Question 1. AI Use Case Identifying Information				Question 2. Contact Information for Listed AI Use Case			Question 3. Summary
1A.AI use case name	1B. Agency with AI use case	Optional Note Field: To clarify 1B or to provide additional information (e.g. Agency co-development)	1C. Office with AI use case	2A. Last Name, First Name	2B. Email Address	2C. Additional point of contact name and email address	Provide a short summary (200 words max) of what the AI does. Include a high-level description of system inputs and outputs.
Using natural language processing to explore and extract information from historical literature/pdfs	Department of Energy		Environment Health, Safety & Security	Gonzalez, Felix	felix.gonzalez@hq.doe.gov		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.
To apply maching learning techniques	Department of Energy		Environment Health, Safety & Security	Gonzalez, Felix	felix.gonzalez@hq.doe.gov		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.
To provide an effective quality assurance method for additively manufactured gas	Department of Energy		Fossil Energy & Carbon Management	Dennis, Richard	Richard.Dennis@unnpp.gov		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.
Geochemically Informed Leak Detection (GILD)	Department of Energy		Fossil Energy & Carbon Management	Kuehn, Ryan	ryan.kuehn@netl.doe.gov		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.
To implement advanced analytical methodologies to research carbon capture solvent loss and degradation	Department of Energy		Fossil Energy & Carbon Management	Kuehn, Ryan	ryan.kuehn@netl.doe.gov		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.
To develop a deep-learning Artificial Intelligence model for analysis of fundamental combustion characteristics	Department of Energy		Fossil Energy & Carbon Management	Kuehn, Ryan	ryan.kuehn@netl.doe.gov		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.
To accurately predict alloy & component performance extrapolated to conditions where experimental results to do not exist.	Department of Energy		Fossil Energy & Carbon Management	Kuehn, Ryan	ryan.kuehn@netl.doe.gov		A ML workflow will be developed to accelerate the design and predict the performance of of high temperature alloys.
To implement novel SSC-CCS sensing technology and associated condition-based monitoring (CBM) software for improved understanding of the boiler tube failure mechanisms	Department of Energy		Fossil Energy & Carbon Management	Kuehn, Ryan	ryan.kuehn@netl.doe.gov		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.
To automate detection of power plant problems such as tube leaks.	Department of Energy		Fossil Energy & Carbon Management	Kuehn, Ryan	ryan.kuehn@netl.doe.gov		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 analysis, and cluster analysis. Successful algorithms will enable smarter operation and maintenance of the plant based on the operating data to avoid severe failures.
To develop a generation plant cost of operations and cycle optimization model.	Department of Energy		Fossil Energy & Carbon Management	Kuehn, Ryan	ryan.kuehn@netl.doe.gov		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.

Develop fast predictive models using novel machine-learning based methods.	Department of Energy	Fossil Energy & Carbon Management	Kuehn, Ryan	ryan.kuehn@netl.doe.gov	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.
To help automate data discovery and preparations to support a range of CS models, tools, and products	Department of Energy	Fossil Energy & Carbon Management	Kuehn, Ryan	ryan.kuehn@netl.doe.gov	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
To develop an AI enabled robots for automated nondestructive evaluation and repair of power plant boilers.	Department of Energy	Fossil Energy & Carbon Management	Kuehn, Ryan	ryan.kuehn@netl.doe.gov	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).
To accelerate data processing of large sensor dataset and for identification and classification of pipeline defects	Department of Energy	Fossil Energy & Carbon Management	Kuehn, Ryan	ryan.kuehn@netl.doe.gov	AI/ML will be used for identification of signatures and patterns representative of hazards, defects, and operational parameters of the natural gas pipeline network.
To accurately predict alloy & component performance extrapolated to conditions where experimental results to do not exist.	Department of Energy	Fossil Energy & Carbon Management	Kuehn, Ryan	ryan.kuehn@netl.doe.gov	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.
To drive insights on emissions from natural gas production, storage, and transmission to determine how best to reduce emissions	Department of Energy	Fossil Energy & Carbon Management	Kuehn, Ryan	ryan.kuehn@netl.doe.gov	AI/ML will be used to recognice patterns in well integrity records that could predict failure events
To develop an Artificial intelligence-based model for rotating detonation engine designs	Department of Energy	Fossil Energy & Carbon Management	Kuehn, Ryan	ryan.kuehn@netl.doe.gov	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.
