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REPRESENTING AVISTA CORPORATION

TECHNOLOGY ASSESSMENT SUMMARY REPORT

PROPRIETARY AND CONFIDENTIAL

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1 Executive Summary

This report summarizes current cost estimates for Avista to join the Western Energy Imbalance Market (EIM). The focus is the technology solutions, including integration, required for effective EIM participation. During the analysis it was determined that Nucleus could not practically be enhanced to provide many of the required functions. Therefore, the analysis estimates the cost and effort to procure and implement Commercial, Off-the-Shelf (COTS) solutions and integrate those solutions. These cost estimates are detailed in the main body of the report and summarized on Line 1 through 5 of Table 1.

During the project, Avista requested other costs be estimated to create a more comprehensive cost picture. Additional cost estimates for system procurement, network modeling, communication infrastructure, generator upgrades and internal and consulting labor for EIM technology implementation and other Project functions are described in the Addendum and summarized on Line 6 through 20 of Table 1.

This report, the associated end-to-end technology overview diagram, the estimating model and schedule describes the assumptions, decisions and conclusions which underpin the values in Table 1. An Executive Summary of the considerations for each of the line items is included as Table 2.

This report provides Budgetary Cost estimates (+/- 25%) for the currently identified scope. The analysis focused on the planned incremental EIM technology components. Detailed requirements were not developed as part of this effort and full impact assessments to existing functionality were not in scope. Avista will need to proceed with this detailed analysis if a decision is made to pursue EIM membership. Following the development of detailed requirements, the estimates can be refined.

Table 1 – Summary Budgetary Cost Estimate for EIM Technology Projects

Line	Cost Estimate Category	Project & Procurement Solutions & Services (in $,000)	Project & Procurement Avista Internal Labor (in Hours)	Post-Project Recurring Services & Avista Labor (in $,000)
1	**Vendor EIM Software Solutions**	$2,100 - $4,500	9,000 - 21,900	$500 - $1,100
2	**Avista ADSS Enhancement Effort**	Included	9,600 - 14,400	
3	**Avista Internal Integration Effort**	Included	8,200 - 12,300	
4	**Custom Reporting Allowance**	Included	2,000	
5	**Other Avista Software Enhancements**	Included	8,000 - 12,000	
6	**Dedicated Security & Architecture**	$0	3,300 - 4,900	$50 - $100
7	**Miscellaneous Software & Hardware Costs**	$330 - $715	0	$25 - $100
8	**Network for Vendor & CAISO**	$150 - $420	2,400 - 1,750	$400 - $730
9	**Program Leadership, Management & SMEs**	$3,200 - $4,900	7,000 - 9,000	
10	**System Selection & Procurement**	$500 - $810	6,800 - 8,800	
11	**Full Network Model for EIM**	$40	800	$50
12	**Generation Participation & Cost Modeling**	Included	2,000 - 3,500	
13	**OATT, MBR & ISO Agreements**	$105 - $190	1,300 - 2,300	
14	**Training & OCM**	Included	4,800 - 8,500	
15	**Transmission Meters & Data Collection**	$340	5,200	$18
16	**Network Improvements for Metering**	$210 - $2,000	2,600	$15
17	**Incremental Permanent Avista FTEs**	$0	7,400	$2,500
18	**EIM Membership & Ongoing Fees**	$290	0	$120
19	**Generation Metering from GPSS**	$3,000 - $4,500		
20	**Dispatch Integration from GPSS**	$1,200 - $1,400		
	Total	**$11,500 - $20,100**	**80,000 - 120,000**	**$3,700 - $4,700**

Table 2 – Executive Summary of Included Cost Estimates

Line	Exec Summary
1	7 applications; Avista effort estimated two ways - prior project and simple WBS; less consulting, architecture and security shown separately.
2	Represents 18 estimated items; 9 additional uncertainty placeholders included; 50% contingency included in upper range.
3	Represents 25 estimated interfaces; 9 additional uncertainty placeholders included; 50% contingency included in upper range.
4	Placeholder for reporting not covered by vendors or vendor customizations to create required reports and analysis tools and an allowance for deprecation impacts on Nucleus.
5	Represents 6 estimated items including the Oracle MDM estimate from Avista; 50% contingency included in upper range.
6	Dedicated cloud architect and security engineer provided by IT; no contingency added to range.
7	Additional ADSS hardware; firewalls; unanticipated software and integration placeholder; no contingency added to range.
8	New dedicated CAISO, AWS and Azure connections; meter data collection costs; minor BUCC improvements; cost and effort low/high are inverted; no contingency.
9	Consulting SI services; Avista Leads for Merchant, Grid Ops, IT, GPSS and OCM plus Directors; adj to reflect "overhead" portion; no contingency added to range.
10	Consulting for Program initiation, requirements and system selection; estimated Avista participation based on simple WBS method in (1); no contingency added to range.
11	EIM share of FNM costs; additional costs for RC integration not included and are described in a separate report; 20% contingency added.
12	High level estimate for basic modeling, GPSS cost gathering (45%) and participation strategy definition (35%); includes 20% contingency on upper side of range.
13	Assumes only basic changes to prior EIM OATTs; full MBR cost but that may not be fully incremental; includes 20% contingency on upper side of range.
14	Time for the recipients; costs for creation is in consulting and vendor costs and Avista Leadership overhead; includes 20% contingency on upper side of range.
15	New meters; communications for sites other than Network / T1; backend MV90 work for both generation and transmission; 20% contingency.
16	New T1 communications for 67% of transmission locations and 36% of generation locations; HPV required at 35% of combined locations; no contingency added to range.
17	11-13 new FTEs in Power Supply, Ops, Accounting, Compliance and ET; incremental IT in (6); project costs include a portion of ramp in period; no contingency.
18	Integration fees and ongoing Grid Management Charges; no contingency.
19	High and Low side metering and transformer upgrades at 11 facilities.
20	EIM Master PLC at 6 locations and reprogramming of the existing unit level PLCs.

2 Technology Approach

As identified in the EIM Technology Inventory and End-to-End EIM flow diagram, Avista will need a mixture of procured and in-house developed applications for EIM participation. Additionally, Avista will need to participate in development of the interfaces to connect existing and new applications.

2.1 Assumptions

In developing the estimates presented in this report, Utilicast converted Avista Labor to costs based on the following assumptions.

Table 3 – Labor Rate Assumption

Category	Rate
ADSS Development	$80
Nucleus Development	$90
Integration Development	$100
Network Modeling	$100
All Other Avista Labor	$100
Consulting (Range based on Expertise)	$185 - $235

Contingency has been applied to some estimates based on a variety of factors – including the source of the estimate, the factors considered in establishing estimate ranges, the level of uncertainty and Avista requests. The contingency values in Table 4 are incorporated in the estimates:

Table 4 – Contingency Assumptions

Line	Category	Contingency
1	**Vendor EIM Software Solutions**	20%
2	**Avista ADSS Enhancement Effort**	50%
3	**Avista Internal Integration Effort**	50%
4	**Custom Reporting Allowance**	0%
5	**Other Avista Software Enhancements**	50%
6	**Dedicated Security & Architecture**	0%
7	**Miscellaneous Software & Hardware Costs**	0%
8	**Network for Vendor & CAISO**	0%
9	**Program Leadership, Management & SMEs**	0%
10	**System Selection & Procurement**	0%
11	**Full Network Model for EIM**	0%
12	**Generation Participation & Cost Modeling**	20%
13	**OATT, MBR & ISO Agreements**	20%

Line	Category	Contingency
14	**Training & OCM**	20%
15	**Transmission Meters & Data Collection**	20%
16	**Network Improvements for Metering**	20%
17	**Incremental Permanent Avista FTEs**	0%
18	**EIM Membership & Ongoing Fees**	0%
19	**Generation Metering from GPSS**	20%
20	**Dispatch Integration from GPSS**	0%

Many estimates are driven in part by project duration. As shown in more detail in Section 4, the EIM project is anticipated to begin with a Planning and Procurement phase in 2019. Avista's team will begin ramping up in early 2019 through mid-2019 with Consulting support generally beginning in mid-2019. The main implementation phase of the project is anticipated to begin in early 2020 and continue through an April 2022 implementation.

