Making Commercial Whole Building Program Delivery Easier and Less Risky

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ABSTRACT

Whole building commercial programs can be challenging to deliver due to their complexity and scope. A broad suite of Federal tools and reference standards can be leveraged to reduce program cost and risk, and improve scalability. These include: OpenStudio® / PAT, Building Energy Asset Score, Building Energy Asset Score Audit Template, Energy Star Portfolio Manager (ESPM), Green Button, Energy Design Assistance Program Tracker (EDAPT), Standard Energy Efficiency Data Platform™ (SEED), Charting and Metrics (ECAM), Building Sync XML (BSXML), and Building Energy Data Exchange Specification (BEDES). However, navigating, adopting, and integrating these tools to support programs is a significant barrier.

The OpenEfficiency Initiative (OEI) is a DoE funded effort to expand the deployment of Federal tools and reference standards into whole building commercial efficiency programs. OEI is developing an open source data exchange platform which is being informed and motivated by pilots. The pilots support three primary use cases: streamlining building modeling, data integration, and program reporting. The pilots were conducted in partnership with The Energy Coalition, SoCalREN, Vermont Energy Investment Corporation, and Xcel Energy.

1: Introduction

Whole building commercial programs face adoption barriers associated with their complexity, which can drive costs. Significant effort has been invested in the development of Federal tools and industry standards which been developed to benchmark, audit, model, measure, manage programs, and match records. These resources can be leveraged to standardize, streamline, and enhance program management. The cost of software development required to integrate and streamline the tools for program management is a barrier to their adoption and can be redundant between program implementers. A holistic, open source solution is required.

The OpenEfficiency Initiative (OEI) provides an open source API based data exchange platform and data model for the integration of Federal tools and standards to support whole building commercial program management. Pilots adopting these resources were developed focusing on three primary use cases: 1) streamlining building modeling, 2) data integration, and 3) program reporting and targeting.

The pilots have informed the development of the OEI Platform and OEI Reporting Data Model which include data fields from OpenStudio®, ENERGY STAR Portfolio Manager® (ESPM), Building Energy Asset Score (Asset Score), Building Energy Asset Score Audit Template (Audit Template), Green Button, and Energy Design Assistance Program Tracker (EDAPT). The data model is Building Energy Data Exchange Specification (BEDES) compliant, and leverages Building Sync XML (BSXML).

2: Background

Commercial whole building programs focus on commercial building energy efficiency from a whole building perspective and consider interactive affects and wholistic elements to achieve energy savings. 261 commercial whole building programs were offered by Consortium for Energy Efficiency (CEE) members in 2016 (CEE, 2016). The top program types that were offered were: new construction/major renovations, energy audit assessment, and recommissioning/retrofit programs (CEE, 2016). Additionally, municipalities such as NYC are adopting benchmarking and/or audit mandates (NYC, 2018). The overarching goal of these programs and mandates is to achieve credentialed energy savings as efficiently as possible.

The International Performance Measurement and Verification Protocol (IPMVP) defines two M&V options that are appropriate for measuring whole building savings: Option C and Option D. Option C is based on whole facility measured consumption compared to a measured baseline. Option D is based on modeling simulations that are calibrated with measured performance (Efficiency, 2012). A key metric of program success is realization rate which is used to evaluate planned energy savings compared to actual energy savings. An ideal realization rate is 100%. Program evaluations have sometimes resulted in realization rates that are far from the ideal: in one example program using Option C the realization rate was 56% and an example program using Option D has a realization rate of 160% (Urbatsch Boyer, 2016). These highly variant realization rates are a risk to programs and have been attributed to lack of standardization of inputs and assumptions, and lack of transparency of analysis (Urbatsch Boyer, 2016).