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	Department of Energy	Fossil Energy & Carbon Management	Kuehn, Ryan	ryan.kuehn@netl.doe.gov	An artificial intelligence/machine learning methodology is being developed for rapid design of sorbents tuned to specific ash impoundment and/or landfill requirements.
To drive insights through data-driven predictive modeling to forecast the remaining lifespan and future risk of offshore production platforms.	Department of Energy	Fossil Energy & Carbon Management	Kuehn, Ryan	ryan.kuehn@netl.doe.gov	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%.
ANN Submodels of Reaction Physics	Department of Energy	Fossil Energy & Carbon Management	Kuehn, Ryan	ryan.kuehn@netl.doe.gov	ANN development of flow physics for code acceleration
To implement high temperature electrochemical sensors for in-situ corrosion monitoring in coal-based power generation boilers.	Department of Energy	Fossil Energy & Carbon Management	Kuehn, Ryan	ryan.kuehn@netl.doe.gov	Application of Novel Analytic Method(s) to Determine Arsenic and/or Selenium Concentrations in Fly Ash Waste Streams Generated from Coal Combustion
To identify CO2 infrastructure needs and storage potential in the Southeastern United States.	Department of Energy	Fossil Energy & Carbon Management	Kuehn, Ryan	ryan.kuehn@netl.doe.gov	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.
To demonstrate multi-gamma based sensor technology for as-fired coal property measurement	Department of Energy	Fossil Energy & Carbon Management	Kuehn, Ryan	ryan.kuehn@netl.doe.gov	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.
To identify non-conventional SOFC geometries and advanced manufacturing of SOFC	Department of Energy	Fossil Energy & Carbon Management	Kuehn, Ryan	ryan.kuehn@netl.doe.gov	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.
To drive insights on the dependencies between the natural gas and electricity sectors to increase reliability of the NG system	Department of Energy	Fossil Energy & Carbon Management	Kuehn, Ryan	ryan.kuehn@netl.doe.gov	Commercially available models will be used to generate predictive scenarios
To drive insights on the power system reliability, cost, and operations during the energy transition with and without FECM technologies	Department of Energy	Fossil Energy & Carbon Management	Kuehn, Ryan	ryan.kuehn@netl.doe.gov	Commercially available models will be used to generate predictive scenarios

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.	Department of Energy	Fossil Energy & Carbon Management	Kuehn, Ryan	ryan.kuehn@netl.doe.gov	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.
To training machine learning (ML) algorithms using micro-seismic event data	Department of Energy	Fossil Energy & Carbon Management	Kuehn, Ryan	ryan.kuehn@netl.doe.gov	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.
Data platform to expedite access and reuse of carbon ore data for materials, manufacturing and research	Department of Energy	Fossil Energy & Carbon Management	Kuehn, Ryan	ryan.kuehn@netl.doe.gov	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.
To develoop low cost conversion of coal to graphene	Department of Energy	Fossil Energy & Carbon Management	Kuehn, Ryan	ryan.kuehn@netl.doe.gov	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).
To design high-efficiency reactors to achieve transformational capture of carbon dioxide	Department of Energy	Fossil Energy & Carbon Management	Kuehn, Ryan	ryan.kuehn@netl.doe.gov	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.
To implement machine learning to predict aerodynamic and combustion characteristics in hydrogen turbine	Department of Energy	Fossil Energy & Carbon Management	Kuehn, Ryan	ryan.kuehn@netl.doe.gov	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.
To automate development of proxy models for power generation combustion systems.	Department of Energy	Fossil Energy & Carbon Management	Kuehn, Ryan	ryan.kuehn@netl.doe.gov	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.
Detection of sand production from real-time production test data using ML categorical analysis	Department of Energy	Fossil Energy & Carbon Management	Kuehn, Ryan	ryan.kuehn@netl.doe.gov	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.
To implement unsupervised learning based interaction force model for nonspherical particles in incompressible flows	Department of Energy	Fossil Energy & Carbon Management	Kuehn, Ryan	ryan.kuehn@netl.doe.gov	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.
To develop a wireless high temperature sensor network for smart boiler systems	Department of Energy	Fossil Energy & Carbon Management	Kuehn, Ryan	ryan.kuehn@netl.doe.gov	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.
To develop 5G integrated edge computing platform for efficient component monitoring in coal-fired power plants	Department of Energy	Fossil Energy & Carbon Management	Kuehn, Ryan	ryan.kuehn@netl.doe.gov	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.
