CUYAHOGA COUNTY DEPARTMENT OF SUSTAINABILITY

Creating State-of-the-Art Utility Microgrids

Worley qualifications for Cuyahoga County's state-of-the-art grid-edge technologies initiative

15 July 2021

Worley Group Inc.
2675 Morgantown Rd.
Reading, PA 19607

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2675 Morgantown Rd.
Reading, PA 19607

worley.com

15 July 2022

Ref: Cuyahoga County Utility & Microgrids
Request for Information

Mr. Mike Foley
Cuyahoga County Department of Sustainability
2079 East Ninth Street
Cleveland, OH 44115

Dear Mike,

SUBJECT: QUALIFICATIONS FOR STATE-OF-THE-ART GRID-EDGE TECHNOLOGIES INITIATIVE

We appreciate the opportunity to partner with Cuyahoga County Department of Sustainability as you work toward promoting state-of-the-art grid-edge technologies throughout your service territory.

Worley has extensive experience in identifying, optimizing, designing, and constructing resilient and distributed energy solutions. Our capabilities enable us to efficiently deliver cost effective, use case specific designs on a programmatic scale. We have highlighted key differentiators for our project capabilities in all forms of resilient distributed energy systems:

The Right People: Our Power & New Energy team brings industry experience second to none. Our Design Lead has over twenty years of experience in all facets of renewable and distributed energy projects. Our Program Managers have 30 years of combined experience developing, operating, and managing all forms of resilient and renewable energy projects. Our Expert Modeler has designed over 300 resilient power and renewable energy projects with capacities from microgrid scale to installations of over 400 MW.

The Right Tools: We use cutting edge software like Replica8 to optimize the production of similar design deliverables when multiple units of the same type are specified. We use VECKTA to perform optioneering in hours rather than the days or weeks typical of manual optimization approaches.

Bringing It All Together: We have the tools and experience to deliver value added solutions to Cuyahoga County from concept through installation, operations, and maintenance. Our tools not only save engineering time and cost, but also ensures a solution that delivers maximum value based on Cuyahoga County performance targets.

We look forward to partnering with Cuyahoga County on your Initiative and look forward to hearing from you soon. Should you have any questions or require further information, please do not hesitate to contact me at 717-945-9877 or via email to Erik.Barnhart@worley.com.

Sincerely yours,

Erik Barnhart
Program Manager, Distributed Energy Systems

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Appendix A. Related project experience

1. Executive Summary

Worley
energy | chemicals | resources

Certainty in Delivery

Creating state-of-the-art utility microgrids

You need the right team with the right experience to execute your portfolio of work. We provide a team that not only delivers a technically strong design but also works to build a culture of success for an extensive portfolio of work.

Kirk has 18+ years of consultant experience in the power system generation and distribution field, working in a joint project team setting, with primary focus on developing renewable energy, microgrid, and/or energy storage solutions.

Kirk Neubauer | Business Development Manager

The right **team assembled,** working in perfect harmony

Erik Barnhart
Program Manager

Worley's Program Manager for Microgrids and Distributed Energy Systems (DES). Erik's 12 years of experience with Microgrids and Distributed Energy Systems include directing operations with energy services companies, managing energy master plans, capital project management, and grid modernization. Subject matter expert for distributed energy systems.

Pedram Charepoo, P.E.
Senior Electrical Engineer

Pedram is a senior electrical engineer with experience in power systems, controls, and instrumentation engineering. He served as the lead electrical engineer for the AEP Columbus Zoo Microgrid project. Pedram also was the lead electrical/sealing engineer for the AEP Athens Water treatment plant turnkey EPC Microgrid project, BayWa Corazon Ranch 200MW PV Solar project, and BayWa 20MW Camden Solar PV project.

Rajib Kundu, M.A.Sc., P.Eng.
Distributed Energy Systems Expert Modeller and Electrical Engineer

Rajib has a Masters of Applied Science in Power System and Energy Management and has developed a $4M microgrid project from scratch (electrical design, communication and SCADA). He has designed C&I and utility scale solar projects and recently secured 504.18 MWp project award in Canada, USA, Middle East, Africa, Australia, and Caribbean Islands. Rajib developed a Net-zero energy neighborhood model for London Hydro, ON project.

Our dedicated Utility Transformation team helps utilities plan for the future energy landscape — looking 10 to 20 years into the future and beyond.

We are uniquely positioned to support you from start to finish. We offer all of these skill sets under one roof to provide you with further opportunities to accommodate and coordinate the growth of state-of-the-art grid-edge technologies.

replic8

Replic8 uses technology to directly reduce development costs

This project execution method uses automation and strategic grouping of deliverables to optimize project delivery by facilitating data centric methods. *Replic8* eliminates human error risk by using data centric algorithms and delivers high quality deliverables faster and at a lower cost than manual effort replication.

Worley's advantage as a one-stop-shop

Backup Generation

- Turnkey installation of backup generation resources designed to power a customer's entire facility or designated critical load panels.
- Generator types to include diesel, natural gas, propane etc. as indicated by the customer's preference and fuel availability.
- Performance of detailed system design including generator sizing, interconnection and protection devices.
- Performance of ongoing operation, maintenance and monitoring of installed systems to ensure their reliable performance.

Energy Storage Systems

- Turnkey installation of battery energy storage systems designed to provide backup power, reliability, or other services for the customer.
- Battery storage may be lithium-ion, advanced lead-acid, flow or other commercially available battery storage technology.
- Performance of detailed system design including battery system sizing, interconnection and protection devices.
- Performance of ongoing operation, maintenance and monitoring of installed systems to insure their reliable performance.
- Assisting with permitting and other compliance issues related to operation of the energy storage system.

Renewable Energy Generation with Energy Storage

- Turnkey installation of renewable energy generation systems designed to meet all or a portion of the customers electric load. To provide resilience for the customer all renewable energy systems are to be paired with an energy storage system to mitigate the intermittent nature of renewable resources.
- Renewable energy generation may include photovoltaic systems (PV), wind, hydro, or other eligible renewable resource.
- Performance of detailed system design including renewable system sizing, interconnection and protection devices.
- Performance of ongoing operation, maintenance and monitoring of installed systems.

Plan it | **Build it** | **Run it**

For your energy project

- Microgrid
- Battery Energy Storage
- Electric Vehicles
- Alternative Energy System

Your priorities

- Cost savings
- Emissions reduction
- Resilience & reliability
- Safety & security

Your data

- Location
- Facility type and use
- Energy use mix/cost
- Load profile

VECKTA

Platform data

- Energy pricing
- Solar and wind data
- Vendor data
- Geospatial analysis

Technical and financial optimization

- Financial proforma
- Customized system design
- Technical report
- Optimized operations

VECKTA solutions

Worley has an exclusive agreement with VECKTA powered by XENDEE, the world's most advanced analysis and optimization software platform for designing energy systems. Together, we offer unmatched value in design and delivery of complete energy solutions.

Demand for alternative energy systems is growing to improve reliability and resilience, reduce environmental impact, and cut costs. Systems that offer these benefits include:

- Microgrids
- Battery energy storage systems
- Renewable generation
- Hybrid systems

With the range of technology options available, and with sizing, configuration and operating parameters to consider, the options are overwhelming. Uncertainty and high costs of feasibility studies, planning, and engineering have presented a barrier for end users and investors alike from entering the market. Further, when companies offer design and engineering at no or low cost, it is generally because they also make the equipment they are recommending, creating a bias that can result in excess capital expense or suboptimal solutions.

We recognize the need for a global energy solutions firm to sit on the customer's side of the table. Worley will:

- Help create your solution remaining technology agnostic
- Maximize return on investment
- Minimize time to results
- Meet and exceed performance goals

We Plan it. Build it. Run it. We've got you covered

You want fast, reliable answers for what your energy system will look like, how much it will cost, and how it will perform. We begin by inputting and force-ranking your priorities, such as resilience, sustainability, power quality, reduced costs, and security. We then add facility-specific data.

Next, utilizing global databases of energy pricing, solar, wind and temperature data, vendor data, geospatial information, and algorithms for system configuration and power flow analysis, the VECKTA platform provides the ability to model any/all energy resources, at any scale, producing a technical and financial optimization report.

Together, we deliver full turnkey solutions

Advisian's technical experts conduct feasibility studies, analysis, design, and optimization using VECKTA software, backed by the full capability of the Worley Group for detailed engineering, procurement, and construction of complete projects. We have the flexibility to focus on a single stage of the process, or support through the entire project lifecycle.

VECKTA

- **Least-cost, best-fit solutions**
- **Validated, auditable results**
- **Access to project financing**

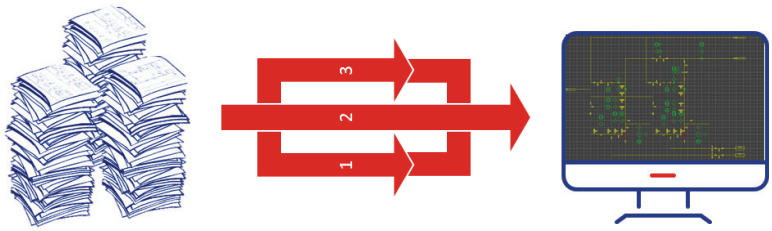
Digital solutions

Our robust suite of tools, scalable to the project and aligned with your requirements, enables us to provide you with valuable cost saving solutions. Savings can extend from capital projects to operations as digital solutions allow all of our customer's employees access to a growing set of facility information in a simple on-line platform.

Worley's digital team has worked with several brownfield operations to cost effectively grow the facilities digital footprint from paper based to web-hosted data. Being software agnostic we offer un-biased advisory services to set a site specific plan, hosted services so our customers do not need complex IT solutions. For a prior customer, Worley charted a similar path over the past three years and the customer has advised that "having correct and completed facility information available to their staff at the workforce is a game changer for productivity."

DataSeer

Cloud-based digital conversion of P&IDs



DataSeer is a cloud-based solution from The Data Refinery, which transforms the use of industrial drawings,

by leveraging neural network techniques such as object detection and image classification to process documents with an exponential increase in speed and accuracy. DataSeer extracts valves, instruments, lines data, and tables from most engineering drawings and assists with the full digital conversion of those legacy drawings.

Augmented Reality (AR)

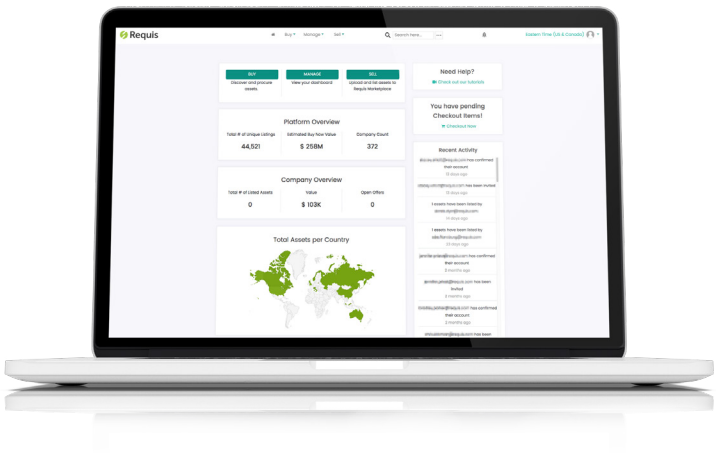
Use of the AR with the Microsoft HoloLens helps to mitigate the risks associated with the current COVID-19 Pandemic by reducing the number of field visits and personnel required to perform site surveys.

Using AR provides workflow savings in projects through reduced field verification visits, early agreement of equipment/ structural locations, early detection of model clashes, tie-in location approvals, changes in piping and equipment location, and alignment of stakeholders in reviewing the model overlay on the actual tie-ins.

Requis

Bringing together the best in the business as they buy, sell or manage their assets efficiently:

- Digitization can provide up to 41% increases in efficiency
- Connecting enterprise buyers and sellers of materials and equipment through an active online marketplace.
- Through enhanced visibility, increased recovery and intelligent re-use of materials, Requis helps users reduce time and costs, and achieve higher cash flow.



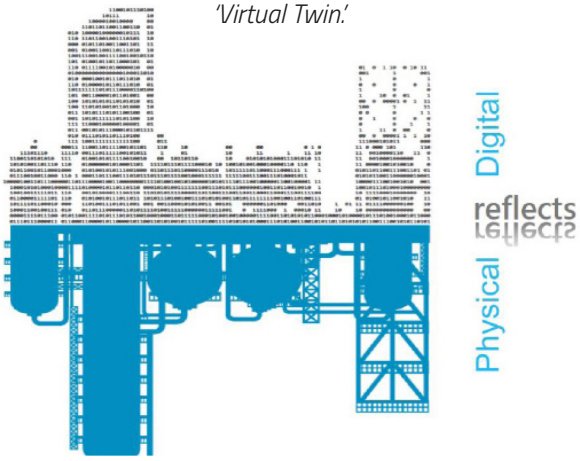
Asset Capture Environment (ACE) – Digital Twin

Technology that provides customers a cost effective alternative to the traditional 3D modelling of existing assets.

This enables plant owners and operators the ability to easily access 3D photo realistic models of their facilities wherever and whenever needed.

By creating digital replicas of pre-existing facilities we create significant opportunities for safety and productivity gains associated with integrity, maintenance, shutdowns, projects and training.

Through ACE, we develop and maintain an intelligent 3D 'Virtual Twin.'



Benefits of ACE

- Single source of engineering truth
- 30% cost reduction compared to traditional methods
- Accurate and efficient virtual model capture
- Can be used to assist with drawing verification or creation
- Ideal for customers with low quality documents and drawings.

Project experience

Providing resiliency for a city's water supply with water treatment plant microgrid in Ohio

AEP, Ohio

Worley, as prime, will deliver a microgrid under lump sum turnkey EPC to AEP Ohio at City of Athens, Ohio Water Treatment Plant and will include a 250 kW /1140 kWh BESS, a microgrid control system, a new electrical distribution system, and integration into 230 kW of existing solar PV. Worley will perform the engineering and procurement on the BESS, microgrid control system, and electrical distribution system. Worley will provide a full-time, on-site construction manager, with installation by a local subcontractor.

Battery helps provide clean drinking water in Eugene, Oregon

Eugene Water & Electric Board

We successfully delivered two battery energy storage system (BESS) installations for the Eugene Water & Electric Board (EWEB) in Eugene, Oregon. Each BESS is independent and will provide emergency power to a new water well system, offering the community fresh drinking water during long-term power outages. The successful installation of two battery energy storage systems provides local communities with fresh drinking water during power outages.

"On time, under budget, with zero incidents... working with VECKTA saved more than 30% on the equipment quotes we got from vendors."

Horn Rapids BESS Project, Richland, WA

Energy Northwest

This greenfield project comprises a 1 MW/ 4 MWh battery system, PCS, controls cabinet and 480 V switchgear to connect into a 500 kW solar PV facility. Worley is responsible for coordinating major equipment vendor, construction vendor, and other stakeholders to deliver this project. We integrated the design from another engineering firm to deliver the overall package.

for any project inquiries, contact:

Maxwell Pitts
Director, Business Development
Power and New Energy Sector | Worley

maxwell.pitts@worley.com

t: +1 (864) 363 8853

"On time, under budget, with zero incidents...working with VECKTA saved more than 30% on the equipment quotes we got from vendors."

Eugene Water & Electric Board

Columbus Zoo
Microgrid, Ohio, USA

Worley, as prime, is delivering a microgrid under lump sum turnkey EPC to AEP Ohio at the Columbus Zoo to protect the polar bear exhibit. This will include ~130 kWdc of ground-mount solar PV, 560 kW/1200 kWh BESS, a microgrid control system, and a new electrical distribution system.

Worley is performing the engineering and procurement on the BESS, microgrid control system, and electrical distribution system as well as Solar PV by local third party under Worley. Worley is providing a full-time, on-site construction manager.

Project experience

Corazon Ranch 1 200MW PV Solar Plant, Texas, USA

Customer: Confidential

Worley is performing the engineering, procurement and construction for a 200 MW PV solar plant in Texas, including the interconnect substation. The project will feature single axis trackers with bifacial solar panels. Execution will be a self-perform, direct-hire approach with specialty subcontractors.

Camden 20MW PV Solar Plant, North Carolina, USA

Customer: Confidential

Worley is performing the engineering, procurement and construction for a 29 MWdc/20 MWac solar PV solar plant in North Carolina. The project will feature single axis trackers with bifacial solar panels. Execution will be a prime approach with specialty subcontractors.

Resiliency Solar Microgrid, Washington, USA

Seattle City Light

Worley, as the prime contractor, will deliver a microgrid under a lump sum turnkey EPC contract to Seattle City Light. The microgrid will be customer-sited at the Miller Community Center and will include ~45 kWac of rooftop solar PV, 200 kW/ 800 kWh BESS, a microgrid control system, and a new electrical distribution system. Worley will subcontract the entire solar effort (engineering, procurement, construction, and commissioning) to a local solar installation firm (Puget Sound Solar) and will only perform the engineering and procurement on the BESS, microgrid control system, and electrical distribution system. Worley will provide a full-time, on-site construction manager for all site-based activities. All physical installation will also be subcontracted to Puget Sound Solar.

California Valley Solar Ranch (CVSR) 250 MW Project

SunPower

Worley provided planning, review, and approval for code compliance on all medium and high voltage features. Initially, Worley provided EPCM services for emergency generators to support the project. The largest emergency generator was necessary to stow the PV panels in event of high winds and a loss of back feed power. Worley supported the load studies and optimization of the generator to function properly and stow the PV panels within the contractually dictated timeframe. This project helped our customer successfully overcome challenges while on schedule.

Senior Housing, New York

Customer: Confidential

Situation: Greenfield development of a premium senior housing complex with 120 rooms, parking garage with EV charging, and ability to ride through an 8-hour outage.

Approach: Load profile built up from specifications and expected use patterns of equipment to be installed, including defining critical loads such as elevator, HVAC, emergency lighting, and security systems.

Results: The optimal configuration included a 250 kW CHP unit, rooftop solar, and a battery energy storage system (BESS), and included an innovative DC microgrid control system with critical loads served by the DC bus.

Worley Life is our enterprise-wide approach for health, safety, environmental and the well-being of our people.

Life builds on Worley's strong safety culture, recognizing that we, and those we work with, are at the center of Life.

The vision of **zero harm to people, assets and our environment** underpins all our business activities. Worley Life emphasizes the importance of our people being fully integrated with our programs, tools, and systems in the performance of all activities. The continuous process of self-examination, and open, honest communication enables our leadership teams to work with our people to reinforce a culture that supports our drive to be an industry leader in HSE performance, while at the same time delivering the highest-quality services to our customers.

Worley holds **safety above all else**

0.17

TRIF (total recordable incident frequency) for the first half of 2020

Why Worley?

The right team assembled

We've got the right team with the right expertise to execute your portfolio of work. Our team will deliver on strong design that builds a culture of success on every project.

A one-stop-shop

We are uniquely positioned to support you from concept through construction with a one stop solution. To complete the future scope of your projects, we leverage our 70+ years of experience. We also offer other solutions that could prove to reduce your operational costs such as our Veckta group that develops Microgrids or our Digital group that offers digital solutions for operating your facility. We also offer Operations & Maintenance capabilities to provide the necessary support for your customers. All of these skill sets provide you with further opportunities to reduce your costs and improve your return on investment for the life of these projects.

Safety above all else

New Worley Life program embeds a safety culture at every level of our organization with a goal of zero harm to employees, customers and subcontractors. Worley Life motivates and influences everyone to stay safe in all that they do.

Digital solutions

- Strong value creation culture.
- Digital tools and leading edge technologies implemented to create efficiency and collaboration on innovative solutions with our customers' project teams.

Experienced

We have delivered over 8+ GW of solar PV projects. Our largest battery energy storage project was 30 MW. We apply best practices and lessons learned from our previous solar PV, BESS, and DES projects to provide you cost effective, safe, and quality solutions.

Sustainability

Access to front-end environmental and regulatory consultants in the geographical area. Subject matter expertise in renewable energy generation, backup generation, storage systems, and microgrid operation, maintenance and monitoring projects.

find out more

Maxwell Pitts

Director, Business Development

Power and New Energy Sector | Worley

maxwell.pitts@worley.com

t: +1 (864) 363 8853

Worley

energy | chemicals | resources

worley.com

2. Qualifications and Experience

Worley Overview

Worley is a global project delivery organization whose mission is to "***help our customers meet the world's changing energy, chemicals, and resource needs***." We cover the full project lifecycle from planning and creating new assets to sustaining and enhancing operating assets, specializing in delivery of complex and innovative projects globally.