There is movement towards open source, transparency, integration, and automation of data flow (EETC, 2016). For example, the five primary technical barriers identified in road mapping building energy modeling (BEM) are: discrepancies between predicted and actual energy consumption, missing input data, time-consuming transfer of input data, outputs not formatted for presentation, and BEM capabilities lag technology advances (Barbour, 2016).

Figure 1 shows a conceptual diagram of the integration of whole building program delivery. Over the course of time a building may have multiple program participations ranging from benchmarks and audits to energy efficiency installs supported by whole building modeling and measurement. Building and project data are collected for each of these types of project. Program relevant data from these project sources can be managed for program management functions. The data can then support program reporting and targeting. A range of tools and standards can be leveraged to support program delivery.

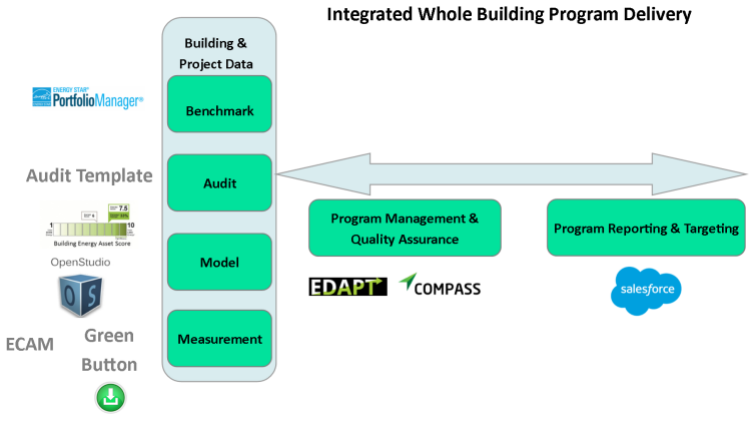

Figure 1: Whole building program functional diagram with relevant tools to support each function.

Table 1 summarizes tools and standards that were included in OEI. 62 CEE members had programs that used Federal tools and standards in 2016 (CEE, 2016). The most commonly used were ESPM and Green Button. OpenStudio and Asset Score were used by a few programs and SEED, BSXML, and BEDES had none (CEE, 2016). While few programs use OpenStudio, it is used by many Building Energy Modeling tools which may be used during some phase of the design process for projects that are in programs (Barbour, 2016).

Table 1: OEI Tools and Standards Summary

Name	Role of Resource	Details	Source
ENERGY STAR Portfolio Manager® (ESPM)	Benchmark	Free, website	EPA (EPA, 2018)
Building Energy Asset Score Audit Template (Audit Template)	Audit	Free, website	DoE (DoE, 2018c)
OpenStudio® / Parametric Analysis Tool (PAT)	Model	Free, open source	DoE (DoE, 2018d; DoE, 2018a)
Building Energy Asset Score (Asset Score)	Benchmark, Model	Free, website	DoE (EERE, 2018)
Green Button	Measurement	Industry standard	GBC (The Green Button, 2018)
Energy Charting and Metrics (ECAM) Tool	Measurement Analysis	Free, transparent	PNNL (California, 2018)
Energy Design Assistance Program Tracker (EDAPT).	Program management & QA	Free, open source	DoE (NREL, 2018b)
Compass	Program management & QA	Example proprietary	PSD (PSD, 2018)
Salesforce	Program reporting & targeting (CRM)	Common CRM tool	Salesforce (Salesforce, 2018)
Building Sync® XML (BSXML)	Standard Schema	Free, transparent	DoE (NREL, 2018a)
Building Energy Data Exchange Specification (BEDES)	Reference standard	Free, transparent	LBNL (DoE, 2018b)
Standard Energy Efficiency Data Platform™ (SEED)	Record matching database	Free, open source	DoE (EERE, 2018)
MuleSoft Anypoint Community Edition	API platform	Free version	Mulesoft (MuleSoft, 2018)

3: OEI Approach

This section describes the approaches for the OEI Platform and OEI Reporting Data Model. The OEI Platform describes a framework for API communication integration of tools and standards. The OEI Reporting Data Model describes the data field integration and structure to deliver value from the tools to support programs. This approach was informed and enhanced from the pilots described in Section 4.

