Overview and Purpose

EERE National Laboratory Guiding Principles require all offices to pursue a merit review of direct-funded national laboratory work (100% of the office portfolio must be merit reviewed by October 2017).

The Vehicle Technologies Office (VTO) will meet this requirement through a "lab call" for projects. All considered projects must respond to the ten areas of interest (AOI) described below. Through this process, VTO seeks proposals for work to address key challenges in specific program areas and will select projects for funding and inclusion in FY16 Annual Operating Plans (AOPs) on a competitive basis. The office full expects to receive more proposals than it is able to fund. It is also an opportunity to leverage industry partnerships and develop innovative approaches to achieve VTO goals.

Only a portion of VTO's total planned FY16 lab funding will be awarded through the FY16 lab call process. The portion not awarded through the FY16 lab call will be planned and incorporated in the FY16 AOP via the traditional process. VTO will use future lab calls (for FY17 and FY18 work, covering different portions of the VTO lab portfolio) to meet the overall EERE requirement of 100% merit review by October 2017.

Timeline and Process Logistics

Timeline:

- *LAB CALL RELEASE DATE:* March 31, 2015
- *PROPOSAL DUE DATE:* April 30, 2015, by 5:00 PM Eastern
- *DECISION TIMETABLE:* Final proposal selections will be made and announced to VTO lab leads by June 1, 2015.

Process Logistics:

All communication to and from VTO regarding this lab call must use VTOLabCall@ee.doe.gov.

- *PROPOSAL SUBMISSIONS*: Lab leads or their designee(s) must submit all proposals via e-mail to VTOLabCall@ee.doe.gov.
- *QUESTIONS DURING OPEN LAB CALL PERIOD:* Specific questions about this lab call should be submitted via e-mail to VTOLabCall@ee.doe.gov. VTO will provide responses to all lab leads via periodic e-mail communications from VTOLabCall@ee.doe.gov to keep everyone informed of the questions and answers. To ensure fairness across all lab participants, please do not ask questions of individual VTO staff directly.
- *NOTIFICATION OF SELECTION:* When selections are finalized, lab leads will receive an email from VTOLabCall@ee.doe.gov.

Lab Call Description – Key Considerations and Areas of Interest (AOIs)

Key Considerations:

CRADAS AND FOA AWARDS: None of the AOIs below should be construed as requiring the renegotiation of an existing CRADA or previously-competed funding opportunity announcement (FOA) award in which

the lab is a prime or sub-recipient. Labs with CRADAs or FOA awards addressing any of the AOIs below should incorporate that work in proposals they submit in response to the AOI to demonstrate existing capability and leverage existing partnerships with industry and other partners. If the proposal is not selected for funding under this lab call, the work under the CRADA or FOA award will continue – there is no additional risk to the provision of DOE funding.

AOI ELIGIBILITY: Applicants should pay close attention to eligibility restrictions, as they vary by AOI. Some AOIs are offered as full and open for competition among all laboratories, while others have restricted eligibility to the lab(s) with identified core and enabling capabilities required for the specific AOI. Please refer to Appendix A for VTO Lab Core and Enabling Capabilities. Proposals involving partnerships among multiple labs are encouraged. Each AOI below is labeled accordingly. In addition to AOIs 1 – 9 below, AOI 10 is an open call for new and innovative ideas to meet key VTO goals and targets. Although AOIs 1-9 require full proposals (see proposal requirements below), responses to AOI 10 are 2-page concept papers. For more information about VTO goals and targets, please see the Vehicle Technologies FY16 budget request, VTO web site, and/or U.S. DRIVE technology roadmaps.

EERE NATIONAL LABORATORY GUIDING PRINCIPLES: To ensure continued alignment with EERE Lab Engagement Principles, applicants should consider the following when developing their proposals in response to the AOIs below:

- VTO seeks fewer, larger projects with an average annual cost of $1M or greater.
- VTO seeks projects with nominal length of 3 years, for FY 16 to FY 18 projects.
- VTO projects must have one SMART annual milestone, 1 go/no-go decision every 18 months, and quarterly progress (process) measures.
- VTO strongly encourages projects that bring together multiple labs in a consortia-based approach to meet a high-level strategic goal, leveraging multiple lab capabilities with strong, centralized leadership. Given the accelerated timeline for the FY16 VTO lab call, this may be appropriate only for work in which collaboration across labs is already ongoing.
- To the extent possible and appropriate, VTO seeks lab projects that involve industry engagement or industry partners.

Areas of Interest

AOI SUMMARY

- AOI 1: ADVANCED COMBUSTION
  - 1A: EMISSION CONTROL RESEARCH
  - 1B: FUNDAMENTAL COMBUSTION RESEARCH WITH OPTICALLY ACCESSIBLE ENGINES
- AOI 2: ANALYSIS
  - 2A: DATA
  - 2B: MODELING
  - 2C: APPLIED ANALYSIS
- AOI 3: DEPLOYMENT – TECHNICAL AND ANALYTICAL ASSISTANCE FOR CLEAN CITIES
- AOI 4: ELECTRIC DRIVE TECHNOLOGIES
  - 4A: NON-RARE EARTH MAGNETIC MATERIALS R&D FOR VEHICLE ELECTRIC DRIVE MOTORS AND SYSTEMS

  - 4B: BENCHMARKING, TESTING, AND ANALYSIS OF ELECTRIC DRIVE TECHNOLOGIES
- AOI 5: ENERGY STORAGE
  - 5A: COMPUTER-AIDED BATTERY ENGINEERING
  - 5B: ADVANCED CATHOD MATERIALS, ELECTRODE DESIGNS, AND DIAGNOSTIC TECHNIQUES
  - 5C: ELECTRODE DIAGNOSTICS AND CHARACTERIZATION
- AOI 6: FUEL TECHNOLOGIES – EXPERIMENTAL WORK SUPPORTING FUEL TECHNOLOGIES FOR HIGH EFFICIENCY ENGINE OPERATION
- AOI 7: MATERIALS TECHNOLOGY
  - 7A: ADVANCING LIGHTWEIGHT METALS AND MANUFACTURING TECHNOLOGIES
  - 7B: ADVANCING LOW-COST CARBON FIBER AND MAGNESIUM CORROSION
  - 7C: MATERIALS FOR HIGH TEMPERATURE COMPONENTS IN HIGH-EFFICIENCY INTERNAL COMBUSTION ENGINES
- AOI 8: TECH-TO-MARKET
- AOI 9: VEHICLE SYSTEMS
  - 9A: MODELING AND SIMULATION
  - 9B: VEHICLE TECHNOLOGY EVALUATIONS
  - 9C: CODES AND STANDARDS
  - 9D: VEHICLE SYSTEMS EFFICIENCY IMPROVEMENTS
  - 9E: CONNECTED AND AUTONOMOUS VEHICLES
- AOI 10: OPEN CALL

AOI 1: ADVANCED COMBUSTION

- *AOI 1A: EMISSION CONTROL RESEARCH*
  - *Eligibility:* RESTRICTED – ANL, ORNL, PNNL ONLY
  - *Estimated DOE Funding Available:* Up to $4.6 million per year (total, annually, across all projects selected), pending availability of funds
  - *Estimated Number of Projects Expected:* Up to 4 projects
  - *Description:*
    This work will include the following activities in support of the VTO Advanced Combustion Engine R&D initiative on Low Temperature Aftertreatment ("The 150^{O} C Challenge"):

    - Engage key suppliers and secure their commitment to contribute key materials to this effort
    - Conduct baseline testing and develop appropriate protocols and standards
    - Prepare white papers on technical issues as required
    - Conduct preliminary investigations on the key technical approaches identified in the planning process

    This work will also include the following activities in general support of the DOE Advanced Combustion Engine R&D:

    - Organize and host working group and program meetings
    - Participate at program reviews and meetings of relevant related technologies

- Provide technical support for related DOE-funded engine research programs
- Review of advanced combustion engine R&D proposals for DOE and other government agencies as directed by DOE

FUNDAMENTAL AND EARLY APPLIED CATALYST AND FILTRATION RESEARCH

Improved catalytic emission control systems are essential for enabling advanced, high-efficiency combustion strategies while minimizing the vehicle-level energy penalty associated with the attainment of future CAFE, US EPA, and CARB emissions standards for both heavy-duty and light-duty vehicles. Simulation and modeling are recognized by the DOE Engine Crosscut CLEERS (Crosscut Lean Exhaust Emissions Reduction Simulation) as being critical R&D components in the development of these controls. To pursue these activities, collaboration among DOE National Laboratories, as well as industry and university participants, is necessary to produce key kinetics and mechanistic information needed for predicting the performance of Lean NOx Trap (LNT) and Selective Catalytic Reduction (SCR) catalysts, and key soot oxidation properties for catalyzed diesel and gasoline particulate filters (DPFs and GPFs). This set of activities will build on the strength of the National Laboratories and leverage other DOE-funded activities, particularly from the Office of Science, to maximize benefits. The overall objectives of this work area are to enhance the capabilities of industry, academia, and DOE to rapidly screen candidate catalyst materials; characterize and understand the function of these devices at the atomic, nano, and micro scales; and predict the integrated performance of the different system designs being considered. This will enable the transportation industry to offer the highest possible fuel efficiencies while meeting mandated emissions standards.

The selected National Laboratories will collaborate with the established focus groups, utilizing industry to guide the activities based on the needs of the vehicle manufacturers and suppliers and other Engine Crosscut Team members. Monthly teleconferences among focus group members will be held to discuss system integration issues and highlight research that is on-going worldwide that the CLEERS group can leverage for the benefit of moving the U.S. industry at a quicker pace.

The scope of work encompasses three subsystem technology areas:

1. urea selective catalytic reduction (SCR);
2. diesel particulate filters (DPF)/gasoline particulate filters (GPF);
3. low temperature catalysis.

The scope for each will address work to characterize and understand the physiochemical phenomena that occurs at multiple length scales for each, but will then work toward relating this to how each technology can work in conjunction with the others in an emission control system in a fuel efficient and effective manner. These activities are to be pursued through cost-shared Cooperative Research and Development Agreements (CRADAs) between the National Laboratories and partners in industry and academia. Unique facilities that support automotive catalyst material discovery through modeling, analysis and testing as well as personnel qualifications shall be described to demonstrate the ability to successfully pursue

this project area.

SYSTEMS EMISSION CONTROL

Conduct applied research and development in emission control technologies for advanced combustion engines that achieve greater fuel efficiency, in light- and heavy-duty vehicles, than engines in the marketplace today. The objective of the research is to enable advanced combustion engines to become commercially viable by achieving cost-effective compliance to U.S. emission regulations; thus, activities focus on enabling market penetration of fuel-efficient engines. Research will be conducted in the following areas:

1. Full emissions characterization, including particulate and hydrocarbon emissions, utilizing novel analytical techniques
2. Characterization of catalyst materials and processes, including aging effects, from the nanoscale to full scale
3. Dynamic studies of emission control technologies, including fuel penalty and fuel efficiency measurements, on multi-cylinder advanced combustion engines in engine dynamometer laboratories

The tasks for emission control research are aligned to research needs defined by the U.S. DRIVE ACEC Tech Team Roadmap, the Low Temperature Aftertreatment Workshop Report, the bi-annual CLEERS Survey, and other industry and stakeholder input. Specific tasks are organized around combustion approaches and include:

1. Emissions Pathways - Leadership and active participation in the ACEC Tech Team and other programmatic activities
2. CLEERS - Coordination of activities and research to support modeling and simulation for all emission control approaches
3. Low Temperature Emission Control - Research to control emissions from Low Temperature Combustion and other advanced combustion techniques that represent challenging low temperature conditions for emission control
4. Lean Gasoline Emission Control - Research to control emissions from Dilute Gasoline Combustion with lean air-to-fuel operation
5. Diesel Emission Control - Research to control emissions from Clean Diesel Combustion engines

- *1B: FUNDAMENTAL COMBUSTION RESEARCH WITH OPTICALLY ACCESSIBLE ENGINES*
  - *Eligibility:* RESTRICTED – SNL ONLY
  - *Estimated DOE Funding Available:* Up to $4.5 million per year (total, annually, across all projects selected), pending availability of funds
  - *Estimated Number of Projects Expected:* Up to 1 project
  - *Description:*
    VTO seeks proposals for advanced combustion engine research that will significantly improve the physical understanding and provide the fundamental science base needed to design the next generation of advanced, high-efficiency, clean light- and heavy-duty engines. The following three technical areas will focus on obtaining experimental data leading to a better

understanding of engine fuel sprays and mixture formation as well as the ensuing combustion process: 1) Low-temperature homogeneous charge or stratified charge gasoline compression ignition combustion; 2) automotive lean gasoline combustion which is more focused on the lighter-loads typical of automotive applications; and 3) clean diesel combustion applicable to both light- and heavy-duty applications.

