Technical Proposal for
Consulting Services to Perform Study of Consequential Issues Materially Affecting Kansas Electricity Rates
Submitted to: Legislative Coordinating Council on Behalf of Kansas Legislature
Submitted by: AECOM Technical Services, Inc.

October 1, 2019
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1. Transmittal Letter
1. TRANSMITTAL LETTER

October 1, 2019

Thomas A. Day, Director
Office of Legislative Administrative Services

Gordon L. Self, Revisor
Office of Revisor of Statutes

Re: Consulting Services to Perform Study of Consequential Issues Materially Affecting Kansas Electricity Rates, Request for Proposal (RFP) Re-Bid Workstream 2

Dear Mr. Day and Mr. Self:

AECOM is pleased to assist the Kansas Legislature in understanding and crafting electric system infrastructure policies for competitive electric tariffs and for maintaining high system reliability as we have previously done for stakeholders in the District of Columbia, Ohio, California, and other states. New technologies are available that can greatly improve electric utility customer service, reliability, and security of supply while supporting overall electrification of transportation, but these technologies must be deployed equitably and leave open market opportunities for commercial businesses. AECOM's deep experience in electric vehicle (EV) infrastructure, battery energy storage, microgrids, and distributed generation will help Kansas to shape appropriate policies. We have both helped draft transportation electrification policies and installed the supporting infrastructure for numerous clients, including the U.S. Government who puts physical and cybersecurity as a top requirement.

Our key personnel provide world-class, unmatched, and credible expertise. Our proposed Project Manager, William (Bill) Haas, has deep policy experience in utility systems and has worked for numerous utilities and government agencies such as the Missouri Department of Economic Development – Division of Energy, Iowa Economic Development Authority, AEP, Commonwealth Edison (ComEd), Potomac Electric Power Company (Pepco), and the United States Agency for International Development (USAID). He has developed and implemented effective state and local energy policies, facilitated large groups of diverse stakeholders within complex regulatory environments, and overseen some of the country's largest and most respected energy efficiency and renewable energy programs. Most recently, Bill led a project aiding the Israelis and Palestinians to stand up new renewable and net-metering tariff structures in the West Bank as a part of a USAID program.

Bill and our AECOM team will work with our long-standing partner, Energeia USA (Energeia), to leverage their electric utility cost-of-service (CoS), rate design experience, and modeling capabilities. Over the course of more than 10 EV-related projects for major utilities, governments, and plug-in electric vehicle (PEV) market players (many completed in partnership with AECOM), Energeia has developed a suite of sophisticated tools and methodologies for answering the key questions facing their clients. Combined, our team’s extensive experience will allow us to provide world-class, unmatched, and credible expertise to the Kansas Legislature through our key personnel and responsive project approach.

As illustrated throughout our proposal, our team’s extensive experience and relevant capabilities will allow us to develop a detailed study to identify and address challenges and opportunities that widespread transportation electrification, advanced energy solutions, and regional markers could bring to the state of Kansas. We have direct, recent experience providing similar consulting services including:

- Analyzing CoS for the country’s largest municipal electric utility to identify whether current rates are cost reflective and to design alternative, more cost-reflective rates for residential and commercial ratepayers.
- Identifying the impact of offering advanced energy solutions on a municipal electric utility’s CoS, which identified more than a billion dollars in lower costs over a 20-year period from the implementation of optimal programs, prices, and technologies.
Consulting Services to Perform Study of Consequential AECOM Issues Materially Affecting Kansas Electricity Rates

- Assisting cities and utilities in the evaluation of smart infrastructure solutions, from EVs and microgrids to smart sensors, streetlights, and traffic management systems using triple bottom line modeling techniques.
- Advising multiple utilities regarding business opportunities associated with EV and EV charging, including market outlooks, value chain opportunities, and fleet integration opportunities.
- Delivering the EV uptake and charging demand forecast for a 10-million-customer regional power system market operator.
- Developing a national EV uptake forecast and optimized public charging infrastructure roadmap, including mix of direct current fast chargers and Level 2 chargers for a national planning organization.
- Developing key EV readiness recommendations for a state government to guide policies, regulations, programs, and planning across transportation, land use planning, and finance areas.
- Developing an optimized EV adoption pathway for a national infrastructure planning body that maximized net social benefits by balancing private and public costs and benefits of EVs including peak electricity demand and fuel costs.

As required by the RFP, we have provided the following statements.

✓ AECOM Technical Services Inc. is the prime contractor and we will be providing project management and electrification consulting services. Our team will be supported by subcontractor, Energeia USA, who will also be providing CoS, rates, and electrification consulting services.

✓ AECOM Technical Services, Inc. is a corporation.

✓ No attempt has been made or will be made by AECOM to induce any other person or firm to submit or not to submit a proposal.

✓ AECOM does not discriminate in employment practices with regard to race, color, religion, age (except as provided by law), sex, marital status, political affiliation, national origin or disability.

✓ AECOM has not included any cost or pricing information in the transmittal letter or the Technical Proposal.

✓ AECOM presently has no interest, direct or indirect, which would conflict with the performance of services under this contract and shall not employ, in the performance of this contract, any person having a conflict.

✓ The person signing the proposal, Bill Abolt, Vice President, is authorized to make decisions as to pricing quoted and has not participated, and will not participate, in any action contrary to the above statements.

✓ AECOM Technical Services, Inc. is a wholly owned indirect subsidiary of AECOM. However, AECOM is not expected to supply any service or furnishing any supplies or equipment that would relate to the performance of this contract.

✓ AECOM agrees that any lost or reduced federal matching money resulting from unacceptable performance in a contractor task or responsibility defined in the RFP, contract or modification shall be accompanied by reductions in state payments to Contractor.

✓ AECOM has not been retained, nor has it retained a person to solicit or secure a state contract on an agreement or understanding for a commission, percentage, brokerage or contingent fee, except for retention of bona fide employees or bona fide established commercial selling agencies maintained by the bidder for the purpose of securing business.

AECOM appreciates the opportunity to submit our proposal and looks forward to the possibility of working with you on this important project.

Sincerely,

AECOM Technical Services, Inc.

Bill Abolt, LEED AP
Vice President
312-373-7547
william.abolt@aecom.com

William Haas, LEED AP
Project Manager
312-373-7672
william.haas@aecom.com
2. Bidder Information
2. BIDDER INFORMATION

AE.COM is one of the largest electricity engineering and consulting services providers in the U.S., bringing unmatched experience and expertise to the Kansas Legislature.

Date Established
AE.COM Technical Services, Inc. was registered in California on September 29, 1970.
Energeia USA was established in 2015.

Ownership
AE.COM Technical Services, Inc. is a wholly owned indirect subsidiary of AE.COM, a Delaware corporation whose stock is publicly traded on the New York Stock Exchange (ACM/NYSE).

Energeia USA is a registered small, woman-owned business based in California. Its sister company, Energeia Pty Ltd, based in Sydney, Australia, was founded in 2009.

AE.COM’s Headquarters in Los Angeles, California.
### Personnel Assigned to the Project by Function and Job Title and the Extent they are Dedicated to Other Matters

The following AECOM and Energeia staff are committed and available to work on this study.

**Exhibit 1. Key Personnel Assigned to the Project**

<table>
<thead>
<tr>
<th>Name</th>
<th>Role/Function</th>
<th>Job Title</th>
<th>Benefit to the State of Kansas</th>
<th>Percent Available</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>MANAGEMENT</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bill Abolt, LEED AP</td>
<td>Project Director</td>
<td>Vice President, Smart Energy Practice Leader</td>
<td>Wide ranging public policy and utility expertise</td>
<td>20%</td>
</tr>
<tr>
<td>William Haas, LEED AP</td>
<td>Project Manager</td>
<td>Director</td>
<td>Wide ranging public policy and utility expertise</td>
<td>40%</td>
</tr>
<tr>
<td><strong>ECONOMICS</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ezra Beeman (Energeia)</td>
<td>Workstream direction, CoS and rate design subject matter expertise</td>
<td>Managing Director</td>
<td>Access to specialist knowledge related to cost reflective rate design and CoS modeling</td>
<td>40%</td>
</tr>
<tr>
<td>Garret Harper, CFA</td>
<td>Economic analysis of the price fluctuations of generation fuels on the cost of electricity</td>
<td>Associate Principal</td>
<td>Access to specialist knowledge related economic analysis and cost benefit analysis</td>
<td>30%</td>
</tr>
<tr>
<td>Katrina Lewis</td>
<td>Integrated resource planning process evaluation</td>
<td>Senior Consultant</td>
<td>Access to specialist knowledge related economic analysis and cost benefit analysis</td>
<td>30%</td>
</tr>
<tr>
<td>Tim Scott (Energeia)</td>
<td>Cost of service analysis, modeling and writing; rates analysis, modeling, and writing</td>
<td>Senior Associate</td>
<td>Access to specialist knowledge related to cost reflective rate design and CoS modeling</td>
<td>40%</td>
</tr>
<tr>
<td><strong>TECHNOLOGY</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Órla Pease, PE, PTOE</td>
<td>Transportation electrification subject matter expertise</td>
<td>Vice President, Transportation</td>
<td>Access to specialist knowledge related to transportation electrification</td>
<td>20%</td>
</tr>
<tr>
<td>Matthew Harris, RPA</td>
<td>Cyber security, information and data management and corresponding rate impacts</td>
<td>Americas Lead – Data Science Center of Excellence Director of Geospatial Data Analysis, Northeast</td>
<td>Access to specialist knowledge related to cyber security as it relates to utilities and their customers</td>
<td>20%</td>
</tr>
</tbody>
</table>
## Consulting Services to Perform Study of Consequential Issues Materially Affecting Kansas Electricity Rates

### Name | Role/Function | Job Title | Benefit to the State of Kansas | Percent Available
--- | --- | --- | --- | ---
Phil Owen, CISSP-ISSAP, ISSEP, ISSMP, CISM, CSSA, CSSK, CHS-IV, CNTA, PMP | Cyber security and cyber security policy, information assurance | Information Technology Director | Access to specialist knowledge related to cyber security and specifically cyber security policy | 20%
Tunde Ukwu, CEM, LEED, CMVP, DGCP | Infrastructure and technology review and forecasting | Certified Energy Manager | Access to specialist knowledge related to electrification infrastructure and technology deployment | 30%
Miles Butler (Energeia) | Task management and advanced energy solution SME | Analyst | Access to specialist knowledge related to advanced energy solution options, risks and issues | 40%
Maria Wong Chang (Energeia) | Advanced energy solutions analysis, modeling, and writing | Senior Associate | Access to specialist knowledge related to advanced energy solutions analysis and modeling | 40%
Paige Humecki, LEED AP O&M | Transportation electrification subject matter expertise | Smart Energy Analyst | Access to specialist knowledge related to EV markets, incentive structures, and charging infrastructure | 40%
Dana Al-Qadi, D. Eng | Utility electrification subject matter expertise | Senior Engineering Consultant | Access to specialist knowledge related to EV markets, incentive structures, and charging infrastructure | 40%
Josh Fujii (Energeia) | Task management and EV services market subject matter expertise | Analyst | Access to specialist knowledge related to EV services market deregulation options, risks and issues | 40%
Kofi Agyeman (Energeia) | EV services market analysis, modeling and writing | Associate | Access to specialist knowledge related to EV services market deregulation analysis and modeling | 40%
Consulting Services to Perform Study of Consequential Issues Materially Affecting Kansas Electricity Rates

Organizational Chart

Exhibit 2. Organizational Chart

AECOM’s Work for Electric Investor-Owned, Cooperatives, Municipalities, or Regulatory Agencies in Kansas in the Last 10 Years

In the last 10 years, AECOM has provided consulting services for the following Kansas electric companies (investor-owned utilities [IOU], cooperatives, municipalities, and regulatory agencies):

- Tallgrass Energy
- Westar Energy Inc.
- Wolf Creek Nuclear Operating Corporation

Financial Statements

3. Qualifications
3. QUALIFICATIONS

AECOM has successfully provided similar consulting services to governments, utilities, and transit agencies across the U.S.

Qualifications and Experience Providing Similar Services

AECOM

AECOM brings both direct and recent experience providing similar consulting services to those requested by the RFP. Our work has assisted governments, utilities, and transit agencies in developing effective policies and regulations while considering the competitive rates and reliable service. Much of our work has included detailed modeling and forecasting efforts combined with extensive stakeholder engagement across all utility customer classes and key stakeholder organizations.

Energeia USA

Energeia has specialized in electric utility CoS and rate design, electrification of transportation, and advanced energy solutions for more than 10 years. Energeia has developed deep subject matter expertise in these areas that will benefit Kansas. In addition to industry leading specialist knowledge, Energeia has developed a suite of specialist tools and models (See Section 10, Technical Literature for more information) that enable it to undertake larger and more complex scopes of work at lower cost and risk compared to those working without access to them.

Established Firm Recognized for Capacity to Perform

AECOM Overview

AECOM is a fully integrated professional and technical services firm positioned to design, build, finance and operate infrastructure assets around the world for public- and private-sector clients. We are a leader in all of the key markets that we serve — including energy, transportation, facilities, environmental, oil and gas, water, and building design and construction. A Fortune 500 firm, AECOM companies have an annual revenue of approximately U.S. $20.2 billion.

What differentiates us from others is the collaborative way we work globally and deliver locally. A trusted partner to our clients, we draw together teams of engineers, planners, architects, landscape architects, environmental specialists, economists, scientists and program managers—all dedicated to finding the most innovative and appropriate solutions and improving the quality of life for those affected by each project.

Formed from many of the world’s finest engineering, design, environmental, and planning companies, AECOM’s technical expertise and creative excellence combine to provide fully integrated capabilities to a broad range of markets. Our adaptable and flexible approach to projects allows us to deliver with consistency, longevity, high quality, and efficiencies in cost and time. Our capabilities include:

- Architecture and design
- Asset management
- Construction
- Cost management
- Decommissioning and closure
- Economics
- Engineering
- Environmental services
- International development
- IT and cybersecurity
- Operations and maintenance
- Planning and consulting
- Program management/construction management
- Risk management and resilience
- Technical services

What Sets AECOM Apart

Local Presence and Global Knowledge

We connect knowledge and experience across our global network of experts to help clients solve their most complex challenges. Our broad range of coverage allows us to reduce costs; perform high-quality, cost-competitive projects; and employ local experts.
Impressive Credentials
As an engineering-based energy services company (ESCO) — we are increasingly sought out by our clients to develop and execute comprehensive energy efficiency, renewable energy, power generation, and energy storage projects. We bring a unique combination of energy services, professional engineering, installation and construction, and program management and construction management capabilities.

National Association of Energy Service Companies
We are one of the only global planning, engineering, and construction management firms that is also a NAESCO accredited ESCO.

Vendor Neutral
We bring a variety of unique skills and capabilities to our clients from a vendor neutral and technology agnostic perspective. We do not manufacture, sell, or represent any specific equipment or technology.

Commitment to Safety
Our culture of caring enables the secure work environment needed to safeguard our people, projects, and reputation and aids in the safe return home of our employees to their families. We strive for zero employee injuries and illnesses, to avoid property damage and to operate and deliver our work responsibly and sustainably.

Energeia Overview
Energeia USA was established in 2015 as the U.S. headquarters of Energeia Pty. Ltd., an Australia company cofounded in 2009. Energeia Pty. Ltd. has grown since 2009 to become the largest specialist energy consultancy in Australia. Energeia’s U.S. ambitions are to establish the best emerging energy focused consultancy in the U.S.

Energeia specializes in providing advisory, research and analytical tool development services in the following areas:
- Energy policy and regulation
- CoS and advanced rate / tariff design
- System / network planning and design
- Wholesale and retail electricity markets
- Smart networks and smart metering
- Energy storage
- Electric vehicles and charging infrastructure
- Distributed generation and storage technologies
- Demand management and energy efficiency

Energeia delivers its services across three lines of business:
- **Proprietary research.** Energeia provides in-depth reports on distributed energy resource related markets and technologies of strategic interest, including EVs, solar PV and storage, smart grids, microgrids, energy efficiency, and home energy management.
- **uSim and wSim utility and market simulators.** Energeia has developed industry leading utility simulation software that models customer behavior, bills, distributed energy resources (DER) adoption, 8760 load profiles, utility sales, capex, opex, rates, and financial performance on an integrated basis.
- **Professional Services.** Energeia offers tailored services in the areas of rate and incentive design, CoS analysis, DER, and load forecasting, system planning, and DER technology-related strategy and plan development.

Energeia is organized into research, consulting, and software development functional units, but there is significant cross-over between the working groups due to the substantial quantitative analysis Energeia performs on behalf of its clients, much of which requires custom tooling.

The software development working group is responsible for the development of Energeia’s utility simulation tool, uSim. The consulting and research teams are responsible for delivering Energeia’s proprietary research reports and professional services.

Sufficient Personnel to Meet Project Deadlines
AECOM’s approach to successful program management is based on the principle that every client’s project is treated with same level of importance. Every step in the process and every team member involved during the project lifecycle — from the initial lead to the project close-out — also carry equal importance. This emphasis on the importance of each customer and attention to detail are key to AECOM’s successful program management and gives the Legislative Coordinating Council (LCC) of the Kansas Legislature the assurance that all aspects of the project will be delivered on-budget, on schedule, and in compliance with all scope and quality requirements.

AECOM and Energeia have carefully reviewed the requirements of the RFP as well as the inputs and level of effort needed to complete the work. We have confirmed the availability of our staff and are fully prepared to begin work on this exciting project.
4. Experience
4. EXPERIENCE

**AECOM’s extensive electrification experience will allow us to quickly and effectively execute the scope of work.**

AECOM is a leader in integrated planning and engineering solutions for a sustainable energy future. The company’s mission is to help its clients reduce energy and water consumption, develop renewable sources, cut carbon emissions, and improve infrastructure and community resilience. We understand state energy and utility policies, regulations, and rates and have worked closely with governments and utilities across the country on electrification.

On the following pages, we have included AECOM’s past experience in implementing successful professional services with similar breadth, scope, and technical skill set. We recognize that much of this work was completed in the state of California due to that state’s already established electricity market regionalization, transportation electrification, and advanced energy solution policy goals.

Additionally, our proposed Project Manager, William (Bill) Haas, worked on several relevant energy projects prior to AECOM. **Bill managed a project for the Missouri Department of Economic Development to develop Missouri’s first Comprehensive State Energy Plan.** Bill served as project manager for this project directly managing a team of more than 15 policy analysts, engineers, designers, and planners while holding responsibility for overall project execution and the development of policy recommendations for the state that were actionable and would deliver lasting value to Missouri residents and businesses. **Bill also managed a project supporting the Iowa Economic Development Authority and the Iowa Department of Transportation in the development of the Iowa Energy Plan.** The Iowa Energy Plan included 15 objectives and 45 strategies that proposed a balanced approach to encourage growth in all of Iowa’s energy sectors while emphasizing sustainable practices, economic development, and the research and development required to keep Iowa on the leading edge of energy innovation. Bill led a comprehensive stakeholder engagement process that included a series of energy forums held throughout the state establishing a platform for public comments and facilitating working group discussions.

Locally, AECOM has had a presence in Kansas for many years and has completed numerous infrastructure, architecture and design, and oil and gas projects in Kansas including the following:

- USACE, Turkey Creek Wing Wall and Tuttle Creek Dam Rehabilitation
- Kansas City Power & Light (KCP&L) La Cygne Power Plant
- Pawnee Watershed District, Horsethief Dam
- Natural Resources Conservation Service (NRCS) Dam Rehabilitation
- Cintas – Former RUS Site, Wichita, KS
- Shell – HollyFrontier Refinery, El Dorado, KS
- Shell – Great Bend Terminal, Great Bend, KS
- Shell – Valley Center Terminal, Valley Center, KS
- Shell – Former Chase Pipeline, Maize, KS
- Shell – Former Texaco Pipeline, Waverly, KS

AECOM provided architecture, interior design, structural engineering, and cost estimating services for the expansion and renovation of Bill Snyder Family Stadium at Kansas State University. This project, the West Stadium Center, represents the centerpiece of an overall master plan for improvements to the stadium, designed with the goal of providing the best experience in the Big 12 for student-athletes and fans alike.
The AECOM team analyzed the impact of high penetration of variable renewable energy resources and distributed solar PV generation on the utility’s system balancing requirements including reserve requirements, ramp rate requirements, system reliability and operation requirements (system inertia and frequency response) and generation dispatch strategies.

The MGREPS goal requires that 33 percent of the utility’s electricity retail sales be served by renewable energy resources by 2020, and 50 percent by 2030. As a result, their generation, transmission, and distribution system is expected to face planning and operating challenges in the near future as solar and other variable energy resources (VER) become a larger component of total energy resources and therefore increase the potential for over/under-generation, frequent load swings, and reliability standard violations. In line with this, the AECOM team recently completed the study objective of analyzing the impact of high penetration of variable renewable energy resources and distributed solar PV generation on the utility’s system balancing requirements including reserve requirements, ramp rate requirements, system reliability and operation requirements (system inertia and frequency response) and generation dispatch strategies.

We used results from the client’s resource planning scenarios to identify time periods and scenarios in which the system might be stressed, and identify potential mitigation options for system stresses both by modifying operation of client resources and potential addition of new resources Results were integrated with detailed sub-hourly and sub-second frequency response analysis of the system to identify the potential value of energy storage additions. This effort included extensive collaboration with client staff and management.
Distributed Energy Resource Integration Study (DERIS)
Los Angeles, California

LADWP engaged AECOM to lead a consortium including Energeia to advise them on their Distributed Energy Resource (DER)-integrated distribution plan. The project estimated the economic impact of optimal integration of rooftop solar PV, battery storage, energy efficiency, demand response and electric vehicles. The project also identified the key organizational capabilities needed for the future.

AECOM was the prime contractor, responsible for managing a complex program of work across a team of five organizations, including Energeia and three other subcontractors. AECOM provided program management and deliverable quality control ensuring high quality project outputs were delivered on time and to budget, despite a very challenging schedule.

DER includes rooftop solar PV, battery storage, cogeneration, demand response, energy efficiency, and vehicle electrification.

The Energeia team was responsible for developing cost reflective, DER resilient rates, and for forecasting DER uptake, operation and system CoS and customer bill impact on LADWP’s system under a no-change and an optimized DER-integration scenario.

As part of the DER optimization scenario, Energeia analyzed LADWP’s CoS at the system, transmission, 34.5kV and 4.8kV level, and by time period, to identify optimized DER programs, incentives and cost-reflective rates designs for delivery of optimized DER adoption patterns and minimization of LADWP’s overall CoS and customer electricity costs. Energeia also benchmarked LADWP’s program targets against best practice DER targets of peer utilities in California and the U.S., including Sacramento Municipal Utility District (SMUD).

Energeia’s recommended rate designs, DER programs and incentives were estimated to save consumers 30 percent by 2030 compared to the no-change scenario. The recommendations were accepted by LADWP and are in the process of being implemented.
Local Transmission Reliability Study
Los Angeles, California

Energeia was contracted as part of a consortium hired by LADWP to analyze the potential for DER to address transmission and resource adequacy constraints expected to emerge due to the decommissioning of 1.5 gigawatts of gas-fired generating plant capacity over the next 10 years.

Energeia assessed the potential for distributed energy resources (DER) to address some or all of the identified constraints in the transmission load flow or resource adequacy (RA) analysis. DER was limited to rooftop solar PV, behind the meter battery storage, energy efficiency, demand response (direct load control only) and EV load management.

Energeia first developed an estimate of incremental achievable potential above the level of DER already assumed in LADWP’s forecast peak demand. Energeia used its bottom-up, 8,760-hour modeling software, uSim, which enabled estimates of incremental achievable potential at the receiving station (RS) level by hour for each of the key study years of 2024 and 2029.

Energeia then developed DER solutions for the identified transmission constraints and risks in 2024 and 2029 and for the resource adequacy constraints starting in 2026.
Interim and New Rate Cycle Support
Los Angeles, California

Energeia is part of the consulting team engaged by the LADWP rates area to support the company’s 2019 interim rate review and the 2020 full rate case. Energeia’s work to date has focused on the impact of DER on rates, and the design of five new rate designs to remove barriers to the efficient electrification of busses in Los Angeles.

Energeia developed charging optimization and storage optimization analytics to anticipate and quantify the net benefits of charging optimization and distributed storage assets to LADWP and to the customer. The rates were welcomed by the bus organizations and passed by the Board. The project was delivered to an extremely challenging schedule (under 3 months).

Energeia also analyzed the impact of energy efficiency programs on customer consumption and bills, taking weather effects and other macroeconomic drivers of demand into account. Energeia also analyzed the impact of proposed bill changes on different customer segments, including vulnerable customers, customers with solar PV, larger customers, and different types of business segments.
Assessment of Growing Plug-in Electric Vehicle Demand and Charging Services
Roseville, California

Client
City of Roseville, California/Roseville Electric Utility

Services
Project management
Projection of PEV and PEV charging technology
Projection of PEV charging utilization trends
Assessment of the utility’s PEV role
Assessment of PEV’s impact on the distribution grid, utility power resources, and electric load forecasting
Reporting

Project dates
2017-2018

Relevance
EV charging services market needs assessment
Transportation use cases
Utility infrastructure planning
EV charger implementation
Electric reliability modeling / capital planning
CoS impact assessment
Regulatory program work

AECOM and Energeia were hired to provide third-party consulting services for the evaluation of impacts on the Roseville Electric Utility (Utility) due to growing customer demand for at-home, at-work, and recreational and pass through transient plug-in electric vehicle (PEV) charging.

The AECOM team assisted the Utility in accessing business strategies and distribution/operational plans for expanding customer demand for PEV charging services in the City of Roseville. This study will be used to create an electric utility business plan for the Utility’s response to customer PEV demand. Ideally, this plan will provide information that will be used to direct utility operations, business policies, and customer program development that will support customer expectations and preferences and facilitate the utilization of PEVs in the City of Roseville. The study will assess various scenarios and recommend operational and business practices that may be adopted by the Utility.

AECOM completed an evidence-based projection of PEV and PEV charging technology considering established policies, market drivers, PEV availability, and anticipated technological advances from 2018-2028. The resulting information, in combination with city-specific data, was then used to model PEV uptake at the utility transformer level. The model outputs include PEV system peak demand impacts, system consumption impacts, CO\textsubscript{2} impacts, feeder peak demand impacts, and demand management impacts. With this information, the City can properly serve and manage PEV charging load and support the development of PEV charging infrastructure.
Fresno County Regional Electric Vehicle Charging Infrastructure Network Plan
Fresno, California

The Fresno Council of Governments selected AECOM and Energeia to develop the Fresno County Regional Electric Vehicle Charging Infrastructure Network Plan, which will identify and address deficiencies of the region’s public and transit electric vehicle (EV) charging infrastructure network within the project area of Fresno County, with an emphasis on disadvantaged communities.

The AECOM team will develop the assessment through a collaborative approach with the Fresno Council of Governments (Fresno COG) to identify and address deficiencies of the region’s public and EV charging infrastructure network with an emphasis on disadvantaged communities. The plan will connect the region to the statewide network, map current and future charger locations, and provide strategies and recommendations to inform the prioritization of future infrastructure investments. The specific scope of work tasks for this project include:

- Engaging in collaboration and community engagement
- Assessing existing EV charging programs
- Completing a gap analysis of EV charging networks
- Delivering a final report to the Fresno COG

**Collaboration and Community Engagement**

The objective of the community engagement task is to conduct outreach to stakeholder groups and the general public to develop a full understanding of Fresno County’s EV infrastructure needs, with an emphasis on outreach to disadvantaged communities. The AECOM team’s approach to this task is based on its experience engaging stakeholders across complex municipal government stakeholder environments.

In collaboration with Fresno COG and the Fresno County Rural Transit Agency (FCRTA), AECOM will identify and establish a group of stakeholders to advise and consult on the EV plan. These members will include local utility, air pollution regulatory authorities, cultural and civic organizations, and tribal governments. AECOM will prepare a roster of all member organizations, including points of contact for each. Roles and responsibilities of each working group member will also be established as part of this task. The public outreach plan will include:

- Workshops to solicit feedback at major project milestones
- A series of focus groups with EV drivers
- One-on-one meetings with agencies currently funding and deploying EV charging infrastructure

Following the development and approval of the public outreach plan, the AECOM team will execute public outreach activities.
Assessment of Existing EV Charging Programs
The AECOM team will work with Fresno COG’s team to finalize the approach and obtain key input and direction from the City. Using the results of the agency meetings held during the community engagement task, the AECOM team will prepare an assessment report of existing EV charging funding programs in Fresno County. Meeting information will be supplemented through agency reports, follow up requests to agency personnel, and Department of Energy and State of California EV charging databases.

The AECOM team will also perform a review of all transit services serving Fresno County. Review will include published transportation agency plans and outreach to transit agency members of the EV Network Charging Working Group.

Gap Analysis of EV Charging Networks
Leveraging our internal library of best practice EV integration solutions, the AECOM team will perform a metrics gap analysis to determine future data needs for Fresno County’s EV infrastructure. Existing metrics and County-level goals will be summarized from the Regional Transportation Plan and Sustainable Communities Strategy (RTP/SCS). The analysis will include gaps in measuring progress towards the goals of both plans as well as metrics to monitor the impacts of those plans on existing and future EV infrastructure.

The gap analysis will deliver ranked technical and financial EV charging and transit solutions for the Fresno COG EV charging network based on a gap assessment of existing programs, feedback through the public engagement process, and technical analysis of siting criteria and integration with the state charging network.

Client Benefits
Fresno COG is benefitting from a team that is a leader in integrated planning and engineering solutions for a sustainable energy future. We understand the State of California and have worked closely with municipal utilities from the Los Angeles Department of Water and Power (LADWP) to the San Francisco Public Utilities Commission (SFPUC). AECOM is also a leader in mobility solutions and recognizes the direct and growing connection between the modern utility grid and vehicle electrification. We have performed vehicle electrification feasibility studies and infrastructure assessments for clients across the U.S. and globally including the Colorado Department of Transportation, Ohio Clean Fuels, and Highways England.

We have engaged with EV stakeholders and developed EV-related business models and plans on behalf of more than 15 clients and have based our general approach on the key learnings from those projects and our understanding of the Fresno COG’s specific circumstances. Our team recently completed a joint project for a confidential California Municipal Utility and for Roseville Electric that includes projection of plug-in EV uptake; charging technology evolution, network, and resource impacts; and a least-cost approach to mitigating them. Therefore, we have recently updated our EV forecasts and understanding of other relevant issues and factors specific to EVs in California. In addition, AECOM team member, Energeia, is a leader in the development of highly granular domestic and commercial EV adoption forecasting. They also specialize in developing business models and plans for entering emerging energy technology market opportunities, including EV-related services such as fleet leasing, financing, charging network access, and charging infrastructure related subcontracting opportunities.

Optimizing the benefits of vehicle electrification, charging infrastructure, grid technologies, and integrating complex program elements requires the identification and tracking of multiple variables including technical, contractual, and regulatory requirements. This complexity can create schedule, budget, and performance risks for communities and their utilities that can discourage project implementation and smart technology adoption.

AECOM has developed and deployed business planning and program management tools that address these risks and are applicable to Fresno COG’s EV charging infrastructure network assessment and can be used to help identify, plan, design, finance, implement, and manage projects that provide the highest level of EV charging services and allow for seamless integration of EVs into the utility’s grid. The two most applicable tools are the Sustainable Systems Integration Model (SSIM™) and the Triple Bottom Line (TBL) investment tool, both of which will be used for the Fresno COG assignment.
Energy Assurance Microgrid
Berkeley, California

The Berkeley Energy Assurance Transformation (BEAT) project seeks to develop a clean energy microgrid community (CEMC) for key facilities located in Downtown Berkeley.

AECOM is currently partnering with the City of Berkeley through the BEAT project to provide comprehensive services for the planning, design and development of an innovative energy assurance microgrid in the city’s downtown area. Our initial work under the assignment focuses on system feasibility and configuration. This effort is directly connected to recommended actions from the Berkeley Resilience Strategy funded by the 100 Resilient Cities initiative of the Rockefeller Foundation. This project is funded by a grant from the California Energy Commission (CEC) as part of the CEC’s Electricity Program Investment Charge (EPIC).