3.1: OEI Platform

The OEI Platform architecture is summarized in Figure 2. The approach is to use MuleSoft Anypoint Community Edition to provide API development and management for the automated communication of data between the various tools. Data continues to be stored in the point of origin, but can be pushed and stored in another tool. For example: ESPM data records are stored by ESPM. The API allows for communication between ESPM and Compass so that when a new or edited record is created in ESPM that data is pushed to and stored in Compass.

API connections to the tools can be reused, avoiding significant custom API development for each use case. Through the exploration of use cases the requirement for this platform with three primary process APIs have been identified for development: Program & Building API, Matching API, and Interval Data Value API. ESPM, Asset Score, Audit Template, Compass, and EDAPT can connect to one primary API hub with data from each tool mapping into the Program & Building API. OpenStudio has existing compatibility with Compass and EDAPT so it does not need a unique connection. The Matching API is to be used to match records from different tools using SEED. Green Button connects to an Interval Data Value API which feeds summary consumption data into the program & building API and can export interval data to ECAM for interval analysis.

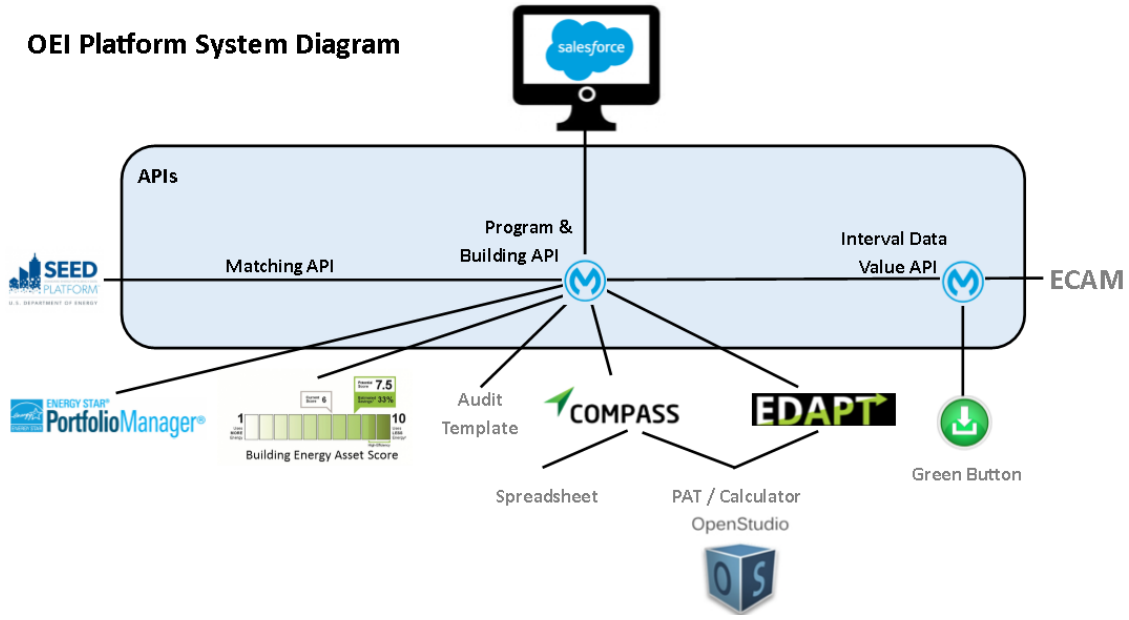

Figure 2: OEI Platform integration design

3.2: OEI Reporting Data Model

The OEI Reporting Data Model is an enabling resource for the delivery of whole building programs aligned with the federal tools. It provides a mapping of ESPM, Asset Score, Audit Template, EDAPT, and Compass fields into one data model, integrated with the fields required for standardized program reporting for a range of different program types. The data model terms are BEDES compliant. The structure is hierarchical and is designed to support program management and reporting within Salesforce.