To optimize Artificial Intelligence to detect and localize currently undetectable legacy wellbores	Department of Energy	Fossil Energy & Carbon Management	Kuehn, Ryan	ryan.kuehn@netl.doe.gov	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
To develop efficient and economic hydraulic fracture diagnostics using metamaterials and edge AI	Department of Energy	Fossil Energy & Carbon Management	Kuehn, Ryan	ryan.kuehn@netl.doe.gov	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.

To implement boiler health monitoring using a hybrid first principles-artificial intelligence model	Department of Energy	Fossil Energy & Carbon Management	Kuehn, Ryan	ryan.kuehn@netl.doe.gov	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.
ML application for parameter estimation and lithofacies recognition using well-log data	Department of Energy	Fossil Energy & Carbon Management	Kuehn, Ryan	ryan.kuehn@netl.doe.gov	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
To develop a "Lizard" inspired robot for in-service inspection of power plant components that contain rough surfaces and limited accessibilities.	Department of Energy	Fossil Energy & Carbon Management	Kuehn, Ryan	ryan.kuehn@netl.doe.gov	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."
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.	Department of Energy	Fossil Energy & Carbon Management	Kuehn, Ryan	ryan.kuehn@netl.doe.gov	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."
To provide natural gas leak detection and quality control	Department of Energy	Fossil Energy & Carbon Management	Kuehn, Ryan	ryan.kuehn@netl.doe.gov	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
To apply machine learning methods to explore the inter-well uncertainty in the Goldsmith Landreth San Andres Unit and to update reservoir models.	Department of Energy	Fossil Energy & Carbon Management	Kuehn, Ryan	ryan.kuehn@netl.doe.gov	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.
To scale up a novel amine-based solvent CO2 capture technology	Department of Energy	Fossil Energy & Carbon Management	Kuehn, Ryan	ryan.kuehn@netl.doe.gov	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.
To implement artificial intelligence "real-time" hydrogen monitoring capabilities compatible with existing pipeline monitoring systems	Department of Energy	Fossil Energy & Carbon Management	Kuehn, Ryan	ryan.kuehn@netl.doe.gov	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.
To identify faults susceptible to induced seismicity	Department of Energy	Fossil Energy & Carbon Management	Kuehn, Ryan	ryan.kuehn@netl.doe.gov	Identification of faults susceptible to induced seismicity by integration of forward and joint inversion modeling, machine learning, and field calibrated geologic models.
To implement Artificial Intelligence Techniques to improve power plant performance	Department of Energy	Fossil Energy & Carbon Management	Kuehn, Ryan	ryan.kuehn@netl.doe.gov	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
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.	Department of Energy	Fossil Energy & Carbon Management	Kuehn, Ryan	ryan.kuehn@netl.doe.gov	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.

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.	Department of Energy	Fossil Energy & Carbon Management	Kuehn, Ryan	ryan.kuehn@netl.doe.gov	Laboratory experiments will be used to optimize a CO2 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.
Legacy well log data analysis for 3D basin model development.	Department of Energy	Fossil Energy & Carbon Management	Kuehn, Ryan	ryan.kuehn@netl.doe.gov	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.
To drive identification of metocean and seafloor geohazards that may impact offshore energy production and infrastructure	Department of Energy	Fossil Energy & Carbon Management	Kuehn, Ryan	ryan.kuehn@netl.doe.gov	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.
To drive insights on environmental performance of the natural gas system to inform effective mitigation strategies	Department of Energy	Fossil Energy & Carbon Management	Kuehn, Ryan	ryan.kuehn@netl.doe.gov	Life Cycle Analysis models will be used to define and estimate environmental parameters/performance
To automate RDE image analysis, machine learning for RDE image analysis is being employed.	Department of Energy	Fossil Energy & Carbon Management	Kuehn, Ryan	ryan.kuehn@netl.doe.gov	Machine learning algorithms are being developed and applied to analyze images of RDEs in operation to determine detonation wave mode, direction and speed.
To improve control of hybrid SOFC-gas turbine power systems.	Department of Energy	Fossil Energy & Carbon Management	Kuehn, Ryan	ryan.kuehn@netl.doe.gov	Machine learning algorithms are being developed and compared to other control methods for SOFC-gas turbine hybrid power generation systems.
To create reduced order models for predicting long term performance degradation behavior of fuel cells and electrolyzers.	Department of Energy	Fossil Energy & Carbon Management	Kuehn, Ryan	ryan.kuehn@netl.doe.gov	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.