VTO's Advanced Combustion Engine R&D program seeks unique, world-leading, and core experimental capabilities in engine combustion research, including advanced in-cylinder engine combustion research and related high-pressure spray research, especially, work that requires laser-based and optical diagnostics. Examples of these unique capabilities include:

1) A low temperature gasoline combustion (LTGC) laboratory equipped with matching all-metal and optically accessible single-cylinder LTGC research engines, to provide high-quality performance data and complementary detailed studies of in-cylinder processes. The optical engine should have extensive optical access for laser-sheet imaging along all combustion-chamber surfaces (cylinder head, piston top and cylinder walls), which is important for studying heat transfer and thermal stratification, critical to LTGC.

2) A heavy-duty diesel engine that has been modified to provide optical access into the combustion chamber for a wide variety of optical diagnostics, including elastic scattering, laser-induced fluorescence and incandescence, laser extinction/absorption, and high-speed imaging and spectroscopy of combustion luminosity, to provide data required to understand and quantify in-cylinder processes that control engine performance metrics including fuel efficiency and pollutant formation.

3) A unique high-temperature, high-pressure vessel with full optical access for a variety of advanced laser diagnostics which provides an extensive range of conditions which is ideal for rigorous investigation and model validation of mixture formation and combustion in fuel sprays.

The experiments should provide fundamental understanding and data to expand predictive engine combustion simulation capabilities such as high fidelity large eddy simulation using high-performance computing resources and a state-of-the art LES/DNS code to extend the knowledge of spray and mixture formation provided by the experiments.

This project will help to coordinate fundamental BES supported combustion research, VTO research at universities, and research at institutions world-wide in support of VTO goals, such as is occurring through the Advanced Engine Combustion (AEC) MOU and the Engine Combustion Network.

AOI 2: ANALYSIS

The Analysis Program plans, executes, and communicates technology, societal, economic, and interdisciplinary analyses for VTO, EERE, DOE, and external stakeholders. Programmatic efforts are designed to comprise an integrated strategy combining a strong foundational of data, relevant analytical models, and insightful applied analyses. Accordingly, VTO seeks proposals in the data, modeling, and applied analysis topics—described below—that build on past Analysis activity, provide clear program benefit(s), and demonstrate new insights and pathways for continued and expanded long-term growth in

analytical knowledge and activity. Proposals are encouraged to explicitly demonstrate anticipated multi-dimensional benefits—first, to completing the proposed data product, model, or analysis; second, to informing the Analysis program; and third, to advancing the larger transportation energy community.

For all Analysis topic areas, applicants are encouraged to leverage expertise through collaboration with labs and academic institutions, and projects should explicitly acknowledge plans to invest public dollars for the public good, i.e. through milestones and/or deliverables comprising publically-available data, models, and or analysis results. Of special note are two sub-topics in the modeling area considered core competencies, and, accordingly, for which proposal eligibility is restricted. Specifically, based on expert community recognition, time-series coherence with past model runs, and significant past investment by both the Department and industry collaborators, the 1) applied vehicle modeling and simulation and 2) emissions/environmental modeling are restricted to Autonomie and GREET proposals, respectively.

- *2A: DATA*
  - *Eligibility:* FULL AND OPEN ELIGIBILITY
  - *Estimated DOE Funding Available:* Up to $750,000 per year (total, annually, across all projects selected), pending availability of funds
  - *Estimated Number of Projects Expected:* Up to 3 projects
  - *Description:*
    VTO's Analysis Program seeks proposals to collect, package, and disseminate vehicle technology-related data. Proposals should include data on energy systems (petroleum, energy); vehicles (characteristics and sales/markets of light-duty, medium-duty, heavy-duty, and non-highway modes, with special emphasis on all alternative fuel vehicles in all classes); and the economy (consumers, households, manufacturing, jobs, and macroeconomic correlations), the environment (emissions, air quality), or policy, as well as appropriate combinations of the preceding topics. Special consideration will be granted to proposals offering detailed data activity in vehicle technology-related market characterization and reporting, as consumer opinion indexing and analysis, and high-fidelity characterization of plug-in electric vehicle market evolution. VTO investment in the data topic area is intended to establish the foundation to inform VTO Analysis, Analysis-supported activities, and the Program Office writ-large, as well as additional stakeholders associated with each. Proposals that involve a consortium effort (multiple lab and/or third-party collaboration) are encouraged.

- *2B: MODELING (Applied Vehicle Modeling/Simulation, Emissions/Environmental Modeling, Vehicle Market Dynamics Modeling, Macroeconomic Accounting Models)*
  - *Eligibility:* ELIGIBILITY VARIES BY SUBTOPIC (SEE TOPIC DESCRIPTION BELOW)
  - *Estimated DOE Funding Available:* Up to $1.5 million per year (total, annually, across all projects selected), pending availability of funds
  - *Estimated Number of Projects Expected:* Up to 5 projects
  - *Description:*
    VTO's Analysis Program seeks proposals to develop, improve, and apply vehicle technology-related analytical models. Investment in the modeling topic area is intended to support the development and application of techno-economic evaluations of VTO technologies in a technology, environment, market, and/or integrated context. Special emphasis is placed on

proposals in applied vehicle modeling and simulation (restricted eligibility), emissions/environmental modeling (restricted eligibility), vehicle market dynamics modeling, and macroeconomic accounting models, as described below. Proposals that involve a consortium effort (multiple lab and/or third-party collaboration) are encouraged.

- *Applied vehicle modeling and simulation (RESTRICTED ELIGIBILITY – ANL ONLY).* A proposal is encouraged to apply the *Autonomie* modeling and simulation software to technology packages based on VTO's current technology R&D portfolio. Results will inform Program benefits applied analyses, as well as generate the meta-data to inform other Analysis activities.
- *Emissions/environmental modeling (RESTRICTED ELIGIBILITY– ANL ONLY).* A proposal is encouraged to apply the GREET modeling tool to select vehicle-fuel pathways for a lifecycle-analysis understanding of emissions, air quality, and other relevant parameter characterizations (i.e. water) of Program Office R&D. Results will inform Program and partnership strategic planning.
- *Vehicle market dynamics modeling (FULL AND OPEN ELIGIBILITY).* Proposals are encouraged to continue to develop models that explore and simulate the interface of new vehicle technologies and market uptake through an understanding and representation of consumer preferences and behavior. Considered proposals must explicitly accommodate VTO Program Office-relevant technologies. Within such a modeling framework, emphasis is placed on modeling frameworks with special sophistication in market segmentation, consumer heterogeneity, policy relevance (and model analysis capability), model transparency, and effective/innovative results communication. Consideration is also granted to deeper research in the fundamentals underlying such models (i.e. driver behavior and relevance to alternative powertrain suitability, range anxiety, refueling availability, etc.). Special consideration is granted to proposals that explicitly intend to build on previous Analysis investment in related efforts.
- *Macroeconomic accounting models (FULL AND OPEN ELIGIBILITY).* Proposals are encouraged to continue to develop accounting tools that track and estimate/project transportation energy use over time. Special emphasis is placed on models that accommodate Program Office-relevant modes (light-duty vehicles, and heavy trucks); though, consideration is also extended to multi-modal projects (and encouraged for multi-modal projects with special light- and heavy-duty vehicle passenger and freight capabilities).

2C: APPLIED ANALYSIS

- *Eligibility:* FULL AND OPEN ELIGIBILITY
- *Estimated DOE Funding Available:* Up to $750,000 per year (total, annually, across all projects selected), pending availability of funds
- *Estimated Number of Projects Expected:* Up to 3 projects
- *Description:*
  VTO's Analysis Program seeks proposals for integrated and applied analysis of VTO portfolio technologies and related transportation energy ecosystems (i.e., vehicles, infrastructure, human factors, and the interactions among them). Investment in this applied analysis topic area is intended to evaluate VTO technologies in a comprehensive framework (i.e. leveraging various/all the modeling elements above) and/or to advance the frontier of transportation

energy knowledge through evaluation of current and/or future potential vehicle technologies in a transportation energy systems framework. An explicit priority is placed on topics in Vehicle Technologies Office prospective benefits calculation (i.e., for GPRA reporting compliance purposes), and special consideration is granted to proposals that explicitly intend to build on previous Analysis investment in that effort. Additional areas of priority emphasis include on plug-in electric vehicle-infrastructure systems interactions and optimization, and Connected and Autonomous Vehicles (CAVs) transportation energy system(s) analysis and implications. Special emphasis, encouragement, and consideration are placed on CAV analysis in support of or in coordination with a related Vehicle Systems AOI Topic. Proposals that involve a consortium effort (multiple lab and/or third-party collaboration) are encouraged.

AOI 3: DEPLOYMENT – TECHNICAL AND ANALYTICAL ASSISTANCE FOR CLEAN CITIES

- *Eligibility:* RESTRICTED ELIGIBILITY – ANL, NREL, ORNL, SNL ONLY
- *Estimated DOE Funding Available:* Up to $5 million per year (total, annually, across all projects selected), pending availability of funds
- *Estimated Number of Projects Expected:* Up to 4 projects
- *Description:*
  For more than 20 years, VTO deployment projects and activities have been managed by the Clean Cities (CC) team. Among those activities is Technical and Problem Solving Assistance. DOE technical experts help end-users address permitting and safety issues, technology shortfalls, and other project implementation barriers. CC experts provide direct response technical assistance for consumers and end-users, serve as liaisons with national fleets, identify market barriers, and educate stakeholders.

  In support of this activity, labs collect and analyze performance data from vehicle demonstrations and deployment projects and use this information to develop analytical tools and case studies. Technical content for the AFDC and fueleconomy.gov websites is also developed as part of this work activity. The labs also facilitate end-user support groups for specific fuels and vehicle applications, assist with complex project planning, and help to connect OEM factory service providers with early adopters and fleets who are experiencing unusual or chronic performance and reliability issues.

