California Solar Initiative

RD&D:

Research, Development, Demonstration and Deployment Program

GO **solar** CALIFORNIA

Final Project Report:

Results of Integrated Energy Project Model Development

Grantee:

kW Engineering

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Additional information and links to project related documents can be found at
http://www.calsolarresearch.ca.gov/Funded-Projects/

Preface

The goal of the California Solar Initiative (CSI) Research, Development, Demonstration, and Deployment (RD&D) Program is to foster a sustainable and self-supporting customer-sited solar market. To achieve this, the California Legislature authorized the California Public Utilities Commission (CPUC) to allocate **$50 million** of the CSI budget to an RD&D program. Strategically, the RD&D program seeks to leverage cost-sharing funds from other state, federal and private research entities, and targets activities across these four stages:

- Grid integration, storage, and metering: 50-65%
- Production technologies: 10-25%
- Business development and deployment: 10-20%
- Integration of energy efficiency, demand response, and storage with photovoltaics (PV)

There are seven key principles that guide the CSI RD&D Program:

1. **Improve the economics of solar technologies** by reducing technology costs and increasing system performance;

2. **Focus on issues that directly benefit California**, and that may not be funded by others;

3. **Fill knowledge gaps** to enable successful, wide-scale deployment of solar distributed generation technologies;

4. **Overcome significant barriers** to technology adoption;

5. **Take advantage of California's wealth of data** from past, current, and future installations to fulfill the above;

6. **Provide bridge funding** to help promising solar technologies transition from a pre-commercial state to full commercial viability; and

7. **Support efforts to address the integration of distributed solar power into the grid** in order to maximize its value to California ratepayers.

For more information about the CSI RD&D Program, please visit the program web site at www.calsolarresearch.ca.gov.

Acknowledgements

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1   Abstract

As experienced energy professionals understand, energy projects are an increasingly messy business: information of all types and levels of complexity must be gathered and processed from multiple sources, then seamlessly passed among various stakeholders. The current process of finding, documenting and communicating energy project information between multiple stakeholders delays project completion and may inhibit the full implementation of energy efficiency measures. The Integrated Energy Project (IEP) model is an effort to develop a new open-source XML format for information exchange that will improve the speed and reliability of communications among stakeholders of integrated energy projects and enhance the effectiveness of those projects.

The model focuses on the common data shared among stakeholders during the lifetime of a project including historical energy use, affected building and energy systems, customer data, proposed upgrades, energy costs and related products. The IEP XML schema documentation is publicly available for energy software developers to implement interoperability with other tools. The intended users of tools implementing IEP are utility programs, rating programs, energy service companies, contractors, customers, and financing entities. Each of these stakeholders can use the model as a means for faster and more effective sharing and storing of relevant IEP data.

The IEP Model development team demonstrated the potential for software integration of the IEP XML schemas though the initial implementation of two existing software tools. Software developers are encouraged to utilize the public data model to develop application programming interfaces, integrate additional software, and contribute to the evolution of the model itself. Through the broader adoption of a common data model by energy software developers the integration of energy software will become much more prevalent and the use of the software much more efficient.

2   Executive Summary

2.1   Purpose

The Internet contains copious amounts of information about how to save energy by implementing individual energy efficiency measures (EEMs) in residential, commercial, industrial and institutional facilities. However, for stakeholders working together to deliver comprehensive solutions as part of an integrated energy project (IEP), there is a glaring need for tools to better facilitate effective communication and collaboration. This creates a significant market barrier to the identification and adoption of integrated retrofit and renewable energy projects.

For example, a consumer can easily find information about sizing and installing solar power systems to generate renewable energy. However, a consumer has few available resources to assist in identifying and coordinating complementary energy efficiency measures (EEMs) that reduce energy consumption. Necessary resources include recommendations of potential measures, identification of qualified contractors, availability of financial incentives, coordination of contracting and purchasing, implementation management, and post-project evaluation. The increased difficulty in finding reliable information for IEP discourages otherwise interested consumers from pursuing these comprehensive projects.

Energy service providers are currently adopting tools to automate their business processes to market, bid, contract, and manage projects in order to increase efficiency, reduce operational costs and increase sales. Unfortunately, these tools and websites (for both consumers and energy service providers) are not integrated with one another and lack a shared standard to easily share mutually-beneficial information about customers, buildings, energy use, projects, products and services.

The lack of a common data format for integrated energy project information prevents easy data transfer between software tools. In many cases the project data cannot be transferred at all. The inability to transmit data between tools results in expensive redundancy of efforts and errors in data entry, analysis and evaluation within entities and across multiple stakeholders who are collaborating on a single project or customer. As a result, customers must bear the burden of iterating through multiple individual energy projects as opposed to implementing a comprehensive strategy that integrates related energy projects into a single, cost-effective program.

To fulfill this need of standardizing IEP data manipulation, the authors created IEP XML: a common data format that integrates the building energy assessment and analysis process with the assessment, quoting and implementation of energy efficiency (EE) and renewable energy (RE) projects. The goal of the initiative was to create an open format that enables all IEP stakeholders to easily collect, transmit and store information about integrated energy projects through various software tools used within the energy ecosystem.

2.2   Scope & Goals

The initial development of the IEP Model targeted lowering barriers to the near-term integration of EE and RE in the residential and small commercial retrofit market. The IEP Model research and development project consisted of three phases: initial research, development of the data model, and a demonstration deployment of IEP XML (extensible markup language) in two existing web applications of our other team members.

The team conducted initial research to identify the business process and software needs of solar installers and energy service providers. The team surveyed existing solar installers and energy service providers to determine any existing pain points in their business processes and what software they used, if any. Additional research investigated existing data models in the energy software space to avoid duplication of effort and support interoperability where sensible. Based on this research, the team identified a range of scenarios in which software might interoperate and created an inventory of the required parameters. The team used this comprehensive inventory of parameters to organize and develop the IEP Model.

Upon completion of the first public draft of the IEP Model in February 2011, the team proceeded to implement the first software integration using the IEP Model. The initial integration took place in an online project management tool for solar contractors. An energy efficiency audit that provides EEMs to customers purchasing photovoltaic solar (PV) systems is a program requirement for participation in the California Solar Initiative Program. Thus, facilitating the delivery of EEM recommendations to consumers was an excellent opportunity to demonstrate IEP Model deployment.

The goal of this initial deployment was to make the process of recommending energy efficiency retrofits as easy as possible for potential PV system consumers. The purpose of the IEP XML

integration with the project management tool was to add value and enhance functionality by providing an energy efficiency audit feature within the tool. In doing so, the desired end result was to encourage increased integration of EE with RE projects.

2.3   Results

Early in the research phase of this project we identified significant opportunities beyond the initial project objective of facilitating more integrated energy projects. It was clear a standard comprehensive data model would create process efficiencies enabled by software interoperability. With this understanding, the team set out to develop a comprehensive data model with value far beyond the scope of this project. As a result of this development, the project team received extremely positive feedback on the model from industry stakeholders and participated in numerous discussions with software developers about potential implementations of interoperability based on IEP XML. Based on this feedback and potential for future adoption, the development of the IEP Model and public release of the IEP XML specification is a success.

Potential Uses of IEP XML

One of the advantages the IEP XML specification is it offers an open, flexible data communication standard. Once implemented this standard facilitates the transmission, analysis and storage of integrated energy project information with the internal and external tools of any user group.

Application Integration

The IEP Model allows service providers to extend their data analysis capabilities by capturing project data in IEP XML and transmitting it to the appropriate analysis tool specific to that project. This benefits service providers by avoiding the redundancy of developing their own version of an existing tool. In addition, the ability to easily transmit project information allows service providers more choices in vendors. Since the project data may be easily transferred, they may choose products from multiple vendors to integrate with their implementation of the IEP Model. An example of this capability is integrated energy project data transferred from a tool such as CAIET (California Integrated Audit Tool) to another analysis tool provided by a third party vendor. Firms may also use IEP XML internally to facilitate the transfer of project data between project analysis and storage tools such as the firm's project tracking databases and energy calculation spreadsheets.

Data Aggregation

In addition, IEP XML provides organizations the ability to maintain a project history for a facility or even multiple utility programs. Since a facility may participate in many different energy related projects concurrently or during its lifetime, it is advantageous to use IEP XML to aggregate project history. This allows building managers to quickly relay the currently installed equipment and appliance list to necessary parties. Also, maintaining a list of multiple facilities and their projects is advantageous to firms dealing with property management where a portfolio may be spread across multiple regions. Utilities can also use IEP XML to aggregate project tracking of multiple energy programs.

<u>Data Portability</u>

IEP XML also allows vendors to develop portable, audit, data collection tools that may be implemented on devices such as tablets and smart phones. A team of auditors may visit a facility simultaneously and collect relevant building data. The data may be aggregated by a service provider and shared with involved parties. Firms may also continue to process their discrete, building information related to their project. At any given time, new data may be collected and shared.

3   Research and Development of the IEP Model

The IEP Model team conducted research to guide the development of the IEP Model. The goal of this research was to identify stakeholders' needs, opinions and opportunities for improvement of the current integrated energy project process. By addressing the current market needs and opportunities, the intended end result of the IEP Model development was to remove barriers currently inhibiting the integration of energy efficiency with solar power system installations, therefore increasing the adoption of energy efficiency measures with solar installations. The team intended to improve the efficiency of the integrated energy project process with the model by reducing redundant data entry and duplicate project efforts by facilitating the exchange of IEP information between stakeholders by creating a common data exchange and storage format in XML (extensible markup language).

The team completed the following research activities to assist the IEP development process:

- Performed surveys of existing solar and energy solutions contractors
- Interviewed a subset of survey respondents to gather additional information
- Identified stakeholders in the IEP
- Identified activities between stakeholders during the IEP
- Assessed existing software applications and tools used for various activities in the IEP project lifecycle
- Defined the common project data exchanged between stakeholders during an IEP
- Created parameter inventories for the IEP Model from the defined common IEP data

3.1   Initial Surveys

Project Task 1.1

Solar Contractor, Energy Auditors and Building System Professional Surveys

The project team conducted an online survey in June and July 2010 of contractors in the solar, energy auditing and building systems professions. The primary goals of the survey were:

- Understand the size and scope of the participants' businesses
- Survey attitudes towards partnering on combined solar and energy efficiency projects
- Identify pain points in business processes
- Survey use of computer software in conducting their businesses
- Discover what domain specific applications they use in their businesses

The project team sent surveys to 1485 recipients via email, gathered from lists provided by the California Energy Commission, Go Solar program and SolarNexus [SN]. Approximately 50 people responded to the first email survey invitation. The team sent a follow-up email two weeks later which added 24 responses. The survey had an overall response rate of 5%. The survey asked all respondents to self-identify their professions. Responses from energy auditors and building system contractors were too few (four and three respectively) to draw any significant conclusions. Solar contractors and Solar + Energy Efficiency contractors had a combined 51 responses. These are the responses reported in this paper.

While 51 contractors took the survey, the actual number responding to individual questions varied, with most questions answered by 30 to 40 people.

The team conducted follow-up phone interviews during August with as many respondents as possible. Ten agreed to be interviewed. In general, their responses confirmed the survey results. The responses to the interviews are included in the narratives below.

Survey Results

Business Descriptions

Owners and managers (82%) primarily responded. 78% of the businesses were sole proprietors or had fewer than five employees. Only three responses came from companies with over fifty employees.

The majority of companies leaned heavily towards residential work; one respondent thought the residential sector was saturated with contractors. Only 15% said commercial work comprised more than 70% of their installations. Another pointed out 50% of his bids were commercial, but 95% of his work was residential. Almost three-fourths of the companies installed fewer than 20 systems in the past twelve months, although 40% expect that number to grow in the coming twelve months:

Approximately how many solar systems did you install in the past 12 months?			How many do you expect to install in the next 12 months?	
Answer Options	Response Percent	Response Count	Response Percent	Response Count
Less than 20	70.0%	28	43.6%	17
20 to 50	15.0%	6	28.2%	11

Three of the interviewees were new to solar, each having done only a few installations. The remainder had more experience doing twenty to thirty installs a year. We spoke with one former contractor whose business did over 500 installs a year (his business is now solar engineering).

We wanted to discover which business processes were problematic for contractors. Marketing, leads, permits, regulations, and incentive/rebate processing were seen as problems or major pain points. Most did not see problems designing and delivering their products or managing their businesses. We probed lead generation and rebate processing in the interviews. No one had positive assessments of lead generation websites. They found the leads were not qualified (4 in 100 panned out), the prices were too high and the lead providers were not responsive. Likewise,

across the interview group, the state and utility rebate processing systems were tolerated at best. Out-of-date, a headache, not efficient, slow, and too many providers characterized the comments.

Partnering with Other Contractors

One of the attractions of the IEP Model is the ability to streamline partnership interactions. We asked contractors with whom they partnered. Being solar contractors it was no surprise 85% partnered with roofing contractors. Between 60% and 70% partnered with architects, general contractors, electrical contractors and engineering firms. 44% partnered with energy auditors, but fewer did with HVAC (27%), Insulation (25%) or door and window (12%) contractors.

To discover how companies used subcontractors we asked which partners they used on every or almost every job. Only 23 participants responded to the question: 61% used electrical contractors, 44% engineering firms, 26% roofing contractors and 22% general contractors. More significant for combining energy efficiency with solar were the partners they didn't work with: 44% said they partnered with energy auditors, but no one said they used auditors on every job. Likewise, insulation and door/window contractors were never used on every job.

The interviews reflected this finding. Partners were not central to their business, but when they did partner it was with a roofer or general contractor (if the job was a remodel). Many were electrical contractors who also did solar, so they had the expertise in house. One larger firm actively worked with an energy consulting firm, subcontracting as the solar component of commercial energy efficiency projects. Another was negotiating to sub-contract for a major solar and roofing company to do both solar and lighting upgrades.

Combining Energy Efficiency and Solar

Respondents were very positive to the notion of offering energy efficiency along with solar to their customers. 51% offer the service today and another 25% expect to offer both services within the next two years. Less than 10% said they would never offer both services.

