Scope of Work

Contents

Glossary

Note not all these terms are used in the methodology but they may be used during the project meetings or in the project report.

All-in Capital Cost = The capital costs for building a facility within the plant boundary, which includes equipment, installation labor, owners' costs, allowance for funds used during construction, and interest during construction.

Appalachia Basin = Marcellus Shale Play and Utica Shale Play.

Average Demand = Average of the monthly demand in megawatts.

Average Heat Rate = The amount of energy used by an electrical generator to generate one kilowatt hour (kWh) of electricity.

Baseload Heat Rate = The amount of energy used by an electrical generator to generate one kilowatt hour (kWh) of electricity at baseload production. Baseload production is the production of a plant at an agreed level of standard environmental conditions.

BCA = Benefit Cost Analysis = The comparison of the benefits and costs of alternative investments or decisions, typically includes financial benefit costs but may also include non-financial measures.

BTM = Behind the Meter refers to anything that is installed on customer site on the customer side of a utility electric meter.

BTU = British Thermal Unit = unit of energy used typically for fuels.

Capacity Factor = The output of a power generating asset divided by the maximum capacity of that asset.

CC = Combined Cycle Combustion Turbine which is a Combustion turbine operating with a heat recovery steam generator to generate additional electricity from a steam generator.

CCCF - Customer Class Coincidence Factor which is the percentage of customer class-specific peak demand that occurs at the same exact time of the utilities total system peak

CCS = Carbon Capture and Sequestration - a term that refers to capturing the carbon emissions and then storing the carbon emissions, so they are not released to the atmosphere

Cost of Capital = The cost of a company's funds (both debt and equity) used for investing. The cost of capital for municipal utility will generally be lower than an investor owned company.

CT = Combustion Turbine

Dth = Dekatherm (equal to one million British Thermal Units or 1 MMBtu)

DER = Distributed Energy Resource, a broad term that refers to generation, storage, demand reduction and energy saving measures that are generally installed on the distribution system and often behind the meter on customer premises

DR = Demand Response or technologies or programs that facilitate the reduction in electricity demand

EE = Energy Efficiency

EV = Electric Vehicles

FOM = Fixed operations and maintenance costs

Futures = Highly standardized contract. Natural gas futures here are traded on the New York Mercantile Exchange (NYMEX) or Chicago Mercantile Exchange (CME).

PPA = Power Purchase Agreement; contract to purchase the power from a generating asset

IRP = Integrated Resource Plan

IPP = Independent Power Producer

LNG = Liquified natural gas

LOLE = loss of load expectation

LOLH = loss of load hours,

LTCE = Long Term Capacity Expansion Plan; optimization process to select generation.

LSE = Load Serving Entity, a term to distinguish the entity that is responsible for the wires system that serves a specific service territory or set of defined customers.

MMBTu = million British Thermal Units, unit of energy usually used for fuels.

MWh = unit of energy usually electric power = 1 million watts x hour

MW = unit of power = 1 million watts

Present Value = Present value is the current value of a future sum of money or stream of cash flows given a specified rate of return. Future cash flows are discounted at the discount rate, and the higher the discount rate, the lower the present value of the future cash flows.

Peak Demand = The maximum demand in megawatts (MW) for a year.

PPA = Purchase Power Agreement, an agreement between two parties for the power.

PV = Photovoltaic

PVRR = Present value of revenue requirements is the present value of the total revenue that must be collected to equal the multi-year stream of the capital, operating and maintenance costs of a particular plan or investment option.

Reserve Margin = The amount of electric generating capacity divided by the peak demand.

RFP = Request for Proposal

RIM = Rate Payer Impact Test (RIM), this is one of the standard methods for measuring cost-effectiveness analysis for all demand-side resources. Others include: Societal Cost Test (SCT), Total Resource Cost (TRC) Test, and the Program Administrator Cost (PAC)

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VOM = Variable operations and maintenance costs

Wheeling = a transaction by which a generator injects power onto a third-party transmission system for delivery to a client (load).

Part I – Integrated Resource Plan

Overview of Scope and Approach

Siemens proposes to organize and undertake the Part I: Integrated Resource Plan ("IRP") scope of services in a logically sequenced and integrated manner, enveloping the nine Tasks set forth in the Columbia Water & Light ("CWL") RFP, and following the methodology described in our original proposal. Our approach is organized around core elements of the IRP, which are sequenced in a way that allows for the effective integration with the analyses called for under Part 2 Tasks 1-7, Master Plan ("MP").

Siemens understands the rapidly changing market environment that will impact CWL's IRP. Changes in the regulatory and market environment, the pace of technology, and emerging energy portfolio delivery options create a complex set of planning issues for CWL to address. While Missouri does not have a renewable portfolio standard, the City has renewable aspirations with the renewable ordinance requiring CWL to meet 15% renewables at present, 25% renewables by 2025, 30% by 2029 and potentially 100% renewables at some date in the next forty years. The City's Climate Action Plan specifies a 35% reduction in greenhouse gases by 2035, 80% by 2050 an 100% by 2060.

The MISO market has significant wind potential which provides the City attractive options to procure contracted and market renewable energy to meet the requirements under the ordinance. The ordinance also mandates that rates should not increase by more than three percent per year as a result of the investments, so CWL must look for the most attractive economic options available. The Missouri Public Service Commission has recommended that the electric utility planning rules be revised to specifically analyze the needs and costs/benefits of distributed energy resources (DER) throughout the value chain. CWL has appropriately enveloped these and other asset performance and reliability standards in its IRP and MP Task Areas. CWL has focused on the potential for distributed and bulk grid – based renewable and distributed energy resources to cost-effectively enable the achievement of these environmental, cost – effective and diversified energy portfolio goals, while maintaining high levels of grid reliability and customer service value.

Siemens deploys a well-tested and industry best practice integrated methodology, treatment of data, forecasting horizon and a common platform for developing the IRP and the Master Plan. This ensures consistency in the data and allows for appropriate levels of communication between the IRP and MP components necessary in a future more dominated by renewables, decentralized load following assets, and enabling technologies such as storage, which can be a generation, transmission or a distribution asset.

The approach described below consists of the following steps:

- Establishment of objectives and metrics
- Identification of key issues and requirements and how they will be analyzed
- A reference case set of assumptions
- Technology assessment
- Definition of scenarios or sensitivities to properly account for uncertainty
- Least cost screening analyses of options and identification of alternative portfolios
- A risk assessment of portfolios against the range of uncertainty
- Selection of the best portfolio (investments) and supporting documentation

This approach entails iteration/communication between the two plan tasks, modeling methods and input assumptions to ensure that the top down approaches utilized in IRPs and the bottom up forecasts used in the Master Plan are consistently structured and applied, including reference cases and ranges of uncertainty properly defined and developed.