Global Footprint

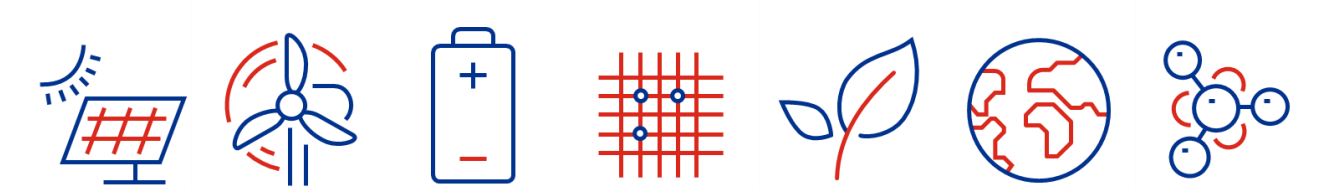
With roughly 52,000 people in over 250 offices throughout 50+ countries, ***Worley is a truly global firm***. We provide our customers with a unique combination of extensive global resources, world-recognized technical expertise and deep local knowledge. We believe this type of "local / global" approach will provide significant advantages for our customers.

Worley's Financial Viability

Worley understands the importance of selecting a firm with the technical experience to deliver the Xcel Energy **Resilience as a Service Program**. But we also believe it's important Xcel select a firm with the financial viability to undertake a portfolio of projects. In that regard, ***Worley offers extreme confidence as a publicly traded firm (listed on the Australian Stock Exchange) with yearly revenues in excess of $6 billion and a U.S. power history of over 130-years***. Our financial viability is further strengthened by our recent (April 2019) acquisition of the Jacobs Engineering Energy, Chemicals, and Resources (ECR) division. This acquisition added ~28,000 employees to our global organization, was reviewed and approved by multiple global regulatory bodies, as well as independent auditors proving our financial strength. Full, independently audited financial results can be provided upon request.

Worley's Power Overview

Our Power Team covers all power sectors, including renewable energy, smart and distributed energy, coal, gas, nuclear, hydro and transmission / distribution. With over 130 years of U.S. power experience and more than 232,000 MW of power projects delivered, including 31,000 MW of renewable energy projects, the Worley power team has unmatched capabilities and experience. Further, refer to the graphic below for a snapshot of our renewable energy experience. These projects offer Worley the understanding and lessons learned to provide Xcel Energy with ***certainty in delivery***.



Solar PV/CSP	Wind	Energy Storage	Smart & Distributed Energy	Waste to Energy & Renewable Fuels	Geothermal	Hydrogen
166+ Solar PV projects **485 MW** Largest PV project **126+** Solar CSP & hybrid projects	**437+** Onshore wind projects **310 MW** Largest onshore wind farm – 365 turbines in 362 days **105+** Offshore wind projects **2600 MW** Largest offshore wind farm	**75+** Energy storage projects **18** Battery (BESS) projects **80 kW** Smallest BESS Project **30 MW** Largest BESS Project	**40+** Microgrids, including renewable and / or CHP systems **67+** Distributed energy systems projects **Over 17 years** Specialized demand response and energy efficiency global experience	**100+** Waste to energy & Renewable fuels **200 MW** Fuel conversion from Coal to Biomass **20+ years** Designed and operating a co-gen facility fueled partly using landfill gas **15 Million** gallons/year of renewable jet fuels, design, fabrication and construction support	**31+** Geothermal projects globally **1,520 MW** Ongoing asset services support for over a decade at the largest geothermal field in the world, The Geysers Power Generation Complex	**20+** Green or blue hydrogen roles undertaken globally, including pilot plants **30 GW** Largest green hydrogen electrolyser studied, combined with offshore wind **20+** Hydrogen pathways considered in commercial detail

2.1 Services

Worley offers a complete suite of services for Distributed Energy Solution projects, including:

- Due Diligence and Independent Engineering Services for lenders and Environmental, Social, and Governance Advisory (ESG) which benefits both debt and equity participants and supports the achievement of a capital project's technical, economic, environmental, and ESG expectations
- Evaluation and Feasibility Studies: Technology comparisons, solar resource and production analysis, plant sizing and design basis optimization, equipment selection, environmental and social impact assessments, and site selection
- Preliminary Design and Cost Estimate Studies: Optimization of system design and layout; engineering drawings including general arrangement drawings, electrical single line drawings, and grading and drainage drawings; performance estimates; CAPEX and OPEX cost estimates

- EPC Specification Development: Technical specifications, preliminary drawings, design basis, and bid reviews
- Detailed Engineering and Design: Customized detailed design, procurement, construction management, and/or full-scale EPC delivery options
- Integration and Interconnection: Load forecasting and system planning, technical support for interconnection application requirements
- Risk Analysis: Risk management plan development or review
- Permitting Support: Regulatory management, permitting and compliance monitoring, technical support for permitting agency requirements
- Operations and Maintenance: Asset management, data acquisition and monitoring, compliance engineering
- Decommissioning Engineering: Including end-of-life handling and recyclability.

2.2 Operations and Maintenance

Integrated Operations and Maintenance

We start O&M in the design phase to achieve early alignment. Our project manager engages with your team in constructability and operability reviews, giving input early in the design process to ensure full alignment across disciplines and a seamless transition to O&M services. To help you achieve your power production goals, Worley brings industry O&M expertise, teams with experience optimizing operations, and organizational reach back capabilities, including:

Over
70 years
of O&M delivery

24 hour
Market Operations Center

Market Operations Center

An integral differentiating feature of our capability is our Market Operations Center

The Worley 24-hour Market Operations Center (MOC) provides:

- Real time markets
- Operations strategy
- RT dispatch
- Curtailment management
- Outage coordination
- Optimization strategies
- Renewables monitoring

The MOC is fully staffed with ISO/RTO–certified, experienced employees and offers an uptime performance guarantee of 99.9% over a calendar year.

We can monitor plant status through our in-house Generation Management System, communicate plant status changes to RTOs and the O&M staff advise your generation sites on dispatch to maximize revenue and minimize risk, and pass telemetry information to the ISO. We adapt this customized service to your site-specific requirements. In the event of a complete distribution system outage, we have two separate power feeds coming from separate distribution feeders and onsite generation feeds. We are able to provide comprehensive market coverage for all North American ISOs.

Remote Monitoring

- Remote reset of project components as necessary (to the extent capabilities exist)
- Respond to alarms by taking corrective action as needed
- Respond to communication failures per agreed procedures
- Remote overview of the project and providing notification to appropriate System Operators, Interconnection/Transmission Owners, and Off-Takers in the event of an outage
- Receive, process and take appropriate action to any curtailments called by project owner
- Receive emergency phone calls 24/7 from toll-free numbers posted at the sites
- Log events electronically, including shutdowns, start-ups, maintenance activities, curtailments, technician call-outs and resets
- Notify the owner's designated representative, as needed, in the event of emergency or other major unusual event

3. Worley's Role

What role(s) from Section 3 would the respondent fulfill?

Worley would be happy to support Cuyahoga County as the Design and Construction Team with EPC Services executing Distributed Energy Systems and Microgrids.

Please provide a brief description of relevant experience for each role.

Please refer to the DES and Microgrid experience list provided in Appendix A. Namely, Worley has executed the first two in history behind-the-meter microgrids for AEP Ohio.

Please provide any edits to the role's definition or responsibilities.

Worley has no edits for this role.

Optional - Within this section, consider providing a hypothetical organizational chart, a Responsible, Accountable, Consulted, and Informed (RACI) matrix, or other visual to help define roles and relationships.

Please see attached DES Organizational chart.

Are there other roles not identified in Section 3 that the County should be aware of?

Worley, along with its subsidiary Advisian can provide best-in-class front end feasibility and conceptual analysis.

What duties would these new roles perform?

Project development support in "right sizing" distributed energy systems, assisting with project financial performance planning and conceptual design basis.

What else should the County know about each newly defined role?

Please refer to the Executive Summary provided in Section 1 for a snapshot of our front end through operations and maintenance capabilities.

What challenges or barriers could you see for your role(s) as envisioned by the County and what might be ways for the County to address those challenges?

In our experience with these initiatives, the potential for duplicative work exists. Great care should be taken regarding Cuyahoga County engaging third-party consultants passing concepts to Worley, oftentimes needing rework or correcting. Current market conditions can greatly impact project COD. Worley has partnered with a multitude of vendors to streamline equipment delivery. Additionally, Worley has worked with these vendors to establish basis of designs for key long lead items, allowing for an expedited engineered solution and delivery.

What's the typical timeline/cycle for the respondents proposed role(s)? (e.g., it takes X year(s) to find customers for a microgrid and build it)

This is highly dependent on a multitude of factors. For example, utility subsidies effecting ability to enter generation into ancillary markets, use case scenarios, sizing, and location, etc. With Advisian's capabilities, we pride ourselves in expediting the development and concept stage as best in class. Our Engineering and Construction capabilities along with solidified vendor relationships allow us to be "first to the field."

Would the respondent meet with the County and/or its representatives to present ideas and to answer follow up questions?

Worley would highly suggest this approach and would be happy to.

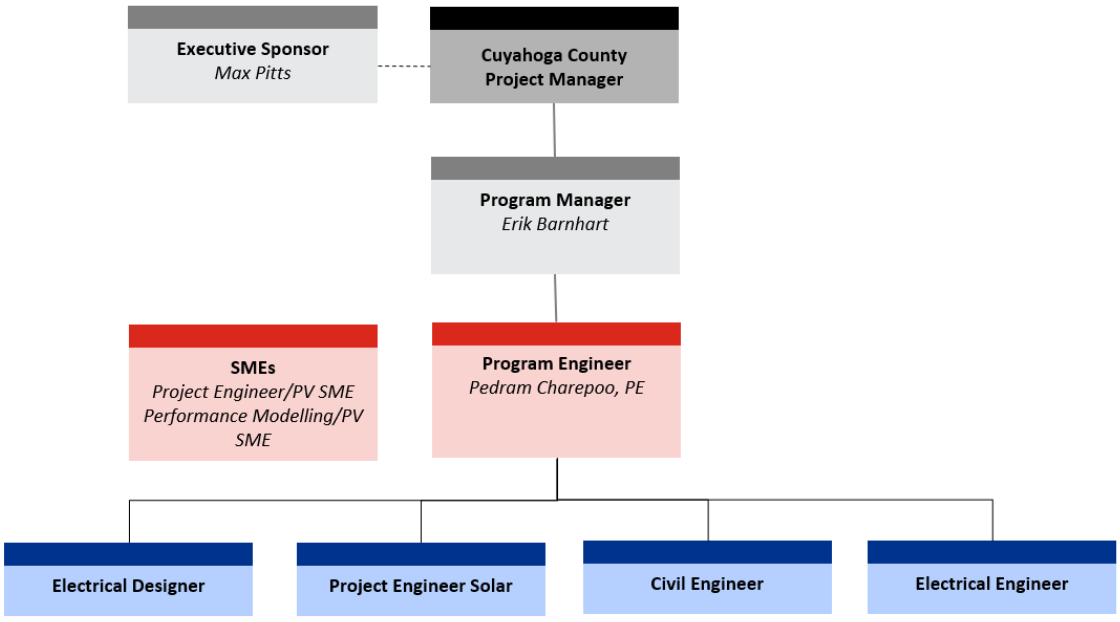
All respondents will be placed on a list for other respondents to consider for teaming and/or subcontracting. If your entity requires exclusion from this list, please state so.

Worley is happy to entertain partnering with respondents.

3.1 Project Organization

We propose a team of experienced professionals, fined tuned to deliver on your business objectives for your projects. Our execution team provides you predictability and cost certainty while seeking to deliver you continuous improvement on our performance. We utilize our technical and execution process to manage the complexities of this multi work front program.

Suggested project organization chart:



Appendix A. Related project experience

Technology	Project count	Page
Distributed Energy Systems		
Distributed Energy Resources	37	1
Microgrids	53	6
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Electric Vehicles	6	11
Battery Energy Storage Systems	42	12
General Energy Storage	10	15
Compressed Air Energy Storage	6	16
Cold Thermal Energy Storage	16	17
Hot Thermal Energy Storage	49	18
Pumped Storage	24	22
Total	**248**	

July 2021
shannon.mccully@worley.com

No.	Technology	Project	State or Province	Country	Region	Customer	Description	Services	Start Date	Completion Date
37	Distributed Energy Resources	Sydney Water Energy Partnerships	New South Wales	Australia	Asia Pacific	Sydney Water	Under this partnership, Worley analyses, designs, installs and operates small scale decentralised renewable projects imbedded in Sydney Water's operations. To date this has included biogas and small scale hydro projects.	Consulting, Engineering, Asset Operation		Ongoing since 2014
36	Distributed Energy Resources	Demand Management Service		New Zealand	Asia Pacific	Aurora Energy	Key experiences include: - Commercial and Industrial Customer education on network charges and opportunities for load curtailment - Power factor correction - Identification of load curtailment opportunities including load scheduling - Load scheduling included hot water heating, water pumping, refrigeration, and large flexible industrial processes - Identification of embedded generation opportunities and investigation of synchronisation of emergency generators - Fuel substitution of electricity for water and space heating in commercial buildings - Grown from a base of 24 customers to over 60 customers over the last 3 years. Load on electrical networks continues to increase. Despite this, in 2009 a peak load reduction of 0.5% was achieved on the Aurora network relative to 2007, even though some larger customers expanded their operations. The peak demand on the network during the last five years has reduced by over 2.5MW. This represents significant cost savings to the end-users and the network company. The DMS has enabled Aurora to improve key performance measures such as network utilisation, by delivering the same energy while operating to a lower peak demand and improving overall customer satisfaction.	Consulting		Ongoing
35	Distributed Energy Resources	Grand Prairie Landfill Gas Production	Texas	USA	North America	Trinity Private Equity Group	5-year Asset Management contract. Landfill Gas Power Generation facility equipped with 2 - 1.9MW Cummins Gensets. Facility is remote operated and sells energy into ERCOT market. Worley will also be providing Remote Operations monitoring and dispatch services.	Asset Management		Ongoing
34	Distributed Energy Resources	2021 Advisory Services for Embedded Networks	Australia wide	Australia	Asia Pacific	Charter Hall Holdings Pty Ltd	Consulting services for review of embedded network agreements and operations.	Consulting	Jun-21	2021
33	Distributed Energy Resources	San Jose DERs Site Prioritization Strategy	California	USA	North America	City of San Jose, California	San Jose engaged Advisian to assess the need and potential for application of DERs or microgrids for 36 sites owned and operated by San Jose. The end result was a strategy for DERs implementation that prioritized sites with the greatest need and the most cost-effective potential for application of DERs.	Consulting - Strategy	Feb-21	2021
32	Distributed Energy Resources	RIAB Standards Update	Pennsylvania	USA	North America	PPL Corporation	This project will develop a new standard for primary and backup feeder relay schemes to support future capability of PPL's Distribution Energy Resources (DER). The existing Relay in a Box design will be revised to use dual SEL-751 relays and will include increased I/O capability and revised logic with expanded functionality.	Engineering		2021
31	Distributed Energy Resources	Additional Microgrid EPC - City of Athens Water Treatment Plant	Ohio	USA	North America	American Electric Power Company, Inc.	Providing resiliency for a city's water supply with water treatment plant mi-crogrid in Ohio; Worley, as prime, is delivering a microgrid under lump sum turnkey EPC to AEP Ohio at City of Athens, Ohio Water Treatment Plant and will include a 250-kW / 1140-kWh BESS, a microgrid control system, a new elec-trical distribution system, and integration into 230-kW of existing solar PV. Worley will perform the engineering and procurement on the BESS, microgrid control system, and electrical distribution system. Worley will provide a full-time, on-site construction manager, with installation by a local subcontractor.	EPC		2021
30	Distributed Energy Resources	Cleantech 2 Acquisi-tion		India and Southeast Asia	Asia Pacific	Shell New Energies US LLC	Transaction due diligence services for acquisition of a company building roof-top and ground mounted solar projects in Southeast Asia.	Due Diligence / Transaction Services		2020
29	Distributed Energy Resources	Field Compression Station – Hybrid Power Study	Queensland	Australia	Asia Pacific	Confidential	Advisian was engaged by the Client to undertake a techno-economic optimisation study for two of their future field compression stations. The study looked at various generation options including grid connection, gas combustion generators, solar PV and battery storage. The three aims of the study included ensuring reliability of supply, reducing electricity costs and reducing carbon emissions. The Client was also seeking an understanding of how their rotating plant would impact this new inverter-based generation. The outcome of the study was a feasibility report outlining the various scenarios modelled and key assumptions. Advisian also provided some context regarding key risks for this type of project in Queensland. This included grid connection considerations, regulatory and approvals requirements as well as the projection for technology costs.	Feasibility Study leveraging XENDEE for Techno-economic Optimisation		2020
28	Distributed Energy Resources	Initial Health, Safety, and Environmental Impact Study	California	USA	North America	Element 16 Technologies	Advisian was contracted to identify preliminary Health, Safety, and Environmental (HSE) considerations associated with a conceptual Molten Sulfur Heat Storage and Energy Generation process, which is planned to be upscaled to a demonstration plant for trialing and fine tuning. Advisian's initial scope of services was a desktop review to identify preliminary HSE risks for further consideration as the project design progresses. Advisian team included experts in sulfur handling, thermal energy storage design, and environmental safety.	Study		2020
27	Distributed Energy Resources	Large Scale BESS		Australia	Asia Pacific	ElectraNet & AGL	In 2014, Worley initiated a project to drive the first use of large scale energy storage as an enabler for higher penetration of variable renewable energy within the National Electricity Market – known as the Energy Storage for Commercial Renewable Integration (ESCRI) project. This project eventually involved a consortium of ElectraNet, AGL and Worley in the building of an innovative Battery Energy Storage System (BESS) at Dalrymple, in South Australia. This was fully commissioned in 2018 and is now operational and can be viewed live at www.escri-sa.com.au. Worley undertook the majority of the early technical assessment and procurement, including project managing the feasibility, and provided light owners engineer services during construction and commissioning. Advisian now reports on asset operation. The asset provides both market facing (arbitrage, caps and FCAS services), as well as regulated services (fast frequency response and unserved energy), including the ability to island together with the 90MW Wattle Point Wind Farm during transmission level faults, therefore creating a microgrid until grid supply is installed.	Technical Evaluation, Procurement, Model-ling, System Integration, Technology Selection Business Case Preparation, Operational Performance		2020