We looked at perceived barriers to offering EE along with solar. The primary concerns were low consumer incentives (64%), lack of customer interest (60%) and low margins (56%). 79% did not think EE measures would reduce the size of the solar systems they could sell. None of the possible issues concerning partnering with other contractors to provide EE with solar elicited a strong negative response. Sales and proposal development were seen as potential problem areas in the relationship, but the strongest anticipated issue was quality control (23% a major issue, 50% somewhat of an issue).

Everyone we spoke with thought selling efficiency along with solar was "a good idea", although only two actively worked with both. One, a general contractor in Sonoma, is a certified auditor. He finds solar is really what clients want and explaining energy efficiency as a first step only changes the client's mind towards energy efficiency a little. He hopes to reduce the size of systems with energy efficiency, but for now it remains "fill up the roof if you can". He sees a sweet spot that's cost effective for PV systems that efficiency first can help fill, although in his opinion, the addition of electric cars will change all that.

Software

The respondents actively use software to run their businesses. The majority used these types of applications "always" or "often":

Proposal Energy Analysis	81%

Proposal Financial Analysis	81%
Incentive/Rebate Processing	81%
Proposal Generation	72%
Job Estimating	72%
Accounting	72%
Billing	72%
Design & Engineering	69%
Product Information	68%
Site Audits	66%
Material Purchasing	59%
Customer Management	56%

Conversely, applications which over one-third chose as "Not Used" were:

Mapping (GIS)	29%
Marketing	31%
Customer Management	34%
Project Management	38%
Timekeeping	41%
In-House/Proprietary Applications	41%
Employee Training	45%
Permits & Inspections	55%

59% said they used proprietary or in-house applications. In our interviews we found the smallest and newest contractors relied on packaged services provided by their equipment distributors. For a flat fee (about $350) the distributor provided all the analysis, design, proposal and rebate paperwork and processing. Those who used these services saw them as good value, costing about 1% of the total installation. Contractors with larger businesses mostly had home-built management, analysis and estimating systems using spreadsheets or spreadsheets combined with off the shelf CRM products such as ACT! or Salesforce. These custom tools satisfied their specific business needs, were easy to build and—to them—functioned better than commercially available tools. The ease with which they created their own tools was also noteworthy.

When asked about the issues they had using software in their business, although thirty people responded, only a few topics stood out. Here the respondents also confirmed their propensity to build in-house applications. The major issues were:

The information we need is in too many places.	56.7%
We have to re-enter data into different applications.	53.3%
We build spreadsheets for most of what we	53.3%

do.

Our processes should be more automated.	43.3%
It's hard to share information.	26.7%
We use a fraction of the software's capabilities.	26.7%
The benefits I get from most software applications aren't worth the cost.	26.7%

Our interviews didn't find significant variance. Most had to manually re-enter data when they switched applications (data connection to spreadsheet, spreadsheet to accounting). They realized this wasn't efficient, but with the low volumes of data, they felt that the inefficiencies weren't too excessive. As his business grows, one contractor fully expected to hire a full-time employee just to handle paperwork; in particular the new utility energy efficiency rebate requirements.

Applications

Compared with the types of applications used in their businesses, the number of domain specific applications they used was surprisingly low. PowerClerk, PVWatts and Clean Power Finance were the only ones used by a significant number. No one said they used eighteen of the forty applications listed. Other than free web tools (Google Earth, Zillow) the remainder had only 1 to 3 responses.

Participants responding used the applications as listed:

Lead Generation		Incentive Processing	
Clean Power Finance	35%	PowerClerk	76%
Cooler Planet	16%	DSIRE	54%
Find Solar	12%	**Estimating and Proposal**	
Get Solar	12%	Clean Power Finance Tools	43%
Iquote	0%	OnGrid	12%
Save Energy 1-2-3	0%	National Estimator	4%
Benchmarking Energy Use		UDA Construction Suite	4%
Portfolio Manager	4%	Corecon Estimating	0%
Building Performance Compass	0%	ProEst Estimating	0%
Cal Energy Performance Benchmark	0%	**Photovoltaic Modeling**	
EnergyIQ (LBL)	0%	PVWatts	54%
Energy Audit & Consumption Analysis		PV Analyzer	8%
Energy Pro	17%	Solar Design Tool	4%
EnergyGauge	4%	PV Designer	4%
Home Energy Saver (LBL)	4%	PV-Sol	0%
BEOpt	0%	**Other Tools**	
EnergyARM	0%	Google Earth	97%

EnergyOrbit	0%	Bing Maps	41%
EnergyPlus	0%	Zillow	38%
eQuest	0%	Google SketchUp	38%
Green Energy Compass	0%	kwHours	0%
Microsoft HOHM	0%		
TREAT	0%		
WattzOn	0%		

In our interviews, Clean Power Finance [CPF] was the most frequently mentioned commercial application. However, many comments we heard were not positive. Some found CPF hard to update or limited in functionality (e.g. Customer Relationship Management). Others thought it costly ($80 to process rebates), finding a do-it-yourself approach equally effective. The solar contactors use Solmetric's SunEye and similar tools for on-site measurements, either modeling the system design in "assistant" packages, manually entering the data into spreadsheets and standalone design tools such as PVWatts, or emailing the data to their distributor for design and analysis. The solar engineering company noted no one design application worked for every instance, particularly when designing utility scale projects. The interviewees also used common Internet mapping tools, but not as significant elements of their design or evaluation processes.

Finally, when we explained the IEP Model to interviewees, the concept was met with near universal acclaim. Everyone quickly grasped the value of standardized data exchange between diverse applications and web interfaces. Anything that made their processes more efficient was seen as positive.

Survey Conclusions

Like any other contracting business, the solar industry is made up of small, medium and large players. Our survey answers came from the owners and operators of small and medium sized companies and should be considered valid for that segment. These companies will be a major market for applications using the IEP Model and designing to their needs should be part of any development program.

The solar contractors were comfortable with partnering with other trades and saw the value of combining energy efficiency and solar as part of a comprehensive energy retrofit project. Working primarily on residences, these contractors are well position to expand their businesses though home retrofits.

The contractors use software in every aspect of their businesses. Their dominant use of home-built application points to a software market still in an early growth stage where the available commercial applications are not yet proving value to the contractors' operations.

As contractors grow their businesses, their data volumes will expand. Repetition and re-entry across the collection of applications they use will decrease efficiency and increase overhead. The contractors clearly see the value of data standards for their industry.

Part of the value that the contractors offer to customers is tied to government and utility rebate reporting and processing systems. Open standards for communicating with these systems will be important as data volume and reporting requirements expand.

3.2   Defining the Integrated Energy Project Process
Project Task 1.2

Evaluation of Existing Software Tools and Resources

The initial surveys and interviews revealed a plethora of software tools used during the integrated energy project lifecycle. The IEP Model team investigated and documented the key aspects of these tools. From the evaluation of the tools the team identified stakeholders in the IEP process as well as the various activities involved in the IEP lifecycle. The team then documented what tools each stakeholder could use and which activities of the IEP process the tool facilitated. The matrix below contains the results of the software tools and resources evaluation outlining the stakeholders and participation in various IEP activities.

IEP Existing Software Evaluation

Product Name	Description	Transfer Project	Interconnect Request	Apply For Incentives	Request/Get Proposal	Design Measures	Analyze Energy & Financial Benefits	Acquire Consumption Data	Request/Get Inspection Results	Request/Get Site Audit	Acquire Financing	Marketer	Contractor	Incentive Program Admin.	Engineer	Utility	QC Inspector	Salesperson	Site Auditor	Consumer	Finance Provider
		IEP Activities										**IEP Stakeholders**									
Cal Energy Performance Benchmarking	Benchmarking - Energy Use	X				X	X					X	X		X	X		X		X	
CPF Tools	Sales Proposal Generation	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Power Clerk	Incentive Program Administration			X										X	X						
CoolerPlanet.com	Lead Generation	X				X						X	X		X						
EnergyOrbit	Energy Consumption Analysis					X	X			X			X		X			X	X	X	
BEOpt (CA) Existing	Energy Consumption Analysis					X	X			X			X		X			X	X	X	
EnergyPlus	Energy Consumption Analysis					X	X			X			X		X			X	X	X	
eQuest	Energy Consumption Analysis					X	X			X			X		X			X	X	X	
In My Backyard	Renewable Energy Estimator						X						X		X						
DSIRE	Database - Reference Info																				
Tariff Analysis Project	Database - Reference Info																				
The Home Energy Saver Pro	Energy Consumption Analysis					X	X	X				X	X		X	X		X		X	
EnergyGauge	Energy Consumption Analysis					X	X			X			X		X			X	X	X	
Energy Pro	Energy Consumption Analysis					X	X			X			X		X			X	X	X	
ENERGYSTAR Portfolio Manager	Benchmarking - Energy Use					X	X			X			X		X			X	X	X	
GetSolar.com	Lead Generation	X				X						X	X		X						
Heat	Site Audit							X											X		
WAP Online	Improvement Program Manager			X		X			X	X			X		X			X	X	X	X
EnergyARM	Improvement Program Manager			X		X					X		X		X			X		X	X
kwHours	Site Audit				X	X			X				X		X			X	X	X	
HOHM	Energy Consumption Analysis					X	X						X		X	X		X		X	
Target Retrofit Energy Analysis Tool	Energy Consumption Analysis				X	X			X				X		X			X	X	X	
Building Performance Compass	Benchmarking - Energy Use					X			X				X		X			X	X	X	
Green Energy Compass	Energy Consumption Analysis					X			X				X		X			X	X	X	
Recurve Software	Improvement Program Manager			X	X	X	X	X	X			X	X		X		X	X	X	X	
PACE Programs	Improvement Program Manager	X				X	X				X	X	X		X	X		X		X	X
Save Energy 1-2-3	Lead Generation	X				X						X	X		X						
SolarEstimate.org	Renewable Energy Estimator	X				X						X	X		X						
SolarNexus	Improvement Program Manager	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Iquote	Lead Generation			X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X
National Estimator	Construction Estimating					X			X				X		X						
WattzOn	Energy Consumption Analysis	X				X	X					X	X		X	X		X		X	
Energy Profile Tool	Energy Consumption Analysis					X	X			X			X		X			X	X	X	
ConstructionSuiteGreen	Construction Estimating					X			X				X		X						
Corecon v7	Construction Estimating					X			X				X		X						
ProEst 11	Construction Estimating					X			X				X		X						
PV Analyzer	PV Modeling					X							X		X						
Solar Design Tool	PV Modeling					X							X		X						
PV-Sol	PV Modeling					X							X		X						

IEP Stakeholders

There may be numerous stakeholders involved during the IEP process depending on the type and complexity of a project. Each stakeholder has one or more needs to be fulfilled during the project. A stakeholder may leverage a software tool or resource in order to fulfill the need. Listed below are the possible stakeholders and their needs.

Consumer – A consumer desires to have a solar power system installed on their building. For an IEP project, they implement energy efficiency measures concurrently with the solar power system installation. A consumer may be one of the following roles:

- Home Owner
- Commercial Building Owner

Service Provider – There can be one or more service providers during an integrated energy project. Each service provider can take on one or more roles. Listed below is each of the possible roles of a service provider identified:

- Solar Contractor – A solar contractor is the entity that is responsible for the installation of a solar power system.

- Energy Service Contractor – An energy service contractor is the entity that is responsible for implementation of energy efficiency and demand response measures.

- Salesperson – A salesperson manages the sale of a solar power system to the consumer.

- Engineer – An engineer is responsible for designing and verifying the performance of a solar power system.

- Site Auditor – A site auditor audits a building to determine the options for energy efficiency measures.

- QC Inspector – A QC Inspector verifies the design and performance of a solar power system.

- Finance Provider – A finance provider provides financing to the consumer for a solar power system.

- Marketer – A marketer develops and manages the distribution of knowledge about services provided by the solar contractor.

Incentive Program Administrator – Various energy providers/utilities provide financial incentives for consumers to install solar power systems and certain energy efficiency measures. During the IEP process, an incentive program administrator handles the application processing and distribution of incentives to the applicant.

Energy Utility/Supplier – This is an organization providing the consumer with electricity for their building.

Reference Data Supplier – An entity that provides and maintains technical or project related information to IEPs. For example, the database for energy efficient resources (DEER) maintains a database of energy efficiency measure costs.

Possible Stakeholders in Integrated Energy Project Activities
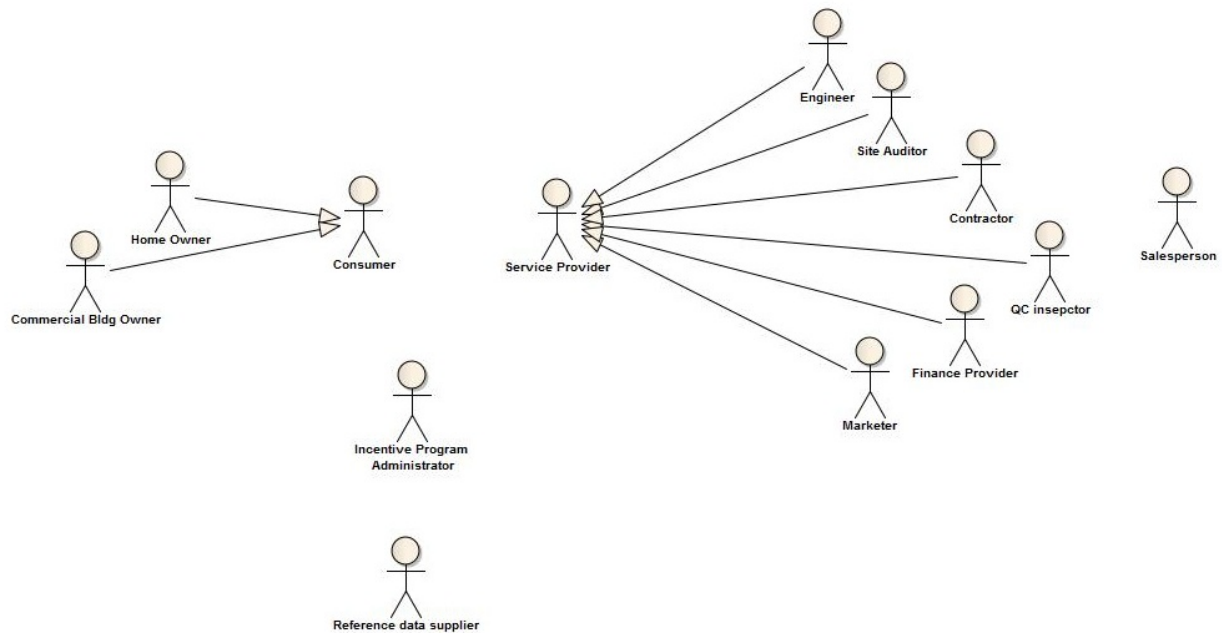
IEP Activities

The team designed the IEP Model to capture the common data to be shared among different stakeholders during the lifecycle of the project. There are many activities that take place during an integrated energy project. The number of activities depends on the scope of the project and the number of involved stakeholders. We identified some of the major activities of an IEP that would benefit from a tool that integrated the IEP XML model. Seen below are descriptions of some of these activities. For the demonstration deployment of the IEP Model, the team utilized their resources and expertise to implement one activity, which was the Contractor Gets Third Party Project Opportunity analysis.

