AI Use Cases	Agency Name	AI Use Case Description	Submitted For	Email	Departmental Elem	Link to Project Name	Primary Focus Areas	Releasable to the Public Invento	Use Case National Security or Research and Development?
	US Department of Energy		Byung-Jun Yoon		BNL		data reduction	Releasable to Public	No
	U.S. Department of Energy	1. Machine learning methods such as cross-correlation, random forest, regression tree and transfer learning are used to estimate the load composition data and motor protection profiles for different climante regions in the Western US 2. Deep learning algorithm is appplied to calibrate the parameters of WECC composite load model to match the responses with detailed feeder model	Gregory Frank	gregory.frank@hq.doe.gov	OE		Load modeling	Releasable to Public	No
Geochemically Informed Leak Detection (GILD)	US Department of Energy	A Bayesian Belief Network has been developed to interogate the altered geochemistry around a potential CO2 leakage site. The use of the BNN and site specific parameters will reduce the percentage of false positives with this method.	Ryan Kuehn	ryan.kuehn@netl.doe.gov	FECM		Decision Intelligence	Releasable to Public	Research and Development
To implement advanced analytical methodologies to research carbon capture solvent loss and degradation	US Department of Energy	A combination of cutting-edge molecular simulations and advanced analytical methodologies in an integrated approach to discover the molecular underpinnings of solvent loss and decipher how to negate solvent degradations at the molecular level, rather than using costly chemical additives.	Ryan Kuehn	ryan.kuehn@netl.doe.gov	FECM		Big Data	Releasable to Public	No
To develop a deep-learning Artificial Intelligence model for analysis of fundamental combustion characteristics	US Department of Energy	A deep-learning Artificial Intelligence model will be pursued for rapid analysis of detailed fundamental combustion characteristics that support the design and troubleshooting process of H2-containing fuel combustor development.	Ryan Kuehn	ryan.kuehn@netl.doe.gov	FECM		Deep Learning - Neural Nework	Releasable to Public	No
To accurately predict alloy & component performance extrapolated to conditions where experimental results to do not exist.	US Department of Energy	A ML workflow will be developed to accelerate the design and predict the performance of of high temperature alloys.	Ryan Kuehn	ryan.kuehn@netl.doe.gov	FECM		Natural Language Processing, Deep Learning, Small and Wide Data	Releasable to Public	Research and Development
To implement novel SSC-CCS sensing technology and associated condition-based monitoring (CBM) software for improved understanding of the boiler tube failure mechanisms	US Department of Energy	A preliminary condition-based monitoring (CBM) package with graphic user interface (GUI) will be developed. This CUI will allow the operators to view the current and historical signals of temperature profiles of the boiler tube at specific sensor locations. Combining the pre-existing conditions and the opinions from designers/operators/experts' experiences, the system will be integrated with EPRI's Boiler Failure Reduction Program to provide assessments on the health conditions of the boiler tubes, warnings/diagnoses on potential failures and locations, and suggestions on maintenance locations and schedules.	Ryan Kuehn	ryan.kuehn@netl.doe.gov	FECM		Sensor Network	Releasable to Public	No
To automate detection of power plant problems such as tube leaks.	US Department of Energy	A variety of analysis techniques will be applied to power plant historian data to attempt to idenfity early markers of power plant problems, such as steam tube leaks. The techniques of interest include online system identification, Kalman filetering, neural networks, dynamic principal components anaslysis, and cluster analysis. Successful algorithms will enable smarter operation and maintenance of the plant based on the operating data to avoid severe failures.	Ryan Kuehn	ryan.kuehn@netl.doe.gov	FECM		Machine Learning, Big Data	Releasable to Public	Research and Development
To develop a generation plant cost of operations and cycle optimization model.	US Department of Energy	A "Cost of Cycling" model (Coco) will be of use to utilities in planning, operating, or altering coal generators. The ability to cycle over different depths and durations at a known cost will increase the usefulness of a boiler. Coco consists of several modular components: a semi-empirical physics-based model, an exergy analysis module, a reliability analysis module and an Artificial Neural Network (ANN) component.	Ryan Kuehn	ryan.kuehn@netl.doe.gov	FECM		Deep Learning - Neural Nework	Releasable to Public	No
Develop fast predictive models using novel machine-learning based methods.	US Department of Energy	Accurate, fast predictive ML models form the foundation for the virtual learning platform. Generating training data then developing ML based models enables a Virtual Learning Environment (VLE) for exploring and testing strategies to optimize reservoir development, management & monitoring prior to field activities.	Ryan Kuehn	ryan.kuehn@netl.doe.gov	FECM		Machine Learning, Adaptive ML	Releasable to Public	Research and Development

To help automate data discovery and preparations to support a range of CS models, tools, and products	US Department of Energy	AI & ML are used to help collect and process data from multipel sources to further integrate and characterize infromation to provide additional data and infromation to support a range of carbon storage work	Ryan Kuehn	ryan.kuehn@netl.doe.gov	FECM	Machine Learning, Natural Langauge Processing, Big Data	Releasable to Public	Research and Development
To develop an AI enabled robots for automated nondestructive evaluation and repair of power plant boilers.	US Department of Energy	AI algorithms based on Multisensory Inertial Odometry will be developed for 3D mapping. The mapping and pose estimation performance will be evaluated initially in dark, confined environments with sparse distinguishable features (e.g., indoor corridors and large test walls). AI algorithms will be designed to recognize previously visited places for spatiotemporal damage tracking, and to allow map merging and updating. Place recognition and damage localization performance will be evaluated using a vertical test steel wall structure, possibly at several testing facilities. AI algorithms for robot learning will be developed to predict cracks and improve prediction accuracy from human feedback. The algorithm will be evaluated using a dataset of boiler (or generally steel) cracks that will be collected during the project (with the assistance of industrial collaborators).	Ryan Kuehn	ryan.kuehn@netl.doe.gov	FECM	AI	Releasable to Public	No
	US Department of Energy	AI within GRIP is used to develop metrics that quantify the impact of the anticipated weather related extreme events. The platform uses utility data combined with physical models, distribution power solver to infer the potential grid impacts given a major storm.	Gregory Frank	gregory.frank@hq.doe.gov	OE	Machine Learning, optimization, Artificial Intelligence	Releasable to Public	No
To accelerate data processing of large sensor dataset and for identification and classification of pipeline defects	US Department of Energy	AI/ML will be used for identification of signatures and patterns representative of hazards, defects, and operational parameters of the natural gas pipeline network.	Ryan Kuehn	ryan.kuehn@netl.doe.gov	FECM	Machine Learning, Sensor Networks, Generative Adversarial Networks	Releasable to Public	Research and Development
To accurately predict alloy & component performance extrapolated to conditions where experimental results to do not exist.	US Department of Energy	AI/ML will be used to interrogate databases comprised of experimental data, literature data, and synthetic data generated improved physics based models to generate reduced order models to accurate predict materials the performance of materials and components under extreme environments (temperature, atmosphere) and complex loading (cyclical, triaxial) for long service life durations.	Ryan Kuehn	ryan.kuehn@netl.doe.gov	FECM	Synthetic Data, Big Data, Deep Learning	Releasable to Public	Research and Development
To drive insights on emissions from natural gas production, storage, and transmission to determine how best to reduce emissions	US Department of Energy	AI/ML will be used to recognice patterns in well integrity records that could predict failure events	Ryan Kuehn	ryan.kuehn@netl.doe.gov	FECM	Big Data, Data Quality	Releasable to Public	Research and Development
To develop an Artificial intelligence-based model for rotating detonation engine designs	US Department of Energy	An artificial intelligence-based model will be used to develop low-loss rotating detonation engine (RDE) designs for use in power generation using natural gas/syngas mixtures. The model formulation will enable full-scale RDE calculations over 100-1000 detonation cycles.	Ryan Kuehn	ryan.kuehn@netl.doe.gov	FECM	AI	Releasable to Public	No
To develop a proof-of-concept artificial intelligence/machine learning algorithm providing the capability to serve as a design tool leading to the development o	US Department of Energy	An artificial intelligence/machine learning methodology is being developed for rapid design of sorbents tuned to specific ash impoundment and/or landfill requirements.	Ryan Kuehn	ryan.kuehn@netl.doe.gov	FECM	Machine Learning	Releasable to Public	Research and Development

To drive insights through data-driven predictive modeling to forecast the remaining lifespan and future risk of offshore production platforms.	US Department of Energy	An Artificial Neural Network and Gradient Boosted Regression Tree were developed and applied to predict the remaining lifespan of production platforms. These big data-driven models resulted in predictions with scored accuracies of 95–97%.	Ryan Kuehn	ryan.kuehn@netl.doe.gov	FECM	Big Data, Deep Learning (Neural Networks), Explainable AI	Releasable to Public	Research and Development
ANN Submodels of Reaction Physics	US Department of Energy	ANN development of flow physics for code acceleration	Ryan Kuehn	ryan.kuehn@netl.doe.gov	FECM	Machine Learning	Releasable to Public	Research and Development
To implement high temperature electrochemical sensors for in-situ corrosion monitoring in coal-based power generation boilers.	US Department of Energy	Application of Novel Analytic Method(s) to Determine Arsenic and/or Selenium Concentrations in Fly Ash Waste Streams Generated from Coal Combustion	Ryan Kuehn	ryan.kuehn@netl.doe.gov	FECM	Big Data	Releasable to Public	No
To identify CO2 infrastructure needs and storage potential in the Southeastern United States.	US Department of Energy	Apply machine learning algorithms and employ the SimCCS optimization model to provide an initial review of CO2 infrastructure needs and apply the SCO2T to SECARB storage reservoir data sets for storage potential in the Southeastern United States.	Ryan Kuehn	ryan.kuehn@netl.doe.gov	FECM	Machine Learning	Releasable to Public	No
To demonstrate multi-gamma based sensor technology for as-fired coal property measurement	US Department of Energy	Applying an advanced multigamma attenuation (MGA) sensor to accurately and precisely measure coal properties at the point of injection into burners. One research objective is to perform MGA testing and databases development for neural network developed fingerprinting of coal properties. This will include neural network refinement with MGA data and to upgrade Microbeam's Combustion System Performance Indices (CSPI) – CoalTracker (CT) program with MGA-based neural network algorithms.	Ryan Kuehn	ryan.kuehn@netl.doe.gov	FECM	Sensor Network	Releasable to Public	No
To identify non-conventional SOFC geometries and advanced manufacturing of SOFC	US Department of Energy	Can utilize extensive experimental and/or modeling data to train a computer to use artificial intelligence to identify cell geometries to optimize stability and performance, and these could be manufactured using advanced manufacturing techniques.	Ryan Kuehn	ryan.kuehn@netl.doe.gov	FECM	AI	Releasable to Public	No
To drive insights on the dependencies between the natural gas and electricity sectors to increase reliability of the NG system	US Department of Energy	Commercially available models will be used to generate predictive scenarios	Ryan Kuehn	ryan.kuehn@netl.doe.gov	FECM	Big Data	Releasable to Public	Research and Development
To drive insights on the power system reliability, cost, and operations during the energy transition with and without FECM technologies	US Department of Energy	Commercially available models will be used to generate predictive scenarios	Ryan Kuehn	ryan.kuehn@netl.doe.gov	FECM	Big Data	Releasable to Public	Research and Development
	US Department of Energy	Computer vision, a broad set of techniques for training statistical models and neural networks to process images, has advanced substantially in recent years. Applying these capabilities to satellite imagery can improve critical infrastructure analysis and interdependency data build-outs. Combining advanced computer vision techniques, a functional taxonomic approach to critical infrastructure, and the unique geo-spatial and dependency datasets the research team developed can produce innovative and state-of-the-art image processing results that advance abilities to secure and defend national critical infrastructure.	Mitchell C. Kerman		INL	Artificial Intelligence, Neural Networks, Sensor Networks, machine vision	Releasable to Public	No