2.2 Recommended Continuation of Existing Solutions

2.2.1 Variable Energy Resource Forecast

Avista currently has two large Variable Energy Resources (VER) on the system, Palouse Wind and Solar Select, and is in active negotiations with one additional significant VER resource which would be online prior to the anticipated EIM membership in April 2022. Additionally, Avista has a significant amount of VER generation in the interconnection queue.

Avista's current forecasting for facilities anticipated to be online by April 2022 are:

1. Palouse: Avista currently receives Real-Time VER forecasts for the Palouse Wind resource from two forecast providers, Meteologica and Vaisala and imports the forecast to ADSS via API. The Meteologica forecast is provided by Palouse Wind and the Vaisala forecast is contracted for separately by Avista. The Real-Time Merchant operator has discretion to use either forecast in bilateral trading decisions.
2. Solar Select: Avista currently only receives Day-Ahead forecasts from Solar Select. Avista does not have an additional backstop forecast for this facility.
3. New Wind Resource R: Forecasting approach is To Be Determined.

Based on current EIM rules, the following are required for VER Resources:

1. An hourly Base Schedule with a target snapshot around T-60 to the beginning of hour T (this requirement may be updated to 15-minute granularity with the proposed Day-Ahead Market Enhancements project).
2. A 15-minute granularity forecast refreshed every 15 minutes with a target snapshot around T-40 to each Fifteen Minute Market (FMM) interval beginning T.

3. A 5-minute granularity forecast refreshed every 5 minutes with a target snapshot around T-10 to each Real-Time Dispatch (RTD) interval beginning T.

For Palouse, there are two simple options for meeting the EIM requirements:

Meteologica has existing functionality to produce 5-minute granular forecasts every 5-minutes. This can be used to meet all CAISO requirements. Meteologica has an existing real-time production input from the resource telemetry which can be incorporated in the forecasts but this is not provided by Avista. If an enterprise solution is implemented, a new interface to provide telemetry for all VER to the VER Forecast provider will be needed.

Based on the Vaisala website, it appears that Vaisala only offers 10-minute granularity and 10-minute refresh capability at this time, which could satisfy CAISO requirements for Base Scheduling and for the RTPD/FMM submission but does not meet CAISO requirements for RTD. However, CAISO is in the process of rolling out a short-term persistence VER Forecast offering. In this approach, CAISO will snapshot the CAISO State Estimator output (adjusted by a reference curve for solar resources) of the VER resource immediately prior to the RTD snapshot. Early CAISO analysis suggests that this simple persistence model, which eliminates all potential data transfer lag, is generally superior to other methods. In combination with the Visala produced forecast, this would meet EIM requirements. If Avista selects Vaisala, there may be some enhancement costs. Budget for an interface to supply Real-Time telemetry to Vaisala has been included.

CAISO currently only accepts a single VER forecast for each resource, so a single selection would be needed for CAISO submissions (Avista's bilateral trading decisions could continue to use either forecast). The chosen forecast provider could be provisioned with the necessary EIM Entity certificate and interface directly with CAISO, or the forecast sent to the EIM Entity Scheduling Coordinator (EESC) Scheduling System to then submit to CAISO. Utilicast recommends a direct to CAISO integration approach to eliminate the time lag and potential point of failure associated with routing the forecast through an additional system. The integration costs estimates do not include an estimate for integrating the VER forecast with the EIM Entity Scheduling System.

For Solar Select, changes will be needed and a solution for new Wind Resource R will also require a forecast that meets the requirements. Avista anticipates going forward that any new VER resources will have the obligation to provide a forecast that is compatible with market needs. However, depending on the number of new VER resources, a consistent enterprise solution may be needed at some point. Meteologica and Visala would be natural options to provide this service but Avista may wish to consider a Request For Proposal (RFP) process. A trial period to assess the accuracy of different providers during an RFP is recommended.

Since this effort was identified late in the process, will likely replace existing costs and is anticipated to be small relative to the work, a cost estimate has not been prepared.

2.2.2 Demand Forecast

Avista should utilize its existing Balancing Authority Area (BAA) demand forecast, produced in ADSS as a blend of Pattern Recognition Technologies (PRT) forecast vendor and internally produced forecasts for Merchant Balancing in Day-Ahead and for the T-75 and T-55 Sufficiency Tests.

For the binding balancing test at T-40, the EIM Entity should use the CAISO Demand Forecast due to the Under / Over Scheduling Penalty treatment defined in the CAISO Tariff. Any EIM Entity COTS application Avista might select will support obtaining the CAISO Demand forecast and balancing to that forecast.

While Avista should opt to use the CAISO forecast due to the Tariff provisions, the CAISO does accept Demand Forecast submissions from the EIM Entity and will evaluate them for accuracy. If Avista's forecast is more accurate than the CAISO forecast in a systematic way, the CAISO may adopt Avista's forecast as its own.

Per discussions during the project, Avista would like to supply its own BAA forecast to the CAISO for accuracy consideration. This will require an interface to submit 5-minute granular forecasts on a rolling 5-minute basis to the CAISO forecast application (ALFS - Automated Load Forecast System). Based on discussions, the cost estimate in this report is based on an ADSS interface with the EIM Entity Scheduling Coordinator (EESC) Scheduling System, which will then submit to CAISO. Any EIM Entity COTS application Avista might select will support submitting the BAA Demand forecast to CAISO. This will result in a submission lag and Avista may consider the effort to develop a direct to CAISO Demand Forecast submission interface but for this estimate we have assumed the data is routed through the EESC Scheduling System.

2.2.3 Nucleus for Deal Capture & Risk and Position Management

The existing Nucleus solution currently performs several functions which will be required for EIM. The following functions are recommended to continue through the EIM implementation:

- Record Bilateral Deals
- Manage Preschedule and Term positions
- Record CAISO Non-EIM Market Awards
- Monitor GHG Position & Mark to Market
- Electronic Quarterly Reporting (EQR) for Bilateral Transactions
- Report Net Scheduled Interchange

The Bilateral and CAISO Non-EIM Market Awards (which are essentially Bilateral Deals with CAISO which must be tagged) will continue to be captured in Nucleus as the system of record for Deal Capture. These transactions will continue to be tagged per WECC rules via webTag. Nucleus will then provide the Bilateral Deals (or a summarized obligation of the Bilateral Deals) to ADSS for Real-Time balancing.

Nucleus will also continue to provide the 7 Day-Ahead Load Forecast and Unit Commitment information the Reliability Coordinator (RC).[1]

ADSS will then schedule Avista generation to Balance against total obligations, including the Demand Forecast and the Bilateral Deals. ADSS will assume primary responsibility for Merchant Balancing responsibilities for CAISO Day-Ahead through T-55, though the Participating Resource Scheduling Coordinator (PRSC) Scheduling System will ultimately be the system of record, including manual adjustments and market impacts. The EESC Scheduling System will be the system of record for BAA Balancing at T-40. Nucleus will cease to perform balancing functions in Real-Time. An impact assessment of deprecating this functionality is needed to determine downstream impacts.

Nucleus will also continue to track Greenhouse Gas (GHG) obligations which are incurred due to Bilateral / Tagged transactions as well as credit purchased by Avista. EIM may also create GHG obligations. To maintain a complete view of the GHG position and mark that position to market, Nucleus will need to obtain the GHG obligations incurred as a result of EIM activities. A new interface to import EIM GHG obligations from the PRSC Settlement System is included in the integration estimate.

Nucleus will continue to perform EQR for Bilateral / Tagged transactions. EIM will create new transactions to include in EQR. These calculations will be performed by the PRSC Settlement System and exported in spreadsheet format. Avista will then manually merge the Bilateral EQR and EIM EQR data. No cost estimate for an API is included.