Siemens proposes to utilize its state-of-the-art methodology that has been refined for more than15 years to determine the portfolio that best meets all of CWL's objectives over a jointly specified range of potential future conditions. We will work with CWL to define all of its critical objectives (such as least cost, most stable, reliable, resilient, and sustainability targets) and select metrics to be applied to the IRP scenario results at the beginning of the process. This ensures that we properly frame the analysis to allow CWL to assess the trade-offs between meeting each of its objectives in selecting its preferred portfolio.

We will utilize CWL's data on its asset and system performance characteristics. We will ensure a full understanding of local and state (e.g. FEECA) regulations and targets for energy efficiency, demand response, carbon reductions or other local of the City imposed requirements. We will also review economic and financial parameters to be used in the study. If significant gaps exist in available data and parameters of current system, future load and peak outlook, or site-specific parameters effecting perspective renewable outputs, Siemens will work with the City to develop necessary assumptions to ensure a sound set of parameters is obtained for key assumptions.

A task-wise description of the Part I: IRP scope of work follows.

Task-Wise Scope of Work

1. *Conduct a load forecast of 5-10 years to determine the electric energy and capacity requirements of the City. Develop a model for which the City may run scenarios based on values of different variables. Include the model as a deliverable. Disclose all assumptions utilized in the creation of the model.*

Siemens will utilize customer-class specific, econometric Time-Series Regression Analysis ("TSRA") to develop forecasted monthly energy sales for 20-years for the three largest customer classes: residential, commercial and industrial. The gross energy consumption forecast will be developed using a TSRA in which the dependent variable, energy sales, is expressed as a equation combining the independent variables. The TSRA model is traditionally developed using variables such as weather (normalized), regional economic indicators, number of customers and other demographic variables for each customer class. The TSRA model uses a least-squares regression technique. This basic approach is widely used to develop long-term load forecasts for independent system operators like PJM , the California Energy Commission and individual utilities. Siemens proposes to use monthly historical data to estimate the regression coefficients and statistical relevance for each variable assessed.

To estimate the peak demand associated with the energy forecast the historical load factors (i.e. the ratio of average demand to the peak demand) for each customer class will be assessed along with the percentage of their peak demand that occurs at the time of the system peak (called Customer Class Coincidence Factor – CCCF – or Contribution to the Peak Factor). This historical class-level load factor is used to develop a forecasted load factor by class. We then separately adjust forecasts for specific DSM, EE or DR programs, DER and EV penetration. Programs like EV and DER penetration can either be assessed as a load adjustment or as a supply option depending on whether the penetration is based on pure economics or other factors (such as regulatory or City goals). We can use either method and will discuss these options in our kickoff meeting.

In addition, based upon available historical information and public studies and grid hosting capacity assessment, Siemens will estimate penetration rates for distributed generation and electric vehicles. Siemens has conducted studies for clients based upon national data and regional published studies. For the IRP, we intend to use established models and price elasticities to address penetration rates and resource price levels. As needed and at an extra cost, Siemens can develop strategies for maximizing the potential for these programs. For solar penetration, we will utilize any justified existing programs such as net metering, solar tariffs, financing programs or other mechanisms in place.

2. *Review all current generation and capacity import contracts. Indicate when those contracts that will need to be renewed and/or that may be approaching end of life.*

   Evaluate the status of the contracts and address the options available to the City of Columbia regarding these contracts. Evaluate the marketability of the contracts.

Siemens will evaluate all generation and capacity import contracts, focusing on whether any contracts should be renegotiated or extended depending upon their pricing terms relative to market alternatives and in consideration of any options embedded in the contracts. The analysis will focus on the quantities, relative values relative to market, asset or contractual alternatives, and their volumes relative to the timing of current contract expiration. We will assess the impact of the contracts on the minimum reserve margin threshold, as well as the contracts' exposure to both upside and potential downside movement of market price levels. The latter could impact the City's ability to meet its maximum acceptable rate adjustment limits. Finally, we will recommend a hedging strategy around current and prospective PPAs to defend contract pricing against out-of-market risk exposure.

3. *Review local generation assets. Predict useful life remaining of current local assets using existing condition assessments or prudent industry standards. Examine the viability of maintaining ongoing operation of existing generation and compare to building new local generation or increasing portfolio of import contracts. Examine the costs and benefits of converting a retired local generation unit from coal fired boiler to biomass fired boiler. Examine the cost and benefits to convert gas turbine units to combined cycle units for improved efficiency and added capacity.*

Siemens will review the condition of and physical useful life of the local assets and the economics of operation up to and beyond its useful life (life extension and potential early retirement) via a robust field assessment backed by experienced generation asset engineers, including those with extensive GE asset experience. We will assess the economics of conversion of existing and retired generation capacity. These options will be screened subsequently in the capacity expansion and dispatch modeling process. If any of these options pass our screening criteria, they will be considered in the least cost evaluations to assess whether they represent economic resource alternatives.

As part of this analysis, we will examine the economics associated with each of the following activities:

A Converting retired coal fired boiler to a biomass fired boiler
B Converting an existing combustion turbine unit to a combined cycle plant
C Maintaining existing capacity or retiring it and replacing with new capacity.

Under activities A and B, above, we will work with CWL to clarify the conversion projects under evaluation, including their locations, current operating and contractual status, the technologies under considerations, and their associated size, configuration, fuel sourcing and other key inputs to a conversion project pro forma and technical performance assessment. We will utilize our knowledge of generation technologies to develop cost estimates for conversion. We will work with CWL to obtain information on the condition of the unit and determine the cost, capacity, and efficiency values post- conversion. We will also review studies that CWL may have previously performed or sponsored in developing cost estimates for conversion. If screening suggests that asset conversion ay be economic, we will include this as a supply option in our Aurora least cost runs to determine the benefit streams available from the conversion. For item C, run an Aurora case with and without existing capacity and its associated maintenance costs with upgrades to determine whether to maintain operations or retire existing units and build new capacity as needed to meet reserve margin or renewable portfolio targets. This will be performed as part of the long-term capacity expansion plan, which considers the suite of technology options available including some of the retrofit options described above.

4. *Develop a resource utilization plan. Identify the utilization of resources and types of units selected to meet future needs and other factors of interest to permit an understanding of the potential future resource needs. In the plan identify strategies that would meet or exceed the minimum renewable energy and greenhouse gas emission requirements established by the City of Columbia. Existing goal is for 15% renewables at present; 25% renewables by 2023; 30% by 2029; and potentially 100% renewables at some future date within the next 40 years. Take into account results of the City of Columbia's Climate Action and Adaptation Plan currently in progress. Currently adopted community wide greenhouse gas emission reductions levels are: 35% by 2035, 80% by 2050, & 100% by 2060. Currently electric use is credited with 45% of emissions.*

As previously mentioned, we typically use renewable and GHG emission targets as minimum constraints in our modeling efforts to ensure that all targets are achieved under any and all future market scenarios. Hence, we first develop a least cost resource plan that will meet all regulations and goals in a reference scenario. Then we will run the model again to determine a least cost scenario under alternative market futures. This will help us define a set of portfolios that can then be tested under all future scenarios.