To create and apply machine learning algorithms to predict carbon dioxide enhanced oil revoery improvements with rich gas in the Bell Creek Field and other selected fields.	US Department of Energy	Create models with ML algorithms to predict CO2 EOR improvements with rich gas in the Bell Creek Field and other selected fields. The results of these models will be compared with the predictions of CMG's reservoir simulations models.	Ryan Kuehn	ryan.kuehn@netl.doe.gov	FECM	Machine Learning	Releasable to Public	No
To training machine learning (ML) algorithms using micro-seismic event data	US Department of Energy	Data acquisition and processing technologies developed in this project use an optical fiber transducer to translate very small micro-seismic events, smaller than M-7, into data that can be processed, correlated with operating parameters, and potentially utilized to train machine learning (ML) algorithms.	Ryan Kuehn	ryan.kuehn@netl.doe.gov	FECM	Machine Learning	Releasable to Public	No
Data platform to expedite access and reuse of carbon ore data for materials, manufacturing and research	US Department of Energy	Data platform to expedite access and reuse of carbon ore data for materials, manufacturing and research. Assembled using data science, NLP methods, and hosted in virtual, multi-cloud platform for online analytics.	Ryan Kuehn	ryan.kuehn@netl.doe.gov	FECM	Natural Language Processing, Deep Learning, Small and Wide Data	Releasable to Public	Research and Development
To develoop low cost conversion of coal to graphene	US Department of Energy	Demonstrate the techno-economical feasibility of a 250 ton/day manufacturing facility to convert coal to high-quality graphene. The core technology is based on flash joule heating (FJH) to convert various coals to graphene. Machine learning algorithms will map out the correlation of processing parameters with the final product (graphene yield, quality, dimensions).	Ryan Kuehn	ryan.kuehn@netl.doe.gov	FECM	Machine Learning	Releasable to Public	No
To design high-efficiency reactors to achieve transformational capture of carbon dioxide	US Department of Energy	Design and fabricate high-efficiency reactors that support advanced sorbents, solvents, or membranes to achieve transformational capture of carbon dioxide (CO2) from fossil-fired power generation systems. An integrated design process will couple computational design optimization with their additive manufacturing capabilities to create novel, efficient reactor geometries, customized for new capture materials.	Ryan Kuehn	ryan.kuehn@netl.doe.gov	FECM	AI	Releasable to Public	No
To implement machine learning to predict aerodynamic and combustion characteristics in hydrogen turbine	US Department of Energy	Design rules and reduced models will be formulated by combining high fidelity simulations of chemically reacting flow, stochastic modeling techniques, reduced modeling through machine learning and testing of injector configurations. These can be used in an industrial setting to predict the aerodynamic and combustion characteristics in hydrogen turbine combustors based upon which design decisions are made.	Ryan Kuehn	ryan.kuehn@netl.doe.gov	FECM	Machine Learning	Releasable to Public	No
To automate development of proxy models for power generation combustion systems.	US Department of Energy	Detailed CFD of large combustion systems will be performed. From the results, machine learning will be used to develop fast proxy models which can will provide results close to the CFD results, but in a small fraction of the time. These fast models will then be used in real-time digital twin models of the power plant, which can be used to help the power plant operator to spot instrumentation failures or cyberattacks on the plant.	Ryan Kuehn	ryan.kuehn@netl.doe.gov	FECM	Machine Learning, Cybersecurity	Releasable to Public	Research and Development
Detection of sand production from real-time production test data using ML categorical analysis	US Department of Energy	Detection of sand production from real-time production test data including pressure temperature will be develped using ML categorical analysis based on field test data as a training and validation data set. Additional groudtruth data will be developed with NETL developed THCM sand production simulator.	Ryan Kuehn	ryan.kuehn@netl.doe.gov	FECM	Machine Learning	Releasable to Public	Research and Development
To implement unsupervised learning based interaction force model for nonspherical particles in incompressible flows	US Department of Energy	Develop a neural network-based interaction (drag and lifting) force model. A database will be constructed of the interaction force between the non-spherical particles and the fluid phase based on the particle-resolved direct numerical simulation (PR-DNS) with immersed boundary-based lattice Boltzmann method (IB-LBM). An unsupervised learning method, i.e., variational auto-encoder (VAE), will be used to improve the diversity of the non-spherical particle library and to extract the primitive shape factors determining the drag and lifting forces. The interaction force model will be trained and validated with a simple but effective multi-layer feed-forward neural network: multi-layer perceptron (MLP), which will be concatenated after the encoder of the previously trained VAE for geometry feature extraction.	Ryan Kuehn	ryan.kuehn@netl.doe.gov	FECM	Deep Learning - Neural Nework	Releasable to Public	No

To develop a wireless high temperature sensor network for smart boiler systems	US Department of Energy	Develop a new wireless high-temperature sensor network for real-time continuous boiler condition monitoring in harsh environments. The wireless high-temperature sensor network consists of wireless radio frequency (RF) high-temperature sensors with integrated attached antennas for wireless internet-based continuous remote monitoring. The wireless sensor network enables real-time and continuous monitoring of boiler conditions to achieve smart boiler system management.	Ryan Kuehn	ryan.kuehn@netl.doe.gov	FECM	Sensor Network	Releasable to Public	No
To develop 5G integrated edge computing platform for efficient component monitoring in coal-fired power plants	US Department of Energy	Develop an on-demand distributed edge computing platform to gather, process, and efficiently analyze the component health data in coal-fired power plants. Given that edge computing servers are closer to the field devices in modernized power plants, the efficiency of edge computing service with respect to dynamic orchestration, resource data collection, and health information monitoring will be investigated for timely detection of remote faults and to perform diagnosis.	Ryan Kuehn	ryan.kuehn@netl.doe.gov	FECM	Distributed / Edge Computing	Releasable to Public	No
To optimize Artificial Intelligence to detect and localize currently undetectable legacy wellbores	US Department of Energy	Develop and apply optimized Artificial Intelligence (Machine Learning) and computational models to create an innovative, cost effective, distributed, and high resolution fiber optic based 4D (spatial and temporal) imaging, mapping, and detection system of undocumented legacy wellbores and assessment of legacy wells in which conventional logging tools cannot provide the needed information	Ryan Kuehn	ryan.kuehn@netl.doe.gov	FECM	Machine Learning	Releasable to Public	No
To develop efficient and economic hydraulic fracture diagnostics using metamaterials and edge AI	US Department of Energy	Develop and demonstrate the feasibility of an acoustic and electromagnetic intelligent proppant that can be used with current industry tools for real-time monitoring capabilities derived from AI hardware. These techniques for hydraulic fracture diagnostics will improve environmental health and safety as well as production efficiency.	Ryan Kuehn	ryan.kuehn@netl.doe.gov	FECM	AI	Releasable to Public	No
To implement boiler health monitoring using a hybrid first principles-artificial intelligence model	US Department of Energy	Develop methodologies and algorithms to yield (1) a hybrid first-principles artificial intelligence (AI) model of a PC boiler, (2) a physics-based approach to material damage informed by ex-service component evaluation, and (3) an online health-monitoring framework that synergistically leverages the hybrid models and plant measurements to provide the spatial and temporal profile of key transport variables and characteristic measures for plant health.	Ryan Kuehn	ryan.kuehn@netl.doe.gov	FECM	AI	Releasable to Public	No
ML application for parameter estimation and lithofacies recognition using well-log data	US Department of Energy	Develop ML model based on existing data set to estimate key parameters for neighboring or blind target well with similar or contrasting geological characteristics for universal ML approach for hydrate application	Ryan Kuehn	ryan.kuehn@netl.doe.gov	FECM	Machine Learning	Releasable to Public	Research and Development
To develop a "Lizard" inspired robot for in-service inspection of power plant components that contain rough surfaces and limited accessibilities.	US Department of Energy	Developing a robot with friction-based mobility capabilities to move on tubes with complex geometries, obstacles, and rough surfaces such as a U-bend corroded tubular structures. Will also integrate automation with couplant-free ultrasound transmission technology and develop an advanced Lamb wave based imaging algorithm to detect and evaluate crack and corrosion defects in tubes/pipes using a network of couplant-free ultrasound sensors placed at the location of the robot's grippers. Applying advanced ultrasound imaging methods such as Lamb wave based Total Focusing Method (TFM) and Multi-Helical Ultrasound Imaging (MHUI), the robot can image the area under and around the grippers from a few connected points. This robot will be able to move on ferromagnetic and non-ferromagnetic materials and will not require smooth and prepared surfaces for mobility or to obtain ultrasound images of the entire cross section of the tube."	Ryan Kuehn	ryan.kuehn@netl.doe.gov	FECM	Robotics	Releasable to Public	No
To use rotary wing flying robots for outdoor inspection and airships for indoor inspection of GPS-denied environments in a representative coal-fired power component.	US Department of Energy	Developing Computer-Aided Design (CAD)-based inspection profiles for space-constrained and Global Positioning System (GPS)-denied areas of a power plant to guide the UTEP GPS-denied Inspection System (UGIS), a small, unmanned aerial system with machine vision in all directions. The system will be validated in its capability to (i) maintain a pre-set distance from complex surfaces (within sub-6" tolerances in all six cardinal directions) in enclosed and GPS-denied areas of a representative coal-fired power plant component; and (ii) perform an automated visual and thermal inspection of uneven vertical and horizontal surfaces in an enclosed and GPS-denied area, using the CAD-based inspection profile corrected locally with onboard machine-vision."	Ryan Kuehn	ryan.kuehn@netl.doe.gov	FECM	Computer Vision	Releasable to Public	No