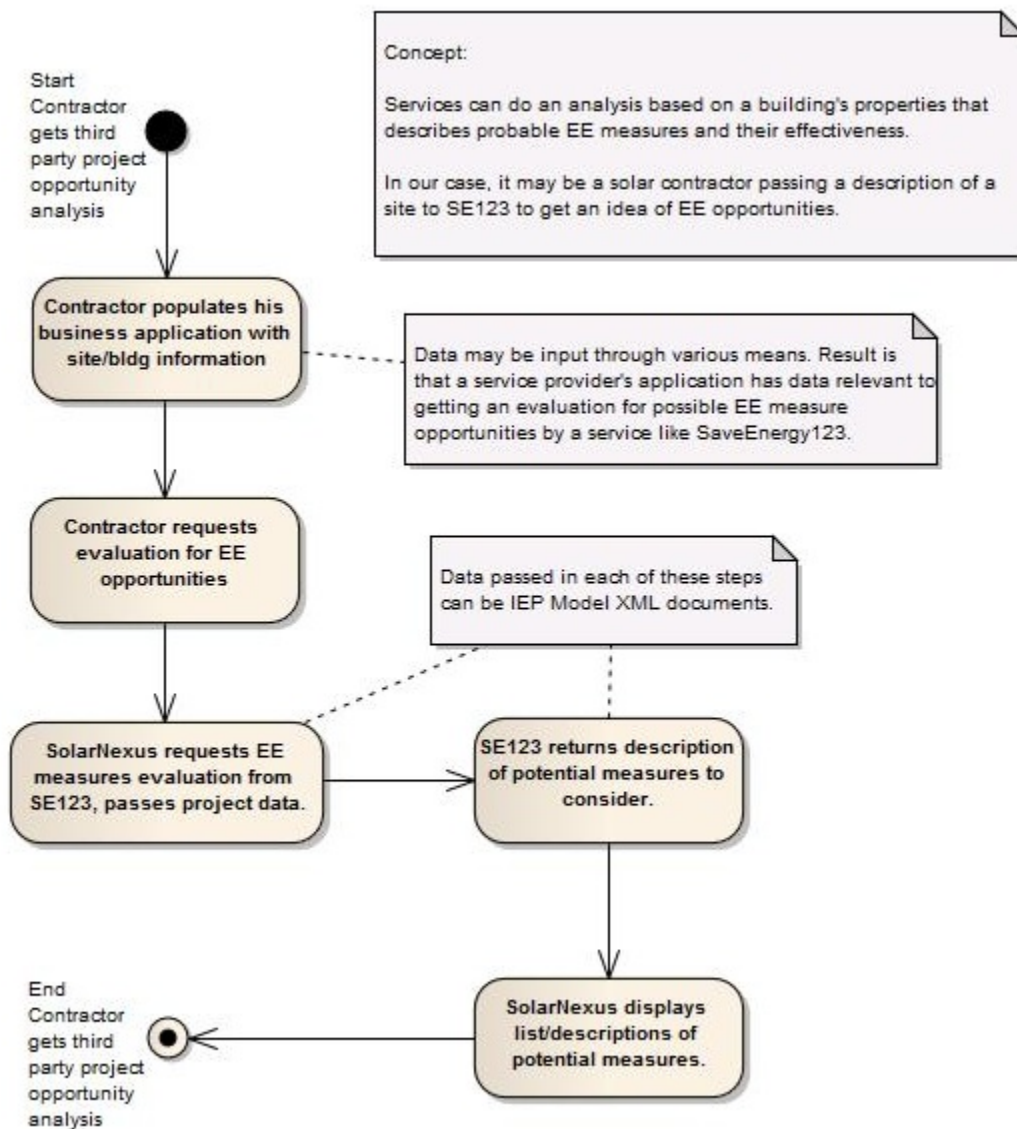**Possible Integrated Energy Project Activities**
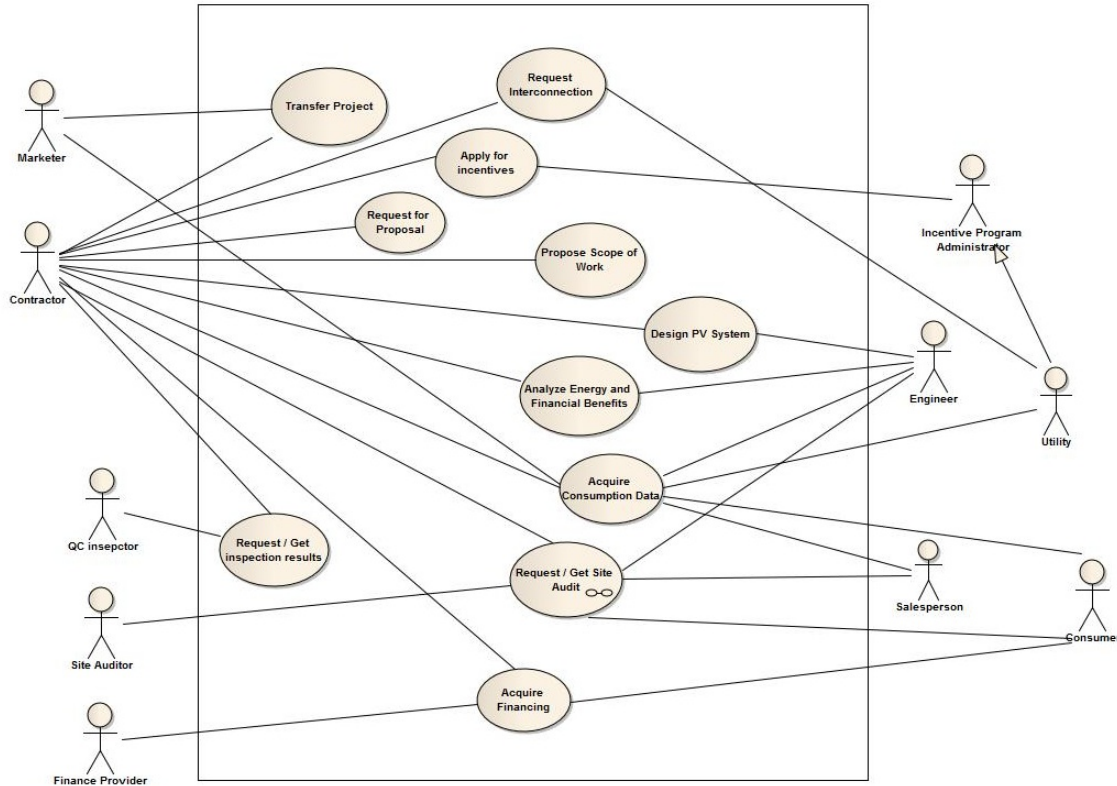
Contractor Gets Third Party Project Opportunity Analysis

Some energy related companies provide online energy auditing tools for consumers and contractors. Consumers can use these tools to compare and contrast different measures to be implemented in their home or building. These same tools can be used by contractors to assess a building's energy usage and provide analysis of desired energy efficiency measures as well as proposing new measure recommendations.

For instance a contractor may be proposing a new solar installation and needs to show the customer alternative energy measures in order to obtain federal, state or local rebates for the project. The contractor can provide the building profile and energy consumption information to a tool such as SolarNexus (SN) that uses an energy efficiency recommendation engine like SaveEnergy123 [SE123], in order to obtain an online energy audit and measure recommendations to present to the consumer.

**Contractor Receives Third Party Project Opportunity**

Contractor Receives Bid Request

In this IEP activity, a consumer has an integrated energy project or projects for which they would like to receive bids. A firm specializing in delivering energy efficiency information and tools to consumers collects proposed project information from the consumer. This tool then passes the project information to an energy project management organization that offers tools to contractors. This activity focuses on the transfer of data between these two different software tools.

For example a consumer provides SE123 with consumption and building profile data for their home, including gas and electrical consumption. The building profile data includes such data as the square footage of the home, its age, insulation levels and HVAC equipment info. SE123 uses this information to suggest measures to the consumer that might include adding solar to their home as well as various energy efficiency measures such as sealing their envelope.

The consumer chooses a couple of these projects such as an insulated roof and a solar system installation. The consumer sends out bid requests to contractors, one of whom is a registered SolarNexus contractor. Once the contractor accepts a bid request via SE123, the contractor can request to receive the project information in SN. SE123 then loads up the related project information that can be transferred using IEP XML. The project information would include such things as a project schema with the various components of the consumer's project including contact information, building information and a scope of work offering multiple measures such as solar and an insulated roof measure. This data would then be passed to the contractor at SN for assessment.

Contractor Receives Bid Request
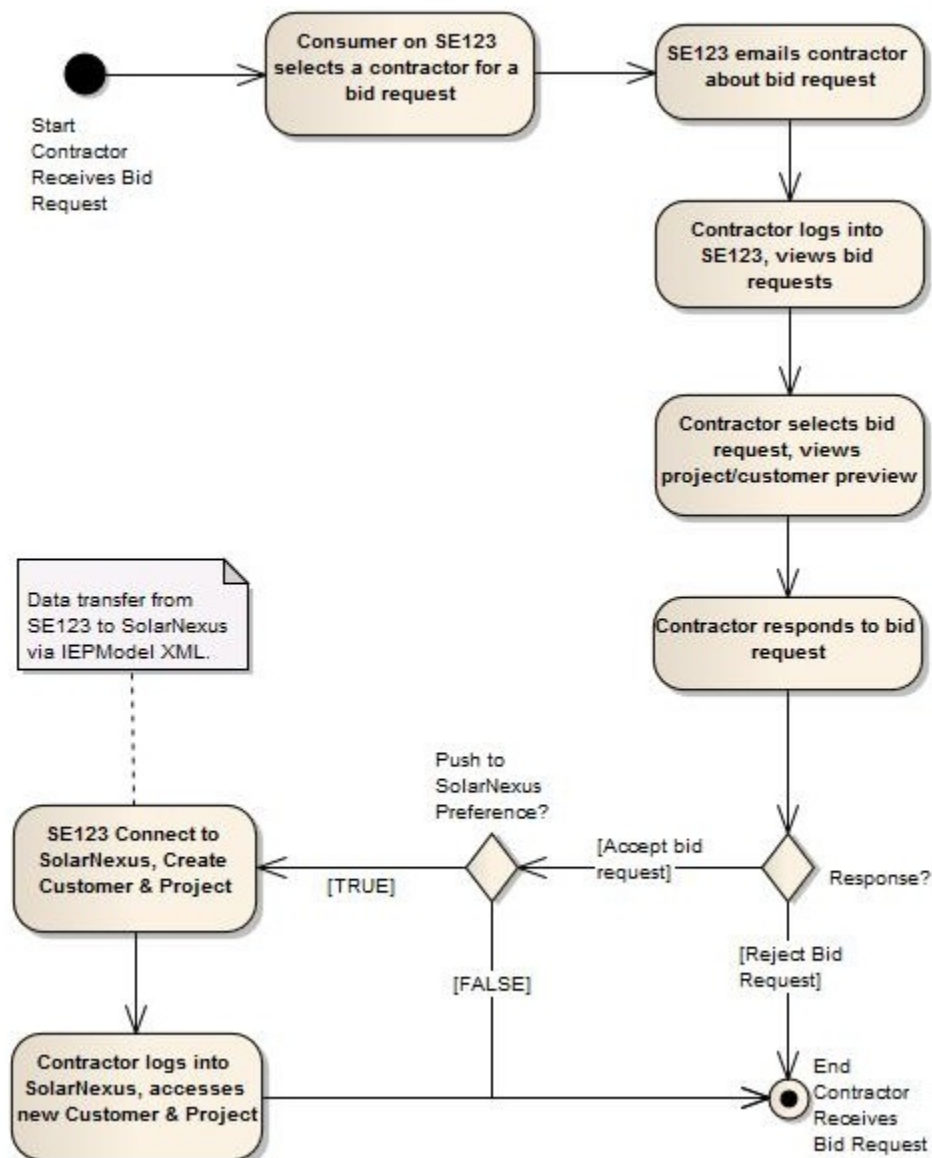
Request/Receive Site Audit

This activity presents the case where a contractor needs to share project, building and consumer data with other contractors. Here again a project may require a home energy audit in order to obtain the Federal, State or Local rebates. This transfer of information via IEP XML allows the contractor and auditor to not only save time by not filling out multiple documents with the same information but also remove or reduce the number of errors inherent in data transfer via voice and/or paper.

