APPENDIX A: FINANCIAL ASSUMPTIONS AND DISCOUNT RATE

Contents

Introduction 2
Rate of Time Preference or Discount Rate 2
Interpretation of Observed Interest Rates 3
What perspective should the rate of time preference represent? 4
Risk and Uncertainty Issues 5
Considerations In Choosing A Specific Value For The Seventh Power Plan 5
Application of the Prescriptive approach to a rate of time preference 9
Recommended Approach 9
Conclusions 11
Additional Financial Analysis: 11
Reference Assumptions 12

List of Figures and Tables

Table A - 1: Assumed Share used in calculation Discount rate 6
Table A - 2: Inflation and Nominal Interest Rates on Common Investments 6
Table A - 3: Range of Assumptions and Discount Rates - Investors 8
Table A - 4: Range of Assumptions and Discount Rates - Consumers 8
Table A - 5: Illustration of Impact of Discount Rate on Resource Selection 10
Figure A - 1: Discount Rate Calculation for Corporate Perspective 12
Figure A - 2: Discount Rate Calculations for Consumer Perspective 13

INTRODUCTION

The Council's planning process involves a number of analytical steps, including estimation of quantities and costs of new resources, projection of future demand for electricity under a variety of assumptions, and simulation of the operation of the regional power system to meet varying future demands with alternative sets of resources. These analytical steps require assumptions regarding financial and economic variables.

When developing the Plan, the Council performs investment analysis, allowing for a comparison of energy generating and efficiency projects that have different patterns of expenditures.

Consideration of these assumptions is important for three reasons: first, the values used directly influence the outcome of the analysis; second, the values used in the various components of analysis must be consistent; and third, some assumptions reflect policy judgments about the relative weight of the present and the future.

RATE OF TIME PREFERENCE OR DISCOUNT RATE

The concept of the rate of time preference arises from the general observation that people, given the choice, would prefer to consume now rather than later (or in other words, to pay later rather than now). Income received now can be reinvested to produce additional income later. This positive rate of time preference is reflected in borrowing, lending and investment behavior throughout the economy. The term "discount rate" is often used for this concept, but is also used in other contexts, such as referring to market rates of interest.

For the purposes of the Council's planning, the rate of time preference is important because evaluating alternatives commonly requires the comparison of streams of costs with different timing. The rate of time preference allows the translation of costs incurred at different times into comparable present values. One example of a situation where this translation is necessary is a comparison of the cost of electricity from wind generators to the cost of electricity from natural gas-fired turbines. The wind generators' costs are concentrated in the first year or two in the initial construction of the generators, while the costs of the gas turbines include both initial construction costs and substantial operating costs (mostly fuel) throughout the life of the turbines. Converting both cost streams into present values allows a valid comparison of the costs of the two alternatives.

The conversion to present value is accomplished by dividing each year's costs by (1+r)t where r = the rate of time preference and t = the number of years from the present, and adding up all years' values. This conversion has been a key feature of Council analysis from the first Power Plan; it is an essential step in the operation of the Regional Portfolio Model (RPM) today. The rate of time preference is also used in levelizing conservation measures' costs in Procost and generating resources' costs in Microfin. The Procost model is used to calculate conservation levelized costs and present value of costs and benefits. The Microfin model is used to estimate levelized cost of generation options other than conservation.

A higher discount rate reduces the importance of future effects more than a lower discount rate. All else equal, a higher discount rate would tend to value a combustion turbine over a wind project, for

example, by disproportionately reducing the higher fuel costs in future years. On the other hand, a lower discount rate would not reduce the effects of those future costs as much. A discount rate of zero percent for example, would treat effects in all years, whether next year or 30 years from now, the same in terms of their impact on the investment decision made now. This notion of time preference is not, however, an abstract preference for the short term versus the long term. Time preference is directly tied to the concept of a market interest rate. Putting aside questions of risk temporarily, a dollar to be paid next year is less of a burden than a dollar this year. That is because one could invest less than a dollar today and, assuming sufficient return on that investment, use the proceeds to pay the dollar cost next year.