Initiated in 2016, the BEAT project seeks to develop a CEMC for key facilities located in Downtown Berkeley CEMC. The project will result in an innovative, scalable, and replicable model for advancing energy reliability, increasing energy efficiency, and improving access to clean energy for public and private facilities in a dense urban context. The project explores the opportunities for dense urban cities to utilize solar and energy storage to share power across multiple facilities. During normal conditions the system could utilize these resources as a way to better regulate day-to-day energy supply, and in the case of a power outage, the system could “island” from the main utility and provide clean backup power for critical buildings.

In addition to a comprehensive financial feasibility analysis, the BEAT team is also developing concurrent regulatory and technical feasibility analyses. Together, these three foundational analyses will guide the development of a shovel-ready CEMC design in downtown Berkeley.

Cyber security was also considered at a conceptual level. AECOM included an appendix in the technical report written by an AECOM expert in cyber security for industrial controls systems. The appendix listed best practices and standards to minimize the risk of cyber security breaches. from the perspectives of:

- Types of equipment to purchase
- Personnel management
- Building out fiber networks for industrial controls
Electric Vehicle Charge Network Program
Management Office (PMO) Services
San Francisco, California

<table>
<thead>
<tr>
<th>Client</th>
<th>Services</th>
<th>Project dates</th>
<th>Relevance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pacific Gas &amp; Electric Company (PG&amp;E)</td>
<td>Preparing project budget and schedule</td>
<td>2018-2020</td>
<td>Utility infrastructure planning</td>
</tr>
<tr>
<td></td>
<td>Construction management</td>
<td></td>
<td>EV charger implementation</td>
</tr>
<tr>
<td></td>
<td>Project reporting and cost control</td>
<td></td>
<td>Electric reliability modeling / capital planning</td>
</tr>
<tr>
<td></td>
<td>Managing project close-out</td>
<td></td>
<td>Regulatory program work</td>
</tr>
<tr>
<td></td>
<td>Serving as the client’s customer-facing representatives</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

AECOM was awarded an impressive project to provide program management services for the installation of 7,500 electric vehicle charging ports over a three-year period. We were selected in part because of our extensive knowledge of PG&E and our expertise in standing up a program of this size and scale.

AECOM is providing program management services by assisting this client to achieve objectives specific to the Electric Vehicles Charge Network (EVCN) Program. These services include planning, analysis, and project controls, which includes scheduling, cost estimating, contract administration, and document control services. Their objectives include the installation of 7,500 electric vehicle charging ports over a three-year period. These goals include the installation of 10-20 ports per site per month in 2018; increasing to 20-30 per month in 2019 and 2020. AECOM’s focus is on attaining project scope, cost, and schedule goals; identifying gaps; and supporting internal reporting requirements for each project.

Client benefits include:
- Using Unifier to streamline existing document control systems
- Performing gap analysis and resulting changes to improve the program’s success
- Establishing a baseline schedule for contractors
- Developing rough order of magnitude program costs
- Reviewing and validating project costs
- Setting up processes and procedures from the operations side and creating a system
- Ensuring accountability
Consulting Services to Perform Study of Consequential Issues Materially Affecting Kansas Electricity Rates

Work performed includes:

- Establishing baseline schedules and costs with contractors
- Issuing contract work authorizations (CWA) based on the MSA and handling payment applications through Unifier
- Helping to re-establish 2019-2020 budgets and achievable outcomes
- Reviewing existing rough order of magnitude (ROM) tool
- Re-establishing a more accurate quantity take-off
- Preparing project budget, schedule, and approval authorizations as required.
- Managing construction performed by internal and external resources. Some work will be performed utilizing an engineer, procure, and construct (EPC) project delivery model.
- Managing all project reporting, particularly milestone attainment, and cost forecast accuracy.
- Managing project close-out and ensuring that all deliverables meet client requirements for as-builts, records retention, and that the customer receives their rebate in a timely fashion.
- Serving as the client’s customer-facing representatives for the program, ensuring customer satisfaction by meeting cycle time requirements, and addressing customer concerns in a timely fashion.
Illinois Tollway Strategic Plan – EV Charging

Client
Illinois State Toll Highway Authority (Illinois Tollway)

Services
Project management
Projection of current and future charging technologies, including PEV, static wireless, and dynamic wireless charging
Projection of PEV charging utilization trends
Coordination with the local utility
Assessment of PEV’s impact on the distribution grid, utility power resources, and electric load forecasting

Project dates
2018-2019

Relevance
EV charging services market needs assessment
Transportation use cases
Utility infrastructure planning
EV charger implementation
Electric reliability modeling / capital planning
Regulatory program work

AECOM is leading a study and pilot of emerging charging technology that can be installed in the Illinois Tollway to support medium and heavy EVs in the future. We are leading these efforts in collaboration with the Illinois Tollway and ComEd utility based on our extensive knowledge of both agencies’ infrastructure and future plans.

AECOM assisted the Illinois State Toll Highway Authority in developing a strategic vision and implementation plan to deliver electric vehicle charging options to customers within the I-294 Central Corridor. Key elements of the plan were a review of existing and future technologies available, a market demand study projecting future charging utilization trends, and the impacts of smart powered lanes on utility resources and load forecasting. At the conclusion of the study workstream, pilot projects will be identified for installation in 2019. Based on the results of the market demand study and pilot projects, options for full-scale implementation of smart powered lanes will be recommended in 2022.
### Washington Metropolitan’s Electric Bus
Washington, DC

<table>
<thead>
<tr>
<th>Client</th>
<th>Services</th>
<th>Project dates</th>
<th>Relevance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Washington Metropolitan Area Transit Authority (WMATA)</td>
<td>Pilot program development, Technology assessment, Economic modeling</td>
<td>2019-ongoing</td>
<td>Technology assessment, EV charging infrastructure assessment, Economic modeling</td>
</tr>
</tbody>
</table>

**AECOM** developed a two-workstream pilot program to meet WMATA’s long-term goal of an all-electric bus fleet.

WMATA intends to operate a fully electric bus fleet, both for its own organizational goals and to meet the requirements of the DC Clean Energy Omnibus Act Amendment of 2018, by 2045. AECOM created a two-workstream pilot program, beginning with an alternatives analysis to assess the possible facilities and subsequent routes from which a pilot program would best be operated. AECOM developed an outline of space needs, infrastructure improvements, and charging requirements for in-depot and on-route charging.

Workstream 1 defined critical elements of the pilot program and provided recommendations. Workstream 2 will detail specific recommendations for size of the pilot fleet, estimates for all aspects of the pilot program, and a full performance monitoring and evaluation process throughout the duration of the pilot.
Consulting Services to Perform Study of Consequential Issues Materially Affecting Kansas Electricity Rates

Electric Vehicle Readiness Plan
Kings County, California

The Kings County Association of Governments selected AECOM and Energeia to develop the Kings County Electric Vehicle Readiness Plan, which will identify and address deficiencies of the region’s public and transit EV charging infrastructure network within the project area of Kings County.

AECOM is currently developing the Kings County Association of Government’s (KCAG) Electric Vehicle Readiness Plan. The goals of the plan are to:

- Coordinate the implementation and siting of appropriate PEV charging infrastructure for public use to foster greater use of PEVs in the region.
- Prepare and guide KCAG member agencies, other local government entities, and private businesses in PEV infrastructure related best practices (codes and ordinances, charging station locations, etc.) address region-specific challenges, and identify grants for implementation.

Through our planning efforts, the AECOM team will provide direction for current and future planning efforts for the deployment of the PEV infrastructure and will be able to guide KCAG member agencies, other local government entities, and private businesses in addressing challenges such as PEV infrastructure permits, policies, building codes, and cost estimates.

Furthermore, the plan will address the need to connect the region by coordinating strategies and recommendations for implementation and siting of appropriate PEV future infrastructure investments for public use in the region.

Client
Kings County Association of Governments

Services
Planning and policy development
Stakeholder engagement
Modeling

Project dates
2019-Present

Relevance
Utility infrastructure planning
EV charger implementation
Electric reliability modeling / capital planning
Planning and policy work
Palestinian Energy Project
Ramallah, West Bank

Bill Haas served as the project manager for the comprehensive policy review and analysis of renewable energy net metering in the West Bank.

To improve the reliability of electricity services, AECOM drew on its past successes to improve the performance and service quality of Palestine’s energy sector. Specifically, the project focuses on improving access to and reliability of electrical services by strategically incorporating renewable energy, which will increase the Palestinian Authority’s control of its electrical supply and improve affordability over time.

Work included extensive stakeholder engagement, benchmarking, and modeling which resulted in a series of recommendations and policy revisions. PEP is supported by USAID and implemented by AECOM.

Select outcomes of the PEP include:

- Trained 242 people on renewable and conventional energy functions.
- Created 25 relevant assessments, policies, strategies, plans, studies, standards regulations or incentives to enhance energy governance.
- Provided renewable energy tariff structure best practices and recommendations for the Palestinian Electricity Regulatory Council and stakeholders.

USAID’s Palestinian Energy Project (PEP) aims to advance the Palestinian energy sector to support affordable and sustainable energy independence in the West Bank and Gaza.

The Palestinian Authority launched several reforms to respond to its dependence on foreign energy, including creation of the Palestinian Energy and National Resources Authority (PENRA), the Palestinian Electricity Regulatory Council (PERC), and the Palestinian Electricity Transmission Company (PETL). The technical capacities of these entities remained weak, however, which threatened public confidence.

Client
U.S. Agency for International Development (USAID)

Services
Policy and regulatory review
Benchmarking
Policy development
Stakeholder engagement

Project dates
2018

Relevance
Energy and policy regulatory work
5. Timeline / Availability
5. TIMELINE / AVAILABILITY

AECOM has carefully reviewed the project requirements and has allocated the appropriate resources to complete the project on time and on budget.

Successful projects require management of many tasks, activities, milestones, and relationships in order to finish on time and achieve our high-quality standards. Our project management system manages schedules and look aheads with real-time status tracking and collaborative contributions to streamline communication and deliver projects in less time and at reduced costs. Our project management system provides the entire project team with instantaneous views of current schedules.

AECOM understands the deliverables required for each workstream and commits to completing each deliverable on time. Exhibit 3 on the following page provides our proposed project schedule identifying major workstreams to be undertaken to conduct the work and the time frame for each.
### Exhibit 3. Project Schedule

<table>
<thead>
<tr>
<th>TASK NAME</th>
<th>2019</th>
<th>2020</th>
<th>2021</th>
</tr>
</thead>
<tbody>
<tr>
<td>Proposal Submitted</td>
<td>01/10/2019</td>
<td></td>
<td>01/10/2021</td>
</tr>
<tr>
<td>Contract Award</td>
<td>02/19/2019</td>
<td>04/11/2019</td>
<td>02/19/2020</td>
</tr>
<tr>
<td>KS/AECOM Kickoff</td>
<td>05/11/2019</td>
<td></td>
<td>05/11/2020</td>
</tr>
<tr>
<td>Data and Information Gathering</td>
<td>08/11/2019</td>
<td>31/12/2019</td>
<td>08/11/2020</td>
</tr>
<tr>
<td>Review and Assessment (Economics, Technology, Markets)</td>
<td>01/01/2020</td>
<td>24/03/2020</td>
<td>01/01/2021</td>
</tr>
<tr>
<td>Final Report Generation</td>
<td>25/03/2020</td>
<td>19/06/2020</td>
<td></td>
</tr>
<tr>
<td>Report Due for Submission to State</td>
<td>01/06/2020</td>
<td></td>
<td>01/06/2021</td>
</tr>
<tr>
<td>Comment Review</td>
<td>02/06/2020</td>
<td>15/06/2020</td>
<td></td>
</tr>
<tr>
<td>Study Completed and Made Available on LCC Website</td>
<td>01/07/2020</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Study Submitted to Committees</td>
<td>12/01/2021</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
6. Methodology
6. METHODOLOGY

The AECON team’s electrification expertise is the result of numerous policy, planning, and implementation assignments across the U.S. and abroad.

The scope of work required by Senate Bill 69 covers a wide range of topics including the regional economy, regional planning, the regional electricity market, transmission investments, the impact of advanced energy solutions, physical, and cyber security, and their respective impacts on utility CoS and electricity rates by customer class. Exhibit 4 below maps each of the specific questions raised in the RFP to the key issues that need to be reviewed and/or assessed in order to provide a response.

Exhibit 4. Overview of the Project Scope

<table>
<thead>
<tr>
<th>#</th>
<th>Question</th>
<th>ECONOMICS</th>
<th>TECHNOLOGY</th>
<th>MARKETS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Whether any costs incurred by Kansas electric public utilities to build and operate EV charging stations, including any necessary upgrades to distribution infrastructure, are recovered from ratepayers not using EV charging services.</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>How rates for EV charging services should be designed to ensure such rates are just and reasonable and not subsidized by other utility customers.</td>
<td>✓</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>The potential effects of deregulating EV charging services in Kansas, including whether deregulation would ensure that EV charging services are not subsidized by public utility ratepayers not using EV charging services.</td>
<td>✓</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Whether Kansas consumers could benefit from improved access to advanced energy solutions, including micro grids, EVs, charging stations, customer generation, battery storage, and transactive energy.</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>5</td>
<td>The extent to which transmission investments by Kansas electric public utilities have impacted retail rates, including any incremental regional transmission costs incurred by Kansas ratepayers for transmission investments in other states, and whether such costs have been fully offset by financial benefits such as improved access to low-cost renewable energy and wholesale energy markets.</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>6</td>
<td>The costs and benefits incurred by Kansas ratepayers for transmission investments in Kansas, used to export energy out of Kansas.</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>7</td>
<td>How rate increases, or the associated rising costs of Kansas investor-owned electric public utilities, impact the retail electric rates of Kansas electric cooperatives and municipal utilities.</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Whether retail electric rates in Kansas are a material barrier to economic development in Kansas.</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>The impact of contract rates with commercial and industrial customers and economic development rates on other customer classes, including whether expanded utilization of such approaches can benefit all customers over time.</td>
<td>✓</td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>10</td>
<td>Whether Kansas electric public utilities recover their costs of serving customers from each customer class on the basis of cost causation.</td>
<td>✓</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>How cyber and physical security and grid stabilization efforts have affected, or are projected to affect, electric public utility rates.</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>12</td>
<td>The value of a utility integrated resource planning process that requires state regulatory approval.</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>13</td>
<td>Economic analysis of the price fluctuations of generation fuels on the cost of electricity.</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
AECOM thrives on providing a one-stop-shop capable of addressing our client’s needs. We have developed the following project delivery methodology to address the key questions set out in the RFP on time and budget and to a high standard of quality. The project delivery methodology, as illustrated in Exhibit 5, includes the following key project workstreams:

- Project Management
- Data and Information Gathering
- Review and Assessment
- Validation and Documentation

Exhibit 5. Our Team’s Project Delivery Methodology
AECOM will apply its certified project management approach to ensure the timely delivery of this project per the requirements of Senate Bill 69. Our project management system is used to deliver multi-billion-dollar infrastructure investments and is designed to ensure the on-time delivery of high-quality outputs to schedule and budget. The key aspect of our project management approach includes:

- Project mobilization
- Kick-off meeting
- Weekly issues management, coordination, plan management and reporting
- Quality control / assurance of deliverables
- Monthly client reporting and invoicing

Upon contract signing, the AECOM project management team will mobilize the project, including programming key project resources to ensure their availability, and scheduling of the kick-off workshop with the Legislative Coordinating Council (LCC). The kick-off workshop will finalize the project reporting arrangements and schedule, key project contacts, and address any other key project risks and issues raised.

The data and information gathering workstream will be the single interface between the LCC and utilities, streamlining communication and thereby minimizing complexity and resource impacts. It will also manage the needs of each of the technical review and assessment workstreams, ensuring all the data needed is identified upfront and linked to workstream need.

The AECOM team recognizes how important the rapid collection of high-quality, relevant data is to the success of this project. We also recognize the potential costs, risks and issues involved in collecting this information for the LCC and the utilities, as well as for the project. We have therefore designed an integrated approach to gathering the information needed using the following approach:

- Development of a request for information (RFI) tool that maps the information needed to the organization and area of the organization it is expected to come from, based on our understanding of utility information systems and practices.
- Validation of our RFI with the LCC to ensure it is appropriate and complete, and development of a workable contact approach (e.g., single point of contact by utility).
- Issuing of the RFI to the utilities, management of any queries, review of incoming data, chasing up any data gaps, and developing data and information workarounds

The economics workstream will tackle the key economics-related topics including CoS, electricity rate design, and integrated resource planning. The team has been selected for their specialist expertise and knowledge of the relevant economic theory and applied disciplines to ensure we are able to provide the best possible insights.

The Economics Cost of Service Review workstream is a foundational piece of work that will be used to address almost all of the questions in the RFP.

The workstream will therefore interact with most of the other workstreams, which will generally provide the inputs needed to determine the costs and/or beneficial impacts to utility CoS over time. The AECOM team’s approach to this workstream involves the following key steps:

- Review current utility CoS by cost category (i.e., generation, transmission, distribution, supply, etc.) and the allocation of these costs to customer classes and rates
- Develop a flexible CoS model that can be applied across utilities that will enable changes to be made to key cost, cost allocation and customer classification assumptions

Policy

Each of the technical reviews and assessments set out below will be reviewed by William (Bill) Haas for their key policy implications. Bill has more than 15 years of energy policy experience working for and as a consultant to government agencies and not-for-profit stakeholder organizations. This analytical approach will ensure all technical findings and recommendations tie back not only to the RFP and the requirements of Senate Bill 69X, but also the key policy drivers that have engendered it.
Consulting Services to Perform Study of Consequential Issues Materially Affecting Kansas Electricity Rates

- Perform assessments to address the key questions in the RFP
  - Assess whether costs for EV charging services are being allocated to ratepayers that do not use the service.
  - Assess whether the costs for regional transmission projects being allocated to Kansas ratepayers exceed the benefits of lower wholesale power costs.
  - Assess the impact of higher IOU costs on cooperatives and municipal utilities.
  - Assess whether customer class cost allocation is based on customer class cost causation.
  - Assess the impact of physical and cyber security on utility cost to serve.
  - Assess the impact of wholesale cost variability on the cost of electricity.

The **Electricity Cost of Service Review** workstream will deliver the following outputs and recommendations:

- The level of net costs for EV charging services, if any, that are being allocated to ratepayers that do not use the service, taking any benefits from higher asset utilization and lower fixed cost allocation into account.
- The level of net costs for regional transmission projects, if any, that are being allocated to Kansas ratepayers, taking any benefits from lower wholesale market prices into account.
- The impact of changes in key IOU costs on cooperatives and municipal utilities, including transmission, wheeling, system balancing, and other pass-through costs.
- Whether customer class cost allocation is based on customer class cost causation, which classes are affected and by how much, and remediation recommendations.
- The net costs of physical and cyber security on utility cost to serve, including, where possible and at a high level, any reported quantified benefits from increased security.
- An estimate of the impact of wholesale cost changes on electricity rates (e.g., a 20 percent increase/decrease in volume weighted average wholesale prices results in a 5 percent increase/decrease in average retail rates).

The **Electricity Rates Review** workstream will primarily review and assess:

- How rates for EV charging services should be designed to ensure such rates are just and reasonable, and not subsidized by other utility customers.
- Whether Kansas electric public utilities recover their costs of serving customers from each customer class on the basis of cost causation.

The **Electricity Rates Review** workstream will interact with the Electricity Cost of Service Review workstream as well to fully address the questions.

The AECOM team’s approach to this workstream involves the following key steps:

- Assess whether current utility rate designs just and reasonably recover costs, and do not cross-subsidize users of utility EV charging services.
- Assess whether current utility rate designs recover costs on the basis of cost causation, i.e., are they allocated to the customer class responsible for causing them.
- Where rates are found to not be cost reflective and/or lead to cross subsidies, the AECOM team will
  - Develop alternative rates for major customer classes to improve their cost recovery on the basis of cost causation, consistent with the recommendations of the National Association of Regulatory Utility Commissioners.
  - Develop alternative rates for EV vehicle charging services to ensure they recover costs on a just and reasonable basis, without cross subsidizing users of EV vehicle charging services.

The **Electricity Rates Review** workstream will deliver the following outputs and recommendations:

- Whether current utility rate designs in general, and EV charging rates in particular, recover costs on a cost causation basis, and/or whether they cross subsidize EV charging service users.
- Tariff designs and EV charging service tariff designs for major customer classes that could materially improve cost causation and reduce cross-subsidies.

The **Integrated Resource Planning Review** workstream will primarily review and assess:

- The value of a utility integrated resource planning process that requires state regulatory approval.

The workstream will interact with the Advanced Energy Solutions Impact Assessment and Regional Markets Costs and Benefits workstreams, as they provide potential resources.

The AECOM team’s approach to this workstream involves the following key steps:

- AECOM will examine current, if applicable, utility plans for meeting forecasted annual peak and energy demand, plus some established reserve margin. This would be achieved through a combination of supply-side and demand-side resources. This approach will integrate insight from many of the other disciplines and give recommendations on best path forward based on all of the data received.
We will then complete a regional benchmarking review to compare the planning work done by Kansas utilities to those completed by other Midwestern utilities. After the benchmarking exercise is completed, the AECOM team will submit to the LCC a detailed memorandum describing the benefits and costs of formalizing or otherwise changing the integrated resource planning process.

The Integrated Resource Planning Review workstream will deliver the following outputs and recommendations:

- The costs and benefits of a utility integrated resource planning process that requires state regulatory approval.
- Policies and other changes that could improve the value of the integrated resource planning process to the state of Kansas.

The technology workstream will tackle the key technology related topics covering transmission investments, the potential benefits of advanced energy solutions, and cyber and physical security. The team has been selected for their specialist expertise and knowledge of the relevant technologies to ensure we are able to provide the best possible insights.

**Advanced Energy Solutions Impact Assessment**

The Advanced Energy Solutions Impact Assessment workstream will primarily review and assess:

- Whether Kansas consumers could benefit from improved access to advanced energy solutions, including micro grids, electric vehicles, charging stations, customer generation, battery storage and transactive energy.
- The value of a utility integrated resource planning process that requires state regulatory approval.

The workstream will interact with the Cost of Service Review, Electricity Rates Review, EV Services Market, and Integrated Resource Planning workstreams as well to fully address the above questions.

The AECOM team’s approach to the Advanced Energy Solutions Impact Assessment workstream involves the following key steps:

- Review utility advanced energy programs against utility best practice from across the U.S. in terms of availability, cost, enrollment and impact.
- Develop a high-level but economically correct model of the potential impact of improved access on utility CoS, electricity rates and customer bills, whether they are enrolled in a program or not.
- Develop an indicative / high level estimate of the economically optimal level of alternative energy solutions to be included in integrated resource plans given relative costs and benefits.

The Advanced Energy Solutions Impact Assessment workstream will deliver the following outputs and recommendations:

- The advanced energy solutions that will benefit Kansas customers by major solution and customer type, the net benefits they could provide and how, and whether they are currently being offered by utilities.
- The role and potential net beneficial impact of identified beneficial advanced energy solutions as part of regulated utility integrated resource plans in Kansas.

**Cyber and Physical Security Review**

The Cyber Security and Physical Security Review workstream will primarily review and assess:

- How cyber and physical security and grid stabilization efforts have affected, or are projected to affect, electric public utility rates.

The workstream will interact with the Cost of Service Review and Electricity Rates Review workstreams as well to comprehensively address the above question.

The AECOM team’s approach to the Cyber Security and Physical Security Review workstream involves the following key steps:

- Review utility programs and costs related to physical and cyber security
- Review of physical and cyber security cost treatment in utility cost of service, cost allocation, and rate design
- Assessment of utility expenditure against peer utilities and best practice

The Cyber and Physical Security Review workstream will deliver the following outputs and recommendations:

- The level of costs in percentage and absolute terms that cyber and physical security and grid stabilization efforts have contributed to, or are projected to contribute to, electric public utility rates.
- Changes to policies that could minimize the cost of cyber and physical security for Kansas ratepayers.
Transmission Investment Review

The *Transmission Investment Review* workstream will primarily review and assess:

- The extent to which transmission investments by Kansas electric public utilities have impacted retail rates, including any incremental regional transmission costs incurred by Kansas ratepayers for transmission investments in other states, and whether such costs have been fully offset by financial benefits such as improved access to low-cost renewable energy and wholesale energy markets;
- The costs and benefits incurred by Kansas ratepayers for transmission investments in Kansas, used to export energy out of Kansas

The workstream will interact with the Cost of Service Review, Electricity Rates Review and Regional Power Market Costs and Benefits review workstreams as well to provide the cost of service and rate impact assessments.

The AECOM team’s approach to the *Transmission Investment Review* workstream involves the following key steps:

- Examine the transmission investments to date and trace the assignment of their costs and benefits to Kansas ratepayers and rates
- Assess the impact of transmission investments on wholesale prices and renewable energy costs for Kansas ratepayers
- Review whether there are constraints within the regional transmission system that are negatively impacting Kansas electricity rates.

The *Transmission Investment Review* workstream will deliver the following outputs and recommendations:

- The net benefits or costs to Kansas ratepayers from regional transmission investments by Kansas electric public utilities
- The net wholesale market and renewable energy benefits or costs to Kansas ratepayers from regional transmission investment
- The costs and benefits incurred by Kansas ratepayers for transmission investments in Kansas, used to export energy out of Kansas
- Changes to policies that could increase the net benefits of regional transmission investments for Kansas ratepayers.

EV Charging Services Market Assessment

The *EV Charging Services Market Assessment* workstream will primarily review and assess:

- The potential effects of deregulating EV charging services in Kansas, including whether deregulation would ensure that EV charging services are not subsidized by public utility ratepayers not using EV charging services.

The *EV Charging Services Market Assessment* workstream will interact with the Electricity Cost of Service Review and Electricity Rates Review workstreams as well to fully address the question.

The AECOM team’s approach to this workstream involves the following key steps:

- Review of the current utility costs of providing the service, cost recovery for the service relative to the costs, and whether any costs are currently being recovered from customers not using the EV charging services.
- Review whether there are any benefits to non EV drivers, for example, due to greater utilization of electricity assets, and how and whether these are being shared between customer classes.
- Review options and best practice for deregulating EV charging services to maximize the benefits to rate payers, EV drivers, as well as the wider community.

The *EV Charging Services Market Assessment* workstream will deliver the following outputs and recommendations:

- Whether deregulation would ensure EV charging services are not subsidized by public utility rates payers not using electric vehicle charging services.
- Key options and approaches for deregulating EV charging services, emerging best practice in this area, and key recommendations for the Kansas legislature to maximize the net benefits across rate payers, EV drivers and the community.
**Regional Power Market Costs and Benefits Analysis**

The **Regional Power Market Costs and Benefits Analysis** workstream will consider and integrate the impacts from a number of other workstreams on regional wholesale power market prices, and feed into other workstreams regarding the impact of those changes on wholesale market costs and benefits.

Each of the following workstreams is expected to have an impact on regional power market prices or be impacted by them:

- Whether Kansas consumers could benefit from improved access to advanced energy solutions, including micro grids, electric vehicles, charging stations, customer generation, battery storage and transactive energy.
- The extent to which transmission investments by Kansas electric public utilities have impacted retail rates, including any incremental regional transmission costs incurred by Kansas ratepayers for transmission investments in other states, and whether such costs have been fully offset by financial benefits such as improved access to low-cost renewable energy and wholesale energy markets.
- The costs and benefits incurred by Kansas ratepayers for transmission investments in Kansas, used to export energy out of Kansas.
- The value of a utility integrated resource planning process that requires state regulatory approval.
- Economic analysis of the price fluctuations of generation fuels on the cost of electricity.

The AECOM team’s approach to this workstream involves the following key steps:

- Analyze historical relationship between transmission investment and regional wholesale prices.
- Develop estimate of the impact of transmission investments on regional wholesale prices paid by Kansas ratepayers.
- Analyze historical relationship between regional exports and regional wholesale prices.
- Develop estimate of the impact of regional exports on regional wholesale prices paid by Kansas ratepayers.
- Analyze historical relationship between alternative energy solution adoption and regional wholesale prices.
- Develop estimate of the impact of advanced energy solutions on regional wholesale prices paid by Kansas ratepayers.
- Analyze historical relationship between fuel prices and regional wholesale prices.
- Develop estimate of the impact of fuel prices on regional wholesale prices paid by Kansas ratepayers.

**Regional Cost Competitiveness Review**

The **Regional Cost Competitiveness Review** workstream will primarily review and assess:

- Whether retail electric rates in Kansas are a material barrier to economic development in Kansas.
- The impact of contract rates with commercial and industrial customers and economic development rates on other customer classes, including whether expanded utilization of such approaches can benefit all customers over time.

The **Regional Cost Competitiveness Review** workstream will interact with the Electricity Cost of Service Review and Electricity Rates Review workstreams as well to fully address the questions.

The AECOM team’s approach to this workstream involves the following key steps:

- Identify major electricity market exposed industries in Kansas.
- Benchmark Kansas electricity rates against other Midwestern states.
- Review contract rates and economic development rates.
- Estimate impact of incremental load from economic development rates on other customer classes.

The **Regional Cost Competitiveness Review** workstream will deliver the following outputs and recommendations:

- Which industries are electricity exposed, and their economic and job contribution to Kansas.
- Kansas’ electricity rates by customer class compared to state peers.
- Whether any differences are a material barrier to economic development in Kansas.
- Whether economic development contracts address the competitiveness gap.
Consulting Services to Perform Study of Consequential Issues Materially Affecting Kansas Electricity Rates

- An estimate of the impact of additional load from economic development contracts on other customer classes.
- An estimate of the impact of additional GDP, jobs and taxes from economic development contracts on the Kansas economy.

Validation and Documentation

Following completion of the Review and Assessment workstream of the project, the AECOM team will engage with the project steering committee and the Commercial Commission to validate our draft key findings and recommendations. Engagement will be delivered via a series of workshops to go through the findings and recommendations in person, prior to drafting the final report.

The final report will be developed following the engagement workshops, and produced to AECOM’s high standards for layout, graphic design, content, and accessibility. Feedback received on the report will be managed via a feedback register to ensure that all feedback is captured, processed, and reflected in the final report.
7. References
At AECOM, every client’s project is treated with same level of importance and we constantly strive for successful project performance.

The client references listed in Exhibit 6 may be contacted for similar work AECOM and Energeia have completed within the last five years.

Exhibit 6. Project References

<table>
<thead>
<tr>
<th>Project Name</th>
<th>Client</th>
<th>Completion Date</th>
<th>Client Contact Information</th>
<th>Firms Involved</th>
</tr>
</thead>
</table>
| Distributed Energy Resource Integration Study (DERIS)    | LADWP                           | 2017            | Haik Movsesian  
DER Planning Engineer  
LADWP  
111 North Hope Street  
Los Angeles, CA 90012  
Haik.Movsesian@ladwp.com  
213-367-3936 | AECOM and Energeia               |
| Interim and New Rate Cycle Support                       | LADWP                           | 2018-2020       | George Chen  
Rates Manager  
LADWP  
111 North Hope Street  
Los Angeles, CA 90012  
George.chen@ladwp.com  
213-367-2531 | Energeia                        |
| Assessment of Growing Plug-in Electric Vehicle Demand and Charging Services | Roseville Electric Utility/City of Roseville, California | 2018 | David Bradford  
Roseville Electric Customer and Government Relations  
2090 Hilltop Circle  
Roseville, CA 95747  
DBradford@roseville.ca.us  
916-746-1672 | AECOM and Energeia               |
| Electric Vehicle Readiness Plan                          | Kings County Association of Governments | Ongoing | Christopher Xiong  
Regional Planner  
Kings County Association of Governments  
339 W D Street  
Lemoore, CA 93245  
Christopher.Xiong@co.kings.ca.us  
559-852-2676 | AECOM and Energeia               |
| Palestinian Energy Project                                | USAID                           | 2018            | Jennifer Kovolski  
DT Global US  
BD Director, Environment and Infrastructure  
1625 Eye Street NW, Suite 200  
Washington DC, 20006  
jennifer.kovolski@dt-global.com  
603-554-2569 | AECOM                           |
8. Bidder Contracts
8. BIDDER CONTRACTS

Please accept the enclosed Design Engineering Services Agreement as the Agreement AECOM proposes to incorporate into the contract generated from the Legislative Coordinating Council on behalf of Kansas Legislature. To the extent that the proposed Agreement is not accepted, AECOM reserves the right to negotiate final contractual provisions in an effort to reach a mutually agreeable contract in line with appropriate industry standards.