A wide range of demand side and supply side alternatives will be screened and considered, including all retrofit decisions and contract alternatives expressed above.

The resource portfolio plan can be a combination of centralized generation resources and distributed energy resources. We can also force over-compliance to determine what the incremental cost achieving greater renewable penetration or greater carbon reductions on the City. These issues are also typically addressed in the Screening Analyses.

Decentralized (often local generation closer to load centers) generation resources are growing in importance due to rapidly declining capital costs, concerns over resilience and customer choice. Jurisdictions around the country are also evaluating distributed resources as an option to meet their energy and capacity needs. As part of this analysis, the Siemens team will review the existing rooftop solar projects and the potential for increased penetration of rooftop resources over time. The value of solar study described below will be utilized to assess the economic potential of rooftop solar in CWL's service territory.

The team will analyze opportunities for energy storage to play a role, either in the deferment of T&D expenses or serving as a resource for the utility to meet wholesale power such as energy, capacity, and ancillary services. Storage is a form of DER when located in front of meter on the distribution or behind the meter on customer premises. In an integrated planning framework, the value of storage must be assessed in a comprehensive manner to allow it to fairly compare with centralized generation resources, or traditional transmission and distribution investments.

For example, distribution connected storage may allow for peak demand reductions on the distribution feeder or the distribution transformer and allow deferral or avoidance of traditional "wire" solutions. This deferral has locational value which must be captured in the DER cost profile prior to assessing DER with centralized resources in an IRP. This is particularly important for storage (but also for other DER resources such as distribute solar) given scale effects and the current capital costs for battery energy storage resources. As such, enabling multiple use cases for storage is the key to the storage analysis. For this analysis, we will assess the value of storage and other forms of DER from utility and customer applications prior to integrating with the wholesale services analysis typically performed in an IRP.

Other forms of decentralized resources such as demand response can also play a role in providing capacity services or supplying ancillary services such as contingency reserves.

5. *Conduct sensitivity studies. Recommend sensitivities, to be examined. Include load growth, cost, reliability and resiliency, renewable expectations, climate regulation, and adoption of new technologies such as electric vehicle charging, increased use of heat pumps, and increased customer solar utilization as mandatory sensitivities.*

When we recommend sensitivities, we tend to focus on factors that are outside of CWL's control. These related to load variability, renewable cost curves, future regulations and technology changes. We generally characterize uncertainties in DER penetration, electric vehicle penetration and heat pump use as uncertainties in load, we characterize new regulations as a separate sensitivity and track reliability and resilience as outputs of how well portfolios perform under each sensitivity.

Our approach is to first define scenarios that will be evaluated and determine a least cost portfolio for each scenario, including the reference scenario. The least cost portfolio for each scenario will be among the portfolios considered for the risk analysis. If there are specific individual sensitivities to a single factor such as EV penetration, or Heat Pumps, they can be performed as well. Once a complete list of portfolio options is selected, we then test how they perform against all futures to see which portfolio performs consistently best against all futures.

Risk Assessment Sensitivity and Scenario Depiction

Factors such as capital costs, fuel costs, interest rates, and load are inherently uncertain. They combine to produce a broad range of possible outcomes for a utility. Much of the implications of uncertainty are not captured by varying one isolated factor (like oil or gas prices). Rather, cases must be constructed that reflect the widest plausible range of these factors to test to assess whether if the best portfolio performs consistently well across a range of possible outcomes dictated by different views of the future. The arbitrary selection of a low and high (often taking a single variable that includes + or – 5%) case is often misleading and uninformative of the collective uncertainties and risks of the factors that should be driving the choice of portfolios. For this reason, Siemens proposes the following risk assessment approach.

Siemens proposes to construct a limited number of "states of the world" scenarios that will place reasonable bounds on uncertainty in several key variables. The process that we have developed for these Scenarios is described in Appendix B (MarketLink). These scenarios can be technology based, regulatory based or market based future states of the world (or combinations of these factors). Given that the City is more likely to be driven by technology and economic growth, we recommend seven scenarios (or states of the world) in addition to a base case. The seven might be selected from the following list (or others the City selects as important):

- Baseline or Reference case
- Rapid technology advance case (lower cost faster for renewables, DER, EV and Battery)
- High future regulatory/low economy case (e.g. high carbon, fracking, low oil and gas prices etc.)
- Low future regulatory/high economy case (e.g. low or no carbon costs, higher oil and gas prices)
- Forced adoption of high rates of DER and EV
- Forced adoption of high rates of renewables and storage
- An EE/DSM/DR sensitivity reflecting more Heat Pumps or Changes to Requirements
- Achieve a 100% renewable or carbon free portfolio within the study horizon, e.g., by the year 2030 or 2035.

As part of the assumptions' development process, Siemens and the City will collaborate to determine the risk factors that will be evaluated for the IRP for each of the futures plus the base case. Siemens will then develop future values for each of the variables below for each future.

- Regional load
- Delivered coal and natural gas prices
- Power market prices (as an outcome of power dispatch analysis)
- Emission prices
- Capital costs for each technology

Because Siemens performs these sensitivities for a wide range of utilities across the country, the inputs are based on well-structured and tested solutions. For example, a high regulatory scenario might have lower load, more coal retirements, more renewables and lower gas usage that the reference forecast.

6. *Review current demand side reduction programs focused on current participation, participation potential, costs and results of the programs. Determine the appropriateness of existing demand and energy reduction programs and make recommendations regarding the continuation of these programs. Determine the impact to existing programs due to current and future state and federal efficiency standards, rebates, or tax credits. Recommend any*

new programs or technologies that would increase the effectiveness of demand side and energy reduction programs.

Siemens will undertake two steps to the evaluation of DSM programs. First, we will evaluate the effectiveness of existing programs and whether adjustments are needed based on economic or expected penetration rates. Second, we will address any changes required in the load forecasting process described above, and potentially including spatial load forecasting methodologies in order to establish the requisite baseline granularity on which to base DSM benchmark performance results, and on how to measure and evaluate program success on an ongoing measurement and verification ("M&V") basis. We will develop baseline load forecasts and then make adjustments to the baseline load forecasts based on our analysis of expected growth in energy efficiency and demand response programs.