From the other side, a dollar benefit this year is more valuable than the same dollar benefit next year, because it can be turned into more than a dollar next year by investing it. The important point here is that dollars at different times in the future are not directly comparable values; they are apples and oranges. Applying a discount rate turns costs and benefits in different years into comparable values. Because the Council's analysis looks at annual cost streams of many resource types, discounting is required in order to make a fair comparison of alternative policies.

Market interest rates embody the effect of everybody's rates of time preference. Individuals and businesses that value current consumption more than future consumption will tend to borrow, and those that value future consumption more will save. The net effect of this supply and demand for money is a major factor in setting the level of interest rates, as are the actions of the Federal Reserve in setting the federal funds rate and influencing inflation expectations through its actions on the aggregate money supply. Market interest rates also embody considerations of uncertainty of repayment, inflation uncertainty, tax status, and liquidity, which together account for most of the variations among observed interest rates.

Because of this overall relationship between rates of time preference and interest rates, the level of the discount rate should be related to the level of interest rates. The difficulty is in determining which interest rate is the appropriate one for the choices being made. There are three general approaches commonly used for this choice, which can be described as the regional consumer's perspective, the corporate perspective and the national perspective. These perspectives will be covered in a later section of this appendix.

Finally, risk and uncertainty in evaluating a capital-heavy project is sometimes treated by modifying the discount rate and sometimes by directly modifying the treatment of costs and benefits in the analysis. There are theoretical arguments in the economic literature on all sides of these issues.

INTERPRETATION OF OBSERVED INTEREST RATES

There is debate among economists about the validity of using observed market rates as the basis of the rate of time preference. The two sides of the debate are generally referred to as the "descriptive" approach, which focuses on decisions observed in the market, and the "prescriptive" approach, which focuses on ethical considerations and market imperfections.

Economists who advocate the descriptive approach argue that observed market behavior is the best evidence of the rates of time preference of individuals who make up society. They argue that behavior is the best basis for translating costs and benefits at different times to comparable *present*

values. This approach is fundamentally the interpretation of market behavior to estimate what rates of time preference underlie that behavior.

Economists who advocate the prescriptive approach argue that a number of market imperfections and perhaps most important, the practical and ethical issues of discounting costs and benefits across long periods of time (greater than 50 years), mean that an appropriate rate of time preference for society should be different than observed market rates of interest. They argue that the rate of time preference is best developed from ethical principles and recognition of market imperfections.

The Council's work has adopted the descriptive approach in the past; this appendix describes the application of that approach to the estimation of the regional rate of time preference first. It will then take up the prescriptive approach and its possible relevance to Council planning methodology for the future.

But what rate of time preference (implied by investments of what level of risk) is appropriate for use with the Council's Regional Portfolio Model (RPM)? The principal use of the Council's rate of time preference is to translate the regional power system costs for various portfolios simulated by the RPM into comparable present values. The RPM explicitly models the most significant risks faced by the power system, so further reflecting risk by using a rate of time preference that includes a significant risk component could result in discounting future benefits more heavily than we should. Because of this, it is recommended that the rates of interest of low-risk investments are the most appropriate basis for a rate of time preference to be used with the RPM.

WHAT PERSPECTIVE SHOULD THE RATE OF TIME PREFERENCE REPRESENT?

In considering a choice of perspective, it's helpful to think of the three perspectives, consumers', corporate, and national, in terms of their different views of taxes.

From an individual consumer's perspective, taxes paid on returns to investment reduce his or her consumption rate of interest, the amount of consumption he or she can enjoy in the future as the result of a reduction in consumption today. In the example above, a 28% tax on investment returns will reduce a nominal 8% return to an after-tax return of 5.8% (before adjusting for inflation).