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26	Distributed Energy Resources	Load and DERs Optimization Project		Portugal	Europe	Tilray	The client established a new operation Portugal to expand supply to the EU market. The first phase was completed in March 2019 and a further three phases of expansion are planned. As the site utilises both gas and electricity and has a thermal and a lighting load the study looked at establishing the expected future energy requirements for the future phases and at ways to optimise the energy and energy costs on site. The use of grid, own generation, load shifting, CHP and BESS were modelled.	Conceptual Study, Options Analysis		2020
25	Distributed Energy Resources	Assessing Government Grant Funding for DES – ARENA		Australia	Asia Pacific	Australian Renewable Energy Agency (ARENA)	Both Advisian and Worley have provided more than five years' service to ARENA, including providing the Chairperson of the ARENA Advisory Panel from 2015 until December 2019, and continues to provide technical assessors and undertake due diligence on an ad-hoc basis. Our staff have assessed more the 500 projects for ARENA, including many in deep technical and commercial due diligence, with more than 50 in the DES area such as those for remote mine sites and towns, large industrial loads, and innovative concepts such as Virtual Power Plants and the evolving blockchain-based retail models. Advisian and Worley staff have also been successful in assisting clients approach ARENA for funding support for DES projects, and have leveraged more than $100M in the last five years for such.	Technical Advisory, Due Diligence	2015	2019
24	Distributed Energy Resources	BP Whiting Refinery Steam Reliability and Optimization	Indiana	USA	North America	DTE Power & Industrial	Worley provided a conceptual design and cost estimate for 7800 gpm demineralized water supply, natural gas/refinery gas fired boilers to produce about 4 MM pounds per hour of steam supply to the Whiting Refinery, and 60 MW generated electricity from steam cogeneration.	Conceptual Design & Engineering		2019
23	Distributed Energy Resources	Cornell University	New York	USA	North America	Cornell University	Scope: Cornell's Lake Source Cooling Heat Exchange Facility supplies 95% of the campus's chilled water. Currently, the system is powered exclusively by electricity from the local grid. This cooled water provides cooling to many critical buildings and laboratories on campus. Cornell is exploring options for backup generation at the LSC heat exchange facility in the event that the grid's power supply is lost. Approach & Results: Advisian brought together a team of experts in distributed energy resources (DERs), microgrids, and New York state regulations and the New York power market to assess the feasibility of various DERs and microgrid configurations. The work included a detailed techno-economic feasibility assessment of multiple configurations and combinations of propane reciprocating engines, diesel reciprocating engines, solar PV (roof and ground mount), and battery storage. In addition, we examined the impact of state regulations, tariff structures, state incentives, and Federal incentives on the economic feasibility of the various options.	Study, Leveraged XENDEE		2019
22	Distributed Energy Resources	MoPop	Northwestern region	USA	North America	Museum of Pop Culture	Situation: Museum in northwestern USA interested in solar PV to reduce energy costs and improve power reliability. Approach: Available space was assessed from satellite images and solar production data and grid power costs determined for the site. Results: Due to low grid power costs at this site and relatively poor solar irradiance, the cost optimal solution was to not pursue the project and simply use grid power. The option remains for the end user to select a system for the value of resiliency, however the economics are not compelling enough at this time.	Study, Leverages XENDEE		2019
21	Distributed Energy Resources	Premium Housing for Sustainable Communities		Various locations	Latin America	Confidential	For a confidential greenfield development of premium housing In Latin America, the question to answer was the right sizing of on-site renewable generation and battery energy storage to provide 100% of the housing and business development's loads, in fully islanded mode, indefinitely. The objective was to minimize cost while also achieving net zero carbon emissions and complete, redundant resilience to outages of the surrounding grid. Approach: As the project was greenfield and energy use data currently does not exist, a load profile had to be built up based on the expected equipment to be used in the buildings, including everything from swimming pool pumps to hairdryers, public lighting to kitchen appliances, etc. The resulting loads totaled just over 625 kW peak demand. This load profile was then used to match supply-side resources that included solar PV, battery energy storage, and two generators to be fueled with bio diesel. Results: On a purely cost optimal basis, the system would be powered 100% from solar PV. However, to achieve redundancy, the model was forced to include two bio-diesel powered generators. In this configuration, the optimal system achieved redundant resilience, ability to self-power 100% of the time, ability to buy and sell power from the grid, and a payback period of under four years.	Study, Leverages XENDEE		2019
20	Distributed Energy Resources	University BESS Assessment	Confidential	USA	North America	Confidential	Situation: A 40MW peak load campus system at a major university had existing gas fired cogen and plans to buy 10MW of solar PV output through a PPA with the local utility, as well as installing up to 5MW of on-campus solar PV and implementing efficiency programs while also adding new loads. Approach: The goal was to size a battery energy storage system (BESS) to minimize costs by reducing the demand charge and by participating in energy arbitrage through time of use (TOU) rates. The net load and generation change between efficiency measures, new loads, existing generation and new renewable power sources was calculated and the BESS sized to match the load and generation profiles. Results: Study is ongoing at this time (Feb. 2019) and will be complete in 6 weeks.	Study, Leverages XENDEE		2019
19	Distributed Energy Resources	Wheatbelt	Western Australia	Australia	Asia Pacific	Confidential	Scope: To investigate and optimize the size solar PV/Battery installation to install at 15 main town locations for fringe of grid customers in West Australia. Approach: Analyzed various customer loads, locations, behind the meter systems and forecasts to determine appropriate BESS/solar sizing to island the communities until power on the grid is restored. Established a prioritized cost-effective approach to strategically siting assets to serve multiple locations on the distribution system in order to minimize BESS costs.	Study, Leveraged XENDEE		2019

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18	Distributed Energy Resources	Grid Edge Project	Oregon	USA	North America	Eugene Water & Electric Board (EWEB)	Scope: The utility at this site wanted to install microgrids featuring existing solar PV and a new battery energy storage system (BESS) behind the meter at two customer sites, to provide a certain level of resilience for the customers (two public schools), and also to use the systems for grid ancillary services and for research purposes, to learn how the microgrids could interact with the rest of the local grid. Approach: XENDEE modeling was used at the conceptual stage to guide the conversation, but ultimately the client chose to abandon the plan to build microgrids and go with only a BESS at one site, rather than microgrids at two locations. The reason for the change in plans was cost constraints. Results: The final choice of the client was to install 1 BESS of 500kW capacity and 1,000kWh energy at one public school. The system was delivered in full, commissioned and in commercial operation on time, under budget, with zero health, safety or environment issues. The client was very happy with the project and has offered further work on similar systems.	Study, EPC, Commissioning/Start Up, Leveraged XENDEE		2018
17	Distributed Energy Resources	PV System Interconnection Projects at Tank Farms / Pumping Stations	California	USA	North America	Shell New Energies	Worley scope of work included conceptual engineering support and design of 3 Solar PV plants and their integration into Shell's existing pipeline facilities. The work included site layouts, metering and protection one-line diagrams, electrical one-line diagrams, material take-offs, total installed cost estimates, preliminary schedules for engineering, procurement and construction, and pre-application and application for interconnection with the grid. The designs of each solar PV plant are to optimize for the specific loads at each existing SPLC facility. System modelling and performance modelling was completed to aid in the interconnection application support of each Solar PV plant. These single axis tracker PV solar plants are 2.1MW, 4.6MW and 7.2MW AC connect to existing equipment at corresponding SPLC facility. The interconnection of the PV plants at the 3 SPLC locations and to the PG&E grid included assessment of existing electrical system, identification of upgrades to meet PG&E requirements, integrating the protection system of the existing facility with the PV plant, sizing the cable between the PV plant and SPLC interface, and routing between the PV plants and SPLC points of interface.	Conceptual Engineering / Pre-FEED, FEED		2018
16	Distributed Energy Resources	Senior Housing	New York	USA	North America	Confidential	Situation: Greenfield development of a premium senior housing complex with 120 rooms, parking garage with EV charging, and ability to ride through an 8-hour outage. Approach: Load profile built up from specifications and expected use patterns of equipment to be installed, including defining critical loads such as elevator, HVAC, emergency lighting, and security systems. Results: The optimal configuration included a 250kW CHP unit, rooftop solar, and a battery energy storage system (BESS), and included an innovative DC microgrid control system with critical loads served by the DC bus.	Study, Leveraged XENDEE		2018
15	Distributed Energy Resources	100% Clean Energy Portfolio		USA	North America	Large Confidential Municipality	The client was seeking support to develop a plan for a 100% Clean Energy portfolio to include targets of 33% renewable energy by 2020 and 50% by 2030. Advisian supported two specific projects: 1. Integrated Resource Plan: develop a research partnership and study the feasibility of a clean energy portfolio. The existing IRP was a 20-year planning document that contemplates a portfolio extending through 2036 while this task is would extend beyond that and examine two scenarios: - 100% Fossil Free. This scenario refers to energy generated from sources other than fossil fuels, such as coal, natural gas, and oil. - 100% GHG Neutral. This scenario refers to achieving net zero GHG emissions by balancing or offsetting the amount of GHG released through an equivalent over-generation of non-GHG emitting energy sources, or purchase of excess GHG credits. 2. Distributed Energy Resource Integration Study (DERIS): to provide flexibility and reliability to the power system. Growing penetration of Variable Energy Resources (VER) to meet the state mandated 50% RPS goals by 2030 will increase the need for flexibility. By 2030, the client's distribution system is anticipated to host 800 to 1200MW of distributed PV solar generation in addition to large scale PV solar and wind energy resources. One option to minimize these flexibility requirements is to strategically deploy Distributed Energy Resources (DER) to areas where these resources will have the highest beneficial impact. Advisian is identified locations within the service territory where DER deployment integration will provide value to both customers and the grid. Advisian also designed and implemented a survey to collect load data and gauge customer participation in a pilot study.	Advisory, Studies, Preliminary / Feasibility		2017
14	Distributed Energy Resources	Provision of Solar Power for Al Maha Camp	Abu Dhabi	UAE	Middle East	Abu Dhabi Gas Industries Limited (ADNOC Gas Processing – formerly GASCO)	Feasibility and FEED for 1.5 MW solar power for Al Maha Camp at Habshan. The scope includes, PV Technology Selection, Plot Selection, Integration with existing substations at 3 different locations for parallel operation to Grid, Front End Engineering Design, EPC Tender Package.	Technology Assessment, Techno Economic Analysis, FEED, EPC Tender Development		2017
13	Distributed Energy Resources	20 MW Residential Ground Mount Conceptual Layouts	Southern California	USA	North America	Confidential	Worley provided conceptual engineering and layouts for ground mount solar PV plants at three potential residential developments with a goal of 'Zero Net Energy' use.	Conceptual Engineering Consulting Services		2015

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12	Distributed Energy Resources	Efficiency Project		New Zealand	Asia Pacific	Fonterra Cooperative Group Ltd	Energy efficiency support for Fonterra's NZ manufacturing business with energy consumption over 20 PJ per year, delivering more than 15% energy savings over six years. Key experience gained from this project includes: - Large scale energy efficiency projects - Production scheduling tools to curtail loads and reduce peak demand - Investigation, evaluation and optimisation of cogeneration plants - Energy management, data collection, monitoring, target development and reporting using our insite2 Carbon and Energy Management System software. - Worley has been working with Fonterra on their Energy Efficiency Project since 2003. - We have been involved in all aspects of this project, and examples of the initiatives implemented include: - Operational improvements in compressed air on one site have reduced electricity consumption by 24% (110kW), with a further 8% delivered through investment in a new compressor. Commissioned 2007. - A site heat storage loop, costing $3.5m, has saved 10% of site thermal energy use (= 45,000 t steam) and 1.2% of site electricity (=2 GWh). Commissioned 2006.	Consulting, Owner's Engineer Study, Detailed Design		2015
11	Distributed Energy Resources	Ft. Rucker PV Project	Alabama	USA	North America	Southern Company	Phase 2 Permit and Civil design support for 10 MW (AC) ground mount solar PV project to be installed on a US Army base.	Civil Detailed Design Permit Support		2015
10	Distributed Energy Resources	Navy 11 MW Conceptual Ground Mount PV Layouts	California	USA	North America	Confidential	Worley provided conceptual engineering and layouts for ground mount solar PV plants at three Navy bases in California.	Conceptual Engineering Consulting Services		2015
9	Distributed Energy Resources	PVSyst Performance Modeling	California	USA	North America	Confidential	Worley provided PVSyst performance modeling services for 50 MW of a rooftop Solar Photovoltaic Program for 25 sites.	Owner's Engineer, PV Plant Performance Modeling		2015
8	Distributed Energy Resources	REV Market Design & Platform Technology	New York	USA	North America	PSC	Reformed the Energy Vision (REV) - Project Management of 70+ industry leaders for the Market Design and Platform Technology Working Groups, facilitated and managed the room for what began as a very contentious debate between utilities, public representatives and private sector leaders regarding roles, responsibilities, and ownership rights of distributed energy resources (DER) and microgrids. While the conversation started out with polarized opinions, the process was carefully led through hearing out of all sides and eventually reaching consensus on appropriate roles and boundaries between the private sector and regulated utilities for ownership of DER and microgrids.	Consulting, Project Management		2015
7	Distributed Energy Resources	PG&E 150 MW Distributed PV Program	California	USA	North America	Pacific Gas & Electric (PG&E)	PG&E's 150 MW Distributed PV Program is one of the largest PV programs by a US utility. Worley provided the full detailed design for the generic project that formed the basis for the technical requirements for this project and is providing the conceptual integration engineering and procurement assistance for the pilot phase which will eventually lead to the full build out.	Owner's Engineer, Civil and Electrical Design		2014
6	Distributed Energy Resources	130 MW Solar Rooftop Program	California	USA	North America	Confidential	Owner's Engineer services for 130 MW solar rooftop program.	Owner's Engineer, Project Management, Engineering Design		2013
5	Distributed Energy Resources	City of Burbank Parking Structure PV Project	California	USA	North America	Burbank Water & Power	Conceptual design of a 2 MW rooftop PV system located on a new parking structure at the Bob Hope Airport in Burbank, California.	Conceptual Engineering, Pre-FEED		2013
4	Distributed Energy Resources	Large Customer Demand Management	Queensland	Australia	Asia Pacific	Ergon Energy	This engagement included Energy Assessments and Demand Side Management programs and an on-site presence in multiple Ergon client sites to identify demand management and energy efficiency opportunities. Opportunities included: - Load Shedding - Load Shifting - HVAC peak demand reduction - Building Management Systems - Load Profiling And Tariff Analysis - Renewable Energy - Power Factor Correction - Air Conditioning Controllers - Lighting load reduction - In-room displays This engagement with Ergon included developing numerous innovative demand side projects simultaneously, clearly identifying and proving demand and usage savings, and helping Ergon Energy's Commercial and Industrial customers bring these projects to completion rapidly to help defer costly network augmentation.	Consulting		2013
3	Distributed Energy Resources	Veteran's Administration Hospital Rooftop PV Project	Confidential	USA	North America	Confidential	Installation 1.4 MW of Photovoltaic panels on three carport structures.	FEED - Front-end Engineering Design		2013
2	Distributed Energy Resources	Pearl Harbor 12 MW Rooftop PV Project	Hawaii	USA	North America	Pacific Energy Solutions (PES)	12 MW Rooftop PV project designed to balance technology, minimize biological, visual, historical and environmental impact, ease permitting; cost-effectiveness, plant performance, O&M costs, reliability and optimize construction schedule.	FEED		2012

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1	Distributed Energy Resources	Demand Side Participation Trial		New Zealand	Asia Pacific	Transpower	This project provided valuable experience in the development and execution of demand management programs. Specific experience was gained in project management, verification of curtailable loads and load type performance. Transpower ran a two-year trial to test the availability, reliability, contract mechanisms and price for Demand Side Participation (DSP) to defer or manage the construction risk of a grid upgrade or investment. Worley managed the project during winter 2007, including: - Development of regulator funding submission - Design of and development of RFI and RFP processes - Execution of RFI and RFP processes including evaluation of responses and contract negotiations - Assisting customers in timing consumption with commercial incentives - Implementation of the DSP contracts including dispatch of loads, monitoring of responses and working with suppliers to achieve the best possible performance - Verification of supplier reports using techniques developed through our previous work on demand side initiatives and energy exchanges. Over 15MW of DSP load from five different aggregators was contracted and dispatched during winter 2007. The Demand Response contribution to the DSP project was acknowledged with a recognition award from Transpower at the completion of the winter 2007 trial.	Consulting, Owner's Engineer		2007

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53	Microgrids	UCSF Parnassus Central Utilities Microgrid	California	USA	North America	University of California at San Francisco	Advisian Worley is in the 6th year of providing O&M services for the UCSF Parnassus Central Utilities Plant and Parnassus Campus Utilities distribution system. Advisian's services include the safe and efficient operation, maintenance, and repair of the DERs within the microgrid to ensure reliable generation and delivery of thermal energy and electricity to its clients. Advisian Worley has worked closely with UCSF to identify and implement key operational efficiency improvement projects with in- house O&M team analysis and home office engineering support. Examples include: - Steam Turbine Re-Rate Project – identified and presented steam turbine efficiency improvement project to UCSF which resulted in a 46% efficiency improvement with a 3 year project cost payback. Completed in December 2013. - Natural Gas Compressor Controls Retrofit – provided controls design, equipment specification, and construction transition plans for retrofit of problematic Natural Gas Compressor controls system. Completed in November 2012. - Chiller Plant Optimization – identified and implemented chiller plant controls strategies to optimize chiller plant efficiency through DCS programming and plant operational strategies which resulted in a 48% reduction in total chiller plant kW/ton energy consumption with zero capital investment required by UCSF. Completed in August 2013.	Operations & Maintenance		Ongoing since 2011
52	Microgrids	Exmouth Power Station	Western Australia	Australia	Asia Pacific	Horizon Power	Worley developed, designed, procured, built and now operate (through TWPS) this diesel and trucked gas-based power station in Exmouth, approximately 1200km north of Perth. Designed to run on duel fuels to allow for prolonged isolation through cyclonic events, this remote system has also undergone significant control change due to the impacts of roof top PV, which is one of the highest per capita in Australia. This has seen alterations to spinning reserve and control philosophies as well as the inclusion of energy storage within the power system by Horizon Power, the system owner. The power station also received input from a small pilot wind farm built by Verve Energy, trialing tilt down wind turbines for cyclonic areas.	Developed, Detailed Design, Procurement, Construction, Operations & Maintenance		Ongoing since 2005
51	Microgrids	Esperance Hybrid Power Station	Western Australia	Australia	Asia Pacific	Infrastructure Capital Group	Worley developed, designed, procured, built and operates (through Transfield Worley Power Services - TWPS) this islanded hybrid power station, which is the largest in Australia with 5.5MW of wind turbines (installed by others although our nominated Project Director deigned this wind farm component) with 33MW of gas turbines. Worley were responsible for the integration of the renewable energy component into the gas power system in a manner which maintains system stability and maximizes the wind penetration, which averages 23%. This facility has now been operating for nearly 10 years and has been an exceptional success. The wind and its integration were part funded by the Australian Government under its former RRPGP program.	Developed, Detailed Design, Procurement, Construction, Operations & Maintenance		Ongoing since 2004
50	Microgrids	UCLA Energy Services Facility Microgrid	California	USA	North America	University of California at Los Angeles (UCLA)	Advisian Worley (previously doing business as Parsons E&C and Parsons Municipal Services) has provided engineering design and O&M services for the UCLA Energy Services Facility (ESF) microgrid for over 20 years, and is the Engineer of Record for the ESF, the integrated Emergency Services Building (ESB), and the adjacent Facilities Replacement Space building (FRS). Home office engineering support continues to be a key service. Recent examples of projects involving technical design, feasibility studies, and financial projections include: - Central Auxiliary Chiller Plant – Cooling Tower Capacity Study - Auxiliary Boiler – Air Permit Application/Dispersion Modeling - SCAQMD Rule 1146 Compliance – OSHPD engineering for Ultra Low NOx Burner Project - Re-Power Study – Evaluation of Combustion Turbine Replacement Options	Engineering Design, Operations & Maintenance, Engineer of Record		Ongoing for over 20 years
49	Microgrids	Channelview Cogeneration Facility		Texas	North America	Channelview Cogeneration	The Channelview Cogeneration plant is a brownfield 950 MW Siemens F-Class natural gas-fired combined cycle generation facility, located in Channelview, Texas. The plant uses heat recovery steam generators to supply steam to adjacent chemical manufacturing and food processing plants. The plant has been fully operational since 2002 and sells steam and a portion of its electric output under various long-term contracts. Worley is responsible for O&M services for the Channelview facility. Under Worley' management, Channelview has been recognized as one of the cleanest and most efficient plants within the Electric Reliability Council of Texas (ERCOT). The plant uses state-of-the-art environmental protection technology and is fueled by natural gas.	Operations & Maintenance		Ongoing
48	Microgrids	Global Microgrid Partnership		Global	Global	Siemens	Advisian have a global partnership arrangement with Siemens, which includes providing engineering and development resources for micro-grids.	Engineering and Development Support		Ongoing
47	Microgrids	Heywood Hospital Microgrid	Massachusetts	USA	North America	Siemens Energy, Inc.	As a subcontractor, Worley will provide engineering and detailed design including development of primary drawings (P&IDs, single-lines, layouts, etc.) and documents. Worley will also work with a local installation firm to obtain installation pricing. Once the project is developed and a firm EPC price is established, the full project will be presented to the hospital. If the project is approved, Worley will be the turnkey EPC subcontractor to Siemens. The microgrid is expected to have a packaged combined heat & power (~1.1-MW), a battery energy storage system (400-kW / 1200-kWh), and replacement emergency generator system.	FEED		Ongoing
46	Microgrids	Monash University Microgrid and Grid Innovation Hub		Australia	Asia Pacific	Monash University	Advisian is a sponsor of the Monash University Microgrid and Grid Innovation Hub.	Sponsor		Ongoing
45	Microgrids	Multiple Microgrid Technical Evaluations		Australia	Asia Pacific	Australian Renewable Energy Agency (ARENA)	Technical evaluations of around 20 microgrid concepts for multiple confidential companies.	Technical Evaluation		Ongoing
44	Microgrids	Islanded Power Options Studies	Queensland, Western Australia	Australia	Asia Pacific	Multiple Resource and Mining Companies	Worley have undertaken a large range of confidential power option feasibility studies for a number of resource clients in the Pilbara of Western Australia and far north-west Queensland. These have included BHP Billiton, Fortescue Metals Group and Rio Tinto. This has included evaluation of fossil and renewable options, including gas, diesel, solar, wind and hybrid plant including the full design and costing of options, some of which have now been delivered by Worley.	Feasibility Studies, Delivery		Multiple
43	Microgrids	Microgrid and Energy Resilience Studies and the Municipalization of Electrical Service	California	USA	North America		Advisian is providing consulting services to evaluate, develop, and deliver municipal electric utility service and/or microgrids projects to targeted facilities or geographical areas of the City. This includes the concept of targeted investment for partial municipalization ("targeted municipalization") of electrical assets either through acquiring PG&E or other privately-owned assets, or constructing municipal assets.	Advisory, Feasibility Studies		2023
42	Microgrids	Gas Turbine-601 Replacement & Optimization	Alberta	Canada	North America	NOVA Chemicals Canada	Scope of services included evaluation of upgrade to the gas Turbine driver and ancillary equipment at NOVA Ethylene 1 facility. Key drivers of the project include environmental performance, operation variable costs, process safety management deficiency, reliability and to meet future energy requirements for the facility.	Conceptual Engineering/Pre-FEED		2023
41	Microgrids	Spring Lake Village Microgrid Feasibility Study	CA	USA	North America	Covia Communities	Technoeconomic feasibility study for a microgrid for an assisted living community in Northern California. Developed a optimal design to meet the identified requirements of the facility around load, reliability, and islanding. Work included sizing and cost estimate for the design that featured a BESS, incorporation of existing solar PV assets, new solar PV assets, and additional natural gas/diesel generation to enable long-term islanding in the face of California's Public Power Safety Shutoffs.	Study - Pre-Feasibility/Feasibility	May-21	2021