To develop a high throughput computational framework of materials properties for extreme environments methods.	Department of Energy	Fossil Energy & Carbon Management	Kuehn, Ryan	ryan.kuehn@netl.doe.gov	Machine learning methods in the literature will be incorporated and validated to reduce the amount of first-principles calculations.
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.	Department of Energy	Fossil Energy & Carbon Management	Kuehn, Ryan	ryan.kuehn@netl.doe.gov	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.
To implement machine learning to study electrochemical performance of solid oxide electrolysis cell electrodes	Department of Energy	Fossil Energy & Carbon Management	Kuehn, Ryan	ryan.kuehn@netl.doe.gov	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.
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.	Department of Energy	Fossil Energy & Carbon Management	Kuehn, Ryan	ryan.kuehn@netl.doe.gov	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).
To leverage disparate data to update assessments, analytics, and infromation for NATCARB and CS Atlas	Department of Energy	Fossil Energy & Carbon Management	Kuehn, Ryan	ryan.kuehn@netl.doe.gov	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.
To drive insights on pipeline maintenance and repair strategies to reduce incidents of pipeline leakage; support evaluation of use and reuse strategies	Department of Energy	Fossil Energy & Carbon Management	Kuehn, Ryan	ryan.kuehn@netl.doe.gov	ML will be used to develop a pipeline risk assessment geospatial model and support evaluation of use and reuse opportunities.
To drive insights using machine learning-based dynamics, control, and health models and tools developed by NETL to gain valuable operational data, insights, and	Department of Energy	Fossil Energy & Carbon Management	Kuehn, Ryan	ryan.kuehn@netl.doe.gov	ML will be used to develop dynamics, controls, and health models for operating power generation facilities
ML-based proxy models and multi-level data driven fracture network imaging to support rapid decision making.	Department of Energy	Fossil Energy & Carbon Management	Kuehn, Ryan	ryan.kuehn@netl.doe.gov	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.
Use ML to enable a geophysical monitoring toolkit, and assimilate real-time modeling and data.	Department of Energy	Fossil Energy & Carbon Management	Kuehn, Ryan	ryan.kuehn@netl.doe.gov	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.
To provide insights into opportunities to beneficiate and use hydrocarbon infrastructure for alternative uses such as offshore carbon storage.	Department of Energy	Fossil Energy & Carbon Management	Kuehn, Ryan	ryan.kuehn@netl.doe.gov	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.

To automate selection or design of a functional sensor material for high temperature sensing.	Department of Energy	Fossil Energy & Carbon Management	Kuehn, Ryan	ryan.kuehn@netl.doe.gov	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 capabiility to predict the sensing performance data of other, simialr structure materials.
To evaluate current infrastructure throughout a study area and evaluating future infrastructure needs to accelerate the deployment of CCUS	Department of Energy	Fossil Energy & Carbon Management	Kuehn, Ryan	ryan.kuehn@netl.doe.gov	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.
Demonstrate the robust performance of our ML method in a commercial-scale synthetic data and integrate image-to-image mapping with convolutional neural networks	Department of Energy	Fossil Energy & Carbon Management	Kuehn, Ryan	ryan.kuehn@netl.doe.gov	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
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 (CO_2) plume during geologic carbon storage.	Department of Energy	Fossil Energy & Carbon Management	Kuehn, Ryan	ryan.kuehn@netl.doe.gov	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.
To develop drag models for non-spherical particles through machine learning	Department of Energy	Fossil Energy & Carbon Management	Kuehn, Ryan	ryan.kuehn@netl.doe.gov	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
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.	Department of Energy	Fossil Energy & Carbon Management	Kuehn, Ryan	ryan.kuehn@netl.doe.gov	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.
To design, proto-type and demonstrate a miniaturized implementation of a multi-process, high-spatial-resolution monitoring system for boiler condition management.	Department of Energy	Fossil Energy & Carbon Management	Kuehn, Ryan	ryan.kuehn@netl.doe.gov	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
To provide combustion performance and emissions optimization through integration of a miniaturized high-temperature multi process monitoring system	Department of Energy	Fossil Energy & Carbon Management	Kuehn, Ryan	ryan.kuehn@netl.doe.gov	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
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.	Department of Energy	Fossil Energy & Carbon Management	Kuehn, Ryan	ryan.kuehn@netl.doe.gov	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.
To develop sub-pilot-scale production of high-value products from U.S. coals	Department of Energy	Fossil Energy & Carbon Management	Kuehn, Ryan	ryan.kuehn@netl.doe.gov	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.