Corporations see returns to investment similarly reduced by corporate income taxes. Their after-tax returns are not really comparable to consumption rates of interest, since those returns are further reduced by individual income taxes before the corporations' stockholders can use them for consumption.

From the national perspective, however, the full return to an investment is available for increased consumption, which includes both the after-tax return to the investor themself, and the goods or

services paid for by the taxes on the investment return. From the national perspective, the consumption rate of interest is equal to the pre-tax rate of return on representative investments.[1]

Risk and Uncertainty Issues

As mentioned earlier, variations in risk and uncertainty account for a major part of the differences among returns to various potential investments. It is important to try to capture these elements of potential investments in the analysis in some manner, and at the same time, avoid double counting them by embodying them in both the discount rate and the rest of the analysis. The Council's resource analysis explicitly accounts for major uncertainties and risks, such as water conditions, load growth uncertainty, fuel prices, power market prices, carbon dioxide mitigation requirements, and so forth.

CONSIDERATIONS IN CHOOSING A SPECIFIC VALUE FOR THE SEVENTH POWER PLAN

The Seventh Power Plan covers 2016 through 2035, with a six-year action plan period of 2016 through 2021. The approach that the Council took for its investment analysis builds on two sets of assumptions. The first is the relative shares of future investment decisions made by different entities (Bonneville, publicly owned utilities, investor owned utilities and residential and business customers). The second is a set of forecast data developed by Global Insight, a national economic consulting firm, whose forecasts are used for various purposes by the Council.

The first set of assumptions looks at decision makers. Because the recommended approach looks at investment decision makers, and because a significant fraction of the conservation resource is expected to be paid for directly by consumers, the Council made assumptions about the shares of the ultimate resource portfolio that will be made up of generation and conservation and the shares of the conservation decisions that will be made by consumers. Generation decisions will be made by utilities; conservation investment decisions will be made both by utilities, through purchase or rebate programs, and by consumers directly. An assumption has also been made about the share of the public agencies' new resource requirements that will be placed on Bonneville. That share will be evaluated at the Bonneville discount rate.

Plausible changes from the reference assumptions can affect the ultimate discount rate (shown in Table A-3) somewhat. Because of this, both the reference assumptions and a range of assumption values have been examined. Both are shown in Table A-1 below. Note values shown in Table A-1 are not discount rates.

[1] A Pacific Northwest *regional* perspective would treat federal income taxes as mostly reductions in the consumption rate of interest, since not all of the goods and services paid for by a marginal dollar of federal taxes paid in the PNW return to the PNW to be consumption for the regional population. An argument can be made that a regional rate of time preference should therefore be lower than a national rate of time preference.

Table A - 1: Assumed Share used in calculation Discount rate

Assumptions	Reference Value	Range
Bonneville share of publics' generation needs	20.0%	10%-30%
Generation share of future resources	15.0%	15%-50%
Conservation share of future resources	85.0%	50%-95%
Utilities share of conservation cost	60.0%	40%-70%
Consumer share of conservation cost	40.0%	60%-30%
Residential sector share of conservation resource	40%	30%-60%
Business sector share of conservation resource	60%	70%-40%

The second set of assumptions consists of cost of capital estimates for the various decision-making entities described above. As noted, they are based on the most recent forecasts of financial variables by Global Insight. There are five basic inputs to Global Insight's calculation for this forecast, all averaged over the years 2015-19: GDP deflator (used to convert to real terms), nominal 30-year Treasury bond rates, 30-year new conventional mortgage rates, long-term AAA rated municipal bond rates and long-term Baa corporate bond rates. These values are shown in Table 2 below:

Table A - 2: Inflation and Nominal Interest Rates on Common Investments

Item	2015-19 Average Nominal	2015-19 Average Real
GDP deflator	1.64%	
30 year Treasury	5.20%	3.5%
30 year new conventional mortgage	6.44%	4.7%
Long-term AAA municipal bond	5.24%	3.54%
Long-term Baa corporate bond	7.28%	5.6%