When possible BSXML was adopted to avoid duplication of work and to achieve integration with the existing schema. Customization was required to support the use case of program management and reporting since BSXML is a scheme designed for building audits. OEI unique objects and fields that support program management can be advocated for inclusion in BSXML scheme and can be adopted by others in their reporting tool of choice.

The OEI Reporting Data Model has been implemented in the OEI Reporting Managed Package in Salesforce (Figure 3). Managed packages are used to distribute and sell applications developed in Salesforce. The OEI Reporting Managed Package will be available for free to Salesforce users. The managed package includes custom report types to enable program reporting. Figure 2 represents the object relationships for the managed package. In Salesforce Objects are the equivalent of database tables. The fields for data records are organized within the objects. The managed package integrates with standard objects in Salesforce to access the existing resources available in Salesforce which support contact interactions, account management, and opportunity tracking.

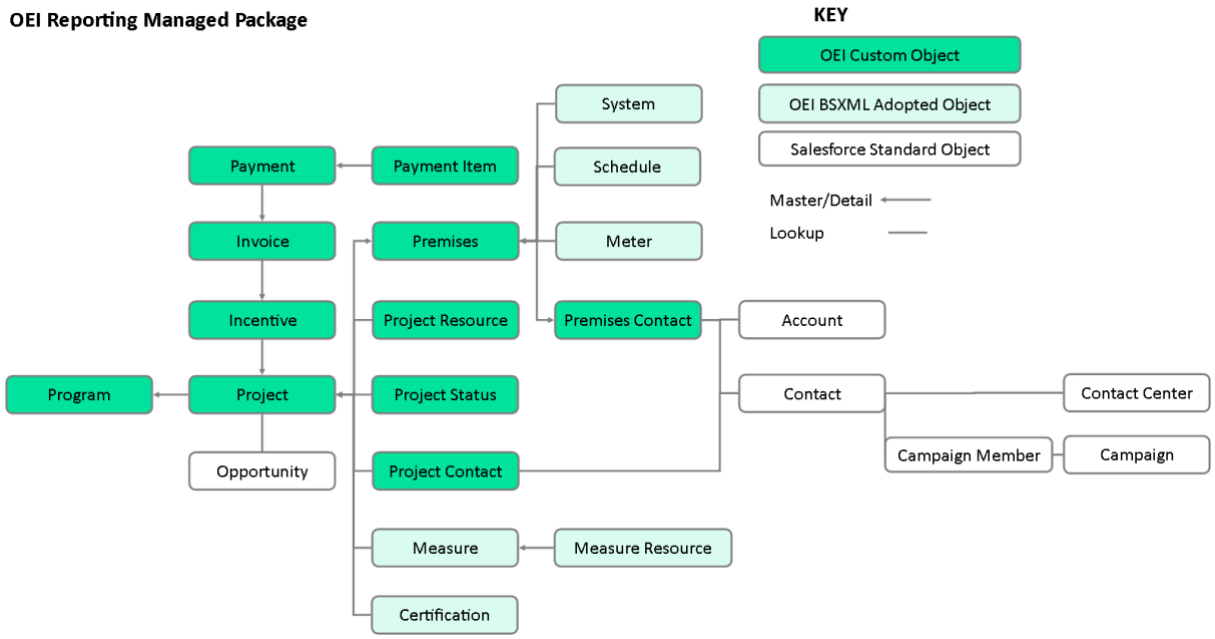

Figure 3: OEI Reporting Managed Package diagram using on the OEI Reporting Data Model

4: Pilots

Pilots were conducted to develop and inform components of the OEI Platform through the perspective of real-world use cases and adoption challenges. The pilots supported three primary use cases: 1) streamlining building modeling, 2) data integration, and 3) program reporting and targeting. These use case are inter-related components that support the systems perspective introduced in Figure 1.