Nucleus also currently serves as a key integration point for ADSS. Based on the initial assessment, it does not appear that a change to this approach is required to support EIM. However, Avista is planning to implement a managed API to facilitate integration going forward for data that is a straight pass-through from Nucleus. Data that requires transformation in Nucleus may not make sense to migrate until a broader Nucleus replacement effort is scoped. Decoupling Nucleus and ADSS via a Managed API makes sense as a foundational project but is not an EIM specific project. Therefore, the costs are not included in the EIM estimates.

Nucleus also currently provides Risk Management and Mark to Market functionality. EIM is an imbalance market which should be responsible for a small percentage of Avista's purchases and sales. EIM transactions are Real-Time only and do not have a forward component. Additionally, EIM transactions are settled within three business days and invoiced on a weekly basis. At this time, EIM impacts to the overall measurement of Risk has not been identified. One aspect to note is that EIM settlements for third party Transmission Customers in the Avista BAA will be settled with Avista. As a result, Avista will be floating the EIM invoice obligations on behalf of these parties for some period of time. If Avista continues to invoice Transmission Customer monthly rather than weekly in line with CAISO invoicing, the float is larger.

Nucleus currently supports the determination and reporting of Net Scheduled Interchange (NSI) to the WECC (Western Electricity Coordinating Council) Interchange Tool (WIT) for the calculation of

[1] Note that there may be changes required as part of the RC change from Peak RC to CAISO, but those impacts are not EIM impacts.

Inadvertent Energy transfers. The EIM dispatch of Energy Transfer System Resources (ETSRs) is considered scheduled interchange and must now be included in this calculation. An interface to provide this value to Nucleus is included in the estimate.

2.2.4 Additional Nucleus Impacts

It may be possible to leverage the new tools to perform some other functions that Nucleus performs today. Avista should consider what functions it might want to remove from Nucleus and include them as optional requirements, to be priced separately, in the RFP for the new tools to evaluate vendor offerings. Functionality that is deprecated from Nucleus may have downstream impacts and an impact assessment should be conducted for any deprecated functions.

Given the central role of Nucleus in Avista's technology footprint it is likely that there will be some changes required to address functions that will no longer be performed in Nucleus, such as the impact from balancing no longer being performed in Nucleus, cited above. While a complete impact assessment is needed, a placeholder budget of $100,000 is included to address potential impacts.

2.2.5 ADSS for Generation Schedule Optimization

Avista should utilize existing Avista Decision Support System (ADSS) functionality for resource base schedule creation. ADSS currently models the complex hydro constraints and operating characteristics of Avista's generation fleet. Some updates will be required to produce the desired output for EIM, but these are much smaller than implementing a new COTS optimization solution. Therefore, ADSS is best positioned to produce generation resource base schedules based on its existing optimization functionality and the enhancements identified.

Once determined, the generation base schedules would be submitted to the PRSC Bidding and Scheduling System and the EESC Scheduling System, requiring interfaces to be developed between ADSS and these vendor solutions.

This approach relies on ADSS to produce the Base Schedules for all Avista-owned and contracted generation Resources and pass the Non-Participating Resources (NPRs) schedules to the EESC for submission. An alternative to this approach is to designate all Avista Resources as Participating Resources (PRs). In doing so, the Merchant would then be responsible for submitting all Avista Resource Base Schedules to CAISO and the EESC could obtain the Base Schedules directly from Base Schedule Aggregation Portal system (BSAP). This alternative can be explored during the design phase with the vendors and might reduce integration costs. In this report, Utilicast has included estimates for two interfaces, one to the PRSC Scheduling System and the other to the EESC Scheduling System.

2.2.6 New Instance of MV-90

Avista should implement a new instance of MV-90 to serve as a collection system for EIM meter data. This new MV-90 instance will serve as the head-end system for generation, interchange, and imbedded load meter data read by Avista for EIM meter submission. MV-90 will need to interface with the meter data communication systems polling these meters and with the EIM Meter Data Management (MDM) solution identified in the following section.

2.2.7 Oracle Utilities Enhancements

Avista should enhance and utilize its existing Oracle Utilities vendor solution for EIM Meter Data Management (MDM). The MDM will interface with Avista's OSISoft Process Information (PI) system, meter data downloaded from the BPA Customer Portal, Hourly Actual Interchange checkouts values from Nucleus, and the new instance of MV-90 described in the following section. Validation, Estimating, and Editing (VEE) will be performed on the EIM meter data, with the PI sourced data validated by shaping 5-minute average values to hourly meter values. The VEE meter data will be aggregated to the Resource ID level, as registered with CAISO, including the EIM Load Aggregation Point (ELAP) Avista BAA load calculation, which will be adjusted to account for transmission losses. The aggregated meter data will be sent to the EESC Settlement System for submission to CAISO, unless Avista determines the additional cost of this desired functionality in the EESC Settlement System is too expensive, in which case the EIM MDM will need to interface directly with CAISO systems.

2.3 Recommended Purchased COTS / Vendor Solutions

This section identifies solutions recommended for purchase through a competitive RFP process. These designations are also identified in the EIM Technology Inventory. The sub-sections identify some of the major considerations identified in establishing the proposed approach.

In general, the following criteria were important in the determination of a purchase recommendation:

- Required CAISO Expertise – Some applications and integrations require considerable expertise in the CAISO markets, technologies and integration standards. Avista has learned a considerable amount on this project, but, as the design and development would likely require considerable outside consulting resources, Avista is better off selecting from existing vendors. For some of the more complex components required for EIM, custom development is likely to entail major risks to scope, schedule and budget.
- Vendor Solution Maturity – A small set of vendors have been developing EIM solutions over the past four years and there are likely to be more than 10 EIM Entities which precede Avista. Some of the EIM vendor applications execute fairly standard functionality. Even when that functionality is complex, if Avista is likely to require minimal customized development from the standard solution, then there is greater benefit to choosing an established solution.
- Maintenance Burden – The CAISO markets are constantly changing. Major changes are released once a year in the Fall Release, with smaller changes about every quarter. There are dozens of planned market enhancements which will impact multiple CAISO applications – in particular, Bidding, Scheduling, Dispatch and Settlements. CAISO only supports two versions of interfaces (current and immediately prior). Sharing these upgrade costs with multiple participants sharing a common vendor solution will lower maintenance costs. Avista should be careful in the RFP process to clearly understand vendor offerings for complying with ongoing CAISO changes.
- Development Fit to Existing Avista Technology – Avista has some in-house applications and established vendor products. When EIM requirements were closer to the natural footprint of existing in-house solutions, in-house solution enhancements are recommended. When the

required EIM functionality is not similar to the natural footprint of an existing solution, vendor solutions were preferred.

The trend for the EIM applications listed below is to use a vendor-hosted / cloud-based delivery model in most cases. The vendor cost estimates in this report assume that all of the applications identified in this section, with the exception of the EMS integration which is an existing on-premise solution, are vendor-hosted / cloud-based. Of these solutions, the most commonly deployed on-premise solutions are the Outage Management solutions.

2.3.1 Generation Outage Management System

Avista should consider purchasing a Generation Outage Management System (GOMS) to replace Avista's in-house developed Generation Outage Coordinator (GOC). Generation outages in EIM are a bit different than the traditional outage definition; they are more akin to availability management. The ability to control resource availability in the market through outages is critical to success. Another key aspect of GOMS in EIM is keeping up with Ambient Derates. ADSS appears to be well positioned to supply this information. To do so ADSS modifications and integration to the GOMS is required.

Purchasing a COTS GOMS to manage outage scheduling / workflows, development of outage calendars and CAISO integration is preferred to updating / developing this functionality in GOC or ADSS. Additionally, a GOMS, which is integrated with CAISO, will facilitate submission of outages for RC purposes after Avista becomes an RC customer of CAISO, rather than continuing the manual process currently used for Peak Outage submission. Other scoped integration points with the GOMS are also discussed in Section 3.3.2.