Site Audit Request
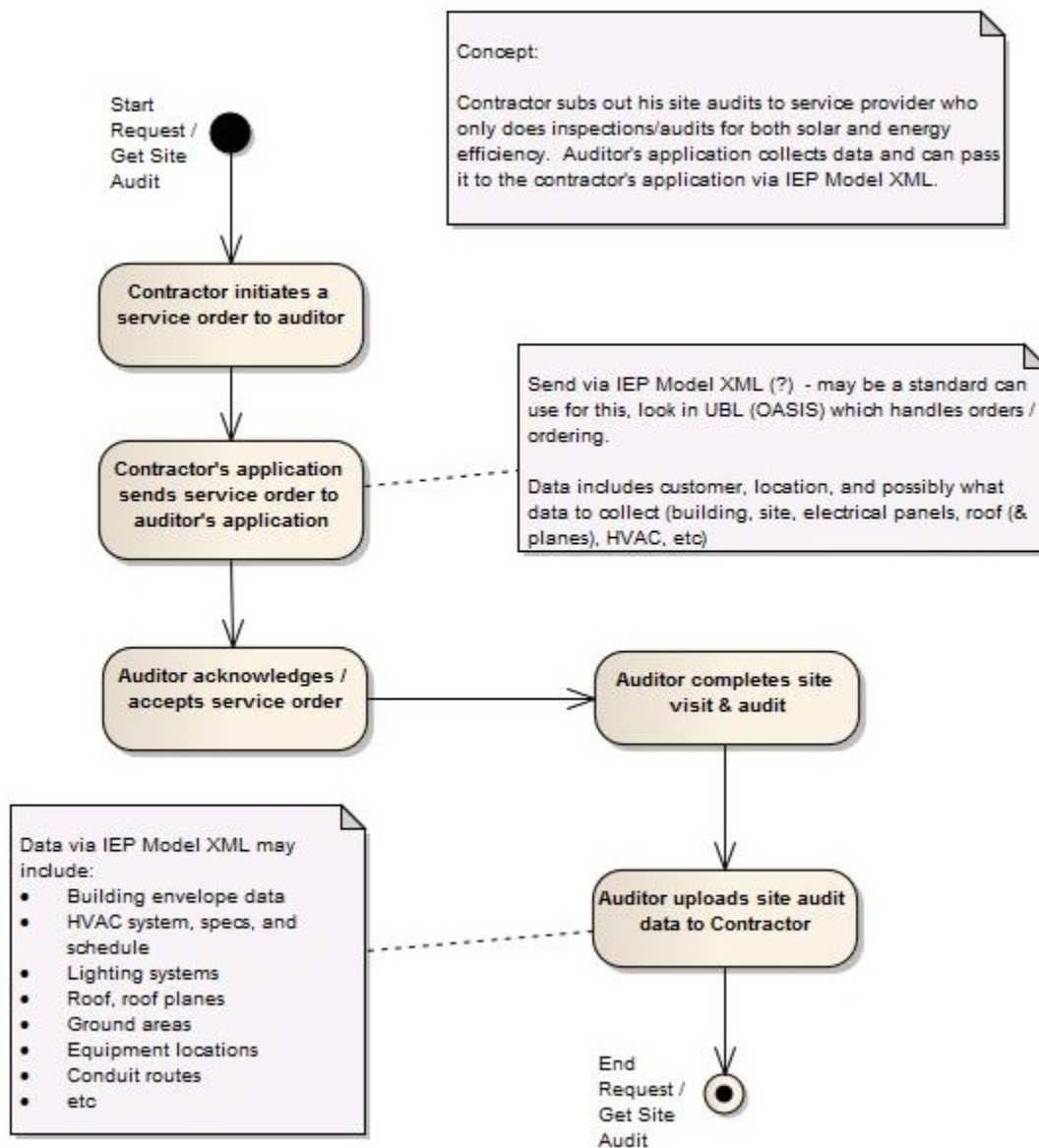
PV System Design

This activity provides an example where an engineer designs a PV system using project data stored in a central database. The engineer requires this data in order to properly assess and design a new PV system. The IEP Model can be the means by which the design tool accesses project data from the database without requiring the contractor to manually enter the data. This updated analysis data can then be stored in the database and accessed by other applications for cost quotation, financial analysis, etc.

PV System Design
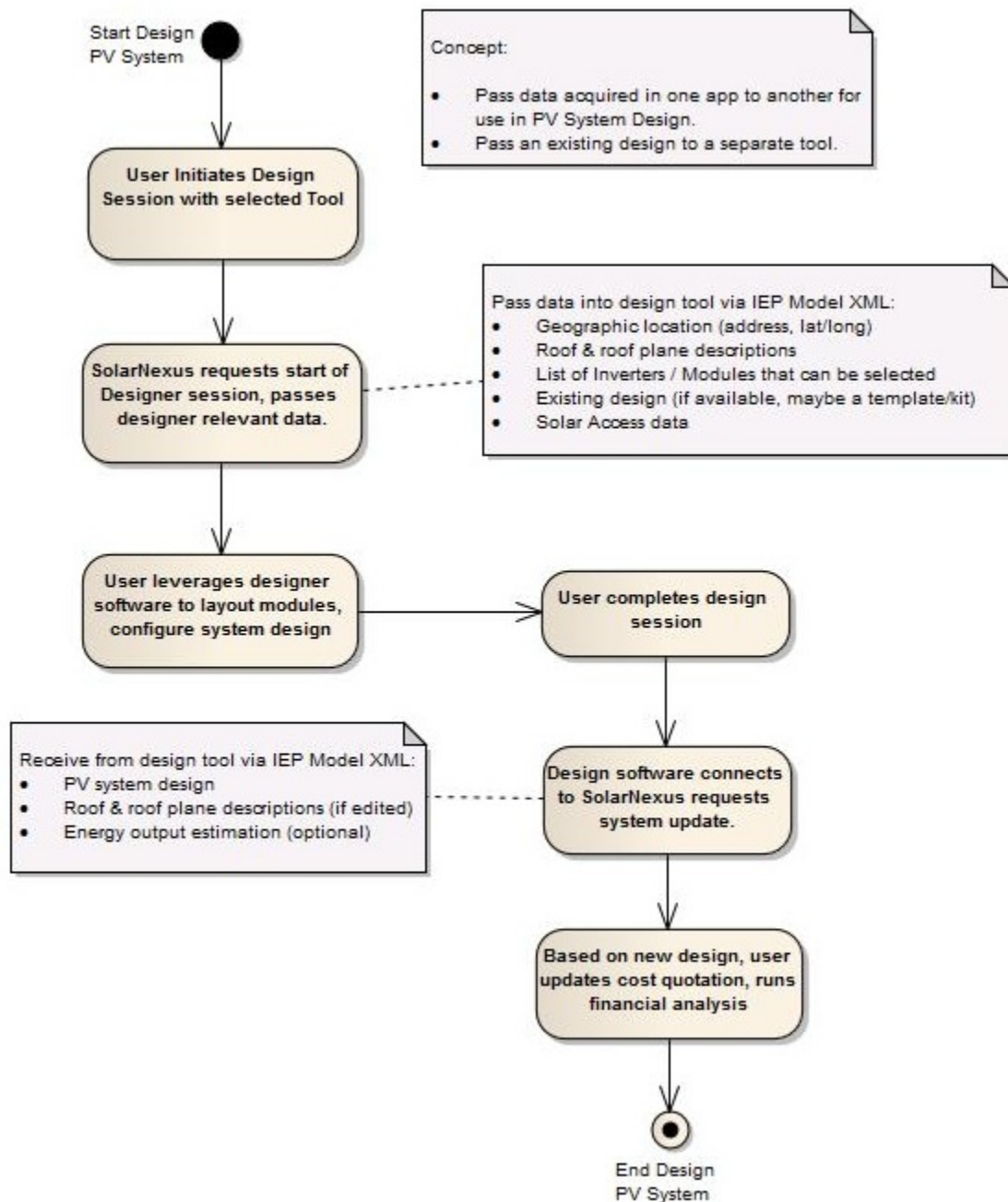
Lookup and Validate Provider Credentials

Multiple stakeholders in various IEP activities have unmet needs for the validation of service provider credentials. IEP XML compliant tools could help address these needs. For example, only licensed contractors may participate in the California Solar Initiative program. Therefore there is a need to easily verify a contractor's license number during the application process. Another example is verifying a HERS rater certification. Since there are multiple databases

storing HERS raters information, it would simplify the process to have a complete, single database to locate verified HERS raters by state. Both these activities would benefit from an IEP XML tool to facilitate the transmission of verified credentials back to the stakeholder. The diagram below also shows other potential stakeholders that would benefit from IEP XML compliant credential validation tools.

Credential Validation Activity
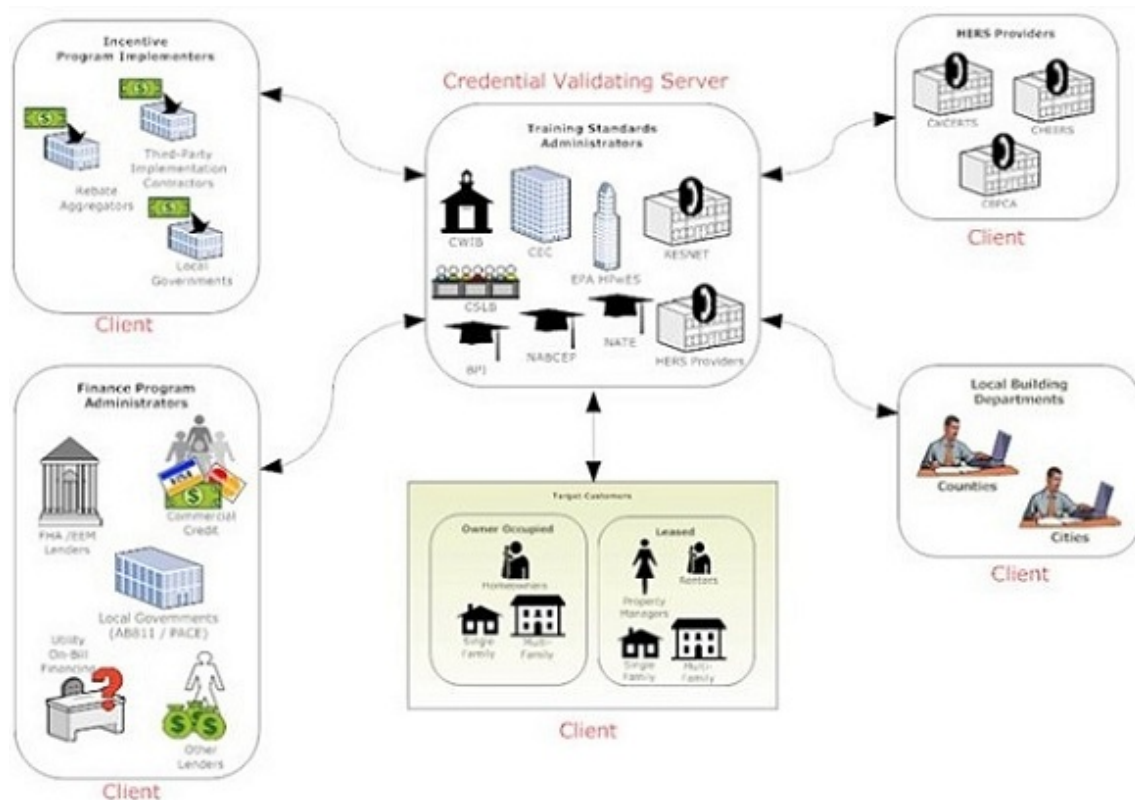
Parameter Inventory Development

We initially used the software design tool Enterprise Architect to document what we refer to as the IEP business domain. With each of the IEP activities previously identified, we evaluated and listed the necessary information to be exchanged during the activity. The team then organized these parameter inventory lists into logical groups. The process of the parameter inventory development was iterative with each step involving both the identification of new parameters as well as common parameters. Through the process of the parameter inventory development the team identified data usage patterns that ultimately led to the organization of the IEP XML schemas.

During the parameter inventory development, the IEP Model team evaluated the existing data models from other tools we identified during our initial research phase. We considered them for potential inclusion or extension and to inform our model development. One of the existing data models evaluated was Green Building XML [GBXML]. Architectural design and building energy modeling software tools use the gbXML model for the exchange of information. While gbXML had a large number of common parameters with the evolving IEP Model inventory, the

scopes of the two models are quite different. The IEP Model focuses on data at the project level and characterizes the stakeholders and measure recommendations surrounding energy efficiency and renewable energy retrofits. However, gbXML focuses at the building level and describes a building's detailed construction and geometry, as well as the configuration, control and performance characteristics of the building energy systems. The gbXML schema is very flat with little hierarchical structure, not relying on references between elements to define their relationships. These differences led us to adopt very little of the gbXML structure, but instead to use it as a reference to compare the completeness of our parameter inventory. However, we did heavily leverage the structure for schedules from gbXML. Schedules are used in gbXML to define a range of things such as occupancy levels, temperature set points, and operating hours. Annual schedules are built up from reusable weekly schedules composed of groups of reusable daily schedules. We used this concept in the schedule development of the IEP Model, but used more of an XML hierarchy.

The ENERGY STAR Portfolio Manager (ESPM) automated benchmarking services (ABS) data model was another existing data model evaluated during the IEP Model parameter inventory development [ESPM ABS]. The ESPM ABS is an application programming interface (API) software developers use to communicate with the ESPM building energy benchmarking tool. As with gbXML, the scope of the ESPM data model is different from the IEP Model in that it focuses on the building as opposed to the project. As opposed to gbXML, the ESPM ABS describes buildings at a fairly high level without describing their energy systems or operation. Another interesting difference is that ESPM ABS defines a common set of XML data types used in the structure of XML documents to be exchanged, but each ABS function defined uses a separate set of XML schemas. While this style is relatively common among APIs created for specific purposes, the goal of the IEP Model was to create a single data model that could be used by multiple APIs serving a wide range of purposes. For this reason we used little of the ESPM ABS structure. However, the team did use the ESPM structure for utility consumption data as a basis for the IEP Model. This aspect of the structure was useful because in many cases utilities automatically upload building utility consumption data to ESPM. Therefore, an IEP Model design goal became the ability to easily transform utility consumption data between the ESPM ABS structure and the IEP structure. Although we did not incorporate the exact structure of utility consumption data in the ESPM model, we modeled equivalent parameters to support transformation between the two structures.