Siemens will determine viable energy efficiency, DSM and DR measures for CWL based on past program experience. In addition, we will identify opportunities to meet future DSM program targets and associated cost-effective program methods to be deployed. If there are no specific targets embedded in CWL's programs, we will evaluate the programs based on select economic criteria, including the Societal Cost Test (SCT) and other benefit/cost tests for comparison. Once the programs are identified, we will develop annual estimates for energy savings and demand reductions resulting from the portfolio of measures over the 20-year horizon of the IRP. Finally, we will estimate the utility costs for administration and alternative incentives to be applied in implementing the alternative DSM measures.

7. *Evaluate the potential for expanded use of private and public distributed generation and storage to contribute to the energy and capacity requirements of the City of Columbia. Examine the effectiveness and appropriateness of distributed energy resources such as, but not limited to, neighborhood and rooftop solar arrays, energy storage, and industrial customer generation to curtail energy and capacity requirements.*

Siemens will identify the expected levels of growth in distributed energy resources including distributed generation resources such as solar and combined heat and power as well as storage. We will assess the penetration of DER, both from the City's perspective and from the customer's perspective, recognizing that penetration levels are based on both costs, from a grid accommodation cost (utility) perspective, and for others it will be based on value (i.e., customer perspective). The benefit stream must be evaluated relative to the Cost of Solar, which can be uncertain, but with the application of accepted methods for calculating costs, can results in informed levels of projected penetration relative to customer value estimations, which are based on avoided (rate) costs and environmental benefits monetized to renewable energy value.

Alternative cost and benefit cases will be evaluated as sensitivities in the Reference Case load forecast which can be considered in scenarios that vary load forecasts. Siemens will identify the expected levels of distributed energy resource penetration and we will develop different growth trajectories as part of the sensitivity analysis performed in Task 5. As discussed above, if DER is assumed to be cost-based, then penetration projections can be evaluated as a supply resource, such analysis is best combined with a customer value assessment with penetration driven by and valued against its load reduction and avoided tariff cost value stream. We will confirm the proposed methodologies for both cost and value-stream creation in the kickoff meeting, highlighting the methodology set forth in Task 9.

8. *Evaluate CWL's position as a MISO member vs. SPP. Evaluate and compare the availability of renewable energy in SPP and MISO.*

Siemens will evaluate the availability of renewable energy in SPP and MISO and the comparative costs and transmission path alternatives. This analysis will inform the issue of whether CWL is advised to remain in MISO, and if renewable resources are available in sufficient quantity and at lower delivered costs form SPP. Both regions are seeing significant penetration of wind resources, but the regions differ in the depth of resource availability, new builds and existing capacity available for contracting or ownership, and their associated transmission costs and applicable allocation rules. The wind resource mix can affect the pricing associated with any renewable contracts that CWL might enter to satisfy both cost and environmental objectives. We will focus on the availability and cost of acquiring resources from both regions and utilize this analysis as inputs to the supply options screening analysis. If a more detailed assessment of joining SPP is required, we will assess the full range of costs and benefits associated with SPP membership both absolutely and relative to MISO membership as an optional task.

9. *Conduct a value of solar study. Evaluate how City of Columbia customers benefit from the proliferation of net metered solar including the solar incentive program costs and accounting for all costs, benefits, and opportunities involved.*

Siemens will conduct a value of solar study that assess the value and costs of solar to the CWL utility customer and to CWL. Our analysis will consider:

For the value to CWL:

1. **Energy savings:** The value of producing a kWh of electricity, the marginal energy costs are based on market prices or fuel savings. (Energy savings are adjusted for potential system losses).
2. **Net energy meter costs:** The value of energy savings could be reduced for any revenue shortfall associated with customer rate for their backflow of net energy metered versus the marginal cost of that energy to CWL. Siemens will conduct a high-level assessment of the marginal cost to CWL versus the marginal rate benefit to customer under CWL's current net metering tariffs.
3. **Generation capacity savings:** The value of the distributed solar capacity, if any, that may be available to CWL based on current market rules in MISO.

4. **Environmental benefits:** Reflect the savings from the reductions in carbon that occurs with solar distributed generation units. Currently this is not a direct cost to the utility and will not be considered in this analysis unless requested.

Other factors that may increase or decrease the value including: Impacts on distribution and sub-transmission facilities, reliability and additional costs related to utility installed batteries.

For CWL customer:

1. **The Energy savings:** The value of producing a kWh of electricity from their distributed solar system versus purchasing the energy from CWL.
2. **Net Energy Metering Benefit:** The value of CWL's tariff to customers. The incremental value of Net Energy Metering to customer will be assessed to compare it to a distributed solar installation that did not benefit from Net Energy Metering. The analysis will assess the value of lost energy for any backflow that might flow from the customer distributed solar system to CWL during periods when the solar production exceeds the customer use. Since customer will tend to install small capacity distributed solar systems when no net metering is available, Siemens will also assess the lost value to the customer of installing a smaller system, with lower overall energy production, to minimize excess energy that would have no value to customers without either net energy metering or onsite storage.

Siemens will develop the value of solar analysis above based primarily on the data from the CWL system modeling and DER analysis in the prior Part I tasks.

Part II – Master Plan

Siemens proposes to utilize the approach and methodologies described below to complete the Tasks identified in the Part II Master Plan section of the CWL RFP. As with the Part I IRP Tasks, Siemens plans to integrate the activities and analysis of the Part I and Part II Tasks where practical.

1. *Determine the load serving ability of the CWL service territory. Conduct a spatial load forecast to determine the localized load serving ability for various locations within the City of Columbia distribution service area. Take into account potential growth, redevelopment, and energy efficiency improvements, private solar generation, other private distributed generation, and proliferation of new technologies such as energy storage and electric vehicle charging stations when conducting the load forecast.*

Siemens will develop a spatially differentiated load forecast of the CWL system that will align with the Part I, Task 1 system load forecast, the customer level DER forecasts, the CWL DSM programs and the distribution network load carry ability.

The spatial load assessment will address both location – based load displacement and electrification – based load enhancement alternatives using a robust GIS-based system planning and simulation software package (e.g., CYME, SINCAL) The spatial load analysis will produce an informed location – based buildup of forecasted load and DER penetration at the feeder level, using either CWL's CYMEDIST network model, with which Siemens has application experience, or utilizing the Siemens SINCAL software as either the primary software, or as a calibration and parallel analysis consistency check on CYME- based analysis.

This Task 1 requires a functioning CWL distribution network model, that accurately depicts the current assets and configuration. Siemens understands that the current CYMEDIST model developed by a third-party consultant is now out of date and will need to be updated to reflect changes and additions to the distribution network. Without reviewing the existing GIS system data and the CYMEDIST model and knowing the extent of changes to the system since the CYMEDIST model was completed, Siemens cannot develop a precise estimate of the level of effort that will be needed to update the model. Therefore, Siemens has included in its estimate for this Task and assumption that 20% of the CWL feeders have undergone changes or additions that will require an update to the feeder representation in CYMEDIST model in developing our cost estimates for this task, we have also assumed that data in the GIS system is accurate and reflects the current CWL system. Should Siemens or CWL determine that more that 20% of the feeders will require updates in the CYMEDIST model, or that the data in the GIS system in not current, Siemens will revise its estimate for updating the distribution network model, possibly with field work and review of as built drawings and submit a revised estimate to CWL review and approval. It is assumed the CWL will be able to identify where system additions were made and the models are outdated, rather than having to compare all the 60 feeders with the GIS maps.