The discount rates that are used for the three major categories of retail load-serving entities (municipals/public utilities, coops and IOUs) are distinguished by their financing costs and estimates can be derived from the above values. Municipal utilities and public utilities are assumed to be able to borrow at AAA municipal bond rates, or 3.5 percent in real terms. Coops are able to finance at about 100 basis points above Treasury rates, implying a rate of 6.2 percent or 4.5 percent in real terms. Bonneville financing is about 90 basis points above Treasury rates for long-term borrowing, implying a rate of 4.4 percent in real terms.

The discount rates used by regional utilities surveyed show a range from 3.6% to 5.8% for IOUs, and 2.4% to 4.9% for public utilities. They represent the tax-adjusted weighted average cost of capital (WACC) for the utilities and typically employ the allowed rate of return from the most recent rate case. A composite value for IOUs using the assumptions above can be calculated using the

current cost of equity, roughly averaged from the data, and a cost of debt based on the forecast cost of Baa debt, adjusted for its tax deductibility. The effective cost of the debt is lower because it is deductible for corporate income tax purposes, just as home mortgage debt is deductible for personal income tax purposes.

The approach for assessing decision making by consumers for the consumer-funded portion of the energy efficiency is similar, though it uses largely different data. The Department of Energy (DOE) conducted a study on consumer discount rates[2] for the purpose of evaluating national lighting standards. On the residential side, it looked at a range of assets and borrowing sources available to individual consumers[3], with the sources weighted by their historic use, based on the Federal Reserve Board's Survey of Consumer Finances over a recent 15-year period. Using this historic data analysis, DOE calculated a real consumer discount rate of 5.6 percent.

The DOE calculation makes an adjustment for the tax deductibility of certain kinds of borrowing (home equity loans) but does not make any adjustment for the tax effects on net returns from the various asset classes it considers (savings accounts, CDs, mutual funds, etc.). This is important because the returns from a consumer's energy efficiency investment are not reduced by taxes (i.e., they are equivalent to after-tax returns from a financial investment). Using the shares of borrowing types and returns from the DOE historical data, as well as the implied average historical inflation rates from the DOE data, and adjusting the returns on investment assets by an assumed 20 percent income tax rate, the DOE-calculated real residential discount rate is reduced from 5.6 percent to 3.9 percent. A range of values is shown for the final calculation, as displayed in Table A-3 below.

The last item to be calculated is the discount rate for business consumers. DOE also estimated values for this, based on a different approach than it had used for residential consumers. DOE used the Capital Asset Pricing Model, a widely used approach in financial economics, to calculate the cost of equity for a large sample of commercial and industrial companies. Using the same data base from which the companies were drawn, DOE extracted estimates of cost of debt, debt/equity ratios and factors relevant to the calculation. Using an estimate of long-term Treasury rates of 5.5 percent (almost identical to the Global Insight forecast used here, 5.2 percent) and an inflation forecast of 2.3 percent (higher than that used here, 1.6 percent) DOE derived real industrial and commercial discount rates of 4.7 and 4.5 percent, respectively.

In order to make the result somewhat more comparable to the calculations in this appendix, the values can be recalculated using the Global Insight forecast of inflation, which has the effect of implying higher real interest rates. That calculation would yield industrial and commercial real discount rates of 4.7 and 4.6 percent respectively.

In addition to the range of values used for the decision-share assumptions, described earlier in this appendix, the recommendation for a discount rate to use in the Council's analysis is based on a range of real discount rates for business and residential consumer decisions. The final set of

[2] http://www.eere.energy.gov/buildings/appliance_standards/residential/gs_fluorescent_incandescent_tsd.html

[3] Similarly to the approach used by Council in earlier plans, when it took a region consumer's perspective.

assumed values for either corporate or consumer perspective, with their ranges, is shown below in Tables A-3 and A-4. The results for the reference case for the corporate and consumer perspectives are presented in the Attachment shown at the end of this appendix.