As noted in Section 12, Exceptions, AECOM is not taking any exceptions to the contract terms in DA-146a.
INTERNAL NOTE TO CONTRACT PREPARER: ALL ITEMS IN RED ARE INTERNAL INSTRUCTIONS, PLEASE READ THE INSTRUCTIONS, MAKE THE APPROPRIATE INSERTIONS, AND THEN DELETE THE INSTRUCTIONS BEFORE ISSUING THIS DOCUMENT. MAKE SURE THE FONT AND SIZE ARE ADJUSTED AFTER YOU HAVE DELETED THE INSTRUCTIONS.

DESIGN ENGINEERING SERVICES AGREEMENT

This Design Engineering Services Agreement ("Agreement") effective this ______________, 20______________, is by and between Insert the full legal name of the Client _______________, a [Insert the state and type of legal entity (e.g., California sole proprietorship/corporation/LLP/LLC.) _______________], ("Client"). and NOTE: AECOM Technical Services, Inc. is listed because it is the primary AECOM legal entity used within the USA. However, a different AECOM legal entity may be required in certain states to meet registration requirements. Check with the Legal team to confirm the applicable AECOM legal entity. If a different AECOM legal entity is used, you need to replace “AECOM Technical Services, Inc.” with the appropriate AECOM legal entity here, on the signature page, and in any Change Orders. AECOM Technical Services, Inc., a California corporation, (“AECOM”); each also referred to individually as (“Party”) and collectively as ("Parties").

In consideration of the mutual covenants and promises contained herein, the Parties agree as follows:

1. SCOPE OF SERVICES

1.1 AECOM shall perform the services set forth in EXHIBIT A ("Services"), incorporated herein by reference.

1.2 AECOM will provide the work products specifically commissioned by Client for delivery by AECOM to Client and listed in EXHIBIT A ("Deliverables") in accordance with the schedule ("Project Schedule").

2. TERM OF AGREEMENT Upon execution by the Parties, this Agreement shall have the effective date set forth above. This Agreement shall remain in force until all obligations related to the Services, other than those obligations which survive termination of this Agreement under Article 27, have been fulfilled, unless this Agreement is sooner terminated as set forth herein.

3. COMPENSATION AND PAYMENT AECOM shall be paid for the performance of the Services in accordance with EXHIBIT B ("Compensation and Payment"), incorporated herein by reference.

4. NOTICE All notices, requests, claims, demands and other official communications herein shall be in writing. Such notices shall be given (i) by delivery in person, (ii) by a nationally recognized commercial courier service; or (iii) by United States Postal Service, registered mail, postage prepaid and return receipt requested. Notices shall be effective upon actual delivery to the other Party at the following addresses:

TO CLIENT:
______________
Attn: _______________ [Project Manager]

TO AECOM:
______________
Attn: _______________ [Project Manager]

Claims-related notices shall be copied to:
AMER-DCSPProjectClaimNotices@aecom.com
or to which address the receiving Party may from time to time give notice to the other Party. Rejection or other refusal to accept, or the inability to deliver because of changed address for which no notice was given, shall be deemed to be receipt of the notice as of the date of such rejection, refusal to accept, or inability to deliver. Claims-related notices need to include the AECOM project name and number found in this Agreement as well as contact information of the person submitting the notice.

5. AECOM’S RESPONSIBILITIES

5.1 AECOM shall perform the Services in accordance with the degree of professional skill, quality and care ordinarily exercised by members of the same profession currently practicing in the same locality under comparable circumstances and as expeditiously as is consistent with professional skill and the orderly progress of the Project. The full extent of AECOM’s responsibility with respect to the Services shall be to perform in accordance with the above standards and to remedy any material deficiencies or defects in the Deliverables at AECOM’s own expense, provided that AECOM is notified by Client, in writing, of any such deficiency or defect within a reasonable period after discovery thereof, but in no event later than 90 days after AECOM’s completion or termination of the Services. AECOM MAKES NO OTHER REPRESENTATIONS OR WARRANTIES, EXPRESS OR IMPLIED, INCLUDING ANY IMPLIED WARRANTIES OF FITNESS FOR A PARTICULAR PURPOSE, MERCHANTABILITY, INFORMATIONAL CONTENT OR OTHERWISE.

5.2 AECOM will endeavor in good faith, as needed, to obtain from the appropriate authorities their interpretation of applicable codes and standards and will apply its professional judgment in interpreting the codes and standards as they apply to the Project at the time of performance of the Services. Notwithstanding the above, the Parties agree that, as the Project progresses, such codes or standards may change or the applicability of such codes or standards may vary from AECOM’s original interpretation through no fault of AECOM and that additional costs necessary to conform to such changes or interpretations during or after execution of the Services will be subject to an equitable adjustment in the Compensation and Project Schedule.

5.3 AECOM shall be responsible for its performance and that of AECOM’s lower-tier subcontractors and vendors. However, AECOM shall not be responsible for health or safety programs or precautions related to Client’s activities or operations or those of Client’s other contractors and consultants or their respective subcontractors and vendors (“Contractors”). AECOM shall have no responsibility for (i) construction means, methods, techniques, sequences or procedures; (ii) the direction of Contractors’ personnel; (iii) selection of construction equipment; (iv) coordination of Contractors’ work; (v) placing into operation any plant or equipment; or (vi) Contractors’ failure to perform the work in accordance with any applicable construction contract. AECOM shall not be responsible for inspecting, observing, reporting or correcting health or safety conditions or deficiencies of Client, Contractors or others at the project site (“Project Site”) other than AECOM’s employees, subconsultants and vendors. So as not to discourage AECOM from voluntarily addressing health or safety issues while at the Project Site, in the event AECOM does identify such issues by making observations, reports, suggestions or otherwise, AECOM shall have no authority to direct the actions of others not under AECOM’s responsibility and control and shall have no liability, responsibility, or affirmative duty arising on account of AECOM’s actions or forbearance.

5.4 Notwithstanding anything contained in this Agreement, AECOM shall have no responsibility for the discovery, presence, handling, removal, transportation, storage or disposal of, or exposure of persons to hazardous materials in any form related to the Project. AECOM shall not be responsible for Client’s pre-existing site conditions or the aggravation of those preexisting site conditions to the extent not caused by the negligence or willful misconduct of AECOM.

5.5 In the event that the Services include construction observation or similar field services, AECOM’s responsibility shall be limited to determining general conformance with AECOM’s design. Visits by AECOM to the Project Site and observations made by AECOM shall not relieve the Contractors of their obligation to conduct comprehensive inspections of the construction work sufficient to ensure conformance with the intent of the construction contract documents, and shall not relieve the Contractors of their responsibility for means, methods, techniques, sequences and procedures necessary for coordinating and completing all portions of the construction work and for all safety precautions incidental thereto.
5.6 Any opinions of probable construction costs provided by AECOM represent AECOM's good faith professional judgment in light of its experience, knowledge and the information reasonably available to AECOM at the time of preparation of the opinion. However, since AECOM has no control over the market, economic conditions or the bidding procedures, AECOM, its directors, officers and employees and subconsultants do not make any guarantees or warranties whatsoever, whether express or implied, with respect to such opinions and accept no responsibility for any loss or damage arising therefrom or in any way related thereto. Any reliance upon such opinions, whether by Client or third parties, do so at the relying party's own sole risk.

6. CLIENT’S RESPONSIBILITIES

6.1 Client shall provide in writing any specific Client requirements or criteria for the Project, including design objectives and constraints, space, capacity and performance requirements, flexibility and expandability, and any budgetary limitations.

6.2 Client shall furnish to AECOM all information and technical data in Client's possession or control reasonably required for the proper performance of the Services. AECOM shall be entitled to rely without independent verification upon the accuracy and completeness of information and data provided by Client or obtained from generally accepted sources within the industry, except to the extent such verification by AECOM is expressly required as a defined part of the Services. AECOM shall not be responsible for defects in its Services attributable to its reliance upon or use of information provided by Client.

6.3 Client shall arrange for access and make all provisions necessary for AECOM to enter upon public and/or private property as required for AECOM to properly perform the Services. Client shall disclose to AECOM any known or suspected hazards at the Project Site which may pose a threat to human health, property or the environment.

6.4 If any document or inquiry requires Client to approve, comment, or to provide any decision or direction with regard to the Services, such approval, comment, decision or direction shall be provided within a reasonable time within the context of the Project Schedule, or if not identified in the Project Schedule, within a reasonable time to facilitate the timely performance of the Services.

7. INDEPENDENT CONTRACTOR Nothing contained in this Agreement shall be construed to create a partnership, joint venture, or create a relationship of employer/employee or principal/agent between Client or Client’s Contractors and AECOM.

8. CONFIDENTIALITY

8.1 AECOM shall treat as confidential information and data delivered to it by Client or developed in the performance of the Services that are specified in writing by Client to be confidential (“Confidential Information”). Confidential Information shall not be disclosed to third parties by AECOM without the consent of Client, except to the extent reasonably believed necessary by AECOM for its performance of the Services, for a period of 5 years following completion or termination of this Agreement.

8.2 Notwithstanding the above, these restrictions shall not apply to Confidential Information which (i) is already known to AECOM at the time of its disclosure; (ii) becomes publicly known through no wrongful act or omission of AECOM; (iii) is communicated to a third party with the express written consent of Client and not subject to restrictions on further use or disclosure; (iv) is independently developed by AECOM; or, (v) to the extent such Confidential Information is required by Law to be disclosed; provided that the information required for disclosure shall remain Confidential Information as to all other persons or entities pursuant to the terms of this Agreement, and provided further that AECOM shall promptly provide Client with written notice of such requirement.

8.3 Upon termination of this Agreement or upon Client's written request, AECOM shall return the Confidential Information to Client or destroy the Confidential Information in AECOM's possession or control. Notwithstanding the above, AECOM shall not be required to destroy Confidential Information held electronically in archive or back-up systems in accordance with general systems archiving or backup policies or required for preservation by law, regulation, audit, data retention or corporate archival purposes or per
regulatory, judicial or governmental order. All such retained Confidential Information shall be kept confidential by AECOM subject to and in accordance with the terms of this Agreement.

9. DATA RIGHTS

9.1 All right, title and interest in and to any Deliverables, and excluding any AECOM Intellectual Property, shall be assigned by AECOM to Client upon full payment for the Deliverables. Client acknowledges and agrees that AECOM is the author of, and retains all rights, title and interest in all other intellectual property, including work papers, templates, details, designs, drawings, plans, renderings, analyses, calculations, models, software, macros, applications, specifications, processes, procedures, interim or draft documents, methodologies, know-how, and any other instruments of service: (a) belonging to AECOM or its consultants prior to the effective date of this Agreement; (b) developed by AECOM or its consultants outside the scope of, or not exclusively pursuant to, this Agreement; (c) licensed by AECOM or its consultants from a third-party; and (d) included within the Deliverables but which are generic, generally applicable to or standard in AECOM’s business (collectively, “AECOM Intellectual Property”). To the extent the Deliverables contain, or Client’s receipt of the Services require the use of AECOM Intellectual Property, to the extent of AECOM’s ownership and control thereof, AECOM hereby grants to Client, upon full payment for the Deliverables and Services, a limited, non-exclusive, non-assignable, royalty-free license to use and sublicense said AECOM Intellectual Property solely and to the extent necessary to achieve the purposes stated in EXHIBIT A.

9.2 Nothing in this Agreement shall be construed to prohibit AECOM or its consultants from using for other purposes, clients or projects the skills, knowledge and experience gained by AECOM or its consultants in the performance of the Services and provision of the Deliverables pursuant to this Agreement, provided that AECOM and its consultants do not use Client’s Confidential Information.

9.3 AECOM, in developing solutions, testing hypotheses, or documenting designs, may employ advanced technologies for simulation, information modeling, generative design, and the development of project documentation (“Technical Tools”). While these Technical Tools may result in digital files and/or simulations or models (“Datasets”), when not specifically defined within this Agreement, these Datasets will not constitute a Deliverable or portion thereof. Rather, the Technical Tools and Datasets will be a byproduct of AECOM’s internal processes and will be AECOM's sole proprietary information. Notwithstanding anything to the contrary in this Agreement, any ownership and data rights provisions will not apply to such Technical Tools and Datasets and AECOM will remain the sole owner of such Technical Tools and Datasets.

9.4 Client understands and accepts that the Services and Deliverables provided by AECOM pursuant to this Agreement are intended by AECOM for the sole use by Client for the specific purpose stated in EXHIBIT A. Client agrees, to the fullest extent permitted by law, to indemnify, defend and hold harmless AECOM and its consultants and their directors, officers, employees, agents, representatives, affiliated and parent companies, (“AECOM Indemnities”) against any and all claims, suits, causes of action, damages, losses, costs, expenses and liabilities (including the aggregate amount paid in reasonable settlement of any actions, suits, proceedings or claims), including reasonable attorneys’ fees and costs of defense, to which AECOM or any of the AECOM Indemnities may become subject as a consequence of any use or modification of, reliance upon, or transmission to a third party of, said Services, Deliverables, AECOM Intellectual Property, by Client outside the scope of this Agreement without the express, written permission by AECOM.

10. RECORD DRAWINGS Client shall direct the Contractors to provide AECOM with updated red-line documentation which accurately and completely reflects any changes between the original design and the final construction. Record drawings to be delivered by AECOM to Client as a part of the Services (“Record Drawings”) reflect the design provided by AECOM as modified by such updated information. Consistently with AECOM’s defined Services, AECOM shall not have an obligation to independently validate such information related to the actual construction. AECOM makes no warranty or guarantee with regard to the accuracy or completeness of the information provided by the Contractors and third parties and shall bear no responsibility for any errors or omissions arising from or related to any defects or deficiencies in such information.
11. ELECTRONIC FILES

11.1 Electronic files to be delivered under this Agreement, if any, contain information to be used for the production of contract documents for the Project and are provided solely as an accommodation to Client. The official Contract Documents of Record (“Contract Documents”) are those documents produced by AECOM which bear seals and/or signatures. Unless otherwise expressly set forth in the Services, no electronic files delivered under this Agreement are Contract Documents.

11.2 The electronic files, if any, were created to supplement the official Contract Documents. Due to the possibility that files of this nature can be modified, either unintentionally or otherwise; or that the information contained in these files can be used in a manner for which they were not originally intended; or that electronic data may be corrupted by electronic transmission, AECOM makes no representation that the files, after delivery, will remain an accurate representation of the source data in AECOM's possession, or are suitable for any other purpose or use.

11.3 All indications of AECOM’s and AECOM’s subconsultants’ involvement, including but not limited to seals and signatures, shall be removed from each electronic display and shall not be included in any prints produced therefrom.

11.4 Client understands and agrees that the right to use the electronic files, if such are provided under this Agreement, is specifically limited to the Project and the purpose defined by AECOM and is conditioned upon proper payment for such use.

11.5 If a third-party license is required to access or use electronic files, Client acknowledges its responsibility at its own expense to obtain all applicable hardware and software needed to legally access the electronic files. AECOM shall have no liability for third parties’ use of or reliance on such files.

12. CERTIFICATION

12.1 For purposes of this Agreement, “certification” means to state or declare a professional opinion based on the standard of performance set forth in Section 5.1 above.

12.2 AECOM shall not be required to execute certificates that would (i) result in AECOM having to certify, guarantee or warrant the existence of conditions whose existence AECOM cannot reasonably ascertain under the existing Services; (ii) require knowledge, services or responsibilities beyond the Services; or (iii) may, in AECOM’s reasonable judgment, require AECOM to make a certification that would not normally be covered by AECOM’s professional or other liability insurance. In addition, Client agrees not to make resolution of any dispute with AECOM or payment of any amount due to AECOM in any way contingent upon AECOM executing such certificates.

12.3 A professional's certification in no way relieves other parties from meeting their respective requirements imposed by contract or other means, including commonly accepted industry standards and practices. If required as a part of its Services, AECOM will provide a written report stating whether, in AECOM’s professional opinion and based on periodic site visits, the construction work complies generally with the Contract Documents.

13. CHANGED SITE CONDITIONS

The discovery of hazardous materials, hazardous wastes, pollutants, contaminants or concealed obstructions or utilities that could not reasonably have been anticipated from information provided to and reasonably apparent to AECOM constitutes a changed site condition. To the extent that such changed site condition increases the health and safety risks associated with the Services or requires AECOM to perform services different or in excess compared to those set forth in the Services, AECOM may, at its sole discretion, elect to suspend and/or terminate the related Services and shall be paid for the related Services up through the date of such termination. To the extent that the changed site conditions impact the cost, level of effort or schedule of the Services, equitable adjustments shall be made to the Services, schedule and fee under this Agreement.

14. MATERIALS AND SAMPLES

Any items, substances, materials or samples removed from the Project Site for testing, analysis, or other evaluation will be returned to the Project Site unless otherwise agreed to by...
the Parties in writing, Client recognizes and agrees that AECOM is acting as a bailee and at no time assumes
title to said items, substances, materials or samples.

15. COMPLIANCE The Parties shall comply with applicable treaties, compacts, statutes, ordinances,
codes, regulations, consent decrees, orders, judgments, rules, and other requirements of governmental or
judicial entities that have jurisdiction over the Services ("Law").

16. FORCE MAJEURE Neither Party shall be responsible for a delay in its respective performance
under this Agreement, other than a delay in payment for Services already performed, if such delay is caused
by extraordinary weather conditions or other natural catastrophes, war, terrorist attacks, sabotage, computer
viruses, riots, strikes, lockouts or other industrial disturbances, acts of governmental agencies or authorities,
discovery of Hazardous Materials or differing and unforeseeable site conditions, or other events beyond the
reasonable control of the claiming Party. AECOM shall be entitled to an equitable adjustment to the Project
Schedule and compensation in the foregoing circumstances.

17. INSURANCE

17.1 AECOM will maintain the following insurance coverages and amounts:

17.1.1 Workers Compensation insurance as required by Law;
17.1.2 Employer’s Liability insurance with coverage of $1,000,000 each accident/employee.
17.1.3 Commercial General Liability insurance with coverage of $2,000,000 per
occurrence/aggregate;
17.1.4 Automobile Liability insurance with coverage of $1,000,000 combined single limit; and
17.1.5 Professional Liability insurance with coverage of $2,000,000 per claim/aggregate.

18. INDEMNITY

18.1 AECOM agrees to indemnify Client, its officers, directors and employees, from third party claims of
loss or damage, exclusive of defense obligations, for bodily injury or property damage ("Claims"), to the
proportional extent caused by AECOM’s negligence or willful misconduct.

18.2 If Services include AECOM’s performance during the construction phase of the Project, Client shall
require Client’s Contractors working on the Project Site to include AECOM, its directors, officers and
employees in any indemnity and in any insurance benefits that Client requires such Contractors to provide
to Client.

19. CONSEQUENTIAL DAMAGES WAIVER NOTWITHSTANDING ANY OTHER PROVISION TO
THE CONTRARY IN THIS AGREEMENT AND TO THE FULLEST EXTENT PERMITTED BY LAW, IN NO
EVENT SHALL EITHER PARTY, ITS PARENTS, AFFILIATES AND SUBSIDIARIES OR THEIR
RESPECTIVE DIRECTORS OFFICERS OR EMPLOYEES BE LIABLE TO THE OTHER FOR ANY
INDIRECT, INCIDENTAL, SPECIAL, CONSEQUENTIAL OR PUNITIVE DAMAGES WHATSOEVER
(INCLUDING, WITHOUT LIMITATION, LOST PROFITS, LOSS OF REVENUE, LOSS OF USE OR
INTERRUPTION OF BUSINESS) ARISING OUT OF OR RELATED TO THIS AGREEMENT, EVEN IF
 ADVISED OF THE POSSIBILITY OF SUCH DAMAGES, AND AECOM HEREBY RELEASES CLIENT AND
CLIENT HEREBY RELEASES AECOM FROM ANY SUCH LIABILITY.

20. RISK ALLOCATION AND RESTRICTION OF REMEDIES THE PARTIES HAVE EVALUATED THE
RESPECTIVE RISKS AND REMEDIES UNDER THIS AGREEMENT AND AGREE TO ALLOCATE THE
RISKS AND RESTRICT THE REMEDIES TO REFLECT THAT EVALUATION. NOTWITHSTANDING ANY
OTHER PROVISION TO THE CONTRARY IN THIS AGREEMENT AND TO THE FULLEST EXTENT
PERMITTED BY LAW, CLIENT AGREES TO RESTRICT ITS REMEDIES UNDER THIS AGREEMENT
AGAINST AECOM, ITS PARENTS, AFFILIATES AND SUBSIDIARIES, AND THEIR RESPECTIVE
DIRECTORS, OFFICERS, SHAREHOLDERS AND EMPLOYEES, ("AECOM COVERED PARTIES"), SO THAT THE TOTAL AGGREGATE LIABILITY OF THE AECOM COVERED PARTIES SHALL NOT EXCEED $250,000 OR THE ACTUAL PAID COMPENSATION FOR THE SERVICES, WHICHEVER IS GREATER. THIS RESTRICTION OF REMEDIES SHALL APPLY TO ALL SUITS, CLAIMS, ACTIONS, LOSSES, COSTS (INCLUDING ATTORNEY FEES) AND DAMAGES OF ANY NATURE ARISING FROM OR RELATED TO THIS AGREEMENT WITHOUT REGARD TO THE LEGAL THEORY UNDER WHICH SUCH LIABILITY IS IMPOSED. CLAIMS MUST BE BROUGHT WITHIN ONE CALENDAR YEAR FROM PERFORMANCE OF THE SERVICES UNLESS A LONGER PERIOD IS REQUIRED BY LAW.

21. DISPUTES RESOLUTION

21.1 Either Party may initiate a dispute resolution by providing written notice to the other Party setting forth the subject of the claim, dispute or controversy and the requested relief. The recipient of such notice shall respond within 5 business days with a written statement of its position and a recommended solution to the Claim.

21.2 If the Parties cannot resolve the dispute through negotiation, either Party may refer the claim, dispute or controversy to a panel ("Panel") consisting of a designated senior representative from each Party ("Representative"), who shall have the authority to resolve it. The Representatives shall not have been directly involved in the Services and shall negotiate in good faith. No written or verbal representation made by either Party in the course of any Panel proceeding or other settlement negotiations shall be deemed to be a Party’s admission. If the representatives are unable to resolve the dispute within 15 business days, either Party may pursue its respective legal and equitable remedies.

22. GOVERNING LAW All contract issues and matters of law will be adjudicated in accordance with the laws of the state where the Project is located, excluding any provisions or principles thereof which would require the application of the laws of a different jurisdiction.

23. TERMINATION

23.1 This Agreement may be terminated for convenience by either Party upon 30 days advance written notice. On termination, AECOM will be paid for all Services performed up through the termination date.

23.2 This Agreement may be terminated for cause by either Party if the other Party materially fails to perform its obligations under this Agreement, does not commence correction of such non-performance within 10 business days of receipt of written notice and/or fails to diligently complete such correction thereafter. The respective rights and obligations of the Parties predating such termination shall survive termination of this Agreement.

24. ASSIGNMENT

24.1 Neither Party may assign this Agreement without the written consent of the other Party, which unconcented-to assignment shall be void ab initio.

24.2 Notwithstanding Section 24.1 above, the Parties recognize that AECOM has affiliated companies who have specialized expertise, necessary certifications/registrations or other capabilities that may make use of such affiliates more suitable for the performance of all or part of the Services. AECOM shall be entitled, without additional consent, to assign this Agreement or performance of the Services, in whole or in part, to any of AECOM’s subsidiaries or affiliates upon written notice to Client.

25. PARTIES IN INTEREST Nothing in this Agreement, expressed or implied, is intended to confer on any person or entity other than the Parties any right or remedy under or by reason of this Agreement. The provisions of this Agreement shall bind and inure solely to the benefit of the Parties and their respective successors and permitted assigns.
26. **WAIVER** Either Party may in writing waive any provisions of this Agreement to the extent such provision is for the benefit of the waiving Party. No waiver by any Party of a breach of any provision of this Agreement shall be construed to be a waiver of any subsequent or different breach.

27. **SEVERABILITY AND SURVIVAL** The invalidity or unenforceability of any particular provision of this Agreement shall not affect the other provisions, and this Agreement shall be construed in all respects as if any invalid or unenforceable provisions were omitted. Articles 4 (Notice), 5 (AECOM’s Responsibilities), 6.2 (Reliance on Data), 8 (Confidentiality), 9 (Data Rights), 10 (Record Drawings), 11 (Electronic Records), 12 (Certification), 14 (Materials and Samples), 17 (Insurance), 18 (Indemnity), 19 (Consequential Damages Waiver), 20 (Risk Allocation), 21 (Disputes Resolution), 22 (Governing Law), 24 (Assignment), 25 (Parties in Interest) and 27 (Severability and Survival) shall survive termination of this Agreement. To the extent any provision of this Agreement violates any law, or is otherwise invalid or unenforceable, said provision shall be revised to the limited extent necessary to make that provision legal and enforceable and, to the fullest extent permitted by law, consistent with Parties’ original intent.

28. **PREPARATION OF AGREEMENT** Each Party has had the opportunity to avail itself of legal advice and counsel. Neither Party shall be deemed to be the drafter or author of this Agreement. In the event this Agreement is subject to interpretation or construction by a court of law or panel of arbitration, such court or panel shall not construe this Agreement, or any portion hereof, against either Party as the drafter of this Agreement.

29. **SIGNATURES** Each person executing this Agreement warrants that he/she has the necessary authority to do so on behalf of the respective Party. This Agreement may be executed in one or more counterparts, each of which shall be deemed an original, but all of which together shall constitute a single agreement.

30. **ORDER OF PRECEDENCE**
   
   Executed Change Orders
   Design Engineering Services Agreement Article 31 “Special Terms and Conditions”
   Design Engineering Services Agreement Articles 1 through 30 and 32
   EXHIBIT B Compensation and Payment
   EXHIBIT A Services
   Other contract documents

31. **SPECIAL TERMS AND CONDITIONS** DO NOT MODIFY ARTICLES 1 THROUGH 30 AND 32. ANY CHANGES TO ARTICLES 1 THROUGH 30 AND 32 ARE TO BE INSERTED BELOW IN THIS ARTICLE 31 AND ARE SUBJECT TO LEGAL APPROVAL. ALSO, CLEARLY INDICATE IF ANY ADDITIONAL EXHIBITS ARE INCLUDED. IF THERE ARE NO CHANGES, INSERT “NONE” IN THE BOX BELOW.

   None

32. **ENTIRE AGREEMENT** This Agreement contains all of the promises, representations and understandings of the Parties and supersedes any previous understandings, commitments, proposals or agreements, whether oral or written. This Agreement shall not be altered, changed, or amended except as set forth in a written amendment to this Agreement, duly executed by both Parties. The attached EXHIBIT C (“Change Order”), incorporated herein by reference, is the preferred form for such use.

   (Signature page follows)
EXHIBIT A

SERVICES

Services: Insert a clear description of the Services or attach the Scope of Services to this EXHIBIT A. If you are attaching a Scope of Services, be sure to reference the attachment in this Section and to exclude any marketing materials from your proposal that are not a part of the actual Scope of Services.

Schedule: Identify the critical dates/milestones associated with the Services.

Deliverables: Clearly define and list the work products to be provided as a part of the Services.

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Client Project Manager

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EXHIBIT B

COMPENSATION AND PAYMENT

1. COMPENSATION
   The Services set forth in EXHIBIT A will be compensated on the following basis:
   
   Check the below box if an advance retainer is being provided. An advance retainer of 15-20% is typically recommended for new Clients. Please check with your Project Director for guidance:

   [ ] Advance retainer of [$ Numerical Amount] The advance retainer is to be applied to the final invoice. Any remainder will be returned to Client within 30 days of receipt of final payment.

   Choose one of the following types of compensation by marking the applicable “[ ]”:

   [ ] Time & Material - See Section 2.1 for Hourly Labor Rates

   [ ] Time and Materials with a Not-to-Exceed (“NTE”) amount of ($ Numerical Amount). The Hourly Labor Rates (if applicable) are as in Section 2.1 below. Reimbursable expenses are included in the overall NTE cap.

   [ ] Lump Sum [$]:

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   [ ] Cost Plus Fixed Fee: [Cost $ Numerical Amount and Fee $ Numerical Amount]

   [ ] Other: Insert other type of compensation if that type is not listed above. Any additional types of compensation require Contract Reviewer/Analyst’s approval.

2. RATE SCHEDULE
   Compensation shall be based on the following Hourly Labor Rate Schedule: Insert “INTENTIONALLY OMITTED” if not used.

2.1 HOURLY LABOR RATE SCHEDULE

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2.2 OTHER HOURLY LABOR RATE CATAGORIES
   If additional labor categories are authorized during the performance of this Agreement, compensation for each additional category will be negotiated at the time the additional Services are authorized.
2.3 **ANNUAL HOURLY LABOR RATE ADJUSTMENTS** The Hourly Labor Rate Schedule is adjusted each calendar year to reflect updated labor cost categories. Labor cost of Services authorized in subsequent calendar years will be based on the applicable Hourly Labor Rate Schedule for those years.

3. **REIMBURSEABLE EXPENSES** Reimbursable expenses are expenditures made by AECOM for goods, travel expenses and vendor services in support of the performance of the Services. Such expenditures will be billed at the actual cost to AECOM plus ten percent (10%) to cover related administrative costs.

4. **CHANGE ORDERS** The Parties may at any time and by written agreement make changes in the Services, Project Schedule, Deliverables, Compensation or other terms and conditions in this Agreement. The Parties shall effect such change through the use of a written Change Order. **EXHIBIT C** is the preferred form for such use.

5. **INVOICING** AECOM will invoice Client on a monthly basis unless otherwise set forth herein.

6 **PAYMENT**

6.1 If payment is based on Time and Materials with a NTE, once AECOM reaches the NTE, AECOM will stop further Services pending a Change Order to adjust the budget and schedule for the continued performance of the Services.

6.2 Timely payment is a material term of this Agreement. Client shall pay all undisputed portions of AECOM’s invoices within 30 days of receipt without holdback or retention. Client shall notify AECOM within fourteen (14) days of the receipt of the invoice of any disputed items. Such notice must be accompanied by a detailed description of any disputed items and include supporting documentation as well as references to the provision(s) of this Agreement which permit a holdback or retention. If such notice is not provided within fourteen (14) days, Client waives its rights to dispute the invoice. Undisputed amounts remaining unpaid 30 days after the invoice date shall bear interest at the rate of 1.5% per month on the unpaid balance and AECOM may suspend the Services pending receipt of such payment. In addition, AECOM retains its unrestricted rights under Article 23 (Termination) of the Agreement.

6.3 If the Project is suspended by Client for more than 30 days, AECOM shall be paid for all Services performed prior to the effective date of suspension within 30 days of such suspension. Upon resumption of the Project, AECOM shall be entitled to an equitable adjustment in cost and schedule to compensate AECOM for expenses incurred as a result of the interruption and resumption of the Services.

6.4 To the extent that completion of the Services is delayed beyond the original scheduled completion date and such delay is not the fault of AECOM, an equitable adjustment shall be made to AECOM’s Compensation and Project Schedule.

6.5 Except as otherwise specifically provided herein, Client shall pay or reimburse AECOM, as appropriate, for all categories of taxes other than income tax, including without limitation, sales, consumer, use, value added, gross receipts, privilege, and local license taxes related to the Services.