As an industry stakeholder, Solmetric Corporation informed the IEP Model team that they developed an XML data model describing PV systems. They developed this model to serve as a file storage format for their PV Designer software product. During our parameter inventory development process we evaluated Solmetric's PV system XML model. This model was quite complete and incorporated much of the same design styles being considered for the IEP Model. These include the significant usage of hierarchy in the data model and division of the overall model into multiple schemas for better organization and modularity. After much review and discussion with Solmetric the IEP Model team incorporated the majority of their data model into the IEP Model with only modest revisions. The collaboration between the IEP Model team and Solmetric was beneficial because it helped us bootstrap the solar portion of the IEP Model, confirm a number of our initial design guidelines, and provided feedback for some of our design suggestions to Solmetric. This collaboration also means that an existing software tool from a leading industry provider uses a portion of the IEP Model.

Another industry stakeholder that contributed to the parameter inventory and initial IEP Model development was GeoPraxis. The IEP Model team engaged GeoPraxis initially due to their history of developing the gbXML standard. However, their involvement with the project led to the addition of the credential validation. GeoPraxis defined the additional parameters necessary to implement the specified data exchange necessary for this activity.

With this input from multiple industry stakeholders and assessment of existing data models the overall IEP business domain was defined. This business domain consists of the objects and associated parameters that are needed to describe an integrated energy project. At this point the parameter inventory was used as the blueprint for the actual XML schema development that compose the IEP Model specification.

3.3   IEP Model Development

Project Task 1.2

The development of the IEP XML schemas began with the migration of the parameter inventories developed in the Enterprise Architect tool to the Oxygen XML Developer tool. The migration took place primarily because the user interface of the Oxygen XML Developer was better suited for the magnitude of the data model being developed. In addition, the project team used the Rally application lifecycle management tool for development tasks such as tracking needed additions and defects.

General Process

The team followed the agile development process characterized by iterative incremental development that evolves over time. This process involved each of the key project team members specifying sets of data elements for particular portions of the model. Periodically the group met to discuss style and common elements of the model. Incremental internal milestones forced collaboration sessions before independent work could diverge too far from the core direction of the model development.

Before the team published the model publically, it developed multiple internal versions of the data model. Following the first public release of the IEP XML schemas, the project team solicited industry stakeholder feedback. The IEP Model version created following the incorporation of stakeholder input became the basis for the demonstration deployment that implemented data exchange between team member tools.

The implementation of IEP XML data exchange between the SolarNexus and SaveEnergy123 web applications also informed the ongoing schema development. Many issues become clear only after programming with that data model. The project team made numerous changes to the schemas during the trial deployment implementation based on lessons learned by the respective developers. The incorporation of all the lessons learned led to the version 1.0 of the IEP XML schemas that represent the first fully implemented form of the data model.

Data Elements

In the activity assessment for the IEP Model, the team identified many activities that only involve a portion of the overall data model. To avoid the requirement that implementations incorporate the entire data model, the team separated the IEP Model into a multiple schemas that

include and reference each other as necessary. This allows for the use of only the appropriate schema or schemas by each particular implementation.

Project

The Project schema consists of all elements utilized to describe an energy project. This schema describes the project using supporting elements. Such elements include Participant, Site, Measure, ScopeOfWork, ExistingLighting, ExistingHVAC, etc.

Participant

The Participant schema describes any party involved in an energy project. This schema includes the Participant element and other supporting elements. The Participant schema captures an entity's contact information, role, and any additional specific information. Possible roles may include, but not limited to consumer, service provider, contractor, and energy auditor.

Site

The Site element describes the property on which the project is being considered or implemented. It describes ownership and jurisdictional information, as well as physical attributes. It includes elements describing both buildings and grounds. The Site element is particularly useful for capturing site audit data prior to defining specific measures, including relevant data about locations for where proposed energy system equipment can be placed.

Building

The Building schema utilizes many elements to describe all aspects of a building. The Building element and supporting Envelope elements describe the building characteristics. Possible depicted building characteristics include age, building use, number and age of occupants, energy systems, and detailed shell information.

Roof Plane

The RoofPlane element defines s single roof plane, including its orientation, structure, and surface. It is an independent schema so that it can be used by the PvSystem schema independent of the Building schema which contains the Roof element.

Measure

MeasureType describes an energy improvement recommendation for a project. The recommendations involve modifications to energy systems or building envelopes. A measure consists of a measure action that describes the type of improvement such as the addition, modification, removal or replacement of existing energy equipment e.g. the addition of a PV system, or replacement of an existing HVAC system with a higher efficiency model. The measure also contains the cost and benefit information as estimated by the participant recommending the measure.

Demand Response and Measure

Demand response is a non-recurring, unpredictable schedule change to reduce the electrical usage at a facility due to high demand on the grid. The IEP Model allows a user to implement a demand response event by creating a schedule change in the Measure element. The user defines the beginning and end date and time of the event and lists the effected systems in the Schedule element of the affected systems SystemProperties.

Common Schemas

<u>Common:</u> The purpose of this schema is to define a set of types and quantities that are frequently used by other schema and can be referenced in a consistent manner.

<u>CommonElectrical:</u> This schema defines elements common to electrical systems.

<u>CommonSolar:</u> This schema defines elements common to all types of solar systems, whether thermal or photovoltaic.

<u>CommonSystemProperties:</u> This schema defines the common elements used by all systems.

Appliance

This energy system schema contains the Appliance element, which describes appliances and other plug loads (a generic device or system that draws electricity from a wall outlet). Generally, the Appliance element is to be used to represent any energy consuming system that one would like to be included in an energy analysis that is not captured by one of the other four Energy Systems (Lighting, Distribution, HVAC and Water Heating). The Project schema includes an element called ExistingAppliance of the ApplianceType to describe the original appliance that is intended to be changed in a project.

Distribution System

This schema contains the DistributionSystem element and other supporting elements that describe a mechanical system for transporting water or air. This mechanical system includes pipes or ducts, which transport the medium and a prime mover (fan or pump) that drives the medium. This system is commonly instanced by HVACSystem and WaterHeatingSystem, though it may be instanced on its own. For example, if an HVAC system conditions a zone by blowing conditioned air into the zone, it may instance a DistributionSystem, which defines the supply and return ductwork.

HVAC System

This schema contains the HVACSystem element, which describes a heating ventilation and air conditioning (HVAC) system. The HVACSystem element includes a CoolingSystemType and HeatingSystemType named CoolingSystem and HeatingSystem respectively. CoolingSystem and HeatingSystem describe the operation, capacity and energy consumption of the cooling and heating systems.

The HVACSystem element references the ID in DeliverySystem of the distribution system it uses to condition the zone. A distribution system may be defined to describe a pump or fan and piping or ducting if these are desired for the model. This distribution system is one that the HVACSystem uses to condition a zone, not one that serves the HVACSystem (i.e. a heat source or sink for the HVACSystem, such as a condenser water loop or water source for a heat pump). Note that no more than one distribution system may be defined for each HVAC system. Therefore, if a building has a hydronic radiant coil heating system and an air-to-air heat-pump cooling system, two HVAC systems must be defined.

Water Heating System

This schema contains the WaterHeatingSystem element, which describes a boiler or water heater. The end use may be HVAC, domestic hot water or another. The element contains properties to describe the tank volume (zero if none/instantaneous) and insulation, the temperature setpoint (type schedule), solar heater attributes and other typical water heater nameplate and

manufacturer specification information. The WaterHeatingSystem element also references a DistributionSystem ID which may be defined to describe a pump and hot water piping.

Lighting System

This schema contains the LightingSystem element, which describes one light fixture or a collection of light fixtures. LightingSystem contains complexTypes to describe the input and output (power) of individual fixtures contained found in SystemProperties, the illuminated area and light level located in LightingZones, the control type found in LightingControlGroup, and the lamps and the ballasts defined in LightingFixture.

PV System

The PVSystem schema is designed for use in a number of different use cases from input to a basic system output estimator (e.g. PVWatts) to describing a full one-line electrical system specification suitable for permitting.

The schema leverages the array concept (a collection of elements describing a set of PV modules that share the same mounting structure) in different forms based on level of information and inverter architecture. An abstract array type serves as the basis for the following three kinds of arrays:

- StringPvArrays – includes a hierarchical tree structure with String/central inverters at top
- AcBranchCircuitArray – includes a structure of AC branch circuits, where inverters are incorporated at the module level
- GenericPvArray – a simple structure used for feasibility studies and high level performance estimates. No specific structure or equipment is defined, merely an STC rating, orientation, and de-rate factors

Additional complex types in PvSystem capture:

- Detailed equipment properties of specific modules, inverters, DC combiners, and disconnect switches used in the design
- Description of roof planes on which arrays can be mounted
- A means for describing the wiring connections made between system components
- A means for describing the method for interconnecting the AC side of an inverter to the existing utility system
- Means of describing equipment and system grounding
- A variety of means for describing shade affecting the system (CommonSolar.xsd)
- Ability to spatially define the system's components in 3 dimensional space relative to a defined origin

Additional Supporting Schemas

There are several top level supporting schemas that are separate specifically for the reason that they are required by more than one top level schema. These include:

- EnergyConsumption – This schema specifically defines the Energy Consumption for any top level system.

- RoofPlane – This schema is used specifically for Solar PV and Solar Water Heating systems

- UtilityService – This schema defines the account information for any power provided by any Utility company

- Zone – This used for defining Heating and Cooling zones within a building

4   Implementation and Deployment of the IEP Model

4.1   Implementing the IEP Model with Partner Software

Project Task 2.1

SolarNexus Implementation

SolarNexus provides an online software platform for solar contractors to assist them with business management. The SolarNexus team modified the platform to incorporate the trial deployment of the IEP Model with the SaveEnergy123 tool. SolarNexus implemented IEP XML in the inputs for Home Energy Loads in the Site tab and the Energy Efficiency (EE) Measures feature within the application. Utilizing these features determines energy efficiency opportunities for a potential solar power installation project. Listed below are the technical specifications of the SolarNexus application and details about the technical integration with SaveEnergy123 using the IEP Model.

Technology Platform

SolarNexus uses the Ruby programming language and the Ruby on Rails framework. The application runs on EngineYard's cloud computing platform. The SolarNexus database utilizes MySQL to store application data. SolarNexus receives Ajax queries from SaveEnergy123 via PHP to communicate project data.

Implementing IEP with SolarNexus' Existing Data Model

SolarNexus created modules to import and export IEP XML from and to its existing application that uses multiple internal data models. Each data model includes a module responsible for generating the XML output in IEP format. There is another module that parses an IEP XML document and imports it to the existing SolarNexus data models. SolarNexus generates XML using the class Builder:XmlMarkup found in Ruby. The XML parser uses the Nokogiri library.

Data Transfer with SaveEnergy123

Before displaying the home energy audit information or the energy efficiency measures form in SolarNexus, SaveEnergy123 scripts included in SolarNexus pages query the SolarNexus API for current SolarNexus project information. This populates the forms with the current SolarNexus project information. When a user changes any form data, SolarNexus sends an Ajax request in the background to SolarNexus' API. The API processes the information and updates the SolarNexus project information.

User Interface Integration with SaveEnergy123

Instead of redesigning the SaveEnergy123 forms in SolarNexus, the team incorporated the SaveEnergy123 HTML in an IFRAME, also loading all the required Javascript and stylesheet files. Since SaveEnergy123 forms use the Yahoo UI, there are a lot of third-party Javascript to load. The reason for showing the SaveEnergy123 form in an IFRAME is to have the SaveEnergy123 stylesheets and scripts fully isolated from SolarNexus's own stylesheets and scripts so no interference can occur.

The SolarNexus user interface has two SaveEnergy123-powered sections:

"Home Energy Loads" – appears as an accordion on the Site tab

"EE Measures" Tab – becomes visible after activating it from the Home Energy Load section

SolarNexus' Site Home Energy Loads Used for IEP XML Inputs

SolarNexus' Energy Efficiency Measure Feature Using IEP XML Outputs
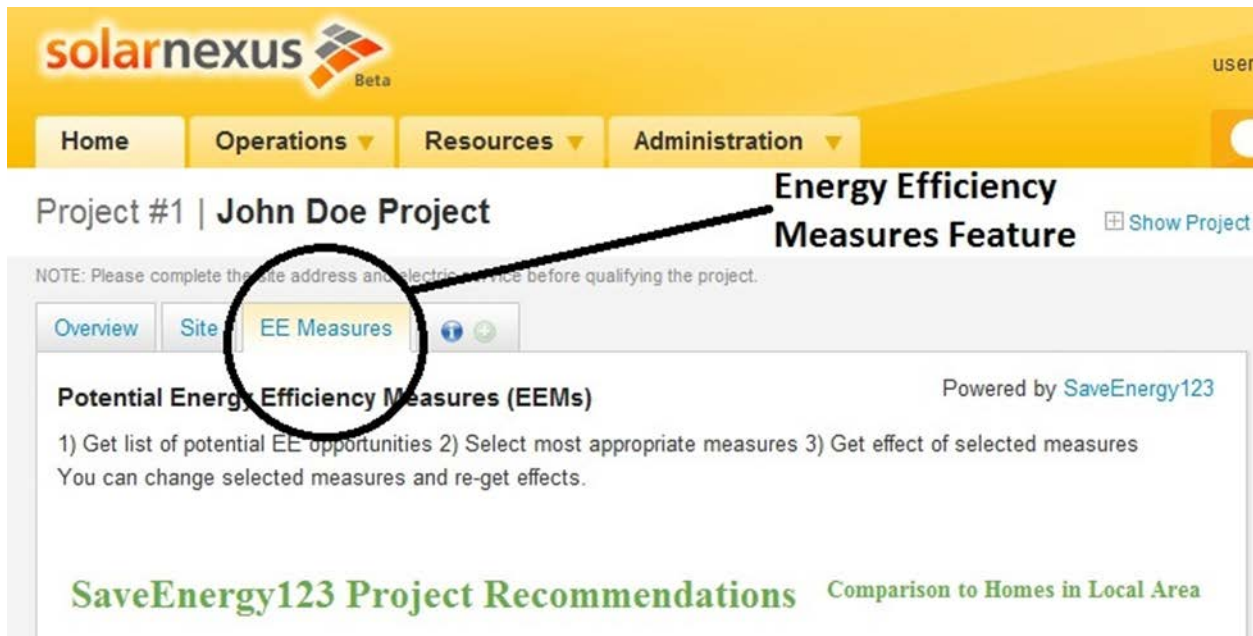
Each UI section has its own controller:

- <u>HomeEnergyLoadsController</u> manages the Home Energy Loads accordion.
- <u>EemsController</u> manages the EE Measures tab. It includes a method to email profile information to the customer. The email includes a link to the customer's saveenergy123.com profile built from within SolarNexus.