No.	Technology	Project	State or Province	Country	Region	Customer	Description	Services	Start Date	Completion Date
40	Microgrids	Weednanna Gold Iron Hybrid Power	South Australia	Australia	Asia Pacific	Alliance Resources Ltd	Advisian, through the use of the XENDEE modelling software, are considering options for microgrid hybrid power generation at the Weednanna Iron Ore and Gold mine site and associated resident accommodation in Kimba, in remote South Australia. The hybrid scenarios will consider solar PV, onshore wind, battery energy storage systems, and smart grid interconnection. The options will be compared with undertaking operations using a conventional diesel-only power plant arrangement. For the scenarios considered, the optimal sizing of the hybrid system will be determined and a Levelized Cost of Energy will be calculated to determine the hybrid plant's economic viability over a 5-year life.	Consulting	Apr-21	2021
39	Microgrids	Mining Truck Electrification		Confidential	Africa	Confidential	Advisian is working with a confidential customer to define a mine electrification and migration to green mobility concept for a pilot mine site to displace diesel fuel and achieve net zero targets. Project involves evaluation and comparison of battery electric and hydrogen fuel cell mining vehicles, capex & opex modelling, technology benchmark, infrastructure assessment and carbon emission analysis.	Conceptual Engineering/Pre-FEED	Feb-21	2021
38	Microgrids	San Jose DERs Site Prioritization Strategy	California	USA	North America	City of San Jose, California	San Jose engaged Advisian to assess the need and potential for application of DERs or microgrids for 36 sites owned and operated by San Jose. The end result was a strategy for DERs implementation that prioritized sites with the greatest need and the most cost-effective potential for application of DERs.	Consulting - Strategy	Feb-21	2021
37	Microgrids	Additional Microgrid EPC - City of Athens Water Treatment Plant	Ohio	USA	North America	American Electric Power Company, Inc.	Providing resiliency for a city's water supply with water treatment plant microgrid in Ohio; Worley, as prime, is delivering a microgrid under lump sum turnkey EPC to AEP Ohio at City of Athens, Ohio Water Treatment Plant and will include a 250-kW / 1140-kWh BESS, a microgrid control system, a new electrical distribution system, and integration into 230-kW of existing solar PV. Worley will perform the engineering and procurement on the BESS, microgrid control system, and electrical distribution system. Worley will provide a full-time, on-site construction manager, with installation by a local subcontractor.	EPC		2021
36	Microgrids	California State University-Fresno	California	USA	North America	Engie	ENGIE North America entered into a competitive bidding process to build and maintain an campus central utility system including boilers, chillers, solar PV (5 MW), energy conservation measures under a thirty-year concession for the California State University-Fresno campus utility system. Advisian brought together a team of technical and business experts to evaluate the assets, the capital investment plans for those assets, and the O&M of those assets. In addition, the Advisian team supported numerous calls with Lenders to answer questions and give the debt financing community comfort with the viability of the ENGIE offer.	Due Diligence		2020
35	Microgrids	Bringing DES value into large scale LNG precincts	Queensland	Australia	Asia Pacific	Confidential	Worley is progressing an innovative project involving the installation of solar PV and medium scale battery energy storage into the existing gas turbine-based islanded power system of one of Australia's largest LNG compression and export facilities. The role to date has included the concept design, FEED, and procurement for a DES to run in parallel with the existing islanded gas turbine fleet, providing both spinning reserve to allow more efficient gas use and the input of variable renewable energy for greenhouse gas savings. Currently just finishing procurement, the project is now entering deployment.	Conceptual Design, FEED, Procurement		2020
34	Microgrids	Replacing Fossil Fuel Systems with DES based on Renewable Energy	Queensland	Australia	Asia Pacific	Confidential	Advisian and Worley are currently engaged with a major gas producer using the VECKTA platform to investigate and optimize the design of remote gas compression systems power supplies using renewable energy. These will be islanded DES systems, replacing the current gas-based systems, and will include a majority renewable energy supply working alongside battery energy storage. This work has involved the introduction of new techniques into the VECKTA platform to align with the unique circumstances and commercial considerations of this client. This flexibility in evolution is one of the key values that Worley can bring through the VECKTA joint venture, aligning modelling development capability with real world energy system and process experience.	Technical Advisory, VECKTA Optimization		2020
33	Microgrids	City of Riverside Microgrid	California	USA	North America	XENDEE – thru DOE to City of Riverside	Microgrid design for Solar PV and BESS to support critical City Operations facilities. The microgrid is being designed to provide maximum resilience for the City's key operations buildings and will incorporate the existing Diesel Generators with the new Power System components.	Engineering (Phase 1), Expected pull thru to EPC.		2020
32	Microgrids	Columbus Zoo Microgrid	Ohio	USA	North America	American Electric Power (AEP)	Worley, as the prime contractor, will deliver a microgrid under a lump sum turnkey EPC contract to AEP Ohio. The microgrid will be customer-sited at the Columbus Zoo and will include ~130-kWdc of ground-mount solar PV, 560-kW / 1200-kWh BESS, a microgrid control system, and a new electrical distribution system. Worley will subcontract the entire solar effort (engineering, procurement, construction, & commissioning) to a local solar installation firm (Third Sun Solar) and will only perform the engineering and procurement on the BESS, microgrid control system, and electrical distribution system. Worley will provide a full-time, on-site construction manager for all site-based activities. The physical installation will also be subcontracted to Third Sun Solar.	Procurement, Construction, Construction Management, Detailed Design and Engineering, EPC, Commissioning/Start-Up		2020
31	Microgrids	Confidential Microgrid Project		Australia	Asia Pacific	Confidential	Feasibility study for power supply options for a data center.	Feasibility Study		2020
30	Microgrids	Fort Detrick Utility Acquisition	Maryland	USA	North America	Axium Infrastructure US	BlackRock Global Energy & Power Infrastructure sought a buyer for the Fort Detrick Energy Production Facility (EPF), which includes the Central Utility Plant (CUP) that supplies steam, chilled water, and uninterruptable/conditioned electricity supply. It also included the distribution network (steam, condensate return, electricity, and chilled water). Our customer sought to make an offer to buy the EPF as part of a competitive bidding process. Advisian served as its independent engineer to conduct a technical due diligence on the project to inform our customer's investment decision.	Due Diligence		2020
29	Microgrids	Initial Health, Safety, and Environmental Impact Study	California	USA	North America	Element 16 Technologies	Advisian was contracted to identify preliminary Health, Safety, and Environmental (HSE) considerations associated with a conceptual Molten Sulfur Heat Storage and Energy Generation process, which is planned to be upscaled to a demonstration plant for trialing and fine tuning. Advisian's initial scope of services was a desktop review to identify preliminary HSE risks for further consideration as the project design progresses. Advisian team included experts in sulfur handling, thermal energy storage design, and environmental safety.	Study		2020
28	Microgrids	Renewable Energy Options Study		Australia	Asia Pacific	Confidential	A study to look at supplementing current gas-fired generation at a power station with a mix of solar PV, wind, battery storage and the possibility of adding a smaller gas engine for spinning reserve, using the XENDEE systems modelling software. The objective was to find the optimal techno-commercial solutions with an aim to reduce CO2 emissions by 50%. This study was conducted at a high-level to allow an initial screening of scenarios to be undertaken.	Study		2020
27	Microgrids	Resiliency Solar Microgrid	Washington	USA	North America	Seattle City Light	Worley, as the prime contractor, delivered a microgrid under a lump sum turnkey EPC contract to Seattle City Light. The microgrid is customer-sited at the Miller Community Center and includes ~45-kWac of rooftop solar PV, 200-kW / 800-kWh BESS, a microgrid control system, and a new electrical distribution system. Worley will subcontract the entire solar effort (engineering, procurement, construction, & commissioning) to a local solar installation firm (Puget Sound Solar) and will only perform the engineering & procurement on the BESS, microgrid control system, and electrical distribution system. Worley will provide a full-time, on-site construction manager for all site-based activities. All physical installation will also be subcontracted to Puget Sound Solar.	Study – Leveraged XENDEE, Engineering Design, EPC		2020

No.	Technology	Project	State or Province	Country	Region	Customer	Description	Services	Start Date	Completion Date
26	Microgrids	Microgrid Feasibility Study using VECKTA Optimization	Massachusetts	USA	North America	Town of West Newbury	Situation: Feasibility assessment of a municipal campus micro grid comprising police station, fire station, town office, senior citizen home, and a community emergency shelter. Technologies considered included solar PV, battery energy storage system (BESS), diesel generator, combined heat and power (CHP), fuel cells, and microgrid control systems. Approach: Using utility bills from the buildings, the modeling team developed a load profile representing the aggregate demand of the campus. Available roof space and parking lot space for solar canopies was confirmed through a site visit and specifications of all existing equipment were noted, as well as the town's performance goals for the system, which was to enable the microgrid to self-power for at least two weeks. Results: The model showed that the optimal configuration involves utilizing all available solar space, a diesel generator, and a battery energy storage system (BESS). CHP and fuel cells were ruled out as being too expensive. As well as the optimized system, consideration was given to incentives and phasing of the project was recommended to take best advantage of changing technology prices and the relevant policy landscape.	Study, VECKTA Optimization		2019
25	Microgrids	North Farm Condo Complex Microgrid Assessment	New England region	USA	North America	Onyx Renewables	Situation: 320-unit condo association in New England experiencing lengthy power outages at times due to being at the extreme end of a remote peninsula. Approach: Target was to design a microgrid that would provide indefinite ride-through capability with onsite generation. Technologies considered included solar PV, battery energy storage systems (BESS), and natural gas generators. Results: The optimal system for supporting indefinite islanding of the microgrid included 1 large natural gas generator, PV solar, and BESS, sized to support 80% of full load (the critical loads). The system sized for 24 hours of ride through also provided sufficient capacity to self-power indefinitely, however, achieving 100% resiliency in this case came at a slightly higher cost that grid power.	Study, VECKTA Optimization		2019
24	Microgrids	Santa Rosa Junior College Microgrid	California	USA	North America	Santa Rosa Junior College	Santa Rosa Junior College (SRJC) is part of the California Junior College System, the largest college system in the world. They have a number of renewable energy generation sources on their campus and want to turn them into a functioning microgrid. SRJC will integrate a new 2-MW / 2-MWh battery energy storage system (BESS) and a campus-wide microgrid control system to optimize the power generation and distribution across the campus. This installation will also offer resiliency to the campus.	Engineering Design		2019
23	Microgrids	University of Toronto – DC Microgrid	Quebec	Canada	North America	University of Toronto	Situation: This innovative project is a first-of-its-kind DC microgrid comprising existing rooftop solar PV, new battery energy storage systems (BESS), a new DC microgrid controller and new EV charging stations. Approach: The winning technology for this project was available from only one small startup company in the world. To vet the technology Worley's engineers visited the assembly space of the small company (ARDA Power) and examined the hardware and software to be applied. Several BESS providers were vetted. Results: Project is ongoing at this time (Feb. 2019) and will be complete within 10 mo.	Study, VECKTA Optimization		2019
22	Microgrids	H2 Microgrid	Western Australia	Australia	Asia Pacific	ATCO	Solar panels are being installed at ATCO's Operations Centre, capable of generating approximately two and half times the daily power requirements of the facility. Excess renewable energy is used to make hydrogen. This can generate electricity in a fuel cell, be injected into the microgrid as a direct fuel or blended with natural gas. Advisian/Worley's scope includes: concept design, business case and ARENA application for this project. We are the lead technical consultant on Phase 2 & 3 of the Project. Finalising engineering design & procurement (phase 2), installation oversight (phase 3).	Technical Advisory, Conceptual Design, Project Management		2018
21	Microgrids	Industrial Microgrid Campus - USA	Confidential	USA	North America	Confidential	Scope: Industrial campus with three manufacturing facilities, three different owners, each having electrical and thermal loads. Challenge was to optimally size generation and storage assets looking at several scenarios, which included converting existing electric chillers to steam driven chillers vs. leaving those loads as they are; comparisons of four different gas engines and combined heat and power (CHP) units; and comparing a forced choice of 5MW solar PV vs. the model's recommended optimal PV sizing. Approach: Load data and utility data were made available from the end users and energy equipment total installed cost data was drawn from recent project experience. Results: The optimal configuration was to stay with electric chillers and install less than 5MW solar PV, using four generator units of all the same type. Due to the high cost of grid electricity at this site, the cost minimum solution pur-chased no grid electricity and self-powered with solar and natural gas 100% of the time.	Study, VECKTA Optimization		2018
20	Microgrids	Industrial Microgrids - Puerto Rico	Puerto Rico	US territory	North America	Confidential	Scope: Two industrial microgrid sites were assessed using a representative (but not actual) load profile provided by the end user, and considering a mix of solar PV, natural gas, and battery energy storage systems (BESS), under two scenarios for both sites. Approach: The given load data was extrapolated and scenarios were modeled to minimize costs and to minimize CO2 emissions. Results: In the given available areas, the CO2 minimized scenarios were shown to be infeasible due to constraints on how much solar PV could be installed. The cost minimized scenarios used natural gas engines and required less space for PV, allowing the modeled system to meet 100% of loads, providing islanding capabilities, at a cost that was competitive with grid power for these sites.	Study, VECKTA Optimization		2018
19	Microgrids	Technology Campus Microgrids	California	USA	North America	Confidential	Scope: Two microgrids were modeled, incorporating existing solar PV and adding more solar plus battery energy storage systems (BESS) to allow both microgrids to function independently of each other and of the macro grid. Approach: Load data from the sites was analyzed along with production data from existing solar PV and tariff data from the utility to achieve the optimal system. Results: For both buildings, modeling showed economic and resiliency advantages of adding solar PV and BESS.	Study, VECKTA Optimization		2018
18	Microgrids	University Campus Assessment	Confidential - midwest State	USA	North America	Confidential	Scope: Initial assessment of the feasibility of a solar powered campus microgrid for a portion of the campus of a large mid-western university. Approach: Load data was provided from the buildings to be included, which along with utility tariff data and technology costs enabled optimization of the energy assets. Results: The model showed savings potential of over 35% on energy costs and CO2 reductions of over 60% while improving campus power reliability and resilience.	Study, VECKTA Optimization		2018
17	Microgrids	Monash University Microgrid		Australia	Asia Pacific	Monash University	Power system analysis of a Solar PV, Battery storage and Electric Vehicle Microgrid installed at Monash University for demonstration and research purposes.	Technical Analysis		2017
16	Microgrids	Ohio State University Comprehensive Energy Management Project	Ohio	USA	North America	Axium Infrastructure	The Ohio State University (OSU) Comprehensive Energy Management Project includes operation and optimization of the university's utility system and construction of a new Energy Advancement and Innovation Center for energy research. The system features district energy networks, which are among the most efficient and cost-effective ways to reduce the carbon footprint. The 50-year concession valued at $1.165 billion USD will provide the university with $250 million worth of energy infrastructure upgrades necessary to make the entire campus more energy efficient, plus provide access to cutting-edge research into new technologies. Worley, serving first as Transaction Advisor and then transitioning to Lender's Engineer, assisted ENGIE, a global energy company, and Axium Infrastructure, an investment company, in their joint winning bid to address OSU's energy sustainability goals. Both ENGIE and Axium expressed strong satisfaction with Worley' work on this project.	Transaction Advisor, Lender's Independent, Engineer		2017

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15	Microgrids	DeGrussa Mine Solar / Battery / Diesel Microgrid Project	Western Australia	Australia	Asia Pacific	Australian Renewable Energy Agency (ARENA)	Advisian was engaged by ARENA to conduct project due diligence and lender's engineer services which covered both the technical and commercial merits of this novel project which saw the integration of 11 MW of PV and a 4 MW Li-ion battery into the existing 19 MW diesel fired power station at the Degrussa gold and copper mine. The study examined the ability of PV and batteries combined to offset the diesel fuel source which is expensive in such remote locations. The positive result of the study led to ARENA investing AUD20.9M in the project, the first large-scale use of PV and battery in such a remote resource grid. As the independent project certifier, services included monitoring and reporting to project parties, certifying milestone payments under the EPC contract and all funding agreements, compliance reviews, as well as ad hoc technical and commercial support.	Project Assessor / Independent Certifier		2016
14	Microgrids	NYPrize	New York	USA	North America	NYSERDA	Process management, rules development, and advisory services on valuation models for community microgrids, for NYPrize, the first-of-its-kind $40M state incentive designed to stimulate community microgrid development in New York.	Consulting		2016
13	Microgrids	Huntlee Development Microgrid Concept Review		Australia	Asia Pacific	LWP Property Group	Advisian undertook the initial concept review of a fully autonomous utility model for this 25,000 person urban development.	Conceptual Review		2015
12	Microgrids	Microgrid Cost-Benefit Analysis & Feasibility Studies Massachusetts, USA	New York	USA	North America	Confidential	Microgrid Advisory - Guidance on conceptual technical design of community microgrids and business models for return on investment accounting for local tariff structures in New York State. This project included assessment of 2 possible community microgrid sites located in the service areas of 2 different utilities having different approaches to billing for contract demand charge and energy use. The viability of the potential projects was closely related to the rate structures of the utilities in question. Through the study the potential impacts of the projects were modeled using both financial and nonfinancial metrics. The selected sites were entered into a competitive process for state funding of further feasibility studies and both projects received funding.	Consulting		2015
11	Microgrids	REV Market Design & Platform Technology	New York	USA	North America	PSC	Reformind the Energy Vision (REV) - Project Management of 70+ industry leaders for the Market Design and Platform Technology Working Groups, facilitated and managed the room for what began as a very contentious debate between utilities, public representatives and private sector leaders regarding roles, responsibilities, and ownership rights of distributed energy resources (DER) and microgrids. While the conversation started out with polarized opinions, the process was carefully led through hearing out of all sides and eventually reaching consensus on appropriate roles and boundaries between the private sector and regulated utilities for ownership of DER and microgrids.	Consulting, Project Management		2015
10	Microgrids	REV Working Group	New York	USA	North America	PSC	Within New York's Reforming the Energy Vision (REV) Proceeding, served as Community Microgrids Working Group Lead to facilitate discussion, align stakeholders, and extract insights from the process to design new regulations and incentives pertaining to microgrids.	Consulting		2015
9	Microgrids	TransGrid iDemand Project		Australia	Asia Pacific	TransGrid	This project involved the installation of 98kW of PV, a 400kWh Lithium Polymer battery, and both DC and AC LED lighting, as part of a trial of peak lopping technologies at the TransGrid Sydney West terminal. Worley undertook the concept design and initial modelling for the project, which is now in operation and which has produced the sites peak demand by around 50%.	Conceptual Engineering Consulting		2014
8	Microgrids	Weipa Power Station	Queensland	Australia	Asia Pacific	Rio Tinto	Worley worked with the asset owners of the Weipa Power Stations which supply electricity to the Weipa Township, East Weipa Bauxite Mine and the Andoom Bauxite Mine located in a remote part of Australia – Cape York. Worley provided power system engineering expertise and support including load flow, generator stability analysis, fuel optimization and protection system analysis.	Engineering		2014
7	Microgrids	Daly Waters PV / Diesel / Demand Side Management Project	Northern Territory	Australia	Asia Pacific	Power and Water Corporation	Worley was involved in two aspects of this Project which was investigating the optimization of the diesel/PV/load interaction for this remote community which was being considered for 250kW of PV supply. This included demand side management and tariff/billing arrangements. The first role was providing advice on the Project program in terms of maximizing Federal funding involved and outcomes, while the second role was peer reviewing and editing the "Solar/Diesel Mini-grid Handbook", which was a Knowledge Sharing deliverable required under ARENA funding.	Advisory, Peer Review		2013
6	Microgrids	Chatham Islands Wind / Diesel Hybrid Grid Stability Study	Chatham Islands	New Zealand	Asia Pacific	CBD Energy	Worley were engaged by CBD Energy to undertake Investigations into the expected power system performance of the installation of two 200kW wind turbine generators to provide power to this island community diesel system, which is one of the most isolated in the world being approximately 700km south-west of New Zealand.	Study		2009
5	Microgrids	Coral Bay Wind/Diesel/ Storage Project		Australia	Asia Pacific	Verve Energy(now Synergy)	Worley provided the Project Director for this high penetration hybrid power system of 2.2MW of diesel and three 275kW tilt down Vergnet wind turbines, as well as a flywheel energy storage system, which was installed in 2007. This project averages more than 50% renewable penetration, and at times over 95%. Work included project approvals, modeling, stakeholder management, specifications, EPC procurement, owners engineering and operational scrutiny. Scope included management of an Australian Government RRPGP grant, which supplied 30% of the total capital expenditure for the project.	Project Director		2007
4	Microgrids	Hopetoun Wind/ Diesel Project	Western Australia	Australia	Asia Pacific	Verve Energy(now Synergy)	Worley provided the Project Manager for this hybrid system consisting of two 600kW wind turbines integrated into a 2.2MW diesel power station. This role included responsibility for land acquisition, siting, all environmental approvals, concept design, procurement (through an single EPC contract), construction and commissioning.	Project Director		2006
3	Microgrids	Rottnest Island Wind / Diesel / Desalination Project	Western Australia	Australia	Asia Pacific	Rottnest Island Authority	Worley provided the Project Director for this high penetration hybrid power system which was bid as an EPC project. This involved the integration of a 600kW wind turbine into the existing power system, which included the installation of low load diesel generators and dynamic grid management devices to control system stability as well as the novel use of switchable water desalination to increase the amount of diesel fuel saved (demand management).	Project Director		2005
2	Microgrids	Denham Wind Turbine	Western Australia	Australia	Asia Pacific	Verve Energy(now Synergy)	Worley provided the Project Manager for this hybrid system consisting of three 300kW wind turbines into the existing remote diesel-based power station of Coral Bay. Situated within the Shark Bay World Heritage area, this project involved a significant approvals and planning process which included both Federal and State agencies, as well as significant technology development involving the trial of low-load diesel and energy storage technology to drive increased fuel savings. This also involved management of a number of Federal and State Government grants which were used to build the facilities.	Project Director		2003
1	Microgrids	Exmouth Mini-Wind Farm Western Australia	Western Australia	Australia	Asia Pacific	Verve Energy(now Synergy)	Worley provided the Project Director and wind farm designer for this small, pilot scale wind farm built in Exmouth to test tilt down wind turbines in a cyclonic zone. This project, funded by the Federal Government, fed power into the Exmouth diesel power station operated by Worley.	Project Director, Design Operations		2002