6.6 Client shall make payments to AECOM using one of the following methods:

6.6.1 **AECOM LOCKBOX:**

AECOM Technical Services, Inc.
1178 Paysphere Circle
Chicago, IL 60674

6.6.2 **ELECTRONIC FUNDS TRANSFER/ACH PAYMENT:**

Account Name: AECOM Technical Services, Inc.
Bank Name: Bank of America
Address1: Building D  
Address2: 2000 Clayton Road  
City/State/Zip: Concord, CA 94520-2425  
Account Number: 5800937020  
ABA Routing Number: 071000039

6.6.3 WIRE TRANSFER:

Account Name: AECOM Technical Services, Inc.  
Bank Name: Bank of America  
Address: 100 West 33rd St  
City/State/Zip: New York, NY 10001  
Account Number: 5800937020  
ABA Routing Number: 026009593  
SWIFT Code: BOFAUS3N

6.6.4 Questions related to payment can be sent to:  
AECOM Cash Applications Supervisor by phone at (804) 515-8490 or by email at  
cashapppremittance@aecom.com

(End of page)
EXHIBIT C

SAMPLE CHANGE ORDER FORM

In accordance with the Consulting Services Agreement dated ___ 20___ between _________ ("Client"), and ____________, a ________ corporation, ("AECOM"), this Change Order, with an effective date of _______________, 20______ modifies that Agreement _______________ as follows:

1. **Changes to the Services:**
   
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2. **Change to Deliverables:**
   
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3. **Change in Project Schedule** (attach schedule if appropriate):
   
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4. **Change in CONSULTANT’s Compensation:**

The Services set forth in this Change Order will be compensated on the following basis:

- [ ] No change to Compensation
- [ ] Time & Material (See EXHIBIT B for the Hourly Labor Rate Schedule)
- [ ] Time and Materials with a Not- to-Exceed amount of $_____. The Hourly Labor Rate Schedule is set forth in EXHIBIT B (if applicable). Reimbursable expenses are included in the overall Not to Exceed cap.
- [ ] Lump Sum $ __________

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- [ ] Cost Plus Fixed Fee: Cost $_____________ and Fee $___________

Therefore, the total authorized Compensation, inclusive of this Change Order is $ _____________.

5. **Project Impact:**

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6. **Other Changes** (including terms and conditions):

7. All other terms and conditions of the Agreement remain unchanged.

8. Each Party represents that the person executing this Change Order has the necessary legal authority to do so on behalf of the respective Party.

---

AECOM Technical Services, Inc.  

CLIENT:

Signature  

Signature

Printed Name  

Printed Name

Printed Title  

Printed Title

Date  

Date

Address  

Address

---

[End of Agreement]
9. Alternative Proposals/Equivalent Items
9. ALTERNATIVE PROPOSALS/EQUIVALENT ITEMS

Not applicable.
10. Technical Literature
10. TECHNICAL LITERATURE

Tools enable more work to be achieved for the same amount of labor. Proven methodologies provide a guide for completion of complex tasks, thereby increasing efficiency and reducing risk of failure.

In this section, we have included supporting documentation for the following:

- AECOM’s Geographic Information System (GIS) Capabilities
- AECOM’s Project Management Tools
- Energeia’s PEV Uptake, Charging, and Power System Impact Modeling System
- Energeia’s Advanced Energy Solution Modeling Tools and uSim Software Methodology
- Energeia’s Cost of Service and Rate Design Methodology

AECOM’s Geographic Information System (GIS) Capabilities

The AECOM Information Management Solutions Team includes staff with extensive national experience providing geospatial services to all levels of government and private entities. AECOM’s Information Management Solutions Team’s culture of being innovative and agile in the use of new technology and approaches with our passion to solve our client’s challenges and explore new opportunities with them, is an integral part of the core values within our geospatial practice.

Coupling our GIS experts with our discipline experts in energy, real estate and economics, transportation, transit, land development, community planning, environment, and disaster response is the key to our innovation and successful delivery on many projects.

Our team’s capabilities include:

- Modeling and analytics
- Leveraging open data
- Desktop, web, and mobile mapping
- 3D visualization and simulations
- Big data and artificial intelligence (AI) modeling
- Database design and maintenance
- GIS and resiliency
- Asset management
- Unmanned aerial vehicle (UAV) drone
- Planning and permitting

We are involved with all aspects and applications of spatial data and our group works closely with clients and project teams to determine the optimal sources and use of data and the methods to manage and access information within the project scope and plan. We use the latest geospatial technologies and processes to capture, analyze, store, manipulate, and present multiple types of spatial information to address our clients’ most complex challenges — examples of our transformative solutions include developing and implementing mobile data collection solutions; managing, maintaining, and analyzing big data; and creating bespoke data analytic toolsets. AECOM has the skills to present analysis, visualization, and mapping as clear and precise data and graphics both in reports and using the latest in enterprise web tools.
AECOM, through multiple electrification, mobility, and smart city assignments in the U.S. and abroad has developed advanced spatial modeling capabilities using existing open data including infrastructure, transit patterns, demographics, land use, and forecasts to provide spatial insights into siting, economic growth and development, gap analysis, and an understanding environmental justice concerns and community inequities.

Modeling scenarios to meet the client’s goal

Identifying Retail Facilities and Job Centers as part of a Long-Range Transportation plan for Cook County, IL
**Consulting Services to Perform Study of Consequential Issues Materially Affecting Kansas Electricity Rates**

**Project Management Tools**

AECOM’s approach to successful program management is based on the principle that every client’s project is treated with same level of importance. Every step in the process and every team member involved during the project lifecycle — from the initial lead to the project close-out — also carry equal importance. This emphasis on the importance of each customer and attention to detail are key to AECOM’s successful program management and gives the Kansas Legislature the assurance that all projects are delivered on-budget, on schedule, and in compliance with all scope and quality requirements, keeping customers happy and helping the Kansas Legislature meet its project goals.

The success of any program is based on a robust channel of communication with all involved. As such, we will facilitate the flow of communication so that AECOM team members remain abreast of Kansas Legislature program needs and requirements through a clear organizational structure and well-defined lines of responsibilities.

**Project Methodology**

All projects require the management, coordination and integration of multiple, concurrent assignments. From concept through completion, we provide necessary technical and administrative services to help our clients meet their program objectives. We act as an extension of our clients’ staff, protecting their interests as our own. As an industry leader in program management services, we oversee activities ranging from planning, coordination, scheduling and cost control, to design, construction, and commissioning. We specialize in serving both public and private clients with extensive expertise in social infrastructure, including facilities for education, healthcare, national governments, sports and leisure, transportation, water and public gathering venues. Representative services include:

- Program planning and management
- Master scheduling/schedule analysis
- Master budget development
- Design management
- Cost management
- Delivery and contracting strategies
- Cost estimating
- Change order management
- Value engineering
- Claims avoidance
- Dispute resolution
- Commissioning
- Facility condition/lifecycle assessments

AECOM employs a project management methodology that is highly successful and embodies certain organizational principles, repeatedly used as keystones to achieve a fully integrated effort that meets standards of quality, adheres to cost estimates and schedules, and attains client acceptance. These principles include:

- Establishing clear lines of communication, responsibility, and authority
- Using uniform means of collecting and disseminating information
- Establishing and maintaining realistic baselines, cost estimates, and schedules—against which performance can be measured
- Promoting the use of standardized and disciplined work practices for all project participants and verifying compliance with these practices
- Assigning personnel with proven leadership and experience whose first priority is to the project
- Satisfying the technical, cost, and schedule requirements of the project

**Technical Practice Network**

Our collaborative Technical Practice Network (TPN) enables our global community of professionals to share expertise, leading-edge technology, and best practices to solve client problems. Our TPN also cooperates with trade associations and universities to extend that knowledge. Our broad capabilities, combined with our deep understanding of local cultures, regulatory practices and emerging global trends, provide clients with a single source for global environmental needs.

**Safety**

AECOM is committed to corporate responsibility for employee safety, health, and environment (SH&E). As an expression of this commitment, AECOM’s SH&E Management System details the policies and commitments AECOM has been developed to ensure employees and clients fully understand and are committed to this corporate responsibility. Our goal is zero workplace incidents.

“Safety for Life” is AECOM’s comprehensive internal SH&E program that drives AECOM toward proactively incorporating safety standards and innovative techniques into everything we do — with the ultimate goal of achieving zero work-related injuries and/or illnesses; preventing damage to property and the environment; and maintaining an overall environmentally friendly and sustainable workplace. Our vision is to lead our
industry in safety by further enhancing our already excellent safety management systems. These systems meet global standards for certification and provide a safe working environment for our employees.

These systems are also executable by our project teams and will continue to meet the strictest requirements of our clients who are most focused on safety. The graphic below lists AECOM's nine "life preserving principles".

### AECOM's Life Saving Principles

- **Demonstrated Management Commitment**
- **Recognition and Rewards**
- **Employee Participation**
- **Safety, Orientation and Training**
- **Budgeting and Staffing for Safety**
- **Incident Investigations**
- **Pre-Planning**
- **Contractor Management**
- **Fit for Duty**

### Quality Focused

Simply stated, AECOM's strengths are its people and its quality work. While awards, commendations, and recognitions are great, we will ultimately measure the quality of our work on this project by how well our work products meet and exceed the client’s expectations.

Under the direction of corporate management, AECOM has established and implemented a Quality Management System (QMS), as shown in the graphic below, to set quality procedures for all project activities. We rigorously follow these procedures so that our deliverables are technically sound and satisfy project objectives.

Our QMS is certified to the internationally renowned ISO 9001:2008 standard, yet it is sufficiently flexible to address the specific requirements of this project. Quality management is central to our project management approach, and our project team includes individuals assigned to specific quality roles under our system.

AECOM’s successful QMS is based on the following quality principles:

- Leading quality at all levels
- Customer focus
- Collaborating for success
- Risk-based thinking
- Employee empowerment
- Organization learning

### AECOM’s Quality Management Program
Energeia's PEV Uptake, Charging, and Power System Impact Modeling System Overview

Over the course of more than 10 PEV-related projects for major utilities, governments, and PEV market players, Energeia has developed a suite of sophisticated tools and methodologies for answering the key questions facing our clients. These tools allow them to deliver greater value for money than if they had to start from scratch.

Energeia’s PEV forecasting model is comprised of two parts, PEV uptake and PEV charging as shown in Figure E1.

Figure E1 – Energeia PEV Forecasting Model

Source: Energeia

The PEV uptake module forecasts PEV uptake for each category of vehicle and driver type using vehicle model availability and the vehicle owner’s return on investment as inputs. The forecast is allocated on a pro-rata basis calibrated to the service territory’s specified vehicles on the road. The PEV charging module then applies a charging regime to each vehicle based on its:

- Charging type
- Arrival and departure time for home and workplace charging or transportation profile for DCFC
- The number of miles traveled
- Grid load to optimize workplace and home charging

The model considers the most representative PEVs based on historical sales data. Each of these categories have specific characteristics which drive both uptake and charging, including:

- Purchase premium
- Energy consumption per mile
- Battery size (kWh)

Fuel costs and average daily driving are based on utility specific data. The model considers the following driver types:

- **Passenger Vehicles**
  - Dedicated Charging, Single car
  - Dedicated Charging, Multiple cars
  - Non-Dedicated Charging
  - Transiting Charging (i.e. driving through)

- **Commercial Vehicles**
  - Light Duty – Short Trips
  - Light Duty – Long-Trips (Depot End of Day)
  - Heavy Duty – Busses (Depot End of Day)
  - Heavy Duty – Long Haul (Rest Stops)

Driver type segmentation subject to data availability of specified inputs for each type.
EV Uptake

EV uptake is determined by a two-parameter function that describes vehicle uptake over time based on:

1. PEV premium payback or ROI:
   \[ EV \text{ Uptake} = \text{Total New Vehicle Sales}_t \times (\alpha \times \text{ROI}_t + \beta \times \text{Model Availability}_t) \]
2. PEV premium payback less than two years (tipping point):
   \[ EV \text{ Uptake} = \text{Total New Vehicle Sales}_t \times \text{MIN(Upper EV Limit, Model Availability}_t) \]

Where:
- \( \text{Total New Vehicle Sales}_t \) = Total new vehicle sales within a given vehicle class in year \( t \)
- \( \text{Model Availability}_t \) = Percentage of models within a given vehicle class available in PEV form in year \( t \). This inclusion of this factor reflects that, for the mass market, a primary driver of vehicle purchase is the availability of that model in PEV form. This factor effectively places an upper bound on PEV adoption, which is determined by a scenario-based parameter.
- \( \text{Upper EV Limit} \) = Upper model availability limit for all vehicles within a given vehicles class
- \( \text{ROI}_t \) = The first-year return on investment for the vehicle owner investing in a PEV in year \( t \) in terms of reduced operational costs (fuel) and premium paid compared to the equivalent ICE vehicle
- \( \alpha \) = Model coefficient derived from historical data of diesel and hybrid electric vehicle uptake for observed ROIs
- \( \beta \) = Model coefficient derived from historical data of diesel and hybrid electric vehicle uptake for observed model availability as well as expected new model introductions based on OEM announcements

EV uptake depends on the functional form assumed for model availability and change in ROI over time. It should be noted that Energeia’s ROI calculation does not consider step changes in depreciation or salvage value due to increasing PEV penetration.

This functional form accordingly considers the supply side constraints (lack of model availability) as well as demand side drivers (reduced operational costs) in the vehicles owner’s decision to adopt. The function is derived from analysis of diesel vehicle and hybrid electric vehicle adoption patterns which showed uptake was best explained by a combination of these parameters. The historical relationship between vehicle uptake and model availability for alternative technologies is shown in Figure E2.

Figure E2 – Relationship between PEV Uptake and Model Availability

![Figure E2 – Relationship between PEV Uptake and Model Availability](source: VFACTS, Energeia)
Limitations

Energeia’s PEV forecasts are independent of the base electricity price forecasts. That is, there is no feedback loop between the forecasted PEV uptake and the corresponding response from networks, retailers, or the wholesale market.

Further, there are a range of future possibilities as to how PEV loads will be priced and how the PEV market will integrate with the electricity market and it is foreseeable that tariff products could evolve to encourage increased charging of PEVs during solar generation times. The PEV uptake model is driven in part by the financial return on investment to vehicles owners based on the PEV vehicle premium and reduced operational costs. The model does not consider costs associated with any required upgrade to the household switch board and/or service, which could add considerable cost. However, this is not expected to be a material number of households based on anecdotal evidence from pilots, etc.

Plug-in Electric Vehicle Charging Demand Impact Model

As illustrated in Figure E1, Energeia has developed a detailed, data-driven approach to forecasting the likely impact of PEV charging on electricity demand, energy resources, and network assets. This approach is driven by the assumed rate structure and level, historical EV adoption patterns, driving patterns, charging infrastructure availability, and the availability of charging management systems.

Energeia’s EV demand model is grounded in actual travel statistics, which drive when EVs are likely to be plugged in (arrival times), and the total energy they need to replenish (distance), and when any smart charging will need to have been completed by (departure time).

Figure E3 compares our modelled average daily driving distance, departure times and arrivals times, to actual transportation statistics. While there are some differences between the modelled and actual driving patterns, the differences are not material.

The actual timing and duration of charging is based on the assumed charging capacity and PEV charging rate structure, and whether the charging is being managed by the utility, driver, or third party. Figure E4 displays the bottom-up modeling of EV charging patterns and battery levels across two different rate structures. Energeia’s PEV modeling system is capable of modeling inclining block, ToU, demand, critical peak and other rates as well.
Figure E4. Aggregated Smart Charging Profiles under High PEV Penetration by Driver Type

Figure E5 displays the modeling results at the aggregated level under high PEV penetration, showing the tight smart charging window. These results reflect the effects of diversity in the charging patterns driven by the different driving patterns illustrated in Figure E3. Diversity effects are significant and often under-estimated by forecasters of PEV impacts.

Energeia’s PEV uptake and operating model can be configured on a special basis, to provide more realistic adoption and demand patterns across a distribution utility. Figure E6 presents the results of our spatial modeling of uptake and impact for a distribution network client. It showed which areas were most likely to experience the strongest growth in PEV demand over time.
Plug-in Vehicle Uptake Optimization Methodology

Energeia has developed a robust uptake optimization methodology over the course of more than five optimization projects for major utilities and industry stakeholders. We have developed—and continue to add to—a database of potential EV uptake interventions, which are run through our EV modeling platform to determine their individual and combined impact on EV uptake, generating an estimate of cost per additional EV and net benefits.

Figure E7 shows the results of Energeia’s analysis of government policy and regulatory options for optimizing the uptake of PEVs.

Figure E7. PEV Policy Optimization Results for Government Client
Figure E8 shows the results of our in-depth research into the likely impacts of additional public chargers on PEV uptake. Each of the included intervention options included in our optimization modeling is based on a comparable level of research and quantitative rigor.

**Figure E8. Results of Research into Relationship of Public Chargers to Uptake**

![Graph showing the relationship between EV uptake and charging stations per capita for different countries.](image)

Figure E9 presents the results of an optimization analysis conducted for a major utility client. It also followed the same optimization methodology but focused on what the utility could do to optimized EV uptake. Each of the included options displayed the highest net benefits to the utility client. In this specific case, the expected impact of the interventions was a 50 percent increase in EV adoption relative to doing nothing.

**Figure E9. PEV Policy Optimization Results for Utility Client**

Whether for a government or commercial client, Energeia’s quantitatively rigorous approach to selecting an optimal portfolio of PEV interventions enables an evidence-based estimate of the business case for the suite of interventions. The results of our net benefits analysis are illustrated in Figure E10 across the key dimension of interest to our client in the circumstances.
Charger Installation and Optimization Model

The evolutions of PEV charging patterns are among the most sought-after answers of our clients. This is because it can greatly impact the expected impact of PEVs on network infrastructure (due to impacts on peak demand patterns and growth rates) and charging business models. The size of PEV charging is less interesting from a resource perspective as it might change the timing of charging, but not the overall amount of energy, which is driven by daily average driving distances.

Based on 7 years of specialized research and analysis of the PEV and charging market and technology evolution, Energeia has developed its own proprietary model of public and private charging. It reflects our view that PEV batteries are likely to reach 100 kWh or more over the next 3-5 years to achieve parity with gasoline-powered vehicles, and that public charges will be 350kW or more so that recharging will also reach parity with gas stations. It also reflects our view that most PEV drivers will charge at home, and the market for public charging will follow the gas station model but be smaller due to the impact of home charging.

A recently completed forecast of charging uptake over time is shown in Figure E11. It shows that the vast majority of chargers are Level 2 (14 kW), with DC Fast Chargers (DCFC) representing only around 10 percent of the market. This has significant implications for the number of two-workstream residential services, and the number of major DCFC-based public recharging stations.
Energeia has also developed optimal public charging models that are designed to address the gaps in current and near-term PEV battery capability. These are comprised of a backbone network to ensure all PEVs are able to move across a given utility network by placing charging infrastructure at distances enabling them to move across major throughways and between popular destinations, including work, as shown in Figure E12.

**Figure E12. Optimal Placement of DC Fast Chargers to Address Near-term PEV Battery Gaps**

Plug-in Electric Vehicle Fleet Integration Model

Fleet operators represent a potential key PEV segment due to their large-scale purchases and relatively high mileage requirements. They are also interesting for transmission and distribution (T&D) utilities as well as government clients, as each of these types of organizations tend to have their own fleets, making it possible for them to unilaterally increase PEV demand through their own procurement policies.

**Figure E13. Transmission Utility Fleet Analysis for Potential PEV Transition**

Figure E13 presents the results of our analysis of the fleet requirements for a transmission utility client in terms of the vehicles they were purchasing and the relative costs of a comparable PEV. This analysis was based on the actual average driving patterns of the client’s fleet vehicles. It showed that while PEVs were currently more expensive, the differences were relatively small and likely to disappear within three years.
Plug-in Electric Vehicle Based Business Modelling and Planning

Energeia is a leader in the development of business models and plans for entering emerging energy technology market opportunities, including electric vehicle related services including fleet leasing, financing, charging network access, and charging infrastructure related cub-contracting opportunities.

Following the development of detailed forecasts of market demand for charging services using our PEV and charging infrastructure models, Energeia’s proven PEV charging business modeling and planning methodology analyses the competitive landscape to identify the areas of greatest competition and greatest opportunity. It also identifies the strategic positioning of major competitors and identifies which have been the most successful. Figure E14 displays the results of our analysis of a number of key charging infrastructure service providers.

Figure E14. Public Charging Network Services Provider Positioning Framework

<table>
<thead>
<tr>
<th>Charging Markets</th>
<th>Charge Point</th>
<th>Tesla</th>
<th>Chargestar</th>
<th>REV Project</th>
</tr>
</thead>
<tbody>
<tr>
<td>Metro-Destination</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td></td>
</tr>
<tr>
<td>Long-Haul Transit</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Network Services</th>
<th></th>
<th>✔</th>
<th>✔</th>
<th>✔</th>
</tr>
</thead>
<tbody>
<tr>
<td>Installation</td>
<td>✔</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Operations</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>Maintenance</td>
<td>✔</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Funding Model</th>
<th></th>
<th>✔</th>
<th>✔</th>
<th>✔</th>
</tr>
</thead>
<tbody>
<tr>
<td>Proprietary Network</td>
<td>✔</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Third-Party Funding</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>User Pays</td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Technology Sourcing</th>
<th></th>
<th>✔</th>
<th>✔</th>
<th>✔</th>
</tr>
</thead>
<tbody>
<tr>
<td>Proprietary Hardware</td>
<td></td>
<td>✔</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Proprietary Software</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
</tbody>
</table>

Source: Company websites

Figure E15 displays the results of our analysis of the charging access plans of a wide range of major U.S. charging infrastructure service providers. This information was used to identify which approaches have been the most successful by analyzing the respective market share and profitability of each of the players.

Figure E15. Charging Services Benchmarking Framework

<table>
<thead>
<tr>
<th></th>
<th>Charge Point</th>
<th>Full Charger</th>
<th>Charge Master</th>
<th>EVnet</th>
<th>Blink</th>
<th>RWE</th>
<th>NRG eVgo</th>
<th>Tesla</th>
</tr>
</thead>
<tbody>
<tr>
<td>Size</td>
<td>Outlets</td>
<td>25,403</td>
<td>16,500</td>
<td>4,000</td>
<td>3,000</td>
<td>3,930</td>
<td>2,800</td>
<td>1,000</td>
</tr>
<tr>
<td>Location</td>
<td></td>
<td>US</td>
<td>FR</td>
<td>UK</td>
<td>NL</td>
<td>US</td>
<td>DE</td>
<td>US</td>
</tr>
<tr>
<td>Pay as You Go</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$/time</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>$/kWh</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>$/charge</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
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<td>Subscription</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sign Up Fee</td>
<td>$0</td>
<td>$0</td>
<td>$0</td>
<td>$0</td>
<td>$0</td>
<td>$0</td>
<td>$0</td>
<td>$0</td>
</tr>
<tr>
<td>Monthly Fee</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Following an analysis of the competitive landscape, and the critical success factors of the most dominant players, Energeia then applies its strategic positioning framework to our clients’ specific strengths and weaknesses to identify a short list of specific market opportunities to analyze further.
We have developed and applied the framework shown in Figure E16 below to a number of T&D clients over the past 2 years, as interest in the market has begun to increase with rising demand for PEVs. It has led to the development of several Board approved business plans.

**Figure E16. PEV Charging Market Opportunity Assessment Framework**

<table>
<thead>
<tr>
<th>Potential Role</th>
<th>Fast Charging</th>
<th>Other Public Charging</th>
<th>Home Charging</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Build</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Plan and develop sites or network*</td>
<td>H</td>
<td>H</td>
<td>N/A</td>
</tr>
<tr>
<td>Design sites</td>
<td>H</td>
<td>H</td>
<td></td>
</tr>
<tr>
<td>Manufacture equipment</td>
<td>L</td>
<td>L</td>
<td>L</td>
</tr>
<tr>
<td>Wholesale equipment</td>
<td>L</td>
<td>L</td>
<td>L</td>
</tr>
<tr>
<td>Install equipment**</td>
<td>H</td>
<td>H</td>
<td>L</td>
</tr>
<tr>
<td><strong>Finance</strong></td>
<td>H</td>
<td>H</td>
<td>H</td>
</tr>
<tr>
<td>Own</td>
<td>M</td>
<td>M</td>
<td>L</td>
</tr>
<tr>
<td><strong>Operate</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Site or Network Marketing</td>
<td>L</td>
<td>L</td>
<td>L</td>
</tr>
<tr>
<td>Site Energy Supply</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Site Field Maintenance</td>
<td>M</td>
<td>M</td>
<td>L</td>
</tr>
<tr>
<td>Site Operation (Demand Management)</td>
<td>L</td>
<td>L</td>
<td>L</td>
</tr>
<tr>
<td>Site Billing</td>
<td>L</td>
<td>L</td>
<td>L</td>
</tr>
<tr>
<td>Charging Network</td>
<td>L</td>
<td>L</td>
<td>L</td>
</tr>
<tr>
<td>Metering</td>
<td>L</td>
<td>L</td>
<td>L</td>
</tr>
</tbody>
</table>

* = Includes prime contracting and land prospecting  
** = Includes make ready and approvals

Source: Various vendor websites

**PEV and Charging Technology and Product Assessment Methodologies**

Energeia has been following the PEV market since 2010 and has developed a framework for tracking the development of PEV and charging products and services over time. The framework focuses on the key functionality and performance elements that we expect will drive consumer demand, operations, and impacts over the long-term, including battery size, charger size, vehicle to grid, and wireless charging capability.

The following tables provide examples of our product and service analytical framework, and how leading OEM players are currently positioning. Among the key trends we have identified is the rapid growth in average battery sizes over time, and the growth of available battery sizes for a given vehicle over time, as shown in Figure E17 on the following page. Based on this observed trend, we concluded that battery sizes were likely to continue to grow to 100 kWh on average over the next 3 years. This has significant implications for the type of charger customers will be seeking (i.e., a larger one).
**Figure E17. Driving Range and Battery Capacity for Current Australian BEVs in 2015**

<table>
<thead>
<tr>
<th>Make</th>
<th>Introduced</th>
<th>Model</th>
<th>Vehicle Class</th>
<th>Range (km)</th>
<th>Battery (kWh)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mitsubishi</td>
<td>2010</td>
<td>i-Miev</td>
<td>PC Small</td>
<td>100</td>
<td>16</td>
</tr>
<tr>
<td>Nissan</td>
<td>2012</td>
<td>Leaf</td>
<td>PC Small</td>
<td>118</td>
<td>24</td>
</tr>
<tr>
<td>BMW</td>
<td>2015</td>
<td>i3</td>
<td>PC Small</td>
<td>190</td>
<td>19</td>
</tr>
<tr>
<td>Tesla</td>
<td>2014</td>
<td>Model S 70</td>
<td>Sport/Luxury</td>
<td>442</td>
<td>70</td>
</tr>
<tr>
<td>Tesla</td>
<td>2015</td>
<td>Model S 85</td>
<td>Sport/Luxury</td>
<td>528</td>
<td>85</td>
</tr>
</tbody>
</table>

Source: OEM websites

**Figure E18. Driving Range and Battery Capacity for Current Australian BEVs in 2015**

<table>
<thead>
<tr>
<th>Power Output (kW)</th>
<th>ABB</th>
<th>Aker Wade</th>
<th>Circontrol</th>
<th>Delta</th>
<th>Electromotive</th>
<th>Fuji</th>
<th>Siemens</th>
<th>Tesla</th>
<th>Tritium</th>
</tr>
</thead>
<tbody>
<tr>
<td>50</td>
<td>50</td>
<td>50</td>
<td>50</td>
<td>50</td>
<td>50</td>
<td>50</td>
<td>50</td>
<td>120</td>
<td>50</td>
</tr>
<tr>
<td>Connector</td>
<td>Combo-2, CHAdeMO</td>
<td>CHAdeMO, SAE 1772</td>
<td>CHAdeMO, SAE</td>
<td>CHAdeMO, SAE</td>
<td>Yazaki</td>
<td>CHAdeMO, SAE, CCS</td>
<td>CHAdeMO</td>
<td>CHAdeMO</td>
<td>CHAdeMO, SAE, CCS</td>
</tr>
<tr>
<td>Standard</td>
<td>IEC 62196.3, CHAdeMO</td>
<td>CHAdeMO, SAE</td>
<td>IEC 61851, IEC 62196</td>
<td>CHAdeMO</td>
<td>CHAdeMO</td>
<td>CHAdeMO, SAE J1773</td>
<td>IEC 62196.3, CHAdeMO</td>
<td>IEC 62196.3</td>
<td>CHAdeMO, SAE, IEC 62196.3</td>
</tr>
</tbody>
</table>

Source: OEM websites

Energeia’s tracking of OEM charging product mixes found that most are offering higher power chargers each year, with more and more offering 7.2 kW and 22 kW (3-workstream) options. We have therefore concluded that, in conjunction with the trend towards larger batteries, we will continue to see larger Level chargers being installed over the next 3-5 years, with implications for PEV charging demand profiles.

**Figure E19. DC Charging Equipment**

<table>
<thead>
<tr>
<th>Power Output (kW)</th>
<th>ABB</th>
<th>BMW</th>
<th>Bosch</th>
<th>DIUS</th>
<th>Eaton</th>
<th>Schneider</th>
<th>Siemens</th>
<th>Tesla</th>
</tr>
</thead>
<tbody>
<tr>
<td>22*</td>
<td>IEC 62196 - Mennekes</td>
<td>3.7</td>
<td>7.2</td>
<td>3.4</td>
<td>7.2</td>
<td>22*</td>
<td>7.2</td>
<td>10</td>
</tr>
<tr>
<td>Connector</td>
<td>SAE</td>
<td>SAE</td>
<td>SAE</td>
<td>SAE</td>
<td>SAE</td>
<td>SAE, Mennekes</td>
<td>SAE, CCS</td>
<td>Tesla, Mennekes</td>
</tr>
<tr>
<td>Standard</td>
<td>IEC 62196.2</td>
<td>SAE J1772</td>
<td>SAE J1772</td>
<td>ZigBee</td>
<td>SAE J1772</td>
<td>SAE J1772, IEC 62916.2</td>
<td>SAE J1772, IEC 62916.2</td>
<td>Tesla, IEC 62916.2</td>
</tr>
<tr>
<td>Price</td>
<td>-</td>
<td>$1,750</td>
<td>$5,800</td>
<td>-</td>
<td>$1,500</td>
<td>-</td>
<td>-</td>
<td>$1,100</td>
</tr>
</tbody>
</table>

* The larger 22kW Level 2 chargers, such as the ABB and Schneider products, require three-workstream power.

Source: Vendor websites

Energeia remains bullish on the market for wireless charging products due to their unrivalled convenience at a relatively low energy cost premium.
Figure E20 shows two examples of wireless charging products. Three products have been introduced internationally: Plugless Power System, HaloIPT and the WiT-3000. The HaloIPT system allows a 6.6kW power output with overall energy efficiency greater than 90 percent.

Meanwhile, under road wireless charging, a potential competitor to the private wireless charging model, is now being piloted in the UK, Germany, Italy, Korea, and the Netherlands.

As is the case with wireless charging, Energeia is bullish on the outlook for V2G or export charging, despite the generally lack of availability. Now, only Mitsubishi, BMW, and Mercedes support V2G, and in the case of Mitsubishi, an adaptor is necessary.

Without supporting tariffs from the electricity supply industry, including retailers, networks, and the market operator, there is little reason to demand the functionality and therefore little reason to offer it.
Energeia’s Advanced Energy Solution Modeling Tools and uSim Software Methodology

Software for planning and delivering the electric utility of the future

Effectively integrating distributed energy resources (DER) into the DNA of your power system and organisation is critical to their long-term success.

Client References

The Los Angeles Department of Water and Power (LADWP) is the largest municipal electricity utility in the US, serving 1.4 million customers.

LADWP installed uSim to help it integrate DER into its power system in an optimised way. It has used uSim to:

- Identify least cost DER investment for each of its 2,000 network assets
- Assess DER alternatives for 1.5GW of thermal plant
- Identify efficient incentive levels for each type of DER

Energy Queensland (EQL) is the largest electricity utility in Australia, serving 2.2 million customers.