In addition, the SolarNexus tool has two more controllers for the backend API functions:

- <u>Se123Api::EnergyProfilesController</u> manages the GET and POST Home Energy Profile calls described above.
- <u>Se123Api::EemsController</u> manages the Get and Post Recommended Measures calls described above.

Before showing the Home Energy Loads section content, the user interface sends a GET Home Energy Profile Ajax request to the Se123Api::EnergyProfilesController. This populates the form with the current energy profile information.

When a user makes changes in the Home Energy Loads section, an Ajax call submits changes to SaveEnergy123 and SolarNexus at the same time. SolarNexus handles the request using the Se123Api::EnergyProfilesController.

Before displaying the EE Measures tab content, the Ajax user interface sends a GET Recommended Measures request to SolarNexus. The user interface is pre-populated with the current SolarNexus energy efficiency measures information.

When a user makes changes in the EE Measures form, SaveEnergy123 recalculates energy costs. An Ajax call to Se123Api::EemsController also posts changes to SolarNexus.

SE123 Implementation

Technology Platform

SaveEnergy123.com's website uses popular, standard web technologies. The core of the website utilizes the Joomla content management system which allows for easy management and handling of many articles and videos on energy saving measures within the home. SaveEnergy123.com uses Javascript and a modern HTML5 framework to create a highly interactive experience for its consumers and contractors. It employs PHP on the server side to store and update consumer home profile data as well as serve up energy consumption data from SaveEnergy123's home energy auditing tool (HEAT).

Implementing IEP with SaveEnergy123's Existing Data Model

SaveEnergy123 uses standard MySQL and PHP backend services to retrieve and update data from its databases. This code then uses the PHP version of the Document Object Model(DOM) for easy implementation from database information to XML formatted output and vice versa. The DOM also allows for easy validation of the created XML output to ensure compatibility.

Translating the SaveEnergy123 core data model to the IEP specifications required a significant amount of work. Though the IEP specification defines a broad base of information, so much of the data was simply transferable. The IEP specification lays out the information for the home profile in a well-defined structure such as information about the consumers and contractors in Participant and building information residing in the Site/Building specifications as well as Heating and Cooling systems in HVAC. The task for developers was determining the best place for the project data within the IEP specification.

Data Transfer with SolarNexus

SaveEnergy123 employs web services based on PHP to translate GET and POST IEP data to and from the website. One webserver then makes a GET or POST request to retrieve or store updated IEP data via the XML format. The XML data returns to the requesting server in one of several formats via XMLHTTPRequest calls: straight XML formatted text, JSON/JSONP encapsulated text or XML data. JSON is a popular and well-supported name/value pair interface for transferring data between servers and web interfaces such as Javascript. JSONP provides a secure interface on top of the JSON interface that blocks script insertion Internet hacks. The SaveEnergy123.com and SolarNexus interface employs the JSONP encapsulated option. This helps avoid security issues inherent in cross-domain scripting used for this specific implementation. The JSONP interface wraps the entire XML stream as a data segment and allows for simple transport and encoding or decoding of the XML data.

The web services described above transfer home energy load profile data and energy efficiency measure data between the SaveEnergy123 and SolarNexus applications. The home energy load interface on the SolarNexus site updates the data in the SaveEnergy123 databases. The energy efficiency measure recommendation interface requests a set of IEP measure recommendations from SaveEnergy123. SaveEnergy123 then accesses the home energy load data stored on its servers, calculates the energy consumption of the home as well as the home's modified energy consumption with the implemented, recommended measures. The SolarNexus recommendations interface receives the energy profile data and recommendations data from SaveEnergy123. The SolarNexus site displays this data to the user in the Energy Efficiency Measures tab.

User Interface Integration with SolarNexus

SaveEnergy123 created a generic version of its home energy auditing tool for usage by web tools for solar contractors, such as SolarNexus. SaveEnergy123 energy auditing tool provides a web interface built on HTML, Javascript, Yahoo UI Javascript interfaces and PHP. It allows contractors to create and define a home energy profile for each customer and provide energy efficiency measure recommendations based upon the profile.

By embedding an implementation of SaveEnergy123, SolarNexus allows a contractor to create a custom, home energy load profile for each unique consumer. The contractor selects the appropriate values from dropdown menus for each of the categories: Home Statistics, HVAC, Hot Water, Insulation, Appliances and Lighting. Specifically, the contractor enters attributes such as the home's square footage, number of stories in the home, heating equipment, cooling equipment, hot water systems, appliances and lighting.

After providing the customer's home energy loads, the contractor views energy efficiency measure recommendations provided by SaveEnergy123. The contractor finds the recommendations in the EE Measures tab of SolarNexus. These recommendations show energy savings in dollars, pounds of CO_2 saved, expected costs for the project and the associated return on investment (ROI). The contractor may also view the overall impact of a selected recommended measure. The impact shows a before and after breakdown of energy usage in the home, combined savings from multiple measures as well as how the consumer measures up against similar homes in their area.

Application Integration Commentary

Integrating disparate software applications is a costly endeavor, and is one of the primary driving forces for data standardization. Since each application has its own independent data models that underlie it, each integration between applications requires an effort between parties to agree upon the data to be transferred and how that data is defined. The IEPM can significantly simplify this effort and lower these costs.

Using the IEPM, the SolarNexus and SaveEnergy123 teams were able to work relatively independently to implement the integration because each team had a pre-agreed upon definition of the data. Although each team spent significant effort in developing the code required to translate their respective data models to and from IEPM, the effort can be regarded as a reusable effort. That is, instead of starting from scratch with another potential integration partner, the translation code to and from IEPM XML can be leveraged again, rather than for integration with only a single application.

If a developer is creating a new application and data model, the time to implement a new interface based upon the IEP specification could be greatly reduced as the IEP models can be greatly leveraged when defining their application's internal data models as well. The flexible nature of the IEP Model allows developers to immediately use the IEP specification for their data definition and allows them to quickly develop data interface for their code.

Another important, but hard to quantify benefit of using the IEPM for application integration is that it can lower the risk for application developers to create interfaces to their application for integrations. The risk is lowered because the work done to translate data to and from internal application data models can be applied across multiple integrations, instead of just one.

4.2   Mobile Data Collection

Project Task 2.5

The use of mobile software to collect data in the field and electronic data transfer to other software tools for analysis could reduce the overall time associated with such data collection and reduce the chances of error associated with manual data transcription. The IEP Model team investigated the feasibility of providing mobile data collection tools to collect information required to produce energy efficiency measure recommendations for solar contractors and others. While 66% of solar contractors surveyed in the initial research phase of the project claimed to use software for performing energy audits, none claimed to use mobile tools to collect the information.

The IEP Model team began by initially evaluating a software product called kW Field developed by kWhOURS. At the time of evaluation this product was not yet publically available, but kWhOURS provided an online demonstration of the functionality under development. The tool is a tablet-based software application for collecting energy audit information in commercial buildings. The demonstrated tool's user interface appeared clean and well thought out. However, the tool limited its data export capabilities to comma-separated value (CSV) files. The use of CSV files for data exchange between software is not the most efficient since it requires additional data mapping from the CSV format to a particular application. Also, it is not robust because the format relies on particular pieces of data being written to particular ordinate positions in the CSV chain. The IEP Model team informed the kWhOURS team of the work being done to develop the IEP Model and encouraged them to adopt XML import and export capabilities utilizing IEP XML in the future.

Another common tool for data collection consists of Microsoft Excel based spreadsheets used either electronically or in hard copy to inventory buildings and energy systems. The RetroFit Depot (http://www.retrofitdepot.org/EnergyAuditForms_More), an initiative of the Rocky Mountain Institute, made a set of sample energy audit forms available to the public. These forms are quite extensive and cover the collection of general project information, building envelope, schedules, and various energy loads. The IEP Model team evaluated these audit forms to potentially adapt them for electronic field data collection. We identified a number of important findings from this evaluation.

Field data collection forms developed in spreadsheet tools are often designed for printing on paper and writing on in the field. The hand written data on these forms must then be manually entered into any software tools used to analyze the collected data. This process is both inefficient and prone to data transcription errors. In order to make this process more efficient and less error prone the forms could be filled out electronically in the field using mobile computer such as a laptop, tablet, or smart phone. The forms could be configured to electronically export IEP XML that could then be consumed by other tools relying on the data. The IEP Model team evaluated data elements on the RetroFit Depot sample forms against the IEP Model in order to ensure the model could capture the form parameters. However, the team identified the format of the user interface was not suitable for electronic field data collection.

Hard copy forms used for field data collection typically contain every possible parameter that might be found. This is done to minimize the number of separate forms required for field data collectors and reduce page flipping in the field. However, this paper interface design is not suitable for mobile electronic data collection. Mobile computers typically have small screens and

input forms must be designed to minimize the visual clutter and allow easy touch-based user interactions. As a result mobile data collection forms need to follow a hierarchical flow of information collection. Designing a hierarchical data collection flow requires a deep understanding of the relationships between the parameters being collected. Conveniently the hierarchy of the IEP Model provides the relationships of the data elements in its structure.

Based on this assessment the team postponed the development of mobile field data collection forms until the completion of IEP XML schema structures. During the final stages of the IEP Model development project the team planned and developed a prototype of a sample field data collection form as a sample application. This sample form involves the collection of high-level project information and measure recommendations in line with an initial project-scoping audit. The IEP Model team developed a sample Microsoft Excel template along with an Add-In that enables the export and import of IEP XML to and from a native XML database. The team also developed another form as an online web form using the programming language PHP that allowed the simple entry of data and export to the same native XML database. These two forms serve as examples of how one can implement data exchanges from various tools using IEP XML.

4.3   Marketing Energy Efficiency and Integrated Energy Projects

Project Tasks 2.2, 2.3, 2.4

The team conducted various market outreach activities and training to different stakeholders during the course of the project. Stakeholders received information targeted to their needs and interests relating to their involvement in the IEP process. The goal of the marketing efforts to IEP stakeholders was to increase awareness about the benefits of integrated energy projects and the IEP Model's potential to facilitate the process. The project team also conducted training to users of the SolarNexus tool that included the demonstration deployment of IEP Model in its energy efficiency feature.

Stakeholder Marketing Outreach Activities

Date	Event	Stakeholders
June 2010	Communicated with other stakeholders about the IEP Model project. Solicited interested parties to commit to providing advisory input on draft specifications.	Software Providers Clean Power Research, GeoPraxis, Solmetric
June 2010	Held introductory webinar on June 24th for interested stakeholders outlining overall project objectives, tasks, and work to date as well as soliciting involvement in stakeholder advisory review. The online location of the webinar is: http://iepmodel.net/page/iep-model-webinar-for-project	
July 2010	Continued to perform outreach informing	Other grant teams

	stakeholders about the IEP Model project and solicit interested parties to commit to providing advisory input on draft specifications.	currently involved in the topic of integrated energy and solar.
August 2010	SolarNexus and SaveEnergy123 conducted individual outreach to interested stakeholders who were unable to attend the first webinar.	
October 2011	In their booth at the Solar Power International Conference in Dallas, SolarNexus demonstrated the tool and its energy efficiency feature that uses IEP Model.	Various solar industry members.
January 2011	SolarNexus teamed with PG&E to produce an educational video for potential consumers of solar power. The video highlights the ways to reduce energy consumption through energy efficiency. The online location of the video is: http://www.youtube.com/watch?v=GnEiMXb79Yw	Consumers
April 2011	Released press release announcing the public draft release of the IEP Model. The online location of the press release is: http://iepmodel.ning.com/page/announcement-of-first-public	

SolarNexus User Training

The IEP Model team deployed its demonstration implementation of the model in the SolarNexus tool. The team notified all potential users of the feature's existence, including a prominent month-long announcement on the Home page of the application seen by users when they logged in, and a notice in the company's emailed newsletter to all current and prospective customers. SolarNexus then provided online training to SolarNexus users, which are solar installers, via a GoToWebinar. The goal of this training was to increase the adoption and use of the energy efficiency feature that utilizes the IEP Model. SolarNexus continues to provide access to the training for interested users through a link on their website which can be found at the following location:

https://www1.gotomeeting.com/register/136767353

4.4   Trial User Selection

Project Task 2.6, 3.1

The demonstration deployment relied on participation from contracting companies using the SolarNexus application within the state of California. The team used data from CSI statistics to develop a sampling plan and select contractors using SolarNexus for the trial deployment.

Evaluation of the CSI statistics revealed a stratification of solar contractors based on the number of annual installed projects. The CSI program defines high volume installers as those installing 200 or more projects per 12-month period. This high volume strata of solar contractors consisted of only 8 organizations in the year preceding the trial deployment referred to as the baseline. These top contractors completed the 48% of the residential and small commercial PV installations in California during this baseline year. There was also a group that performed only one project in the baseline period that consisted of 374 contractors. This group is referred to as the low volume strata. The medium volume strata was the largest consisting of 576 contractors that performed between 2 and 199 installations in the baseline year.