4.1: Streamlining Building Modeling

Building Energy Modeling (BEM) tools have barriers related to availability and accuracy

of inputs, time consuming data entry, and ability to support emerging technologies (Barbour, 2016). To address these challenges OpenStudio prototype models and a calculator tool were developed.

Using the OpenStudio based DoE prototype energy models as a foundation, short programming scripts, or OpenStudio "measures", were developed to transform the prototype energy models into close approximations of actual buildings. Additional OpenStudio measures were used to automate the application of the proposed energy efficiency improvements to the energy model.

The service provider enters data into the calculator GUI, which is a PSD hosted web application. The demo calculator GUI can be seen in Figure 4a. The data entry fields are a limited subset of inputs available in PAT, customizable to the use case. The calculator website communicates via html to the PAT command language interpreter (CLI) which runs PAT / OpenStudio simulations. It provides a visualization of data using the D3 platform.

The standardized calculations have leveraged OpenStudio measures that were designed to create XML data descriptions of the energy savings. This use of a standardized output means that the results of the calculations can be fed directly into a portal designed to support OpenStudio energy models for whole building programs, such as EDAPT and Compass as diagramed in Figure 4b.

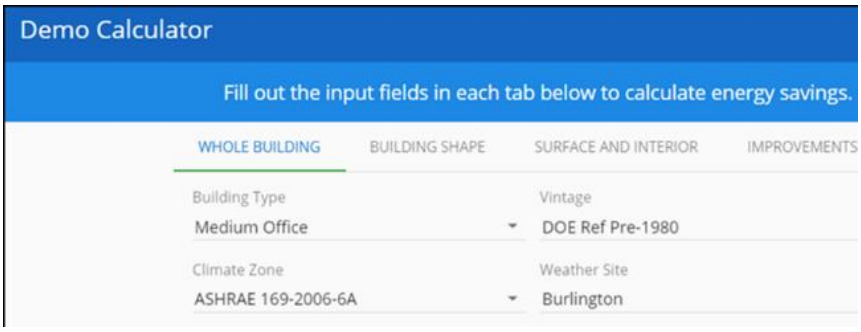

Figure 4a: Calculator Demo GUI. Figure 4b: OpenStudio® Calculator diagram with EDAPT.

The resulting system of calculation is similar to a deemed savings calculation that might be described in a state or utility Technical Resource Manual (TRM), where savings are calculated in advance using: prototype models and simplified assumptions for average conditions. The benefits are that the selected conditions can be varied to match the actual conditions of the building, improving the accuracy of the calculations and expanding the range of technologies for which savings can be successfully calculated. This calculation process reduces calculation time and risk of user error. The calculations are transparent and reproducible using the OpenStudio user interface.

VEIC Pilot. The calculations in the pilot were developed to support the Vermont Energy Investment Corporation. They were applied to buildings in Vermont considering the adoption of VRF and DOAS technology. The median time building modelers expect modeling to take for

energy efficiency program application submissions is 14 hours (Barbour, 2016). The calculator takes less than 15 minutes to perform all required data entry and to run the simulations. The calculations are under consideration for adoptions in a State TRM. The technology has been demonstrated to state regulators, utilities, and others who are attempting to introduce these technologies into incentive programs.

4.2: Data Integration

Data integration is both a challenge to programs and an opportunity. Without automated integration, use of multiple tools is time consuming and cumbersome. Through effective data integration, typically siloed data sources can be combined to generate value added information and processes can be streamlined. Data can be integrated and managed in program management portals, such as EDAPT and Compass or they can be stored and matched in SEED. A TEC / SoCalREN pilot was developed to explore the integration of various Federal tools and reference standards.