To provide natural gas leak detection and quality control	US Department of Energy	Employing machine learning techniques to train sensing systems to quantify the concentration of natural gas species, distinguish between natural gas at different parts of the processing pipeline, and distinguish natural gas from natural and man-made interfering sources such as wetlands and agriculture	Ryan Kuehn	ryan.kuehn@netl.doe.gov	FECM		Machine Learning	Releasable to Public	No
To apply machine learning methods to explore the inter-well uncertainty in the Goldsmith Landreth San Andres Unit and to update reservoir models.	US Department of Energy	Engineered water can lower interfacial tension and minimize capillary forces that gravity can push the oil up and out of the matrix. This proposal is to test this technology in the field scale, in Goldsmith Landreth San Andres Unit. Apply history matching of flexible interface-based reservoir models and ML methods such as generative adversarial networks that provide new methods to explore the inter-well uncertainty and to update the reservoir models.	Ryan Kuehn	ryan.kuehn@netl.doe.gov	FECM		Machine Learning	Releasable to Public	No
	US Department of Energy	Explore the use of big data, artificial intelligence (AI), and machine learning technology and tools on phasor measurement unit (PMU) data to identify and improve existing knowledge, and to discover new insights and tools for better grid operation and management.	Gregory Frank	gregory.frank@hq.doe.gov	OE		Artificial Intelligence, Transfer Learning, Reinforcement Learning, Sensor Network	Releasable to Public	No
To scale up a novel amine-based solvent CO2 capture technology	US Department of Energy	For a comprehensive evaluation of the novel solvent technology, the test plan includes: parametric testing to determine optimal operating conditions; evaluation of system response and operation during process dynamics that occur naturally at power stations including variations in flue gas flow rates and/or CO2 inlet concentrations; emissions studies under steady-state and dynamic conditions; and long-term steady-state testing. Data from the test campaign will be utilized to validate a new solvent-specific module in ProTreat® process simulation software that is critical for further scale-up and economic evaluations.	Ryan Kuehn	ryan.kuehn@netl.doe.gov	FECM		AI	Releasable to Public	No
To implement artificial intelligence "real-time" hydrogen monitoring capabilities compatible with existing pipeline monitoring systems	US Department of Energy	Hydrogen detection using an intelligent optical sensor for "real-time" monitoring of hydrogen concentration within a pipeline-quality natural gas stream throughout transportation infrastructure for efficient end-use. Combines artificial intelligence chip and an inexpensive miniaturized surface plasmon resonance sensor to facilitate a more comprehensive set of sensing capabilities, which will allow for continuous unmanned monitoring of natural gas blends, pipeline efficiency, and hydrogen delivery.	Ryan Kuehn	ryan.kuehn@netl.doe.gov	FECM		Sensor Network	Releasable to Public	No
To identify faults susceptible to induced seismicity	US Department of Energy	Identification of faults susceptible to induced seismicity by integration of forward and joint inversion modeling, machine learning, and field calibrated geologic models.	Ryan Kuehn	ryan.kuehn@netl.doe.gov	FECM		Machine Learning	Releasable to Public	No
Evaluation of Potential Technology Pathways to Image Rock Properties	US Department of Energy	Identify/apply machine learning strategies that achieve faster 3D imaging and/or higher resolution visualization than compared to traditional geophysical methods for time lapse data, provide data and physics driven upscaling of laboratory imaging data that has much finer resolution downscaling geophysical imaging data has coarser resolution, and couple physics-based ML for CO2 saturation visualization in 3D ML for upscaling & downscaling relevant physics.	Ryan Kuehn	ryan.kuehn@netl.doe.gov	NETL		Machine Learning	Releasable to Public	Research and Development
To implement Artificial Intelligence Techniques to improve power plant performance	US Department of Energy	Implement a real-time, on-line preventative maintenance system aimed at extending operational lifespan of coal-fired plant operations. This will be accomplished by first modeling existing operational behavior based on historical instrumentation data utilizing advanced AI techniques. The resultant models and associated user interfaces will be deployed into an on-line system for real-time monitoring of equipment health	Ryan Kuehn	ryan.kuehn@netl.doe.gov	FECM		Process Optimization	Releasable to Public	No
Transform reservoir management decisions through rapid analysis of real time data to visualize forecasted behavior in an advanced control room "human-in-the-loop" format.	US Department of Energy	Improve low-fidelity model performance by transfer-learning with high-fidelity data, and reduce uncertainty by combining high-fidelity and lower-fidelity models for improved UQ performance.	Ryan Kuehn	ryan.kuehn@netl.doe.gov	FECM		Machine Learning, Decision Intelligence, Transfer Learning	Releasable to Public	Research and Development

Using natural language processing to explore and extract information from historical literature/pdfs	U.S. Department of Energy	Increase the efficiency of a users of to find important records in the DOE environment, safety, and health (ES&H) datasets (e.g., occurrence reporting and processing system, fire protection, lessons learned, accident and injury reporting system, contractor assurance system CAS). The tool can be used to improve decision-making in job planning activities, identifying hazards, and obtaining insights from operating experience and lessons learned data discovery and analysis, accident investigations among other areas.	Felix Gonzalez	felix.gonzalez@hq.doe.gov	EHSS		Artificial Intelligence, Natural Langauge Processing	Releasable to Public	No
To apply maching learning techniques	U.S. Department of Energy	Information exchange between U.S. Department of Energy and U.S. Nuclear Regulatory Commission on applications of artificial intelligence, machine learning, natural language processing and data analytics in obtaining insights from operational, environmental, safety and health datasets.	Felix Gonzalez	felix.gonzalez@hq.doe.gov	EHSS		Artificial Intelligence, Predictive analytics, outlier detection, Natural Langauge Processing, Data Science, Data Analysis, nuclear engineering, probabilistic risk assessment, data collection	Releasable to Public	No
To apply machine learning and data analytics techniques to integrated subsurface datasets to predict key reservoir properties and compare various fields across the area of study and to correlate vintage data with new data and address the distribution of fractures and vugs.	US Department of Energy	Laboratory experiments will be used to optimize a CO_2 flood composition specific to HTD rock properties, and subsequently design and simulate injection scenarios that offer wettability alteration, foaming, and reduced surface tension. This work will improve oil recovery from matrix porosity and mitigate the impact of fracture zones. The optimized design will be implemented and tested in a Trenton/Black River field. The results will provide strategies to improve oil recovery in complex carbonate formations in the Michigan Basin as well as in other carbonate plays.	Ryan Kuehn	ryan.kuehn@netl.doe.gov	FECM		Machine Learning	Releasable to Public	No
Legacy well log data analysis for 3D basin model development.	US Department of Energy	Legacy well log data from Alaska North Slope will be analyzed with ML models to identify most susceptible layers to global climate change or most acccessible layers for gas production and their continuity for 3D basin model development.	Ryan Kuehn	ryan.kuehn@netl.doe.gov	FECM		Machine Learning	Releasable to Public	Research and Development
To drive identification of metocean and seafloor geohazards that may impact offshore energy production and infrastructure	US Department of Energy	Leverage multiple machine learning models to evaluate and predict different metocean (meterological and ocean) and seafloor hazards that may impact offshore energy infrastructure intrgrity, operational safety, and environmental stewardship in the offshore.	Ryan Kuehn	ryan.kuehn@netl.doe.gov	FECM		Machine Learning, Deep Learning, Transfer Learning	Releasable to Public	Research and Development
To drive insights on environmental performance of the natural gas system to inform effective mitigation strategies	US Department of Energy	Life Cycle Analysis models will be used to define and estimate environmental parameters/performance	Ryan Kuehn	ryan.kuehn@netl.doe.gov	FECM		Big Data, Data Quality	Releasable to Public	Research and Development
To automate RDE image analysis, machine learning for RDE image analysis is being employed.	US Department of Energy	Machine learning algorithms are being developed and applied to analyze images of RDEs in operation to determine detonation wave mode, direction and speed.	Ryan Kuehn	ryan.kuehn@netl.doe.gov	FECM		Deep Learning, Adaptive ML.	Releasable to Public	Research and Development
To improve control of hybrid SOFC-gas turbine power systems.	US Department of Energy	Machine learning algorithms are being developed and compared to other control methods for SOFC-gas turbine hybrid power generation systems.	Ryan Kuehn	ryan.kuehn@netl.doe.gov	FECM		Machine Learning	Releasable to Public	Research and Development