No.	Technology	Project	State or Province	Country	Region	Customer	Description	Services	Completion Date
5	Smart Grids	Mining Truck Electrification		Confidential	Africa	Confidential	Advisian is working with a confidential customer to define a mine electrification and migration to green mobility concept for a pilot mine site to displace diesel fuel and achieve net zero targets. Project involves evaluation and comparison of battery electric and hydrogen fuel cell mining vehicles, capex & opex modelling, technology benchmark, infrastructure assessment and carbon emission analysis.	Conceptual Engineering/Pre-FEED	2021
4	Smart Grids	Weednanna Gold Iron Hybrid Power	South Australia	Australia	Asia Pacific	Alliance Resources Ltd	Advisian, through the use of the XENDEE modelling software, considered options for microgrid hybrid power generation at the Weednanna Iron Ore and Gold mine site and associated resident accommodation in Kimba, in remote South Australia. The hybrid scenarios considered solar PV, onshore wind, battery energy storage systems, and smart grid interconnection. The options compared undertaking operations using a conventional diesel-only power plant arrangement. For the scenarios considered, the optimal sizing of the hybrid system was determined and a Levelized Cost of Energy calculated to determine the hybrid plant's economic viability over a 5-year life.	Study	2021
3	Smart Grids	Smart Wires Pilot Project	California	USA	North America	Los Angeles Department of Water & Power (LADWP)	LADWP is considering a pilot installation of SmartWires technology. Based on the location, Advisian reviewed studies required to ensure reliability of the bulk power system. The team, 1. Developed the SmartWires scope of works for transmission planning studies. We provided a list of studies and model requirements for SmartWires to perform, including: - Steady state analysis - Voltage stability - Short Circuit analysis - Harmonic injection analysis - Subsynchronous Control Interaction studies (SSCI) - Subsynchronous Torsional Interaction studies (SSTI) - Harmonic Control Instability 2. Reviewed and provided comments on the study reports provided by Smart wires. Conducted independent studies as required.	FEED, Conceptual, Preliminary Engineering	2020
2	Smart Grids	Baltimore Smart City Evaluation	Maryland	USA	North America	Constellation Energy, an Exelon Company	As an enhancement to extension of street lighting, provided identification and assessment of smart technologies through application of mesh networks and Internet of Things (IoT) technology including advanced lighting, security, parking, and enhanced data access. Engagement with technology vendors and city stakeholders to build decision and financial models.	Conceptual Design, Economic Analysis, Advisory	2018
1	Smart Grids	Review of Green Grid Study		New Zealand	Asia Pacific	Ministry of Business Innovation and Employment (MBIE)	Advisian was retained to be one of two expert reviewers of the government's funding of the Green Grid programme which looks into significantly enhancing the use of renewable energy, and the development if smart grids to manage the intricacies of accommodating significant volumes of intermittent generation. The ultimate outcome of the project is to ensure that New Zealanders have access to reliable, safe, and affordable renewable energy. The review involved considering the future work programme and the quality of the published and unpublished research from both a technical and economic stand point. Having completed the review, a report was prepared for MBIE and Government, making recommendations on future work for the research project, and various government agencies impacted by project outcomes – policy and regulatory changes. In addition, a recommendation was made for future funding by both Government and industry.	Technical Advisory	2017

No.	Technology	Project	State or Province	Country	Region	Customer	Description	Services	Completion Date
6	Electric Vehicles	Mining Truck Electrification		Confidential	Africa	Confidential	Advisian is working with a confidential customer to define a mine electrification and migration to green mobility concept for a pilot mine site to displace diesel fuel and achieve net zero targets. Project involves evaluation and comparison of battery electric and hydrogen fuel cell mining vehicles, capex & opex modelling, technology benchmark, infrastructure assessment and carbon emission analysis.	Conceptual Engineering/Pre-FEED	2021
5	Electric Vehicles	Melbourne Electric Bus Depot Feasibility Study	Victoria	Australia	Asia Pacific	EnergyAustralia Pty Ltd	Addition of electric charging infrastructure to an existing bus depot to allow conversion of bus fleet from diesel to electricity.	Study - Bankable/ Definitive Feasibility	2021
4	Electric Vehicles	Greenhouse Gas Abatement Study		Australia	Asia Pacific	Confidential	Our customer has committed to a goal of Net Zero Emissions by 2050. As a part of this, they committed to eliminate 900 million litres per annum of diesel use at their mine sites, which accounts for 43% of the operations CO2-e emissions. Advisian was required to review the current operations to determine the current diesel fuel use on site and to develop concepts for reduction and elimination of diesel use on site by 2040. Advisian assessed multiple technologies for electrification of the operations though: - Trolley assist (overhead power system for wire-to-wheel) and trailing cable - Alternative fuels such as the capture of fugitive methane from the mines (compressed natural gas duel fuel system) - Hydrogen and zero-carbon fuels i.e. biofuels and hydrogen-based fuels such as blue diesel and Dimethyl Ethers (DME's). - Power generation on site with two cases - 100% behind the meter renewables and 30% behind the meter renewables + 70% green energy from the grid under PPA Outcome - The project has the potential to offset between 56.1Mt of CO2-e through electrification or 84.2Mt of CO2-e through the capture and use of fugitive methane and use of compressed natural gas as a fuel across the customer's assets.	Study	2020
3	Electric Vehicles	EV Charging Stations Project		New Zealand	Asia Pacific	Confidential	Worley was contracted to provide engineering, construction and commissioning of EV charging stations at multiple locations in New Zealand. Installations included office locations in the city and hydrocarbons site installation in safe areas. Construction work packs were produced that included all standard deliverables such as MTO, Declaration of Conformity to relevant standards, Electrical protection change control documentation and standard drawings including stand design etc.	Engineering, Construction, Commissioning	2018
2	Electric Vehicles	Adelaide City Transport Strategy	South Australia	Australia	Asia Pacific	Adelaide City Council	Advisian and the Research Centre for Integrated Transport Innovation (rCITI) - University of New South Wales, are working with Adelaide City Council to develop a long-term smart transport strategy. The strategy will describe how the City can position itself to manage disruption, grab the opportunity presented by all the technology evolving at this time, and ensure it maximises value for money from any investment it makes.	Strategic, Business Case, Commercial and Financial Advisory	2017
1	Electric Vehicles	Potential Impacts of New Energy on Victorian Distribution Businesses and the Technical Regulatory Environment	Victoria	Australia	Asia Pacific	Energy Safe Victoria	As the responsible safety regulator, Energy Safe Victoria needed to understand the implications of the rapid and widespread uptake of new energy technologies. Advisian conducted a comprehensive study that included an examination of the rapid uptake of EVs, their impacts on the grid and potential use as energy storage and transmission devices. The report found that the widespread uptake of EVs will act as an accelerant for the changes already being seen in the shift to new energy.	Technical Analysis	2016

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42	BESS	3 PV with BESS Projects		Queensland, South Australia & New South Wales	Australia	Asia Pacific	Confidential	Three parallel projects integrating PV and BESS with focus on load arbitrage and grid support services. Total of 635MW PV and 800MWh BESS.	Owners Engineering and Strategy Support services, Technical specification provision, Technology Assessment. Due Diligence	Ongoing
41	BESS	Commercial BESS Program	Los Angeles, San Francisco, New York City	California, New York	USA	North America	Romeo Power Technology	Consulting, conceptual engineering, and permitting support for the installation of lithium-ion battery energy storage systems in commercial buildings. The installation would include five (5) in New York City, two (2) in San Francisco, and one (1) in Los Angeles. Each BESS would be in the range of 100-kW to 200-kW, with a 2 – 4 hour duration. Efforts included site walkdowns, conceptual layouts and single-lines, certification support for the BESS provider, project planning, development of detailed permitting process reports, including key relationships with city agencies, utilities, and certification partners to ensure successful permitting, interconnection and implementation in accordance with applicable fire and safety codes and with the client's accelerated timeline for deployment.	Engineering Design, TA/OE (pre NTP), Permitting	Ongoing
40	BESS	EPRI Utility Battery Storage Cost Estimates			USA	North America	Electric Power Research Institute (EPRI)	Conceptual level study to develop and compare cost estimates for commercially available electrochemical electricity storage technologies and compare their lifecycle costs. As part of this study, Advisian reached out to a number of battery vendors to obtain current performance and cost data. This information was used to develop the complete system costs including the batteries, invertors, transformers and other equipment. The lifecycle costs were compared utilizing various metrics calculated from a custom economic model.	Study, Cost Estimate	Ongoing
39	BESS	Searcy PV Power Project with BESS		Arkansas	USA	North America	Entergy	Advisian was contracted to develop a Li-Ion Battery Energy Storage Systems (BESS) specification for inclusion of scope book for a utility scale project. Specification to include the minimum required performance, desired performance characteristics and operating ranges, performance testing requirements, required codes and standard, equipment and system warranties and training requirements. Additionally, certification requirements, approved vendors and listing agencies for major equipment.	Technical Advisory	Ongoing
38	BESS	Solar BOT (Build-Own-Transfer) Various Project Technical Support & Self Build Solar Groundmount and Rooftop Projects including BESS		Multiple locations	USA	North America	Confidential	Advisian started supporting the Customer on their Build-Own-Transfer (BOT) projects. Advisian supported the development and review of the technical specifications for the BOT projects. Advisian performed preliminary technical review of various proposals to highlight any technical concerns or environmental permits/ compliance. Once bidders were selected, Advisian continued serving the Customer as Owner's Engineer for a 100MW PV ground mount project, two 100MW PV ground mount projects and a 50MW PV project. Additionally, Advisian is also the technical advisor on several self-build projects, including a 100MW PV ground mount, solar rooftop projects and Battery Energy Storage System (BESS). The scope of work for the various projects includes developing or updating technical specifications, particularly the solar PV and BESS specifications. Conceptual design development and review, performance review and cost estimates.	Conceptual Engineering, Technical Advisory, Owner's Engineer	Ongoing
37	BESS	Exmouth BESS Owners Engineer	Exmouth	Western Australia	Australia	Asia Pacific	Exmouth Power Station	After completing two previous phases of screening and conceptual studdies, Advisian was re-engaged by the client (Exmouth Energy) to support them in the procuremenet and construction of a small BESS into the existing thermal power station. The purpose of the BESS is to allow additional uptake in rooftop solar in the community to provide more resiliancy to the system and remove some of the strain on the thermal generation units.	Owners Engineer	2022
36		Technical advice for Loy Yang BESS	Loy Yang	Victoria	Australia	Asia Pacific	AGL Energy Limited	Advisian will provide written technical advice as to whether we consider the BESS development project will have a material impact on the supply reliability. The focus of this response will be independent advice that can be provided to Basslink.	Consulting - Capital Project Advisory	2021
35	BESS	Mining Truck Electrification			Confidential	Africa	Confidential	Advisian is working with a confidential customer to define a mine electrification and migration to green mobility concept for a pilot mine site to displace diesel fuel and achieve net zero targets. Project involves evaluation and comparison of battery electric and hydrogen fuel cell mining vehicles, capex & opex modelling, technology benchmark, infrastructure assessment and carbon emission analysis.	Conceptual Engineering/Pre-FEED	2021
34	BESS	Solar PV and Battery Feasibility Study	Booragoon	Western Australia	Australia	Asia Pacific	City of Melville, Western Australia	Assess the best sites and size of solar PV with battery storage to be installed using XENDEE software.	Engineering	2021
33	BESS	Upstream Next Gen - Green Battery Manufacturing Facility	Confidential	Confidential	Confidential	Europe	Confidential	Worley will be a part of Europe's first large-scale battery factory with the aim of producing the world's greenest batteries. As part of the first stage of development, our Stockton-UK office was awarded the concept study for the upstream facility where Active Cathode Material (ACM) will be produced for later use in the downstream building for battery cell production.	Conceptual Engineering/Pre-FEED	2021
32	BESS	Synergy Big Battery Project	Perth	Western Australia	Australia	Asia Pacific	Synergy	Tender Engineering for the large scale BESS.	Engineering	2021
31	BESS	Weednanna Gold Iron Hybrid Power	Kimba	South Australia	Australia	Asia Pacific	Alliance Resources Ltd	Advisian, through the use of the XENDEE modelling software, considered options for microgrid hybrid power generation at the Weednanna Iron Ore and Gold mine site and associated resident accommodation in Kimba, in remote South Australia. The hybrid scenarios considered solar PV, onshore wind, battery energy storage systems, and smart grid interconnection. The options compared undertaking operations using a conventional diesel-only power plant arrangement. For the scenarios considered, the optimal sizing of the hybrid system was determined and a Levelized Cost of Energy calculated to determine the hybrid plant's economic viability over a 5-year life.	Study	2021
30	BESS	Liddell Power Station BESS and Switchyard Advisory		New South Wales	Australia	Asia Pacific	AGL Power Generation Pty Ltd	Advisan his providing advise on the technical merits of two installation options for a battery energy system at Liddel Power Station. Technical merits relate to harmonics minimisation and whether the additional cost is warranted and recommended to achieve a technical advantage. Additional scope includes the technical specification for updates to the connecting switchyard (including circuit breakers etc.), and creation of several Single Line Diagrams. Follow-on work will include an initial 500MW battery assessment.	Consulting - Capital Project Advisory	2021
29	BESS	Lafarge Solar BESS Engineering	Calgary	Alberta	Canada	North America	TransAlta Corporation	Scope to develop multiple design and EPC options and pricing for a Solar/ BESS installation at a cement plant. Options included a 150MW solar with 42MWh BESS, the second option was a 25MW solar with a 42MWh BESS.	Engineering	2021
28	BESS	27MW/23MWhr Battery plus 3MW of Solar PV at an Australian LNG Facility			Australia	Asia Pacific	Confidential	The LNG Battery Energy Storage and Solar (BESS) project involves integration of a 27MW/23MWhr battery plus 3MW of solar PV generator into an existing LNG facility power network. The objective of the project is to allow one of the existing gas turbines used for power generation at the LNG plant to be taken out of service for significant proportion of the time. This will reduce power generation costs, CO2 production and fuel gas consumed for power generation making this gas available for additional LNG production. Worley provided sup-port to the project through the Assess and Select phases and was recently undertaking EPCM for the FEED/Define phase of the project until it was placed on hold by the Customer due to COVID and Oil price uncertainties. The expected annual savings from the project is in the order of 600 TJ additional LNG production and 30+ kTonnes CO2e saved.	Project support, EPCM	2020