EQL installed uSim to help it design DER resilient tariffs and to better integrate DER into its planning and strategy function. It has used uSim to:

- Identify the impact of innovative new rate designs on DER adoption
- Develop DER-integrated 5-year forecasts at the HV asset level
- Identify efficient DER investment portfolios for each network asset

End-to-End DER Integration Support Across the Utility Planning Cycle

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Key Reasons for Buying uSim

Why do you need a DER integration tool?
- DER biggest driver of load changes
- Manage risk of revenue under-recovery
- Manage risk of asset stranding

What can a DER integration tool do?
- Optimise rates and incentives
- Optimise investment and cost-to-serve
- Optimise DER program design and delivery

Why is uSim the best tool for you?
- Native use of interval data for most accurate modelling
- More rates, incentives and DER options
- Widest asset coverage from utility generation to LV network
- Easy to setup and operate using Software-as-a-service (Saas)
- Best customer support, same day response
- Configurable simulation accuracy and speed

Easily Demonstrate DER Integration Impacts to Key Stakeholders

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### Software-as-a-Service Package

**Customer Segments**
- Residential ✓ ✓ ✓ ✓ ✓
- Commercial ✓ ✓ ✓ ✓ ✓
- Industrial ✓ ✓ ✓ ✓ ✓

**System Assets**
- Generation ✓ ✓ ✓ ✓ ✓
- Transmission ✓ ✓ ✓ ✓ ✓
- Distribution ✓ ✓ ✓ ✓ ✓

**Tariff Types**
- Flat ✓ ✓ ✓ ✓ ✓
- Inclining / Declining-Block ✓ ✓ ✓ ✓ ✓
- Time-of-use ✓ ✓ ✓ ✓ ✓
- Maximum Demand / Capacity ✓ ✓ ✓ ✓ ✓
- Critical Peak ✓ ✓ ✓ ✓ ✓
- Real-Time ✓ ✓ ✓ ✓ ✓

**DER Resources**

**Energy Efficiency**
- Voltage Management ✓ ✓ ✓ ✓ ✓
- HVAC ✓ ✓ ✓ ✓ ✓
- Lighting ✓ ✓ ✓ ✓ ✓
- Pools ✓ ✓ ✓ ✓ ✓
- Refrigeration ✓ ✓ ✓ ✓ ✓

**Demand Response**
- HVAC ✓ ✓ ✓ ✓ ✓
- Lighting ✓ ✓ ✓ ✓ ✓
- Pools ✓ ✓ ✓ ✓ ✓
- Electric Vehicles ✓ ✓ ✓ ✓ ✓
- Lithium Batteries ✓ ✓ ✓ ✓ ✓
- Solar PV ✓ ✓ ✓ ✓ ✓
- Microgrids ✓ ✓ ✓ ✓ ✓
- Virtual Power Plants ✓ ✓ ✓ ✓ ✓
- Distributed System Operator ✓ ✓ ✓ ✓ ✓

**Platform**
- Energy Systems 1 1 1 Unlimited
- Network Voltages Unlimited Unlimited Unlimited Unlimited
- Users Unlimited Unlimited Unlimited Unlimited
- Agents 1,000 1,000 Unlimited Unlimited
- Cores** 20 20 50 50

---

* = Any end use can be added
** = Included in package, additional may be purchased
Consulting Services to Perform Study of Consequential Issues Materially Affecting Kansas Electricity Rates

uSim DER Optimisation Workflow

Characterise Your Customers

uSim helps you map your customers to their Distributed Energy Resource (DER) potential and roll this up to any asset on the system

Characterise Their Load

uSim enables interval data level segmentation of DER impacts at the end user level, providing for cross-program interactions

Identify Your DER Resources by Asset

uSim enables true resource integration across conventional and DER resource categories, increasing planning efficiency and customer choice

Project Baseline System Impacts

uSim can quantify the cost of doing nothing, and identify the key DERs needing to be addressed

Target Your DER Optimized Configuration

Deploy Programs to Hit Target

Deploying DER effectively significantly reduces utility costs to serve, making electricity more affordable while maintaining or improving reliability

uSim turns optimised system, region and asset plans into actionable DER programs including efficient incentive levels, structures and program cost targets

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uSIM – Energeia’s Integrated Customer Demand Model

Overview
Energeia has developed, configured, and operated its DER simulation platform, uSim, to model how various scenarios settings influence outcomes in the electricity system. Energeia’s uSim has been used to provide insights into the linkages between rate reform and energy system response for several studies.

uSim is an agent\footnote{Agents are the principal decision makers within the simulation. It is the decisions that Agents (and the customers they represent) make that drive network decisions, energy prices and the fate of the grid.}-based model that simulates customer level decision making with respect to DER investment and operation under different rate, technology, and macro-economic settings, and estimates the corresponding impact of agent decision making on electricity networks investments and wholesale markets.

uSim operates across a range of different functions and modules, through an iterative process year-on-year, for each year of the simulation period. The key modules include:

- **Core Simulation Platform** – Contains the main customer and network function of the models (as outlined in the Core Simulation Platform section of this Appendix) and is linked to the DER Optimizer module.
- **DER Optimizer** – Calculates the optimal DER configuration for a customer given the provided constraints (explained in more detail in the DER Optimizer section of this Appendix), forming a subset of the Core platform.

The functions and sub-functions of each of the above modules of the simulation platform are summarized below, including a high level of overview of interactions between different parts of the model, limitations of assumptions and their impact on modeling.

The core simulation platform is made up of the main customer and network functions of the model:

- The simulations begin with agents, which represent a group of real-world customers. Agents are the principal decision makers within the simulation.
- The agents are then aggregated to network assets, which are made up of multiple zone substations.

Decisions to purchase DER systems, switch rates/incentives or disconnect from the grid are made by agents and zone substations. The results then feed back into network operating and capital costs, which determine network revenue allocations in the following year.

Inputs
Most inputs are loaded directly into the model in their raw form; however, customer data requires pre-processing to be made into usable inputs for the model. The subsections below discuss this customer pre-processing, which begins with defining populations and segments, assigning the customers to agents and finally mapping agents to zone substations.

The inputs for the model, including pre-processing steps, are as follows:

- **Electricity Customers** – Residential and commercial customer populations are generated based on utility data. Customer characteristics included the number of customers, customer class and premise types, number and capacity of solar PV systems, and total aggregated load profile on a zone substation level. Individual customer characteristics were assigned based on their assigned zone substation and its characteristics. Note that there are key limitations of the customer generation process, such as modelled customers do not represent actual customers connected to a network and the lack of other real-world characteristics, such as gas connections.

- **Agents** – Customers generated are segmented into agents based on a unique set of characteristics, such as customer class, dwelling types, solar PV system size and load profile\footnote{CSIRO provided 45 customer load profiles for each class of customer (residential or business) for each network, which were assigned to each of the agent types per class.}. Agents may not be accurately representing the distribution of customer’s annual consumption, particularly in the largest and smallest agents representing the tail of the distributions, resulting in some agents having much larger weightings than preferred.

- **Zone Substations** – Zone substations are modelled individually to capture the network costs, especially costs incurred by peak demand growth. Zone substation characteristics are obtained from the utility and divided into asset categories, value of operating and maintenance costs and costs of upstream and downstream transmission lines. This model does not require investment to augment HV feeder lines and LV distribution assets over time and does not allow for the construction of new zone substations — network expansion is only available through increasing the capacity of existing sites.

The inputs and assumptions relied upon in Energeia’s integrated model have been thoroughly researched, referenced and validated, and they are kept relatively up to date. This is due to our ongoing proprietary research service, which undertakes a major review of each technology area on an annual basis, and the frequency of
our consulting engagements to update and tailor the model to address client’s key questions.

Regular maintenance and development of our modeling system means that we can use one of the most comprehensive and sophisticated modeling tools in Australia at the relatively low incremental cost of updating, configuring and operating it. Our modeling inputs and assumptions are also typically subject to review and validation by our clients as part of each assignment, which means they are relatively robust.

Key modeling assumptions are drawn from our scenario planning work with clients. They provide an internally consistent set of future assumptions regarding retail energy prices, consumer side technology prices, economic growth, exchange rates and population growth.

**Model Operation**

**Calculate Network Revenue Target**

The target network revenue represents the revenue that the network aims to recover across all customer classes. It is made up of four components:

- **Operating expenses** – includes operating and maintenance costs taken from utility data where possible.
- **Capital costs** – consisting of the return on regulated asset base, taken from utility, and a depreciation allowance. These are unique for each utility.
- **Adjustment for under or over recovery of revenue in previous years** – allowance to recover missing revenue as a result of customers changing rates, purchasing DER or moving to a stand-alone power solution.
- **Balancing item**

The revenue target is calculated at the start of each year modelled using a simplified version of the methodology used by the AER when setting network revenue allowances:

\[
\text{Target (\$)} = \text{Opex (\$)} + \text{Return on RAB (\$)} + \text{Depreciation (\$)} + \text{Balancing Item (\$)} + \text{Unders & Overs (\$)}
\]

**Add New Customer Connections**

New connections are a key source of demand and consumption growth for electricity networks, and the energy sector as a whole. In the model, new connections are modelled by creating additional agents. One residential and one commercial agent is spawned each year for each network and is assigned a randomly selected load profile within each class. Probability weightings are not applied to demand profile selection, so a very large profile has the same probability of being selected as a standard customer profile. This is most noticeable for commercial connections, where the range of customer sizes is wider than for residential.

New connections are assigned a random dwelling type and the default rate for their network. However, they have the opportunity to change rate immediately to save on their bills.

Agents representing new connections are assigned scaling factors that represent the population of new customer connections on each zone substation. The population growth factors are exogenous model inputs and are unique to each zone substation. Note that using only a single agent to represent all new connections in a given year can cause volatility if the randomly selected profile for the new agents is extreme.

**Calculate Rates**

Rates are initially calculated each year to ensure that networks can recover their revenue allowance. The initial calculation formula assumes that there are no changes to the demand profiles of customers during the year (such as load growth, adoption of a Stand-alone-power-system or SAPS, changing rates or taking up DER). Under this constraint, the network will exactly recover its regulated revenue.

The limitations of this approach are:

- That customer demand profiles change from the profiles used so revenue recovery will always be different than target.
- Rates will under-recover whenever the effects of SAPS take-up, changing rates and taking up DER are greater than the effect of demand growth.
- If per-connection population and demand growth is negative, networks will always over-recover.

**Peak Revenue Allocation**

Networks recover enough revenue from the peak component of the rate\(^3\) to cover the cost of the contribution to peak demand by each customer class. Peak components are calculated based on the peak revenue divided between commercial and residential customers. Rates that do not have a peak mechanism collects revenue from all components.

- **Dynamic Peak Day Calculation (for Certain Dynamic Rates)** – Critical Peak Periods (CPP) are set to occur at the same time that network peak events are expected. Selecting CPP events requires finding the largest N number of peak intervals from network demand profiles excluding the effect of customer-owned batteries.

\(^3\) Peak components are rate mechanisms that specifically target customers during peak demand periods (these include the peak period of a time of use or maximum demand rate, critical peak events, and similar components in other rates).
Issues Materially Affecting Kansas Electricity Rates

- **Residual Allocation** – Network revenue that is not recovered through a peak mechanism is allocated to the residual components of a rate. Residual revenue is allocated between customer classes based on the allocation ratio implied by the current rate settings by each network. As the model progresses, and the value of residual revenue allocated to the network rises, this ratio is retained. Residual components charges are set to maintain a ratio of revenues. However, the chargeable quantity for each residual rate component may change over time, resulting in the revenue ratio between different residual components changing. For example, if a rate has Fixed and Anytime Energy residual charges and network wide consumption halved, the charges for both components would rise to recover the lost revenue, but the percentage of revenue recovered from the Anytime Energy charge would half.

**Rate Restructuring**

The model contains two mechanisms for restructuring rates available once to each rate in a single model run:

- **Price Rebalancing** – The residual rebalancing mechanism allows the residual rate prices to be rebalanced so that each component generates a target share of residual revenue. The residual rebalancing mechanism readjusts the relative sizes of the residual charges on a rate. The mechanism also corrects for the drift in revenue recovery ratios between the different residual components caused by the rate calculation. Price based normalization causes all rate components to increase in price when revenue from one component falls. Since this mechanism is only available at most once per model run, the percentage of revenue recovered by each component will continue to drift from the specified ratio over time.

- **Rate Restructure** – The residual restructure mechanism resets a rate to have its residual components simplified or standardized. The residual restructure mechanism sets new rate components, essentially creating a new rate.

**Wholesale Energy Prices**

Wholesale energy prices are a component of the retail rate and compensate retailers for the cost of purchasing electricity in the spot market. This cost is averaged across all customer classes (residential customers get the same price as business customers) and are applied at the same pass through rate to all peak and non-peak rate components that are energy-based charges.

All rates have a Feed-in-Rate (FiT) component that is available to customers with exports. The FiT rate is set by determining the average $/kWh a solar PV system would earn if it exported all the energy it generated for the year and was paid the wholesale market price in each interval (except where it falls below certain threshold levels).

**Retail Overhead and Profit**

Retail rates are the rates that customers see and pay. In this simulation, retail rates are structurally similar to their corresponding network rate but with an additional wholesale, fixed and FiT component determined using an overhead plus profit margin calculation for each component of the rate.

**Process Agent DER Decisions**

Agents are the principal decision makers within the simulation. It is the decisions that agents (and the customers they represent) make that drive network decisions, energy prices and the fate of the grid. Agents go through three different ‘decision’ processes. Each agent will go through a set of decision-making steps to consider moving off the grid, changing rates or taking up DER. These decisions are made in a specific order and when a decision to take an action is made the process ends immediately with no further decisions made.

Each of the individual decisions utilize the DER Optimizer, which determines the optimal DER configuration for an agent subject to the inputs provided. The DER Optimizer also completes a range of other tasks, such as applying technology dispatch algorithms and calculating bills. Further detailed discussion in DER Optimizer section of this Appendix.

**Load Growth**

Each agent begins the model with a single year demand profile. As the model progresses, this demand profile is adjusted to represent underlying trends in customer electricity demand patterns through applying a peak growth rate to the peak intervals (largest 5 percent of half-hourly intervals) and an average growth rate to the remaining consumption intervals.

**On-Grid DER Uptake**

Customers connected to the grid have the option to purchase DER and/or change rates. The selection of the best DER and rate combination is done within the DER Optimizer, which selects the combination with the highest NPV based on the inputs provided (further discussed in DER Optimizer section of this Appendix). An uptake function, based on a payback metric for DER purchasing or bill savings for rate change, is then applied to the best option to determine the uptake probability and whether the agent made a purchase. Agents that do not purchase any DER or change rates are eligible for the third and final decision-making step, rate churn.

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*Residual rate components are components that do specifically avoid targeting peak demand. The most common types of residual rate components are a daily fixed charge and an energy charge that was paid the wholesale market price in each interval (except where it falls below certain threshold levels).*
**Rate Churn**
Rate churn represents the effect of changes in occupancy at a premise and new and replacement meters. When a customer moves in or out of a house or business premise or the meter on the premise is replaced, the connection is changed to the default network rate. Rate churn is represented in the simulation by switching agents from their current rate to the default rate. The rate of rate churn is an input, with values specified for every year, customer class and network. Because of the approach, agents that are already on the default rate will not change.

**Agent to Zone Substation Scaling/Aggregation**
After agents have been processed, the results, including new load profiles, DER quantities and bills, are applied to networks. This process starts by applying the results of each agent to all the applicable zone substations the agent may be related to. Each agent represents a set of real-world customers that may be spread throughout the Agent’s parent network.

As the results of each agent are added to the individual zone substations, the results are multiplied by a scaling factor that represents the number of customers the Agent represents that are connected to the zone substation. Agent scaling factors vary between zone substations.

**Calculate Zone Substation Capex Requirements**
The modelled cost of a network is built around the zone substation. The sections below step through the process of determining the cost of a zone substation. This starts with determining whether the zone substation is in breach of its reliability requirements. If a breach has occurred, a demand profile forecast is generated, which is used in developing a remediation plan.

A network can defer augmentation of a zone substation by:
- Leasing a battery to temporarily reduce peak demand.
- Taking the traditional option and augmenting the substation.
- Installing new equipment with higher rated capacities, to meet reliability targets, depending on the options allowed by each scenario.

Zone substations have finite lifetimes due to deterioration in their condition, and when the end of life is reached the substation must be replaced. When this occurs, the same steps are taken as in the augmentation case.

Following the zone substation augmentation or replacement decision, information about the zone substation and its customers is aggregated to the parent network. The simulation then progresses on to network level calculations to size and select the least cost solution.

**Capacity Limits**
The simulation assumes all zone substations are rated on an N-1 basis. This assumes individual zone substations have capacity more than their rated capacity but are always required to have 100 percent asset redundancy. The simulation allows for a reasonable amount of exceedance of the N-1 rating. This allowed exceedance is expressed as the number of half hour intervals per year when the demand on a zone substation is greater than its rated capacity. The number of intervals is an input into the simulation.

If a zone substation has not breached a capacity limit and has not reached the end of its life, it takes no further actions for the current year. If this is not the case, the zone substation moves to the next step, which is to calculate a demand forecast.

The method used to model capacity limits has the following limitation:
- Actual installation of N-1 redundancy differs by state, network and within networks. Some areas, such as CBDs, have greater than N-1 redundancy whereas others have no redundancy.

**Demand Forecast**
The construction of a new zone substation requires knowledge about the future demand profile of the asset to be replaced. The chosen construction option must be built large enough to service demand decades into the future. A linear extrapolation is used to produce a 20-year forecast of future demand, based on previous years’ peak demand growth. The growth rate is applied uniformly over the asset’s interval demand profile to generate a full year profile of half hourly demand for each forecast year.

The method used to forecast demand for determining asset build sizes has the following limitations:
- The forecast is dependent on two data points, current demand and demand growth of (up to) five years previously. If demand is volatile, the forecast may vary widely one year to the next. Therefore, the year when a constraint is breached may have a large influence on the augmented capacity of an asset.
- Forecasts in the first few years of the model are unlikely to be representative of the long run given less historical data is available.

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5 N-1 refers to having the ability to supply all demand on the zone substation when one set of equipment (transformer, switchgear, sub transmission feeder line etc.) is down.

6 In the first four years of the simulation a shortened demand history is used. In the initial year of the simulation, when no historical demand is available to create a forecast from, a simulation wide default growth rate is used.
DER investment may reduce demand over a period, resulting in a forecast decline, but if penetration of DER is near the maximum, the declining demand may not be sustainable. This can lead to a zone substation reaching the end of its life being replaced by a substation that is smaller than necessary for the target lifetime, requiring augmentation only a few years later when demand growth resumes.

**Contracted Battery Option**

Networks have the option to lease a battery and place it at a zone substation (or to contract to customers within that zone substation). The battery can be used to remediate shortfalls of the zone substation (due to demand exceeding capacity) by discharging when demand is above the substation’s rated capacity.

Networks can obtain contracted batteries on a one-year lease basis. The battery leasing business requires a higher rate of return on their investment than the network’s own WACC and includes an assumption for recovery of depreciation over an assumed battery life. In return, networks gain the flexibility to use the batteries for a short period of time.

Contracted batteries are dispatched with the objective to keep demand on the zone substation below the rated capacity. The contracted battery will only operate to reduce demand to the rated capacity, it will not reduce demand further, solar shift or wholesale price arbitrage.

The battery in general has no preference in terms of when it charges. The exception is when the zone substation has net negative demand caused by large volumes of rooftop solar PV exports by customers of the substation, where the battery will attempt to charge from this to increase minimum demand.

The utilization rates of contracted batteries are generally very low, only discharging when demand is greater than the rated capacity of the zone substation, occurring a handful of times a year. Due to this low level of utilization, battery degradation due to cycling is negligible in most cases and is not included in the pricing function for the battery lease.

**Augment or Replace with New Zone Substation**

The traditional response to an ageing or over capacity zone substation is to replace it with a new, correctly sized substation. Despite the new options that are now available, a new substation is still the primary method for maintaining the network and supplying electricity to customers.

The peak demand forecast for the substation is used to determine an appropriate build size, large enough that the asset will not breach its rated capacity in the final forecast year plus an additional margin.

**Aggregate Results to State and NEM**

The simulation platform works primarily on a network level, with each network operating independently of other networks. This means that agent and network decisions are contained within a single network.

The simulation platform calculates the total electricity demand profile for each state. State demand is the sum of industrial, commercial and residential demand in each network in the state from the simulation, plus an additional balancing item for the large-scale industrial demand within the state.

Large scale industrial customers are those connected to a zone substation that does not serve any residential or commercial customers or are connected directly to a sub-transmission line or bulk supply point. These customers are not modelled in the simulation and are only relevant for determining prices in the spot market. The load profiles of large industrial customers do not change over the course of the simulation.

**DER Optimizer**

The DER Optimizer is one of the core modules within the simulation platform and is used throughout the simulation. It calculates the optimal DER configuration for a customer or zone substation given the specified options and constraints.

The DER Optimizer takes a brute force approach, testing every valid combination of technologies, sizes and rates that are available for each customer or zone substation. For each combination of DER and rate, the first step taken by the optimizer is to apply the behavior change effect of the rate in the combination, followed by all combinations of allowable sizes of DER technologies being tested.

The DER adjusted profile is then used to calculate the customer’s retail electricity bill. This bill, plus the cost of DER and value of unserved energy is used to calculate the NPV, payback and other summary statistics for each technology and size combination. From all the combinations, the option with the highest NPV is selected for the customer, even when the highest NPV is negative. The payback of this “winning” combination is then used by the uptake function to determine if the customer purchases the combination.

**Technology and Rates Combinations Loop**

The first step of the DER Optimizer is to select a combination of rates and technologies. A combination is made up of a rate and, at most, one variant of each DER technology – provided the combination is valid. Examples of an invalid combination are a solar panel without an inverter, solar panels on a customer with no roof space, a battery with a DER restricted rate or the customer’s current rate with no DER.
Some technologies can be augmented, such as solar PV and batteries, with new purchases adding to the existing capacity installed, whereas other technologies must be fully replaced as follows, such as inverters and diesel generators.

Technology combinations add further complexity:

- Inverters can be retained even as the solar PV systems and batteries they serve are augmented. The customer will have the option of purchasing an augmentation option that uses their current inverter or purchasing the augmentation with a new inverter. The existing inverter may become a constraint on the operation of the newly acquired capacity, justifying an inverter upgrade.
- If a customer does not currently own a battery, they are required to purchase a new inverter. This constraint is applied to force existing solar customers to purchase a new inverter as most currently available inverters are not compatible with battery storage systems.

### Rate Induced Behavior Change

The demand profile of the customer using the DER Optimizer is first adjusted for the effects of behavior change. Behavior change is implemented as a percentage reduction in consumption applied to every half hour interval when peak rate mechanisms are active. Peak mechanisms that are more concentrated have larger behavior change effects. For example, the behavior change effect of a Critical Peak Price rate, which has a handful of event days each year, has a larger behavior change effect during peak events than a Maximum Demand rate that has a peak period on every weekday of the year.

Behavior change effects are exogenous inputs from previous studies and are applied similarly to classes of rates.

The method used to model rate induced behavior change has the following limitations:

- Behavior change is applied to all intervals within the peak period for the rate, regardless of whether the interval contributed to the total bill for the peak mechanism (i.e. a peak interval with demand of only half the current monthly peak will be reduced by behavior change despite the interval not increasing the customer’s bill).
- Behavior change reduces total customer consumption but does not shift consumption to an off-peak time. In practice, it could be expected that at least some portion of the energy avoided during peak periods would be shifted to off peak times.

### Solar PV

Solar PV is not controllable by its owner and is therefore unaffected by most variables once the size is determined. Due to this, solar PV is the first DER technology that is applied to the demand profile:

- A state-based solar profile trace, multiplied by the size of the solar PV system, is subtracted from the demand profile. The same profile is applied to all residential and commercial customers in the same state and is obtained from the actual output of a representative 1kW solar PV system. Since the profile is from an actual solar system's output, it includes the effects of seasons and weather effects such as cloud cover. Solar profiles do not change between years.
- Solar PV systems do not degrade over time but have a finite life and fail immediately when the end of life is reached. However, if a solar PV system is augmented, the new system, including the capacity retained from the old system, will have the lifetime of a new system.

The method used to model solar PV has the following limitations:

- All customers within one state have the same solar profile, which excludes the beneficial effects of geographic diversity on solar PV output. Cloud cover, which greatly reduce solar PV output, affect all panels within a state simultaneously.
- The solar output profile source does not necessarily align to the original dates of the demand profiles that agents in the model have. In many cases, customer and network peak demand occurs on very hot, sunny days. Since the source data does not align, the network peak event may for example coincide with high cloud cover, rendering solar PV ineffective at reducing peak demand.

### Battery

Batteries are used to increase the value of solar PV generation and to arbitrage rates by shifting the battery owner’s grid demand to times when retail electricity prices are lower. Batteries have a set of characteristics that limit their ability to complete their objectives:

- **Depth of Discharge** – The depth of discharge (DoD) of a battery is the maximum percentage of the battery’s rated capacity that can be used. A battery with a rating of 1kWh and a 90 percent DoD can be discharged to a minimum level of 0.1kWh. At this point the battery must be recharged. This is a built-in feature by the manufacturer of the battery that improves the lifetime of the battery. Discharging to very low levels has a greater effect on the battery’s degradation.
- **Output Limits** – Batteries are constrained by how quickly they can be charged or discharged. Higher rates of charging or discharging generate additional heat and degrade the battery faster. The charging and
Consulting Services to Perform Study of Consequential Issues Materially Affecting Kansas Electricity Rates

The method used to model batteries has the following limitations:

- Each battery variant has the same charging rate for all sizes, which means the model will prefer purchasing a larger capacity battery when the customer needs a battery with a faster rate of discharge.
- Only one battery variant is available to each customer class in the simulation, so customers are not able to select between different battery characteristics that may be more optimal for a given situation.
- There are additional technical factors that affect battery degradation, such as heat and the rate of charging and discharging, that are not incorporated into the degradation calculation.
- The degradation calculation always assumes the battery is discharging beginning at 100 percent but actual degradation depends on how much the battery discharges and the levels the battery is discharging between. For example, a battery cycling between 20 percent and 30 percent will degrade more than a battery cycling between 45 and 55 percent.
- Battery lifetime is calculated using a simplified assumption of constant degradation over time. However, degradation will vary over time as the discharge profile of the battery changes. The cause of this variation is due to customer demand changes, other technology purchases and previous degradation of the battery affecting how the remaining capacity can be used.

### Battery Algorithm

The battery algorithm determines when the battery charges and discharges aiming to lower the battery owner’s bill as much as possible by taking advantage of rate arbitrage opportunities. The algorithm runs across all battery sizes and selects the battery size associated with the lowest NPV.

The battery algorithm works within the physical constraints of the battery and the inverter. The battery is not allowed to charge or discharge at a rate greater than the inverter size, unless it is charging from solar PV, when it is constrained only by the physical charge limit of the battery. This is because both systems are assumed to be ‘behind’ the inverter and can operate DC to DC.

The algorithm is built based on the battery having perfect foresight of the owner’s demand. This means the results of the algorithm set an upper limit for the savings achievable by a battery in a real-world situation.

The algorithm will reduce a customer’s retail electricity bill as much as possible, starting with the most valuable action and progressing to lower value actions. A high value action is usually discharging in response to a peak mechanism in a rate, such as clipping demand spikes in response to a maximum demand charge. Lower value actions include arbitraging price differentials for a time of use energy charge, charging during the off peak and discharging during the peak period and then possibly during the shoulder period.

The battery algorithm will charge the battery during the time with the lowest cost to charge. This is often when there are solar PV exports which have a minimal cost to the customer of the foregone FiT revenue which would otherwise be received for exports. Some rates also have a period where the energy charge is zero, but the peak demand charge remains active. In this case, the battery will charge as much as possible when the energy is free without triggering an increase in the peak demand charge.

An example of a battery algorithm functioning across varying rates are shown in [Figure 1](#), [Figure 2](#) and [Figure 3](#). [Figure 4](#) shows an example of the impacts of EV on demand and [Figure 5](#) shows an example of the impact of a VPP on battery charging and discharging.
Figure 1 – DER Impact on a Customer Load Profile on an Inclining-Block Rate (Indicative)

Source: Energeia

Figure 1 – DER Impact on a Customer Load Profile on a Time-of-Use Rate (Indicative)

Source: Energeia

Figure 2 – DER Impact on a Customer Load Profile on a Max Demand Rate (Indicative)

Source: Energeia

Figure 3 – DER and EV Impact on a Customer Load Profile on an Inclining-Block Rate (Indicative)

Source: Energeia
The battery algorithm has the following limitations:

- All customers have the same algorithm so often act with a herd instinct, effectively eliminating diversity. i.e. Large numbers of customers will charge at the same time, potentially causing new peak demand events.
- The battery algorithm is particularly poor at optimizing battery activity when a rate has an inclining or declining block mechanism. This is because the end price for electricity consumption during each rate component period is not well defined. If a second mechanism exists, such as a peak charge, the algorithm will struggle to determine whether further activity to lower the peak charge is worthwhile.

**Inverter**

The inverter is assumed to be between the solar PV and battery storage units and the house circuit. The solar PV unit can therefore charge the battery at the same time as it is exporting to the house circuit, which allows solar usage to be greater than inverter capacity. Therefore, the inverter capacity can be smaller than the output of the solar PV unit, and it is assumed the inverter limits power flowing above its capacity, rather than fully disconnecting the solar PV and battery storage system when overloaded.

For this reason, the inverter constraint is applied after the battery algorithm has run to calculate solar generation. The inverter also applies as a constraint within the battery algorithm.

**Calculate NPV**

To compare different technology and rate combination purchase options, the NPV of each option is used. The NPV formula uses the discount rate of the buyer of the DER system and ongoing payments determined by the DER lifetime and system characteristics as discussed in the sub-sections below.

For an on-grid DER system the NPV is calculated separately for each component within the combination being tested. This is due to the different lifetimes for each technology, which affects over how many years the capital costs can be spread over.

Bill savings are applied to different components of an option by calculating the marginal contribution in a pre-specified order. The calculation begins with the customer’s existing load profile, including the effect of any technologies they may already own. Then any new technologies, including augmentations, are applied in the following order:

- **Rate Change** – The bill effect of a rate change is applied first. This is only necessary if the option being tested includes a rate that is different to the customer’s current rate. Because rates are easily changeable, the NPV of the rate change is set to the bill savings (or cost) of the rate in the current year.
- **Solar PV (including inverter cost)** – Next, the NPV for the solar PV is calculated using the lifetime of the new solar PV system and the additional bill savings calculated from the customer’s new demand profile. The DER optimizer does not consider the possibility that the existing battery of a customer may discharge differently due to the new solar PV. If an inverter is being purchased, the cost of the inverter is included in the solar PV NPV.
- **Battery (including inverter cost if there is no solar PV)** - After the NPV of the solar PV system has been completed, the battery NPV is calculated using the demand profile that includes new solar PV. The battery NPV is calculated assuming the bill savings obtained in the current year will be received in every future year until the battery degrades to 70 percent of its new capacity. This lifetime calculation assumes the same degradation every year into the future.

**Outputs**

Energeia’s uSim model is able to produce comprehensive reporting on a customer, network, state and market operation level. The following sections presents some of Energeia’s uSim modeling capabilities.
Technology and Rate Adoption

Each agent’s optimized technology and rate adoption are reported each year and aggregated to customer and network segments. This is displayed in Figure 6 which shows the rate penetration within the residential segment for a recent project. Similarly, from the same report, Figure 7 shows the cumulative DER capacity for solar, battery storage and diesel within a state.

Figure 5 – Cumulative Residential Rate Penetration by Scenarios

Figure 6 – Total DER Capacity by Scenarios

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Demand Profiles

Energeia’s uSim produces agent-aggregated demand profiles on an asset level basis, including peak, min and average day demands. Error! Reference source not found. shows the total peak demand on across various scenarios, as a sample of potential outputs.

Figure 7 – Total Peak Demand

Applications

Energeia has worked with a wide range of clients to provide insight into their key business challenges and opportunities including:

- The effect of rate reforms on customer consumption patterns and future revenues.
- The size and shape of future growth opportunities in emerging energy markets.
- The effect of new technology and rates on peak demand growth and load factors.
- The timing and nature of technology enabling cost effective disconnection from the grid.
- Optimal customer segments for solar PV leases and power purchase agreement.
Energeia’s Cost of Service and Rate Design Methodology

Overview

Tools enable more work to be achieved for the same amount of labor. Proven methodologies provide a guide for completion of complex tasks, thereby increasing efficiency and reducing risk of failure.