To create reduced order models for predicting long term performance degradation behavior of fuel cells and electrolyzers.	US Department of Energy	Machine learning algorithms are being used to analyze large datasets of microstructural and perfromance degradation simulations of various electrode microstructres to develop reduced order models that can be used for long-term perfromance degradation predictions of large area fuel cell/electrolysis cells and cell stacks. The reduced order models can be used for dynamic simulations that can more accurately mimic the changing loading conditions of the modern grid.	Ryan Kuehn	ryan.kuehn@netl.doe.gov	FECM		Synthetic Data, Big Data, Deep Learning	Releasable to Public	Research and Development
To develop a high throughput computational framework of materials properties for extreme environments methods.	US Department of Energy	Machine learning methods in the literature will be incorporated and validated to reduce the amount of first-principles calculations.	Ryan Kuehn	ryan.kuehn@netl.doe.gov	FECM		Machine Learning	Releasable to Public	No
To develop a novel platform for secure data logging and processing in fossil fuel power generation systems using blockchain and machine learning to reduce down time for fossil energy power plants, limit reductions of power and reduce cost for repairs.	US Department of Energy	Machine learning model development will consist of traditional machine learning and deep learning algorithms implementation for anomaly detection. Machine learning server will be used to develop the traditional models using One-Class Support Vector Machine (SVM) and K-Mean Clustering and deep learning models using Recurrent Neural Network (RNN) and its various implementations like Long Short-Term Memory (LSTM), Gated Recurrent Unit (GRU), Generative Adversarial Network (GAN), and Autoencoders using the sensor data collected from secure sensor network.	Ryan Kuehn	ryan.kuehn@netl.doe.gov	FECM		Machine Learning	Releasable to Public	No
To implement machine learning to study electrochemical performance of solid oxide electrolysis cell electrodes	US Department of Energy	Machine learning will be used to study the dependence of electrochemical performance on microstructural details of an electrode, including tortuosity, pore connectivity, pore size and size distribution, and grain size and size distribution.	Ryan Kuehn	ryan.kuehn@netl.doe.gov	FECM		Machine Learning	Releasable to Public	No
To normalize various forms of machine data to enhance analytics and machine learning to more robustly detect cyber-attacks on generation, transmission and distribution systems.	US Department of Energy	Machine, traditional log, PCAP and historian data will be monitored and analyzed from all sources. Working with plant SME's, intuitive analytics, machine learning, and User Behavior Analytics (UBA) algorithms; team members will develop baselines. The baselines will allow classification of system anomalies as either expected (add to baseline) or unexpected (investigation required).	Ryan Kuehn	ryan.kuehn@netl.doe.gov	FECM		Cybersecurity	Releasable to Public	No
To leverage disparate data to update assessments, analytics, and infromation for NATCARB and CS Atlas	US Department of Energy	ML Is utilized to parse and generate additional data and information that can be parsed and labeled to provide additional inputs for geologic carbon storgae assessments from multiple sources.	Ryan Kuehn	ryan.kuehn@netl.doe.gov	FECM		Machine Learning, Data Quality, Sparse Data	Releasable to Public	Research and Development
To drive insights on pipeline maintenance and repair strategies to reduce incidents of pipeline leakage; support evaluation of use and reuse strategies	US Department of Energy	ML will be used to develop a pipeline risk assessment geospatial model and support evaluation of use and reuse opportunities.	Ryan Kuehn	ryan.kuehn@netl.doe.gov	FECM		Machine Learning, Decision Intelligence, Deep Learning	Releasable to Public	Research and Development

To drive insights using machine learning-based dynamics, control, and health models and tools developed by NETL to gain valuable operational data, insights, and	US Department of Energy	ML will be used to develop dynamics, controls, and health models for operating power generation facilities	Ryan Kuehn	ryan.kuehn@netl.doe.gov	FECM	Machine Learning, Improving Data Quality, Decision Intelligence	Releasable to Public	Research and Development
ML-based proxy models and multi-level data driven fracture network imaging to support rapid decision making.	US Department of Energy	ML-based proxy-models of fracture network, HF geometry, HF properties, bottomhole pressure and drainage volume contribute to fracture network, production forecast and well drainage volume visualizations.	Ryan Kuehn	ryan.kuehn@netl.doe.gov	FECM	Machine Learning, Decision Intelligence	Releasable to Public	Research and Development
Use ML to enable a geophysical monitoring toolkit, and assimilate real-time modeling and data.	US Department of Energy	ML-enabled rapid and autonomous geophysical monitoring and real-time modeling and data assimilation tools (along with visualization and decision-support frameworks), work together to radically improve pressure and stress imaging.	Ryan Kuehn	ryan.kuehn@netl.doe.gov	FECM	Machine Learning, Decision Intelligence	Releasable to Public	Research and Development
To provide insights into opportunities to beneficiate and use hydrocarbon infrastructure for alternative uses such as offshore carbon storage.	US Department of Energy	Multiple big data-driven AI/ML models will be used to evaluate geologic, geospatial, and infrastructure related information to inform predictions using natural language processing, Artificial Neural Networks, and possibly bayesian networks as well.	Ryan Kuehn	ryan.kuehn@netl.doe.gov	FECM	Machine Learning, Decision Intelligence, Explainable AI	Releasable to Public	Research and Development
To drive insights on the safe use and reuse of high-risk, permanent and semi-permanent offshore infrastructure.	US Department of Energy	Multiple big data-driven AI/ML models will be used to evaluate production and transport infrastructure integrity including Bayesian Networks, Artificial Neural Networks, and time series analyses.	Ryan Kuehn	ryan.kuehn@netl.doe.gov	NETL	Machine Learning, Decision Intelligence, Explainable AI	Releasable to Public	Research and Development
To automate selection or design of a functional sensor material for high temperature sensing.	US Department of Energy	Neural networks will be trained on a set of material data for simple and complex oxide materials, which includes both chemical structrure data and sensing response data. The neural network will then be tested for its capability to predict the sensing performance data of other, simialr structure materials.	Ryan Kuehn	ryan.kuehn@netl.doe.gov	FECM	Machine Learning	Releasable to Public	Research and Development
To evaluate current infrastructure throughout a study area and evaluating future infrastructure needs to accelerate the deployment of CCUS	US Department of Energy	One key task focuses on evaluating current infrastructure throughout the Initiative study area and evaluating future infrastructure needs to accelerate the deployment of CCUS. LANL will utilize its unique technologies for this project focusing on SimCCS, with a minor consulting role using NRAP and machine learning algorithms.	Ryan Kuehn	ryan.kuehn@netl.doe.gov	FECM	Machine Learning	Releasable to Public	No
Demonstrate the robust performance of our ML method in a commercial-scale synthetic data and integrate image-to-image mapping with convolutional neural networks	US Department of Energy	Our method quickly incorporates streaming observations for accurate and timely forecasts with uncertainty quantification, taking reservoir simulation data as inputs and incorporating real-time observation streams for accurate, timely geological carbon storage forecasts. Computation effort is distributed over many machines, facilitates coupled inversions using many ML models, and allows for ML-Driven optimization and sensitivity analysis	Ryan Kuehn	ryan.kuehn@netl.doe.gov	FECM	Machine Learning, Decision Intelligence, Sensor Networks, Deep Learning (Neural Networks)	Releasable to Public	Research and Development

To develop and validate an integrated package of joint seismic-pressure-petrophysics inversion of a continuous active-source seismic monitoring dataset capable of providing real-time monitoring of a carbon dioxide (CO2) plume during geologic carbon storage.	US Department of Energy	Outcomes will include (a) a workflow for processing continuous active source seismic monitoring (CASSM) data, (b) Bayesian inversion algorithms using of CASSM data and pressure response data, and (c) integration with data assimilation algorithms for continuously updating site-specific models used for prediction and reservoir management.	Ryan Kuehn	ryan.kuehn@netl.doe.gov	FECM	Big Data	Releasable to Public	No
	US Department of Energy	Physics-based multi-scale modeling was coupled with deep, recursive, and transfer learning approaches to accelerate nuclear materials research and qualification of high-entropy alloys. Applying AI to combinatorial-based materials research enables subsequent analysis to focus on a limited number of candidates predicted to have the necessary materials properties for the application.	Mitchell C. Kerman		INL	Transfer Learning, Deep Learning, recursive learning, Machine Learning, materials science	Releasable to Public	No
To develop drag models for non-spherical particles through machine learning	US Department of Energy	Produce comprehensive experimental and numerical datasets for gas-solid flows in well-controlled settings to understand the aerodynamic drag of non-spherical particles in the dense regime. The datasets and the gained knowledge will train deep neural networks to formulate a general drag model for use directly in NETL MFiX-DEM module. This will help to advance the accuracy and prediction fidelity of the computational tools that will be used in designing and optimizing fluidized beds and chemical looping reactors	Ryan Kuehn	ryan.kuehn@netl.doe.gov	FECM	Machine Learning	Releasable to Public	No
To implement big data analytics and machine learning applications to inform decision making and improve the ultimate recovery of unconventional oil and natural gas resources.	US Department of Energy	Project will conduct numerical analysis of all-digital pressure sensing technology will be used to create a synthetic dataset with downhole pressure sensor readings for each stage and will be analyzed statistically with DA to integrate with software.	Ryan Kuehn	ryan.kuehn@netl.doe.gov	FECM	Big Data	Releasable to Public	No
To design, proto-type and demonstrate a miniaturized implementation of a multi-process, high-spatial-resolution monitoring system for boiler condition management.	US Department of Energy	Project will develop control logic for automated control of bituminous coal-fired boiler. Plant operational data will be compared against monitoring data to determine when different sensor output from a miniaturized high temperature multi-process, high-spatial-resolution monitoring system signifies damaging conditions in that region of the boiler, and what operational changes can be made to eliminate the damaging condition. The control logic will be developed for automated control of soot-blowing and other boiler operations	Ryan Kuehn	ryan.kuehn@netl.doe.gov	FECM	Sensor Network	Releasable to Public	No
To provide combustion performance and emissions optimization through integration of a miniaturized high-temperature multi process monitoring system	US Department of Energy	Project will develop control logic for automated control of lignite coal-fired boiler. Plant operational data will be compared against monitoring data to determine when different sensor output from a miniaturized high temperature multi-process, high-spatial-resolution monitoring system signifies damaging conditions in that region of the boiler, and what operational changes can be made to eliminate the damaging condition. The control logic will be developed for automated control of soot-blowing and other boiler operations	Ryan Kuehn	ryan.kuehn@netl.doe.gov	FECM	Sensor Network	Releasable to Public	No