  This scope of work for Technical and Problem Solving Assistance should include, but not be limited to, the following activities:

  - Analytical Tools and Case Studies – Alternative Fuels Technical Assistance, including the development of analytical tools and case studies for AFVs, idle reduction and Renewable Natural Gas (RNG).
  - Economic Impact Analysis – Training and refinement of a tool to document jobs and economic impacts of natural gas vehicle industry
  - Electric Drive Technology Planning - Track latest in technology that will guide consumer decision tree development and on-going adoption of codes and standards
  - Idle Reduction – Provide technical and marketing updates for the Clean Cities idle reduction portfolio
  - International Efforts – Support requests as needed for natural gas, propane, electric vehicle and Clean Cities Best Practices for international audiences

- Renewable Natural Gas - Provide technical and marketing materials for the Clean Cities RNG portfolio
- Strategic Planning and Miscellaneous Meetings – Assist DOE in analysis of niche markets to develop a Clean Cities Strategic Plan and coordinate meetings as assigned
- Clean Cities Technical Response Service – Hotline and other direct response technical assistance for consumers and end-users
- Industry and Stakeholder Technical Assistance – Tiger Team technical Assistance (in house and subcontracted subject matter experts); industry engagement to identify market barriers, educate stakeholders, address emerging technologies; NGV Technology Forum and AFV incident investigation, codes and standards support; biofuel use quality and safety evaluations and end-use performance testing and research
- Technical Analysis and Data Management – Maintenance of key data sets for web tools and analysis (laws and incentives, stations, vehicles, heavy duty, publication search, truck stop electrification, coalition mapping); analysis support to evaluate market data, identify needs for new analytical tools, Polk Data analysis, annual coalition performance metric data collection and analysis
- Fuel Economy Research – Fuel Economy research related to consumer behaviors, vehicle buying and driving habits and preferences, focus group studies
- Validation & Testing - Validation and testing of FE practices, Alternative Fuels technical assistance related to conversion systems, EPA/CARB emissions compliance, and vehicle performance
- NGV/Propane Vehicle Facilities – Develop criteria for NGV and Propane maintenance facilities that are used to inform the relevant codes and standards governing these facilities and develop relationships and educational material for outreach to standards committee members, maintenance facility owners, and vehicle operators to provide the foundation for improving requirements and standards.

AOI 4: ELECTRIC DRIVE TECHNOLOGIES

- *4A: NON-RARE EARTH MAGNETIC MATERIALS R&D FOR VEHICLE ELECTRIC DRIVE MOTORS AND SYSTEMS*
    - *Eligibility:* RESTRICTED ELIGIBILITY – AMES, ORNL, NREL ONLY
    - *Estimated DOE Funding Available:* Up to $2.5 million per year (total, annually, across all projects selected), pending availability of funds
    - *Estimated Number of Projects Expected:* Up to 1 project
    - *Description:*
      Novel, non-rare earth magnets are needed to meet the performance and cost requirements for vehicle electric drive motors and systems. Proposals are sought for R&D projects to develop the materials and processes needed to fabricate high performance permanent magnets (PM) that can be used for advanced traction drive motors with an internal PM rotor design. Materials and magnets must meet the EDT goal for enhanced performance at elevated temperature (180–200°C) and reduced cost. Proposed efforts should build on previous R&D focused on anisotropic magnets with maximum magnetic energy density and a minimum content of costly materials, and identify tasks to improve magnet forming processes and magnet mechanical properties. Efforts should identify pathways to reducing magnet and motor manufacturing costs and improving the lifetime and reliability of the

magnets and motors in electric vehicle drivetrain applications. Rare earth permanent magnets are currently used to achieve targets and requirements for electric drive motors and systems, but availability and cost are key barriers.

Proposals should highlight previous research efforts and accomplishments, including unique expertise necessary to develop novel magnetic materials that achieve the VTO targets and requirements required for advanced motors for electric drive applications. Proposals should identify lead lab core competency tasks and how efforts will be coordinated with lab enabling competencies and expertise in motors and motor thermal management. Proposals involving partnerships among multiple labs are encouraged.

Magnetic Materials and Magnet R&D - Technical Targets and Requirements:

- High energy density permanent magnets (PM) for compact, high torque vehicle drive motors
- Motor specific power >1.4kW/kg
- Motor power density >4.0Kw/L
- Motor cost <$8/kW
- Motor Efficiency >94%
- Magnets with greatly reduced or eliminated RE elements, especially dysprosium (Dy) and neodymium (Nd)
- High temperature tolerance (up to 180–200°C)
- Tolerance of temperature swings
- 15 year minimum lifetime and reliability of magnets and motors in vehicle applications
- Magnets and materials capable of mass production

- *4B: BENCHMARKING, TESTING, AND ANALYSIS OF ELECTRIC DRIVE TECHNOLOGIES*
  - *Eligibility:* RESTRICTED ELIGIBILITY – ORNL, NREL ONLY
  - *Estimated DOE Funding Available:* Up to $1.4 million per year (total, annually, across all projects selected), pending availability of funds
  - *Estimated Number of Projects Expected:* Up to 1 project
  - *Description:*

    Automotive manufacturers and suppliers typically do not publish details about the design, functionality, and operation of EV/HEV technology developments and on-road technologies. In addition, any published details and specifications need to be verified and clarified. Proposal is sought to perform teardown assessments, testing, and analysis to obtain comprehensive information on design, functionality, and sub-component characteristics of electric drive components. Components will be completely instrumented and tested in a dynamometer test cell to evaluate individual components and devices. Testing and analysis will enable confirmation of operational conditions and characteristics such as performance, efficiency, and reliability. This research provides the information necessary to assess current electric drive technology status, to identify future research priorities and pathways, and to establish long-term research targets and requirements.

    Proposals should highlight previous benchmark, testing, and analysis experience and accomplishments, and the unique expertise and capabilities required to perform in-depth

testing, analysis, and assessment of electric drive technologies, components, and devices. Proposals should also identify lead lab tasks for components (power electronics and motor) testing and analysis, and tasks for lab core competency in component thermal management testing and analysis. Proposed project should highlight collaboration between the labs, and how efforts and tasks will be coordinated. Proposals involving partnerships among multiple labs are encouraged.

AOI 5: ENERGY STORAGE

- *5A: COMPUTER-AIDED BATTERY ENGINEERING*
  - *Eligibility:* FULL AND OPEN ELIGIBILITY
  - *Estimated DOE Funding Available:* Up to $3 million per year (total, annually, across all projects selected), pending availability of funds
  - *Estimated Number of Projects Expected:* Up to 3 projects
  - *Description:*

    The objective of this AOI is to expand upon the current state of electric drive vehicular battery modeling using the Computer Aided Engineering for Electric Drive Batteries (CAEBAT) open architecture or other commercially available battery software suites. VTO initiated the CAEBAT activity to introduce battery simulation and modeling design tools to the development of batteries early in the product life-cycle, thereby reducing development time and accelerating time-to-market. Initial efforts focused on the development of multi-physics simulation models capturing realistic three-dimensional geometries and configurations of cell and pack level batteries or other electrochemical storage devices that could meet the requirements of electric drive vehicles. These models addressed the chemical, electrical, and thermal physics in the electrochemical cells, modules, and battery packs while trying to optimize computational efficiency.

    In a parallel effort, the open architecture platform was developed to serve as a backbone that seamlessly allowed these different models to communicate with each other through a common language and agreed upon input and output standards. Information describing the open architecture concept and implementation can be found at: http://energy.ornl.gov/CAEBAT/home/home.cgi. Combining this open architecture software with the electrochemical and thermal models, the CAEBAT program has begun to develop a suite of software tools that enable automobile and battery manufacturers, pack integrators, and other end-users to simulate and design battery packs, accelerating development of battery systems, ultimately reducing battery cost.

    This AOI will expand upon the current state of electric drive vehicular battery modeling by developing and validating new advanced computational models. The models must use the CAEBAT open architecture platform and/or be compatible with existing commercially available software tools. Specific areas of interest include but are not limited to:

    - Dramatically improving the computation efficiency of current electrochemical and thermally coupled material, cell, module and battery pack models.

- Developing models capable of predicting the combined structural, electrical, and thermal responses to abusive conditions such as crash-induced-crush, overcharge/overdischarge, thermal ramp, and short circuits.
- Developing microstructural models as a tool to design battery electrodes through a better understanding of the basic physics occurring at the particle and electrode level. This subtopic could require the use of supercomputers and simulations would be carried out using geometrically accurate models of particles (morphology and particle size distribution) as well as binders and conductivity enhancers.

Where appropriate, modeling efforts will be evaluated based on their ability to incorporate multiple cathode and anode materials relative to industry such as, but are not limited to, $LiCoO_2$, NCA, NMC, $LiFePO_4$, Mn-spinel, graphite, titanate, and silicon; the ability to incorporate new materials as they are developed is highly desirable. All models must also be capable of modeling different form factors such as, but not limited to, spirally wound, wound prismatic, and stacked electrode that are enclosed in either a pouch or hard case. Modeling tools should be designed to run on a personal computer, therefore computational efficiency for all areas of interest is required. Models that require multiple processors will be accepted for review, but we do not intend for models selected to require supercomputers for adequate processing times (except for microstructure topic). Proper model validation should be incorporated into all applications.

- *5B: ADVANCED CATHODE MATERIALS, ELECTRODE DESIGNS, AND DIAGNOSTIC TECHNIQUES*
  - *Eligibility:* FULL AND OPEN ELIGIBILITY
  - *Estimated DOE Funding Available:* Up to $5 million per year (total, annually, across all projects selected), pending availability of funds
  - *Estimated Number of Projects Expected:* Up to 6 projects
  - *Description:*

    The Advanced Battery Materials Research (BMR) Program seeks proposals in the following subtopics: (1) Exploratory, next-generation cathodes and diagnostic techniques, (2) Improved, high-performance cathodes and diagnostic techniques, and (3) Advanced electrode designs.

    Present day Li-ion batteries employ one or more of three cathode chemistries: (i) layered $LiNi_{1/3}Mn_{1/3}Co_{1/3}O_2$ and analogous compositions, (ii) spinel $LiMn_2O_4$, or (iii) olivine $LiFePO_4$. Depending on the choice of the cathode material, issues such as high cost, short cycle/calendar life, and/or safety concerns have plagued their commercialized for PHEV and EV applications. The BMR Program seeks to address the issue of cost ($/kWh) with this solicitation while being mindful of the need for excellent cycle/calendar life and safety. One method of achieving lower cost is to identify new cathode that promise higher energy (i.e., higher capacity or higher voltage) than presently used materials. Other approaches are to increase the performance of the existing materials mentioned above and of the electrode itself.

    The focus of subtopic 1 is the design, synthesis and characterization of next-generation cathode materials. Novel materials must have attributes that are superior to the three

cathodes listed above (i.e. capacities > 180 mAh/g). They must also have acceptable safety characteristics and be able to meet the stringent cycle-life and calendar-life requirements for vehicle applications. Estimates of the capacity and average voltage of the proposed cathode material must be provided. Preliminary data to support these estimates is highly encouraged. To increase the success of the effort, advanced, diagnostic techniques should be an integral part of the effort. Diagnostic studies have provided a detailed understanding of the life-limiting and performance-limiting processes in lithium ion batteries in the past and have led to new cathode designs and formulations strategies. Activities which advance the diagnostic technique throughout the course of the investigation are desired.

The focus of subtopic 2 is the modification of existing cathode materials to increase the voltage or capacity (and thereby the energy) without sacrificing safety and cycle life. Sulfur and oxygen cathodes, while holding enormous promise, are not being sought in this solicitation; proposals in these areas will be rejected. Proposals that aim to increase cell energy by increasing the cell voltage above 4.3 volts vs Li/Li+ must demonstrate how the material will avoid or minimize electrolyte oxidation. As in Topic 1, advanced diagnostics techniques are expected to be essential to the success of the effort.

The focus of subtopic 3 is electrode design and how to optimize them for energy density and cycle life. Present day batteries have only approximately 50% of their volume occupied by the active mass. Lithium ion batteries could last longer if this percentage was increased and the electrodes stored more charge. In addition, the structural stability and mechanical integrity of electrode materials during lithiation and delithiation have a significant impact on cycle life. Stresses in the electrodes have been attributed to not only the internal chemical processes that take place during cycling, but to stack level stress and external mechanical loads acting on the battery pack during manufacturing. New electrode processing techniques that can increase the percentage of active material and methods to reduce the structural stability and mechanical integrity of electrode materials during cycling are of interest. Diagnostic techniques that relate parameters in the micro-scale particle level with the macro-scale electrode level would be complementary to this effort.