Table A - 3: Range of Assumptions and Discount Rates - Investors

		Assumptions to Drive Discount Rate	
Assumptions	**Reference**	**Up**	**Down**
Inflation rate	1.6%	1.6%	1.6%
BPA share of publics' generation needs	20.0%	30.0%	10.0%
Generation share of future generation resources	15.0%	5.0%	50.0%
Conservation share of future resources	85%	95.0%	50.0%
Consumer share of conservation cost	40.0%	60.0%	30.0%
Residential share of consumer conservation	41.0%	60.0%	30.0%
Business share of consumer conservation	59.0%	40.0%	70.0%
Residential real Cost of Capital	3.0%	4.0%	2.0%
Business real Cost of Capital	7.7%	8.7%	6.7%
Investor/Corporate Discount Rate	**5.1%**	**5.40%**	**4.8%**

Table A - 4: Range of Assumptions and Discount Rates - Consumers

		Assumptions to Drive Discount Rate	
Assumptions	**Reference**	**Up**	**Down**
Inflation rate	1.6%	1.6%	1.6%
BPA share of publics' generation needs	20.0%	30.0%	10.0%
Generation share of future resources	15%	5.0%	50.0%
Conservation share of future resources	85%	95.0%	50.00%
Consumer share of conservation cost	40.0%	60.0%	30.0%
Residential share of consumer conservation	41.0%	60.0%	30.0%
Business share of consumer conservation	59.0%	40.0%	70.0%
Residential real discount rate	3.0%	4.0%	2.0%
Business real discount rate	4.3%	8.7%	6.7%
Consumer Discount Rate	**3.8%**	**3.9%**	**3.5%**

APPLICATION OF THE PRESCRIPTIVE APPROACH TO A RATE OF TIME PREFERENCE

Up to this point, the discussion has revolved around using the descriptive approach to estimations of discount rates. The issues raised by advocates of the prescriptive approach are probably not relevant to the Council's choice of a rate of time preference for use in Microfin, ProCost, or the Regional Portfolio Model. They could, however, be relevant to the Council's consideration of environmental costs, particularly those elements of environmental costs that persist for a long time. The most obvious example of such costs are greenhouse gas emissions. The current emissions, and those that occur over the next 20 years, may have large effects over the next 100 years or more. In cases of long-term, uncertain effects, the prescriptive approach may have something to offer.

Advocates of the prescriptive approach to the rate of time preference have tended to focus on the problems of discounting over long periods (e.g. >50 years). They assert that over the very long term, the validity of using market rates of interest as the basis of rates of time preference is debatable. This method has received increased attention as part of efforts to evaluate climate change policy options, since greenhouse gasses (GHG) remain in the atmosphere for generations. However, other situations, such as investments in long-lived assets such as hydroelectric projects, bridges, irrigation projects and levees, raise similar issues. Unlike the costs and benefits of decisions whose impacts play out over 20-30 years, the costs and benefits of these kinds of decisions fall at widely separated intervals on completely different groups of people.

One way to pose the issue is, "I can think of investment decisions as trading my consumption now for my consumption X years in the future, and weighting my consumption in those two periods based on my investment opportunities and my preference for immediate gratification. How then should society weigh my consumption now against that of my great-granddaughter 100 years from now?

Does it make sense to weigh her consumption at less than 1 percent of mine, which would be the result of a 5 percent rate of time preference ($1.00 of her consumption, divided by $(1.05)^{100}$, or $0.0076) $76/10,000 dollars."

Key point is that over the very long term, the validity of using market rates of interest as the basis of rates of time preference is debatable.

Advocates of the prescriptive approach argue that market rates of interest give little or no guidance in approaching the issue. Others assert that the problem is even more fundamental than correctly reflecting the interests of future generations. They assert that non-human species and the environment as a whole deserve standing in weighing such decisions, in ways that conventional economics is inadequate to reflect.