To apply maching learning techniques, using geotechnical characterization and fract data and computer simulations, to maximize oil recovery, specifically in the Utica/Point Pleasant shale.	US Department of Energy	Project will use ML techniques using geotechnical characterization and frac data with computer simulations to maximize oil recovery. A sensitivity analysis will be conducted to determine the most important criteria.	Ryan Kuehn	ryan.kuehn@netl.doe.gov	FECM	Machine Learning	Releasable to Public	No
To develop sub-pilot-scale production of high-value products from U.S. coals	US Department of Energy	Provide sub-pilot-scale verification of lab-scale developments on the production of isotropic and mesophase coal-tar pitch (CTP) for carbon fiber production, using coals from several U.S. coal-producing regions. An extensive database and suite of tools for data analysis and economic modeling, with an associated web-based community portal, will be developed to relate process conditions to product quality, and to assess the economic viability of coals from different regions for producing specific high-value products.	Ryan Kuehn	ryan.kuehn@netl.doe.gov	FECM	Big Data	Releasable to Public	No
To implement AI methods for graphene production	US Department of Energy	Scale up and commercialization of a breakthrough process, Flash Joule Heating (FJH), to transform different coal grades into high-quality graphene by using artificial intelligence techniques (AI) for process optimization and quality control of the graphene.	Ryan Kuehn	ryan.kuehn@netl.doe.gov	FECM	AI	Releasable to Public	No
To implement sensor-driven deep learning/artificial intelligence for power plant monitoring	US Department of Energy	Sensor-driven deep learning/artificial intelligence for intelligent health monitoring capabilities that occur at the sensor (embedded computing) or base station (edge computing). Will give power plant operators more prediction tools about scheduling maintenance. Focus is on a high-priority in-situ boiler temperature measurement system that relies on chipless RFID technology and much-needed temperature, pressure, environmental, and water quality industrial sensors.	Ryan Kuehn	ryan.kuehn@netl.doe.gov	FECM	Deep Learning - Neural Nework	Releasable to Public	No
To drive insights on water recovery from cooling tower plumes	US Department of Energy	Study of plume formation and collection on mechanical (induced) draft cooling towers, partly in a high-fidelity controlled environment and partly on a full-scale industrial cooling tower. It will start by building the needed laboratory setup and installing various sensors on the lab cooling tower. At the same time a computational fluid dynamics (CFD) model will be implemented to get precise full-scale plume models. Using the insights into power-plant plume characteristics the project will iterate on and experimentally test electrodes and collectors, which make up modular panels, on the lab cooling tower. What has been learned from the full-scale plume modeling and sensor data analysis will then be applied to develop a design model to build the optimal collection apparatus for given working conditions	Ryan Kuehn	ryan.kuehn@netl.doe.gov	FECM	Sensor Network	Releasable to Public	No
To develop a new multi-modal approach to modeling of creep deformation in nickel-base superalloys	US Department of Energy	The data mining analysis will utilize the creep database accumulated from well-known sources as well as open literatures on these alloys	Ryan Kuehn	ryan.kuehn@netl.doe.gov	NETL	Big Data	Releasable to Public	No
	US Department of Energy	The goal of this project is to develop an analysis framework enabled by dynamic sandboxes that allows for automated analysis, provides non-existing core capabilities to analyze industrial control system malware, and outputs to a format that is machine readable and an industry standard in sharing threat information. This will enable further analysis efforts via machine learning and provide a foundational platform that would allow for timely, automated analysis of malware samples.	Mitchell C. Kerman		INL	Machine Learning, Cybersecurity	Releasable to Public	No
	US Department of Energy	The goal of this research is to discover methods and technologies to bridge gaps between the various industrial control systems (ICS) communication protocols and standard Ethernet to enable existing cybersecurity tools defend ICS networks and empower cybersecurity analysts to detect compromise before threat actors can disrupt infrastructure, damage property, and inflict harm. Research focuses on electronic signal analysis of captured communication to determine the protocol, using use machine learning to identify unknown protocols. Findings will be incorporated into a prototype device.	Mitchell C. Kerman		INL	Machine Learning, Cybersecurity	Releasable to Public	No

	US Department of Energy	The goal this research is to develop and validate novel and scalable models to achieve faster-than-real-time prediction and decision-making capabilities. To achieve the project goal of autonomous operation of microreactors, a novel hybrid modeling approach combining both physics-based and artificial intelligence techniques will be developed at the component or sub-system level, integrated with anticipatory control techniques, and scaled. A novel distributed anticipatory control strategy will be developed as part of the scalability analysis to understand the risk of cascading failures when emerging reactors are deployed as part of a full feeder microgrid.	Mitchell C. Kerman		INL	Artificial Intelligence, nuclear engineering	Releasable to Public	No
To provide integrated boiler management through advanced condition monitoring and component assessment.	US Department of Energy	The Integrated Creep-Fatigue Management System represents an online boiler damage monitoring system applicable to creep and fatigue. The system will be configured to allow connectivity to the plant data historian (e.g., OSISoft:PI) and to commercial finite element software (e.g., ANSYS and Abaqus). In addition to configuring interaction with finite element software, existing damage mechanism monitoring modules will also be deployed using online analytical calculations. This functionality will be applied to terminal tubes entering the boiler header for which the combined mechanisms of creep and oxidation can be calculated without the need for a finite element analysis.	Ryan Kuehn	ryan.kuehn@netl.doe.gov	FECM	Sensor Network	Releasable to Public	No
To develop and validate sensor hardware and analytical algorithms to lower plant operating expenses for the pulverized coal utility boiler fleet	US Department of Energy	The objective is to develop and validate sensor hardware and analytical algorithms to lower plant operating expenses for the pulverized coal utility boiler fleet. The focus is on relatively inexpensive new "Internet of Things" technologies to minimize capital investment. Three technologies will be explored for demonstration and full-scale testing in a coal-fired power plant. The first focuses on gas and steam temperature control issues at low load. The second uses sensors and analytic algorithms for monitoring coal pulverizer operation at lower loads to reduce the minimum firing capability of coal burners. The third investigates new sensors and advanced controls to better balance air and fuel at each burner enabling reduction in the minimum firing capability of coal burners.	Ryan Kuehn	ryan.kuehn@netl.doe.gov	FECM	Sensor Network	Releasable to Public	No
To leverage ML models to increase the size and complexity of problems that can be optimized within IDAES.	US Department of Energy	The objective is to leverage ML models as surrogates for complex unit operations or to bridge between scales to increase the size and complexity of models that can be optimized within IDAES.	Ryan Kuehn	ryan.kuehn@netl.doe.gov	FECM	Machine Learning, Reinforcement Learning	Releasable to Public	Research and Development
	US Department of Energy	The objective of this project is to research, assess, and implement machine learning and artificial intelligence and physics-based algorithms for signal decomposition and provide a straightforward framework wherein an anomaly detection algorithm can be trained on existing expected data and then used for false data injection detection. An advanced library for signal decomposition and analysis will be developed that allows combining machine learning and artificial intelligence algorithms and high-fidelity model comparisons for greatly improved false data injection detection. This library will facilitate online and posteriori analysis of digital signals for the purpose of detecting potential malicious tampering in physical processes.	Mitchell C. Kerman		INL	Machine Learning, Artificial Intelligence, Cybersecurity	Releasable to Public	No
To field-test an advanced machine learning approach integrating controllable completions (interval control valves [ICVs]) to enable active well control during carbon dioxide (CO2) enhanced oil recovery (EOR).	US Department of Energy	The overarching goals of the proposed project are to 1) implement controllable completions through a rigorously monitored field test in a reservoir that has undergone primary and secondary recovery but has yet to pursue tertiary recovery, 2) apply advanced data analytics and machine learning to evaluate the test performance and develop a semiautonomous active control system, and 3) assess various business case scenarios to accelerate the development and application of this system for commercial EOR.	Ryan Kuehn	ryan.kuehn@netl.doe.gov	FECM	Machine Learning	Releasable to Public	No

Use ML to reduce high-fidelity physical models to a fast calculation that requires minimal effort to initiate.	US Department of Energy	The platform will combine an intuitive user interface and visualization capabilities from gaming software with the speed and enhanced detail in evaluating reservoir dynamics and processes through ML /reduced order model approaches. Advancements made with ML will alleviate the need for both the expert user and the computational infrastructure and make understanding subsurface fluid flow accessible to the everyday user with a moderate level of understanding of the physics of the system. ML will allow the experts to reduce the high-fidelity physical models to a fast calculation that requires a minimal amount of effort to initiate, but allows a user to investigate their own scenarios without the need for predetermined models. Application of the platform will rapidly enhance the experience base required for deploying and managing commercial-scale projects, particularly for CO2 storage projects where field experience is limited, because of the anticipated intuitive translation of subsurface dynamics in real-time.	Ryan Kuehn	ryan.kuehn@netl.doe.gov	FECM	Machine Learning, Improving Data Quality, Decision Intelligence	Releasable to Public	Research and Development
To provide an effective quality assurance method for additively manufactured gas	U.S. Department of Energy	The primary goal of this project is to develop a cost-effective quality assurance (QA) method that can rapidly qualify laser powder bed fusion (LPBF) processed hot gas path turbine components (HGPTCs) through a machine learning framework which would assimilate in-situ monitoring and measurement, ex-situ characterization, and simulation data. The project technical deliverable will be a rapid QA tool capable of: i) building a metadata package of process-structure-property data and models intended for LPBF-processed HGPTCs by mining both simulation and in-situ/ex-situ characterization data; and ii) qualifying online/offline a manufactured component by inputting simulation with/without in-situ monitoring data to the developed algorithms to predict porosity and fatigue properties. The target application of this QA tool will be advanced HGPTC produced by LPBF in Inconel 718. Data mining techniques will be developed to consolidate and analyze the heterogeneous big data stemmed from the aforementioned methods of upfront simulation, online monitoring and post-build characterization, and thus enabling a collaborative learning about the process-microstructure-properties relationship. The resultant QA package includes a process-structure-property database and machine learning tools for using LPBF metal AM to fabricate HGPTC. The developed metadata package enables online/offline qualification of additively manufactured turbine components by inputting simulation with/without in-situ monitoring data to the developed machine learning algorithms to predict porosity and fatigue properties.	Richard Dennis	Richard.Dennis@unnpp.gov	FECM	Artificial Intelligence	Releasable to Public	No
To deploy dynamic neural network optimization to minimize heat rate during ramping for coal.	US Department of Energy	The primary objective of the proposed work is to 1) deploy dynamic neural network optimization (D-NNO) to minimize heat rate during all phases of operation (ramping, low load, and high load) at a coal power plant. The project will build a high-fidelity, systems-level, dynamic model of the plant for a rapid prototyping environment for the D-NNO and to allow researchers to better understand the dynamic phenomena that occur during ramping and at various plant loads, and Commercialize D-NNO as a readily-available software application by working with an industry-proven software platform. The plant will be perturbed over time to allow machine learning (ML) models to be fitted to the plant's response data.	Ryan Kuehn	ryan.kuehn@netl.doe.gov	FECM	Deep Learning - Neural Nework	Releasable to Public	No
	US Department of Energy	The project developed a framework and process to translate industrial control system features to a machine-readable format for use with automated cyber tools. This research also examined other current and evolving standards for usability with diverse grid architectures that represent a set of variable conditions to establish the foundation for determining where future research should focus and to support improvements to industry standards and architecture designs for machine-learning cyber defense solutions. This project's success can serve as the foundation for prioritizing the next research steps to realize automated threat response, improving the timeliness and fidelity of cyber incident consequence models, and enriching national capabilities to share actionable threat intelligence at machine speed.	Mitchell C. Kerman		INL	Machine Learning, Cybersecurity	Releasable to Public	No