To implement AI methods for graphene production	Department of Energy	Fossil Energy & Carbon Management	Kuehn, Ryan	ryan.kuehn@netl.doe.gov	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.
To implement sensor-driven deep learning/artificial intelligence for power plant monitoring	Department of Energy	Fossil Energy & Carbon Management	Kuehn, Ryan	ryan.kuehn@netl.doe.gov	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.

To drive insights on water recovery from cooling tower plumes	Department of Energy	Fossil Energy & Carbon Management	Kuehn, Ryan	ryan.kuehn@netl.doe.gov	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
To provide integrated boiler management through advanced condition monitoring and component assessment.	Department of Energy	Fossil Energy & Carbon Management	Kuehn, Ryan	ryan.kuehn@netl.doe.gov	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.
To develop and validate sensor hardware and analytical algorithms to lower plant operating expenses for the pulverized coal utility boiler fleet	Department of Energy	Fossil Energy & Carbon Management	Kuehn, Ryan	ryan.kuehn@netl.doe.gov	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.
To leverage ML models to increase the size and complexity of problems that can be optimized within IDAES.	Department of Energy	Fossil Energy & Carbon Management	Kuehn, Ryan	ryan.kuehn@netl.doe.gov	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.
To field-test an advanced machine learning approach integrating controllable completions (interval control valves [ICVs]) to enable active well control during carbon dioxide (CO_2) enhanced oil recovery (EOR).	Department of Energy	Fossil Energy & Carbon Management	Kuehn, Ryan	ryan.kuehn@netl.doe.gov	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.
Use ML to reduce high-fidelity physical models to a fast calculation that requires minimal effort to initiate.	Department of Energy	Fossil Energy & Carbon Management	Kuehn, Ryan	ryan.kuehn@netl.doe.gov	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 CO_2 storage projects where field experience is limited, because of the anticipated intuitive translation of subsurface dynamics in real-time.
To deploy dynamic neural network optimization to minimize heat rate during ramping for coal.	Department of Energy	Fossil Energy & Carbon Management	Kuehn, Ryan	ryan.kuehn@netl.doe.gov	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.
To implement lifetime model prediction for Ni-based superalloy power plant components	Department of Energy	Fossil Energy & Carbon Management	Kuehn, Ryan	ryan.kuehn@netl.doe.gov	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.

To implement high temperature electrochemical sensors for in-situ corrosion monitoring in coal-based power generation boilers.	Department of Energy	Fossil Energy & Carbon Management	Kuehn, Ryan	ryan.kuehn@netl.doe.gov	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.
To develop a general drag model for assemblies of non-spherical particles created with artificial neural networks	Department of Energy	Fossil Energy & Carbon Management	Kuehn, Ryan	ryan.kuehn@netl.doe.gov	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.
To develop a robotic inspection tool to evaluate the structural integrity of key components in fossil fuel power plants.	Department of Energy	Fossil Energy & Carbon Management	Kuehn, Ryan	ryan.kuehn@netl.doe.gov	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
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.	Department of Energy	Fossil Energy & Carbon Management	Kuehn, Ryan	ryan.kuehn@netl.doe.gov	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.
To develop and evaluate a general drag model for gas-solid flows via physics-informed deep machine learning	Department of Energy	Fossil Energy & Carbon Management	Kuehn, Ryan	ryan.kuehn@netl.doe.gov	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.
To use advanced machine learning techniques to analyze static and dynamic measurements of proppant distribution and fracture geometry data.	Department of Energy	Fossil Energy & Carbon Management	Kuehn, Ryan	ryan.kuehn@netl.doe.gov	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.
To leverage machine learning and predictive analytics to advance the state of the art in pipline infrastructure integrity management.	Department of Energy	Fossil Energy & Carbon Management	Kuehn, Ryan	ryan.kuehn@netl.doe.gov	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.
To drive insights into solid oxide cell performance and degradation through big data analysis and computer vision	Department of Energy	Fossil Energy & Carbon Management	Kuehn, Ryan	ryan.kuehn@netl.doe.gov	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.
To develop a robotics enabled eddy current testing system for autonomous inspection of heat exchanger tubes.	Department of Energy	Fossil Energy & Carbon Management	Kuehn, Ryan	ryan.kuehn@netl.doe.gov	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.
To assess the amount and valence state of heavy metals in coal fly ash	Department of Energy	Fossil Energy & Carbon Management	Kuehn, Ryan	ryan.kuehn@netl.doe.gov	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.