- *5C: ELECTRODE DIAGNOSTICS AND CHARACTERIZATION*
  - *Eligibility:* RESTRICTED ELIGIBILITY – ANL ONLY
  - *Estimated DOE Funding Available:* Up to $1 million per year (total, annually, across all projects selected), pending availability of funds
  - *Estimated Number of Projects Expected:* Up to 1 project
  - *Description:*
    The objective of this AOI is to provide the battery research community with a collaborative center of competency, essentially an R&D support facility, dedicated to the testing and characterization of electrodes and other cell components as fabricated for advanced battery research. Such a post-test diagnostic and characterization facility will help in understanding the primary causes of cell failure, including capacity loss, power fade, electrolyte dry out, electrode delamination, and others. The proposer must demonstrate experience and proficiency in the tear down, diagnostics, and analysis leading to a quantitative understanding of cell degradation mechanisms. There must be a clear history of contribution to area of

translational battery research, including experience with a multitude of cell forms, formats, chemistries, and charging and thermal histories. The proposers should provide a list of equipment they current have available for performing these tasks (note that equipment purchases will not be funded under this lab call) and should provide examples of post-test analyses that have been performed, the lessons learned, and how those lessons were used to improve next generation cell performance.

AOI 6: FUEL TECHNOLOGIES – EXPERIMENTAL WORK SUPPORTING FUEL TECHNOLOGIES FOR HIGH EFFICIENCY ENGINE OPERATION

- *Eligibility:* FULL AND OPEN ELIGIBILITY
- *Estimated DOE Funding Available:* Up to $9.6 million per year (total, annually, across all projects selected), pending availability of funds (includes $3 million from the Advanced Combustion Engine program and $6.6 million from the Fuel Technologies program)
- *Estimated Number of Projects Expected:* Up to 6 projects
- *Description:*
  The goal of this effort is to support advanced fuel and engine technologies that will enable optimal performance of advanced internal combustion engines for passenger and commercial vehicles. Fuel properties, such as octane and cetane, have been widely discussed in recent years as potential design variables for future mainstream vehicles. Applications are sought for innovative and cost-effective approaches to exploiting fuel properties to enable or enhance efficient combustion in reciprocating internal combustion engines.

  Internal combustion engines (ICEs) will continue to dominate the vehicle fleet for the next several decades—as either prime movers or range extenders for the increasing number of electric vehicle (EV) drive systems expected. Co-development of fuels and engines has proved successful for controlling criteria pollutants and provides great promise for increasing vehicle efficiency and reducing greenhouse gas emissions. By establishing a link early in the R&D cycle of both fuels and engines, a complete systems-based approach to create optimized solutions can be realized. Work will involve studying multiple optima for fuel properties/formulation and engine efficiency, as well as techno-economic criteria.

  Proposed work should be fuel-focused research on the facilitation or enhancement of combustion optimized to achieve subprogram efficiency and emissions goals for 2025. These goals include:

  - By 2020, optimize advanced conventional fuel-engine systems for use in light- and heavy-duty vehicles provide high efficiencies and meet prevailing emissions standards (e.g., EPA Tier 3 standards), which incorporate use of non-petroleum based, low-carbon blending components. Such systems should have the potential to achieve at least a 10 percent replacement of petroleum fuels by 2025.
  - By 2025, optimize fuel-engine kinetically controlled combustion systems for use in light-duty vehicles provide high efficiencies and meet prevailing emissions standards, which incorporate use of non-petroleum based, low-carbon blending components. Such systems should have the potential to achieve at least a 15 percent replacement of petroleum fuels by 2030.
  - By 2025, optimize fuel-engine kinetically controlled combustion systems for use in light-duty vehicles provide high efficiencies and meet prevailing emissions standards, which incorporate use

of non-petroleum based, low-carbon blending components. Such systems should have the potential to achieve at least a 10 percent replacement of petroleum fuels by 2030.

Proposals involving partnerships among multiple labs are encouraged.

Well-to-wheels analysis will not be reviewed this year and is therefore excluded from this lab call.

AOI 7: MATERIALS TECHNOLOGY

- *7A: ADVANCING LIGHTWEIGHT METALS AND MANUFACTURING TECHNOLOGIES*
  - *Eligibility:* RESTRICTED ELIGIBILITY – ORNL, PNNL ONLY
  - *Estimated DOE Funding Available:* Up to $2 million per year (total, annually, across all projects selected), pending availability of funds
  - *Estimated Number of Projects Expected:* Up to 1 project
  - *Description:*
    Lightweight metals represent an important suite of technologies for reducing vehicle weight. However, many technical barriers complicate their use. Applications to this area should include at least the following tasks:
    - Friction stir scribe joining of Al to steel
    - High strength dissimilar Al alloy tailor welded blanks
    - Mg intensive vehicle developments (approx. $30k per year)
    - Enhanced sheared edge stretchability of AHSS/UHSS
    - Optimizing Processing Parameters for High Strength Steels Using an Integrated Experimental-Computational Framework

- *7B: ADVANCING LOW-COST CARBON FIBER AND MAGNESIUM CORROSION PREVENTION*
  - *Eligibility:* RESTRICTED ELIGIBILITY – ORNL, PNNL ONLY
  - *Estimated DOE Funding Available:* Up to $1.9 million per year (total, annually, across all projects selected), pending availability of funds
  - *Estimated Number of Projects Expected:* Up to 1 project
  - *Description:*
    Carbon fiber composites and Mg alloys represent some of the most promising yet challenging lightweight materials systems. In particular, the high cost of carbon fiber and the poor corrosion resistance of Mg alloys are tremendously important technology barriers. In pursuit of overcoming these hurdles, applications should include at least the following tasks:
    - Innovative and technically feasible approach to processing low cost carbon fiber. Specifically, VTO is interested in a 3-year project to demonstrate feasibility and scale-up of atmospheric plasma processing for low-cost conversion of oxidized precursor to carbon fiber.
    - Application of world-class lab characterization tools and personnel toward understanding (1) mechanisms for Mg corrosion in automotive environments including formation of corrosion products/films, response to changing chemistry in the alloys and environments, and effects of other external factors such as galvanic couples, and (2) mechanisms for corrosion protection through the use of automotive-relevant coating systems, including interaction between alloy, surface preparation methods, and coating chemistries.

- *7C: MATERIALS FOR HIGH TEMPERATURE COMPONENTS IN HIGH-EFFICIENCY INTERNAL COMBUSTION ENGINES*
    - *Eligibility:* FULL AND OPEN ELIGIBILITY
    - *Estimated DOE Funding Available:* Up to $1.5 million per year (total, annually, across all projects selected), pending availability of funds
    - *Estimated Number of Projects Expected:* Up to 1 project
    - *Description:*
      Internal combustion engines with high efficiency and high specific power output result in higher cylinder pressures and place ever increasing demands on material properties. Further, as the temperature increases, the mechanical properties decline rapidly. These factors have resulted in the need for cost effective materials with superior strength, oxidation resistance, and high temperature performance. This AOI seeks a coordinated suite of material solutions for high temperature engine components for use in next generation automotive and heavy-duty engines. Activities within this suite of work should support goals of the Material Genome Initiative by addressing known ICME gaps.

      Proposals should include a clear work plan including components covered, component specific materials development suites, milestones, down selects, and task level go/no-go decision points. Required reporting will include quarterly progress reports, timely submission to annual report, and presentations at annual merit reviews. Proposals should include a list of relevant material development successes along with existing facilities/capabilities that would be utilized by tasks within the proposal. Proposals should also include a list of additional resources that would be necessary to successfully complete the project in a timely manner. It is expected that there will only be one award so it is suggested multiple laboratories with complimenting capabilities collaborate to provide the best value to the Government. Detailed commercialization plans are required and multiple CRADAs with different component suppliers are acceptable. Examples of historic successes of partnerships and technology commercialization's with industry partners listed in the commercialization plan are required. Letters of support/commitment from industry partners are strongly encouraged.

AOI 8: TECH-TO-MARKET

- *Eligibility:* RESTRICTED ELIGIBILITY – ANL, INL, LBNL, NREL, ORNL, PNNL, and SNL[1]
- *Estimated DOE Funding Available:* Approximately $1.7 million (total, annually, across all projects selected), pending availability of funds.[2] NOTE: Each lab's proposed FY16 tech-to-market budget should be no more than 125% of its FY15 tech-to-market funding from VTO.
- *Estimated Number of Projects Expected:* Up to 7 projects
- *Description:*
  The goal of VTO tech-to-market (T2M) activity is to significantly increase the intensity of industrially-impactful R&D at the labs, in alignment with the EERE Lab Impact Initiative. For FY16, VTO seeks new ideas for T2M activities to increase meaningful interactions between

[1] EERE requires offices to have a tech-to-market plan with each lab to which it plans to send $5M or more in a given fiscal year.
[2] EERE requires offices to direct 1% of their total direct AOP funding (across all labs) toward new activities associated with T2M Activity Plans.

the labs and industry, strengthening stakeholder engagement and facilitating the successful transfer of VTO lab innovations to the commercial market. Proposals for FY16 VTO T2M funding must support activities that were not funded in FY15 or new ideas to build on FY15 year successes.

Proposals should address the following:

- Rationale or analysis supporting the T2M strategy
- Stage of technologies in the R&D portfolio of the plan
- Description of the potential near and long-term markets of entry
- Organizations currently involved or expected to be involved in the transition of this portfolio to the market

Proposals should include descriptions of specific T2M activities to address key technologies in the VTO-funded lab research portfolio. Examples include, but are not limited to, "industry style" business development training, small business technical assistance, industry workshop at the lab with a focus on specific technology area and how industry can access lab capability, and conference booth/roadshow/industry visit to raise awareness of specific technology solutions with a focus on partnerships with industry for technology transfer. Each activity should include clear metrics. Collaboration across labs in support of T2M activities is encouraged.

AOI 9: VEHICLE SYSTEMS

Subtopic areas. Some of these topic areas align with the Focus Areas within the Vehicle Systems portfolio. Where appropriate, larger multi-lab proposals that cover more than one of these topic areas are encouraged.

- *9A: MODELING AND SIMULATION*
  - *Eligibility:* RESTRICTED ELIGIBILITY – ANL ONLY
  - *Estimated DOE Funding Available:* Up to $1.5 million per year (total, annually, across all projects selected), pending availability of funds
  - *Estimated Number of Projects Expected:* Up to 1 project
  - *Description:*
    The Vehicle Systems Program seeks proposals to continue the development of Model-Based Systems Engineering (MBSE) tools that can accelerate the development and reduce the cost of bringing advanced vehicle technologies to the market. These tools can also be used by industry, national labs, academia, and others in the research community to analyze the performance and fuel consumption benefits of individual component technologies as well as larger vehicle systems. The project selected in this area should include the development of MBSE software tools, the development of validated vehicle and subsystem models (both plant and control) using test data, the creation of automated processes to enhance the speed and functionality of the MBSE software, and analysis activities to support requests from DOE.

- *9B: VEHICLE TECHNOLOGY EVALUATIONS*
  - *Eligibility:* RESTRICTED ELIGIBILITY – ANL, INL, NREL ONLY
  - *Estimated DOE Funding Available:* Up to $3.8 million per year (total, annually, across all projects selected), pending availability of funds
  - *Estimated Number of Projects Expected:* Up to 3 projects
  - *Description:*
    The Vehicle Systems Program seeks proposals to conduct laboratory and field testing and evaluation of light-, medium-, and heavy-duty vehicles in coordination with the industry contractor for Advanced Vehicle Testing and Evaluation (AVTE). Laboratory testing of light-duty vehicles will include both non-destructive instrumentation for benchmarking of vehicles that are put into service in the AVTE fleet, as well as in-depth benchmarking and testing of specific vehicles at DOE's direction. Evaluation of medium- and heavy-duty vehicles will be conducted through both laboratory testing and in-service evaluations in collaboration with fleet operators. Data collection for all of these activities will be done to enable analysis to quantify the performance and fuel consumption benefits of the vehicle technologies being evaluated, as well as to enable validation of vehicle models developed through the Modeling & Simulation activity.