TEC / SoCalREN Pilot. The Energy Coalition (TEC), in its work supporting the Southern California Regional Energy Network (SoCalREN), has focused on reducing the cost of energy usage benchmarking for municipal agencies. The goal has been to integrate and manage data related to building performance.

The TEC Pilot system integration is diagramed in Figure 5. The pilot is creating an automated data flow from ESPM, Green Button, and spreadsheets into the program management software Compass. Compass manages the building and meter records.

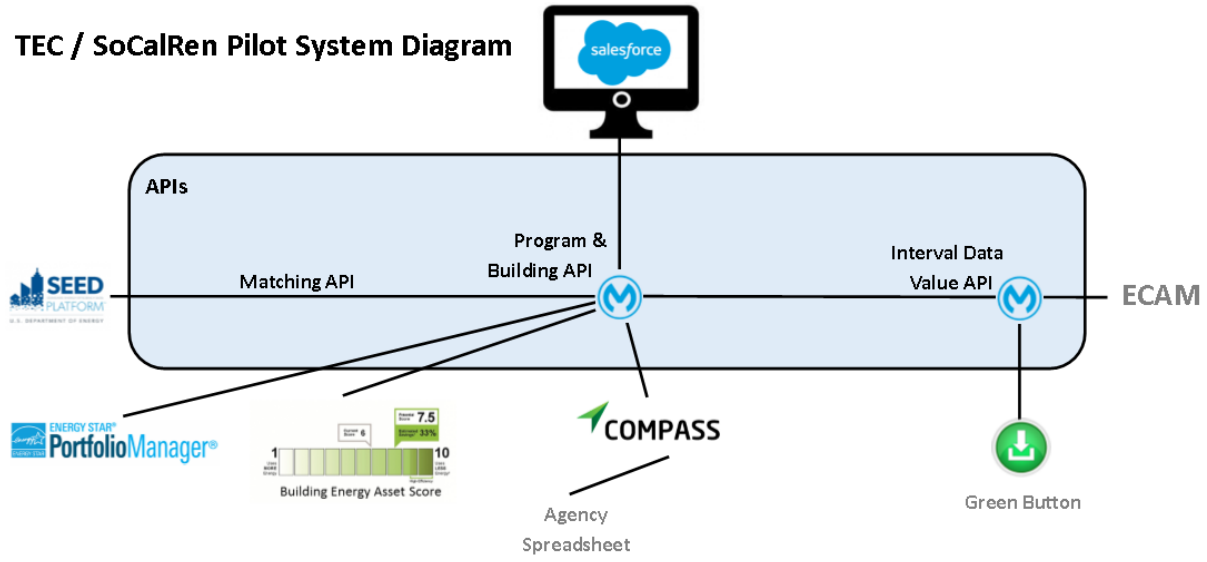

Figure 5: TEC / SoCalREN Data System Diagram

ESPM shares building record data and monthly meter data entered by the building's owner/agency and shared with TEC. Green Button shares meter data from the utility, Southern California Edison (SCE), for accounts that the agency shares with TEC, which are then shared with a Green Button database. The spreadsheet has building records and their respective meter

records. The spreadsheet data is collected by agencies, provided to TEC, and uploaded into Compass by TEC.

MuleSoft Anypoint Community Edition is the API development and management platform used to support data flow between ESPM and Compass. Compass exports reports for portfolio energy consumption for agencies. These reports provide .docx or .pdf performance metrics and evaluation information. The spreadsheet uploads and exported documents are semi-automated, requiring a user in the loop to click a button to trigger document generation, and have no manual data entry requirements.

Integration of ESPM, spreadsheets, Compass, and MuleSoft, have been piloted and adopted into operations. Portfolio performance reporting with Compass has also been piloted and adopted into operations. For each report run, multiple days of staff time doing data entry is saved. Integration with Green Button is in process. ECAM will provide interval meter data analysis and visualization in M.S. Excel. A SEED use case has been defined for matching value-added building records with ESPM records. More use cases leveraging the data are emerging.