The proposed "bottom-up" distribution system – based spatial load analysis will be integrated with the top-down system-wide peak load and energy forecast developed in aggregate and by customer class under Part I, Task 1. The disaggregation of coincident peak loads by locations within the CWL distribution area will be accomplished via a spatial load forecasting method, described below.

The Siemens spatial load forecast used the customer class level load system forecast described in Part I, Task 1, analysis of the distribution system and geospatial information to create a forecast by substation, feeder and line transformer.

The approach to spatial load forecasting will include the following steps:

1. Update the distribution network model to reflect the current assets, configuration and loads.
2. Produce a geographic map with by land-use zone and distribution overlaid on the distribution network model
3. Develop Cell Level Load Forecast for the Geospatial Map
4. Reconcile Cell Loads with System Level Loads
5. Allocate DG forecast
6. Substation assessment to host the forecasted loads and DER and identification of potential solutions.

The Option 1 spatial load forecast will be based on the following assumptions

a. The spatial load forecast will be developed for 5, 10- and 20-year horizons. The forecast will provide greater detail for 5 years 10 years, which are required for the detailed transmission and distribution planning. The 20-year forecast will be provided based largely on extrapolation of the 10-year results.

b. The aggregated system-level load forecast by customer class will be completed with the Part I, Task 1 scope, including the load profile, peak demand and energy as well as its allocation by existing feeders and hence substations.

c. All the required information to revise the distribution network model is available in GIS maps that can be imported into CYMEDIST or PSS®SINCAL. Siemens has assumed the CWL staff will be able to identify where system additions were made and the CYMEDIST models are outdated, rather Siemens having to compare all the 60 feeders with the GIS maps. Further, the estimate for this task assumes that a maximum of 20% of the feeders will require update.

d. The spatial load forecast will be used to create up to 3 demand snapshots for the load flow analysis to be carried out in detail for 5 years out and 10 years out. These demand conditions are expected to include: i) peak load night-time conditions and no contribution of PV, which represent peak inflows to the feeder and minimum voltages, ii) minimum load condition and maximum contribution of PV, which would represent maximum outflow and higher voltages, and iii) a work-day daytime mid load, with average PV generation that can be used to assess maximum charging to storage. The selected snapshots to study will be mutually selected by CWL and Siemens.

e. We understand that there are currently 8 transmission to distribution substations supplying 60 feeders and the spatial load forecast will be centered on the areas covered by these feeders and the immediate areas where new load can appear.

f. The CYME models need to be updated and all the required information is available in GIS maps that can be imported into CYME or PSS®SINCAL. The budget for this activity is tentative as no information on the level of work required of the update is available, as indicated above.

1. Update Distribution Network Model

Siemens' approach to spatial load forecasting for CWL will begin with updating the CWL distribution network model developed by a third-party consultant a number of years ago. We understand the model had not been kept current and does not include the changes and additions that CWL has made since the analysis was completed. As indicated earlier, our update assumes that the GIS data is correct and can be used to update the model.

To update the model, Siemens will first review the existing model to assess how the 3rd party has constructed the model, its existing detail and its ability to converge on a load flow solution. The ability to converge on a load flow solution provides preliminary indication that it is a functioning model with all the required electrical continuity.

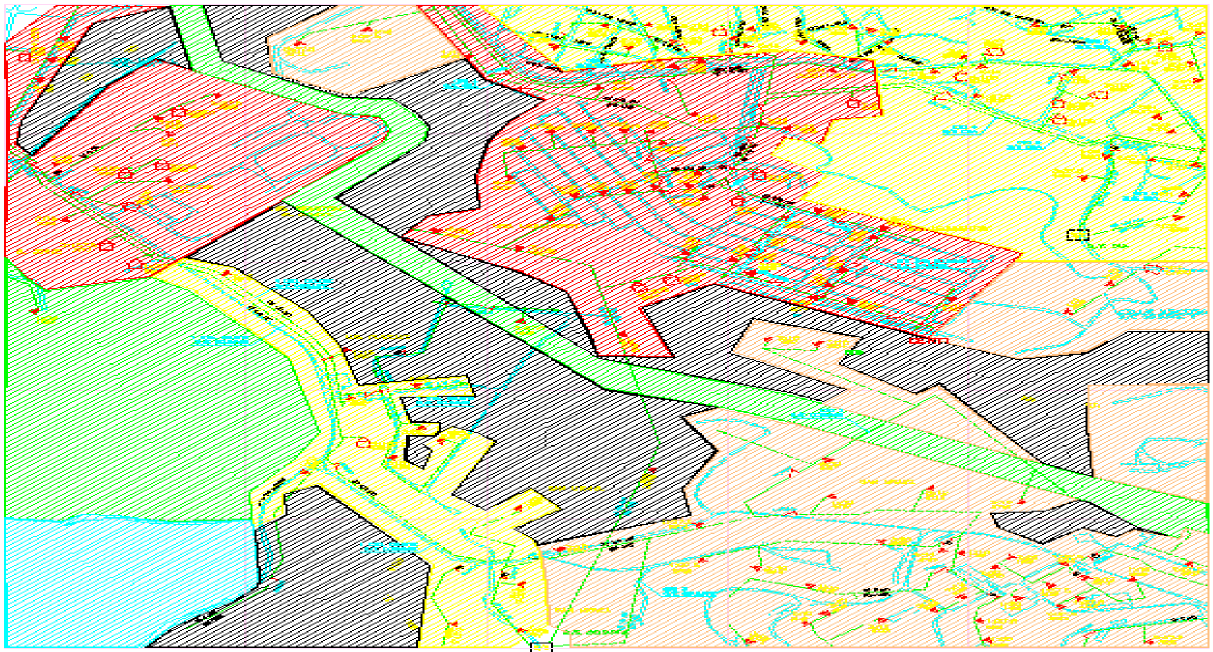
Following the review of the model, Siemens will work with CWL staff to identify the feeders that have undergone changes since the last distribution network model update, and import the updated GIS data into the model, which is expected to reflect as-built conditions. No field review is considered at this time, however a cursory review of the changes implemented (e.g. reconductoring) will be made.

The model will be revalidated using load flows to ensure continuity and reasonableness of results.