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	Department of Energy	Fossil Energy & Carbon Management	Kuehn, Ryan	ryan.kuehn@netl.doe.gov	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.
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.	Department of Energy	Fossil Energy & Carbon Management	Kuehn, Ryan	ryan.kuehn@netl.doe.gov	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.
To apply machine learning applications to map carbon ore, rare earth element, and critical mineral resources	Department of Energy	Fossil Energy & Carbon Management	Kuehn, Ryan	ryan.kuehn@netl.doe.gov	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.
Using natural language processing to explore and extract information from historical literature/pdfs	Department of Energy	Fossil Energy & Carbon Management	Kuehn, Ryan	ryan.kuehn@netl.doe.gov	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.
Advanced Image Segementation	Department of Energy	Fossil Energy & Carbon Management	Kuehn, Ryan	ryan.kuehn@netl.doe.gov	U-Net CNN segmentation to isolate pore and fluid from computed tomography scans of multiphase transport in cores.
To improve subsurface stress characterization for carbon dioxide storage projects by incorporating machine learning techniques.	Department of Energy	Fossil Energy & Carbon Management	Kuehn, Ryan	ryan.kuehn@netl.doe.gov	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.
Machine Learning for geophysical data inversion	Department of Energy	Fossil Energy & Carbon Management	Kuehn, Ryan	ryan.kuehn@netl.doe.gov	Use machine learning to generate synthetic seismic and gravity data, and data driven inversion for leak detection
Machine learning for legacy well evaluation	Department of Energy	Fossil Energy & Carbon Management	Kuehn, Ryan	ryan.kuehn@netl.doe.gov	Use machine learning to identify common attributes that correlated to well integrity issues to prioritize for monitoring and remediation.
Using AI to improve predcitions of subsurface properties, analyze multi-variate inputs, address knowledge and information gaps to improve predictions and modeli	Department of Energy	Fossil Energy & Carbon Management	Kuehn, Ryan	ryan.kuehn@netl.doe.gov	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.
To analyze data and derive insights and improve predictions to forecast wellbore kick events to reduce loss of control events.	Department of Energy	Fossil Energy & Carbon Management	Kuehn, Ryan	ryan.kuehn@netl.doe.gov	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.
To automate data acquisition, exploration, transformation and integration	Department of Energy	Fossil Energy & Carbon Management	Kuehn, Ryan	ryan.kuehn@netl.doe.gov	Using AI deep learning and natural language processing capabilities to explore, transform and integrate datasets from Fossil Energy Carbon Management (Fossil Energy & Carbon Management) program funded projects to derive crosscutting insights, generate new, integrated datasets/databases, and support energy, environmental and infrastructure related studies going forward.
To use data analytics and machine learning techniques to advance understanding of the characteristics of the Emerging Paradox Oil Play	Department of Energy	Fossil Energy & Carbon Management	Kuehn, Ryan	ryan.kuehn@netl.doe.gov	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.
To implement machine learning to identify the micro-seismic during fracking	Department of Energy	Fossil Energy & Carbon Management	Kuehn, Ryan	ryan.kuehn@netl.doe.gov	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.
To help automate data integration and exploration for geologic core properties related information.	Department of Energy	Fossil Energy & Carbon Management	Kuehn, Ryan	ryan.kuehn@netl.doe.gov	Using natural language processing, deep learning neural networks, and possibly tensor flow for image analytics.
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	Department of Energy	Fossil Energy & Carbon Management	Kuehn, Ryan	ryan.kuehn@netl.doe.gov	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.

To improve coal fired plant performance through integrated predictive and condition-based monitoring tools	Department of Energy	Fossil Energy & Carbon Management	Kuehn, Ryan	ryan.kuehn@netl.doe.gov	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.
To verify and validate testing of advanced power generation technologies	Department of Energy	Fossil Energy & Carbon Management	Kuehn, Ryan	ryan.kuehn@netl.doe.gov	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
To use machine learning to assist in data analysis for the history of plastic upcycling.	Department of Energy	Fossil Energy & Carbon Management	Kuehn, Ryan	ryan.kuehn@netl.doe.gov	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.
To predict the presence of faults susceptible to movement in the presence of fluid injection	Department of Energy	Fossil Energy & Carbon Management	Kuehn, Ryan	ryan.kuehn@netl.doe.gov	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.
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.	Department of Energy	Fossil Energy & Carbon Management	Kuehn, Ryan	ryan.kuehn@netl.doe.gov	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.