Over the course of more than 40 cost of service (CoS) and advanced rate design related projects for major utilities, governments, and regulators, Energeia has developed a suite of sophisticated tools and methodologies for answering the key questions facing our clients. These tools allow them to deliver greater value for their money than if they had to start from scratch.

This attachment summarizes Energeia’s key methodologies and tools for analyzing utility CoS, advanced rate design options and customer and utility impacts.

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- Cost of Service Modelling
- Cost-Reflective Rate Design
- Customer and Utility Impact Assessment

Cost of Service

Energeia’s approach to CoS and rate design is grounded in our ten-year history of helping utilities adjust to the growing impact of distributed energy resources. Our tools and techniques are now on their third generation thanks to our experience in Australia, which has seen some states reach nearly 50 percent of premises having solar PV, and increasingly, battery storage.

The following sub-sections summaries our key analytical procedures used to develop bottom-up, forward looking, highly granular CoS estimates and DER-resilient rate designs.

Model Customers and 8760 Loads

Our CoS estimation and rate design approach relies heavily on detailed understanding of customer demand. We therefore start our analysis with the development of a customer model, based on a wide range of data, but mainly comprised of data from the Customer Information System, Billing System, Metering System, and Data Historian. The figure below illustrates how we draw from available systems and data sources to bring together an integrated view of customers, including their:

- Current rate and bill
- Annual hourly (8760) load profile
- Existing DER
- Potential DER
- Price elasticity of demand drivers
Energeia Data Integration from a wide Range of Internal and External Sources

With this data on customer population in hand, we then develop a stratified sample design tailored to specific situations and needs. An example of the approach we adopted for a large municipal client is shown below. We expect sample designs to include each of the major customer classifications, plus any additional classifications we identify via data mining, cluster analysis and stakeholder discussions, etc.

Sample Design and Customer Segmentation Developed for Large Municipal (MWhs)

<table>
<thead>
<tr>
<th>Premise Type</th>
<th>A1 Building</th>
<th>A1 Suite</th>
<th>A2 Building</th>
<th>A2 Suite</th>
<th>A3 Building</th>
<th>A3 Suite</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Church/Club</td>
<td>23,052</td>
<td>6,633</td>
<td>33,893</td>
<td>14,566</td>
<td>4,368</td>
<td>1,976</td>
<td>84,689</td>
</tr>
<tr>
<td>Heavy Industrial</td>
<td>11,300</td>
<td>2,679</td>
<td>8,973</td>
<td>1,088</td>
<td>47,846</td>
<td>29,234</td>
<td>101,121</td>
</tr>
<tr>
<td>Hotel/Motel</td>
<td>5,904</td>
<td>1,824</td>
<td>30,812</td>
<td>8,132</td>
<td>125,407</td>
<td>54,208</td>
<td>226,286</td>
</tr>
<tr>
<td>Light Industrial</td>
<td>13,532</td>
<td>33,303</td>
<td>42,236</td>
<td>60,348</td>
<td>47,846</td>
<td>29,234</td>
<td>258,597</td>
</tr>
<tr>
<td>Multi Family</td>
<td>1,914</td>
<td>1,859</td>
<td>36</td>
<td>128</td>
<td>2,447</td>
<td>3</td>
<td>5,461</td>
</tr>
<tr>
<td>Total</td>
<td>1,138,109</td>
<td>1,012,105</td>
<td>1,136,249</td>
<td>562,249</td>
<td>1,296,475</td>
<td>1,456,070</td>
<td>6,601,257</td>
</tr>
</tbody>
</table>

We then use the sample to estimate 8760 profiles for the customer within a segment that does not have a complete 8760 profile. We also use the sample design to generate 8760 profiles for each asset and calibrate the estimated 8760 profile to match each asset 8760 in the current year.
Classify Customers

The next step in our process is to analyze demographic, psychographic (if available) and 8760 data to identify potential customer classifications, where a new definition might lead to a significant change in the new segment’s:

- Cost-to-serve of the segment (e.g. much higher or much lower than old segment)
- Price elasticity of demand (degree of response to changes in prices, bills, or DER costs)
- Vulnerability (ability to carry changes in prices / bill)

We use a bottom-up, k-means clustering to identify fundamental peak day and avg. load shapes, which drive cost-to-serve and bills, but say nothing directly about price elasticity and vulnerability. The slide below shows the peak and avg. daily load curves at different ks. We typically use ks that result in meaningful segments, i.e., all greater than 10 percent of the total. Example output of this process is shown below.

Illustration of k-means Clustering to Identify Potential Customer Classifications by Load Shape

![Graph showing peak, average, and hybrid load shapes with normalised demand over time](image)

While the above approach can generate new insights into key customer segments that need to be considered when changing rates and allocating costs, it is only one input into the process. The other key input is identification of different price elasticities of demand, e.g., renters vs. owners (the former is limited) and those in apartments vs. those in free standing buildings (with rooftops for solar PV), and whether the site has major loads able to be managed, e.g., pool pumps.

Where new loads are to be considered, for example bus electrification and DCFC charging sites, Energeia develops bottom-up estimates of the expected load shape, and then considers whether these load shapes are materially different to existing customer classifications in terms of cost-to-serve or price elasticity of demand. The figure below provides an example of the bottom-up modeling we did for a major metropolitan city, based on publicly available route information.
Energeia has developed a tool that is able to identify the specific hours for optimal classification of the peak period. The figure below illustrates the tools outputs, which show the optimal number of hours (and the hours themselves), compared to the current peak setting.
Technical Analysis of Peak Period Optimization

In addition to determining the current optimal peak period, Energeia analyses historical data to identify any trends that could require adjusting the peak period, for example, due to solar PV, storage or electric vehicle adoption. This type of trend analysis is illustrated in the figure below.

Illustration of Period Trending to Ensure Optimal Period Setting

The final peak period analysis we do is to simulate changes in the load shape over time using uSim, our electricity system simulation software. This generates 8760 load shapes for each asset for each year, enabling us to identify and accommodate any expected changes in the peak period over time.

Model Cost-to-Serve

Our approach to developing the cost-to-serve model itself depends on the available data. We therefore typically kick-off the process by meeting with all subject matter experts to identify available data, discuss the pros and cons of the previous approach, and the key lessons learned. From there, we issue a request-for-information, and manage cost inputs using this tool.

Most studies we have completed are based on current or backward-looking costs, as captured in the balancing sheet, and profit and loss statements, and potentially via procurement contracts in the gas of new generation or major asset builds. Our approach to analyzing these types of data are to categorize these costs by functionality and by asset category.
Energeia will also factor in any forward-looking information, including the cost of emissions permits, balancing market costs, generation fuel, RPS compliance costs, etc. Any major planned capital programs, e.g. a smart metering rollout or a major IT system upgrade, will also be added to the CoS model.

We aim to develop as granular a cost category as allowed by the data, e.g. estimating the costs of the medium voltage, high voltage and sub-transmission networks separately, so that these costs can be more accurately allocated to customer classes and their marginal costs correctly signaled.

Energeia is unique in our ability to model a forward-looking cost-to-serve, using our uSim software. We use the latest cost data to configure the software, and ensure it is calibrated to the existing cost structure and revenue requirements in the current period. The software can provide a cross-check on existing forecasts of capex and opex, or it can be used to develop forecasts.

Importantly, uSim’s cost forecasting capability can enable the cost of emerging cost drivers like solar PV exports to be quantified. It can also be used to provide evidence-based cost allocations over time, as the peak period shifts, and along with it, different customer classes’ contribution to the peak.

Once the historical and current costs have been categorized, they need to be allocated to customer classes.

### Allocate Costs

Our approach to allocating costs is to use the 8760 profiles for each customer class to identify the contribution to peak demand for each asset category, e.g., low voltage, medium voltage, high voltage, sub-transmission, transmission and generation. We can also use this approach to allocate voltage management related costs, e.g., from rising real power exports from solar PV and other generation.

We will discuss allocation of non-system and fixed costs, where other factors such as equity, price elasticity of demand, and other factors may come into play. Energeia’s uSim software can be used to inform the residual cost allocation process, by providing insights into how different allocations affect customer bills, DER adoption, and cost-to-serve.

### Develop Rates

Energeia’s approach to developing rates is to:

- Engage with subject matter experts and stakeholders
- Identify the approaches taken by peer utilities
- Develop rates using similar structures based on specific cost structure
- Develop rates from a first principles basis
- Test all rates using uSim to determine their relative performance

Energeia will kick off this process by meeting with subject matter experts and key internal and external stakeholders, to understand the pros and cons and key lessons learned from the last rates process, as well as any insights and perspectives on the current process.

Energeia will then undertake a benchmarking of peer rates structures, and ideally reach out to peer rates managers to discuss the pros and cons of their approach, and any key lessons learned.

Energeia will then construct a portfolio of potential rate options based on costs using the following principles:

- **Peak period kWh prices** – These will be set to recover the long-run-marginal-cost (e.g., generation, transmission and distribution) and short-run-marginal-cost (e.g., fuel and variable O&M) of an incremental unit of supply.
- **Off-peak kWh prices** – This will be set to recover the forecast volume weighted short-run-marginal-cost of supplying the energy (i.e., fuel and variable O&M).
- **Maximum demand prices** – This will be set to cover the long-run-marginal-cost of the dedicated assets, e.g., the HV circuit feeding the premise.
- **Annual fixed prices** – This will be set to recover the customer classes’ share of non-system costs (e.g., buildings, executives, meters).
- **Other prices** – These will be used if needed to recover residual costs not covered by the other cost reflective pricing mechanisms above.
An example of a bundle of rates with different structures and cost recovery mechanisms is shown below. This is from a previous rates design and optimization project, where we tested 18 different permutations of a seasonal ToU rate structure across residential and small business customers.

Illustration of the Range of ToU Rate Designs

<table>
<thead>
<tr>
<th>Description</th>
<th>Monthly Maximum Demand</th>
<th>Maximum ToU Rate Demand</th>
<th>Average Monthly Demand</th>
<th>Monthly Average Demand</th>
<th>Residual Mechanism</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 MMD/OPD/OPE/F</td>
<td>✅</td>
<td>✅</td>
<td>✅</td>
<td>✅</td>
<td>✅</td>
</tr>
<tr>
<td>2 MMD/OPD/ATU/F</td>
<td>✅</td>
<td>✅</td>
<td>✅</td>
<td>✅</td>
<td>✅</td>
</tr>
<tr>
<td>3 MMD/OPE/ATU/F</td>
<td>✅</td>
<td>✅</td>
<td>✅</td>
<td>✅</td>
<td>✅</td>
</tr>
<tr>
<td>4 MMD/OPE/F</td>
<td>✅</td>
<td>✅</td>
<td>✅</td>
<td>✅</td>
<td>✅</td>
</tr>
<tr>
<td>5 MMD/OPD/OPE/PE/F</td>
<td>✅</td>
<td>✅</td>
<td>✅</td>
<td>✅</td>
<td>✅</td>
</tr>
<tr>
<td>6 MMD/OPD/F</td>
<td>✅</td>
<td>✅</td>
<td>✅</td>
<td>✅</td>
<td>✅</td>
</tr>
<tr>
<td>7 MMD/OPD/F</td>
<td>✅</td>
<td>✅</td>
<td>✅</td>
<td>✅</td>
<td>✅</td>
</tr>
<tr>
<td>8 MMD/OPD/F</td>
<td>✅</td>
<td>✅</td>
<td>✅</td>
<td>✅</td>
<td>✅</td>
</tr>
<tr>
<td>9 ATU/OPE/ATU/F</td>
<td>✅</td>
<td>✅</td>
<td>✅</td>
<td>✅</td>
<td>✅</td>
</tr>
<tr>
<td>10 ATU/OPD/F</td>
<td>✅</td>
<td>✅</td>
<td>✅</td>
<td>✅</td>
<td>✅</td>
</tr>
<tr>
<td>11 ATU/OPD/F</td>
<td>✅</td>
<td>✅</td>
<td>✅</td>
<td>✅</td>
<td>✅</td>
</tr>
<tr>
<td>12 MMD/OPD/ATU/F</td>
<td>✅</td>
<td>✅</td>
<td>✅</td>
<td>✅</td>
<td>✅</td>
</tr>
<tr>
<td>13 MMD/OPD/ATU/F</td>
<td>✅</td>
<td>✅</td>
<td>✅</td>
<td>✅</td>
<td>✅</td>
</tr>
<tr>
<td>14 MMD/OPD/F</td>
<td>✅</td>
<td>✅</td>
<td>✅</td>
<td>✅</td>
<td>✅</td>
</tr>
<tr>
<td>15 MMD/OPD/F</td>
<td>✅</td>
<td>✅</td>
<td>✅</td>
<td>✅</td>
<td>✅</td>
</tr>
<tr>
<td>16 MMD/OPD/ATU/F</td>
<td>✅</td>
<td>✅</td>
<td>✅</td>
<td>✅</td>
<td>✅</td>
</tr>
<tr>
<td>17 MMD/OPD/ATU/F</td>
<td>✅</td>
<td>✅</td>
<td>✅</td>
<td>✅</td>
<td>✅</td>
</tr>
<tr>
<td>18 MMD/OPD/ATU/F</td>
<td>✅</td>
<td>✅</td>
<td>✅</td>
<td>✅</td>
<td>✅</td>
</tr>
</tbody>
</table>

We are able to model a wide range of rates designs in uSim to discover the rate design that best fits the selection criteria, which may include:

- **Efficiency** – Provides efficient signals, based on CoS and elasticity of demand
- **Effectiveness** – Is actionable by customers and/or their agents
- **Equity** – Allocates costs fairly and with regard to vulnerable customer groups
- **Stability / Sustainability** – Minimizes price year-to-year variability

Energeia will work to develop a framework for selecting the optimal rate designs. Each rate design will be scored against this framework, enabling a systematic, and evidence-based consideration of all prospective rate designs.

Model Rate Impacts

uSim estimates the impact of each tariff on DER adoption, customer bills, revenue recovery, and CoS. DER adoption is based on historical price elasticity of demand by segment. Customer bills are based on the estimated 8760 load profiles. Revenue recovery is based on the level of DER adoption, and CoS is based on the (positive and negative) impact of DER on thermal and voltage constraints.

Examples of this type of analysis are shown in the figures below.

Illustration of the Impact of Rate Design on 10-Year Solar PV and Storage Adoption (DER)
The figure below shows the reduction in customer bills compared to the reduction in utility costs by type of rate. Some of the designs result in large cross-subsidies, e.g., IBT, while others, ATE/F, virtually eliminated them. Removal of cross-subsidies is only one of multiple selection criteria of course.

Illustration of the Impact of Rate Design on 10-Year Cross-Subsidies

The figure below shows the increase in utility prices due to changes in CoS. The reason the IBT results in the highest price increase is due to it driving uneconomic levels of investment in DER, and uneconomic timing of battery and EV charging, which ultimately leads to higher levels of capex and a lower load factor than more cost reflective rates.

Illustration of the Impact of Rate Design on the 10-Year Price Path

uSim can generate a wide range of outputs for comparing across rates designs, including:

- Coincident maximum demand
- Non-Coincident maximum demand
- Consumption
- Total energy costs including DER costs
Consulting Services to Perform Study of Consequential Issues Materially Affecting Kansas Electricity Rates

- DER adoption, MW and MWh by DER type
- DER 8760 by DER type and by asset
- Capex and opex by driver
- Capex and opex by asset category
- Customer segment level bills
- Customer segment level 8760s
- Emissions

Energeia will create a reporting dashboard to generate the key inputs needed to select the final rate designs and transitional designs. Ultimately, we will look to develop a slide similar to the one below, highlighting the impact that an optimized portfolio of rates is expected to have on system costs.

Illustration of Optimized Rate Design Impacts on System Load and Associated Cost-to-Serve

Approach to Addressing Data Gaps

Missing Customer and Asset 8760 Data

Energeia will develop a bottom up model of customer’s 8760 profiles for each customer, each customer class (existing and recommended), and for each major asset, e.g. medium and high distribution feeders and substations, transmission lines and substations, and its generation system.

Energeia’s uSim software enables it to develop statistically robust estimates of customer 8760 load shapes using very limited data. Energeia has applied this method at a large Muni where they had less than 50,000 8760 profiles of their residential and small business customers.

The figure on the following page shows how a sample of residential and small business 8760 data from smart meters from a Federally funded smart grid program (indicated by red and blue in the larger map) were applied statistically to the muni’s customer base, down to the premise level.
Illustration of Using Sampling to Develop Customer Level 8760 Load Profiles

The figure below illustrates the mapping of each customer segment (which will be defined in consultation with subject matter experts) to HV feeders. A similar mapping will be done for each major distribution, transmission and generation asset. This allows very accurate cost allocation.

Illustration of Mapping Customer Segments to Feeders
With statistically robust 8760s in hand for each customer segment, it will be possible to accurately estimate:

- Distinct customer classifications
- Cost contribution by asset category and customer classification
- Bill impacts by rate design and customer classification
- DER adoption by rate design and customer classification
- Revenue impacts by rate design and customer classification

Energeia has applied its 8760 estimation approach to a number of large municipal utilities in California, and to over half of the distribution and transmission utilities in Australia.

**Missing Battery, EV and other DER Adoption and Impact**

One of the key data issues the project will face is how to estimate the impact of rates on customer adoption of solar PV, battery storage, EV and other DER, including how customers that buy batteries and EVs operate those devices. Energeia’s uSim enables estimation of customer adoption rates by tech type and rate design, and provides 8760 estimates of how DER will operate, illustrated in the graphic below for a typical weekday.

**DER Impact on a Customer Load Profile on an Inclining-Block Rate (Indicative)**

![Der Impact on a Customer Load Profile on an Inclining-Block Rate](image)

Source: Energeia

**DER Impact on a Customer Load Profile on a Time-of-Use Rate (Indicative)**

![Der Impact on a Customer Load Profile on a Time-of-Use Rate](image)

Source: Energeia
Consulting Services to Perform Study of Consequential Issues Materially Affecting Kansas Electricity Rates

**DER Impact on a Customer Load Profile on a Max Demand Rate (Indicative)**

Source: Energeia

**DER and EV Impact on a Customer Load Profile on an Inclining-Block Rate (Indicative)**

Source: Energeia

**DER and VPP Impact on a Customer Load Profile on an Inclining-Block Rate (Indicative)**

Source: Energeia

**Missing or Incorrect Customer Metering or SCADA 8760 Data**

Another key data issue is bad or missing 8760 data from smart meters and SCADA/ADMS historians. Energeia has developed automated approaches to dealing with data gaps and outliers. This is particularly important when forecasting spatial peaks for distribution network CoS estimates, where temporary switching appear to create a new asset peak if not identified and revised.
Illustration of Data Processing Techniques (dotted line) for Missing and Incorrect Data
11. Human Trafficking
11. HUMAN TRAFFICKING

Within AECOM’s Global Code of Conduct, we have the following policy regarding human rights and human trafficking.

**Meeting Global Employment Standards**

As part of our commitment to our global community, we uphold individual human rights and follow employment laws in all the locations where we conduct business.

In support of this commitment, we provide reasonable working hours and conditions. Further, AECOM has a zero-tolerance policy regarding the use of forced labor or human trafficking. We will never knowingly conduct business with subcontractors, business partners, suppliers, or third parties who violate these laws. If you have reason to believe AECOM is conducting business with an entity engaging in forced labor or human trafficking practices, report the misconduct to Management, Human Resources, or In-House Counsel immediately.

Keep in mind that our company operates in countries where we do not have a permanent presence. Because of this, supervisors should seek guidance from In-House Counsel regarding the employment law standards governing these operations.

AECOM views corporate responsibility as an extension of our purpose: Built to deliver a better world. Our approach is inspired by our employees, who make a positive and tangible impact in communities around the world.
12. Exceptions
12. EXCEPTIONS

AECOM accepts all terms and conditions of the RFP by submitting a proposal, and AECOM agrees to the contract terms in DA-146a.
Appendix A: Required Forms
APPENDIX A: REQUIRED FORMS

The following required forms have been included in this section:

− Signature Sheet
− Certification of Company Not Currently Engaged in a Boycott of Goods or Services from Israel
− Tax Clearance Certificate
SIGNATURE SHEET

Item: Consulting Services to Perform Study of Consequential Issues Materially Affecting Kansas Electricity Rates

Agency: Legislative Coordinating Council on Behalf of Kansas Legislature

Closing Date: October 1, 2019, 5:00pm (CDT)

By submission of a bid and the signatures affixed thereto, the bidder certifies all products and services proposed in the bid meet or exceed all requirements of this specification as set forth in the request and that all exceptions are clearly identified.

Legal Name of Person, Firm or Corporation: AECOM Technical Services, Inc.

Mailing Address: 300 South Grand Avenue, Suite 1100

City & State: Los Angeles, CA Zip: 90071

Office Phone Number: 213-593-8000 Local Number: 312-373-7547 (Bill Abolt)

Cell Phone Number: 312-373-7547 (Bill Abolt) Fax Number: 213-593-8178

Tax Number: 95-2661922

CAUTION: If your tax number is the same as your Social Security Number (SSN), you must leave this line blank. DO NOT enter your SSN on this signature sheet. If your SSN is required to process a contract award, including any tax clearance requirements, you will be contacted by the Office of Legislative Administrative Services.

E-Mail: william.abolt@aecom.com

Signature: __________________________ Date: 10/01/2019

Typed Name: Bill Abolt, LEED AP Title: Vice President

In the event the contact for the bidding process is different from above, indicate contact information below.

Bidding Process Contact Name: Bill Abolt, LEED AP

Mailing Address: 303 E Wacker Dr Suite 1400 City & State: Chicago, IL Zip: 60601

Office Phone Number: 312-373-7700 Local Number: ________________________________

Cell Phone Number: 312-373-7547 Fax Number: 312-373-6800

E-Mail: william.abolt@aecom.com
CERTIFICATION OF COMPANY

NOT CURRENTLY ENGAGED IN A BOYCOTT OF GOODS or SERVICES FROM ISRAEL

In accordance with HB 2482, 2018 Legislative Session, the State of Kansas shall not enter into a contract with a Company to acquire or dispose of goods or services with an aggregate price of more than $100,000, unless such Company submits a written certification that such Company is not currently engaged in a boycott of goods or services from Israel that constitutes an integral part of business conducted or sought to be conducted with the State.

As a Contractor entering into a contract with the State of Kansas, it is hereby certified that the Company listed below is not currently engaged in a boycott of Israel as set forth in HB 2482, 2018 Legislature.

______________________________   ______________________
Signature, Title of Contractor      Date

Bill Abolt, LEED AP
Vice President
AECOM Technical Services, Inc.
10/01/2019
CERTIFICATE OF TAX CLEARANCE

AECOM Technical Services Inc.

ISSUE DATE
09/27/2019

TRANSACTION ID
T6RJ-FMAX-J674

CONFIRMATION NUMBER
C7FE-P3YM-DHXA

TAX CLEARANCE VALID THROUGH
12/26/2019

Verification of this certificate can be obtained on our website, www.ksrevenue.org, or by calling the Kansas Department of Revenue at 785-296-3199
Appendix B: Acknowledgement of Addenda
APPENDIX B: ACKNOWLEDGEMENT OF ADDENDA

AECOM acknowledges receipt of questions and answers on September 20, 2019.
Appendix C: Resumes
APPENDIX C: RESUMES

Resumes for the following key personnel have been included in this section:
- Bill Abolt, LEED AP
- William Haas, LEED AP
- Garrett Harper, CFA
- Katrina Lewis
- Órla Pease, PE, PTOE
- Matthew Harris, RPA
- Tunde Ukwu, CEM, LEED, CMVP, DGCP
- Paige Humecki, LEED AP O&M
- Dana Al-Qadi, D. Eng
- Ezra Beeman (Energeia)
- Tim Scott (Energeia)
- Miles Butler (Energeia)
- Maria Wong Chang (Energeia)
- Josh Fujii (Energeia)
- Kofi Agyeman (Energeia)
Bill Abolt, LEED AP
Project Director

Education
MPA, Public Administration,
Northern Illinois University
BA, Political Science,
Augustana College, Rock Island, Illinois

Years of Experience
With AECOM: 4
With Other Firms: 29

Registrations/Certifications
LEED Accredited Professional

Bill Abolt is a vice president at AECOM where he leads its Smart Energy Practice and focuses on energy, sustainability, and resilient urban infrastructure in the largest metropolitan economies in North America. He has 33 years of experience managing complex environmental, energy, and public issues and programs.

Bill has developed, administered, and implemented comprehensive energy and sustainability programs for utilities, government, and private clients. He has extensive experience with alignment of grants, incentives, and other third-party resources with project and enterprise-wide budgeting, planning, and sustainability goals.

Previously, he served as environment commissioner, director of the office of budget and management and chief of management, office of the mayor for the City of Chicago, where he was responsible for developing Chicago’s energy assurance/critical infrastructure plans and its strategy to become one of the greenest cities in the nation.

Selected Project Experience

Sustainability Action Agenda and Smart City Strategy, City of Detroit, Detroit, Michigan. Serves as project director and principal-in-charge. AECOM is assisting the City of Detroit in the development of a comprehensive sustainability plan for the City’s operations and the community as a whole. AECOM was also selected to develop Detroit’s Smart City Strategy. The planning approach includes extensive community engagement across multiple communication platforms as well as best practice analysis and triple bottom line modeling of sustainability and smart city actions and outcomes. [$565,000 combined value both projects] [2018]

Energy Assurance Microgrid, City of Berkeley, Berkeley, California. Project director. AECOM was selected by the City of Berkeley to provide comprehensive services for the planning, design, and development of an energy assurance microgrid for the City’s downtown. The microgrid project is an outcome of the City’s 100 Resilient Cities Strategy. Served as project director for the AECOM led team that also includes Lawrence Berkeley National Laboratory. To implement the project, AECOM assisted the City in securing and implementing a California Energy Commission to develop the business plan and technical configuration of the microgrid system. [$1.2 million] [2016-2018]

ComEd Bronzeville Microgrid and Community of the Future, Chicago, Illinois. Project director for AECOM support of ComEd’s Smart City and Technology Initiatives. AECOM provides program design and management support to ComEd’s Community of the Future Smart City pilot in Chicago’s Bronzeville neighborhood, which is a comprehensive smart city initiative that is deploying a range of smart technologies from electric vehicle sharing and community energy storage to peer-to-peer energy platforms and smart kiosks. AECOM also helped Exelon’s Chicago utility develop fully integrated resiliency performance metrics for its first microgrid, located in Bronzeville. [$1.15 million] [2016-2018]

West Side Resilience Strategy, City of Chicago, Chicago, Illinois. Project director for AECOM’s support of the City’s resiliency strategy for six communities on Chicago’s west side. Work includes development of an integrated green and grey infrastructure strategy designed to both reduce flooding risk and deliver social, economic, and environmental co-benefits. Specific work elements included identification and detailed modeling of system risks and performance, triple bottom line cost benefit analysis, and financial leveraging strategy development. [$1.3 million] [2016-2018]
Chicago 100 Resilient Cities Support, Chicago, Illinois.
Project director. AECOM serves as the strategy partner to the City of Chicago for the Rockefeller Foundation’s 100 Resilient Cities Program (100RC). 100RC helps cities around the world become more resilient to the physical, social, and economic challenges that are a growing part of the 21st century. [$300,000] [2017-2018]

Community-Scale Greenhouse Gas Emissions Inventory, Chicago, Illinois. Project director for Green House Gas inventory for the City of Chicago. AECOM helped Chicago to conduct a GHG emission inventory in compliance with the Global Protocol for Community-Scale GHG Emissions Inventories. The GPC provides the first global standard protocol under which cities can complete community-scale inventories. With completion of the inventory, Chicago joins other global cities in completing one of the first GPC-compliant GHG inventories in the world. Responsible for subsequent annual updates of the inventory. [$100,000] [2017-2018]

Smart Utility Vision, Boston Planning and Development Agency, Boston, Massachusetts. Project director and senior smart technologies leader for the integrated utilities master plan. The City of Boston, through BPDA, is rethinking the way that utility infrastructure is designed and implemented. The project focuses on a 144-acre redevelopment area in South Boston that is expected to see significant urban growth. By improving coordination among utilities and implementing smart utility technologies, the project aims to make urban districts more affordable, resilient, connected, and sustainable. Project work included identification and triple bottom line modeling of Smart City technologies and integrated infrastructure approaches, such as comprehensive green infrastructure and microgrids, across all utility types (i.e., energy, water/wastewater, transit/mobility, and data/telecommunications). [$218,000] [2016-2017]

ComEd Smart Streetlights, Chicago, Illinois. Project director for the feasibility analysis and business case development for the city-wide smart streetlight project. Analysis focused on the comprehensive modernization of the urban streetlight system to achieve energy savings, implement Smart City service improvements, increase revenue generation opportunities, and support city sustainability and resilience goals. Analysis included evaluation of existing system condition, potential to integrate streetlights into utility smart grid improvement plans, expected energy savings, feasibility of smart city applications and revenue streams, and deploy options and schedules that optimize revenues and services. [$400,000] [2016-2017]

Resilient Green Infrastructure Financing Analysis and Energy Efficiency and Clean Power Plan Support, Natural Resources Defense Council, Chicago, Illinois. Project director for the assessment of national best practices in public financing strategies to support urban green infrastructure and resilience investments. Analysis focused on expanded use and leveraging of Clean Water Act State Revolving Loan Funds and private investment to support local government capital improvement programs. The project provided specific recommendations for potential inclusion in Chicago’s HUD Workstream II Disaster Resilience application. The Clean Power Plan Project provided consulting support and technical analysis for the Midwest office of NRDC. Work supported expansion of energy efficiency programs for commercial real estate, universities, and multi-family buildings. [$110,000] [2014-2016]

Wisconsin Focus on Energy, Madison, Wisconsin. Served as managing director of state-wide energy efficiency and renewable energy program serving customers of more than 100 participating utilities in the state. Oversaw the comprehensive redesign and expansion of the portfolio of energy programs and rollout of those programs to all customer classes. Achieved highest levels of electric and gas energy savings, cost effectiveness, and customer participation in the program’s history. Established comprehensive customer satisfaction tracking systems and exceeded annual and historic customer satisfaction targets. Developed and implemented, first of its kind for a utility energy program, ISO 14001 certified Environmental Sustainability Management System. [$28 million] [2011-2014] [Prior to AECOM]

Energize Missouri, Jefferson City, Missouri. Project director for the State of Missouri’s energy program and Energy Conservation Block Grant program, which were enacted under the federal economic stimulus program, The American Reinvestment and Recovery Act of 2009. The program deployed energy investments to commercial, industrial, institutional, and residential energy customers to reduce energy use and expand renewable energy. It delivered more than 200 million kWh in annual energy saving and established best practices for portfolio monitoring and risk assessment of invested funds across U.S. Department of Energy grant recipients. [$2.9 million] [2009-2012] [Prior to AECOM]
ComEd Commercial Real Estate Building Performance with Energy Star Program. Chicago, Illinois. Project director and senior technical advisor to utility program targeting energy efficiency savings from large, multi-tenant commercial real estate. The program was designed to overcome barriers to increasing efficiency in multi-tenant buildings including lease-based split incentives and complex ownership structures. The program delivered savings from both base building and tenant spaces and exceeded targets for electric energy savings from this hard to reach customer segment. [$350,000] [2010-2011] [Prior to AECOM]
William S. Haas, LEED AP
Project Manager

Education
MPA, Public Administration, Northern Illinois University
BA, Political Science, Augustana College, Rock Island, Illinois

Years of Experience
With AECOM: 4
With Other Firms: 29

Registrations/Certifications
LEED Accredited Professional

William (Bill) Haas is a director at AECOM for the Smart Energy market sector. In addition, he supports AECOM energy projects by providing technical expertise and management support.

Bill has developed and implemented effective state and local energy policies, facilitated large groups of diverse stakeholders within complex regulatory environments, and overseen some of the country’s largest and most respected energy efficiency and renewable energy programs. His specialties include policy analysis and regulatory development, state-wide energy planning, climate and sustainability strategies, and large-scale program deployment and management.