- *9C: CODES AND STANDARDS FOR PEV/GRID CONNECTIVITY*
  - *Eligibility:* RESTRICTED ELIGIBILITY – ANL ONLY
  - *Estimated DOE Funding Available:* Up to $1.5 million per year (total, annually, across all projects selected), pending availability of funds
  - *Estimated Number of Projects Expected:* Up to 1 project
  - *Description:*
    The Vehicle Systems Program seeks proposals to provide technical expertise and leadership to directly support the vehicle standards process relating to the specification and/or test procedures for vehicle-grid connectivity. This project will produce unbiased technical data to support decision making and develop the necessary hardware and software tools required for standards validation and refinement. These activities will be conducted in cooperation with standards development organizations such as SAE, ISO/IEC, IEEE, and NIST. Specific technology areas for which standards development will be supported include conductive charging of plug-in vehicles (both AC and DC), wireless charging, vehicle/grid communication, control, and metering. Additionally, this project will involve efforts to harmonize standards for plug-in vehicle and grid interoperability internationally.

- *9D: VEHICLE SYSTEMS EFFICIENCY IMPROVEMENTS*
  - *Eligibility:* RESTRICTED ELIGIBILITY – LLNL ONLY
  - *Estimated DOE Funding Available:* Up to $800,000 per year (total, annually, across all projects selected), pending availability of funds
  - *Estimated Number of Projects Expected:* Up to 1 project
  - *Description:*
    The Vehicle Systems Program seeks proposals to reduce the fuel consumption of long-haul tractor trailers through the development of aerodynamic drag reduction technologies. This project will produce detailed information regarding the potential fuel consumption benefits

of a variety of drag reduction solutions, including both add-on devices and integrated tractor/trailer designs, through both computational fluid dynamics modeling and wind-tunnel testing. Aerodynamic solutions for tanker trucks will also be investigated. Additionally, this activity will involve coordination with partners including long-haul truck fleets, truck manufacturers, trailer manufacturers, and other technology providers.

- *9E: CONNECTED AND AUTONOMOUS VEHICLES*
  - *Eligibility:* FULL AND OPEN ELIGIBILITY
  - *Estimated DOE Funding Available:* Up to $1 million per year (total, annually, across all projects selected), pending availability of funds
  - *Estimated Number of Projects Expected:* Up to 2 projects
  - *Description:*
    The Vehicle Systems Program seeks proposals to quantify the potential efficiency and fuel consumption reduction benefits of various connected and autonomous vehicle (CAV) technologies. Solutions considered will include those enabled by vehicle-to-vehicle and vehicle-to-infrastructure communication, new sensor advancements, and other technologies covering all levels of automation for light- and heavy-duty vehicle applications. The project will consider energy impacts at both the individual vehicle level as well as at the macro level (i.e., opportunities created by connectivity and automation that lead to improved traffic flow and reduced congestion). Secondary impacts that could enhance or inhibit energy benefits from specific CAV solutions (e.g., an increase in vehicle miles traveled) will also be investigated. This activity will provide information to the Vehicle Technologies Office to help determine the impact of the emerging CAV technologies on VTO research and development efforts, and to guide future potential investments in this space. In order to successfully provide this information, a combination of instrumented vehicle testing, modeling and simulation, and analytical studies will be required. Submissions under this topic area are open to all national laboratories. Proposals that involve a multi-lab consortium effort are encouraged.

AOI 10: OPEN CALL

- *Eligibility:* FULL AND OPEN ELIGIBILITY
- *Description:*
  This AOI seeks new ideas to meet VTO goals and targets. Proposals – in the form of concept papers no more than two pages in length (see below) – must align with the overall VTO mission and scope but are not limited to the program areas and specific topics in the AOIs described above. VTO seeks innovative approaches to solving challenges that, if deemed meritorious, could be further developed into full proposals for consideration in the FY16 AOP, either as new projects or over-target projects should additional funding become available. Concepts that include a multi-lab consortia approach as well as concepts that involve strong industry engagement are encouraged.

Application and Submission Information

Application Process

Full proposals for AOIs 1 – 9 must be submitted through the VTO laboratory leads or their designees. Proposals must be submitted via e-mail to VTOLabCall@ee.doe.gov by the submission deadline of *April 30, 2015* at 5 PM Eastern time. All submissions must conform to the guidelines for format and length, and be submitted at or prior to the deadline listed.

General Proposal Requirements

Individual proposals must be submitted in PDF format as a single file (do not bundle multiple proposals in a single file), conforming to the following filename convention:

Filename = AOI #-AOI Title-Lab name-Principal Investigator.pdf

For example, an ORNL project under AOI topic 2b for principal investigator John Smith would have the filename "2b-ORNL-Modeling-Smith.pdf."

Proposals should be formatted for 8.5 x 11 paper and have 1-inch margins on each side. Typeface size should be 12 point, except tables and figures which may be in 10-point font. Proposal length for AOIs 1-9 submissions is limited to 10 pages, including all the sections listed in the outline below. Concept paper length for AOI 10 is limited to two pages, following the outline listed below.

Proposals Responding to AOIs 1-9

Proposal content aligns with content required in the EERE AOP project forms, with additional information to assist reviewers in evaluating technical details.

General Information

This section summarizes the basic information about the proposed project: title; VTO program, activity, and subactivity the project serves; and project principal investigator (with contact information).

Project Overview

This section should contain a concise narrative that captures the problem statement, the major R&D challenges, and any context needed to provide the reader with a complete understanding of the project and how it supports office, program, and activity goals. If this is a multi-performer project, this section should include a description of each performer's role and responsibility. This section should also address the extent to which the project addresses the EERE core questions of impact (high-impact problem); additionality (does EERE funding make a large difference); openness (focusing on the broad problem); enduring economic impact; and proper role of government. The text of this section should provide an overview of how the project addresses national objectives on climate, oil dependency, and economic competitiveness.

Project Objectives

This section should describe the project-specific goals, objectives, and expected outcomes. The proposal should include a clearly defined, aggressive and quantitative end-of-project goal that supports larger VTO programmatic goals. Details on the technical aspects of the goals, objectives, and outcomes should be included in this section to explain the specific technical areas to be addressed and the scientific merit of

the work. The proposer should include the technology barriers addressed by the work and how the project addresses them.

Project Management

This section should define the key milestones to be addressed by the project (1 annual SMART milestone, 1 go/no-go every 18 months, 4 quarterly progress measures), with dates and specific descriptions of what should be accomplished to meet the milestones. This section should address key technical risks and the steps to be taken to minimize those risks.

Project Approach/Tasks

This section should list the key tasks and provide brief descriptions for each task, including roles and responsibilities of any partners. A cost estimate (total) for each task should be provided here, with an indication of the total costs for the project.

Addendum for Supplemental Information

- Highlight any inter-lab collaborations or other teaming arrangements/partnerships.
- Highlight technical partners from industry or academia and their roles.
- Describe capabilities of Principal Investigator to complete the work.
- Describe any facilities to be used in the completion of the work, particularly ones that represent unique laboratory core capabilities.
- Describe the potential for the technology to be transferred to the private sector for commercialization, or for the activity to enable transfer/deployment of EERE technologies.
- Describe the data management plan and explain how it will support validation of research results.

Concept Paper Outline (AOI 10)

Because of its exploratory nature, AOI 10 has different proposal requirements. Specifically, VTO seeks two-page concept papers that summarize the new ideas being proposed, and how projects based on these new ideas would help achieve VTO goals and objectives. Concept papers should include the following:

- The lab and principal investigator proposing the technology/new idea;
- The VTO program and subprogram areas under which the technology/new idea would be considered;
- The proposed technology, including its basic operating principles and how it is unique and innovative;
- The proposed technology's target level of performance (with technical data or other support to show how the proposed target could be met);
- The current state-of-the-art in the relevant field and application, including key shortcomings, limitations, and challenges;
- How the proposed technology will overcome the shortcomings, limitations, and challenges in the relevant field and application;
- Any key collaborations and partners, as well as a general description of their respective roles and responsibilities;
- The potential impact that the proposed project would have on the relevant field and application;
- The key technical risks/issues associated with the proposed technology development plan; and

- The impact that EERE funding would have on the proposed project.

Application Review Information

Merit Review and Selection Process

Proposals submitted to the appropriate e-mail address will receive a return e-mail confirming receipt. Upon receipt and review for initial compliance with requirements, all proposals received by the deadline will undergo a thorough technical review by independent subject matter experts selected for each AOI. VTO will draw its expert reviewers from the government, academic, and industry organizations familiar with the VTO portfolio, goals, and objectives. VTO will collect and collate review scores and comments for use in making final project selections. The VTO Selection Official will consider the merit review results to make the final project selections. For transparency, VTO will provide summaries of the review results to assist labs in understanding how their proposal was scored and aid in improving future work.

Technical Review Criteria (AOI 1-9)

Below are the specific technical review criteria against which the proposals for AOI 1-9 will be reviewed.

Criterion 1: Technical Merit, Innovation, and Impact (Weight: 50%)

- 1(a) Degree to which the project addresses program barriers, contributes to achieving national goals (climate, oil dependency, and economic competitiveness), Office targets/goals, and has potential to advance the state-of-the-art.
- 1(b) Extent to which the proposed project addresses EERE core questions – addresses a high impact problem, provides additionality, has the potential for enduring economic impact/provides high value to the government, presents an innovative approach and/or new performers and is appropriate for Federal funding.
- 1(c) Sufficiency of technical detail to assess whether the proposed work is scientifically meritorious.

Criterion 2: Project Approach (Weight: 30%)

- 2(a) Relevance and appropriateness of the approach and critical path and description of key tasks, metrics (including baseline), and SMART milestones leading to a big outcome.
- 2(b) Degree of likelihood that the work plan will succeed in meeting project goals.
- 2(c) Identification of key technical risks and the quality of management and mitigation strategies to address them.
- 2(d) The level of suitability of the Data Management Plan for the proposed research and the extent to which it supports the validation of research results.
- 2(e) If the project is R&D technology focused, how does it identify and address the current and/or potential opportunities to move that technology towards eventual transition to the private sector? If a project is not R&D focused, how does it contribute to or further enable the technology transfer of one or more EERE technologies?

Criterion 3: Team, Resources, and Inter-Lab Collaboration (Recommended Weight: 20%)

- 3(a) Degree to which the project leverages a core or enabling capability.
- 3(b) Capability of the Principal Investigator(s) and team to address all aspects of the work – qualifications, expertise, and time commitment of the team.

- 3(c) Sufficiency of the facilities to support the work (if applicable).
- 3(d) Degree to which the team demonstrates the ability to facilitate and expedite further development and commercial deployment of the proposed technologies (or wider implementation of the proposed deployment activity), as appropriate.
- 3(e) Degree to which inter-lab collaboration is occurring, as appropriate.
- 3(f) Level and appropriateness of partnerships, and the clarity in the description of roles and responsibilities.
- 3(g) Reasonableness of budget and spend plan for proposed project and objectives.
- 3(h) Sufficiency of the budget for the innovation proposed.

Technical Review Criteria (AOI 10)

Below are the specific technical review criteria against which concept papers for AOI 10 will be reviewed.

Criterion 1: Impact of the Proposed Technology Relative to State of the Art (45%)

- Method used to identify current state of the art technology; and
- If technical success is achieved, the proposed idea would significantly improve technical and economic performance relative to the state of the art.

Criterion 2: Overall Scientific and Technical Merit (45%)

- The proposed technology is unique and innovative; and
- The proposed approach is without major technical flaws.

Criterion 3: Team and Approach (10%)

- The proposed team includes the correct capabilities to complete the work;
- The proposed team includes a multi-lab consortium approach wherever possible; and
- The proposed team demonstrates strong industry engagement wherever possible.