Though there are distinct differences in the underlying data model, workflows and permission structure between GOMS and TOMS there are also many overlapping features. Every other EIM participant has selected the same vendor for both Generation and Transmission outage management. It is likely that Avista will want to select a single vendor for both GOMS and TOMS as well.

This system may be implemented prior to EIM to support Avista processes and RC functionality, depending on resource availability, but it is unlikely to be ready for RC Parallel Operations in Summer 2019. It is likely that Avista will need to rely on a modification to the current manual process for filing outages with Peak for some time before cutting over to the new GOMS. The definition of this manual process is beyond the scope of this assessment.

2.3.2 Transmission Outage Management System

Avista currently uses the Control Room Outage Window (CROW) outage management software for Operator Logging and managing Transmission Outages, along with spreadsheets. This application doesn't integrate directly with CAISO's outage management system so Avista needs to evaluate purchasing a third-party interface application or consider purchasing a new Transmission Outage Management System (TOMS) that currently integrates directly with CAISO. Integration with CAISO for outage management is critical for EIM participation, as providing timely and accurate transmission rating information is critical to success. A COTS TOMS will also support the outage scheduling and approval process and typically will have several reporting features to develop outage calendars.

The basis for all transmission information in EIM is the Full Network Model (FNM). A TOMS should use the EIM FNM as the data foundation of the FNM equipment identifiers, which will be required for outage submissions to CAISO.

Though there are distinct differences in the underlying data model, workflows and permission structure between GOMS and TOMS there are also many overlapping features. Every other EIM participant has selected the same vendor for both Generation and Transmission outage management. It is likely that Avista will want to select a single vendor for both GOMS and TOMS as well. If the Merchant team has access to the Outage Management system for Generation, a strong permission structure is required to ensure that Transmission information cannot be viewed by the Merchant team.

This system may be implemented prior to EIM to support Avista processes and RC functionality depending on resource availability, but it is unlikely to be ready for RC Parallel Operations in Summer 2019. It is likely that Avista will need to rely on a modification to the current manual process for filing outages with Peak for some time before cutting over to the new TOMS. The definition of this manual process is beyond the scope of this assessment.

2.3.3 Participating Resource Scheduling Coordinator Bidding & Scheduling System

Avista should purchase a PRSC Bidding & Scheduling System. The proposed approach includes retaining and extending the optimization functionality in ADSS and using the PRSC Bidding & Scheduling System primarily as an interface to CAISO. The functionality for Bid and Schedule exchange with CAISO is very similar to the full market functionality, so vendor solutions are more robust than just the EIM capabilities. This solution will likely also support the RC schedule submission requirements going forward. There are many Avista-CAISO interfaces required for this solution, so leveraging a vendor to insulate Avista from CAISO application changes is also beneficial.

Given Avista will be retaining ADSS, integration between ADSS and the PRSC Scheduling System will be required and is included in the estimates. An alternative would be to extend ADSS to perform the CAISO data exchange. However, the complexity of the BSAP and Scheduling Infrastructure Business Rules (SIBR) interfaces is substantial and it is best to use existing and vendor-maintained COTS interfaces to accomplish these tasks.

Additionally, the cost estimated in this report anticipate that PCI Gen Manager is retained as the CAISO full market intertie bidding solution. It is likely that PCI would seek to license the EIM module separately from the existing solution, but Avista should review the contract. Given the similarity between the bidding and results functionality between EIM and the full CAISO market, Avista should include specifications for CAISO full market intertie bidding in the RFP process to assess vendor offerings to provide a consolidated platform.

2.3.4 Dispatch Integration to EMS

Avista should purchase the GE EMS integration and processing capability for CAISO dispatch signals provided through the Automated Dispatch System (ADS) to EIM participants. Automated processing and centralized communication of the 5-minute dispatch signals from the market is critical for EIM participation, as timely relaying of dispatches to Participating Resources is critical to success.

Additionally, integration of the adjustment to Net Scheduled Interchange (NSI) due to the Dynamic ETSR transfers must be integrated to EMS to calculate Area Control Error (ACE).

2.3.5 EIM Entity Scheduling Coordinator Scheduling System

Avista should purchase an EESC Scheduling System. The process of aggregating tags to Resource IDs for Base Scheduling and Real-Time Interchange Scheduling and communicating this information with the ISO is both critical to EIM success and very complex. Three software vendors have provided this functionality – OATI, MCG and PCI. Each of these vendors had considerable experience developing solutions for the CAISO market and the first implementation of each of these solutions was challenging, expensive and had a number of defects discovered in production. These solutions have been refined through subsequent implementations. There are many Avista-CAISO interfaces required for this solution, so leveraging a vendor to insulate Avista from CAISO application changes is also beneficial.

2.3.6 Participating Resource Scheduling Coordinator Settlement System

Avista should purchase a PRSC Settlement System. The processing of the EIM settlements is complex. Avista has an existing vendor solution (PCI) for this functionality for the CAISO intertie business. The EIM system will have many and more complex charge codes to process, but the overall workflow is the same. It is likely that PCI would seek to license the EIM module separately from the existing solution, but Avista should review the contract.

The PRSC Settlement System will be an important data hub. The assessment also included an evaluation of the currently specified CAISO OASIS and Customer Market Results Interface (CMRI) reports. There is a considerable amount of data critical for evaluating market results contained in these reports and a settlement system vendor will typically consume this data and maintain the interfaces with the CAISO as they are updated. Avista should be specific in its expectations with vendors during the RFP regarding OASIS and CMRI functionality.

There are essentially three classes of Settlement Systems:

1. Solutions which support the basic parsing of the settlement data and basic verification of the settlement amounts with limited consumption of OASIS and CMRI data.
2. Solutions which also provide advance shadow settlements capabilities which allow users to analyze charges in more detail with more consumption of OASIS and CMRI data and some abilities to integrate settlement and market result data for analysis.
3. Solutions which also provide advance analytics capabilities to identify profitability and adjustments to strategy through robust integration of multiple data sources.

More robust solutions are typically more expensive. Avista should include requirements for each of these in the RFP and evaluate whether bundling the analytics capabilities with the settlement solution is cost effective, or if a more basic settlement system with database access would allow Avista to better or more cost effectively analyze results.

Aside from parsing the Settlement Data, performing Shadow Settlements and potentially providing analytics capability, a PRSC Settlement Solution should also include

- Approval Workflows
- Dispute Support and Lifecycle Management
- Invoice Processing and Reconciliation
- Meter Data Acquisition from CAISO's MRI-S
- EIM GHG obligation tracking
- EIM EQR calculations

2.3.7 EIM Entity Scheduling Coordinator Settlement & Allocations System

Avista should purchase an EESC Settlement System. The processing of the EIM Settlement charges is complex. Additionally, the EESC will be required to allocate CAISO charges to its Transmission Customers (TCs) – becoming in essence a mini-ISO settlement department in the process. This is complex functionality and requires integration with the EESC Scheduling System and the Tagging system. Depending on the whether Avista prefers a single vendor for these three functions or different vendors, Avista may need to play a role in the integration. Based on the analysis, Avista prefers to keep options open for vendor selection and therefore an estimate is included for this interface in Section 3.3.2.

For the EESC Settlement System, the analytical capabilities are not nearly as important as they are with the PRSC Settlement System. However, the system should still support

- Approval Workflows for CAISO and TC Calculated Amounts
- Dispute Support and Lifecycle Management, including on behalf of 3rd Parties
- CAISO Invoice Processing and Reconciliation
- Creation of EIM Invoices for Transmission Customers[2]
- Meter Data Acquisition from MRI-Ss

Avista should include requirements for the EESC Settlement System to submit and synchronize meter data with MRI-S in the RFP and evaluate whether routing the Meter Data through the EESC Settlement system is preferable to having the EIM MDM directly submit and sync meter data with CAISO.

