 0.89% and a minimal premium for utilities at -0.01%.

10.9.5 Nominal ROEs

Utility

The utility ROE is 7.17% in nominal terms. The utility ROE is the single most influential parameter in the estimate of the discount rate because of the 60% weight given to utilities compared to IPPs, and the decrease in interest rates due to the tax shield on debt (debt interest payments are tax deductible).

The estimated utility ROE in EPA 2023 Reference Case is lower than what state and federal commissions have awarded the shareholder-owned electric utilities recently.[127] In some cases, commissions use a different approach or assumptions.[128] Regardless of methodology, the trend over time is to lower returns, and this is a long-term analysis focused on the cost of capital for future investments that can occur 25 years or more in the future. Thus, it could be that returns are trending toward this level and that sufficient capital can be attracted in the future at these lower rates. Another possible explanation is that while the utilities are allowed to earn higher returns, actual earnings will be, over time, lower than allowed, and closer to the required utility ROE estimated here.

IPP

The nominal ROE for IPPs is 9.74%. The IPP required ROE is sensitive to the amount of debt, and the analysis assumes future delevering. Specifically, the IPP ROE assumes 55% debt rather than 64% debt, which is the 2016-2020 average.

[126] Unlevered betas are lower than levered betas. Levered beta is directly measured from the company's stock returns with no adjustment made for the debt financing undertaken by the company. The leveraged beta of the market equals one.

[127] Based on Bloomberg data, the average authorized ROEs for nine Utility Companies (Southern Company, American Electric Power Co, WEC Energy, CMS Energy, Cleco Corp, Allete Inc., Black Hills Corp, and NextEra Energy) was 9.86% in 2019. This was less than the average earned ROE according to S&P Global Intelligence of 10.21% in 2019, and slightly higher than their average authorized ROE of 9.64%.

[128] Some regulatory commissions use what is known as the dividend growth model. This model assumes that the current market price of a company's stock is equal to the discounted value of all expected future cash flows. In this approach, the time period is assumed to be infinite, and the discount rate is a function of the share price, earnings per share and estimated future growth in dividends. The challenge with using this approach is estimating future growth in earnings. Commissions rely on stock analyst forecasts of future growth rates for dividends. In other cases, commissions may allow for other parameters such as flotation costs (costs of issuing stock). We did not use this approach because it is less commonly used. There also appears to be a tendency of allowed rates of return as a group to be too low during periods with high financial costs and too high during periods of low financing costs. This may be to ensure comparability with similar utility companies. There is also a literature that indicates that as betas deviate from 1, the CAPM returns are too low and too high. We did not address these issues directly in part because the results were comparable to other results, with the exception of being lower than allowed returns.

10.9.6 WACC/Discount Rate

The WACCs are 4.88% in nominal terms for utilities and 6.65% in nominal terms for IPPs (see Table 10-3). Using a 60:40 utility/merchant weighting, the weighted average WACC under utility financing and merchant financing is a 5.59% WACC. The real hybrid WACC is 3.76%.

10.10 Calculation of Capital Charge Rate

10.10.1 Introduction to Capital Charge Rate Calculations

The capital charge rate is used to convert the capital cost into a stream of levelized annual payments that ensures the capital recovery of an investment. The number of payments is equal to the book life of the unit or the years of its book life included in the planning horizon (whichever is shorter). Table 10-9 to Table 10-11 presents the capital charge rates by technology type used in EPA 2023 Reference Case. As discussed in section 10.3, the changes to the Tax Code have caused capital charge rates to vary by run year. Therefore, the tables below show the rates for the individual run years through 2030. Capital charge rates are a function of the underlying discount rate, book and debt life, taxes and insurance costs, and depreciation schedule.

Table 10-9 Real Capital Charge Rate – Blended (%)[129] in the EPA 2023 Reference Case

New Investment Technology Capital Hybrid (60/40 Utility/Merchant)	2023	2025	2028 and Beyond
Environmental Retrofits - Utility Owned	10.58%	10.58%	10.58%
Environmental Retrofits - Merchant Owned	12.66%	12.70%	12.99%
Advanced Combined Cycle	8.29%	8.30%	8.39%
Advanced Combustion Turbine	8.64%	8.63%	8.69%
Ultra-Supercritical Pulverized Coal	7.92%	7.93%	8.01%
Nuclear without Production Tax Credit	7.90%	7.89%	7.94%
Biomass	7.66%	7.65%	7.65%
Wind, Solar and Geothermal	8.15%	8.15%	8.15%
Wind, Landfill Gas, Solar, and Geothermal without Property Tax and Insurance	7.00%	6.99%	6.99%
Landfill Gas	8.14%	8.14%	8.18%
Hydro	7.66%	7.67%	7.75%
Energy Storage	10.94%	10.93%	10.94%
Energy Storage without Property Tax and Insurance	9.79%	9.78%	9.80%

Table 10-10 Real Capital Charge Rate – IPP (%)