2. Produce a Geographic Map

After updating the model, Siemens will define and identify land-use zone types and locations to be used as input to the spatial load forecast. We will work with CWL staff to define the types of land-use zones which describe the CWL customer mix and development potential. The zone data will be summarized on a geospatial map, similar to the Exhibit 1 below, that will enable the data to be overlaid on the distribution network model.

Exhibit 1: Illustrative Geospatial Grid Map



3. Develop Cell Level Load Data for the Geospatial Map

The Geospatial Map is then divided into small areas, or cells, within each zone. Each cell will contain characteristics on the current load, transformer load, feeder capacity and the future load (per our forecast methodology, below). The area dimensions will be logically specified to represent a group of line transformers, and connecting feeder levels, subject to the availability of grid operating and load data granularity. The actual load is calculated as the sum of the load of all transformers inside each small area. These values are used as starting point to establish the local grid saturation factor, i.e., the grid load relative to the load when the cell is fully built out (Saturation or Maximum Load). The geospatial map will also include: street names, parcels (if we have the meter coordinates), zoning from city planners (colored areas), distribution lines with their transformers, switches and normal positions indicated, as well as capacitor, voltage regulators, conductor sizes and type, substations and reclosers and any SCADA equipment (dynamic switches) on the distribution grid indicated.

4. Reconcile Cell Loads with System Level Loads

The bottoms-up substation and feeder level historical load profile provided by CWL are used to populate the distribution system model inputs and geospatial map. These loads will be rolled up from the feeder level to the zonal level and reconciled with the Part I, Task 1 system level load forecast.

Using the cell-level map, we relate the area of each zone to the grid via an Excel file that sums the location-based load measurements and establishes a forecast basis at the cell level, rolled up to the zone level for the entire city.

Each zone in the map has a color represents a zone by type (e.g., residential, commercial, etc.). The Saturation Factor can then be calculated by evaluating the load divided by the area's Saturation Load. We then sum all the cells to see how far the total values are from the total forecasted substation loads, and after applying this procedure several times, forecasted Saturation Factors are developed to derive feeder and location based projected load. The Saturation Factors forecast process first increases the load at cells where there is existing electric infrastructure and then extends to empty cells (i.e. cells where there is not currently any load) and where growth can occur.

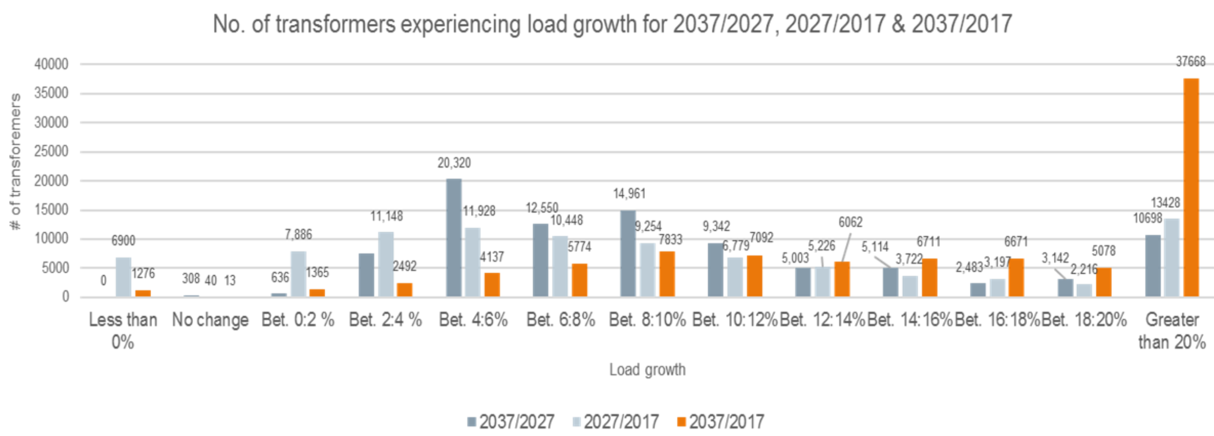
Key aspects considered for the saturation factor forecast include:

1. Areas that city planner expects to be developed
2. Areas with construction permits
3. Areas closer to already used land
4. Areas closer to highways, streets or other transportation facility
5. Areas closer to job locations and growth
6. Areas near commercial centers and shopping malls

When a saturation factor for a future term is entered, the total load of all cells are summed again and compared with the values computed from the top-down model customer class forecast, with the process iterated until a close match is found to the load calculated from the top-down method.

At the end of this process a load forecast for each cell covering the grid is available and it is allocated (on a preliminary basis) to existing distribution transformers inside the grid or to "equivalent" transformers for those cells where there are no existing transformers. Exhibit 2 below shows a typical graph used to report the load growth observed by distribution transformers (over 90,000 transformers in this city).

Exhibit 2: Illustrative Growth Report



The forecast by transformer will represent; a) expected load at the time of the feeder peak, b) expected load at the time of feeder light load conditions, c) expected load at the time of system peak (to identify coincidence factor) and d) intermediate load conditions to be selected.

5. Allocate DG Forecast

The forecasted expected adoption of distributed generation by customer class and as a result of its own initiatives is spatially allocated in this phase considering the customers geographical location and type; e.g. large PV arrays tend to be correlated with commercial customers, whose location is known from the forecast. Other initiatives like demand response or storage are considered to be sponsored by the utility and its location is identified in the analysis below.

6. Assessment of Substation Ability to Host Forecasted Load and DER and Identification of Solutions

After the forecast by distribution transformer of load and DER and hence at the feeder level, the expected load to be served by the existing substations can be determined for the planning horizons 5, 10 and 20 years out and the need for reconfiguration and new substations assessed.

However, before starting to configure the substation areas, we determine the optimal distance from a substation from which a load can be served (optimal coverage area) based on:

- Distribution feeder's nominal voltage
- Load Density
- Feeder conductor size
- Substation standard diagrams, number of feeder per transformer and standard HV/MV transformer size

We will then assess for each substation based on the current coverage area, the expected total peak load for each substation (considering a coincidence factor) and compare it with the installed transformation capacity and the coverage area will be compared with the optimal values determined in the step above.

This analysis will provide a view of the substations that require either transformer capacity expansion or redefinition of their coverage areas and the timeframes. For those cases that redefinition of coverage areas is necessary to avoid over-extension, we will assess transferring load to adjacent substations or to a new substation. For the location of new substations, we will start from the location of the load centers of the future coverage areas and working with CWL to identify a likely location of the substation based on land availability and location of existing transmission lines.

At the end of this analysis the coverage areas of each of the substations in CWL territory, as well as the proposed location of new substations, will be defined. For each of these substations and timeframes, the expected peak load, light load (including DG impacts) and intermediate load conditions will be provided. Note that the recommended coverage areas and transformation capacity may be adjusted as a result of the transmission study, Task 4, and distribution study, Task 5.