To implement lifetime model prediction for Ni-based superalloy power plant components	US Department of Energy	The project focus is to improve available lifetime prediction models using data obtained from based nickel-based superalloy power plant components that have undergone long-term service. Technical objectives include evaluating the complementarity between deterministic and probabilistic models for gas turbine material systems, characterizing the microstructure and mechanical and thermal properties of components that have operated in power plants for periods of time between 8,000h and 32,000h and using the microstructural characterization data to validate the lifetime models based on the service history of the components.	Ryan Kuehn	ryan.kuehn@netl.doe.gov	FECM	Big Data	Releasable to Public	No
	US Department of Energy	The project goal is to prove that enhancing attack detection via innovative machine learning and artificial intelligence techniques into the fifth generation (5G) cellular network can help to secure mission-critical applications, such as automated vehicles and drones, connected health, emergency response operations, and other mission-critical devices that either are or will be connected to the 5G cellular network.	Mitchell C. Kerman		INL	Machine Learning, Cybersecurity	Releasable to Public	No
To implement high temperature electrochemical sensors for in-situ corrosion monitoring in coal-based power generation boilers.	US Department of Energy	The project is collecting metal degradation data in the electrochemical corrosion system and developing a predictive model and database relevant to performance of materials under industrial conditions. Corrosion monitoring software will be developed. The software will be able to receive and process the sensing data during testing at a plant site. The software will be able to accurately track and predict corrosion progress before damage occurs and interface with existing plant programmable logic controllers (PLCs) to promote condition-based maintenance (CBM) scheduling.	Ryan Kuehn	ryan.kuehn@netl.doe.gov	FECM	Sensor Network	Releasable to Public	No
To develop a general drag model for assemblies of non-spherical particles created with artificial neural networks	US Department of Energy	The project plans to develop a more accurate artificial neural network (ANN)-based method for modeling the momentum exchange in fluid-solid multiphase mixtures to significantly improve the accuracy and reduce the uncertainty of multiphase numerical codes and, in particular, of MFiX, by developing and providing a general and accurate method for determining the drag coefficients of assemblies of non-spherical particles for wide ranges of Reynolds numbers, Stokes numbers, and fluid-solid properties and characteristics. The research team will achieve this goal by conducting numerical computations with a validated in-house CFD code and using artificial intelligence methods to develop an ANN that will be implemented in TensorFlow and linked with the MFiX code.	Ryan Kuehn	ryan.kuehn@netl.doe.gov	FECM	Deep Learning - Neural Nework	Releasable to Public	No
To develop a robotic inspection tool to evaluate the structural integrity of key components in fossil fuel power plants.	US Department of Energy	The project will design and develop a prototype robotic system capable of navigating through a complex piping system and provide information (visual, UT, LiDAR) on the structural integrity of the pipes	Ryan Kuehn	ryan.kuehn@netl.doe.gov	FECM	Robotics	Releasable to Public	No
To develop a novel end-to-end trainable artificial intelligence (AI)-based multivariate time series learning system for flexible and scalable coal power plant fault detection and root cause analysis.	US Department of Energy	The project will design and develop the individual modules of the DANCE4CFDD AI system, including the data process pipeline for training and evaluation, AI model, AI training pipeline, and performance evaluation module. The system will be designed to allow flexibility of experimenting with alternative strategies, while maintaining a consistent performance evaluation. The project will identify the best model structure, hyper parameters, and training algorithm. The project will conduct an extensive set of experiments to study the effect of different model structure, hyper parameters, and training algorithms and aim to identify the best model and learning strategy for accurate fault detection and diagnosis.	Ryan Kuehn	ryan.kuehn@netl.doe.gov	FECM	AI	Releasable to Public	No
To develop and evaluate a general drag model for gas-solid flows via physics-informed deep machine learning	US Department of Energy	The project will evaluate the performance of several ANN algorithms for machine learning, pertinent to the deep neural network (DNN) algorithms. The DNN candidates will include random forest (RF), BPNN, XGBoost, and other supervised deep neural network algorithms. The best DNN algorithm will be identified by ranking of these algorithms' performance. The Recipient will integrate the deep learning ANN model (DNN model) into the multiphase flow simulation software MFiX-DEM, which is part of the NETL's open source CFD suite of software MFiX. The DNN based drag model developed on TensorFlow will be implemented using NETL's existing software links between MFiX and TensorFlow.	Ryan Kuehn	ryan.kuehn@netl.doe.gov	FECM	Deep Learning - Neural Nework	Releasable to Public	No

To use advanced machine learning techniques to analyze static and dynamic measurements of proppant distribution and fracture geometry data.	US Department of Energy	The project will use advanced ML techniques to analyze static and dynamic measurements of proppant distribution and fracture geometry data from thousands of microchips injected with proppant near the wellbore.	Ryan Kuehn	ryan.kuehn@netl.doe.gov	FECM		Machine Learning	Releasable to Public	No
To leverage machine learning and predictive analytics to advance the state of the art in pipline infrastructure integrity management.	US Department of Energy	The purpose of this project is to leverage advances in machine learning and predictive analytics to advance the state of the art in pipeline infrastructure integrity management using forecasted (predicted) pipeline condition, using large sets of pipeline integrity data (periodic nondestructive inspection, NDI) and continuous operational data (e.g., sensor data used to monitor flow rate and temperature) generated by oil and gas (O&G) transmission pipeline operators.	Ryan Kuehn	ryan.kuehn@netl.doe.gov	FECM		Cybersecurity	Releasable to Public	No
	US Department of Energy	The Resilient Attack Interceptor for Intelligent Devices approach focuses on developing external monitoring methods to protect industrial internet of things devices by correlating observable physical aspects that are produced naturally and involuntarily during the operational lifecycle with anomalous functionality.	Mitchell C. Kerman		INL		Artificial Intelligence, Cybersecurity	Releasable to Public	No
	US Department of Energy	The standard thermal diffusivity measurement technique laser flash is enhanced by modifying the traditional experimental set up and analyzing results with a machine learning based tool that includes a finite element model, a least-squares fitting algorithm and experimental data treatment algorithms. This tool helps elucidate thermo-physical properties of a material from a single laser flash measurement.	Mitchell C. Kerman		INL		Machine Learning, materials science	Releasable to Public	No
	US Department of Energy	The team hypothesizes that artificial intelligence can predict events using the integrated data from test bed sensors and physics-based models. A second hypothesis is that integrating software and artificial intelligence with sensor data from a test bed will lead to a framework for future digital twins. The team will train artificial intelligence models to determine what attributes are most important for enabling intelligent autonomous control and will determine best practices for digital twin cybersecurity.	Mitchell C. Kerman		INL		Artificial Intelligence, nuclear engineering, Cybersecurity	Releasable to Public	No
To drive insights into solid oxide cell performance and degradation through big data analysis and computer vision	US Department of Energy	The team uses deep learning models to analyze large banks of high-dimensional simulation results, determine the most impactful input parameters, produce tailored recommendations for industrial manufacturers, and ultimately generate a reduced-order model for predicting long-term performance of solid oxide cells. The team is also developing computer vision models to extract critical high-resolution information from easily obtained low-resolution or 2D microstructural data, and also using computer vision to super-resolve that low-resolution data, producing full sets of high-resolution 3D data from low-resolution 3D tomography or even from 2D micrographs. The team has recently developed and published a generative adversarial network model for generating high-fidelity synthetic microstructural data of solid oxide cells. Machine learning is also used in the team's reduced order phase field simulations of microstructural changes.	Ryan Kuehn	ryan.kuehn@netl.doe.gov	FECM		Deep Learning, Computer Vision, Generative Adversarial Networks	Releasable to Public	Research and Development
	US Department of Energy	This approach exploits the millimeter wave beam directionality and utilizes the beam sensing capabilities at end devices to prove that an autonomous radio frequency beam scheduler can support secure 5G spectrum sharing and guarantee optimality for base stations. Measurements and predictive analytics are used to develop the autonomous beam scheduling algorithms. These improvements will benefit mission critical communications and emergency response operations as well as enable secure communication for critical infrastructure without expensive and competitive licensed bands.	Mitchell C. Kerman		INL		Predictive analytics, autonomous optimization, 5G communication	Releasable to Public	No
	US Department of Energy	This project addressed limitations in current probabilistic risk assessment (PRA) by combining a support vector machine and PRA software to auto-detect system design vulnerabilities and find previously unseen issues, reduce human error, and reduce human costs. This method does not require training data that would only be available in the event of system or subsystem failures.	Mitchell C. Kerman		INL		Machine Learning, probabilistic risk assessment	Releasable to Public	No