RECOMMENDED APPROACH

For the Seventh Power Plan, the Council used a hybrid of the descriptive and prescriptive approaches in adopting a discount rate. It should be noted that, unlike much of the analysis and data

provided by the Council in its power plans, which are directly useable by the entities acquiring resources, costs of capital and discount rates derived from them are specific to each entity. A composite rate, such as is used by the Council, will not likely be appropriate for use by any particular utility, though the Council's approach to choosing a value should be useful and is recommended.

As stated previously, because the discount rate reduces the value of future costs, risks and benefits, it can alter the relative economic ranking of resource options. Table A-5 below shows the impact of a wide range of alternative discount rates on the levelized cost of resource types that have different cost streams. The first two resources, energy efficiency and wind generation, are dominated by capital cost and have no, in the case of efficiency, or few, in the case of wind, ongoing maintenance cost. The second two resources, combined and simple cycle combustion turbines, require less up front capital, but have more significant ongoing fuel and maintenance costs.

As an illustration review of Table A-5 shows that the rank ordering of this set of illustrative resources from lowest to highest cost remains largely unchanged across discount rates ranging between zero and twenty percent. The sole exception is that wind resources are slightly less expensive than a combined cycle turbine using zero discount rate.

While there are alternative methods to selecting a discount rate, it appears that over the range of potential values that could be justified on the basis of any of the approaches described above, the relative economics of resource options are not materially altered.

Table A - 5: Illustration of Impact of Discount Rate on Resource Selection

(Levelized cost 2012$/MWh at various discount rates)

Discount Rate	**0%**	**3%**	**4%**	**5%**	**7%**	**20%**
Energy Efficiency (TRC)	50	43	41	39	36	24
Wind	88	66	60	55	47	21
Combined-Cycle Combustion Turbine	79	58	53	48	41	18
Single-Cycle Combustion Turbine	256	189	173	158	134	61

Conclusions

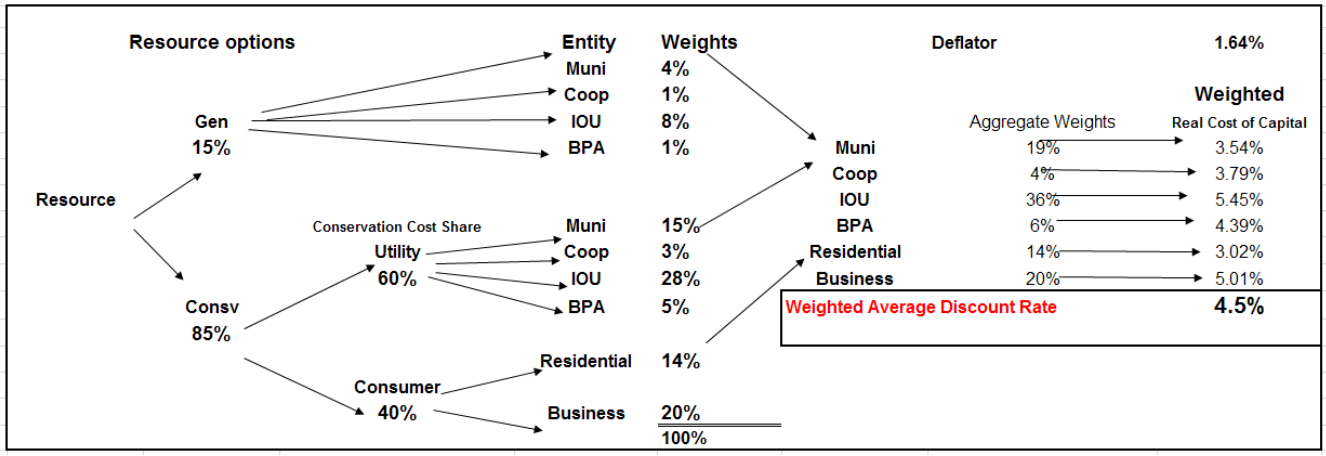
In order to reflect both descriptive and prescriptive approaches, and given that the use of either corporate or consumer perspectives makes no material difference in resource selection, the Council used a real discount rate of 4 percent for its analysis in the Seventh Power Plan. However, as a sensitivity analysis Council decided to test both 4% and 5% discount rate to see if there is significant difference in the Plan's outcome. As of writing for the draft plan, evaluation of impact on resource plan with 5% discount rate has not yet been completed