The resulting deliverables of this task will include:

1. Data files gathered
2. Combined city map and the network map
3. Zone load index for each zone and cell
4. Excel Spread sheet with cell level data on land use, the cell Saturation Factor
5. Forecasts by substation, feeder and distribution transformer
6. Center of load coordinates, HV/MV transformation capacity and suggested substation load service coverage in map form for new and existing substations
7. Conclusion and recommendations

2. *Determine the appropriateness of using battery storage, utility provided solar, or other distributed generation as options for serving local load serving ability needs. Include how these options could be used to prolong investments in the distribution system.*

The traditional solution to address distribution reliability problem such as thermal overload, system losses, or a voltage issue is to replace conductors or substation equipment such as transformers. However, non-wire alternatives (NWA) such as battery energy storage, Demand response, distributed generation (behind the meter or distribution connected) can play an important role in addressing the reliability issue.

We propose to center our analysis in the use of storage to address distribution reliability needs as discussed below under distribution system study, Task 5.

3. *Review existing CWL standards for system reliability. Make recommendations to modify the City of Columbia electric engineering standards by taking into account economic viability, customer satisfaction, and best practices of the electric utility industry. Determine the risks associated with the standards. Document the standards in such a manner that they can be implemented as an official City of Columbia policy. Recommend a process in which standards are reviewed and updated. Document the NERC function types for which the City of Columbia is registered. Evaluate the appropriateness of each of these registrations.*

Siemens views this Task 3 as having three distinct elements:

1. Review and make recommendations as appropriate to CWL planning and reliability standards
2. Review and make recommendations as appropriate to CWL engineering standards and a recommend a process for their continued review and updates
3. Document CWL existing NERC function type registration and the assess the appropriateness each for CWL operations.

Siemens approach to each of the elements is described below:

1. **Review CWL Planning and Reliability Standards.** Siemens will review existing the existing CWL planning and reliability standards in conjunction with its assessment of the T&D system expansion requirements. As part of our work to determine recommended T&D expansion recommendation, we will discuss with CWL staff the historical system performance, outage history and the existing standards. The standards will then be reviewed taking into account best practices, performance history, system design, and peer reliability metrics. The standards will be revised to reflect the level of grid performance targets and expectations given City targets.

2. **Review CWL Engineering Standards.** Siemens will begin this portion of the task with a preliminary review of the existing CWL Engineering Standards. This preliminary review will provide Siemens an understanding of the number of existing standards, their scope and relative completeness and quality. Following this preliminary review, Siemens will discuss the standards with experienced CWL staff from the engineering, construction and operations and maintenance to seek input on how the existing standards are being applied, their appropriateness and effectiveness for the CWL system. We will also solicit from the CWL staff information on any known or emerging changes to the system or state or City requirements that might require new or revised standards (e.g., revised DER interconnection standards that require smart inverters with the capability of remote changes to power factor, or voltage and frequency cutoff settings). Siemens will then revise the existing standards and create new standards where appropriate for CWL review. The revisions and any new standards, recommended by Siemens will take into account economic viability, customer satisfaction, and best practices of the electric utility industry. With the standards, Siemens will also create a recommended process for their periodic review and update, which will also be presented to CWL for review. Once CWL comments are received to the recommended standards and

update process, Siemens will prepare a final version of each for approval and implementation by the City.

Note that because Siemens was unable to review the existing standards or discuss the CWL needs with the CWL staff, our budget for this work is necessarily a preliminary estimate and represents our estimate of a minimum budget for this effort. After we have completed our review of the existing standards and discussed the standards with the CWL staff, we will either confirm that the preliminary budget is sufficient to complete the work or submit a revised adjustment to the budget for CWL review and approval.

3. **Evaluate NERC Registration.** Siemens will review the existing CWL NERC function type registrations. We will review the appropriateness of each registration and recommend changes as needed.

4. *Make recommendations regarding the expansion of the City of Columbia transmission system. Recommendations must take into account established NERC and other regulatory standards, requirements of the MISO ISO and established or modified CWL standards for system reliability. Evaluate CWL's transmission system as a MISO member bordering SPP and AECI territories and determine how that affects regulatory requirements. Address the needs of the transmission level interconnections with the University of Missouri and City of Fulton when making the recommendations.*

The goal of Task 4 is to make recommendations regarding the expansion of the City of Columbia transmission system considering, historical performance, forecasted loads and supply, NERC and other regulatory standards, MISO requirements, and CWL standards for system reliability.

Siemens PTI will evaluate the adequacy and limitations of the CWL transmission system to supply the existing and new substation projected load growth, fully reflecting spatial load growth, battery applications and distributed generation. Staring from the substations and load identified in the prior tasks, the main objectives of this task is:

1. Identify need for new or upgraded interconnecting lines to maintain reliability over the near-term transmission planning horizon (years 1 to 5) and long-term transmission planning horizon (years 6 to 10), fully informed by the IRP's generation, load and contract source – sink assessment to meet projected transmission capacity requirements.
2. For an analysis beyond 10 years the availability of adequate MISO level transmission models may be limited, however we propose extrapolating the analysis above, to 20 years out, by increasing the CWL loads and evaluating impacts on the system and recommended reinforcements.
3. Identify the extent that additional storage (to that identified by the analysis of the distribution system) can help mitigate the need for transmission expansions.

Major steps in this analysis are described below.

1. **System Model Update.** Update the transmission system models used by CWL for NERC TPL compliance using the load forecast from Master Plan, Part II, Task 1. The transmission models include 161 kV and 69 kV lines and substations with loads represented at the 161 kV and 69 kV substations. Transmission system will be assessed out using the MTEP transmission models and for one critical dispatch (e.g. summer peak) and up to two alternative generating resource portfolios, resulting from Part I tasks, including utility scale and DER. The analysis will be centered on Area 333 (CWLD) 161 kV and 69 kV system with a total of 4 cases.
2. **Long-term Performance Evaluation.** Evaluate CWL transmission system performance in year 10 of the planning horizon to identify any overloads or voltage issues. Identify reinforcements needed to resolve any reliability issues and address the needs of the transmission level interconnections with the University of Missouri and the City of Fulton. Perform a final contingency analysis to verify compliance with reliability criteria. This will create a vision on how the system should look in year 10 of the planning horizon.
3. **Staging of Investments.** In this task we will evaluate transmission system performance in years 1 through 5 to identify any overloads or voltage issues and select the in-service dates of the year 10 reinforcements that will address them. The candidate long-term investment(s) to solve the issues found are implemented in the model to verify their effectiveness. This procedure is repeated until no problems are found in years 1 through 5 and establishes the required in-service date for the investment(s). This analysis may identify some local overloads that do not merit advancement of any of the long-term investments. In this eventuality temporary solutions will be proposed.
4. **Design Long-term Transmission System.** If a need for new substations or new transmission lines are identified in the prior tasks, this task will identify the final recommended location for the substations, and for new transmission lines, the proposed route, length and conductor.