The same vendors which offer EESC Settlement applications also offer PRSC Settlement applications and there may be benefits to choosing the same vendor for both solutions. However, this is not required and several EIM participants have selected different vendors for EESC and PRSC Settlements.

The emphasis of the EESC Settlement System is on transforming the CASIO settlements into TC Allocations and the related workflows to manage the creation of TC Settlement Statements and TC Invoices throughout the dispute and resettlement period. The PRSC Settlement System has a greater emphasis on analysis. If all Avista Generation Resources are treated as PRs, then Avista can get a complete picture of Generation performance in a single system, decreasing the need for a common

[2] It may be possible to consolidate EIM TC invoicing with settlement and invoicing for other Transmission Services. This consolidation has not been scoped in this assessment but Avista may wish to include this as an optional feature in the RFP for this solution or include it on a roadmap for future capabilities.

platform (Merchant tag settlements will still be determined by the EESC Settlement System and sent to the Merchant TC).

In some cases, EIM entities have seen the integration between the EESC Scheduling System and the EESC Settlement System as more important than a common platform with the PRSC Settlement System. This "bid-to-bill" connection can be especially helpful when validating tagged schedule submission / status / timing between the Market and Settlements to ensure that TC Allocations are accurate.

Another consideration is the alignment of the personnel that will be performing Merchant Analysis and TC Allocation functions. Despite the different focus of the applications, there is a considerable overlap in the data and processes. If there is a single team that is tasked with this work, a common platform will reduce training needs and ease the ability for team members to assist and backup each other. If these are distinct teams (e.g. if the Merchant Analyst sits on or near the Merchant Trade Floor) the need for a single vendor solution is lessened.

2.4 In-House or Contract Custom Development

In addition to the new applications described in Section 2.3, several in-house development efforts were identified and estimated. This section describes the functionality identified for in-house development.

2.4.1 ADSS Enhancements

Avista should enhance existing ADSS functionality for Base Schedule and Bid creation. ADSS currently models the complex hydro constraints and operating characteristics of Avista's generation fleet and Avista has extensively researched vendor solutions and has not found satisfactory alternatives. Therefore, ADSS is best positioned to produce pre-hour optimal Base Schedules and Bids based on its existing optimization functionality.

ADSS optimal schedule determination will be enhanced to include functionality to create Base Schedules anticipated to meet CAISO Demand Forecasts and Flex Ramp Requirements. However, the approach used for estimation is a simplification from the CAISO Flex Ramp approach in a number of ways to achieve a tradeoff between accuracy and cost (e.g. using an Ancillary Service (A/S) type product rather than a direct ramp rate evaluation, using prior period Base Schedules as the initial condition). This approach can be evaluated going forward.

ADSS will need to be enhanced to produce EIM compliant 4-part bids for each PR, specifically: the energy bid, minimum load cost, startup cost, and the GHG adder. This will be straightforward for thermal resources but will require additional development for the hydro resources. Once produced, the bids would be submitted to the PRSC Bidding and Scheduling System, requiring an interface to be developed between ADSS and this vendor solution. Based on the evaluation, ADSS also has the required information to calculate Ambient Derates for both gas and hydro resources. The Resource Level capabilities will be exported to the GOMS for submission to the CAISO. Synchronizing outages back from either the Avista GOMS or the CAISO OMS to allow validation and reporting in ADSS is desirable and has been included in the cost estimates but could be optional. Direct integration with the CAISO is generally intended to be avoided, if possible, so the initial preferred approach for discussion with the GOMS vendor is that this synchronization is with the GOMS.

Due to Market timelines, a full ADSS optimization may not be run for the T-75 and T-55 balancing submissions by the PRSC. Additionally, the EESC Scheduling System is responsible for the T-40 balancing. ADSS will be enhanced to create a simplified balancer screen and logic to economically zero imbalance. Estimates are included for these enhancements assuming that ADSS will then push the results directly to the EESC Scheduling System. This approach should be validated with the EESC Scheduling System vendor to evaluate whether off the shelf functionality might meet the EESC needs, potentially saving development of one interface.

During this evaluation, 18 enhancements were identified and estimated (see Table 8). For each enhancement, an effort estimate was identified for Requirements, Design, Development and Testing. Due to uncertainty in the Requirements, COTS vendor selections and the Managed API approach and in accordance with Avista estimating guidelines, 50% contingency has been added to the ADSS enhancement estimates. Additionally, it is likely that additional enhancements points will be identified as Avista defines the detailed functional requirements. Therefore, an additional nine enhancements (three hard, three medium and three easy) are included in the estimated effort.

2.4.2 Avista Integration

Avista procured COTS and in-house solutions will need to integrate, allowing for automated and timely communications of data between solutions to successfully participation in EIM. Some estimated integrations between various COTS solutions may be de-scoped if a single vendor is chosen, while other integrations will persist regardless of the chosen vendor solutions. For example, Avista EIM meter data in Oracle Utilities will need to be passed to the EESC Settlement System via an integration between these two solutions.

During this evaluation, 25 interfaces were identified and estimated (see Table 9). For each interface, an effort estimate was identified for Requirements, Design, Development and Testing. Due to uncertainty in the Requirements, COTS vendor selections and the Managed API approach and in accordance with Avista estimating guidelines, 50% contingency has been added to the interface estimates. Additionally, it is likely that additional integration points will be identified as Avista defines the detailed functional requirements and develops a greater understanding of the impacts to existing or deprecated Nucleus functionality, Real-Time situational awareness and reporting and analysis needs. Therefore, an additional nine interfaces (three hard, three medium and three easy) are included in the estimated effort.

2.4.3 Custom Reporting

To properly assess the EIM results and adjust behavior to optimize market results, Avista will need to update existing reporting capabilities, develop new reports and develop new situational awareness tools. Some of these functions are likely to be provided by the CAISO reporting applications and some by the vendor solutions. It is likely that Avista will need to augment those capabilities using PI, Tableau or other reporting solutions. The preferred location for the source data cannot be established until the reporting requirements are clearer, but it is likely not Nucleus. This custom reporting would be created by Avista in-house resources.

2.4.4 Other In-House Enhancements

Various Avista in-house solutions or existing COTS solutions will need to be enhanced in support of EIM participation. Some of these enhancements may be adequately covered by existing COTS functionality, for example meter data validation rules, but have been estimated for Avista internal work for now until detailed determinations can be made on the scope of such uses.

3 Estimated Costs

This section provides high-level estimated costs for the proposed solution.

3.1 Existing Application Cost Estimates

Effort estimates were prepared for some additional existing application and in-house development. Effort was broken down by project phase. The summary effort, including contingency, is presented in Table 5. Additional details are provided in the Requirements Inventory.

Table 5 – Estimated In-House Enhancement Budgetary Cost by Function

#	Name	Est Effort (in hours)
53	Track GHG Payments and Open Position	400
55	Process Generation Meter Data: Gather data and perform VEE	1,600
56	Process Generation Meter Data: Apply correction factors	500
57	Process Transmission Meter Data	800
60	Oracle MDM Setup	5,100
70	Oracle MDM Integration	1,700
78	Misc Meter Processor	500
54.3	Nucleus Impacts Placeholder	1,000
Estimated EIM Other In-House Effort		**12,000**

The approach to VER Forecasting is still to be determined. No cost estimate is included in this report. No changes to the Demand Forecast were identified.

The proposed solution for MV-90 to be the primary meter data acquisition will require incremental license and maintenance costs. Though these costs will support both Transmission and Generation meter data acquisition, these costs are accounted for in line 15 of Table 1 – Summary Budgetary Cost Estimate for EIM Technology Projects. Oracle MDM license and maintenance pricing is based on a per meter approach. Because the Oracle MDM is the solution for the AMI project and Avista has already acquired many licenses, there is no incremental cost anticipated for the small increase in EIM meters.