California PV Installer Distribution in Baseline and Trial Deployment Periods
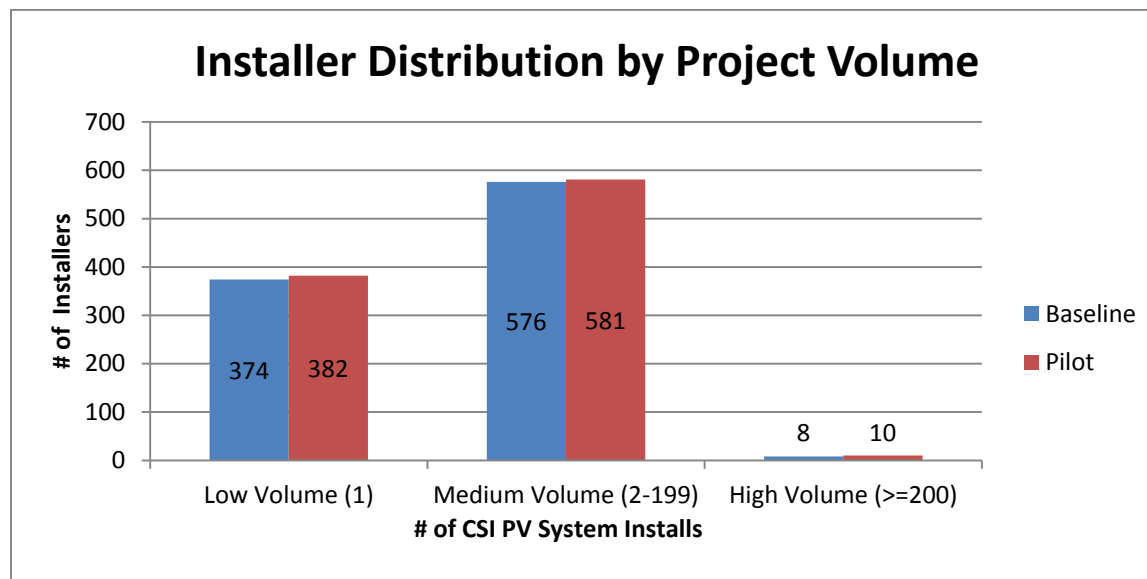
Based on a sample of the SolarNexus users cross-referenced against the CSI public data the project team determined that the user-base of the SolarNexus tool consisted primarily of medium-volume installers at the time of the trial deployment. Based on the medium volume installer population size the sample size required to meet our statistical criteria of 90% confidence, 20% precision and a coefficient of variation of 50% was 17 SolarNexus contractors to participate in our demonstration deployment. These contractors were to be distributed throughout the state.

47 individual California contractor company accounts in SolarNexus had access to the project's energy efficiency home audit features. A best effort was made to confirm that all of the accounts were actual practicing contractors. The participating companies were mostly solar contractors, with a mix of electrical contractors and general contractors also represented. SolarNexus does not collect or track data on the number of employees within each company, only the number of user logins within each company. However, a survey of a small set of SolarNexus contracting companies across all states confirms that a large majority of them are small (<30 employees). The 47 companies were very geographically distributed throughout the state, from San Diego to Chico and widely distributed in between.

Overall, participation in the study was lower than anticipated. Getting significant numbers of participating contractors proved to be relatively difficult. A number of dynamic market factors

contributed significantly to the study's lower than anticipated contractor participation. A short discussion of factors is included here in order to better contextualize the study's results.

One factor limiting the pool of SolarNexus-using participants among practicing solar contractors is the prominent ascendance of third party financing in the deployment of solar systems. Prior to the crash of the housing market, one of the most widely used mechanisms used to finance the purchase of residential PV systems was home equity loans or mortgage refinances. The precipitous decline in home values wiped out much of this source of financing. Companies like SunRun, Sungevity, SolarCity, and Clean Power Finance have ascended to prominence by including compelling lease and/or PPA offers that alleviate the need for the end customer to come up with their own financing. Although some of these companies partner with independent contractors who provide the sales and installation processes, all these companies require their partner contractors to use the finance provider's proprietary sales software solutions, which reduce the demand for the proposal-generating features of SolarNexus.

To underscore this point, CSI data shows that the top ten contractors in California did 35% of residential and light commercial sales (by MWp) in 2010, compared to 47% in 2011. This came at the expense of small and medium-sized contractors that did not have financing as readily available. Furthermore, in 2011, 86% of these systems with 3rd Party Ownership (a CSI notation for leases/PPAs) were done by the top ten. This implies that the financing mechanisms are still mostly just for the largest PV contractors. So it is clear that the gains by the largest contractors are directly correlated to their use of such financing mechanisms, and come at the expense of smaller contractors.

Another factor was a significant increase in the number of competitive software offerings introduced to the market over the course of the project's life, diluting opportunities for adoption.

As a result of these challenges the team was limited to the existing population of 47 medium volume solar contractors. The user selection consisted of getting 17 of the existing SolarNexus users to adopt usage of the integrated energy efficiency features and compare them against the remaining users that did not use the feature.

4.5   Managing Trial Deployment

Project Task 2.8

Several steps went into managing the deployment of the software trial. The team implemented the IEP Model in the energy efficiency feature of the SolarNexus application. After the team selected the trial deployment participants and provided training for the new energy efficiency feature, the team began monitoring usage data, provided a venue to report issues with the software and continued to update the model to fix issues and add additional data structure.

The trial began in July 2011 with email notifications and in application messages pushed out to SolarNexus users announcing the newly integrated energy efficiency feature. In September reports showed lower than expected usage. The team performed additional outreach and set up a webinar to existing and prospective SolarNexus users to highlight the integrated energy efficiency feature and increase usage.

Additionally, the SolarNexus application provides a form to report any issues with the software including those pertaining to the energy efficiency users. This method was to provide communication regarding issues and follow up information for users from the developer

regarding their report. During the pilot no issues were reported yet usage continued to remain low.

5   Analyzing the Implementation of the IEP Model

5.1   Follow-up Surveys

Project Task 3.2

The team conducted web-based surveys to help assess the impacts of the demonstration IEP Model implementation. The team surveyed solar contractors using the EE measure recommendation feature in the SolarNexus tool. In addition, the project team performed an additional survey sent to all solar contractors installing more than five PV systems in California in the last twelve months. The respondent list of contractors came from the CSI statistics data set.

Solar contractors participating in the trial IEP Model deployment answered questions about their experience using the EE measure recommendation feature in the SolarNexus tool. 90 solar contractors received invitations to the survey and five responded. The survey response rate was 5%. Out of the five responses, two respondents were unaware that the EE measure recommendation was an optional feature available as part of the PV project proposal process. It is unclear whether these respondents were users who participated in the webinar hosted by the project team that including training on the feature. Two of the respondents indicated they knew about the EE measure feature but either had not needed it yet or not been using the software lately. The two respondents who knew about the feature but had not used it did not have any projects in the baseline or trial period of the IEP deployment. While a low response rate of users with projects during the trial period prevented the team from fully assessing the impact of this feature, it does indicate that the integration of the SaveEnergy123 powered EE measure recommendations into the SolarNexus tool was seamless to the users. This is a positive outcome of the demonstration deployment as it demonstrates that third-party powered functionality can be added to web applications and appear to be part of the host application. This integration facilitated by IEP XML allows application developers like SolarNexus to include functionality that is not part of their core business.

The initial intent of part of the IEP Model impact assessment was to survey both solar contractors using the integrated EE measure feature in the SolarNexus tool and the project customers receiving these recommendations. However, project customer contact information was not available as expected. Solar contractors using the SolarNexus tool provided their customers with an email summarizing the recommendations and containing a link to the SaveEnergy123 website to pursue implementation of the recommended measures. The SaveEnergy123 application saves the EE measure recommendations in an anonymous profile. The link provided to customers allowed them to review these EE measure recommendations and complete a personal profile in the SaveEnergy123 tool. After following the link and completing the profile customers could obtain quotes for implementation of the recommended measures from the network of contractors available in SaveEnergy123. While viewing the SaveEnergy123 application user logs, the IEP Model team identified that some of these customers followed the email link. However, none of the customers completed their personal profiles in the

SaveEnergy123 tool. This lack of customer contact information in the SaveEnergy123 tool prevented the distribution of customer surveys.

5.2   Impact of the IEP Model

Project Tasks 2.7, 3.3, 3.4, 3.5

Market Baseline Analysis

The IEP Model team analyzed the CSI data set to determine the baseline activities of solar contractors participating in the trial deployment. The trial deployment began in July 2011. The project team collected data from the trial launch until February 2012. Because this period is less than one full year and due to the seasonal characteristics of solar PV installation activities the team used the same months in the previous year to characterize the baseline. The team filtered the CSI data to compare the subset of months from the July 2010 through February 2011 baseline period. Solar installers using the EE measure feature in SolarNexus were matched up to the baseline CSI data on company name.

Of the participating contractors, those using the EE recommendation feature in the SolarNexus tool, only 25% performed any PV installations in the baseline period. This indicates that a large portion of the SolarNexus users were new solar installers entering the market during the trial IEP Model deployment.

Post-Installation Data

The IEP Model team filtered the CSI data set for the trial deployment period from July 2011 through February 2012. Matching the installer name from the SolarNexus data set to the CSI data identified participant projects. The team used data on participant projects collected from the SolarNexus tool and from the CSI data set to analyze the impact of the IEP Model demonstration deployment. The common data between the CSI and SolarNexus data sets includes:

- PV systems size
- PV system cost
- Number of systems installed

The availability of information about proposed and installed EE measures varies between the CSI data set and the data collected by the SolarNexus tool. There is no information in the CSI data set about the implementation of EE measures associated with PV projects. However, since the SolarNexus tool generates project proposals for customers, data was available for EE and PV projects. The information collected by SolarNexus included whether EE measure recommendations were made, and if the project was sold with or without the recommended EE measures. This data was not available in the CSI data set.

Solar Contractor Survey Results

The team sent out a brief survey to solar contractors who installed more than five solar projects. These contractors participated in the California Solar Initiative program during the 2011 program year.

Question One Results

1. Does your company install or recommend installers for customers to implement any energy efficiency projects?		
Answer Options	**Response Percent**	**Response Count**
Yes, we currently install some energy efficiency projects.	41.7%	5
Yes, we recommend reputable installers for some energy efficiency projects.	8.3%	1
Yes, we both install and recommend reputable installers for implementing energy efficiency projects.	50.0%	6
No, we do not provide customers with installation services or recommended installers for energy efficiency projects.	0.0%	0
number of respondents who answered question		12
number of respondents who skipped question		0

All respondents indicated that as part of their PV system installations they either install EE measures themselves, recommend qualified installers, or both. This is significantly higher than the 51% of installers surveyed in the research phase of the project that claimed to implement or recommend EE measures. The response to this survey question indicates an increase in PV installers implementing or recommending EE measures.

Question Two Results

2. Approximately what percentage of your total PV projects sold includes implementation of energy efficiency (EE) projects?		
Answer Options *Percentage of PV projects sold with implemented EE projects*	**Response Percent**	**Response Count**
1-5%	27.3%	3
6-10%	45.5%	5
11-15%	0.0%	0
16-20%	9.1%	1
Over 20%	0.0%	0
Unsure	18.2%	2
number of respondents who answered question		11
number of respondents who skipped question		1

A majority of respondents (72.8%) indicate that the proportion of their PV projects that involve integration with EE is 10% or less. This is consistent with the data gathered on SolarNexus participants in the IEP Model trial.

Question Three Results

3. How do you think the installed size of a customer's PV system is affected by providing recommendations for energy efficiency projects?		
Answer Options	**Response Percent**	**Response Count**
The PV system size decreases.	63.6%	7
The PV system size remains the same.	36.4%	4
Unsure.	0.0%	0
number of respondents who answered question		11
number of respondents who skipped question		1

Question Four Results

4. On average, how much do you think the size of a PV system decreases as a result of providing energy efficiency recommendations? i.e. As a result of providing energy efficiency recommendations, I believe the size of a customer's PV system decreases by __%.		
Answer Options *Percentage Decrease in PV System Size*	**Response Percent**	**Response Count**
1-5%	0.0%	0
6-10%	16.7%	1
11-15%	50.0%	3
16-20%	16.7%	1
Over 20%	0.0%	0
Unsure	16.7%	1
number of respondents who answered question		6
number of respondents who skipped question		6

The responses to survey questions three and four indicate that a majority of installers feel that PV system size decreases by 15% or less when providing EE measure recommendations.

Question Five Results

5. Do you think providing energy efficiency recommendations increases of the number of PV systems sold?		
Answer Options	**Response Percent**	**Response Count**
Yes	40.0%	4
No	50.0%	5
Unsure	10.0%	1
number of respondents who answered question		10
number of respondents who skipped question		2

Question Six Results

6. Approximately how much do you think the rate of sales for PV systems increases as a result of providing energy efficiency recommendations? i.e. I think that providing our customers with energy efficiency recommendations increases PV system sales by approximately __%.		
Answer Options *Increase in Number of Sales (%)*	**Response Percent**	**Response Count**
1-5%	50.0%	2
6-10%	0.0%	0
11-15%	25.0%	1
16-20%	0.0%	0
Over 20%	0.0%	0
Unsure	25.0%	1
number of respondents who answered question		4
number of respondents who skipped question		8

The responses to questions five and six show that solar installers are nearly evenly split on whether inclusion of EE recommendations results in increased PV sales penetration. Of those responding positively to integrated projects resulting in higher sales, most felt the sales rate increase was 5% or less.

Evaluating the responses to all survey questions together it appears that while most PV installers offer integrated EE/PV projects they do so on a relatively small proportion of their projects and feel that it reduces PV system size more than it increases sales volume. This indicates that PV installers offer or recommend EE services based on customer request and not by default.

Contractor Participation Results

The SolarNexus application was available for free to any contractor who wished to use it. The home energy loads and recommended EE measures features were available as a standard part of the application. This allowed contractors to "self-select" whether or not they wished to use those features of the application. Feature usage breaks down as follows:

- 10 of 47 companies used the features more than one time (21%)

- 14 of 47 companies used the features only once (30%)

- 23 of 47 companies did not use the features (49%)

Participating contractors had the opportunity to use the EE measure (EEM) feature for projects at any stage. Contractors defined projects in the SolarNexus tool, proposed a portion of these projects to the customer for consideration, and sold some of the proposed projects. Therefore, the contractor usage for the trial breaks down as follows:

Contractor Participation Project Summary

Total number of total installers using SolarNexus during trial: 47
Number of installers who used EE feature (trial participants):   24

Number of projects created by installers using EE feature: 79
Number of projects proposed by installers using EE feature: 19
Number of projects sold by installers using EE feature: 6

Trail Usage Data Results

The following table lists the characteristics of the projects contractors entered into SolarNexus during the IEP Model trial deployment.