To develop a robotics enabled eddy current testing system for autonomous inspection of heat exchanger tubes.	US Department of Energy	This project aims to developi recurrent neural networks (RNNs) trained by categorized historic data and newly measured data for insitu analysis of the measurement to realize autonomous inspection of exchange heat tubes. The developed testing system is expected to show artificial intelligence-powered autonomy with enhanced measurement accuracy and efficiency.	Ryan Kuehn	ryan.kuehn@netl.doe.gov	FECM	Deep Learning - Neural Nework	Releasable to Public	No
	US Department of Energy	This project developed method to analyze collected radiation spectra using advanced, scalable deep learning by combining spectroscopic expertise with high performance computing. Sophisticated deep learning can overcome the weaknesses of existing spectroscopic techniques and enhance the value of difficult measurements. This method was trained, tested, and operated on the International Space Station’s Spaceborne Computer-2 supercomputer, returning zero errors over the course of 100 training hours. This demonstrated performance autonomously in far-edge, low-wattage computing situations and in hazardous radiological environments where interference can cause errors.	Mitchell C. Kerman		INL	Deep Learning, Machine Learning, spectroscopy	Releasable to Public	No
	US Department of Energy	This project focuses on the reduction of manual labor and operational cost required for training an electromagnetic (EM)-based anomaly detection system for legacy industrial control systems devices and Industrial Internet of Things. This research would enable EM-based intrusion detection systems to be deployed to protect legacy control systems.	Mitchell C. Kerman		INL	Machine Learning, anomaly detection, Cybersecurity	Releasable to Public	No
	US Department of Energy	This project uses post irradiation examination of uranium-10wt.% zirconium (UZr) metallic fuel as a case study to show how artificial intelligence (AI)-based technology can facilitate and accelerate nuclear fuel development. The approach will 1) revisit the microstructural image and local thermal conductivity data collected from UZr, 2) build a benchmark dataset for the microstructural patterns of irradiated UZr, and 3) train the machine learning and deep learning models to uncover the relationships between micro/nanoscale structure, zirconium phase redistribution, local thermal conductivity, and engineering scale fuel properties.	Mitchell C. Kerman		INL	Artificial Intelligence, Machine Learning, Deep Learning, nuclear engineering, materials science	Releasable to Public	No
	US Department of Energy	This project will address the efficient use of limited experimental data available for nuclear digital twin (NDT) training and demonstration. This involves developing sparse data reconstruction methods and using NDT models to define sensor requirements (location, number, accuracy) for the design of demonstration experiments. NDTs should leverage 1) sparse sensing for identifying optimal locations and the minimal set of required sensors and 2) sparse learning and recovery of full maps of responses of interest for stronger prediction, diagnostics, and prognostics capabilities.	Mitchell C. Kerman		INL	Sensor Networks, nuclear engineering	Releasable to Public	No
	US Department of Energy	This project will apply machine learning to accelerate multiphysics computation through automatic identification of regions with large nonlinearity. The efficacy of the new algorithm will be tested against several multiphysics problems that exhibit poor convergence with current state-of-the-art methods. This will be the first step in studying deep learning techniques to enable multiphysics simulations that are prohibitively expensive when conducted via conventional scientific computing schemes.	Trevor Prescott	trevor.prescott@hq.doe.gov		Deep Learning, Machine Learning, computational science	Releasable to Public	No
	US Department of Energy	This project will develop a learning-based and digital twin enabled modeling and simulation framework for economic and resilient real-time decision-making of physics-informed integrated energy systems (IES) operation. High-fidelity physics models will be linked with large-scale grid monitoring data to provide real-time updates of IES states, predictive control systems, and optimized power dispatch solutions. Learning-based algorithms will make real-time decisions upon detection of component contingencies caused by climate-induced or man-made extreme events, such as cyber-attacks or extreme weather, thereby mitigating their impacts through appropriate counter measures.	Mitchell C. Kerman		INL	Artificial Intelligence, integrated energy systems	Releasable to Public	No
	US Department of Energy	This project will develop a novel deep reinforcement learning approach that can manage distributed or tightly coupled multi-agent systems utilizing deep neural networks for automatic system representation, modeling, and end-to-end learning. This new control method will enable complex, nonlinear system optimization over timescales from milliseconds to months.	Mitchell C. Kerman		INL	Deep Learning, Reinforcement Learning, Artificial Intelligence, Neural Networks	Releasable to Public	No

US Department of Energy	This project will develop a novel physics-based tool that combines 1) reduced-order models, 2) machine learning algorithms, 3) fuel performance methods, and 4) state-of-the-art thermal property characterization equipment and irradiated nuclear fuel data sets to accelerate nuclear fuel discovery, development, and deployment. The models will describe thermal conductivity, specific heat, thermal expansion, and self-diffusion coefficients as a function of temperature and irradiation.	Mitchell C. Kerman	INL	Machine Learning, nuclear engineering	Releasable to Public	No
US Department of Energy	This project will develop a system that utilizes non-traditional measurement sources such as vibration, acoustics, current, and light, and traditional sources such as flow, and temperature in conjunction with data-based, machine learning techniques that will allow for signal discovery. The goal is to characterize stages within a solvent extraction process can increase target metals recovery, indicate process faults, account for special nuclear material, and inform near real-time decision making.	Mitchell C. Kerman	INL	Machine Learning, nuclear nonproliferation	Releasable to Public	No
US Department of Energy	This project will develop machine learning enabled integrated resource planning methodologies to help quantify key resilience elements across integrated energy systems and their vulnerabilities to threats and hazards. This includes the ability to accurately analyze and visualize a region's critical infrastructure systems ability to sustain impacts, maintain critical functionality, recover from disruptive events. This advanced decision support capability can improve our understanding of these complex relationships and help predict the potential impacts that microreactors and distributed energy resources have on the reliability and resiliency of our energy systems.	Mitchell C. Kerman	INL	Machine Learning, neural network, Cybersecurity	Releasable to Public	No
US Department of Energy	This project will develop passive instrumentation to determine permanent strains induced by irradiation and extract critical parameters using modeling and simulation as well as machine learning algorithms. An irradiation experiment will be conducted that will benefit from engineered anisotropic materials and characterize the directional deformation in response to neutron radiation. The results of the experiment will be incorporated into the model so that the material response can be predicted for future uses as a probe material.	Mitchell C. Kerman	INL	Machine Learning, materials science	Releasable to Public	No
US Department of Energy	This project will develop the capability to intelligently control and optimize advanced manufacturing processes instead of the existing trial and error approach. To achieve this goal, artificial intelligence (AI) based control algorithms will be developed by employing deep reinforcement learning. To reduce the computational expense with advanced manufacturing models, physics-informed reduced order models (ROMs) will be developed. The AI-based control algorithms will employ the ROMs' predictions to adaptively inform processing decisions in a simulation environment.	Mitchell C. Kerman	INL	Artificial Intelligence, deep reinforcement learning, advanced manufacturing	Releasable to Public	No
US Department of Energy	This project will implement an advanced machine learning based 5G attack detection system that can achieve high classification speed (10k packets per second) with high accuracy (90% or greater) as well as address a vulnerability to zero-day attacks (90% accuracy against real zero-day attacks recorded by Amazon Web Services) using field programmable gate array based deep autoencoders.	Mitchell C. Kerman	INL	Machine Learning, Cybersecurity	Releasable to Public	No
US Department of Energy	This project will research artificial intelligence enabled Monte Carlo algorithms to significantly reduce the computational burden by reducing the number of finite element evaluations when estimating low failure probabilities. These will be implemented in the Multiphysics Object-Oriented Simulation Environment, which will help the nuclear engineering community to efficiently conduct probabilistic failure analyses and uncertainty quantification studies for the design and optimization of advanced reactor technologies.	Mitchell C. Kerman	INL	Artificial Intelligence, nuclear engineering	Releasable to Public	No
US Department of Energy	This project will use machine learning interatomic potentials to study the influence of radiation damage on physical properties of calcium fluoride and uranium dioxide. Electron irradiation experiments and thermal conductivity measurements will be performed to validate the effectiveness of the developed potentials. The high throughput capability of this method will become an important combinatorial materials science tool for developing and qualifying new nuclear fuels.	Mitchell C. Kerman	INL	Machine Learning, materials science	Releasable to Public	No
US Department of Energy	This research identified and labeled type and structure data in an automated and scalable way such that the information can be used in other tools and other Reverse Engineering at Scale research areas such as symbolic execution. This was done initially by utilizing heuristic methods and then scaled by adopting a machine learning approach.	Mitchell C. Kerman	INL	Machine Learning, reverse engineering	Releasable to Public	No

	US Department of Energy	This research uses state-of-the-art machine learning (ML) techniques in a new and novel manner to identify and correlate the critical microstructural features in a multiphase alloy that exhibits high strength and fracture toughness. Experimental data will be used to train a convolutional neural network (CNN) in a semi-supervised environment to identify key microstructural features and correlate those features with the strength and toughness. The resulting machine learning tool can be trained for additional microstructural features, different alloys, and/or target mechanical properties.	Mitchell C. Kerman		INL	Machine Learning, convolutional neural network, materials science	Releasable to Public	No
	US Department of Energy	This research will advance the state of the art for red team security assessment of machine learning and artificial intelligence systems by providing methods for the reverse engineering, exploitation, risk assessment and vulnerability remediation. The insights gained from the explorations into vulnerability assessment research will proactively address critical gaps in the cybersecurity community's understanding of these systems and can be used to create appropriate risk evaluation metrics and provide best practices for inclusion into consequence-driven cyber-informed engineering.	Mitchell C. Kerman		INL	Artificial Intelligence, Machine Learning, reverse engineering, Cybersecurity	Releasable to Public	No
	US Department of Energy	This research will develop a digital twin of a centrifugal contactor system that receives data from traditional and real time sensors, constructs a digital representation or simulation of the chemical separations component within the nuclear fuel cycle, and performs data analysis through machine learning to determine anomalies, failures, and trends. The research will include the identification and implementation of advanced artificial intelligence, machine learning, and data analysis techniques advised by a team of nuclear safeguards experts.	Mitchell C. Kerman		INL	Machine Learning, Artificial Intelligence, nuclear nonproliferation	Releasable to Public	No
	US Department of Energy	This research will develop a methodology that relies on mechanism-informed machine learning models, rapid ion irradiation and creep testing techniques, and advanced characterization coupled with automated image analysis to enable reactor developers to quickly understand the complex linkage between alloy composition, thermomechanical processing, the resulting microstructure, and swelling and creep behavior. This project will (1) develop and demonstrate a high-potential methodology for rapid development of future in-core materials and (2) provide critically important information on alloy design for optimized swelling and creep behavior to the advanced reactor development community.	Mitchell C. Kerman		INL	Machine Learning, nuclear engineering, materials science	Releasable to Public	No
	US Department of Energy	This research will investigate in situ the effects of different components on the degradation behavior in a solid-state ceramic membrane reactor by embedding sensors that will collect current and impedance data during operation. Artificial intelligence will be used to understand the large amounts of data and predict reactor failure under harsh operating conditions.	Mitchell C. Kerman		INL	Artificial Intelligence, Deep Learning, Sensor Network, materials science	Releasable to Public	No
To assess the amount and valence state of heavy metals in coal fly ash	US Department of Energy	This research will systematically characterize arsenic (As) and selenium (Se) speciation within a representative matrix of coal fly ashes using state-of-the-art synchrotron X-ray spectroscopic and microscopic techniques in order to develop a comprehensive correlation and searchable database for coal source/type, generation condition, As/Se speciation, and As/Se mobility. The resulting database will detail correlations among coal type and source, utility operating conditions, and As/Se speciation and mobility.	Ryan Kuehn	ryan.kuehn@netl.doe.gov	FECM	Big Data	Releasable to Public	No
To develop high fidelity tools which run in near real time not only help in the field to guide and optimize complex operations but can be used as digital twins	US Department of Energy	To develop high fidelity tools which run in near real time not only help in the field to guide and optimize complex operations but can be used as digital twins for cyber security and cyber-physical modeling.	Ryan Kuehn	ryan.kuehn@netl.doe.gov	FECM	Big Data	Releasable to Public	Research and Development