Selection Notification

VTO anticipates completing the project selection process and notifying labs of the final results by the end of May 2015 for AOI 1-9 projects. For AOI 10, VTO anticipates completing the review of concept papers for new ideas at this time as well and will work directly with lab leads on next steps for full proposals in the June/July timeframe. VTO will notify lab leads of selection results via email from VTOLabCall@ee.doe.gov and will provide lab leads with summaries of the review scores and anonymized review comments for each proposal submitted.

Questions/Agency Contacts

Specific questions about this lab call should be submitted via e-mail to VTOLabCall@ee.doe.gov. To ensure fairness across all labs, individual VTO staff cannot answer questions while the lab call remains open. To keep all labs informed, VTO will send questions and answers to all lab leads via periodic e-mail communication from VTOLabCall@ee.doe.gov.

Appendix A: VTO Laboratory Core and Enabling Capabilities and Facility Matrix

EERE Definition of Lab Capabilities and Status

Symbol	Capability Type	Definition
●	Core Capabilities	Core Lab Capabilities: 1. Encompass a substantial combination of facilities and/or teams of people and/or equipment designed to solve a long-term, difficult challenge associated with clean energy. 2. Have a unique, world-leading component. 3. Are relevant to the EERE Mission and evolving technology/market conditions. EERE commits to steward core capabilities over the long-term (decadal) by funding them directly through AOPs and not regularly competing them through FOAs. Core capabilities distinguish the National Laboratories from one another and industry. As such, each National Laboratory will have a limited number of core capabilities. By definition, they are comprised of enduring intellectual and/or physical assets that are held primarily by a single laboratory and are not easily duplicated by other laboratories, academia, or industry.
◑	Enabling Capabilities	Enabling Capabilities: 1. Resident technical expertise or major research facilities that EERE accesses to address specific needs and which may exist to support and enable a National Laboratory's core capability or strategic initiative 2. Specific, critical expertise that is readily accessible and complements core capabilities and/or needs at the labs. 3. Are relevant to the EERE Mission and changing technology/market conditions. EERE commits to support enabling capabilities over a three- to five-year period by funding them directly through AOPs and not regularly competing them through FOAs. EERE will continue to invest in these capabilities for as long as they enable critical, relevant EERE-funded RDD&D and may invest in the same enabling capabilities at multiple laboratories.
○	Competed Capabilities	Competed Capabilities : 1. Available from multiple sources through FOAs and/or lab calls. Emerging capabilities could be designated initially through a competitive process. 2. Are relevant to the EERE Mission and changing technology/market conditions EERE competes these capabilities either through a lab call or FOA, such that EERE funding for this capability at a lab cannot be predicted prior to award.
1-24	DOE Core Capabilities	The DOE/Office of Science has defined 24 core capability categories (e.g., chemical engineering). Each EERE capability can be cross-walked to one or more DOE/Office of Science Core Capability Categories. Generally, these capability types differ from (but relate to) DOE capability categories because they incorporate domain-relevant expertise.

Status (of a Capability or Facility)

Existing	This capability/facility currently exists at one or more national laboratories. If it is a core capability, EERE is the primary steward. If it is an enabling capability, then it is currently relevant and important to EERE priorities. If it is a competed capability, then it is currently being competed (either through a FOA or lab call). Existing facilities are ones with no current or projected construction and for which EERE's level of support and type of use is unexpected to change significantly over the next three years.

Emerging	An emerging capability/facility is one that is not fully developed. EERE may choose to compete emerging capabilities as they identify the long-term lead for this capability. EERE should clarify its vision for emerging capabilities through the comments column. Emerging facilities are ones that have current or planned construction or major capital improvements planned which will substantially change the nature or extent of EERE's use and/or stewardship.
Transitioning	This capability is being transitioned to a different state . If it is a core capability, that may mean EERE plans to discontinue long-term stewardship, but will consider it either an enabling or competed capability. This state can also be used for capabilities that EERE wishes to transition to the private sector. Transitioning facilities are ones where the level or nature of EERE's support is projected to change over the three-year outlook. Transitioning facilities may be ones where EERE is increasing or decreasing O&M support, R&D, or R&D funding.

Guidance for developing your office-specific capability matrix

Core Capabilities: Only one core capability per row. Enabling or competed capabilities cannot overlap.
Enabling Capabilities: As many enabling capabilities per row as apply.
Competed Capabilities: OPTIONAL. Competed capabilities that are not open to labs do not need to be included in this matrix.

Template for Office-Specific Capability Matrix

Instructions: Refer to the Capability Definition tab for full definitions of core, enabling, and competed capabilities. First fill out the matrix by typing "1" for core capabilities, "0.5" for enabling capabilities, and "0" for competed capabilities. When you have entered all your capabilities, highlight all affected cells, navigate to "Conditional Formatting" (In the Home Tab) and select "Icon Sets" then "5 Quarters" (where the circles are pictures). Having completed this conditional formatting, all 1s should appear as full circles, .5s as half, and 0s as empty.

● Core Capability ◑ Enabling Capability

	State	Cross-Walk to DOE Core Capabilities	Related Facility	Ames	ANL	BNL	INL	LANL	LBNL	LLNL	NETL	NREL	ORNL	PNNL	SNL	SRNL	Cross-Walk to DOE Core Capabilities	Comments
Batteries and Electric Drive Technologies/Energy Storage R&D																		
Battery Development																		
Battery Cost Modeling	existing	23			◑													
Testing, Analysis & Design																		
Performance & Life testing	existing						●											
Enabling Performance & Life	existing				◑													
Safety and abuse testing	existing													●				
Thermal Response testing	existing	23									●							
Battery Design	Transitioning	19									◑	◑						This activity will eventually be fully competed
Requirements analysis	existing				◑		◑				◑							
Applied Battery Research																		
Cell Prototyping	existing	19			◑				◑			◑	◑	◑				
Material Scale Up	existing	18			●													
Post Mortem Analysis	existing	17, 18			●													
Electrochemistry Optimization	existing	6, 17, 18			◑													
Exploratory Battery Materials Research																		
Scientific Diagnostics	existing	6			◑	◑			◑				◑					
Materials Modeling	existing	6, 10, 17							●									
Materials Research	Transitioning	6, 17, 18			◑				◑			◑	◑					This activity will move towards FOAs
Advanced Processing																		
Materials Processing	existing	18			◑													
Electrode Processing	existing	19			◑							◑						
Batteries and Electric Drive Technologies/Advanced Power Electronics and Electric Motors R&D																		
Electric Motors																		
Electric Motor & Motor Materials R&D	Existing	20, 19, 11, 12, 17										●						
Non-Rare Earth Materials/Magnetic Materials R&D	Existing	17, 5		●														

Electric Motor Thermal Management	Existing	20, 19										●							
Power Electronics																			
Power Electronics Component and Power Electronics Materials R&D	Existing	17, 12, 20, 11											●						
Power Electronics Thermal Management	Existing	20, 19										●							
Benchmarking Testing and Analysis																			
EDT Modeling, Analysis, and Benchmarking	Existing	23, 12, 11, 17											●						
Thermal Management Modeling, Analysis and Benchmarking	Existing	23, 12, 11, 17										●							
Power Electronics and Motor Testing and Validation	Existing	20, 23, 19											●						
Advanced Packaging Technologies and Designs																			
EDT and System thermal management	Existing	23, 19										●							
High Temperature EDT and System Design Innovations	Existing	23, 19											●						
Packaging Innovations, Designs and Electrical Reliability	Emerging	17											●						
Packaging and Thermal Reliability Evaluations	Emerging	17										●							
Vehicle & Systems Simulation & Testing																			
Vehicle Modeling and Simulation																			
Simulation Framework for Vehicle System Performance Prediction	Existing	23			●														
Vehicle System & Component Level Models	Existing	23			◑							◑	◑						
Technology Impact on Fuel Efficiency Analysis	Existing	22, 23			◑		◑					◑	◑						
CoolCalc Thermal Model for HD Vehicles	Existing	23										●							
Vehicle Technology Evaluations																			
LD Vehicle & EVSE Field Data Collection & Analysis	Existing	23					●												

MD and HD Field Data Collection & Analysis	Existing	23										●						
Full Vehicle Lab Testing under Controlled Temperature Environments	Existing	23	APRF		●													
Integrated Systems Lab Testing	Existing	23	VSI Lab										●					
HVAC & Thermal Load Testing & Analysis	Existing	23										●						
Codes and Standards																		
Codes and Standards Development & Validation	Existing	23	ANL Interoperability		●													
Technology Invesigations for Codes & Standards Planning & Development	Existing	21, 23			◑		◑						◑	◑				
Test Procedures Development	Existing	23			◑		◑						◑					
Vehicle Systems Efficiency Improvements																		
HD Vehicle Aero Drag Reduction Design & Testing	Existing	23								●								
Fast Charge & Wireless EVSE Testing	Existing	23					●											
Wireless Technology Development & Demonstration	Existing	20,23											●					
Thermal Technology Development for Auxiliary Systems	Existing	23			◑								◑					
HVAC, Load Reduction, & PreConditioning Technology Development	Emerging	23										◑						
Grid Integration																		
Requirements Development	Emerging	20, 23										●						
Technology Requirements Investigations	Emerging	20, 23			◑		◑		◑				◑	◑				
ESIF Technology Development & Evaluation	Emerging	20, 23	ESIF									●						

Autonomous and Connected Vehicles																		
Requirements Analysis for Maximized Energy Efficiency of Autonomous Vehicles	Emerging	23			◑		◑					◑	◑					
Combustion and Emission Control																		
Combustion																		
Laser-based Optical diagnostics	Existing	6, 11,	*CRF*												●			
X-Ray-based Spray diagnostics	Existing	5, 6, 11	*APS*		●													
CFD Simulation of Engines	Existing	10, 11, 12						●										
Chemical Kinetics Modeling	Existing	6, 11, 12, 18								●								
Combustion and Emissions Diagnostics	Existing	9, 11, 23	*FEERC*										●					
Modeling of Combustion processes	Existing	11, 12, 19	*MIRA, TITAN*		◑			◑		◑			◑		◑			
Engine Optimization	Existing	19, 23			◑								◑					
Emission Control																		
Catalyst Characterization	Existing	6, 9,11, 12, 18	*EMSL, IIC*											●				
Emissions Characterization	Existing	6, 9,12, 19, 23	*FEERC, HFIR*										●					
Particulate Characterization	Existing	6, 9	APS		◑								◑					
Modeling of Emission Controls	Existing	9, 11, 12, 18											◑	◑				
Emission Control Optimization	Existing	19, 23			◑								◑	◑				
Materials Technology/ Propulsion Materials																		
Materials for High Efficiency Engines																		
Friction Stir Processing and Rapid Solidification Processing	Existing	17, 19												◑				
Mechanical Testing (tensile, Fatigue, Fracture Toughness, etg)	Transitioning	17, 19	HTML										◑	◑				
High Temperature Mechanical Testing (tensile, Fatigue, Fracture Toughness, etg)	Transitioning	17, 19	HTML										◑					

High Resolution Materials Characterization (TEM, SEM, High Power X-ray, Neutron Imaging)	Existing	17, 19	ACEM, HTML, HFIR, APS		◑								◑	◑				
Materials Characterization	Transitioning	17, 19	HTML										◑	◑				
Alloy Smelting and Casting	Existing	17, 19											◑	◑				
Computational Materials Science	Existing	12, 17, 19, 23											◑	◑				
Materials for Energy Recovery and Exhaust After-treatment																		
High Temperature Mechanical Testing (tensile, Fatigue, Fracture Toughness, etc.)	Transitioning	17, 19	HTML										◑	◑				
High Resolution Materials Characterization (TEM, SEM, High Power X-ray, Neutron Imaging)	Existing	17, 19	ACEM, HTML, HFIR										◑					
Materials Characterization	Transitioning	17, 19	HTML										◑					
Insitu Gas - High Resolution Materials Characterization	Existing	17, 18	ACEM										◑					
Insitu Gas Bench Top Reactor Catalyst Evaluations	Existing	17, 18											◑	◑				
Materials Synthesis	Transitioning	12, 17, 19	HTML										◑					
Materials Thermal Property Analysis	Transitioning	17, 19	HTML										◑					
Computational Materials Science (FEA)	Existing	12, 17, 19, 23											◑					
Materials for Electric Drive System Components																		
Friction Stir Joining	Existing	17, 19												◑				
Mechanical Testing (tensile, Fatigue, Fracture Toughness, etg)	Transitioning	17, 19	HTML										◑	◑				
Materials Characterization	Transitioning	17, 19	HTML										◑	◑				
Fine Scale Sample Preperation of Brittle Materials (FIB, Ion Mill, etg)	Transitioning	17, 19	HTML										◑					