Table 6 – Estimated License & Maintenance for Existing Applications

#	Solution	License ($,000)	Maintenance ($,000)
	VER Forecast	$0	$0
	Demand Forecast	$0	$0
	MV-90 License & Maintenance	$115	$18
	Oracle MDM	$0	$0
	GE EMS	$0	$0
Estimated License & Maintenance for Existing Applications		**$115**	**$18**

3.2 COTS / Vendor Cost Estimates

Table 7 provides budgetary level costs for the identified COTS solutions. Detailed requirements were not in scope for this project and no vendor bids were solicited. The high-level ranges provided are based on prior EIM implementations and include license and vendor labor.

The range is quite wide for some of the solutions. Some of the main reasons for the range are:

- The vendor capabilities in some areas vary significantly. For example, for the PRSC Settlement Solution, a basic solution might be implemented for quite a bit less than one that incorporates a more robust analytics platform. For a settlements and analytics application, this may represent good value. In other cases, such as more robust bidding support, this may not provide value to Avista given the anticipated enhancements to ADSS.
- In some cases, the variation may also be explained partially by the upfront costs versus the recurring costs and how much ongoing change is covered by the recurring charges – the same vendor may not be at the top or bottom of both ranges.
- The level of support for configuration / customization during implementation assumed also can vary quite a bit. Some vendors implementation costs have been scaled to account for estimated Change Orders.

Avista business and technology team labor is also estimated for each of the solutions. Two methods were used for the estimate.

The first approach used is a top-down approach using a previous project as a reference.

- The Avista labor required for the recent PCI Settlement System implementation was compared to the vendor costs. The vendor license, vendor implementation and Avista internal labor costs were about one third each (after adding in an estimate for some labor which was not coded correctly in the time tracking system). Since the COTS estimates are inclusive of license and vendor implementation costs, a ratio of 0.5 was applied to estimate the base Avista labor.
- The PCI Settlement System implementation appears to be a simpler project in terms of the configuration required than the solutions identified for EIM. Based on the level of configuration

required for a given EIM solution, the Avista base labor was scaled up by an additional 10% to 50%, depending on the solution.

- Calculations were performed on the pre-contingency high and low license and implementation cost estimates.
- This approach includes Business Owner and Project Management effort to the extent that those individuals recorded time to the project.
- This approach estimates only the project labor and cannot be used for the procurement labor since the data does not exist.
- As described below in the second approach, the effort for the Security Engineer and Cloud Architect are deducted from the total. The following deductions are used:
    - Security – Project – 1,600 hours
    - Architecture – Project – 700 hours

The second approach used is a bottom up approach using a reference project.

- The PRSC Scheduling System project was broken down into 30 tasks. Ten tasks relate to the Avista and consultant efforts for procurement (e.g. requirements, system selection) and 20 tasks relate to the Avista and consultant effort for Implementation (e.g. design, testing, process definition).
- For each task, three roles were identified – a primary driver / doer, SME / workshop participant and reviewer / approver. For each role, the number of individuals and the anticipated effort was estimated.
- After a total was calculated for each phase, the other COTS implementations were scaled based on how difficult they appear to be relative to the PRSC Scheduling System using the same ratios as in the first method. An exception is the Dispatch Integration to EMS, for which a lower ratio was used since the effort is much simpler than the PRSC Scheduling effort.
- This approach incorporates both consultant and Avista effort. To isolate the Avista effort, the estimated consulting share was deducted from the total to determine the Avista share.
- This approach incorporates both Avista Security Engineer and Cloud Architecture effort. Avista has requested a dedicated line item for these efforts because the plan is to pursue a single / dedicate point of contact for the EIM Program. As effort estimate was identified for these roles in the reference PRSC Scheduling System project and scaled to the other projects using the same ratios described above.
    - Security – Procurement – 600 hours; Project – 1,600 hours
    - Architecture – Procurement – 600 hours; Project – 700 hours

The ranges in Table 1Table 7 are derived from the first method with the values from the second method landing about 80% of the way toward the high side of the range.

Table 7 – Estimated COTS Budgetary Cost Range by Solution

Solution	Estimated License & Implementation (in $,000)	Avista Internal Labor (in hours)	Estimated Annual Recurring Charges (in $,000)
Gen Outage Management (GOMS)	$300 - $450	800 - 2,500	$30 - $100
Trans Outage Management (TOMS)	$400 - $550	1,300 - 2,900	$50 - $150
PRSC Bidding & Scheduling System	$150 - $600	800 - 2,500	$75 - $175
EESC Scheduling System	$400 - $750	1,900 - 3,500	$100 - $175
PRSC Settlement System	$125 - $650	1,000 - 2,900	$50 - $175
EESC Settlement System	$300 - $575	1,400 - 3,500	$75 - $175
Dispatch Integration to EMS	$100 - $200	300 - 400	No Change
Sum of Lows & Sum of Highs	$1,775 - $3,725	7,500 - 18,200	$380 - $950
Contingency	20%	20%	20%
Range with Contingency	$2,100 - $4,500	9,000 - 21,900	$500 - $1,100

3.3 In-House or Custom Development Cost Estimates

3.3.1 ADSS Cost Estimates

Effort estimates were prepared for each of the ADSS enhancements identified. Effort was broken down by project phase. The summary effort, including contingency, by function is presented in Table 8. Given that detailed requirements have not been defined, it is likely that additional enhancements will be identified as the project progresses. A placeholder for nine additional enhancements – three hard, three medium and three easy – is included to account for the current uncertainty in the eventual solution. Additional details are provided in the Requirements Inventory.

Table 8 – Estimated ADSS Enhancement Budgetary Cost by Function

#	Name	Est Effort (in hours)
1.2	CAISO Master File Data Model	500
6.2	Ambient Derate Provision	500
6.4	Outage Synch	600
16.1	Determine Flex Ramp Requirements for Base Schedule Determination	1,000
16.4	Process Flex Ramp Uncertainty	400
16.5	Process BAA Demand Forecast	300
16.6	Compare BAA Demand Forecast to Internal Forecast	400
17.2	Create 4-Part Bids: Data Structure	500
17.3	Create 4-Part Bids: Fossil Cost to CAISO Bid Logic	800
17.4	Create 4-Part Bids: Hydro Cost to CAISO Bid Logic	1,600
17.5	Create 4-Part Bids: CAISO Bid Rule Pre-Checking	600
17.6	Create 4-Part Bids: CAISO Bid Creation UI	600
17.7	Create 4-Part Bids: CAISO Bid Creation Workflow	400
18.2	Create Balancing Stack: Data Structure	500
18.3	Create Balancing Stack: Create Stack Segments	800
18.4	Create Balancing Stack: Order Stack Segments	800
20	Provide Balancing Stack to Transmission Operations	300
23	Generation Auto Balancer	1,000
200s	Allocation for Scope Uncertainty	3,000
Estimated EIM ADSS Enhancement Effort		**14,400**

3.3.2 Integration Cost Estimates

Effort estimates were prepared for each of the integration points agreed for scoping. Effort was broken down by project phase and was conservatively estimated. The summary effort, including contingency, is presented in Table 9. Several more potential interfaces were identified during the analysis. Many of these are anticipated to be included in the "out of the box" vendor solutions.

Given that detailed requirements have not been defined, it is likely that additional interfaces will be identified as the project progresses. A placeholder for nine additional interfaces – three hard, three medium and three easy – is included to account for the current uncertainty in the eventual solution. Additional details are provided in the Requirements Inventory.