Selected Project Experience

Illinois State Toll Highway Authority, Tri-State Corridor Management, Illinois. Project manager. AECOM is providing design corridor management services for I-294 (Central Tri-State) from 95th Street to Balmoral Avenue. As part of the project, we are evaluating various ways in which the corridor could include electric vehicle charging infrastructure. Work includes developing a forecast of electric vehicle use along the corridor, an evaluation of various charging technologies including dynamic, in-lane charging, and an economic feasibility analysis. [2018-ongoing]

USAID, Palestinian Energy Project, Ramallah, West Bank. Project manager for the comprehensive policy review and analysis of renewable energy net metering in the region. USAID’s Palestinian Energy Project aims to advance the Palestinian energy sector to support affordable and sustainable energy independence in the West Bank and Gaza. The project focuses on improving access to and reliability of electrical services by strategically incorporating renewable energy, which will increase the Palestinian Authority’s control of its electrical supply and improve affordability over time. Work included extensive stakeholder engagement, benchmarking, and modeling which resulted in a series of recommendations and policy revisions. [2018]

City of Roseville, Plug-in Electric Vehicle Consultant, Roseville, California. Project manager for the project to assess and forecast the impacts of growing plug-in electric vehicle demand and charging services on the City’s electric utility. Work involved optimizing the benefits of vehicle electrification, charging infrastructure, and grid technologies while identifying and tracking multiple variables including technical, contractual, and regulatory requirements. In addition, business planning and program management tools were applied to help the utility identify, plan, design, finance, implement, and manage projects that will provide competitive PEV charging services and allow for seamless grid integration. [2018]

Commonwealth Edison, Geothermal Energy Efficiency Program, Chicago, Illinois. Project manager supervising the design and implementation of a pilot geothermal heat pump incentive program for ComEd’s commercial, industrial, and public sector customers. The project involves developing a geothermal heat pump equipment work paper for the Illinois Technical Reference Manual, benchmarking existing geothermal energy program offerings across the U.S., developing the pilot program design framework, engaging eligible customers through extensive marketing and outreach, and implementing the program to achieve significant energy savings for ComEd’s Energy Efficiency Program portfolio. [$250,000] [2017-ongoing]

City of Chicago, Greenhouse Gas Inventory Update, Chicago, Illinois. Project manager who is providing energy policy and strategy expertise to the project by evaluating various policy changes and programmatic initiatives to increase energy efficiency and support distributed renewable energy installations. In support of Mayor Emanuel’s Executive Order establishing a goal of reducing city-wide greenhouse in accordance with the Paris Climate Agreement, AECOM is updating the City’s greenhouse gas inventory and developing greenhouse gas reduction strategies for the City of Chicago. [$75,000] [2017-ongoing]
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Greenest Region Compact Sustainability Network – Metropolitan Mayors Caucus, Chicago, Illinois. Project manager. To help the 273 communities in the Chicago region’s Metropolitan Mayors Caucus convert their sustainability plans into implemented projects, AECOM worked to design comprehensive programs and targeted technical assistance to effectively leverage and coordinate available resources. This work involved addressing municipal specific barriers to implementing a variety of sustainability projects including large-scale green infrastructure, distributed solar, deep energy efficiency retrofits, green fleet and fueling infrastructure, and smart streetlight upgrades. [$100,000] [2016]

Iowa Economic Development Authority and the Iowa Department of Transportation, Iowa Energy Plan, Iowa. Managed a project supporting the Iowa Economic Development Authority and the Iowa Department of Transportation in the development of the Iowa Energy Plan. The plan included 15 objectives and 45 strategies that proposed a balanced approach to encourage growth in all of Iowa’s energy sectors while emphasizing sustainable practices, economic development, and the research and development required to keep Iowa on the leading edge of energy innovation. Led a comprehensive stakeholder engagement process that included a series of energy forums held throughout the state establishing a platform for public comments and facilitating working group discussions. [2015-2016] [Prior to AECOM]

Illinois Clean Energy Community Foundation, Renewable Energy Policy and Program Training, Chicago, Illinois. The Illinois Clean Energy Community Foundation was established in December 1999 as an independent foundation with a $225 million endowment provided by Commonwealth Edison, the investor-owned electric utility serving the Chicago area. ICECF’s mission was to improve energy efficiency, advance the development and use of renewable energy resources, and protect natural areas and wildlife habitat in communities all across Illinois. Managed a project to provide the ICECF Board of Directors with a training session on renewable energy technologies and best practices in renewable energy policies and program design. [2014] [Prior to AECOM]

Wisconsin Public Service Commission, Focus on Energy Program Administration, Wisconsin. Program director who oversaw all aspects of the project including budget, revenue, staffing, program design, program delivery, and stakeholder communications. Established a 30-person local office to support program operations, oversaw the complete redesign of the entire portfolio of program offerings, and achieved the highest levels of energy savings and cost effectives throughout Focus on Energy’s long history. [2011- 2013] [Prior to AECOM]

Missouri Department of Natural Resources, Missouri State Energy Program and Energy Efficiency and Conservation Block Grant Program, Missouri. Managed a team to assist the Missouri Department of Natural Resources in the design, administration, and implementation of the State Energy Program and Energy Efficiency and Conservation Block Grant program funded through the American Recovery and Reinvestment Act of 2009. The projects were extremely successful saving a reported 195,697,944 kWh. In addition, U.S. DOE recognized the projects for developing a best practice project monitoring approach and the innovative Best-Price Program offering was awarded an Inspiring Efficiency Award from the Midwest Energy Efficiency Alliance and highlighted in the New York Times. [2009-2012] [Prior to AECOM]
Garrett Harper, CFA
Economic

Education
BA Economics, Connecticut College, 2007

Years of Experience
With AECOM: 7
With Other Firms: 5

Professional Affiliations
CFA (Chartered Financial Analyst) charter, 2013, CFA Institute
Urban Land Institute

Garrett Harper is an Associate Principal in AECOM’s Chicago office and was previously based in Singapore. He has 12 years of experience providing development advice and evaluating demand and various revenue streams related to infrastructure, real estate, and other assets.

He focuses on assessing development strategy, risk allocation, economic potential and financial structure, often at the intersection of major infrastructure works and related real estate development. This interface also creates opportunities to evaluate new concepts that relate to technology, mobility, and energy.

Garrett approaches his work from first understanding an area’s market fundamentals, economic outlook, and the competitive positioning. From this quantitative base, potential development strategies can be tested in both economic and financial terms as well as physically in terms of transport and urban planning impacts. Despite having a focus on the financial outputs, Garrett always makes a point to “look beyond the models” to validate strategies in terms of practical operations and sound planning principles.

Garrett received his Chartered Financial Analyst credential from the CFA Institute in September 2013. The CFA Program provides a rigorous real world understanding of the investment decision-making process across asset classes along with a strong code of ethics.

Selected Project Experience

Advanced Manufacturing Innovation Center (AMIC) Development Plan and Financial Plan, St Louis, Missouri. Programming and financial planning lead. The AMIC is a concept established through AECOM’s previous economic development strategy work in St Louis related to the potential risk posed by a declining Defense-oriented Aerospace industry. The project combined a stakeholder engagement process with industry analysis and global benchmarking of manufacturing innovation centers. Outputs include an architectural building plan for the Innovation Center, an operational and organizational strategy, and target industry sub-sectors as well as a 5-year financial sustainability plan for the new entity.

Shopping Center Distributed Energy Services Portfolio Analysis, U.S. Project manager and financial analysis lead. AECOM was appointed by a major owner of shopping centers nation-wide to evaluate their portfolio to determine the potential to establish an energy services business. Partnering between AECOM’s Economics, Energy, and High-Performance Buildings teams, AECOM helped screen the opportunities by state and utility service area, model the energy usage of tenants, and determine the financial feasibility of investing in various energy service solutions. The portfolio analysis filtered to select target centers that were evaluated as potential pilot projects.

Bronzeville: Community of the Future Smart City and Resilience Initiatives, Chicago, Illinois. Business case review. AECOM is working a range of initiatives with the local utility (ComEd) to create a range of initiatives related to smart city, resilience, and sustainability in Bronzeville. The engagements and initiatives represent partnership between the utility, community stakeholders, private industry, and City officials to improve the liveability, resilience, and prosperity of the neighborhood. Garrett’s role is focused on the economic and financial viability of specific projects as well as understanding the economics drivers for the neighbourhood overall.

Illinois State Toll Highway Authority, Tri-State Corridor Management, Illinois. Capital program economic model and distributed generation feasibility. AECOM is providing design corridor management services for the $4 billion reconstruction and improvement of I-294 (Central Tri-State) across 22 miles. As part of this role, the Advisory team is developing an economic model intended to inform the capital budgeting process with sensitivity analysis for external shocks related to commodity pricing, project delays, and supply constraints. In addition, they are developing financial feasibility analysis for distributed generation resources within the improved corridor.
Hospital Consolidation and Redevelopment Potential Pre-Feasibility Study, Confidential Client, Midwest. Valuation and commercial model lead. Garrett evaluated a proposed campus consolidation among multiple hospitals as well as the redevelopment potential of freed-up land and legacy assets. As part of a broader architectural study, Garrett estimated the value of active hospital assets, development land, and legacy medical buildings intended for conversion. Valuation approaches included transaction benchmarks, replacement cost estimates, residual valuation, and discounted cashflow analysis.

Chicago Affordable Housing Lab, Milken Institute and AECOM. Project manager and financial structure lead. AECOM is collaborating with the Milken Institute to host a session with the City of Chicago regarding affordable housing. The intent is to develop ideas that can have a major impact on the city. The current work is focused on innovations in the financing, policy and governance of both current and potential new programs related to affordable and market rate housing.

Lipinski Building Redevelopment Feasibility Study, Chicago, Illinois. Financial analysis and procurement strategy lead. The Lipinski Building is a historic office building in the Gold Coast of Chicago currently occupied by the Railroad Retirement Board (RRB) and owned by GSA. AECOM was engaged by GSA to evaluate the redevelopment potential if RRB were to consolidate their space. The study included a review of real estate demand then a first pass pro forma to select a short list. That short list was progressed with preliminary architectural design, review of historic preservation requirements, and cost estimates prepared. From these, a more robust financial assessment evaluated the viability of each option and potential procurement structures.

Developer Solicitation Review, County of San Diego General Services Department. Bid review. AECOM has been appointed to assist the selection panel in evaluating the developer responses for two county-owned sites intended for mixed income or affordable housing. Garrett reviewed developer submissions (Formal Offers, Pro Formas), identifying issues as well creating a consistent understanding of revenue streams to the county across bids.

National Western Center Economic Development Strategy, Denver, Colorado. Financial analysis lead. AECOM was engaged by the City of Denver to complete an analysis of economic development implications associated with National Western Center (NWC) revitalization. The AECOM approach was anchored by two core missions. First, place NWC revitalization in an economic and market context, focused on the emerging agricultural value chain along Colorado’s Front Range; and second, to establish a high-level understanding of the opportunity for commercial and private sector activity at the NWC site. Within these missions, AECOM identified industry sector, cluster, and end-market opportunities that build on the inherent strengths and comparative advantage of the NWC and the Front Range. National and global agriculture industry trends were also studied.
Katrina Lewis leads, researches, and implements smart city initiatives around the United States. She is a senior consultant and project manager for the Smart Energy Team within AECOM’s Energy Business Line and is currently leading efforts to identify future initiatives.

Katrina’s experience includes strategic planning and visioning for municipal-level resilience, sustainability, and smart city strategies, developing metrics to provide a quantifiable foundation for sustainable development, quantifying the community-level benefits of smart and sustainable initiatives including microgrids, green infrastructure, and electric vehicle fleet conversion; identifying areas of opportunity to engage the communities around resilience planning and creating Excel-based triple bottom line prioritization and optimization models for municipal-level decision making.

Selected Project Experience

**Detroit Sustainability Action Agenda, City of Detroit Office of Sustainability, Detroit, Michigan.** Project manager for the development of Detroit’s first Sustainability Action Agenda. Oversight of data-driven analysis and expansive community engagement. The Detroit Sustainability Action Agenda aims to create an overarching vision to identify concrete next steps for Detroit to create a healthier, greener, more resilient, equitable and prosperous city for all residents. [$365,000] [2018-ongoing]

**Community of the Future Smart City and Resilience Initiatives, ComEd, Chicago, Illinois.** Lead for Commonwealth Edison’s development of Smart City, Resilience, and Sustainability Initiatives relating to their Community of the Future in Chicago’s Bronzeville neighborhood. Manages the development and implementation of targeted engagements and partnerships and the continuous research of best practices. The engagements and initiatives represent partnership between the utility, community stakeholders, private industry, and City officials to improve the livability, resilience, and prosperity of the neighborhood. Through the best practice research, leads the creation of monthly reports to track new developments and technologies applicable to expanding Community of the Future initiatives. [$560,000] [2017-ongoing]

**City of Chicago Resilience Plan, 100 Resilient Cities, Chicago, Illinois.** Project manager who collaborates with the City of Chicago’s Chief Resiliency Officer and 100RC to provide technical leadership in identifying and addressing the resilience challenges and opportunities in Chicago. This work involves assisting the CRO in building stakeholder engagement around resiliency, identify focus areas, navigating the City’s policy landscape, and building on existing resilience work and achievements throughout Chicago. [$321,790] [2017-ongoing]

**City of Minneapolis Electric Vehicle Fleet Transition Study, Minneapolis Public Works Fleet Service Division, Minneapolis, Minnesota.** Led the effort to assess the costs and benefits of transitioning the City of Minneapolis’ vehicle fleet to electric vehicles. The project examined the greenhouse gas emissions reductions and maintenance, and fuel savings associated with replacing internal combustion engine vehicles with battery electric vehicles for light-duty, heavy-duty, and non-road categories. Created a cost-benefit model to analyze the attractiveness of six different transition scenarios, considering municipal financing mechanisms and budgets. [$100,000] [2017]

**Boston Smart Utilities Vision, Boston Planning and Development Agency, Boston, Massachusetts.** Project lead for defining smart city opportunities, leading a team in identifying best practice smart technologies and strategies to develop a Smart Utilities Vision for a
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redevelopment along South Dorchester Avenue in Boston, Massachusetts. Led the conceptual design and costing of smart technologies and strategies to model the triple bottom line impacts of the smart investments compared to standard utility and municipal practices. Smart strategies modeled included green infrastructure, district energy, microgrids, distributed generation, multiuse utility tunnels, electric vehicle charging infrastructure, and smart traffic management solutions.

Resilient Corridors, Chicago Department of Planning and Development, Chicago, Illinois. Led the development and assessment of the co-benefits associated with converting vacant lots to stormwater landscapes along specific corridors on the south and west sides of Chicago. This work laid out methodologies for measuring co-benefits associated with the landscapes to be tracked over the course of the landscape design, construction, and operation. [$876,613] [2017-ongoing]

Resilience Performance Metrics Development, ComEd, Chicago, Illinois. Developed resilience performance metrics relating to community and critical infrastructure resiliency for a utility microgrid initiative. Quantified and monetized specific benefits of the microgrid and related grid modernization efforts to the local community. Developed metrics around economic and health impacts, as well as the impact on community safety and livability. [2017]

Greenest Region Compact Sustainability Network, Metropolitan Mayors Caucus, Chicago, Illinois. Designed comprehensive programs and targeted technical assistance to effectively leverage and coordinate available resources. This work involved addressing municipal-specific barriers to implement a variety of sustainability projects including green fleet and fueling infrastructure, large scale green infrastructure, distributed solar, deep energy efficiency retrofits, and smart streetlight upgrades. [$100,000] [2016]

Mount Elliot Employment District Economic Development Strategy, Detroit, Michigan. Analyzed global and local high-growth end markets to assess the potential for growth in Detroit. This work included analyzing national employment data and technological innovations to identify high-growth, high-potential markets and their related industries. Additionally, in order to assess the feasibility of microgrid installation as part of the project, researched the regulatory environment and policy support for microgrids in Michigan. Compiled and analyzed power outage data in the Detroit metro region as an indicator of potential grid reliability issues. [2016]

St. Louis Economic Development Partnership Aerospace Impact Study, St. Louis, Missouri. Conducted an analysis of current and historic trends in manufacturing, specifically within aerospace manufacturing. This analysis covered exports, GDP, employment, and wages and benchmarked the St. Louis region to peer and top-performing benchmarked regions. The study also discussed the advanced manufacturing sectors present in the St. Louis region and highlighted sectors where the potential for growth is highest. These high-potential sectors were linked to high growth end markets by analyzing national employment data trends and technological innovations. [2016]

Southwest Industrial Corridors Strategy Industrial Market Analysis, City of Chicago Department of Planning and Development, Chicago, Illinois. Created a decision tool to assess the level of impact of specific development projects on an industrial corridor’s health. She collected baseline data on three industrial corridors in Chicago and collaborated to develop metrics to measure impacts across four key categories: economic vitality, transportation linkages, expand local jobs, and urban authenticity/campus environments. [$119,500] [2016]

National Western Center Economic Study, Denver, Colorado. Analyzed the potential for Denver to capitalize on its existing strength in agriculture and food production/manufacturing to increase economic activity in targeted high-potential markets. This work included analyzing local and national employment data and technological innovations to identify high-growth, high-potential markets, and their related industries. [$250,000] [2017]

Comprehensive Energy Management Plan, Metropolitan Water Reclamation District, Chicago, Illinois. As part of a larger team tasked with creating a comprehensive energy management plan for the Great Chicago Metropolitan Water Reclamation District, produced an analysis on the energy efficiency incentives available. This work included details on how to best leverage each incentive and general best practices in energy management programs. [$75,000] [2016]

Stakeholder Relationship Mapping and Engagement Strategy, Midwestern Utility Client (Confidential). To inform the development of a stakeholder outreach and engagement strategy around a utility client’s community initiative, mapped the relationships among a broad range of stakeholders to identify underleveraged relationships within the client’s and the client’s partners’ networks and to identify underleveraged connections around specific themes and existing programs. Certain critical connections were highlighted and suggestions around how to leverage these connections were developed. Key missing connections were also identified and outreach strategies to form missing connections were made. Taking into consideration budgetary, political, and timing constraints, made final recommendation of a targeted, integrated engagement strategy. [2016].
With 20 years of experience, Órla Pease brings expertise in the management, planning, engineering design and analysis of urban streets, intersections, traffic signals, technology, safety and transit related projects. Her experience in working directly with clients in the management of complex, multidisciplinary transportation projects combined with her knowledge of the latest technology trends and ability to develop innovative project solutions has resulted in successful project delivery and safer streets. She has demonstrated the ability to work across multiple agencies, managing multi-million-dollar contracts involving many stakeholders.

Selected Project Experience

South Broad Street Curbless Intersections, Philadelphia Streets Department, Philadelphia, Pennsylvania. Project manager for this complete streets design project to address drainage, ADA-compliance, crosswalk visibility, and cross-slope issues at the intersections of South Broad Street with Chestnut Street, Walnut Street, Sansom Street and Moravian Street. Existing conditions presented challenges for pedestrians, including safety concerns. This project involved extensive coordination with stakeholders, including PennDOT, SEPTA, and the Avenue of the Arts, to develop an alternative crosswalk treatment. The final design involved raising the roadway profile to create “curbless” intersections, using stamped colored asphalt crosswalks. [Prior to AECOM]

Port Authority of Allegheny County, Bus Rapid Transit (BRT) Final Design Services, Pittsburgh, Pennsylvania. Lead traffic engineer for the final design of a new BRT system on nine bus routes in Pittsburgh. Final engineering design task include roadway reconstruction, intersection bump outs, pedestrian and bicycle facilities, ADA design, final signal design for 86 traffic signals, lighting design, off and on-street bike lanes and signals along almost 7 miles of City arterials. Each design involves the use of ITS elements to create “Smart Spine” corridors including fiber optic interconnect, adaptive signal control, dedicated short range communication (DSRC), cloud-based emergency vehicle pre-emption, transit signal priority (TSP) and system integration using “Clever Devices”. All designs elements are following the cities complete streets policy and the NACTO street design guides including the use of BAT (Bus and Turns) lanes and Bus Only lanes. Traffic Analysis tasks include review of existing traffic signal equipment to determine need for replacement; traffic signal (and other traffic control devices) warrants; developing traffic signal timings and clearance calculations using the MUTCD and operations analysis using a VISSIM traffic model for the entire network. [Prior to AECOM]

Pennsylvania Turnpike, 5th Mode of Transportation (Hyperloop), Planning, Engineering and Support Services. Route planning and modeling support for the development of conceptual scenarios to introduce Hyperloop to Pennsylvania. The first task order assignment includes the development of alignments and scenario impact assessment for the deployment of Hyperloop. Potential impacts identified include environmental, quality of life and right-of-way as well as financial implications including capital and O&M costs and potential project revenue. [Prior to AECOM]

Forest City, Yards West Infrastructure Design, Washington, DC. Complete streets peer reviewer and design assistance for the design of the public realm of the new development within the Yards neighborhood, just north of the Anacostia riverfront. Design elements include roadway layout, site grading, drainage, green infrastructure,
creation of a smart utility corridor, and accommodation of future mobility needs such as CAVs. Sensitivity and priority was given to pedestrian mobility to create a curb-less roadway to facilitate retail, social and livability patterns. [Prior to AECOM]

Roosevelt Boulevard Rapid Transit, City of Philadelphia Streets Department, Philadelphia, Pennsylvania. Project manager for this design project that launched a new BRT service on Roosevelt Boulevard named “Boulevard Direct.” Responsibilities included the design of ten stations following complete streets guidelines, and consisted of new sidewalks, pads, shelters, landscaping, lighting, digital signing, real-time information kiosks and smart trashcans. As the project was funded through a Congestion Mitigation and Air Quality (CMAQ) grant, all state and federal guidelines were followed, including producing a categorical exclusion (CE) document. This project was on an extremely aggressive schedule, with only four months to produce all clearances and advertise the Bid documents through the PennDOT ECMS system. The aggressive schedule necessitated daily coordination with all stakeholders, including the City, PennDOT, SEPTA, and DVRPC to meet deadlines. This project completed construction and the new service started in October 2017. [Prior to AECOM]

Roosevelt Boulevard Program Management and Support Services Open End, Philadelphia, Pennsylvania. Served as program manager and worked with the City to provide project management and technical support services for the Roosevelt Boulevard Multimodal Corridor Program, a 14-mile corridor that received TIGER funding to address its numerous safety problems. This agreement was funded by TIGER Federal funds as well as state and local funds. These assignments included on site program management assistance; Concept Development and support services for multiple grants received by the city; GIS Land use data inventory update; compilation of available GIS data; Hot spot identification and analysis; LiDAR Survey, utility one-call and drafting in preparation for design tasks. [Prior to AECOM]

Safe Routes to School (SRTS), GSI Improvements, Philadelphia Water Department, Philadelphia, Pennsylvania. Overseeing various traffic engineering components of this project, which will use SRTS grant money to install Green Streets Infrastructure, and pedestrian safety improvements in the vicinity of three elementary schools in Philadelphia. The tasks include a safety study, signal analysis, signal design, signing and pavement marking plans and maintenance and protections of traffic plans. [Prior to AECOM]

North Camden Waterfront Park Trail Design, Camden, New Jersey. Contract manager responsible for oversight for this conceptual design project in the City of Camden, New Jersey. The project includes two sections of trails, one in North Camden, and the other in the Cramer Hill section of the city. Project scope specifically includes mapping existing data, GIS data analysis, feasibility assessment and conceptual design. Responsibilities include review of all project deliverables including an assessment of ADA accessibility to and along the trails and studies to determine if and where traffic control devices are warranted or need to be replaced. Portions of the trail overlap the street network, and conceptual design is following complete streets guidelines. [Prior to AECOM]

NJ Route 9, Linwood, Bicycle and Pedestrian Study, Linwood, New Jersey. Traffic engineer for this bicycle and pedestrian safety study on NJ Route 9 in Linwood at the intersection with a local street which leads to two local schools. NJ Route 9 is a principal arterial with posted travel speeds of 40 mph. This project included significant public coordination, including a phone survey with residents and local officials, and local coordination meetings. Conducted traffic data collection efforts; performed signal warrants; and developed five alternatives for an unsignalized pedestrian crossing. [Prior to AECOM]

Woodland Avenue Project (TIGER Grant), City of Philadelphia Streets Department, Philadelphia, Pennsylvania. Deputy project manager on this project, that received TIGER Grant funding, to improve the Woodland Avenue corridor. The project includes preliminary and final signal design for 26 intersections, ADA improvements, and transit signal priority (TSP). The project was fast tracked, going from survey to advertisement in only 12 months. Construction was completed in 2015. [Prior to AECOM]

Citywide Retiming Initiative, City of Philadelphia Streets Department, Philadelphia, Pennsylvania. Project manager for this project, whose responsibilities include overall project management, project scheduling, staff assignments, review and approval of Synchro, SimTraffic and clearance calculation deliverables, and development of optimized timing plans. The Project included signal retiming for 280 traffic signals along fifteen corridors. The project was part of a citywide, ARLE and CMAQ-funded retiming initiative to improve corridor travel times and reduce congestion and delay. The project included manual turning movement counts, ATRs, collection of travel time data, existing conditions inventory, Synchro/SimTraffic modeling, preparation of work orders, and an after study included in a final report. [Prior to AECOM]

University of Pennsylvania Spruce Street Plaza Improvements, University of Pennsylvania, Philadelphia, Pennsylvania. Lead traffic engineer for this planning and design project for the University of Pennsylvania. Responsible for conducting a Road Safety Audit with City of Philadelphia Department of Streets and University police officers. The field audit was followed by a collaborative meeting, during which everyone involved shared field notes. Deficiencies with signing and striping, pedestrian/bicycle facilities, traffic signals, pavement and human behaviors that contribute to the safety of an area were noted. A pedestrian origin and destination study was performed in front of the hospital to determine the need
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for a midblock crossing. A detailed 3D VISSIM model of the proposed crossing was developed to assess potential traffic impacts. Also responsible for the preparation of signal plans for the installation of a new midblock crossing adjacent to the hospital as well as adjusting the street lighting in the area. Responsibilities included alternatives development and analysis, traffic modeling, signal design, signing and striping and preparation of Highway Occupancy Permit applications. [Prior to AECOM]

St. Joseph’s University, Cardinal Avenue Midblock Pedestrian Crosswalk, Philadelphia, Pennsylvania. Served as Project manager. Responsible for the planning, concept development and final design for a midblock crosswalk on Cardinal Avenue including a Rectangular Rapid Flashing Beacon, passive actuation and bump outs to address pedestrian safety concerns. Responsibilities include signal design, data collection, pedestrian gap study, pedestrian origin and destination information, geometric design, ADA ramp design and signing and striping plans. [Prior to AECOM]

HAWK Beacon Assessment, DelDOT, Delaware. Project manager for a comprehensive traffic study for Delaware’s first installation of the HAWK signal, which was installed to improve safety for students crossing a major arterial in Newark, DE. The study involved HAWK research, and an analysis of traffic flow, vehicle and pedestrian safety, and driver behavior for the traffic device. Identified the improvements which were implemented by DelDOT to improve driver compliance with the HAWK signal, included upgrades to signing, striping, and additional signal equipment. After improvements were implemented, driver compliance increased from 64 to 78 percent. [Prior to AECOM]
Matthew Harris, RPA
Technical

Education
MA, Anthropology, Temple University
BA, Anthropology, Kutztown University; Minors in Geology and Geography

Years of Experience
With AECOM: 8
With Other Firms: 11

Registrations/Certifications
Registered Professional Archaeologist

Areas of Expertise
Spatial / Statistical Analysis and Modeling
Digital Data Collection / Management
GIS
Machine Learning, Deep Learning
R, Python, SQL
Bayesian Statistics
AWS, Azure Clouds

Training
CAD/GIS Technology Center, Spatial Data Standard (SDSFIE)

Matthew Harris is currently the Americas lead for the AECOM Data Science Center of Excellence and Director of Geospatial Data Analysis for the Northeast region. He has 19 years of experience in applying innovative, technological, and quantitative solutions to wide range of problems in the energy, transportation, and engineering business lines.

As the America’s Lead for the Data Science Center of Excellence (CoE), he is tasked with assisting teams in developing technological solutions to drive major pursuits, mentor developing colleagues, and to find new innovations to add client value. The CoE focuses on tailoring innovative digital approaches and promising technologies for major clients in the transportation, power, water, air quality, and remediation business lines. Additionally, Matthew is an instructor of the Smart Cities Practicum class and Public Policy Analytics courses of the Masters in Urban Spatial Analytics program in the Stuart Weitzman School of Design at University of Pennsylvania. Co-leading students in client/deliverable based projects focused on machine learning, sensor mesh IoT, traffic modeling from big data, and public policy development. Topics such as ethical machine learning, data bias, and algorithmic transparency are highlighted in this curriculum. Additional grant-funded research projects include using machine learning to achieve better street-scape design and public engagement through Smart Mobility applications.

Selected Project Experience

Data Inventory, Gap Analysis, and Predictive Analytics for Runway Incursion Characterization, Federal Aviation Administration. Technical lead. In support of the Federal Aviation Administration’s (FAA) Runway Incursion Mitigation (RIM) program, this project is tasked with conducting a three-workstream data analysis to ultimately increase runway safety. The three workstreams include 1) Data collection and characterization to understand the landscape of data availability and quality; 2) Gap analysis to define the current state of the data landscape and active measures to be taken to improve these data; and 3) Exploratory data Analysis (EDA) to combine numerous data sources, take advantage of the opportunities and insights within these databases, and understand which facets of these data will best contribute to a Machine Learning approach to predicting the circumstances under which incursions occur. Currently in the first-workstream, this project is being piloted at the 50 largest airports in the U.S. and has sampled nearly 10,000,000 records from six FAA databases, publicly available sources, and created new datasets for characterization.

Traffic Planning Forecast Model and Application, City of Louisville, Kentucky. Team lead and technical advisor. In conjunction with the City of Louisville Office of Civic Innovation and Technology and University of Pennsylvania, this project set out to add new analytical capabilities to the Waze Warp cloud platform for maintaining user generated Waze data from the Waze Connected Communities Program (CCP). Using a one-year sample of Waze data the Penn Team analyzed and modeled over 42-million traffic jam observation to understand the pattern of traffic relative to weather, time of day, road type, and dimensions of the built-environment across Louisville, KY. Using the machine learning approaches of hierarchical Random Forests and more traditional statistical models such as multi-level Poisson GLMs, the team was able to featurize
the massive dataset and create predictions for traffic density and wait times for any hour or any day of the year under a variety of weather conditions. A web-based application was developed to visualize these predictions and the attributes of the machine learning models. This tool was developed to only incorporate publicly available data along with the Waze data so that any other Waze CCP program participant can easily replicate the models for their jurisdiction.

**Spatial Machine Learning Models for Cultural Resource Sensitivity Planning, Pennsylvania Department of Transportation, Pennsylvania.** Principal investigator and technical lead. The goal of this project is to develop a set of statewide data analysis and predictive model to assist the planning of transportation projects. PennDOT is developing tools to streamline individual projects and facilitate Linking Planning and NEPA, a federal initiative requiring that NEPA activities be integrated into the planning workstreams for transportation projects. The purpose of Linking Planning and NEPA is to enhance the ability of planners to predict project schedules and budgets by providing better environmental and cultural resources data and analyses. To achieve the goal of this project, a set of machine learning models were developed to analyze the landscape at known Native American archaeological sites in Pennsylvania and extrapolate identified patterns to all areas of the state. The model building process included the use of three statistical machine learning algorithms: backwards stepwise logistic regression based on the Akaike Information Criterion, Multivariate Adaptive Regression Splines, Random Forest algorithm, and Gradient Boosting Machines. These algorithms were employed in a best-practices framework that included feature selection, spatial cross-validation for model parameterization and selection, and evaluation on independent samples. This process was repeated for each of 132 study areas that cover the extent of Pennsylvania. The final sensitivity layer derived from this process is a composite of predictions from the algorithm that best characterized that data for each area of the 132 study areas. In addition, the predictive output of each of the algorithms will be returned to PennDOT for use in future studies.