High Temperature Mechanical Testing (tensile, Thermal Fatigue, Fracture Toughness, etg)	Transitioning	17, 19	HTML										◑					
Computational Materials Science	Existing	12, 17, 19, 23											◑	◑				
Integrated Computational Materials Engineering Tools for Powertrain Materials Development																		
Predictive Composition of Application Specific New Materials(Magnetic, Thermoelectric, etc)	Existing	12, 17, 19, 23											◑					
Computational Materials Science (DFT, CalPHAD)	Existing	12, 17, 19, 23											◑					
Materials Synthesis	Transitioning	17,	HTML										◑					
Materials Validation (Characterization)	Transitioning	17, 19	HTML										◑					
Materials Technology/ Lightweight Materials																		
Automotive Materials																		
Materials Processing of Fine-grain Structures	Existing	17, 19											◑	◑				
Computational Materials Science	Existing	12											◑	◑				
Thermomechanical Processing and Forming	Existing	17, 19											◑	◑				
High Resolution Materials Characterization (TEM, SEM, High Power X-ray, Neutron Imaging)	Existing	17, 19	HTML, HFIR, EMSL		◑								◑	◑				
Mechanical Testing (tensile, Fatigue, Fracture Toughness, etg)	Transitioning	17, 19	HTML										◑	◑				
Low Cost Carbon Fiber																		
Prototype Carbon Fiber Production Line	Existing	17, 23	CFTF										●					
Computational Materials Science	Existing	12, 17, 19, 23											◑	◑				
Materials Characterization	Existing	17, 19											◑	◑				
Mechanical Testing (tensile, Fatigue, Fracture Toughness, etg)	Existing	17, 19											◑	◑				

Precursor and Fiber Evaluations	Existing	17, 19	PES & PL										●					
Materials Development	Existing	12, 17, 19											◑	◑				
Multimaterials & Enabling Technologies																		
Friction Stir Processing/Joining	Existing	17, 19											◑	◑				
Mechanical Testing (tensile, Fatigue, Fracture Toughness, etg)	Existing												◑	◑				
High Resolution Materials Characterization (TEM, SEM, High Power X-ray, Neutron Imaging)	Existing	17, 19	HFIR, HTML, EMSL		◑								◑	◑				
Materials Characterization	Transitioning	17, 19	HTML										◑	◑				
Mechanical Fastening Development	Existing	17, 19											◑	◑				
Computational Materials Science	Existing	12, 17, 19, 23											◑	◑				
Sheet Processing and Heat treatment	Existing	17, 19											◑	◑				
Residual Stress Measurements	Existing	17, 19	HFIR										●					
Laser Assisted Joining	Existing	17, 19											◑					
Alloy Development	Existing	17, 19											◑	◑				
Polymer Composites																		
Computational Materials Science	Existing	12, 17, 19, 23											◑	◑				
High Resolution Materials Characterization (TEM, SEM, High Power X-ray, Neutron Imaging)	Existing	17, 19	HFIR, HTML										◑	◑				
Materials Characterization	Existing	17, 19											◑	◑				
Materials Development	Existing	12, 17, 19											◑	◑				
Fuels and Lubricant Technologies																		
Fuel Technologies																		
Experimental evaluation of fuel kinetics	Existing	18			◑							◑		◑	◑			
Chassis dyno testing at altitude	Existing	9	ReFUEL Lab									◑						

Laser-based Optical diagnostics	Existing	6, 11,18,24	CRF											●				
Experimental evaluation of emerging fuel characteristics	Existing	18,19	NTRC/FEERC, CRF										◑	◑	◑			
Lifecycle Modeling	Existing	9, 23			◑													
Fuel quality and compatibility of emerging fuels	Existing	18,19										◑	◑	◑				
Single cylinder research engine capability	Existing	19			◑							◑	◑		◑			
Kinetic mechanism development for new fuels/fuel components	Existing	6,12								◑								
Lubricant Technologies																		
Lubricant and coating synthesis, formulation, and evaluation	Existing	6,17,18,19			◑								◑	◑				
Lubricant Polymer Synthesis	Existing	6												◑				
Outreach, Deployment, and Analysis																		
Advanced Vehicle Competitions																		
Student Competition (including testing of vehicles)	Existing				◑													
Vehicle Technologies Deployment																		
Technical and Problem Solving Assistance	Existing	9,22 23			◑							◑	◑					
Data Collection and Analysis	Existing	9,22 23			◑							◑	◑					
Clean Cities Technical Response Service	Existing	23										◑						
Fuel Economy Guide and Fueleconomy.gov	Existing	9, 21, 22, 23											◑					
Alternative Fuels Data Center Operations and Maintenance	Existing	9, 21, 22, 23										◑						
Outreach and Education Initiatives and Materials	Existing	9,22 23			◑							◑	◑					
Industry and Government Interagency Collaborations, Stakeholder Engagement	Existing	9,22 23			◑							◑						

Clean Cities Coalition Training and Skills Develpment	Existing	9,22 23			◑							◑							
Legislative and Rulemaking																			
Regulatory Analysis and Tracking	Existing	23										◑							
Analysis																			
Data Assembly and Publication	Existing	22											◑						
Vehicle Sales Tracking and Analysis	Emerging	22			◑														
Consumer Preference Data Collection	Emerging	22										◑							
LDV Applied Modeling and Simulation	Existing	19, 23			◑														
Consumer Choice Modeling	Emerging	22			◑							◑	◑	◑	◑				
Lifecycle Modeling	Existing	9, 23			◑														
Macroeconomic Accounting	Existing	23			◑														
Energy Security Modeling	Existing	22											◑						
Baseline and Scenario Benefits Analysis	Existing	22, 23			◑														
HIDE THIS ROW - DO NOT DELETE (It exists to ensure circles appear correctly)														●	◑	○			
ADD ANY ADDITIONAL PROGRAMS AND CAPABILITIES ABOVE THIS ROW TO MAINTAIN FORMATTING																			

EERE Funding and Utlization Models for National Laboratory Capital Research Assets

Background: Every year, EERE Technology Offices identify major research facilities at DOE National Laboratories that they steward. A major research facility is a facility or group of facilities that together support an enabling or core capability being stewarded by EERE at the National Laboratory. They include, but are not limited to, formal user facilities. The compilation of EERE Technology Offices' Capital Research Asset Matrices forms Appendix D of the EERE Lab Constitution.

Instructions: Each EERE Technology Office must update their matrix annually. Matrices should provide the three-year outlook for facilities and should highlight any significant (>15%) shifts in funding sources by using the status "transitioning". All transitioning facilities should contain more detailed status information in the comments section. In deciding whether to list a major research facility, consider whether the loss of the facility would have a mid- or long-term impact on your office's programmatic goals.

Office	Lab	Formal User Facility?	Name of Major Research Facility	Major Research Facility Status	Stewardship Plan Required?	Direct O&M Support	RD&D Support (by Source)			Comments
							EERE Funding		Industry Funding	
							EERE RD&D (AOP Direct and/ or EERE share of CRADAs)	Industry RD&D (Targeted FOAs)	Industry RD&D (WFO and/or Industry share of CRADAs)	
VTO	ANL	no	Battery Cell Fabrication Lab	Existing	No	0%	80%		20%	
VTO	ANL	no	Battery Materials Scale Up facility	Existing	No	0%	75%		25%	
VTO	ANL	no	Battery Post Mortem Analysis Laboratory	Existing	No	0%	80%		20%	
VTO	ANL	no	Battery Performance and Life Testing Facility	Existing	No	0%	100%			
VTO	INL	no	Battery Performance and Life Testing Facility	Existing	No	0%	100%			
VTO	SNL	no	Battery Safety and Abuse Testing Facility	Existing	No	0%	80%		20%	
VTO	ORNL	no	Battery Electrode and Cell Processing Lab	Existing	No	0%	70%		30%	
VTO	NREL	no	Battery Thermal Analysis Facility	Existing	No	0%	50%		50%	
VTO	ORNL	No	Power Electronics & Electric Motors Research Center	Existing	No	0%	90%	10%	0%	
VTO	AMES	No	Materials Science and Engineering Facility	Existing	No	0	90%	10%	0%	
VTO	NREL	No	Advanced Electronics Lab	Existing	No	0	90%	10%	0%	
VTO	ANL	No	Ceramic Materials and Membranes Research Center	Existing	No	0		90%	10%	
VTO	ANL		Advance PowerTrain Research Facility	Existing	No	0%	95%	0%	5%	
VTO	ORNL		Vehicle System Integration Lab	Emerging	No	0%	30%	0%	70%	
VTO	SNL	No	Combustion Research Facility (CRF)	Existing	No	0%	90%		10%	On occasion, we help purchase capital equipment and buildings upgrades

VTO	ANL	No	Fuel injection Spray Hutch at the Advanced Photon Source	Existing	No	0%	95%		5%	Operational costs of the hutch are part of the annual research budget
VTO	PNNL	Yes	Environmental Molecular Sciences Laboratory (EMSL)	Existing	No	0%	90%		10%	This is a SC/BES Facility
VTO	PNNL	Yes	Institute for Integrated Catalysis (IIC)	Existing	No	0%	90%		10%	This is a SC/BES Facility
VTO	PNNL	No	Diesel Emissions Research Lab	Existing	No	0%	80%		20%	
VTO	ORNL	Yes	Fuels, Engines, and Emissions Research Center (FEERC)	Existing	No	0%	80%	5%	15%	
VTO	NREL	No	REFUEL	Existing	No	0%	50%	20%	30%	On occasion, we help purchase capital equipment and buildings upgrades
VTO	ORNL	No	Carbon Fiber Technology Facility (CFTF)	Emerging	No	27%				O&M Support Shared with other Offices; all VTO funds ($1.5M) support O&M
VTO	ORNL	No	High Flux Isotope Reactor (HFIR)	Existing	No	0%	50%	25%	25%	This is a BES facility
VTO	ORNL	No	Precursor Evaluation System (PES)& Pilot Line(PL)	Existing	No	0%	50%		50%	
VTO	ORNL	No	Aberration-Corrected Electron Microscope (ACEM)	Existing	No	0%	60%	20%	20%	On occasion, we help purchase capital equipment/instrument upgrades
VTO	ORNL	No	High Temperature Materials Laboratory(HTML)	Transitioning	No	0%	60%	20%	20%	The HTML is no longer a user facility, but the microscopes and other high temperature materials characterization instruments are utilized by the program on an as needed basis.