Table 9 – Estimated Integration Budgetary Cost by Interface

#	Name	To <> From	Est Effort (in hours)
3.2	Derate Transmission	EMS >> TOMS	600
5.2	Suggest Generation Outages	EMS >> GOMS	500
6.3	Outage Sync	GOMS >> ADSS	500
10	Obtain NPR Base Schedules	ADSS >> EESC Sched System	500
16.2	Obtain Flex Ramp Uncertainty	PRSC Sched System >> ADSS	400
16.3	Obtain BAA Demand Forecast	PRSC Sched System >> ADSS	500
21.1	Retrieve RT RS Results	EESC Sched System >> PRSC Sched System	400
25	Receive Balancing Stack	ADSS >> EESC Sched System	500
34	Tag Snapshot for TC Allocations	EESC Sched System >> EESC Settle System	500
35	Receive Gen and ETSR Dispatches	CAISO ADS >> EMS	100
52	Import GHG Settlement	PRSC Settlement >> Nucleus	400
58	Export Generation SQMD	MV-90 >> Oracle Utilities MDM	400
59	Export Transmission SQMD	PI >> Oracle Utilities MDM	400
61	Submit SQMD to CAISO	Oracle Utilities MDM >> CAISO MRI-S	500
64	Receive PR Invoice Amounts	PRSC Settle System >> Oracle Financials	100
65	Receive EE Invoice Amounts	EESC Settle System >> Oracle Financials	100
69	Obtain PR Base Schedules	ADSS >> PRSC Sched System	500
71	Send 4-Part Bids	ADSS >> PRSC Sched System	600
72	Send Load Forecast	ADSS >> EESC Sched System	500
75	Telemetry for VER	EMS or PI >> VER Forecast	400
76	VER Forecast Alternate Path	VER Forecast >> EESC Sched System	400
79	Hourly Checkout Value	Nucleus >> Oracle MDM	400
200s	Allocation for Scope Uncertainty	Overall implementation work	3,300
Estimated EIM Integration Effort			**12,300**

3.3.3 Custom Reporting

A placeholder budget is included to account for the development of new reports and new situational awareness tools to assess the EIM results and adjust behavior to optimize market results.

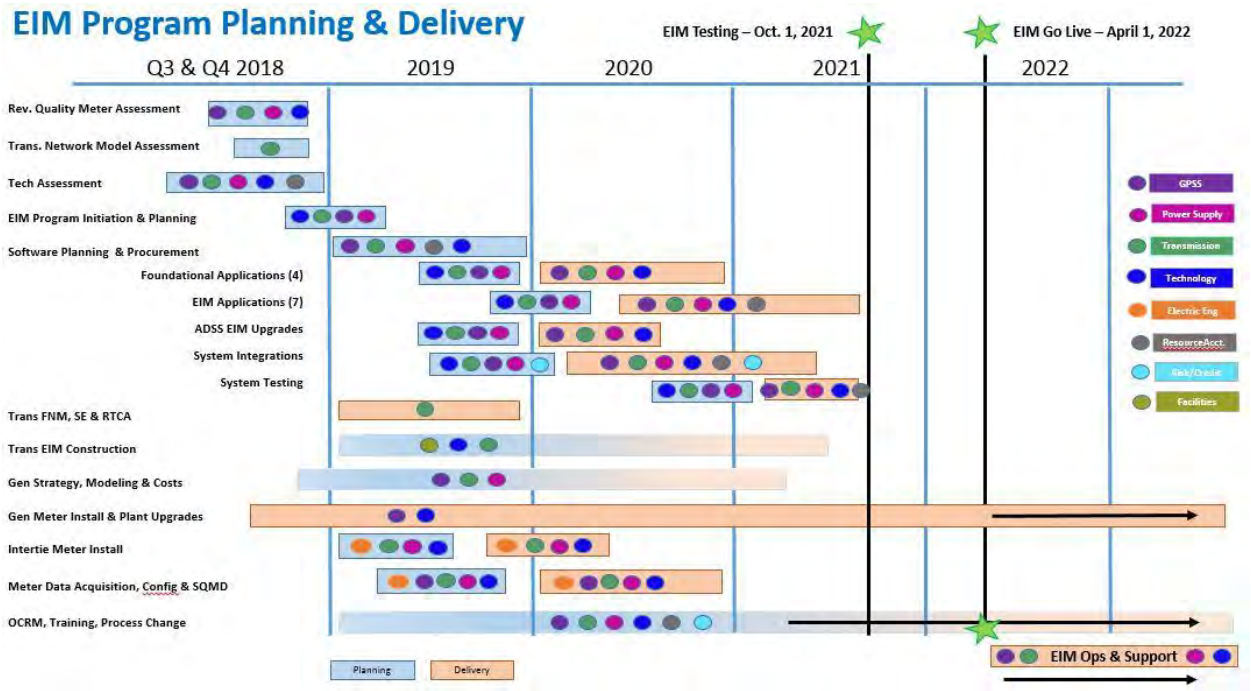
Table 10 – Estimated Custom Reporting Budgetary Cost Placeholder

#	Name	Est Effort (in hours)
54.1	Key Performance Indicator Placeholder	1,000
54.2	Situational Awareness Placeholder	1,000
Estimated EIM Other In-House Effort		**2,000**

4 Proposed High-Level Schedule

Based on the number of solutions which need to be implemented, Avista's resource availability, procurements timelines and the EIM implementation timeline, a preliminary high-level schedule has been developed to support technology prioritization discussions which is shown as Figure 1.

Figure 1 – High Level EIM Schedule



5 Conclusion

Several Avista in-house systems were evaluated for possible enhancements and integrations as alternative EIM solutions to vendor systems. Specifically, the existing functionality of Nucleus and ADSS were considered for EIM solutions.

Based on the required EIM functionality, complexity of that functionality and maintenance required for on-going EIM changes as the market is enhanced, Nucleus is not an option for the core EIM solutions. Nucleus will be enhanced, as identified in this report, to support EIM impacts to certain Energy Trading and Risk Management (ETRM) and other existing functions.

Based on the current EIM assessment efforts, and known requirements, it's anticipated that the new EIM solutions will have some overlap with existing Nucleus functions. Identifying the downstream impacts of retiring Nucleus functionality was not included in this assessment, and will require additional investigation during COTS products are reviewed and implemented. Avista may also choose to include optional functionality in the RFP for the EIM solutions to evaluate if the new tools can replace existing

Nucleus functions. Analysis of EIM impacts on existing Nucleus functions should be in-scope for the Requirements gathering process.

The project team determined that the existing functionality of ADSS and custom nature of hydro resource optimization made ADSS a prime candidate system for creating generation bids and schedules rather than vendor solutions, since the hydro optimization would be a custom vendor implementation largely duplicating existing ADSS functions.

Several of Avista's planned commercial software procurement are best leveraged for EIM solutions in addition to their original scope. Specifically, Avista's planned GOMS and TOMS vendor solutions should be aligned with EIM requirements to streamline their implementation and subsequent use for EIM participation.

6 Addendum – Supplemental Cost Analysis

Following the initial Technology Assessment, Avista requested the analysis be broadened to include Very Rough Order of Magnitude (VROM) estimates for a number of other efforts and costs which will be incurred either for EIM or contemporaneous with EIM. This Addendum attempts to summarize the additional effort and cost estimates, the source of the estimate and the level of confidence in the estimated value.

6.1 Planning, Requirement & Procurement Phase

Avista anticipates using 2019 to further plan the project and begin the procurement process for the required systems in anticipation of implementation work beginning in 2020.

To support this effort, additional consulting resources are anticipated. As a placeholder, budget for one resource from April 1, 2019 through December 31, 2019 is included.

Avista will also participate in the planning and procurement process. The bottom up approach to estimating the PRSC Scheduling System effort described in Section 3.2 was used to estimate Avista's labor. Using the 10 tasks related to procurement (e.g. requirements, system selection), an initial effort estimate was determined. The anticipated consulting effort applicable to system selection was deducted from the total to derive an Avista-specific estimate.

This estimate assumes that a single procurement and contracting specialist is assigned from Avista to support all the EIM related procurement since there will be a number of similarities across these procurement efforts. Further, it was assumed that all vendors would have existing Master Service Agreements (MSAs) with Avista. If new MSAs need to be negotiated, additional effort will be required.