To build the first data analytics and artificial intelligence field laboratory for unconventional resources in the Powder River Basin, focusing on optimization of hydraulic fracture stimulations through the use of multiple diagnostic technologies.	US Department of Energy	To establish a tight oil Field Laboratory in the Powder River Basin and accelerate the development of three major unconventional oil resources through detailed geologic characterization and improved geologic models leading to significant advances in well completion and fracture stimulation designs specific to these three formations. Utilize multi-variate analysis to understand the interrelationship between completion and stimulation controls on well productivity.	Ryan Kuehn	ryan.kuehn@netl.doe.gov	FECM	AI	Releasable to Public	No
To apply machine learning applications to map carbon ore, rare earth element, and critical mineral resources	US Department of Energy	To identify information gaps, GIS and machine learning applications will be used to map carbon ore, rare earth element, and critical mineral resource infrastructure, and market data in consultation with NETL geospatial modeling activities. Research needs and technology gaps will be assessed, and resources targeted for sampling and characterization. This effort will provide a complete Northern Appalachian carbon ore, rare earth element, and critical mineral value chain basinal assessment to enable quick development of commercial projects.	Ryan Kuehn	ryan.kuehn@netl.doe.gov	FECM	Big Data	Releasable to Public	No
Using natural language processing to explore and extract information from historical literature/pdfs	US Department of Energy	Training and adaptation of natural lanaguage processing algorithms to improve exploration and extraction of information from old, historical scientific literature. Extraction of knowledge and data, as well as preservation of key information.	Ryan Kuehn	ryan.kuehn@netl.doe.gov	FECM	Machine Learning, Natural Langauge Processing, Big Data	Releasable to Public	Research and Development
	US Department of Energy	Typical contingency analysis for a power utility is limited to n-1 due to computational complexity and cost. A machine learning framework and resilience-chaos plots are leveraged to reduce computational expense required to discover, with 90% accuracy, n-2 contingencies by 50%.	Mitchell C. Kerman		INL	Machine Learning, Cybersecurity	Releasable to Public	No
Advanced Image Segementation	US Department of Energy	U-Net CNN segmentation to isolate pore and fluid from computed tomography scans of multiphase transport in cores.	Ryan Kuehn	ryan.kuehn@netl.doe.gov	FECM	Data Labeling	Releasable to Public	Research and Development
To improve subsurface stress characterization for carbon dioxide storage projects by incorporating machine learning techniques.	US Department of Energy	Use deep neural network machine learning with convolutional and recurrent layers to improve clustering of microseismic events using their spectro-temporal patterns. Develop innovative machine learning assisted process for calibrating a coupled stress prediction model through “history matching” with observations of stress dependent behavior derived from geophysical analyses including and especially those developed in this project.	Ryan Kuehn	ryan.kuehn@netl.doe.gov	FECM	Machine Learning	Releasable to Public	No
Machine Learning for geophysical data inversion	US Department of Energy	Use machine learning to generate synthetic seismic and gravity data, and data driven inversion for leak detection	Ryan Kuehn	ryan.kuehn@netl.doe.gov	FECM	Machine Learning	Releasable to Public	Research and Development
Machine learning for legacy well evaluation	US Department of Energy	Use machine learning to identify common attributes that correlated to well integrity issues to prioritize for monitoring and remediation.	Ryan Kuehn	ryan.kuehn@netl.doe.gov	FECM	Machine Learning	Releasable to Public	Research and Development
Using AI to improve predcitions of subsurface properties, analyze multi-variate inputs, address knowledge and information gaps to improve predictions and modeli	US Department of Energy	Use of AI methods such as fuzzy logic, neural networks, tensor flow, and natural language processing to assist with knowledge and data exploration, transformation and integration, as well as modeling and analysis of multi-variate data used in the resource assessment method to improve outputs and predictions.	Ryan Kuehn	ryan.kuehn@netl.doe.gov	FECM	Machine Learning, Decision Intelligence, Deep Learning	Releasable to Public	Research and Development

To analyze data and derive insights and improve predictions to forecast wellbore kick events to reduce loss of control events.	US Department of Energy	Use of neural networks and/or AI cluster data analysis methods to improve detection and forecasting of wellbore and drilling related loss of control events, known as kicks, to imrpove real-time detection and prediction of these conditions.	Ryan Kuehn	ryan.kuehn@netl.doe.gov	FECM	Deep Learning (Neural Networks)	Releasable to Public	Research and Development
To automate data acquisition, exploration, transformation and integration	US Department of Energy	Using AI deep learning and natural language processing capabilities to explore, transform and integrate datasets from Fossil Energy Carbon Management (FECM) program funded projects to derive crosscutting insights, generate new, integrated datasets/databases, and support energy, environmental and infrastructure related studies going forward.	Ryan Kuehn	ryan.kuehn@netl.doe.gov	FECM	Machine Learning, Natural Langauge Processing, Big Data	Releasable to Public	Research and Development
To use data analytics and machine learning techniques to advance understanding of the characteristics of the Emerging Paradox Oil Play	US Department of Energy	Using data analytics and machine learning techniques to advance understanding of the characteristics of the entire Parardox oil play through integration of geologic and log-derived "electrofacies" models and upscaling to 3D seismic data and propagation through the seismic volume.	Ryan Kuehn	ryan.kuehn@netl.doe.gov	FECM	Machine Learning	Releasable to Public	No
To implement machine learning to identify the micro-seismic during fracking	US Department of Energy	Using machine learning, geophysics, and civil engineering to develop a tool that can identify the micro-seismic events to help manage operations and mitigate the risk of hazardous seismic events during drilling and fracking operations. This tool uses novel deep learning algorithms for detailed real-time discrimination. The developed technology will be leveraged for the US Air Force, which uses deep learning to discriminate nuclear blast from earthquakes through a global sensor network.	Ryan Kuehn	ryan.kuehn@netl.doe.gov	FECM	Machine Learning	Releasable to Public	No
To help automate data integration and exploration for geologic core properties related information.	US Department of Energy	Using natural language processing, deep learning neural networks, and possibly tensor flow for image analytics.	Ryan Kuehn	ryan.kuehn@netl.doe.gov	FECM	Machine Learning, Natural Langauge Processing, Big Data	Releasable to Public	Research and Development
Using a combinaton of AI/ML methods to address data and knowledge extraction, as well as to provide modeling analysis to improve prediction of subsurface proper	US Department of Energy	Using several AI/ML methods to i) improve information and knowledge extraction from images, graphs, and text-based geoscience products to improve data and knowledge available for modeling. Ii) also using deep learning methods such as neural networks and tSNE cluster analytics to model and improve prediction of subsurface reservoir properties.	Ryan Kuehn	ryan.kuehn@netl.doe.gov	FECM	Natural Language Processing, Deep Learning, Small and Wide Data	Releasable to Public	Research and Development
To improve coal fired plant performance through integrated predictive and condition-based monitoring tools	US Department of Energy	Various recurrent neural networks (RNNs) will be trained, starting with traditional recurrent neural network architectures such as Jordan and Elman RNNs. Recurrent neural networks are highly effective for predicting time series data, as they contain "memory" neurons which preserve information from previous passes through the RNN. Jordan RNNs take the output of the previous prediction using the previous input time series data, and feed that back into the hidden layer for the next input time series data. Elman RNNs instead preserve the values from the hidden layer and feed those into the next hidden layer. Using architectures such as Jordan and Elman RNNs as a baseline, progressively more complex RNNs will be developed using neuro-evolution techniques such as an Ant Colony Optimization based algorithm and Neuro-Evolution of Augmenting Topologies (NEAT). Long Short-Term Memory architectures will also be examined and optimized. The goal will be to find the simplest structure that has the most reliable predictions. An RNN with a simpler architecture is favorable, as it provides less opportunity for unforeseen effects to occur given unseen data.	Ryan Kuehn	ryan.kuehn@netl.doe.gov	FECM	Deep Learning - Neural Nework	Releasable to Public	No
To verify and validate testing of advanced power generation technologies	US Department of Energy	Verification and validation testing with direct support and collaboration from operating power plants with advanced power generation technologies and prime mover and downstream systems using near-real-time data, resulting in better informed plant operators, and reduced disruptions, while meeting changing service demands based on enhanced operating flexibility	Ryan Kuehn	ryan.kuehn@netl.doe.gov	FECM	Big Data	Releasable to Public	No

To use machine learning to assist in data analysis for the history of plastic upcycling.	US Department of Energy	We currently use data mining to analyze the overall plastic upcycling technology used through different decades, including the distribution of types of plastic, and the types of technology for specific types of plastic over time. We will incorporate machine learning to find appropriate articles and find trends it could be able to anticipate future trends. Ultimate goal is to develop a big data-based AI/ML tools to predict products of gasification process using varied fuels, i.e., coal, biomass, plastics and their mixtures.	Ryan Kuehn	ryan.kuehn@netl.doe.gov	FECM	Machine Learning	Releasable to Public	Research and Development
To predict the presence of faults susceptible to movement in the presence of fluid injection	US Department of Energy	Will apply and develop deep learning approaches to identify unique signals from microseismic sources, properties, and locations related to the induced seismicity, and to detect low magnitude events and undetected/hidden fault/fracture systems. Project will modify an open-source convolutional neural network code (e.g. ConvNetQuake) that is very effective and computationally powerful in classification problems. The approach will train using a large dataset of waveforms from the IBDP site where event locations will be labeled using the K-means clustering and joint-inversion results); the waveform data will be divided into event windows. To avoid overfitting of data-driven models, project will increase training sets recorded at multiple stations by perturbing actual data with noise. The input for the deep learning approach will be multi-channel waveform data. These trained models will predict and classify the data as either noise or microseismic event. This approach will allow the Recipient to discover new data features that improve identification of undocumented microseismic events and undetected faults to improve the geological model and the forward model.	Ryan Kuehn	ryan.kuehn@netl.doe.gov	FECM	Deep Learning - Neural Nework	Releasable to Public	No
With sensor technologies and network developed, in the future, AI/ML may be used to accelerate data processing of sensor data from the sensor network.	US Department of Energy	With sensor technologies and network developed, in the future, AI/ML may be used to accelerate data processing of sensor data from the sensor network to identify and predict risks and failures in plugged wells.	Ryan Kuehn	ryan.kuehn@netl.doe.gov	FECM	Machine Learning, Sensor Networks, Generative Adversarial Networks	Releasable to Public	Research and Development

185 were identified as releasable to the public
26 were REMOVED

17 were identified by SC to be removed
3 were identified by OE to be removed
9 were duplicates tied to different projects