CC#	Core Capabilities	Definition
1	*Particle Physics*	The ability to carry out experimental and theoretical research to provide new insights and advance our knowledge on the nature of matter and energy, and the basic nature of space and time itself. This includes the design, operation and analysis of experiments to discover the elementary constituents of matter and energy and probe the interactions between them and the development of models and theories to understand their properties and behaviors.
2	*Nuclear Physics*	The ability to carry out experimental and theoretical research to provide new insights and advance our knowledge on the nature of matter and energy. This includes the design, operation and analysis of experiments to establish the basic properties of hadrons, atomic nuclei, and other particles, and the development of models and theories to understand these properties and behaviors in terms of the fundamental forces of nature.
3	*Accelerator Science and Technology*	The ability to conduct experimental, computational, and theoretical research on the physics of particle beams and to develop technologies to accelerate, characterize, and manipulate particle beams in accelerators and storage rings. The research seeks to achieve fundamental understanding beyond current accelerator and detector science and technologies to develop new concepts and systems for the design of advanced scientific user facilities.
4	*Plasma and Fusion Energy Sciences*	The ability to conduct world-leading plasma research that can range from low-temperature to high temperature/high pressure plasmas. This ability can be in operation of the state-of-the-art experimental fusion facilities to carry out world-leading research on the fundamental physics of plasmas, in theory and computations, which is critical to the full understanding of the plasma phenomena being studied or to enable technologies that allow experiments to reach and in many cases exceed their performance goals.
5	*Condensed Matter Physics and Materials Science*	The ability to conduct experimental, theoretical, and computational research to fundamentally understand condensed matter physics and materials sciences that provide a basis for the development of materials that improve the efficiency, economy, environmental acceptability, and safety in energy generation, conversion, transmission, and utilization. Areas of research include experimental and theoretical condensed matter physics, x-ray and neutron scattering, electron and scanning probe microscopies, ultrafast materials science, physical and mechanical behavior of materials, radiation effects in materials, materials chemistry, and bimolecular materials.
6	*Chemical and Molecular Science*	The ability to conduct experimental, theoretical, and computational research to fundamentally understand chemical change and energy flow in molecular systems that provide a basis for the development of new processes for the generation, storage, and use of energy and for mitigation of the environmental impacts of energy use. Areas of research include atomic, molecular and optical sciences; gas-phase chemical physics; condensed phase and interfacial molecular science; solar photochemistry; photosynthetic systems; physical biosciences; catalysis science; separations and analytical science; actinide chemistry; and geosciences.
7	*Earth and Atmospheric Systems Science*	Applies knowledge of earth systems and the principles of atmospheric physics to (1) understand the spatial and temporal dynamics and quality of renewable energy resources; (2) the influences of terrain and atmospheric processes and systems on the availability, behavior, and quality of the resource(s); and (3) the causes, impacts, and predictability of climate change. Applies understanding of steady and unsteady state fluid flow to measure, characterize, model, and predict the energy in moving fluids, including wind, ocean currents, and waves. Applies understanding of radiometry to measure, characterize, model and predict solar resources. Supporting capabilities include thermo and fluid dynamics, oceanography, aerodynamics and aeroelasticity, hydrology, atmospheric physics, and computational science.

CC#	Core Capabilities	Definition
8	*Biological and Bioprocess Science and Engineering*	Applies understanding of complex biological systems and phenomena to design, prototype, test and validate processes components, technologies and systems relevant to (1) bioenergy production, (2) environmental contaminants processing, and (3) global carbon cycling and biosequestration. Primary supporting disciplines include systems biology, molecular science, agricultural science, materials science and engineering, and computational science.
9	*Environmental Science and Engineering*	The ability to understand environmental and ecological systems, processes, and interrelationships to predict, assess, and mitigate the impacts of past, current, and future energy production, transmission, distribution, and use on air, water, land, and complex subsurface environments. Knowledge is used to develop technologies that minimize emissions and/or control technologies that protect the environment.
10	*Applied Mathematics*	The ability to support basic research in the development of the mathematical models, computational algorithms and analytical techniques needed to enable science and engineering-based solutions of national problems in energy, the environment and national security, often through the application of high-performance computing. Laboratory Core Competencies in this area would involve a critical mass of world-leading researchers with recognized expertise and publications in such areas as linear algebra and nonlinear solvers, discretization and meshing, multi-scale mathematics, optimization, modeling of complex systems, and analysis methods (e.g., analysis of large-scale data, uncertainty quantification, and error analysis).
11	*Advanced Computer Science, Visualization, and Data*	The ability to have a widely-recognized role in advances in all applications in computational science and engineering. A core competency in these areas would involve a large pool of nationally and internationally recognized experts in areas such as programming languages, high-performance computing tools, peta- to exa-scale scientific data management and scientific visualization, distributed computing infrastructure, programming models for novel computer architectures, and automatic tuning for improving code performance, with unique and/or world-leading components in one or more of these areas. A core competency would also require access to (note: these resources do not need to be co-located) a high end computational facility with the resources to test and develop new tools, libraries, languages, etc. In addition, linkages to application teams in computational science and/or engineering of interest to the Department of Energy and/or the Department of Homeland Security would be beneficial to promptly address needs and requirements of those teams.
12	*Computational Science*	The ability to connect applied mathematics and computer science with research in scientific disciplines (e.g., biological sciences, chemistry, materials, physics, etc.). A core competency in this area would involve a large pool of nationally and internationally recognized experts in applied mathematics, computer science and in scientific domains with a proven record of effectively and efficiently utilizing high performance computing resources to obtain significant results in areas of science and/or engineering of interest to the Department of Energy and/or the Department of Homeland Security. The individual strengths in applied mathematics, computer science and in scientific domains in concert with the strength of the synergy between them is the critical element of this core competency.
13	*Applied Nuclear Science and Technology*	The ability to use a broad range of facilities, instrumentation, equipment and, often, interdisciplinary teams that apply the knowledge, data, methods, and techniques of nuclear physics, nuclear chemistry, and related accelerator physics to missions of the Departments of Energy and Homeland Security. The elements of this capability are often brought together in unique combinations with those of other disciplines to address high priority needs such as new and improved energy sources and systems; radioisotope production and advanced instrumentation for nuclear medicine; development of methods and systems to assure nonproliferation and combat terrorism; and environmental studies, monitoring, and remediation.

CC#	Core Capabilities	Definition
14	*Nuclear and Radio Chemistry*	The ability to use a broad range of facilities, instrumentation, equipment and, often, interdisciplinary teams that apply the knowledge, data, methods, and techniques of nuclear chemistry, mechanical engineering, chemical engineering to missions of the Departments of Energy and Homeland Security. The elements of this capability are often brought together in unique combinations with those of other disciplines to address high priority needs such as new and improved nuclear systems; radioisotope production and advanced instrumentation for nuclear medicine; development of methods and systems to assure nonproliferation and combat terrorism; and environmental studies, monitoring, and remediation.
15	*Nuclear Engineering*	The ability to use a broad range of facilities, instrumentation, equipment and, often, interdisciplinary teams that apply the knowledge, data, methods, and techniques of nuclear engineering, mechanical engineering, nuclear reactor physics, measurable science and risk assessment to missions of the Departments of Energy and Homeland Security. The elements of this capability are often brought together in unique combinations with those of other disciplines to address high priority needs such as new and improved energy sources and systems; advanced instrumentation for nuclear systems; and development of methods and systems to assure nonproliferation and combat terrorism.
16	*Applied Geosciences and Engineering*	Applies a quantitative understanding of geologic phenomena, subsurface geologic systems, and coupled surface and subsurface processes to the identification and development of robust, reliable, and cost-effective subsurface energy and waste management systems. Primary supporting disciplines include geology, geoengineering, geophysics, geochemistry, geostatistics; computational science; mechanical engineering; chemical engineering; risk assessment; chemistry; and physics.
17	*Applied Materials Science & Engineering*	The ability to conduct theoretical, experimental, and computational research to understand and characterize materials with focus on the design, synthesis, prediction and measurement of structure/property relationships, the role of defects in controlling properties, and the performance of materials in hostile environments. The strong linkages with molecular science, engineering, and environmental science provides a basis for the development of materials that improve the efficiency, economy, cost-effectiveness, environmental acceptability, and safety in energy generation, conversion, transmission, and end-use technologies and systems. Primary supporting disciplines and field include materials synthesis, characterization, and processing; chemical and electrochemistry, combinatorial chemistry, surface science, catalysis, analytical and molecular science; and computation science.
18	*Chemical Engineering*	The ability to conduct applied chemical research that spans multiple scales from the molecular to macroscopic and from picoseconds to years. Chemical engineering translates scientific discovery into transformational solutions for advanced energy systems and other U.S. needs related to environment, security, and national competitiveness. The strong linkages between molecular, biological, and materials sciences, engineering science, and separations, catalysis and other chemical conversions provide a basis for the development of chemical processes that improve the efficiency, economy, competitiveness, environmental acceptability, and safety in energy generation, conversion, and utilization. A core capability in chemical engineering would underpin R&D in various areas such as nanomanufacturing, process intensification, biomass utilization, radiochemical processing, high-efficiency clean combustion, and would generate innovative solutions in alternative energy systems, carbon management, energy-intensive industrial processing, nuclear fuel cycle development, and waste and environmental management.

CC#	Core Capabilities	Definition
19	*Mechanical Design and Engineering*	Applies the principles of physics, mechanics, and materials science to analyze, design, test, validate, and enable operation of advanced engineered systems, machines and tools. Includes equipment used to move or extract energy bearing materials (e.g., oil, gas, coal) or from moving fluids (e.g., water, wind, steam); equipment used to convert energy to useful services (e.g., mobility, home heating and cooling, robotics, imaging devices, etc.) or to manufacture products; and/or systems that will be operated in the ocean environment. Primary supporting disciplines include physics, materials science, oceanography, aerospace engineering, mechanical engineering, chemical engineering, electrical engineering and computational science.
20	*Power and Electrical Engineering*	Applies understanding of electromagnetic phenomena to design and engineer circuitry and electrical and electronic devices and equipment to address the efficiency and reliability of power transmission systems and grid interface of variable generation. Primary supporting disciplines include electrical engineering, power systems engineering, computational science, and materials synthesis, characterization and processing.
21	*Cyber and Information Sciences*	The disciplines, technologies, and practices designed to protect, analyze, and disseminate information from electronic sources, including computer systems, computer networks, and sensor networks. A core competency in this area would involve recognized expertise in one or more of the following topics: cyber security, information assurance, information analytics, knowledge representation, and information theory. This core competency would be applied to: the protection of information systems and data from theft or attack; the collection, classification, analysis, and sharing of disparate data; and the creation of knowledge from heterogeneous information sources.
22	*Decision Science and Risk Analysis*	Derives knowledge and insights from measured and modeled data sets to further the understanding of and tradeoffs among resource and technology options, to identify and quantify the risks and impacts of current and emerging technologies on environmental systems, and to assess the impact of market dynamics, human behavior and regulations, policies or institutional practices on the development and uptake of technology. Primary supporting disciplines include engineering, environmental science, applied math, finance, business, social and political science, and market and behavioral economics. This capability provides credible and objective information to support DOE and others to support strategic planning and program direction, policy formulation and implementation, efforts to remove market barriers to deployment and engagement with stakeholders.
23	*Systems Engineering and Integration*	The ability to solve problems holistically from the concept and design phase to ultimate deliverable and completion phase, by synthesizing multiple disciplines to develop and implement optimal solutions for technologies, manufacturing processes, interdependent energy systems, and sustainable infrastructure. Applies measurement science and knowledge of the physical and natural environment to diagnose and quantify operational parameters. Uses control theory and modeling to optimize performance through design of controls and feedback loops that communicate among individual components to enable interoperability and overall system performance. Areas of application of this capability include development of programs in energy supply, storage, transportation, and efficiency; and deployment of novel solutions to materials and sensor problems in fields of interest to the Department of Energy and/or the Department of Homeland Security.
24	*Large-Scale User Facilities/Advanced Instrumentation*	The ability to conceive, design, construct and operate leading-edge specialty research user facilities. This includes the ability to manage effectively construction of $100 million or greater one-of-a-kind scientific facilities, and to host hundreds to thousands of U.S. and international users in addition to carrying out world-class research at the facility itself. The ability to conceive, design, build, operate and use first-in-class technical instruments intended for a particular research purpose, often requiring the material expertise of multiple scientific disciplines. Instrumentation that can be created by a small number of individuals or that would sit on a laboratory bench-top is not considered part of this core capability.