No.	Technology	Project	City	State or Province	Country	Region	Customer	Description	Services	Completion Date
27	BESS	Owners Engineering for a 40MW PV & 78MWH Battery			Australia	Asia Pacific	Ergo Mining (Pty) Ltd	Worley reviewed the proposed solution and the PPA to help address risks of the project.	Owner's Engineer	2020
26	BESS	Replacing fossil fuel systems with DES based on renewable energy		Queensland	Australia	Asia Pacific	Confidential	Advisian and Worley are currently engaged with a major gas producer using the VECKTA platform to investigate and optimize the design of remote gas compression systems power supplies using renewable energy. These will be islanded DES systems, replacing the current gas-based systems, and will include a majority renewable energy supply working alongside battery energy storage. This work has involved the introduction of new techniques into the VECKTA platform to align with the unique circumstances and commercial considerations of this client. This flexibility in evolution is one of the key values that Worley can bring through the VECKTA joint venture, aligning modelling development capability with real world energy system and process experience.	Technical Advisory, VECKTA Optimization	2020
25	BESS	Maryland Solar PV BESS TIC Cost Estimate		Maryland	USA	North America	Constellation NewEnergy, Inc.	Using VECKTA optimization software, Worley assisted this customer in determining the optimal Solar PV plant size (MW) and TIC cost estimate based on various project drivers.	Plant Sizing and EPC Cost Estimate, VECKTA Optimization	2020
24	BESS	Bringing DES value into large scale LNG precincts		Queensland	Australia	Asia Pacific	Confidential	Worley is progressing an innovative project involving the installation of solar PV and medium scale battery energy storage into the existing gas turbine-based islanded power system of one of Australia's largest LNG compression and export facilities. The role to date has included the concept design, FEED, and procurement for a DES to run in parallel with the existing islanded gas turbine fleet, providing both spinning reserve to allow more efficient gas use and the input of variable renewable energy for greenhouse gas savings. Currently just finishing procurement, the project is now entering deployment.	Conceptual Design, FEED, Procurement	2020
23	BESS	Colusa Battery Charger Study,	San Francisco	California	USA	North America	Pacific Gas & Electric (PG&E)	Advisian was retained by PG&E to increase station reliability in the event of a Public Safety Power Shutoff affecting the station's offsite AC power supplies. The Colusa plant would maintain the STG 125VDC battery's charging circuit if the station loses AC power. Advisian added a transfer switch and appropriate circuit protections to the battery's 480VAC charging circuit and have a trailered 480VAC generator tied into the 480VAC bus. Our scope included the following: - Load and generator sizing - Transfer switch (manual) selection, sizing, and location - Generator interface selection, sizing, and location - Cable sizing - Raceway and circuit routing - Major equipment bill of material - Charger controls	FEED, Conceptual, Preliminary Engineering	2020
22	BESS	Energy Storage Studies			Netherlands	Europe	Confidential Client	A high-level study on batteries and electrolyzers for green hydrogen in industry, both being an option to be used as ancillary grid services. The battery option will also be compared to competing technologies with comparable capacities, for example CHP's and gas turbines.	Study	2020
21	BESS	Expert Witness Guam Solar + Storage Bid			Guam, US Territory	Asia Pacific	Engie North America	Advisian supported a dispute on a bid by one of the bidders in Guam by providing expert witness testimony on the 30 MW solar PV and storage project.	Advisory	2020
20	BESS	Horn Rapids BESS Project	Richland	Washington	USA	North America	Energy Northwest	Greenfield project comprising of a 1MW/4MWh battery system, PCS, controls cabinet and 480V switchgear to connect into a 500 kW solar PV facility. Worley is responsible for coordinating major equipment vendor, construction vendor, and other stakeholders to deliver this project. Solution: - Integrate engineering design with another firm to deliver an overall design package. - Responsible for all aspects of a lump sum turn-key EPC project Customer Benefits: 25 year performance guarantee on the BESS	EPC	2020
19	BESS	Large Scale BESS			Australia	Asia Pacific	ElectraNet & AGL	In 2014, Worley initiated a project to drive the first use of large scale energy storage as an enabler for higher penetration of variable renewable energy within the National Electricity Market – known as the Energy Storage for Commercial Renewable Integration (ESCRI) project. This project eventually involved a consortium of ElectraNet, AGL and Worley in the building of an innovative Battery Energy Storage System (BESS) at Dalrymple, in South Australia. This was fully commissioned in 2018 and is now operational and can be viewed live at www.escri-sa.com.au. Worley undertook the majority of the early technical assessment and procurement, including project managing the feasibility, and provided light owners engineer services during construction and commissioning. Advisian now reports on asset operation. The asset provides both market facing (arbitrage, caps and FCAS services), as well as regulated services (fast frequency response and unserved energy), including the ability to island together with the 90MW Wattle Point Wind Farm during transmission level faults, therefore creating a microgrid until grid supply is installed.	Technical Evaluation, Procurement, Model-ling, System Integration, Technology Selection Business Case Preparation, Operational Performance	2020
18	BESS	Renewable Energy Options Study			Australia	Asia Pacific	Confidential	A study to look at supplementing current gas-fired generation at a power station with a mix of solar PV, wind, battery storage and the possibility of adding a smaller gas engine for spinning reserve, using the XENDEE systems modelling software. The objective was to find the optimal techno-commercial solutions with an aim to reduce CO2 emissions by 50%. This study was conducted at a high-level to allow an initial screening of scenarios to be undertaken.	Study	2020
17	BESS	Resiliency Solar Microgrid	Seattle	Washington	USA	North America	Seattle City Light	Worley, as the prime contractor, will deliver a microgrid under a lump sum turnkey EPC contract to Seattle City Light. The microgrid will be customer-sited at the Miller Community Center and will include ~45-kWac of rooftop solar PV, 200-kW / 800-kWh BESS, a microgrid control system, and a new electrical distribution system. Worley will subcontract the entire solar effort (engineering, procurement, construction, & commissioning) to a local solar installation firm (Puget Sound Solar) and will only perform the engineering & procurement on the BESS, microgrid control system, and electrical distribution system. Worley will provide a full-time, on-site construction manager for all site-based activities. All physical installation will also be subcontracted to Puget Sound Solar.	Study, Engineering Design, EPC	2020
16	BESS	Santa Rosa Junior College		California	USA	North America	Santa Rosa Junior College	Situation: Campus microgrid to serve a college system that integrates existing solar PV, adds more PV, battery energy storage systems (BESS), and natural gas generation. Approach: Historical load data, utility cost data, and recently quoted energy technology costs were included in the model to determine the cost optimal system that also minimizes CO2 emissions and ensures resiliency for at least 24 hours of ride through. Results: Modeling identified the optimal sizes of the PV, BESS, and natural gas engines to be added to the existing system accounting for existing generation and load profile.	Study	2019

No.	Technology	Project	City	State or Province	Country	Region	Customer	Description	Services	Completion Date
15	BESS	Assessing Government Grant Funding for BESS – ARENA			Australia	Asia Pacific	Australian Renewable Energy Agency (ARENA)	Both Advisian and Worley have provided more than five years' service to ARENA, including providing the Chairperson of the ARENA Advisory Panel from 2015 until December 2019, and continues to provide technical assessors and undertake due diligence on an ad-hoc basis. Our staff have assessed more the 500 projects for ARENA, including many in deep technical and commercial due diligence, with more than 20 in the BESS area including smaller, urban and small commercial behind the meter systems, up to large, transmission level systems including those providing both market and grid services.	Technical Advisory, Due Diligence	2019
14	BESS	Ensham Coal Mine Renewables Pre-feasibility Study			Australia	Asia Pacific	Idemitsu Australia	Following a previous scope of work on energy and GHG emissions, Advisian was re-engaged by Idemitsu in 2018 to conduct a series of high-level assessments on renewable energy technologies. This involved a pre-feasibility study at both their Ensham and Boggabri mines and a feasibility study at their Muswellbrook mine. Several renewable energy technologies were considered across all sites with solar PV and battery proving front-runners at Ensham and Boggabri whilst Muswellbrook was well situated for a pumped hydro, solar PV and wind hybrid generation and storage facility. - The assessments involved a site visit and selection, concept design, technical optimization and financial analysis. Based on these findings, Advisian made recommendations to the client regarding next steps in the various developments. The study also considered additional revenue streams and costs savings through potential export, and on-site consumption for the client and in partnership with developers and investors.	Feasibility and Pre-feasibility Studies, Conceptual Design, Technical and Financial Assessment	2018
13	BESS	Grid Edge Project	Eugene	Oregon	USA	North America	Eugene Water & Electric Board (EWEB)	Lump sum, EPC approach to install 500-kW / 1000-kWh of battery energy storage systems (BESS) at the Howard Elementary School in Eugene, Oregon, USA. The installation is to provide further resiliency to the school during weather events, as well as additional value streams / benefits when able.	Engineering, Procurement, Construction, Commissioning	2018
12	BESS	Hinds Battery Energy Storage Project		Mississippi	USA	North America	Entergy	Advisian was contracted to develop a Li-Ion Battery Energy Storage Systems (BESS) minimum functional specification for a standalone pilot facility to connect to an existing distribution network that includes a 500 kW PV plant. Specification to include the minimum requirements based on the BESS specification previously developed for Client with additional inclusion of civil/structural and ancillary systems necessary for a standalone system.	Technical Advisory	2018
11	BESS	Alice Springs Energy Storage			Australia	Asia Pacific	Confidential	Advisian was appointed to support the Client to recover project schedule. A full project review was conducted to baseline the current status, to focus effort to complete design, compile the project documentation and resolve Client matters, expedite procurement and to ready the project for construction. Some minor design elements were also completed.	Owner's Engineer and Project Manager during execution	2017
10	BESS	Confidential 250 MW Solar PV with Battery Energy Storage		Confidential	USA	North America	Confidential Customer	A preliminary design study and interconnection application for a large-scale 250 MW PV generation power plant with battery energy storage system (BESS). The analysis included optimizing the size of both the BES and PV to meet client operational specifications throughout the year. A conceptual design accompanied the optimization which was used for the development of the interconnection application and project description for the battery vendor RFI.	Study, Conceptual Design, Interconnection Application	2017
9	BESS	Energy and GHG Emissions for 3 Mine Sites - Board White Paper			Australia	Asia Pacific	Idemitsu Australia	Advisian investigated Energy and Greenhouse Gas (GHG) policies, risks and abatement opportunities for Idemitsu's Australian coal operations at Ensham, Boggabri and Muswellbrook. This work followed a Green Paper on GHG risks presented to the Board in January 2017, which recommended additional work to explore opportunities for action in more detail. The outcome was a set of opportunities ranging from efficiency improvements, fuel switching and renewable energy self generation projects. These ranged from rooftop solar PV installations to conversion of diesel haul trucks to LNG.	Board Paper	2017
8	BESS	Simple Behind the Meter PV Augmentation for a Coal Mine	Hunter Valley		Australia	Asia Pacific	KEPCO	Advisian undertook complete technical and commercial feasibility for the addition of behind-the-meter solar PV as grid supply augmentation for KEPCO for the proposed Bylong Valley coal mine in the Hunter Valley of New South Wales. This work included the technical design, the inclusion of and business case around energy storage, all technical studies including those associated with grid connection, the merits of exporting into the National Electricity Market (NEM), project sizing, technology selection, all environmental and planning studies, cost and schedule estimates, reporting and the consideration of funding sources. While the coal mine was ultimately knocked back in State planning approval, the feasibility was positive and showed that solar PV could provide a commercial case in a behind-the-meter DES configuration.	Technical and Commercial Feasibility Study	2017
7	BESS	Solar Farm with Battery Energy Storage - Grid Connection Studies			Australia	Asia Pacific	Confidential	Advisian was engaged to complete grid connection studies for a new solar and battery storage project.	Studies	2017
6	BESS	DeGrussa Mine Solar / Battery / Diesel Microgrid Project		Western Australia	Australia	Asia Pacific	Australian Renewable Energy Agency (ARENA)	Advisian was engaged by ARENA to conduct project due diligence and lender's engineer services which covered both the technical and commercial merits of this novel project which saw the integration of 11 MW of PV and a 4 MW Li-ion battery into the existing 19 MW diesel fired power station at the Degrussa gold and copper mine. The study examined the ability of PV and batteries combined to offset the diesel fuel source which is expensive in such remote locations. The positive result of the study led to ARENA investing AUD20.9M in the project, the first large-scale use of PV and battery in such a remote resource grid. As the independent project certifier, services included monitoring and reporting to project parties, certifying milestone payments under the EPC contract and all funding agreements, compliance reviews, as well as ad hoc technical and commercial support.	Project Assessor / Independent Certifier	2016
5	BESS	PV / BESS / Fuel Cell Assessment			USA	North America	Confidential	Worley provided a detailed technical assessment, CAPEX and OPEX comparisons of the three technologies operating in generation mode only for 1, 3, 5 and 10 MW configurations fueled by natural gas and biomass syn gas.	Owner's Engineer	2016
4	BESS	Energy Storage Feasibility Study for South Australia		South Australia	Australia	Asia Pacific	Australian Renewable Energy Agency (ARENA)	The project involved a study for the implementation of a small utility-scale (3-30 MW) Battery Energy Storage System in South Australia. A formal RFI was issued to all global BESS Integrators and providers to obtain current technology information as well as pricing, performance, guarantees, and technology paths. A financial analysis was performed on the project which is a services arbitrage model in a deregulated electricity market.	Owner's Engineer, Conceptual Design, Cost Estimate	2015
3	BESS	2 MW (4 MWhr)Feasibility Study	Central Valley		California	North America	Calpine	Worley provided small scale BESS technology evaluation and testing criteria.	Owner's Engineer, Conceptual Design, Cost Estimate	2014
2	BESS	100 MW (400 MWhr) BEES Project	Southern California	California	USA	North America	Calpine	Worley provided Owner's Engineer services including design analysis of Customers nominated large scale battery Vendor and the conceptual design of the utility-scale BOP including Site arrangements, battery housing (main structure, foundations, HVAC, lighting, and fire protection), substation interconnection plus a detailed cost estimate.	Owner's Engineer, Conceptual Design, Cost Estimate, 20% Design for Cost Estimate	2013
1	BESS	100 MW ES Project in Southern California	Southern California	California	USA	North America	Calpine	Provided balance of plant and network interconnection conceptual design and cost estimate for a utility-scale 2 x 50 MW (4 hours) battery energy storage facility.	Owner's Engineer, Conceptual Design, Cost Estimate	2013

No.	Technology	Project	State or Province	Country	Region	Customer	Description	Services	Completion Date
10	General Energy Storage	Remote Islanded Ppower Station Operations: Exmouth (9 MW), Coral Bay (2,2 MW), Yarnima (190 MW), Esperance (38 MW)	Western Australia	Australia	Asia Pacific	Synergy, BHP and Infrastructure Capital Group	Worley is involved with the asset management, operations and maintenance of a range of islanded power systems in Western Australia for a number of clients including mining operations, through the joint venture company TW Power Services (www.twps.com.au). This 50/50 joint venture is between Worley and Broadspectrum and operates around 14,000 MW of plant in total. These remote power systems include those with significant wind energy input, including Esperance (6.6 MW of wind into gas turbines) and Coral Bay (825 kW into diesel recips). Worley is examining using VECKTA in the addition of further renewable energy and energy storage into some of the currently operated systems.	Asset Management, Operations & Maintenance	Ongoing
9	General Energy Storage	HAZOP - Flow battery	Zuid-Holland	Netherlands	Europe	Vopak Europe & Africa BV	Consulting study fow Flow batteries.	Study	2021
8	General Energy Storage	Solar and Storage Model		Australia	Asia Pacific	Confidential	Advisian developed a model that optimised the combined operation of the solar plant and energy storage system.	Conceptual Design, Advisory	2017
7	General Energy Storage	20MW Fringe of Grid Solar Plus Energy Storage Project		Australia	Asia Pacific	Confidential	Development support of this project in terms of the use PV on the fringes of grid systems for both supply of energy and network support. This involves considering the project in terms of the regulatory aspects of network ancillary services at distribution level, the development of the technology required and the basic functional specification of such an asset.	Owner's Engineer, Advisory	2017
6	General Energy Storage	100% Clean Energy Portfolio	California	USA	North America	Los Angeles Department of Water and Power (LADWP)	A qualitative and investigative study to provide the technical inputs for the financial feasibility of the utility achieving a 100% clean energy portfolio. The study identified the major building blocks of various renewable energy, clean energy, and energy storage options including potential capacity estimates, conceptual designs, and nominal performance. This project shows the breadth of Advisian's experience and understanding of clean energy options and their development.	Study	2017
5	General Energy Storage	Potential Impacts of New Energy on Victorian Distribution	Victoria	Australia	Asia Pacific	Energy Safe Victoria	Advisian delivered two reports to meet the customer's need for a high level understanding into the potential impacts of developments in embedded renewable generation and energy storage technology on the Victorian distribution business and the technical regulatory environment over the next 15 years. - Stage 1 Report: Impacts on the regulatory interfaces between the existing grid and the emerging technologies, the reliability of supply, and the impact on energy safety. - Stage 2 Report: Development of potential scenarios ranging from single dwelling uptake to wholesale adoption of new technologies such as communities opt to go 'off grid' or develop power villages, ad-hoc uptake by individual consumers of embedded generation and storage, large uptake of electric vehicles etc.	Technical Analysis	2016
4	General Energy Storage	TransGrid Grid Scale Energy Storage		Australia	Asia Pacific	TransGrid	Worley/Advisian provided an overview of range of grid-scale storage technologies currently available in the market, covering current cost, cost projections, ability to deliver different applications (primarily to meet peak demand requirements and ancillary services), performance capability, technology maturity, high-level operational and maintenance requirements and case studies. Worley/Advisian provided a cost estimate of battery grid-scale storage technologies currently available in the market, covering current cost, cost projections, performance capability, high-level operational and maintenance requirements. This work was used to support the specification and procurement of a pilot energy storage plant of approximately 1 MW, 4 hour rating.	Feasibility Study, Technology Survey	2015
3	General Energy Storage	TransGrid iDemand Project		Australia	Asia Pacific	TransGrid	This project involved the installation of 98kW of PV, a 400kWh Lithium Polymer battery, and both DC and AC LED lighting, as part of a trial of peak lopping technologies at the TransGrid Sydney West terminal. Worley undertook the concept design and initial modelling for the project, which is now in operation and which has produced the sites peak demand by around 50%.	Conceptual Engineering Consulting	2014
2	General Energy Storage	Energy Storage Technologies	South Australia	Australia	Asia Pacific	South Australian Government	Worley examined the economic potential for energy storage technologies that are envisaged to strengthen the viability of connecting additional wind generation in South Australia. Analysis of both large and small scale schemes were carried out. Large scale schemes included Hydro Pumped Storage, Compressed Air Energy Storage, Gas Pipeline Compression. Small scale storage schemes included Battery storage (Sodium-Sulphur, Vanadium Redox, RedFlow, Nickel Cadmium, Lead acid and Lithium Ion) and mechanical storage through fly wheels.	Economic and Technical Analysis	2011
1	General Energy Storage	Energy Storage Feasibility for South Australia	South Australia	Australia	Asia Pacific	Commissioner for Renewable Energy	Worley developed a pre-feasibility study into large scale (50-500 MW) energy storage options for surplus wind generation on the Eyre Peninsula in South Australia. The pre-feasibility study is to stimulate private equity and financing interest for the cost effective options which could proceed to a full feasibility study and environmental assessment. Storage options covered included vanadium redox and lead acid batteries; hydro pumped storage; sea water pumped storage; compressed air energy storage; and off-shore compressed air energy storage. The study also investigated development potential and impact on existing transmission systems.	Consulting	2011

No.	Technology	Project	City	State or Province	Country	Region	Customer	MW	Description	Services	Start Date	Completion Date
6	Compressed Air Energy Storage	Compressed Air Storage Technology Roadmap		California and othes	USA, Australia, other	Multiple	Roland Berger LLC	100-300	Technical assessment of adiabatic compressed air storage and technical comparison with other long duration storage technologies. Develop a roadmap on the potential evolution of CAES technology over the next 15-20 years. Also, identified key risks that might derail the commercialization of the technology.	Consulting	Jun-21	2021
5	Compressed Air Energy Storage	Assessing Government Grant Funding for CAES – ARENA			Australia	Asia Pacific	Australian Renewable Energy Agency (ARENA)		Both Advisian and Worley have provided more than five years' service to ARENA, including providing the Chairperson of the ARENA Advisory Panel from 2015 until December 2019, and continues to provide technical assessors and undertake due diligence on an ad-hoc basis. Our staff have assessed more the 500 projects for ARENA, including many in deep technical and commercial due diligence, with around 5 in the CAES area including various storage mediums, adiabatic systems, and novel concepts such as the use of flooded underground mine sites for such..	Technical Advisory, Due Diligence	2015	2019
4	Compressed Air Energy Storage	300MW CAES Project		California	USA	North America	Pacific Gas & Electric (PG&E)		Worley provided Owner's Engineering services consisting of modelling of candidate depleted natural gas reservoirs, CAES technology assessments, and conceptual engineering of a 300 MW CAES plant. The work included development of performance specifications for the planned reservoir test facility, conceptual design and cost estimate of the surface compression/generation plant. The study is funded by the DOE ARRA Smart Grid Stimulus Program, the CPUC, and the California Energy Commission.	Owner's Engineer, FEED, Cost Estimates, 30% Detailed Design		2015
3	Compressed Air Energy Storage	150MW CAES FEED Study		New York	USA	North America	New York State Electric & Gas (NYSEG)		Worley developed surface plant designs and cost estimates to compare two CAES technologies. This project, which would have been located on an aquifer/cavern, was part of the DOE ARRA Smart Grid Stimulus program.	Consulting, Study, FEED, Cost Estimates		2011
2	Compressed Air Energy Storage	100-300MW CAES Feasibility Study		California	USA	North America	Pacific Gas & Electric (PG&E)		Provided feasibility study for CAES configurations (100 through 300 MW) to determine optimal plant capacity and cost estimate	Consulting, Conceptual Engineering, Cost Estimates		2010
1	Compressed Air Energy Storage	270MW CAES Conceptual Design		Texas	USA	North America	Confidential Customer		Investigated and provided preliminary conceptual design and cost estimate for a 270 MW CAES project located on a domal salt reservoir in Texas.	Consulting, Conceptual Engineering, Cost Estimates		2010