5. *Make recommendations regarding the expansion of the City of Columbia distribution system. Recommendations must take into account existing or modified standards for system reliability. Take into account the localized growth of the system to determine recommendations regarding how to provide adequate capacity for that growth.*

The Task 1 spatial load forecast and initial assessment of existing and new substation coverage areas will provide an informed framework to evaluating distribution system expansion requirements.

In performing the distribution grid expansion assessment, the Siemens team will first review the any distribution system studies conducted by CWL or its advisors. This will serve as a baseline of information for historical reliability issues on the system. We will review the assumptions made in CWL's prior analysis, as well as the tools and methodologies deployed.

Siemens will perform a detailed distribution analysis utilizing CYME as applied by CWL and, with CWL's approval, Siemens' proprietary distribution planning tool PSS®SINCAL. This integrated T&D modeling system will utilize the feeder level load and DG forecast to determine when and where voltage and thermal violations are likely to appear.

The analysis will start by mapping the expected load growth and DG forecast to the existing distribution transformers in the model and to equivalent transformers in "empty" cells that will be initially connected to the closest feeder. Next, the information on new substations and existing substations coverage areas will be used to define the connection of the feeders to supply (substations) points.

A load flow study will be carried out for up to 3 conditions at both 5 years and 10 years out. The three conditions are expected to include: i) peak load conditions / no contribution of PV, ii) minimum load condition / maximum contribution of PV, and iii) a selected intermediate condition that may include work-day daytime load, with average PV and maximum charging to storage.

The load flow will be carried out for normal and emergency switching conditions and voltage and thermal overloads identified; for example, high voltage violations are expected during light load high PV production, while thermal issues are expected for peak load with no PV production.

Solutions for the issues identified will be proposed, including traditional wired solutions or non-wires alternatives including battery energy storage that can be owned or sponsored by CWL.

As indicate above, the feeder analysis will be carried out for 5 years out and 10 years out, to identify short- and medium-term investments that will include NWAs and traditional infrastructure upgrades. In addition to the investment costs of the alternatives, the applicable benefits from reduced losses, reduced supply costs, reduced emissions and other characteristics, will also be considered in the selection of the preferred solution. The 10 year forecast complements the substation analysis (see above tasks) and is focused on new feeders and any need to increase capacity of existing feeders (e.g. reconductoring of mainlines, voltage regulation and storage), the 5 year out adds to the analysis details on the balance of the system; e.g. laterals and informs investment priorities for the first 5 years.

The results of the assessment can then be utilized to develop a short to medium term distribution investment plan. For the long term (20 years out), a top down extrapolation of future investments can be produced based for example on expected capital expenditure per new customer.

6. *Review the capital projects currently forecasted by CWL and determine if they are in keeping with the recommendations established by the master plan. Identify projects that may be unnecessary. Identify projects that might be considered to meet established recommendations. Determine the prioritization of these projects.*

Following the completion of the prior Part I and Part II Tasks 1 through 5, and informed by their results, Siemens will review the CWL generation, transmission and distribution capital plans and any supporting analysis or justification produced by CWL or third party. Based on this review Siemens will provide recommendations for appropriate revisions or additions. Our analysis will address any identified opportunities to defer or displace, or defer generation, transmission or distribution investments with cost effective DER solutions.

7. *Review the costs and benefits of adaptation of AMI metering or other "smart-grid" technologies.*

Siemens team will begin this task with a review of any prior cost/benefit analysis the City has already conducted. If such studies are not available, the Siemens team can perform an independent cost-benefit analysis. Siemens is one of the leaders in hardware and software products design and deployment for AMI and has performed several AMI cost and benefit analyses leveraging our deep technical and methodological knowledge. This evaluation is expected to support a business case for eventual filing to City Council for approvals and rate recovery of the value and specific benefit to cost justification to the City.

The Siemens team proposes the following approach for the AMI Analysis.

The key assumptions and our recommended analytical approach supporting this cost/benefit analysis include the following:

1. **Business Case Approach:** We will review and discuss the strategic imperatives of the City in the formulation of the business case.
2. **Implementation Schedule:** We will take into account the timing around the roll out of the AMI infrastructure.
3. **Vendor Pricing:** Siemens has deep expertise in costing out individual components of the AMI infrastructure. As part of the pricing detail, we will leverage our internal know-how and vendor data to arrive at an expected level of pricing associated with the objectives of the AMI roll-out.
4. **Cost Estimate Approach:** As part of the development of the cost estimates, we will review any existing quotes the City may have received.
5. **Benefit Estimates Approach:** There are several benefits associated with AMI but the major ones fall in the operational and customer categories. The operational benefits include meter reading automation, operational efficiencies in field and meter services, reduction in non-

technical losses, improvement in outage management and remote service connects and disconnects and enablement of new tariff structures. The customer benefits include billing accuracy improvement, informed decision on energy usage, and reliability improvement through quicker identification of outages. Other benefit categories may include ability to integrate and dispatch distributed energy resources.

6. **Cost-Benefit Analysis Framework:** There are several cost-benefit analysis frameworks, which typically include the payback period method, the NPV method, and the total Resource Cost (TRC) test. Another important consideration is the choice of discount rate for the NPV analysis. We will work with the CWL to determine the best discount rate for this analysis.

Quantifying the benefits includes making assumptions about changes in behavior – reductions in consumption and peak usage as well as time shifting of usage. These changes are the result of technologies that enable the programs (e.g. dynamic pricing) and delivery of information (e.g. in home displays, websites). Thus, the potential benefits include both the direct benefits of reduced consumption and demand, as well as the indirect benefits enabled as a result of deploying these technologies. The key technologies that enable the provision of detailed cost and usage information are smart meters, in home energy displays (which connect wirelessly to smart meters), and online solutions.

Smart meters allow retailers and distributors to develop new tariff structures and information products. They also potentially allow them to change their customer service options, which can affect consumers positively by enabling energy efficiency and demand response. In addition, smart meters can deliver business cost efficiencies, which can be passed through as cost savings to customers. These utility operating benefits are an important component element of the overall economic analysis, including a direct tie to the IRP evaluation criteria.

The following are key cost elements in deploying a consumer empowerment infrastructure will be included in the cost analysis: a) Hardware: smart meters, communication networks, optionally in-home displays including websites and smart phones); b) Software: networking software, back office systems to manage detailed energy information data; c) Labor: installation, integration, project management; and d) Marketing and education: materials and programs to inform consumers about the workings and the benefits of the consumer empowerment, thereby facilitating the delivery of programs to consumers in order to incentivize or enable consumer behavior change.