4.3: Program Reporting and Targeting

The EDAPT and Compass systems act as portals for the collection of information from program service providers and supports the transformation of that information into standardized data. This data can be passed to the reporting system, for many program implementers the reporting and CRM system is Salesforce. The use of a CRM for the reporting systems has the additional advantage of linking to customer information systems and potentially supporting program marketing. These external hubs reduce the cost of program operations and reduce the cost of program reporting and tracking. There are two pilots for this use case, one in collaboration with The Energy Coalition (TEC), and one in collaboration with Xcel Energy.

TEC Pilot. TEC has piloted two aspects that leverage integration to support program reporting and targeting: the combination of ESPM Score and Asset Score to target buildings and the automation of program data from Compass to Salesforce.

An ESPM Score and an Asset Score were created for 6 buildings with the goal to test using benchmarking metrics to target buildings for energy efficiency program participation. As seen in Figure 6, depending on where the building falls with respect to its score can be used to drive what type of program participation and communications will be most effective. For instance, a building with a low Asset Score and high ESPM Score should have capital improvements recommended.

3 of the buildings tested had both high Asset Scores and high ESPM scores. 2 buildings had a moderate Asset Score and high ESPM Score. 1 building had a moderate Asset Score and moderate ESPM Score. This alerted program staff that they were not selecting low efficiency buildings for interactions. Without this information programs could spend time and resources targeting the wrong group of buildings and not reach buildings that can achieve more savings. Currently, with siloed systems, an energy efficiency program does not have access to benchmark results and could not as easily make this determination.

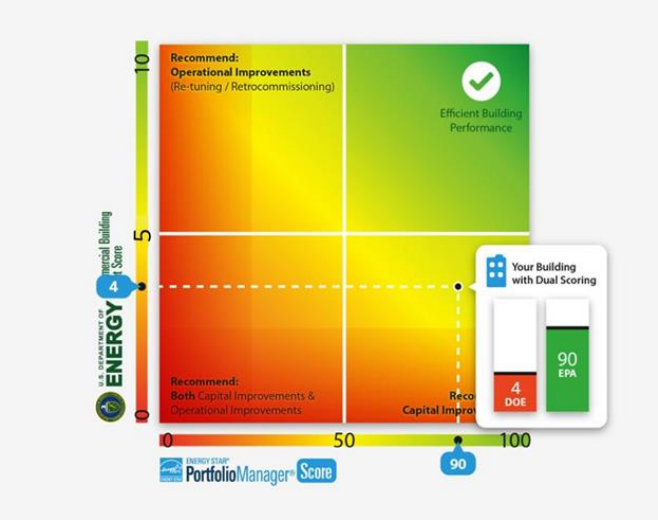

Figure 6: Building targeting concept via the combination of ESPM Score and Asset Score

Compass and Salesforce were integrated with MuleSoft APIs so that when buildings are created or updated in Compass, their record is created or updated in Salesforce. This effort leveraged an existing Salesforce managed package and an existing MuleSoft API. Including project management, planning, and testing, this integration was executed within a month and took less than a day of software developer person-hours. It has reduced TEC program management labor hours by eliminating the task of data entry of building data into Salesforce. It has also eliminated data quality issues with records updated in one system, not being updated in the other system. The automated updates occur within seconds. This is particularly important time saver because TEC's use case involves hundreds to thousands of buildings per agency upload.

Xcel Pilot. Xcel Energy currently uses EDAPT for whole building commercial program management. They are integrating EDAPT with Salesforce to enhance program reporting and management support. They are adopting a managed package that is based on the OEI Program Reporting Managed Package and uses BEDES taxonomy with the same terms as the OEI Reporting Data Model. The tailored beta version has limited objects and fields, selected because they can be populated with data available via the EDAPT API (Figure 7). In addition to the objects and their fields, the managed package includes a permission set, an app, and custom report types.