No.	Technology	Project	State or Province	Country	Region	Customer	Description	Services	Completion Date
16	Cold TES	Confidential Combined Cycle Project		Confidential location	Confidential	Confidential	Evaluation of Thermal Energy Storage based Inlet cooling for 550 MW CC plant based on 10 blocks of 2x1 7FA gas turbines.	Feasibility Study	Ongoing
15	Cold TES	PP#10 CC Project, Saudi Arabia		Saudi Arabia	Middle East	Saudi Electricity Company (SEC)	Evaluation of Thermal Energy Storage based Inlet cooling for 3,700 MW CC plant based on 10 blocks of 4x1 7EA gas turbines.	Feasibility Study	Ongoing
14	Cold TES	DOE FOA 2001 Cold TES Study	North Carolina	USA	North America	The University of North Carolina at Charlotte	Use of new technology for thermal energy storage - we will be supporting conceptual engineering and techno-economic analysis.	Conceptual Engineering/Pre-FEED	2023
13	Cold TES	Thermal Energy Storage Analysis (Valley and Apex)	California	USA	North America	Los Angeles Department of Water and Power (LADWP)	LADWP selected Advisian (Worley Group) to [1] assess existing plant facilities for ability to accommodate a new thermal energy storage system (chillers and chilled water tank for gas turbine air inlet cooling), [2] determine impacts and effect on performance of plant operations, and [3] perform economics analysis to determine advisability of making such an investment. LADWP and Worley also completed a comparative analysis of other energy storage options and facility improvements. Key Achievements included developing tools to perform involved and complicated economic analysis.	Conceptual Engineering, Pre-FEED, Engineering	2017
12	Cold TES	Qatar D IWPP, Qatar		Qatar	Middle East	GS Construction	Evaluation of various configurations including Turbine Inlet Cooling with TES for a 2,400 MW, 130 MIGD power and desalination Plant .	Feasibility Study	2014
11	Cold TES	Waad Al Shamal Project		Saudi Arabia	Middle East	Saudi Electricity Company (SEC)	Evaluation of various inlet cooling option include TES for a 1,200 MW CC plant.	Feasibility Study	2014
10	Cold TES	Qatar D IWPP Qatar		Qatar	Middle East	GS Construction	Evaluation of various configurations including Turbine Inlet Cooling with Thermal Energy Storage (TES) for a 2,400 MW, 130 MIGD power and desalination Plant .	Feasibility Study	2014
9	Cold TES	Confidential Screening Study		USA	North America	Confidential	Evaluation of various TIAC Options with TES) and operating scenario with a 1,500 MW CC plant.	Owner's Engineer services including front end studies	2014
8	Cold TES	Confidential Combined Cycle Project		USA	North America	Confidential	Evaluation of various advanced class gas turbines (F, thru' J) with chillers including thermal Energy storage) for a nominal 800 – 1200 MW CC plant.	Owner's Engineer	2013
7	Cold TES	Confidential Combined Cycle Project		Saudi Arabia	Middle East	Confidential	Evaluation of cooling options (evap cooler vs Chillers with and without Thermal Storage) for various advanced class gas turbines (F, thru' H) for nominal 4,000 MW CC plant (Four blocks of 3x1 configuration).	EPCM	2013
6	Cold TES	Calpine Oneta Energy Center based 1300MW CCGT plant in Oklahoma 2 x Blocks of 2x1 and GE 7FA.03	Oklahoma	USA	North America	Calpine Operation Services Inc. (COSCI)	FS and conceptual cost estimation for adding inlet chillers including Thermal Energy Storage to 4 x GE 7FA.03 gas turbines. Study evaluated BOP systems, site specific constraints, electrical system, generator cooler issues etc.	Pre-FEED Study	2012
5	Cold TES	Aramco Cogen Plants (Abquaiq, Hawiyah and Ras Tanura Refineries		Saudi Arabia	Middle East	Aramco	Evaluation of Chiller Options with Thermal Energy Storage (TES) for 3 Cogen plants ranging from 130 - ~400 MW.	Proposal Engineering Support	2012
4	Cold TES	Calpine Baytown Energy Center SIEMENS SGT65000FD3 based 3X1 CCGT Project - Pre-FEED	Texas	USA	North America	Calpine Operation Services Inc. (COSCI)	Feasibility Study of Gas Turbine inlet Chilling – power augmentation with and without thermal energy storage (existing project). Scope included evaluating BOP issues covering generator cooling aspects, auxiliary cooling systems etc.	Pre-FEED Study	2012
3	Cold TES	Calpine Baytown Energy Center SIEMENS SGT65000FD3 based 3X1 CCGT Project, OE	Texas	USA	North America	Calpine Operation Services Inc. (COSCI)	EPC Functional specification development and bid evaluation. For Thermal Energy Storage (TES) System.	Owner's Engineer	2012
2	Cold TES	Nine Mile 6	Louisiana	USA	North America	Entergy	2x1 GE 7FA.04 550 MW nominal Combined Cycle Power Project. Study included direct and TES systems.	Feasibility Study and Economic Evaluation	2011
1	Cold TES	Ontelaunee CC Plant		USA	North America	LS Power	2x1 560 MW CC plant with Siemens 501FD gas turbine. Study included both absorption and mechanical chiller with and without Thermal Energy Storage (TES).	Feasibility Study	2007

No.	Technology	Project	State or Province	Country	Region	Customer	Description	Services	Completion Date
49	Hot Thermal Energy Storage	Likana 600 MW Tower CSP Project		Chile	Latin America	EIG Investors	Worley is performing Technical Advisory services for Likana Central Tower project (expected to consist of 3 plants and up to 600 MW of total capacity). Worley developed the functional specification for the central tower plants and the TES system including technical requirements, guaranteed values and acceptance and final tests. The objective of these plants is to generate electricity during the night, so the TES molten salt system will provide >10 h storage.	Technical Advisory	Ongoing
48	Hot Thermal Energy Storage	Cerro Dominador / Atacama I 110MW CSP Project		Chile	Latin America	EIG Investors /Cerro Dominador	Worley is providing both Technical Advisor and Owner's Engineering services (engineering review) for the 110 MW CSP Tower project (with 17.5 h of molten salts storage) in the Atacama Desert during the Construction phase.	TA/OE (Pre NTP), Owner's Engineer (Post NTP)	Ongoing
47	Hot Thermal Energy Storage	Shagaya Renewable Energy Project		Kuwait	Middle East	Kuwait Institute for Scientific Research (KISR)	Worley is providing both Project Management and Owner's Engineering for the delivery of a 50 MW solar thermal, a 10 MW photovoltaic and a 10 MW wind farm in a special precinct of Kuwait. The TES system is able to store 1200 MWh_{th} equivalent to 10 h storage (37,000 Tn of molten salts).	Owner's Engineer, PMC Site Services, O&M monitoring	Ongoing
46	Hot Thermal Energy Storage	100 MW CSP Redstone Project		South Africa	Africa	ACWA Power / SolarReserve (consortium)	Worley has been awarded a contract to perform Owner's Engineering services for the Redstone Project. The project is currently on hold.	Owner's Engineer, Technical Advisory	On hold
45	Hot Thermal Energy Storage	Assessing Government Grant Funding for HTES – ARENA		Australia	Asia Pacific	Australian Renewable Energy Agency (ARENA)	Both Advisian and Worley have provided more than five years' service to ARENA, including providing the Chairperson of the ARENA Advisory Panel from 2015 until December 2019, and continues to provide technical assessors and undertake due diligence on an ad-hoc basis. Our staff have assessed more the 500 projects for ARENA, including many in deep technical and commercial due diligence, with more than 10 systems involving various HTES technologies, including phase change materials, immiscible solids, carbon blocks, concrete and more traditional molten salt systems.	Technical Advisory	2015 - 2019
44	Hot Thermal Energy Storage	5MW FEED & Estimate	California	USA	North America	Heliogen, Inc.	FEED and CAPEX estimate for 5MW CSP-tower (w/TES) & PV Hybrid project.	FEED - Front-End Engineering Design	2022
43	Hot Thermal Energy Storage	ENDURE Consulting	Colorado	USA	North America	National Renewable Energy Laboratory (NREL)	Consulting for long-duration grid-connected patented energy storage technology. Involves TES and heat engine discharge system.	Consulting - Other	2022
42	Hot Thermal Energy Storage	HT TES & Materials Consulting	Colorado	USA	North America	National Renewable Energy Laboratory (NREL)	Teaming with NREL and CO School of Mines, project is analyzing hot molten salt TES tank design, fabrication and NDE techniques, with goal of improving long-term reliability and making ASME code revision recommendations. DOE funded.	Asset Services	2022
41	Hot Thermal Energy Storage	DOE Gen3 CSP Advanced High Temperature TES Analysis		USA	North America	NREL (DOE)	A DOE-funded 3-year study focused on reducing costs of next-gen chloride salt (~750°C) CSP TES system (referred to as Gen3 by DOE). Advisian will perform conceptual design and cost estimating of a novel confidential TES system with the purpose of reducing next-gen liquid TES costs.	Technical Consulting, Conceptual Design, Cost Estimating, Advanced Analysis (FEA)	2022
40	Hot Thermal Energy Storage	Electro-Thermal Energy Storage Pilot Project and Commercialization Technology Consulting		Confidential location	Confidential	Malta Inc.	Malta's energy storage system takes electricity, converts and stores that electricity as heat, and then converts it back to electricity. In charge mode, the system operates as a heat pump, storing electricity as heat in molten salt. In discharge mode, the system operates as a heat engine, using the stored heat to produce electricity.	Technical Consulting, Cost Estimating	2022
39	Hot Thermal Energy Storage	Noor Energy 1 700MW CSP Tower & Trough and 250MW PV project	Dubai	UAE	Middle East	Noor Energy 1 P.S.C. (Consortium between DEWA and ACWA Power)	Owner's Engineer for the largest hybrid solar energy project in the world, being built by a consortium of the Dubai Electricity and Water Authority (DEWA) and ACWA Power. The project consists of a 100MW solar thermal tower, a 600MW parabolic trough solar thermal plant, and a 250MW solar photovoltaic plant. The project also has 15 hours of molten salt thermal energy storage allowing the solar energy to be stored and used when required by the Dubai grid. The plant can therefore also be operated as a baseload plant.	Owner's Engineer	2022
38	Hot Thermal Energy Storage	DOE Gen3 CSP Gas-Phase FEED		USA	North America	Brayton Energy	Brayton Energy is leading the R&D and commercialization of a gas phase next-gen (referred to as Gen3 by DOE) CSP-tower technology that uses sCO_2 as both the heat transfer and power cycle motive fluid (via a closed-loop Brayton Cycle). The technology incorporates novel low-cost particle TES. Advisian is Brayton's partner on the FEED of a pilot project, as well as technical consultant on the commercialization. The project is funded by the DOE.	Technical Consulting, FEED, Cost Estimating	2021
37	Hot Thermal Energy Storage	Technology Pre-Feasibility Study	Confidential	USA	North America	Confidential	TES technology R&D, screening/feasability study, technoeconomic analysis.	Conceptual Engineering/Pre-FEED	2021
36	Hot Thermal Energy Storage	Novel TES Insulation Panel Design	Colorado	USA	North America	National Renewable Energy Laboratory (NREL)	Lab-scale next-gen TES tank/system design & testing support.	Detailed Design & Engineering	2021
35	Hot Thermal Energy Storage	CST & TES Demo Plant	Confidential	Confidential location	Confidential	Heliogen, Inc.	Conceptual engineering and feasibility level capital cost estimating for ultra-high temperature CST + TES demonstration project. Stored heat will be used by a 3rd parties' propriety petrochemical plant.	Feasibility Study	2020
34	Hot Thermal Energy Storage	Initial Health, Safety, and Environmental Impact Study	California	USA	North America	Element 16 Technologies	Advisian was contracted to identify preliminary Health, Safety, and Environmental (HSE) considerations associated with a conceptual Molten Sulfur Heat Storage and Energy Generation process, which is planned to be upscaled to a demonstration plant for trialing and fine tuning. Advisian's initial scope of services was a desktop review to identify preliminary HSE risks for further consideration as the project design progresses. Advisian team included experts in sulfur handling, thermal energy storage design, and environmental safety.	Study	2020
33	Hot Thermal Energy Storage	DOE Gen2 CSP Advanced TES Analysis		USA	North America	NREL (DOE)	A DOE-funded study focused on reducing costs of "conventional" nitrate salt TES systems (referred to as Gen2 by DOE). Advisian performed confidential system conceptual re-design and cost estimating, including analyzing confidential unique insulation system, with the purpose of reducing near-term TES costs.	Technical Consulting, Conceptual Design, Cost Estimating, Advanced Analysis (FEA)	2020

No.	Technology	Project	State or Province	Country	Region	Customer	Description	Services	Completion Date
32	Hot Thermal Energy Storage	TES HSE Pilot Project Screening Study		Confidential location	Confidential	Element 16	Element 16's TES technology is based on liquid sulfur vs molten nitrate salt. Advisian performed a high-level health safety & environmental (HSE) study, and technology design review for E16's pilot project.	Technical Consulting	2020
31	Hot Thermal Energy Storage	Confidential		China	China	Confidential	Nominal 1 MWe molten salt-trough CSP-hybrid demonstration project. Scope included heat/mass balance, P&IDs, equipment & salt piping procurement specifications, preliminary detailed salt piping design.	Consulting, Technical Advisor, Detailed Design	2019
30	Hot Thermal Energy Storage	1414 Degrees Due Diligence		Australia	Asia Pacific	ARENA	Performed high-level due diligence of 1414 Degrees' molten silicon TES technology (yes, 1414°C!)	Technical Consulting, Advisory	2018
29	Hot Thermal Energy Storage	Yumen 50MW Trough CSP Project with Storage		China	China	North China Engineering Power (NCPE)	Engineering Design review and Project Management assistance. The scope of work is focused primarily on the review of the non-conventional systems of the plant (solar field, HTF system, and storage system) and the firefighting system. It will also oversee the integration of the conventional part (in particular the power island) within the rest of the systems. Silicon oil is used instead of HTF as the thermal fluid.	Technical Advisory	2018
28	Hot Thermal Energy Storage	Feasibility Study for Achieving 15% K-Companies Electricity Consumption by 2020		Kuwait	Middle East	Kuwait National Petroleum Company	Worley is performing Feasibility Study and FEED services for a solar energy facility to consist of a blend of solar and storage technologies. CSP technology with molten salt TES system was considered due to grid stability issues.	Feasibility Study	2018
27	Hot Thermal Energy Storage	Hot & Cold TES Systems Techno-economic Analysis		USA	North America	Google (Alphabet)" X", The Moonshot Factory	Google X was the incubator of the Malta energy storage concept/company, performing R&D, component development, technology de-risking, technoeconomic analyses, etc. Alphabet then spinoff Malta Inc. as a private company (see above).	Preliminary engineering, cost estimating	2017
26	Hot Thermal Energy Storage	Gansu Jinta 100MW CSP Tower Project with Storage		China	China	China Three Gorges New Energy Co., Ltd	Technical advisory services including feasibility study, tender package development and bid evaluation for the non-conventional systems of a 100 MW molten salt tower project in China including heliostat field, solar receiver, tower, and molten salt system.	Feasibility Study, Technical Advisory	2017
25	Hot Thermal Energy Storage	Jemalong Solar Station #1	New South Wales	Australia	Asia Pacific	VASTSolar	Nominal 30 MW greenfield tower project with 4 hours of thermal storage. Supported VASTSolar with conceptual engineering (with focus on thermal storage, steam generation and plant engineering & design) and overall project cost estimating for the purposes of submitting estimate to project funding partners. Worley also formulated the project's governance framework, and undertook the Project Director's role as part of the overall project steering committee.	Consulting, Owner's Engineer, Cost Estimating	2016
24	Hot Thermal Energy Storage	CSP Hybrid Review & Evaluation Study		USA	North America	Electric Power Research Institute (EPRI)	Feasibility study covering an overview of existing global CSP-Hybrid plants, as well as a techno-economic analysis (LCOE) of advanced ISCC plants using parabolic trough technology with molten salt HTF.	Feasibility Study, Conceptual Engineering Cost Estimates	2016
23	Hot Thermal Energy Storage	Central Enerstar Maria Elena One (CEME-1)		Chile	Latin America	Enerstar	70 MW parabolic trough CSP with 14 hour TES and 70 MW PV. The main deliverables of the project included: - Heat & Mass Balance - Water consumption estimates and balance - Solar Field design - Thermal Energy Storage design and optimization - Power block design - Generation estimates and production scenarios - Interconnection studies - Cost estimation - Environmental permitting TES was also critical to the feasibility by providing process heat to the adjacent mining operations which required 24hr supply.	Feasibility and Technology, Assessment, Conceptual Design, Cost Estimating, EIA Technical Support, Process Water Heating Study	2016
22	Hot Thermal Energy Storage	Khi 50 MW CSP Plant		South Africa	Africa	Abengoa	Direct steam Concentrated Solar Power (CSP) plant, with 200m Tower technology. Worley' scope includes OE and technical advisory services for the construction of the plant including: - Technical support: contract management, claim management, scheduling, connection to the grid, performance tests and plant acceptance tests - HSE support - Entire review of detailed engineering - Construction and commissioning supervision. The thermal energy is used to produce superheated steam, which drives a 50 MW steam turbine. The plant includes a TES system (water/steam accumulators) that allows the generation of electricity for 2.5 equivalent h after the sunset.	Owner's Engineer	2016
21	Hot Thermal Energy Storage	Perenjori Dispatchable Solar Thermal Power Project	Western Australia	Australia	Asia Pacific	Australian Renewable Energy Agency (ARENA)	Undertook the Milestone 3 review of this project, which was essentially a review of the project's Final Report, covering site selection and assessment, design of major engineering elements, performance calculations, operations and maintenance plan, economic analysis.	Technical Review	2015
20	Hot Thermal Energy Storage	Tamarugal CSP & PV Project	Tamarugal	Chile	Latin America	SolarReserve	Basic engineering services to support the completion of the Environmental Impact assessments and to develop preliminary design documents.	Engineering Services	2015
19	Hot Thermal Energy Storage	Rice 150 MW CSP Plant	California	USA	North America	Cobra	Detailed Design and Engineering for a 150 MW CSP plant, with Tower technology and molten salts thermal energy storage (TES) system.	Design Engineering and Design	2015

No.	Technology	Project	State or Province	Country	Region	Customer	Description	Services	Completion Date
18	Hot Thermal Energy Storage	Kaxu 100 MW CSP Plant		South Africa	Africa	Abengoa	CSP plant, with parabolic trough collector technology with molten salts thermal energy storage (TES) system. Worley' scope includes OE and technical advisory services for the construction of the plant including: - Technical support: contract management, claim management, scheduling, connection to the grid, performance tests and plant acceptance tests - HSE support - Entire review of detailed engineering - Construction and commissioning supervision Worley conducted site supervision and PMC services for the molten salt system (2.5 h storage), which included engineering review, tank fabrication inspection, salt melting and tanks pre-heating supervision, HEX installation, and overall commissioning and performance test witnessing.	Owner's Engineer	2015
17	Hot Thermal Energy Storage	NOOR III Ouarzazate 100 MW Solar Tower Project – Phase 2		Morocco	Africa	EDF Energies Nouvelles	Worley provided technical advisory services for the NOOR III 100 MW Solar Tower plant including: technical review of Minimum Functional Specification and gap analysis; identification of additional technical requirements; preparation of the complementary technical specification based on the gap analysis; evaluation of technical EPC proposal and technical support during the bidding process.	Technical Advisory	2014
16	Hot Thermal Energy Storage	Various projects - Provinces of Ciudad-Real, Toledo, Badajoz and Murcia, Spain		Spain	Europe	SolarReserve	Worley provided technical advisory and environmental services to complete the permitting on the 50 MW solar thermal tower projects, including: site selection / site environmental evaluation, stakeholder engagement (regional authorities and land owners), Environmental Impact Assessment (EIA), permit application, ensuring environmental compliance.	Environmental Support	2013
15	Hot Thermal Energy Storage	Redstone 100MW CSP Project		South Africa	Africa	SolarReserve	Worley provided technical advisory services for the 100 MW CSP Redstone project involving technical review of the existing documentation; preparation of the RFP for the EPC tendering process; EPC Technical Specification on the basis of existing FEED and technical advice during the RFP preparation process and successful completion of the entire EPC Tender Package within a 6-week time span enabling SolarReserve to complete the tender process for bid submission within Round 3 ("Third CSP Bid Submission") of the REIPPP Program.	Technical Advisory	2013
14	Hot Thermal Energy Storage	Ouarzazate 160MW Solar Power Project		Morocco	Africa	Moroccan Agency for Solar Energy (MASEN)	Assessment of resource, site analysis, capital cost and operations costs of multiple technologies that would be considered for a program to install 2000 MW of solar generation in country through 2020. Conceptual design, bid evaluations and customer assistance in selecting bidder for initial 160 MW project phase. Total install expected to reach 500 MW in 2015.	Technical Advisory, Conceptual Engineering	2013
13	Hot Thermal Energy Storage	Kalahari Solar One Project	Northern Cape	South Africa	Africa	Group Five and Kumba	Owner's Engineer for 75 MW parabolic trough plant with 7 hours thermal energy storage.	Owner's Engineer for prefeasibility and feasibility to financial close	2013
12	Hot Thermal Energy Storage	100 MW Power Tower	Arizona	USA	North America	US Dept. of Energy National Renewable Energy Laboratory (NREL)	Investigation of a 100 MW molten salt power tower project with 6hr of TES. Conceptual engineering, capital cost estimating, detailed plant material breakdown. NREL used the results to update System Advisor Model (SAM) and perform a detailed project life cycle assessment.	Conceptual Engineering, Cost Estimating	2012
11	Hot Thermal Energy Storage	Solar Tower Permitting	Northern Cape	South Africa	Africa	SolarReserve	Prefeasibility of 3 potential power tower projects in South Africa. Environmental permitting including grid interconnection design and permitting, water supply and discharge, plant licensing with regulator.	Environmental Permitting	2011
10	Hot Thermal Energy Storage	150 MW Solar Generation Framework		Oman	Middle East	Public Authority for Electricity and Water (PAEW)	150 MW. Provided CSP technology assessments, site location and evaluations, performance modeling, generation of Minimum Functional Specification, RFI preparation, participation in RFI review, other contractual analysis. The option of powering a desalinization plant with solar venerated steam also included.	Project Management, Conceptual Engineering	2011
9	Hot Thermal Energy Storage	Termosol 1 & 2		Spain	Europe	FPL Energy	2 x 50 MW parabolic trough. In country environmental permitting support and environmental monitoring during construction.	Preliminary Engineering, Environmental Permitting, Environmental Monitoring	2011
8	Hot Thermal Energy Storage	Confidential		California	North America	Wilson Turbo-Power, Inc.	A 200kW demonstration project for proof of concept for Wilson's Brayton Cycle CSP design. The demonstration project concentrated sunlight from a collector field of self-powered, wireless controlled heliostats onto an optical receiver atop an 80 foot tower. Compressor discharge air from a conventional gas turbine is heated in the receiver and expanded through the turbine for power generation. Supplemental natural gas firing is used to achieve standard turbine inlet temperatures. The turbine genset recovers waste heat in a regenerator. Thermal energy storage extends operating hours and mitigate transient effects. The project was funded by the DOE.	Balance of Plant Design , Tower Design, Thermal Energy Storage Design	2011
7	Hot Thermal Energy Storage	Cinco Casas 50MW Solar Thermal Tower Project		Spain	Europe	SolarReserve	Worley provided all the environmental services to complete permitting on the 50 MW solar thermal tower project. Worley prepared preliminary engineering to support permitting and a completed front end engineering (FEED) to support bidding the project. This included preliminary plans, specifications, and a complete design basis to support the project.	Preliminary Engineering, Environmental Permitting	2010
6	Hot Thermal Energy Storage	Crescent Dunes 100MW Solar Energy Project	Nevada	USA	North America	SolarReserve	SolarReserve requested the feasibility evaluation of value engineering concepts, conceptual design, and design basis documents for a 100 MW tower CSP plant with molten salt technology.	Design Basis Preliminary, Engineering	2010