**Flood Resiliency and Preservation Planning Survey, Disaster Planning for Historic Properties Initiative, Monroe, Bedford, Cameron and Philadelphia Counties, Pennsylvania.** Technical lead. The project centered upon a large-scale digital data collection and elevation survey for 5,000+ historic properties in hazard-affected areas within four counties of Pennsylvania. The team utilized LTE-connected hand-held tablets in the field to identify, update, and record new historic properties. A cloud-based mobile application framework was developed for this project to facilitate fast data collection and standardization. Over 1,500 newly identified historic structures were documented in this manner. The R statistical programming language served as a back-end for resource attribute analysis, visualization, and report generation. The R language was also used to create FEMA compatible Flood Depth Grid analysis to assess storm water inundation potential. This system enforced standardization and automated the production of more than 3,000 survey forms.
Phil Owen is Director of Information Assurance and Information Systems Security Engineering for AECOM’s Enterprise Risk Analysis Program (eRAP). He has more than 30 years of experience in Information Technology, with the last 20 years focused on Information Assurance and Information Security.

Phil provided senior level knowledge and expertise to multiple DoD, federal civilian, state and local, and commercial customers. He is recognized as a subject matter expert in multiple domains within the information assurance community. He was selected to participate in the National Initiative for Cybersecurity Education (NICE) National Cybersecurity Workforce Framework 2.0 (NCWF 2.0) development. Phil wrote the cloud services overlay for NIST SP 800-53 Rev. 4. One areas of specialization is Industrial Control Systems, and Phil is currently engaged in providing IA/ISSE expertise to the U.S. Army Corp of Engineers on multiple engagements. He served in an IA/ISSE advisory capacity for the Federal Trade Commission and provides ICS/SCADA Security expertise to the AECOM Critical Infrastructure Protection Campaign.

Prior to the Enterprise Risk Analysis Program, Phil served in multiple IA/ISSE roles for URS and Apptis. He led numerous system certification and accreditation efforts for DoD and federal civilian clients. He developed and delivered Information Systems Security Officer training for the U.S. Department of the Treasury. Previously served in various IA/ISSE roles for numerous government and commercial clients.

With more than 28 years of experience supporting organizations in multiple industry sectors, Mr. Owen is widely recognized for his expertise in the fields of IA/ISSE, risk analysis, and vulnerability assessment. He received his Masters in Computer Science from the University of Oxford and a Bachelor’s Degree from Auburn University.

Selected Project Experience

U.S. Army Corps of Engineers Rock Island Arsenal UMCS RMF Assessment and Authorization, Rock Island, Illinois. Performed IA and ISSE tasks to prepare Rock Island Arsenal UMCS for RMF Assessment and Authorization. Performed hardware and software inventory lists, reviewed existing security controls, made recommendations for security control updates, and prepared the Security Authorization Package for RIA UMCS. RIA UMCS was granted an unconditional three-year Authority to Operate.

U.S. Army Corps of Engineers Advanced Metering Program (USACE AMP), Multiple CONUS and OCONUS locations. IA/ISSE Lead: IA/ISSE Lead for an Army-wide program designed to securely capture and quantify utility usage and trending data. Performed beyond-scope integration and engineering tasks to enable successful end-to-end integration when disparate systems were not communicating.
Tunde Ukwu, CEM, LEED, CMVP, DGCP
Technical

Education
MS, Mechanical Engineering, George Washington University, 2018
BS, Mechanical Engineering, University of Maryland, 2011

Years of Experience
With AECOM: 2
With Other Firms: 6

Registrations/Certifications
Certified Energy Manager
LEED Green Associate
Certified Measurement and Verification Professional
Distributed Generation Certified Professional

Tunde Ukwu has more than 7 years of experience performing ASHRAE 1-3 energy audits using FEMP 4.0 standards through IPMVP, serving on teams that prepared multiple investment grade audits for federal, public and private sector clients. He is responsible for developing energy conservation measures through investment grade energy audits that carried the project from the pre-design stage through construction and performance. Tunde has worked on multiple ESPC projects, benchmarking, project development, M&V, cost/benefit analysis, fuel conversion calculators, system design, and system planning.

Tunde applies his training and job experience in pursuit of innovative and effective energy conservation measures. He has experience examining customer utility data and administering technical renewable energy recommendations based on net data and generation. As an energy consultant, he seeks sound and fiscally beneficial technical measures while taking customer needs into account.

Selected Project Experience
National Geospatial-Intelligence Agency, Springfield, Virginia. Energy engineer for energy management and program support for a DoD agency. Led development of 13 ECMs that would result in significant EUI reduction in accordance with federal mandates. Identifying energy efficiency and renewable energy opportunities to reduce cost and decrease the agency’s greenhouse gas emissions. Advising agency regarding project
implementation options including third-party financed ESPC and UESC. [2018-ongoing]

Washington Metropolitan Area Transit Authority
Washington, DC. Worked on development of electric vehicle pilot deployment for 1600 bus fleet. Conducted utility analysis of bus depots and garages to determine operating costs for pilot and full deployment in accordance with 2045 deadline. Coordinates with utility concerning infrastructure upgrades and corresponding utility work. [2018 ongoing]

City of Seat Pleasant Seat Pleasant, Maryland.
Developed street lighting pilot program to improve lighting quality and public safety through the upgrade of luminaires and installation of monitoring equipment. This equipment provides intersection safety analytics, intelligent video, and intelligent lighting. Coordinating with the utility in order to facilitate installation and switch utility rates, resulting in significant stipulated annual cost savings. [2018-ongoing]

Pepco Holdings, Washington, DC. Managing the EV Smart Program that is deploying chargers for public, residential, and commercial end users. Developing a program for the launch and managing the rebate disbursement. [2018-ongoing]

St. Mary’s County Metropolitan Commission, St. Mary’s County, Maryland. Development of multiple ECMs of wastewater treatment facility after performing multiple ASHRAE II & III energy audits. ECMs include HVAC, lighting, water, pumps, insulation, and process improvements. [2018-ongoing]

AECOM, Germantown, Maryland. Senior Energy Engineer working on multiple concurrent capital energy projects. Duties include energy project development, project management and performing ASHRAE standard Level I-III investment grade audits. ECM development has ranged from HVAC improvements, lighting retrofits and optimization, battery storage, building envelope improvements, water reduction, renewable energy and EV installations. Mr. Ukwu also has experience in utility scale
Consulting Services to Perform Study of Consequential Issues Materially Affecting Kansas Electricity Rates

AECOM

program management and smart city ground up development. [2018-ongoing]

**Siemens Government Technologies, ESPC (Remote).**
Senior engineer who worked on multiple ESPC projects, including National Park Services National Capital Region, Federal Bureau of Prisons, JSMD Lima, as well as provided support for a host of other federal ESPC projects. Developed energy conservation measures through investment grade energy audits that continue from design all the way to construction. These audits come with a savings guarantee that is verified annually throughout the contract term. Energy conservation measures range from water, building envelope, HVAC, controls, scheduling, utility rebates, and other areas. [2016-2018] [prior to AECOM]

**Pepco Holdings Inc., Washington, DC. Green Power Connection, lead technical consultant.** Provided technical GPC consulting services to renewable energy customers in all PHI regions. Applied knowledge of PHI policies and tariffs for different forms of DG, state and federal regulations, IEEE Standards, and internal knowledge of PHI's distribution and transmission system to each client’s situation to develop appropriate net metering or renewable power interconnection. Applied project management, leadership, and communications with customers and served as the sole point of contact and liaison with internal departments to ensure the timely distribution of critical information - GPC/NEM applications, customer documents/drawings, and other supporting documents. Maintained strict deadlines under each jurisdiction’s governing commissions and maintained open communication with clients concerning regulatory updates. [2014-2016] [prior to AECOM]

**Pepco Holdings Inc., Newark, Delaware. Energy engineer.** Carried out site inspections and energy surveying for residential and commercial customers with energy profile concerns, and as the lone CEM certified engineer in the group, took on the majority of the large commercial audits. Responsible for the inspection and/or evaluation of building envelopes, mechanical systems, electrical systems, or process systems to determine the energy consumption of each system along with corresponding calculations. Promoted many state and federal government energy programs. Performed cost-benefit analysis of installation and usage of new equipment. Developed an energy model for fuel conversion that was the basis for the website calculator. [2012-2014] [prior to AECOM]

**Labinal Salisbury, Salisbury, Maryland.** Mechanical engineer. Completed wire design as per job requirements for various aircraft vendors. Implemented design changes via CAD as well as physical drawings. Liaison with vendors concerning RFIs as well as change orders. Complete Bills of Materials as well as estimates for assemblies. Interacted with kit facilitators to fulfill changes if needed as well as engineering corrections. Managed wire cut requests from manufacturing and plant technologists. Applied lean principles to expedite prompt product shipment. [2012] [prior to AECOM]

**Service Experience**

**Change Agent.** Created and implemented change management strategies and plans that maximize employee adoption and usage and minimize resistance. Drive faster adoption, higher ultimate utilization, and greater proficiency of the changes that impact employees in the organization to increase benefit realization, value creation, ROI, and the achievement of results and outcomes. [2012-2018] [prior to AECOM]

**STEM Project New Castle County, Concord High School, New Castle, Delaware.** Assisted with engineering design projects for 10 teams of high school seniors. Provided design help as well as resources and engineering undergraduate experience for design expo at the school to show the projects’ publicly. [2012-2013] [prior to AECOM]

**DuPont Electrical Safety Speaking Engagement.** Delivered multiple seminars on electrical safety. [2012-2013] [prior to AECOM]

**Professional Field Experience**

**ManTech International Corp - NASA, Greenbelt, Maryland.** Engineering intern sophomore. Assisted in testing of spacecraft equipment in Class 10,000 cleanroom. Used Pro-engineer to check and make needed changes to models. Conducted acoustic and vacuum testing of spacecraft equipment and materials. Demonstrated an ability to work both independently and within the group to achieve project goals. Coordinated support from other areas such as optics, thermal, electrical, and contamination. Developed assembly procedures, generated, and maintained flight hardware inventories and logbooks. Provided field support at other NASA installations or vendors that will be required for the fabrication, assembly, and launch effort of NASA projects. [2007] [prior to AECOM]

**Math Tutor, Prince George’s Community College, Largo, Maryland.** Assisted students in various mathematical disciplines, ranging from pre-algebra to differential equations and linear algebra. [2006-2007] [prior to AECOM]

Assisted students in various mathematical disciplines, ranging from pre-algebra to differential equations and linear algebra. [2006-2007] [prior to AECOM]
Paige Humecki is an analyst for the Energy Business Line at AECOM with a specialty in energy engineering and technical analysis for smart energy initiatives.

Based in Chicago, Paige brings professional experience in energy management, project management, and technical analysis. This experience includes modeling financial and environmental benefits for capital energy efficiency projects, analysis of building energy and water performance, developing rooftop solar installations, and reporting performance on greenhouse gas reduction targets through ENERGY STAR, municipal benchmarking programs, and the Global Real Estate Sustainability Benchmark.

**Selected Project Experience**

**Chicago Department of Fleet and Facility Management, Water Efficiency Audits, Chicago, Illinois.** Analysis of real-time water data at ten municipal facilities, including libraries, police stations, and fire stations for potential water savings. Included audit of three facilities in which water conservation measures were identified and quantified. [2018-ongoing]

**City of Chicago Resilience Plan, 100 Resilient Cities, Chicago, Illinois.** Analyst providing technical expertise to support collaborations between the local electric utility and the City. Our scope of services includes workshop development, stakeholder engagement, and technical support for strategizing resiliency efforts. [2018-ongoing]
Dr. Dana Al-Qadi is a civil and environmental engineer with experience in smart cities, energy, and drinking water treatment and design. Current projects include smart city technology, asset management, energy efficiency, solar implementation, vulnerability assessments, urban and rural resilience, performance metrics, and stakeholder engagement.

Dana's project experience also includes work on sustainable point-of-use drinking water treatment for developing global communities and working with municipalities on water main design and potable water treatment plants. Additional project experience includes EPA compliance, sustainable infrastructure, and developing financing strategies and best management practices for urban green infrastructure. Her past research experience also includes a background in pathogen inactivation in drinking water supply.

Selected Project Experience

Emergency Response Plan, City of Evanston, Evanston, Illinois. Updated an emergency response plan for the City of Evanston by including updated emergency response protocol, contact information, and policies using the J-100 methodology in order to meet the latest AWIA legislative requirements. [ongoing]

Missouri: Roadmap to Resilience, Missouri, Illinois. Managing a project for the Missouri Department of Economic Development to understand the reliability and resiliency needs of small and medium-size communities in Missouri and develop a scalable and comprehensive Resilience Roadmap for communities to address resilience topics such as critical facilities, partnering opportunities, financing opportunities, economic development, and energy burden. [ongoing]

Kings County Association of Governments Electric Vehicle Readiness Plan, Kings County, California. Managing work for the Kings County Association of Governments electric vehicle readiness plan to identify KCAG's PEV infrastructure needs including local stakeholder outreach, a public outreach plan and developing potential charging sites based on technical analysis. [ongoing]

Illinois Solar for All, Illinois Solar Energy Association, Illinois. Support in program development for Illinois Solar for All, an innovative program providing incentives for low-income communities to implement solar. The program includes job training to accelerate workforce development and minimum allocations to benefit environmental justice communities. [ongoing]
Community of the Future Smart City and Resilience Initiatives, ComEd, Chicago, Illinois. Supporting a number of pilot projects within ComEd’s Community of the Future in Bronzeville to leverage investments in the microgrid and enhance community resilience. [ongoing]

Exelon Business Services Company, Commonwealth Edison Microgrid Resilience, Chicago, Illinois. Developed microgrid resilience metrics as part of ComEd’s infrastructure resilience efforts aligning with their Community of the Future pilot. [ongoing]

Vulnerability Assessment Update, Genesee County Drain Commission, Division of Water and Waste Services, Flint, Michigan. Performed updates to the vulnerability assessment based on the RAM-W methodology with new critical assets incorporated and vulnerabilities identified based on the physical protection system effectiveness. Included participation in a workshop with the client stakeholders to review old facilities and incorporate new facilities, establishing relative consequence values for each facility. [2019]

100 Resilient Cities Program, City of Chicago Resilience Plan, Chicago, Illinois. Strategic partner for the City of Chicago as they develop their Resilience Strategy and meet the City’s resilience goals. [2019]

Village of Wheeling, Proposed Interconnection, Wheeling, Illinois. Designed interconnection for the Village of Wheeling to serve as emergency backup water source, conducted hydraulic analysis and modeling to determine appropriate interconnection design, completed a report of findings for the village, and compiled specifications and construction drawings. [2019]

Vulnerability Assessment, Karegnondi Water Authority, Flint, Michigan. Developed the vulnerability assessment for the newly formed Authority. The document was prepared based on the RAM-W methodology with critical assets identified and vulnerabilities characterized based on the physical protection system effectiveness. Responsibilities included participating in a workshop with the client stakeholders to review facilities and to establish relative consequence values for each facility. [2019]

Artificial Intelligence/Machine Learning Asset Inventory, Commonwealth Edison, Chicago, Illinois. Managed a pilot project using Google Street View compatible imagery to test out impact of artificial intelligence and machine learning algorithms on improving asset management strategies for a local electrical utility. [2019]

Emergency Response Plan, Village of Wheeling, Wheeling, Illinois. Updated an emergency response plan by including updated emergency response protocol, contact information, and policies. [2018]

Village of Oswego, Feasibility Study, Oswego, Illinois. Conducted routing analysis as part of feasibility study for Village of Oswego’s consideration of alternate water sources for their community. [2018]

Boston Development Authority, Boston Smart Utilities Vision Program Development, Massachusetts. Provided engineering and policy recommendations for innovations in utility infrastructure for enhanced social equity, resource efficiency, resilience, and community impact. [2017]

City of Decatur, CMOM and Consent Order Compliance Program and Asset Management Program, Decatur, Illinois. Conducted and managed a capacity, management, and O&M analysis to ensure compliance with the EPA’s consent order and an asset management plan to manage assets including staffing, operations, and maintenance of the system, capital improvements, financial strategy, and compliance and preparedness. [2017]

UI Labs, City Digital Smart Green Infrastructure Monitoring Pilot, Chicago, Illinois. Engineer performing analysis of reported green infrastructure data from pilot sensors implemented in numerous sites in the City of Chicago to inform green infrastructure design and develop applications for real-time maintenance, hydrology models, and sensor packages. [2017]

Genesee County Division of Water and Waste Services, Lake Huron Water Supply, Water Treatment Plant and Upland Raw Water Impoundment, Genesee County, Michigan. Assisted in plans for the Genesee County water treatment plant, being designed and constructed in conjunction with the Karegnondi pipeline that supplies drinking water to more than 2,400 square miles along Michigan’s I-69 corridor. [2015-2017]

Greenest Region Compact Sustainability Network, Metropolitan Mayors Caucus, Chicago, Illinois. Assisted 273 communities to implement sustainability plans. Designed comprehensive programs and targeted technical assistance to leverage and coordinate resources. [2016]

Village of Glenview, North Maine Utility Study, Chicago, Illinois. Performed a condition assessment and fiscal impact analysis of the water and sewer infrastructure assets of the utilities system. The study identified the capital needs of the water and sanitary sewer systems and conducted a financial valuation of the system. [2013]

Smart Low Carbon Community Roadmap, Commonwealth Edison, Chicago, Illinois. Developed an implementation roadmap to reduce carbon within a pilot area by modeling carbon impact of smart technologies, livability benefits, and co-benefits.

Ezra Beeman
Economics

Education
MS, Applied Finance, Macquarie University, Australia
BA, Economics, Claremont McKenna College, United States
BA, Philosophy, Claremont McKenna College, United States

Years of Experience
20+

Ezra will lead all Energeia managed workstreams and tasks, provide subject matter expertise as required, solution design and quality assurance. Ezra has more than 20 years of electricity industry experience in the U.S, Europe, and Australia, more than 15 of which have been as a consultant to the power industry. As the Managing Director of Energeia USA, Ezra has been the project director or project manager for each of the rate design, CoS, and advanced energy projects listed in the reference section.

Ezra is a former utility pricing strategy manager and has led all of Energeia’s rate design and CoS studies to date. This includes the design of five new rates for electrification of LA’s bus and train network, including storage and solar solutions as part of four of the rates. Ezra is also the architect of Energeia’s industry leading utility simulation software uSim, which automates best practice approaches to CoS, customer classification, cost allocation and rate design processes, delivering a step change in analytics at a fraction of the cost of manual approaches.

Ezra is an expert in consumer-side energy technology, including virtual power plants, battery storage, home/building energy management systems, electric vehicles, peer-to-peer trading and microgrids. Ezra has designed virtual power plant software, home energy management software, and customer-power system co-optimization software, which has been applied to systems of up to 8 million connections. His pioneering work in consumer side energy technology was recognized by the granting of a patent in the area of battery management optimization and value stacking.

Prior to Energeia, Ezra worked for a major transmission and distribution utility with over 1.8 million customers, where he held various smart grid, rate design and network development roles. As the Manager Pricing Strategy, Ezra designed and led the company’s rate R&D efforts, including the setup of customer research projects, such as testing of critical peak pricing, seasonal Time-of-Use, and the impact of in-house displays and communication on customer response.

Selected Project Experience

Summary of Experience – Energeia
As the Managing Director, Ezra led the company from its inception in 2009 to becoming Australia’s largest, power sector specialized consultancy and industry research firm. In 2015, Ezra also became the Managing Director of Energeia USA, its U.S. affiliate headquartered in California. Ezra has overall responsibility for global performance, with a focus on developing Energeia’s reputation and business in the U.S. In this role his major achievements have been:

Rate Design and CoS
– Developing an optimized approach to integrating DER into LADWP’s system by optimizing rate and incentive design, smart grid technology deployment, network planning and DER program mix and targeting over the next 10 years that saved the company and its customers billions in avoidable costs compared to current strategies
– Subject matter expert and Energeia workstream lead supporting the assessment of Electric Vehicle (EV) uptake and electricity demand impacts on a Northern California publicly owned utility’s electricity distribution network and cost-to-serve, as well as the design of optimized EV rates, incentives and services (ongoing).
Advanced Energy Solutions

Developing specific, reliable, implementable, practical and least cost DER solutions tailored to address LADWP’s forecast system constraints expected to arise under a range of alternative One-Through-Cooling repowering scenarios, including a no repowering scenario (ongoing).

- Developing a specification for a virtual power plant (VPP) software capable of aggregating loads to meet contracted service terms based on a set of contractual, grid and device constraints. The specification for a start-up distributed energy utility is now in production and being used to deliver VPP services to utilities in Australia on a pilot basis.

- Developing a specification for a home energy management software based on his value stacking patent that identifies the optimal charging and discharging schedule for a battery of a given size based on a forecast of a given customer’s load, solar PV generation and load control. The software has been implemented and is achieving industry leading levels of bill savings.

- Developing a business strategy for a specialist smart energy system developer targeting new residential and commercial developments aiming to leverage distributed energy solutions to minimize building energy and connection related costs and emissions. The strategy identified the overall size of the market, the key types of buildings that would benefit the most.

Summary of Experience – Energy Australia

As the Manager – Alliance Strategy, Ezra was responsible for managing the implementation of two Alliances to deliver up to $1.14B in capital projects over five years. In this role his major achievements were:

- Managing the legal and commercial negotiations to achieve commercial alignment, and developing a comprehensive Alliance implementation plan, including a resourcing model for $6.1B capital program.

As the Executive Manager – Strategic Services, Ezra was responsible for the coordination of the Executive team on behalf of the Executive General Manager, Network. His duties included:

- Providing advice to the Executive General Manager, Network; Strategy development, business planning and divisional communication; performance measurement, monitoring and reporting; board, ministerial and inter-divisional interfaces and coordination of the executive team.

As the Manager – Network Metering & Pricing Strategy, Ezra was responsible for the formulation, justification and delivery of company’s strategic pricing and metering initiatives. His responsibilities included:

- Leading the development and delivery of the $380M Advanced Metering Infrastructure (AMI) strategy, which included a large technology pilot & customer research study.

- Designing and implementing Daily kWh Time-of-Use (ToU) rates as the default rate based on a detailed CoS model for new residential and small business customers for a 1.8 million customer electric utility.

- Designing and implementing Seasonal kWh ToU and critical peak pricing rates for residential and business customers for 1.8 million customer electric utility’s Strategic Pricing Study involving 1,200 customers.
Tim Scott
Economics

Education
BA, Economics, University of California, Davis

Tim is a pivotal member of Energeia’s modeling and research team, with experience in statistical and programming languages Python, Stata, VBA, and SQL. Tim has a strong background in market research, analysis, and database management in the energy sector.

Tim will serve as an economic researcher, modeler and writer for this engagement.

Tim’s EV related experience includes extensive market research around electric vehicle infrastructure, electric vehicle uptake/penetration, and electric vehicle rate design. His electric vehicle research has provided a foundation for Energeia’s electric vehicle uptake modeling and charging infrastructure forecasting.

Tim’s CoS and rate design experience includes CoS modeling to develop the optimal electricity rate to minimize the cost of electrifying the entire bus fleet in a POU service area. Tim developed algorithms using VBA to generate reporting of the cost/benefit analysis for the bus companies under the designed rates.

Tim’s advanced energy solutions experience includes in-depth market research on the latest technology and costs associated with DER such as battery storage, electric vehicle chargers, virtual power plants, and more. Tim has developed excel models forecasting the potential impacts that distributed energy resources will have on electricity grid demand, as well as spatial models to evaluate the potential integration of distributed energy resources on the grid.

Selected Project Experience

Summary of Experience – Energeia

As a Senior Associate, Tim has worked on a number of client engagements:

Rate Design of Electric Bus Charging for a Large California POU. This project analyzed the current and future state of electric bus charging for the POU and designed rates appropriate for the charging patterns on the POU’s network. Tim worked to process and integrate the utility’s current electricity rates into a CoS model for serving an electrified bus fleet. Tim developed algorithms using VBA to generate reporting of the cost/benefit analysis for the bus companies under the designed rates.

Local Transmission Reliability Study for Los Angeles Department of Water and Power. This project leveraged data from the OTC study to determine the near- and long-term course of actions for planning, designing, and implementing mitigation solutions for the local transmission system. Tim analyzed the forecasted impact that distributed energy resources will have on the POU’s grid. He developed hourly profiles for DER technologies and provided a breakdown of system and DER coincident and non-coincident peaks on the POU’s grid. Tim’s modeling was key in Energeia’s determination of achievable incremental DER analysis.

Once-Through Cooling Study for Los Angeles Department of Water and Power. This project analyzed the viability and capability of DER for replacing LADWP’s OTC units. Tim was a principal researcher on this project, researching and supplying analysis on a wide range of distributed energy resources and related technologies. He provided evaluation of the costs and latest technological integration capabilities for DER equipment such as battery storage, electric vehicle chargers, and building management systems.
Miles Butler
Technology

Education
BA, Physics, Drury University

Miles concentrates on advanced computation techniques and software engineering at Energeia and is responsible for managing the development of Energeia’s agent-based utility simulation platform, uSim. His skills and core competencies include analytical modeling, advanced mathematics, machine learning, and the design and implementation of large-scale data pipelines.

Miles will provide advanced energy solutions subject matter expertise and related task management services for the project.

Miles has been involved in several of Energeia’s rate design projects, including for LADWP in its pursuit of a fully electrified bus fleet, and for Powerhive, Inc. in its mission to expand rural access to reliable electricity across the globe.

Miles is integral in Energeia’s energy solution projects. He has modelled energy efficiency savings and forecasted electric vehicle adoption, from the network level down to the customer level. He also regularly conducts research campaigns to inform the firm’s modeling with robust and exhaustive assumptions.

Selected Project Experience
Summary of Experience – Energeia
As a Senior Associate, Miles has worked on the following engagements:

Once-Through Cooling Study for Los Angeles Department of Water and Power. This project analyzed the viability and capability of DER for replacing LADWP’s OTC units. Miles developed and configured Energeia’s DER platform to simulate uptake of solar photovoltaics, energy storage, demand response, energy efficiency, and electric vehicles for LADWP. Miles also developed a customer-level energy efficiency model for this project, which leveraged a great deal of internal research to model the economic viability and energy impact of specific energy efficiency products for the average POU customer in multiple segments.

Rate Design of Electric Bus Charging for a Large California POU. This project analyzed the current and future state of electric bus charging for the POU and designed rates appropriate for the charging patterns on the POU’s network. Miles managed the processing and interpretation of the large datasets underlying the modeling effort. He also designed a model to forecast and analyze the revenue effects of peak period shifting due to solar and other DERs.

Rate Design for Powerhive, Inc. This project analyzed customer consumption data and designed rates to incentivize new connections without affecting revenue. Miles performed the statistical analysis of customer consumption, identifying the key thresholds and critical points for a new block rate structure.
Maria Wong Chang
Technology

Education
BS, Pharmaceutical Chemistry with
Highest Honors, University of California, Davis

Maria has worked within Energeia’s consulting and research team for over a year. During that time, she has developed and expanded her experience programming and analyzing data in Python, MATLAB, VBA, SQL and QGIS. At Energeia, Maria has contributed to multiple projects such as the development of electric vehicle uptake models, demand response participation analysis, assessment of smart metering programs, and valuation of power reliability cost.

Maria will provide technical task support services across research, cost and business analysis, techno-economic modeling, and technical writing tasks for the project.

Maria has done extensive desktop research in transportation electrification at the national level. Her research has focused on the key drivers for electric vehicle uptake, as well as best practice regarding charging station location indicators.

Maria has also contributed to Energeia’s rate design and CoS projects by developing and manipulating historical databases of customer meter data and electricity rates. Beyond research and database development, Maria also contributes her strong modeling skills to the consulting and research team, being a key member in the development of forecast models such as the one generated for the Local Transmission Reliability Study.

Selected Project Experience

Summary of Experience – Energeia
At Energeia, Maria has worked on multiple client engagements:

Electric Bus Rate Design for a Top California Municipal Utility. Energeia was engaged to aid with the design of an electric rate to address projected transportation electrification of Buses and Trains. Maria contributed to background research to identify best practices of electric transportation in the. She was also a key member in the development of EV charging loads, which were then used as inputs for the rate design model.

Once-Through Cooling Study for a Top California Municipal Utility. Energeia’s role in this project was to estimate the extent which DER can be used to partially—or completely—replace the capacity of some of the utility’s thermal generating units. Maria contributed to the analysis of the utility’s metering data by helping to generate a historical database of the Utility’s electricity rates.

Local Transmission Reliability Study for a Top California Municipal Utility. Energeia was engaged to model future demand on the Utility’s transmission grid, which included accounting for DER reduction of peak demand and energy load. Maria was a key member in the development of the forecast model. She also did extensive research regarding the DER targets of the region.
Josh Fujii
Markets

Education
BA, Economics with Distinction,
University of California, Davis

Joshua is a key member of Energeia’s modeling and research team, with experience in data analysis using Excel, Python, MySQL, QGIS, and Tableau. He has a deep understanding of multi-variate regression analysis.

Josh will provide economic workstream management and task management services. Josh will also be the senior economic analyst and researcher on the project, managing each workstream and task to schedule, budget, scope, and quality.

Josh has worked on each of the Energeia USA reference projects, developing a proven ability to manage and oversee Energeia’s consulting and research focused personnel.

Josh has a solid understanding of CoS, program management and rate design concepts and issues. He has worked across each of the LADWP rate and CoS projects, providing economic and financial analysis and research, as well as developing key CoS models and pricing models for the bus rate design project. Josh was the project manager on the bus rate project, and general rate support project that preceded it, and has successfully managed over twenty projects to Energeia’s project management standard.

Josh’s EV related experience includes EV uptake and spatial allocation analysis mapping EV uptake to transformer locations on a geospatial basis. He has also identified optimal siting of EV infrastructure using demographic and economic drivers. Joshua has headed this work across multiple U.S. jurisdictions.

Selected Project Experience

Summary of Experience – Energeia
At Energeia, Maria has worked on multiple client engagements:

Illinois Tollway Strategic Plan, Electric Vehicle Charging.
Energeia developed electric vehicle adoption and charging demand forecasts for the Tollway. Joshua spearheaded the development of the electric vehicle uptake and charging demand forecasts, which segmented EVs by each driver and vehicle subsegment and analyzed daily and hourly expected demand from DCFC and wireless charging. Joshua also led the EV market research, modeling quality assurance, and graphic development for this engagement.

Rate Design of Electric Bus Charging for a Large California POU.
This project analyzed the current and future state of electric bus charging for the POU and designed rates appropriate for the charging patterns on the POU’s network. Joshua managed the modeling efforts in developing a charging profile for the utility, allocating charging demand to assets on the utilities territory, and determining the appropriate rate structure and values for various scenarios from which the customer may choose.

Once-Through Cooling Study for Los Angeles Department of Water and Power.
This project analyzed the viability and capability of DER for replacing LADWP’s OTC units. Joshua configured and operated Energeia’s agent based DER simulation platform, which simulated uptake of energy efficiency, solar photovoltaics, energy storage, demand response, and electric vehicles for LADWP. He was also responsible for quality control, data visualization, generating results tailored to the needs of LADWP.
Kofi Owusu Agyeman
Markets

Education
BS, Energy Resources Engineering,
Stanford University, Stanford, 2019

Kofi Agyeman is an associate with Energeia’s consulting team, with experience in data analysis using Excel, Python, and SQL. At Energeia, Kofi has worked on researching best practices for electric vehicles uptake.

Selected Project Experience

Summary of Experience – Energeia
At Energeia, Kofi has worked on multiple client engagements:

Electric Vehicle Uptake at the County Level. This project analyzed the uptake of electric vehicles to quantify the charging infrastructure requirements for the county. Kofi provided research and analytical support to the project, including researching best practice municipal electric vehicle enablement.

Battery Project Benefits Assessment. This project analyzed the benefits of adding battery storage in terms of reduced electricity charges, and revenue from wholesale market demand response, and transmission and distribution non-network alternatives. Kofi was part of the research, analysis and modeling team that built a flexible battery valuation tool, capable of modeling potential benefits over a wide range of scenarios.
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