New Investment Technology Capital (IPP)	2023	2025	2028 and Beyond
Environmental Retrofits - Merchant Owned	12.66%	12.70%	12.99%
Advanced Combined Cycle	9.43%	9.46%	9.70%
Advanced Combustion Turbine	10.08%	10.05%	10.19%
Ultra-Supercritical Pulverized Coal	9.42%	9.43%	9.64%
Nuclear without Production Tax Credit	9.41%	9.38%	9.49%
Biomass	8.73%	8.72%	8.71%
Wind, Solar and Geothermal	9.14%	9.12%	9.12%

[129] Capital charge rates were adjusted for expected inflation and represent real rates. The expected inflation rate used to convert future nominal to constant real dollars is 1.76%. The future inflation rate of 1.76% is based on an assessment of implied inflation from an analysis of yields on 10-year U.S. Treasury securities and U.S. Treasury Inflation Protected Securities (TIPS) over a period of 5 years (2016-2020).

New Investment Technology Capital (IPP)	2023	2025	2028 and Beyond
Wind, Landfill Gas, Solar, and Geothermal without Property Tax and Insurance	7.99%	7.97%	7.97%
Landfill Gas	9.15%	9.15%	9.28%
Hydro	10.61%	10.67%	11.01%
Energy Storage	11.77%	11.74%	11.77%
Energy Storage without Property Tax and Insurance	10.62%	10.58%	10.63%

Table 10-11 Real Capital Charge Rate – Utility (%)

New Investment Technology Capital Utility	2023	2025	2028 and Beyond
Environmental Retrofits - Utility Owned	10.58%	10.58%	10.58%
Advanced Combined Cycle	7.52%	7.52%	7.52%
Advanced Combustion Turbine	7.69%	7.69%	7.69%
Ultra-Supercritical Pulverized Coal	6.93%	6.93%	6.93%
Nuclear without Production Tax Credit	6.90%	6.90%	6.90%
Biomass	6.94%	6.94%	6.94%
Wind, Landfill Gas, Solar, and Geothermal	7.50%	7.50%	7.50%
Wind, Landfill Gas, Solar, and Geothermal without Property Tax and Insurance	6.35%	6.35%	6.35%
Landfill Gas	7.46%	7.46%	7.46%
Hydro	7.01%	7.01%	7.01%
Energy Storage	10.38%	10.38%	10.38%
Energy Storage without Property Tax and Insurance	9.24%	9.24%	9.24%

10.10.2 Capital Charge Rate Components

The capital charge rate is a function of the following parameters:

- Capital structure (debt/equity shares of an investment)
- Pre-tax debt rate
- Debt life
- Post-tax return on equity
- Other costs, such as property taxes and insurance
- State and federal corporate income taxes
- Depreciation schedule
- Book life

Table 10-12 presents a summary of various assumed book lives, debt lives, and the years over which the investment is fully depreciated. The EPA 2023 Reference Case assumes a book life of 15 years for retrofits. This assumption is made to account for recent trends in financing retrofit investments.

Table 10-12 Book Life, Debt Life, and Depreciation Schedules in the EPA 2023 Reference Case

Technology	Book Life (Years)	Debt Life (Years)	U.S. MACRS Depreciation Schedule (Years)
Combined Cycle	30	20	20
Combustion Turbine	30	15	15
Coal Steam and IGCC	40	20	20
Nuclear	40	20	15

Technology	Book Life (Years)	Debt Life (Years)	U.S. MACRS Depreciation Schedule (Years)
Solar, Geothermal, and Wind	30	20	5
Landfill Gas	30	20	15
Biomass	40	20	7
Hydro	40	20	20
Batteries	15	15	7
Environmental Retrofits	15	15	15

Depreciation Schedule

For the utility sector, the U.S. MACRS depreciation schedules were obtained from IRS Publication 946 which lists the schedules based on asset classes.[130, 131] The document specifies a 5-year depreciation schedule for wind energy projects and 20 years for electric utility steam production plants. These exclude combustion turbines and nuclear power plants, which each have a separate listing of 15 years. As a result of the tax code changes, the merchant sector is allowed to depreciate assets on an accelerated schedule through 2027. Accelerated depreciation is allowed starting in 2018 with 100% depreciation and phases out at 20% annually between 2023 and 2027.

Taxation and Insurance Costs

The maximum U.S. corporate income tax rate is 21%.[132] State taxes vary, but the weighted average state corporate marginal income tax rate is 6.45%. This yields a net effective corporate income tax rate of 26.1%.

U.S. state property taxes are approximately 0.9%, based on the national average. This is based on extensive primary and secondary research conducted by the EPA using property tax rates obtained from various state agencies.

Insurance costs are approximately 0.3% on a national average basis.

[130] MACRS refers to the Modified Accelerated Cost Recovery System, issued after the release of the Tax Reform Act of 1986.

[131] IRS Publication 946, “How to Depreciate Property,” Table B-2, Class Lives and Recovery Periods.

[132] Internal Revenue Service, Publication 542.