No.	Technology	Project	State or Province	Country	Region	Customer	Description	Services	Completion Date
5	Hot Thermal Energy Storage	Rice 150MW CSP Solar Energy Project	California	USA	North America	SolarReserve	150 MW CSP project utilizing central receiver concentrating solar technology with molten salt as the thermal medium. The project was a "Greenfield" project on private land. The transmission line and interconnection are on Federal Land requiring engineering coordination with the Bureau of Land Management. Worley completed all preliminary engineering for the permitting. Worley also completed project construction estimates (including labor estimates), project commissioning and operation maintenance plans (including estimates), and a project design basis to support the selection of an EPC contractor. Preliminary studies were included as part of the front end engineering that included water use and cycle efficiency optimization.	Design Basis Preliminary Engineering	2010
4	Hot Thermal Energy Storage	Confidential Solar Trough Project - 100MW, 200MW, 300MW		Confidential location	Confidential	Iberdrola Renewables	Parabolic trough project with three plant sizes: 100 MW, 200 MW, 300 MW. Site Evaluation, Design Basis, Water/Heat Balances, Site Plan, Conceptual PFDs, Electrical Single Lines, Capitol Cost Estimates, Performance Modeling.	Owner's Engineer, Preliminary Engineering, Cost Estimate	2010
3	Hot Thermal Energy Storage	System Advisor Model (SAM) CSP Trough Plant Cost Assessment		California	North America	US Dept. of Energy National Renewable Energy Laboratory (NREL)	100 MW parabolic trough power plant, wet and dry cooled; capital and O&M cost estimates. Includes layouts, flow diagrams, performance estimates, equipment lists. NREL used results to update System Advisor Model (SAM).	Owner's Engineer, Study, Conceptual and Preliminary Engineering, Cost Estimates Performance Estimates	2009
2	Hot Thermal Energy Storage	Agua Caliente 100 - 250MW Solar Thermal Plant		USA	North America	NextLight Renewable Energy	100 – 250 MW plant, site evaluation, plant sensitivity studies, design basis, water/heat balances, site plan, conceptual P&IDs, grading and drainage plan, electrical single lines, capital/O&M cost estimates, performance modeling, permitting support and EPC Spec/Evaluation.	Owner's Engineer, Preliminary Engineering, 30% Design, Cost Estimate, Permitting	2009
1	Hot Thermal Energy Storage	150MW CSP Reference Plant	Confidential	USA	North America	SolarReserve	Preliminary design for a 150MW molten salt central receiver power island and overall plant layout.	Detailed Design	2009

Pumped Storage experience

No.	Technology	Project	State or Province	Country	Region	Customer	Description	Services	Completion Date
24	Pumped Storage	Ludington Pumped Storage Electrical Design Services	Michigan	USA	North America	Consumers Energy	Providing electrical design services in support of Ludington pumped storage hydroelectric facility balance of plant equipment overhaul to Units 1 & 3. This encompasses the motor generator controls integration (MGCI). Modifications are being made to electrical schematic, loop, and wiring diagrams, conduit and layout drawings, creation of circuit and raceway routing schedules, and review of as-built plant conditions.	Electrical Design Support	Ongoing
23	Pumped Storage	Halverson Canyon Pumped Storage Hydropower Plant		USA	North America	Daybreak	Concept Design and support for developer to present its application to the USA Bureau of Reclamation, for the development of the Halverson Canyon Pumped Storage Hydropower Plant, including all technical, environmental, social and risk related aspects of the project.	Concept design and Developer Application Proposal Preparation	2021
22	Pumped Storage	PG-DS-1.3.90 LPS Cooling Water Surge Correction - Change Order # 1	Michigan	USA	North America	Consumers Energy	Change Order to an existing order for additional engineering and design work at the Ludington Pumped Storage Plant.	Engineering	2021
21	Pumped Storage	Assessing Government Grant Funding for Hydro – ARENA		Australia	Asia Pacific	Australian Renewable Energy Agency (ARENA)	Both Advisian and Worley have provided more than five years' service to ARENA, including providing the Chairperson of the ARENA Advisory Panel from 2015 until December 2019, and continues to provide technical assessors and undertake due diligence on an ad-hoc basis. Our staff have assessed more the 500 projects for ARENA, including many in deep technical and commercial due diligence, with more than 10 in the hydro-electric area, including innovative projects using abandoned mining pits, the use of underground flooded mine workings, and more traditional pumped hydro (including those using seawater.	Technical Advisory, Due Diligence	2019
20	Pumped Storage	Fenicia Project – Hydropower and Thermal Power Assets		Spain	Europe	Repsol	Undertaken a Technical and Environmental Due Diligence (herein after T&E DD) to estimate existing, potentially existing and future liabilities for Repsol that would follow the acquisition of power generation assets, currently owned by Fenicia in Spain, that are either in operation or under decommissioning. The assets and facilities that are subject to this T&E DD include the following: Two (2) Combined-Cycle Gas Turbine (CCGT) plants; Twelve (12) Hydroelectric Power Plants (HPP) in operation, including One (1) pumped storage plant: Aguayo ,Six (6) storage plants: La Remolina, Aguilar, Torina, Arbón, Doiras and Silvón and Five (5) run of river plants: Camarmeña, Urdón, Arenas, La Paraya and Bárcena. The evaluation also included Assets under decommissioning: Three (3) Coal-fired Plants and One (1) CCGT.	Technical and environmental Due Diligence	2018
19	Pumped Storage	Muswellbrook Mine Pumped Storage Hydropower Plant		Australia	Asia Pacific	Idemitsu	Concept design for a new Pumped Storage hydro power plant using as the downstream reservoir a decommissioning coal mine pit. Several upstream reservoir options were evaluated and their consequent pump hydro layout. Capacities changed from 250MW to 375MW with Francis reversible turbine. Head varied from 285 to 470m and tunnel length between 2.2km and 3km.	Concept Design	2018
18	Pumped Storage	Power Generation Portfolio in Spain		Spain	Latin America	Repsol	A Technical and Environmental Due Diligence (T&E DD) was completed to estimate existing, potentially existing and future liabilities for Repsol that would follow the acquisition of power generation assets currently owned by Fenicia in Spain that are either in operation or under decommissioning. The assets and facilities subject to this T&E DD include: Two (2) Combined-Cycle Gas Turbine (CCGT) plants; twelve (12) Hydroelectric Power Plants (HPP) in operation (699MW total); one (1) pumped storage plant (Aguayo); six (6) storage plants (La Remolina, Aguilar, Torina, Arbón, Doiras and Silvón); and five (5) run-of-river plants (Camarmeña, Urdón, Arenas, La Paraya and Bárcena). Assets under decommissioning that were evaluated were: three (3) coal-fired plants and one (1) CCGT.	Technical Due Diligence	2018
17	Pumped Storage	Energy and GHG Emissions for 3 Mine Sites - Board White Paper		Australia	Asia Pacific	Idemitsu	Advisian investigated Energy and Greenhouse Gas (GHG) policies, risks and abatement opportunities for Idemitsu's Australian coal operations at Ensham, Boggabri and Muswellbrook. This work followed a Green Paper on GHG risks presented to the Board in January 2017, which recommended additional work to explore opportunities for action in more detail. The outcome was a set of opportunities ranging from efficiency improvements, fuel switching and renewable energy self generation projects. These ranged from rooftop solar PV installations to conversion of diesel haul trucks to LNG.	Board Paper	2017
16	Pumped Storage	Central Pangal HPP		Chile	Latin America	Pacific Hydro	After an accident with the penstock that supplies power to the plant, Worley was hired to perform an evaluation of the damage and of the causes of the accident and propose corrective measures. Central Pangal is a 37.4 MW capacity hydropower plant in operation since 1921	Technical Assessment	2017
15	Pumped Storage	Confidential Seismic Analysis Project	California	USA	North America	Confidential	This Confidential Power Plant is a seven unit pumped-storage hydroelectric plant operated by a confidential utility which provides peak load power from the falling water of a large nearby supply. Worley performed a seismic analysis, calculation for structural steel members, concrete structures and foundations including design of all steel connections, model, how structures will perform during high seismic event, and determine the weakest link. The scope of work to support the customer with updating the seismic analysis of the hard structures at the Power Plant consisted of the following structures: 1. Main powerhouse 2. Unit 7 Powerhouse 3. Penstocks 4. Outlet Tower and Access Bridge 5. Industrial tank with Concrete Slab 6. Emergency spillway The above tasks also included training for Engineering Associates. Worley provided training to the customer's personnel through interactive discussions and meetings regarding this scope of work.	Owner's Engineer Engineering Asset Services	2017

shannon.mccully@worley.com

Pumped Storage experience

No.	Technology	Project	State or Province	Country	Region	Customer	Description	Services	Completion Date
14	Pumped Storage	Pumped Storage HPP		Chile	Latin America	Origin Chile	Design at all stages of pumped storage plant. It consists of an upper reservoir with CFRD dams, pressure tunnel (D=6.0m, L=1,000m), pressure pipe (D=4.2m and D=3.0m, L=1.623m), underground powerhouse with 4 reversible Francis units, turbine/pumps (4x180MW), Qdesign=150m3/s, Hgross=547m, lower reservoir with filling dam, bottom drain, patio de alta and 2x220kV transmission line. Both reservoirs would have an useful volume of 5.6M m3, the upper one would consist of 5 dams of the CFRD type between 14 and 75m high, while the lower reservoir would be formed by a fill dam and geomembrane, between 8 and 22m high. The civil, hydraulic & electromechanical and transmission system design was executed, supporting Origin Chile from the beginning of the project, during the different engineering phases.	Conceptual, Feasibility and Basic Engineering, Basic Studies, Transmission Lines, DGA Sector Permit	2016
13	Pumped Storage	Castaic Hydroelectric Power Plant Control System Upgrade	California	USA	North America	Los Angeles Department of Water and Power (LADWP)	LADWP installed a new Control System at the 7-unit pumped storage hydroelectric Castaic Power Plant as part of the Castaic Modernization Project. The purpose of the Castaic Power Plant Control System Upgrade was to replace and improve the existing plant controls with modern, state of the art hardware and software. The project increased overall generating capacity, improved plant reliability, and increased plant availability. Worley' scope of work included writing operating procedures for 14 modes of operation and training Plant Operators on the new procedures.	Owner's Engineer	2016
12	Pumped Storage	Castaic Pumped Storage Hydropower Plant	California	USA	North America	Los Angeles Department of Water and Power (LADWP)	Worley supported the LADWP Castaic project by creating a P6 schedule for the project based on the limited files and information received from the EPC Contractor. Based on the P6 schedule, LADWP tracked the progress of the EPC Contractor and completed weekly updates with Worley schedules on actual work completed by the EPC Contractor.	Technical Consultancy, Schedule Analysis of EPC Contractor	2014
11	Pumped Storage	Castaic Pumped Storage Hydropower Plant	California	USA	North America	Los Angeles Department of Water and Power (LADWP)	Worley supported the LADWP Castaic project with change order analysis and estimating some of the change orders that LADWP received from the EPC Contractor, some of which were for the Oil Transfer System.	Technical Consultancy, Change Order Management	2014
10	Pumped Storage	Foz do Chapecó HPP		Brazil	Latin America	FCE - Fóz do Chapecó Energía	As a member of a consortium with a construction company, Worley provided Detailed Design and technical supervision of works, including a geology project, geotechnical civil design, civil designs (road, hydraulic and structures), architectural design, electrical engineering design, and mechanical engineering design.	Detailed Design (member of the EPC consortium)	2011
9	Pumped Storage	South Australia Energy Storage Options		Australia	Asia Pacific	South Australian Government	Study of alternatives to enhance a new transmission system with energy storage options to balance the generation of renewable energy with network requirements. As part of the scope was the consideration of potential for pumped storage schemes. The study of pumped storage schemes included definition of minimum and maximum scale of projects, identify potential sites either at new or existing reservoirs, preliminary design to identify main characteristics of projects and provide an estimate for capital and operational costs.	Site Identification, Preliminary Design and Cost Estimate	2011
8	Pumped Storage	Salto Pilão HPP		Brazil	Latin America	CESAP - Consórcio Empresarial Salto Pilão	The Salto Pilao HPP (181 MW, 8 m-high concrete-gravity dam) allows the leverage the generation of electricity. The gross head of about 206m distributed along the stretch of about 20 km from Itajai-Açu river that begins downstream of the city of Lontras and ends downstream of the confluence of the river with Hercilio the Itajaí-Açu in the state of Santa Catarina. The underground scheme of the project includes more than 10km of underground tunnels. Worley provided the consolidated basic design, detailed design and technical support for construction. The services included: geology project, geotechnical civil design, road design civil, civil hydraulic design, civil design structures, architectural design, electrical engineering design, mechanical engineering design, special studies. Was part of the EPC consortium.	Basic & Detailed Design (member of the EPC Consortium), Technical Support for Construction	2010
7	Pumped Storage	Serra do Facão HPP		Brazil	Latin America	SEFAC - Serra do Facão Energia S.A.	Complete Basic and Detailed Design of all disciplines for the construction of the Serra do Facão Hydropower Plant (212 MW, 95m high rock-fill dam with clay core) and site support for construction and commissioning. Worley was part of the EPC consortium. The scope included the transmission line and the connecting bay at the grid substation.	Basic & Detailed Design (member of EPC Consortium)	2009
6	Pumped Storage	Luiz Carlos Barreto de Carvalho HPP		Brazil	Latin America	FURNAS	The Luiz Carlos Barreto de Carvalho HPP exceeds 1,000 MW. The reservoir of the HPP operates normally at a nearly constant level due to the regularization provided by the Furnas plant upstream. At the time of its completion, the Strait of Plant was constituted in one of the lowest costs per kW installed in the world due to the characteristic of its reservoir (trickle), which allowed for the forclosure of small expenses. Inaugurated in 1969, the plant is located in São Paulo State of Brazil, and has 6 turbines, totaling 1050 MW of total installed capacity, which is sufficient to supply 20 cities. Worley and a construction company formed a consortium to provide detailed design for civil, mechanical and electrical works. Worley was responsible for part of the mechanical auxiliary systems and all of the electrical auxiliary systems.	Detailed Design of the refurbishment of the plant procurement of auxiliary electromechanical equipment, systems and materials of the balance of plant. (Member of the EPC Consortium)	2008
5	Pumped Storage	Campos Novos HPP		Brazil	Latin America	ENERCAN	The Campos Novos HPP has a reservoir flooded area of 25.9 km² and installed power of 880 MW - one of the lowest ratios between wetland and energy generated in Brazil. The dam is the fourth highest in the world with rockfill concrete face, 202m height and 592m crest length. In operation since 2006, the HPP meets approximately 25% of energy consumption of the state of Santa Catarina. Worley provided the following services: - Designed the Guide Channel, the Spillway, a Water Intake and the Penstock for the hydroelectric power plant (in a model EPC contract) - Procured part of the Balance of Plant equipment and systems and managed the interfaces.	Basic & Detailed Design Procurement (member of the EPC Consortium)	2006

July 2021
shannon.mccully@worley.com

Pumped Storage experience

No.	Technology	Project	State or Province	Country	Region	Customer	Description	Services	Completion Date
4	Pumped Storage	Piranhas HPP		Brazil	Latin America	BRASCAN Energética S.A.	CNEC Worley completed the Detail Design and integration between equipment and civil structure for a HPP with a RCC and earth-filled dam with a 31m height. The aqueduct circuit for the flows of two turbines, 9.4 MW each, comprised a channel dug into the ground, a forebay, and a tower water intake and penstock, and steel-reinforced concrete support blocks. Complete basic and detailed design of all disciplines were completed for implementation. Site support was provided for construction and commissioning.	Basic & Detailed Design and site support for construction (member of the EPC Consortium)	2006
3	Pumped Storage	Guangzhou Pumped Storage Plant	Guandong	China	China	Guang-Dian Power Grid Group	Assessment of condition and operation of 2400 MW pumped storage and hydroelectric scheme as part of technical review for proposed IPO of the Guang-Dian Power Grid Group assets.	Technical Assessment	2002

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No.	Technology	Project	State or Province	Country	Region	Customer	Description	Services	Completion Date
2	Pumped Storage	Machadinho HPP		Brazil	Latin America	MAESA - Machadinho Energética S.A.	The HPP Machadinho, on the Pelotas River on the border between the municipalities of Piratuba, in the state of Santa Catarina, and Maximiliano de Almeida, in the state of Rio Grande do Sul, has a capacity of 1140 MW with three electricity generating units interconnected to the National Grid at the Southern Subsystem. Worley provided audit services, consolidation of the basic design, and the full development of the detailed design, which involved coordinating the project, civil, electrical and mechanical detailed design, technical assistance on site for implementation of the works, and managing the commissioning of equipment. Following best practices by CBDB (Brazilian Committee on Dams) and ICOLD (International Commission on Large Dams), Worley visually inspected structures, managed stability of natural slopes, managed safety of underground excavations, completed instrumentation and analysis sounding of the earth dam, concrete foundations and their structures, maintained dam systems, spillways, and power and lighting, and prepared final reports on the safety assessment of the development and operation manuals.	Basic & Detailed Design (member of the EPC Consortium), Site Support for Construction	2002
1	Pumped Storage	Pedra do Cavalo HPP		Brazil	Latin America	CHESF – Companhia Hidroelétrica do São Francisco	Basic Design of Pedra do Cavalo Hydropower Plant, including a pump storage HPP with two groups of turbines-pumps coupled to 150 MW generators-motors for a pumping capacity of 115m^3/s. The HPP also included two regular turbine-generator units with 150MW capacity each, and the scope included the design of the 230 KV substation.	Basic Design of Pump Storage HPP	1985

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