Additional Financial Analysis:

For additional financial analysis information related to conservation and generation resources see appendices G and H.

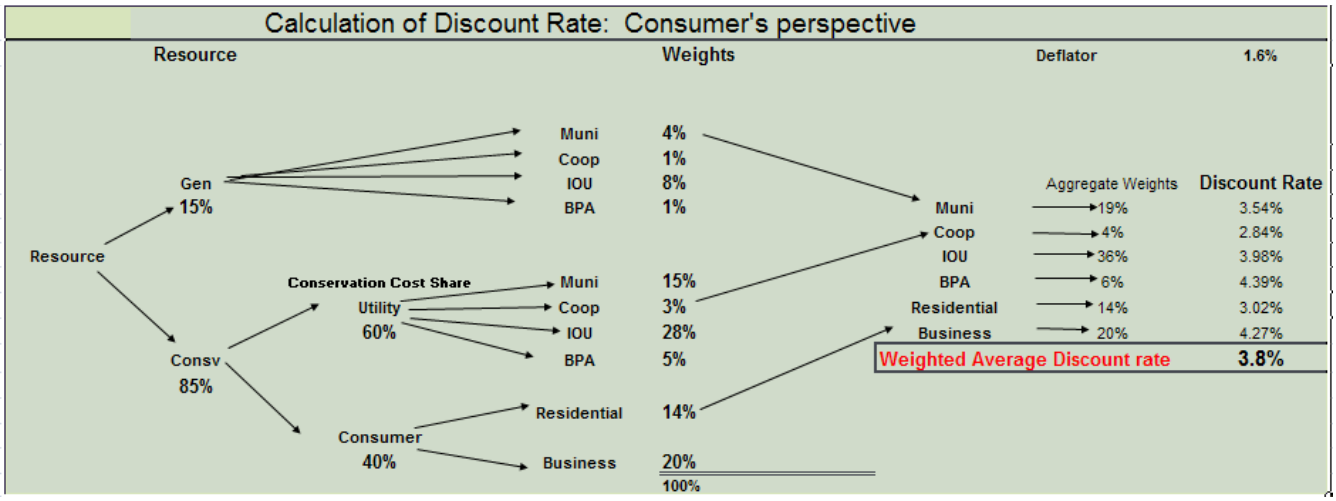
REFERENCE ASSUMPTIONS

Figure A - 1: Discount Rate Calculation for Corporate Perspective



Resource Purchaser	Funding Source	Real Cost of Capital	Weighted Discount Rate
Muni	AAA Municipal Bonds	3.54%	0.69%
Co-op	Coop WACC	3.79%	0.16%
IOU	IOU WACC	5.45%	1.98%
BPA	30 yr Treasury. + 90 Basis	4.39%	0.26%
Residential Customers	Various	3.02%	0.42%
Business Customers	Various	5.01%	1.55%
			4.5%

Figure A - 2: Discount Rate Calculations for Consumer Perspective



Resource Purchaser	Funding Source	Weighted Discount Rate
Muni	AAA Municipal Bonds	0.69%
Co-op	30 yr Treasury. + 100 Basis	0.12%
IOU	IOU WACC After tax	1.45%
BPA	30 yr Treasury. + 90 Basis	0.26%
Residential Customers	DOE adj. Calc. Residential.	0.42%
Business Customers	DOE adj. Calc. Commercial	0.86%
		3.8%