These costs are summarized on line 10 of Table 1 – Summary Budgetary Cost Estimate for EIM Technology Projects. Please see Avista – Integration EIM Cost Summary tabs "1a, 10. Vendor Software" and "9b, 10. Consulting" for additional details.

6.2 Generation & Network Modeling

Separate from the Technology Assessment, an evaluation of updates and improvements to the Full Network Model (FNM) required for EIM participation was conducted. The analysis also included implementation of State Estimation (SE) and Real-Time Contingency Analysis (RTCA) and hardware to support these functions. Only the FNM upgrades are EIM-related. The other functions are necessary due to the RC Transition and other Avista objectives. These costs are summarized on line 11 of Table 1 – Summary Budgetary Cost Estimate for EIM Technology Projects. Please see Avista – Integration EIM Cost Summary tab "11. FNM" for additional details.

Implementation of EIM will also require generation performance and cost modeling. Avista has begun this effort through the supplemental EIM Planning project by beginning to develop a Resource Participation Strategy. For EIM, many aspects of the generation resources will need to be modeled for the CAISO Master File. Additionally, several kinds of costs will need to be determined or refined (Heat Rates, Maintenance Costs). A placeholder budget is included for this effort. These costs are summarized

on line 12 of Table 1 – Summary Budgetary Cost Estimate for EIM Technology Projects. Please see Avista – Integration EIM Cost Summary tab "12. Gen Cost Modeling" for additional details.

A major topic in EIM is the need to provide Settlement Quality Meter Data (SQMD). A separate project was undertaken to assess the current state of Avista's Generation and Intertie Metering equipment including Current Transformers (CT), Potential Transformers (PT) and Meters as well as the compliance with the EIM requirements. For the Generation meters, a separate modernization project has already been authorized. However, based on the assumptions in that business case, current progress and the EIM Requirements, GPSS has provided an updated estimate for generation metering as part of this effort. Additionally, Meter swaps are anticipated at several intertie locations. These costs are summarized on line 15 and 19 of Table 1 – Summary Budgetary Cost Estimate for EIM Technology Projects. Please see Avista – Integration EIM Cost Summary tabs "15. Transmission Meters" and "19, 20. Gen Controls and Meters" for additional details.

In the EIM, it is important to maximize the resources which can be offered to the Market and to be able to follow 5-minute dispatch instructions. Avista's current plant communications and infrastructure (PLC, RTU, SCADA) may not support the requirements at some locations. A placeholder budget provided by GPSS is included for these enhancements. These costs are summarized on line 20 of Table 1 – Summary Budgetary Cost Estimate for EIM Technology Projects. Please see Avista – Integration EIM Cost Summary tab "19, 20. Gen Controls and Meters" for additional details.

6.3 Network & IT Infrastructure for Applications

With the current direction of the Technology Assessment leveraging cloud-based deployments, network availability and performance will be key to the performance of the COTS applications. Additionally, connectivity to the CAISO is critical. Avista's IT team's estimated costs to support enhanced connectivity for the COTS solutions, communications with CAISO and an allowance for MV-90 capabilities at the Back Up Control Center (BUCC) in case MV90 is on the SCADA network. If MV90 is on the ET network, the backup will be in San Jose. AWS/Azure estimates were used for the COTS solutions; Avista already has a dedicated network connection to OATI's data center. These costs are divided into the following categories:

- Incremental Internet Connectivity and Dedicated Circuits – Additional networking for generation control, connectivity with CAISO and connectivity to the Azure and AWS clouds as well as BUCC improvements were budgeted. Budgetary costs for this upgrade were provided by Avista.
- ADSS Hardware – The current EIM vision includes ADSS becoming a central system in the hourly schedule and bid creation process and upgrading the Hardware at the San Jose location is recommended. Budgetary costs for this upgrade were provided by Avista.
- Dedicated Project Resources – A dedicated Security Engineer and a dedicated Cloud Architect were included by Avista.
- Miscellaneous Costs – A small placeholder for additional firewalls, integration services and unidentified software were included by Avista.

These costs are summarized on line 6, 7 and 8 of Table 1 – Summary Budgetary Cost Estimate for EIM Technology Projects. Please see Avista – Integration EIM Cost Summary tabs "6-7. IT VROMs" and "8, 16. Network VROMs".

6.4 Generation and Intertie Equipment Upgrades & Communications

EIM requires revenue metering at both generation and intertie locations. At this time, the preferred approach to retrieving the meter data for Avista owned meters at generation and intertie locations is to poll the revenue meter using MV-90 using IP. To date, 52 locations have been identified as potentially requiring communications upgrades.

- About half of the intertie locations currently use dial-up connections to communicate meter data to Mission. Continued use of the existing dial-up modems for certain locations (those with a Bulk Electric System (BES) Low Impact designation, as opposed to no BES impact designation) require that equipment to be isolated from control equipment under the new NERC CIP Standard 003-6.
- The current Avista Standard is to replace dial-up modems with T1 connections. If T1 connections are used, High Voltage Protection (HVP) may be required. If so, it would substantially increase the cost. A site by site assessment is needed to determine HPV requirements. In some locations, cellular modems might be feasible. This option has not been assessed.
- Some locations, including most of the generation locations, may not have a BES impact. If there is no BES impact, dial-up connections may still be feasible.
- Using a "backup meter" which is isolated from SCADA connectivity might be feasible. BPA has used this approach in some cases.
- For EIM it may be possible to use the existing SCADA data combined with the existing BAA hourly check-out values to calculate a settlement quality actual interchange value. This would not be possible for the generation locations. Idaho Power Company (IPC) has used this approach in some cases. However, significant data losses are possible with this approach and may not be acceptable.
- Avista may decide upgrading communications capabilities is advisable as part of a general modernization effort regardless of EIM requirements.

A site-by-site analysis is required to define the preferred approach. At this time, a placeholder VROM is included based on the following:

- Network and Communications for Generation Controls and Metering – Site by site analysis of the 28 identified generation locations has not been completed and the cost estimates in this report are approximates based on the share of locations that is likely to need a T1 connection (10) and the number of sites likely to require HVP for that connection (8). Other approaches are under consideration (e.g. cellular, separate circuits for dial-up capability). Aside from EIM requirements, CIP 3-6 standard will impose some communication requirements, which may indicate a T1 connection is the best option. Until Avista can complete a site by site analysis, or

decide to fund all upgrades to a corporate standard to achieve O&M savings, these costs estimates should be interpreted cautiously.

- Network & Communications for Transmission Metering – Site by site analysis of the 24 identified transmission locations has not been completed and the cost estimates in this report are approximates based on the share of locations that is likely to need a T1 connection (16) and the number of sites likely to require HVP for that connection (10). A higher proportion of Transmission locations was anticipated to require T1 and HPV than generation due to the higher likelihood that the locations are BES locations. Until Avista can complete a site by site analysis, or decide to fund all upgrades to a corporate standard to achieve O&M savings, these costs estimates should be interpreted cautiously.

These costs are summarized on line 16 of Table 1 – Summary Budgetary Cost Estimate for EIM Technology Projects. Please see Avista – Integration EIM Cost Summary tab “8, 16. Network VROMs”.

6.5 Project Implementation

The EIM Program will also require daily management and coordination, strategy definitions, extensive training and Organizational Change Management (OCM). New sections of the Avista Open Access Transmission Tariff (OATT) must be filed with FERC and a Market Base Rate (MBR) study performed. Consulting resources are anticipated to provide Program Management support and Subject Matter Expertise across the project. Several new permanent FTEs will also be added during the project and become part of ongoing operations.

These costs are summarized on line 9, 13, 14 and 18 of Table 1 – Summary Budgetary Cost Estimate for EIM Technology Projects. Please see Avista – Integration EIM Cost Summary tabs “9a. Prog Management and Leader” and “9b, 10. Consulting” and “13. OATT and MBR” and “14. Training and OCM” and “18. CAISO Fees”.