Avg System Size, all defined:	5.382	kWstc
Avg System Size, all sold:	4.227	kWstc
If EEMs were requested and a system defined, average system size:	5.313	kWstc
If EEMs were requested and a system sold, average system size:	7.36	kWstc
If EEMs were NOT requested and a system defined, average system size:	5.404	kWstc
If EEMs were NOT requested and a system sold, average system size:	3.287	kWstc
Avg PV System size reduction of defined systems where recommended EEMs were requested:	0.091	kWstc
Avg PV System Size Reduction of Sold Systems where recommended EEMs were requested:	-4.073	kWstc

It is difficult to draw conclusions from this data due to the small number of projects using the EEM feature that were actually sold. However, one interesting point is that while the average size of PV systems that were sold is smaller than the average size of all systems defined, the average size of PV systems proposed with EEMs is larger than the average PV system size proposed without EEMs. One possible reason for this is that customers with high electric usage will likely benefit more from EEMs and yet still require larger capacity systems. If this is in fact the case then installers who offer EEMs would have a higher likelihood of selling larger PV systems combined with EEMs to large energy consumers.

Comparative Analysis

One of the findings from the analysis of trial participant data is that a large number of SolarNexus users use only parts of the software and for different aspects of their business, or are just in the beginning stages of using it consistently. Unfortunately, this resulted in a very small data set from which to evaluate impacts. Furthermore, we found a high correlation between accounts that did not use the EEM feature with inconsistent use of the software. Those user accounts using the base features of the SolarNexus software most actively were also the most likely to use the energy efficiency features. This means that there was a very small set of data from our control group of SolarNexus users that did not use the EEM feature. Due to the small data set the team performed a comparative analysis of SolarNexus users that used the EEM feature with CSI participants in the same sales volume strata that did not use the SolarNexus EEM feature.

To perform the analysis the team used the CSI public data set filtered for residential and small commercial systems (<=10 kW) in the trial period from July 2011 to February 2012 and for medium volume installers with between 2 and 199 installations per year. Since the team removed trial participants from this filtered CSI data set, all medium volume installers during the trial period that did not use the EEM feature in the SolarNexus software were evaluated. This data set served as the control group for the comparative analysis against users of the trial deployment.

Baseline and Trial Period Participant Data Comparison

The IEP Model team used baseline and trial period filtered CSI program data sets for trial participants to determine changes in systems sold, average system cost, and average system size. The analysis included a comparison of the trial participant metrics to the same metrics for non-participating medium volume installers as well as all non-participating installers. Of the 24 trial participants only 6 installed projects in the baseline CSI data set. This small number of participants with both baseline and trial data made it difficult to draw significant conclusions.

	Baseline Period			Trial Period		
	# of Projects	Average size (kW CSI-AC)	Average $/W	# of Projects	Average size (kW CSI-AC)	Average $/W
Participant Totals	115	5.266	$ 8.14	72	4.910	$ 7.95
Med. Volume Installer Non-Participant Totals	6,951	4.863	$ 7.99	6,812	4.903	$ 7.40
All Volume Installer Non-Participant Totals	10,608	5.123	$ 8.02	14,590	5.531	$ 7.96

	Overall Changes Between Baseline and Trial Periods		
	# of Projects	Average size (kW CSI-AC)	Average $/W
Participant Totals	-37.4%	-6.8%	-2.4%
Med. Volume Installer Non-Participant Totals	-2.0%	0.8%	-7.3%
All Volume Installer Non-Participant Totals	37.5%	8.0%	-0.7%

The data demonstrated the following differences between the participant and non-participant groups in the baseline and trial period comparison:

1. Number of projects installed decreased 37.4% for trial participants and 2.0% for non-participants. Overall there was an increase in the number of projects installed in California, but this is primarily due to large growth of the highest volume installers.

2. Average system size decreased 6.8% for participants, increased 0.8% for medium volume non-participants, and increased 8.0% for all non-participants.

3. Average cost per watt decreased less for trial participants than non-participants in the same volume strata, but more than the change for all non-participants.

During the comparative analysis we identified that the installer group most responsible for the increase in installations statewide were the highest volume installation firms. Verengo Solar and SolarCity saw the most notable increases with 266% and 229% growth in installations respectively from our baseline to the trial period. These two installers alone account for 21% of California residential and small commercial PV installations during the trial period. While there are other installation firms that saw increased system installs between these periods, in general the shift of projects to high volume installers with zero down financing options for customers resulted in a decrease in installs by medium volume installers.

It's important to note that due to the small number of participants with both baseline and trial period data there is not a statistically significant sample with which to compare against non-participants. Therefore, it is difficult to make any definitive conclusions. However, it appears from this comparative analysis that the participant group did not differ significantly from the non-participant medium volume installers. The decrease in participant system installs does not appear to have any correlation to the IEP Model trial deployment, but more a result of larger market forces.

Estimated Impacts

The team's primary objective of the IEP Model project was to develop a model that facilitates the integration of EE/DR+PV such that all cost effective EE and DR opportunities are implemented before sizing the PV system. We developed the IEP XML specification to facilitate the integration not only between EE/DR+PV installers, but also among many other stakeholders in the integrated energy project lifecycle. We received positive stakeholder feedback on the specification and interest in numerous potential implementations of IEP XML to facilitate software interoperability. We are confident that further integration of energy software tools beyond the trial deployment will encourage further integration in energy project implementation.

At the outset of this research project we expected that integrated energy projects might require smaller PV systems than would be installed without EE and DR first. We estimated that on average 15% annual energy savings could be achieved through EE resulting in a 15% smaller PV system. While this estimate is consistent with survey responses from PV installers, it was not demonstrated in the trial deployment. In fact, we found through our initial installer interviews that PV systems often use all available roof space without meeting all of the site energy needs. The ability to provide integrated EE/DR+PV projects may better meet some customers' energy

goals particularly larger energy consumers. Data from our trial deployment actually found that integrated projects involved larger PV systems than non-integrated projects.

Our primary performance objective for this project was to increase PV penetration rates through increased sales due to the improved ROI of integrated projects facilitated by integrated energy software. We proposed a target performance objective of a 27.5% increase in installed PV capacity for installers of integrated projects participating in our demonstration deployment of integrated EE and PV software. Unfortunately a number of market forces prevented us from meeting this performance objective. Due to large drops in home values, equity financing became largely unavailable pushing consumers toward innovative solar financing mechanisms. Solar installers offering financing and lease packages like Verengo Solar and SolarCity each saw installations grow over 200% in one year. Clean Power Finance began offering financing along with software tools to independent installers about the same time we launched our trial deployment potentially contributing to our lower than expected participation. These market events were unexpected and likely contributed to our inability to meet our performance objective. However, we still feel strongly that software integration is an important component to the growth of the energy industry and that IEP XML has the potential to play a critical role in that growth.

6   Recommendations

After three public iterations, the IEP XML specification is currently in version 1.1, published at the time of this writing. Each version benefited significantly from the actual software implementation work that preceded it. The specific implementation of IEP XML in the integration of the SolarNexus and SaveEnergy123 tools validated the solar, project, building and measure constructs of the model. However, there are a number of components of the model that will benefit from additional implementations. The areas of the data model that require further validation through actual implementations include lighting, HVAC systems, water heating systems, and distribution systems. Feedback resulting from future implementations will need to be incorporated into future revisions of the IEP XML specification.

In addition to fully validating the model through further implementations, it may be logical to define common application programming interfaces (APIs) based on the data model. While the IEP Model team developed APIs during the demonstration implementation between SolarNexus and SaveEnergy123, its scope is limited since it only covers the specific application functionality involved with that integration. We expect similar limited scope APIs will be created as part of future IEP XML implementations. However, at some point there may be value in developing a single comprehensive API around the IEP XML specification. This would greatly simplify the development work required to implement future application integrations and could provide accepted mechanisms for data aggregation and portability scenarios as well.

To support the evolution of the IEP XML specification and associated API, the IEP Model would best be managed by a standards development organization or the like. During this grant project, multiple discussions occurred about potential standards organizations that could oversee the ongoing IEP Model development. However, the ideal situation is currently unknown. Discussions initiated by California Energy Commission staff about the potential formation of a new standards organization specifically intended to oversee California ratepayer funded software seem the most promising. However, the likelihood and timeline of the organization forming is

unclear. In the meantime, the IEP Model authors plan to continue evolving the specification based on our own ongoing implementation development as well as any industry stakeholder feedback received. The IEP Model project website (http://iepmodel.net) will continue to host the specification and related documentation, provide news and updates, and accept input from interested industry stakeholders on the evolution of the model.

7   Public Benefits to California

By facilitating the interoperability of energy project software through a whole realm of possible implementations, the development of the IEP XML data model provides significant value to stakeholders within the California energy ecosystem and beyond. Throughout the development of the specification, the IEP Model team involved numerous stakeholders who clearly understand the potential opportunities for integration either immediately or in the near future. The possible implementations extend far beyond the original goal to support more integrated EE/DR+PV projects. The IEP Model has the potential to coordinate numerous points in the energy project lifecycle that could benefit from using a common format for data transfer.

7.1   Possible IEP Implementations

IEP XML documents can be used to collect, transmit, and store information about integrated energy projects through application integration, data aggregation, and data portability. The demonstration scenario implemented under this grant project was that of application integration. The project implemented a specific integration between the SolarNexus and SaveEnergy123 web applications using IEP XML as the basis for an application programming interface (API). Both tool vendors are now looking to leverage the integration they performed with each other's tools to integrate with additional third-party tools. They have already completed mapping their applications to the IEP common data model and documented key lessons learned and best practices which will help inform future implementers and decrease the amount of work with each successive implementation.

The following is a list of some potential, future application integrations using IEP Model:

- Integration of PV performance estimating tools like PVWatts with project management functions like those available in SolarNexus

- Integration of contactor PV System design software and permitting agency software, allowing output of a PV system design from the contractor that can be automatically read and evaluated by the permitting agency software for conformance to agency rules

- Integration of certificate validation lookup databases with applications providing customers with listings of service providers required to maintain such certifications, such as HERS provider registries or state contractor databases

- Integration of online energy audit tools like SaveEnergy123 with benchmarking tools like ENERGY STAR Portfolio Manager

Data aggregation is another important usage scenario for IEP XML. Most significantly this has been discussed in the context of the California Integrated Customer Energy Audit Tool (CA-ICEAT). The California Public Utility Commission (CPUC) ordered the investor owned utilities (IOUs) to develop the CA-CICEAT for their customers. However, each IOU selected a different

vendor to build its respective implementation of the CA-ICEAT. The CPUC now faces a challenge in aggregating the similar data collected by each IOU's separate tool. Without a common reporting format among the tools, the CPUC will either receive unique reporting from each of the IOU's tools (therefore putting the burden of aggregating the data on the CPUC), or the utilities will be required to convert their unique report format into a common reporting format for the CPUC (therefore putting the burden on the IOUs). By having each of the CA-ICEAT vendors implement a common project reporting format such as IEP XML, both the IOUs and the CPUC would reduce their data aggregation burden. Implementation of an IEP XML data reporting function would also prepare the distinct CA-ICEAT tools for application integrations that could provide functionality beyond the core strengths of the tool vendors.

In addition to application integration and data aggregation, the IEP XML specification can potentially support data portability among energy software tools. Data portability means that a user of a particular application can save and retain their energy project information to pass on to another organization or application in the future. Saving information offline and locally gives users of online energy service applications confidence and control of their project data. Users can rest assured that they have their current data even if the service provider goes out of business or suffers a loss of data. It also provides them with the ability to port their data from one provider to another supporting the same data exchange format. This type of data portability can provide users with the confidence to use web applications more deeply, knowing they can maintain a local backup of their data and move it to another provider as needed.

8   References

[CPFT] Clean Power Finance (CPF) Tools. http://www.cleanpowerfinance.com/solutions/for-installers/cpf-tools/.

[ESPM ABS] ENERGY STAR Portfolio Manager Automated Benchmarking Services, http://www.energystar.gov/index.cfm?c=spp_res.pt_host_preview_doc

[GBXML] Green Building XML. http://www.gbxml.org/aboutgbxml.php

[SE123] SaveEnergy123. http://www.saveenergy123.com/.

[SN] SolarNexus. http://solarnexus.com/.

[XML] Extensible Markup Language 1.1, http://www.w3.org/TR/xml11/

[XSD] XML Schema, http://www.w3.org/XML/Schema

9   Online Resources

Name	Description	URL
IEP Model Project	Main homepage for project hosting information and a discussion forum about the IEP initiative.	http://iepmodel.net/
IEP Model Downloads	Links to download IEP XDS, documentation, summary report and sample project.	http://files.iepmodel.net/downloads/
IEP Model Schema Documentation	List and diagrams of IEP schemas and related annotations.	http://www.files.iepmodel.net/documentation/Project.html
IEP Top Level Schema Documentation	General overview of project and high level descriptions of IEP schemas.	http://files.iepmodel.net/documentation/

10   Appendices

The following separate documents are provided as appendices to this report.

Available for download at:
http://www.calsolarresearch.ca.gov/Funded-Projects/solicitation1-kw-engineering.html

10.1 Initial Stakeholder Survey Questions

Questions sent in June and July 2010 via email to contractors in the solar, energy auditing and building systems professions.

10.2 Summary of Responses from Initial Stakeholder Survey

Summary of responses received from the initial survey performed by the project team.

10.3 Additional Information on Evaluation of Existing Software Tools

Includes the evaluation matrix from the summary report with the addition of URLs and descriptions for the evaluated software resources.