Xcel is not using MuleSoft API so their IT group is responsible for the API development for achieving communication between EDAPT and Salesforce. That integration has been on-going for months. The time and effort to connect EDAPT to Salesforce via API has been on the order of 10x more than the level of effort that it took to connect Compass to Salesforce via MuleSoft API. This highlights the challenges that Utilities face integrating tools and the advantage of adopting existing API connections. Because they are adopting a one to one connection between Salesforce and EDAPT, similar levels of effort will be required if they integrate with other tools. Additional effort is needed to convince utilities to adopt a new platform and it is hoped this pilot will serve as a useful example.

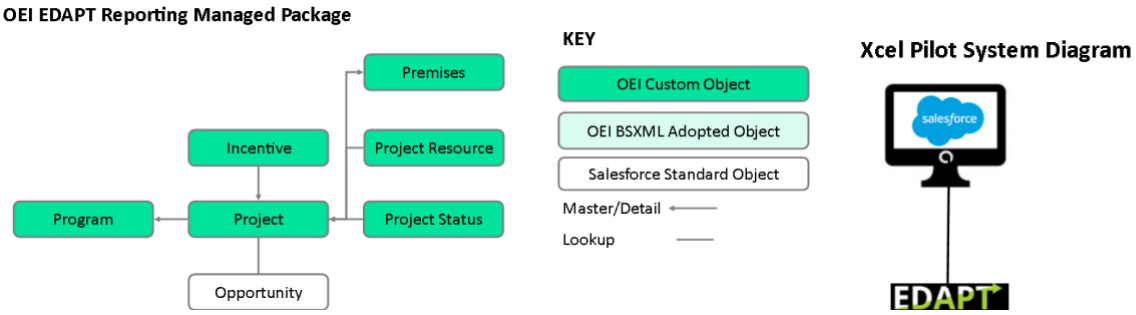

Figure 7a: (Left) EDAPT Program Reporting Data Model diagram. Figure 8b: (Right) Xcel pilot system diagram.

5: Future Work

Future work will involve developing additional API connections, assessing the impact of OEI on program design, and building collaborations and partnerships for adoption. The OEI Platform is currently under development. Existing MuleSoft connections will be generalized using the OEI Platform integration design and the OEI Program Reporting Data Model. Additionally, API connections must be made to Asset Score, BSXML, and SEED. There is particular interest to develop the MuleSoft API connection between SEED and Salesforce.The evaluation of each pilot will continue to reveal program design best practices and adoption barriers. A quantitative and qualitative evaluation can assess how the OEI Platform addresses common commercial whole-building energy efficiency program barriers. The success of any effort towards standardization requires collaboration among a wide range of stakeholder groups. An open source repository of resources for adoption will be published online. OEI Reporting Data Model fields and structure that is program specific will be advocated for inclusion in BSXML so that the OEI Reporting Data Model can be adopted through BSXML. OEI will continue to maintain and grow existing collaborations while reaching out to additional stakeholders to grow momentum.

6: Conclusions

The quantity and complexity of existing Federal tools and industry standards can be overwhelming and one-off integration of these resources can be expensive and time consuming. The calculator leveraging OpenStudio prototypes reduced modeling time by more than a factor of 10 while improving transparency and enabling technologies for program inclusion. The TEC pilot provided spreadsheet upload and ESPM connectivity for agency portfolio reporting, taking a reoccuring process that would take days to complete and transforming it to a task completed in minutes. The OEI Platform API connections and the OEI Reporting Managed Package using the OEI Reporting Data Model can be used to connect program management software to Salesforce, saving months of integration time.

OEI has explored tool utility through pilots with real-world use cases in parallel to the development of the OEI Platform. The OEI approach pulls from these experiences to deliver a robust solution that can make whole building modeling, data integration, and project reporting and targeting easier and less risky.

7: Acknowledgement

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