USDRIVE

DRIVING RESEARCH AND INNOVATION FOR VEHICLE EFFICIENCY AND ENERGY SUSTAINABILITY

Integrated Systems Analysis Tech Team Roadmap

February 2018

This roadmap is a document of the U.S. DRIVE Partnership. U.S. DRIVE (Driving Research and Innovation for Vehicle efficiency and Energy sustainability) is a voluntary, non-binding, and non-legal partnership among the U.S. Department of Energy; USCAR, representing FCA US LLC, Ford Motor Company, and General Motors; five energy companies – BP America, Chevron Corporation, Phillips 66 Company, ExxonMobil Corporation, and Shell Oil Products US; two utilities – Southern California Edison and DTE Energy; and the Electric Power Research Institute (EPRI).

The Integrated Systems Analysis Tech Team (ISATT) is one of 13 U.S. DRIVE technical teams whose mission is to accelerate the development of pre-competitive and innovative technologies to enable a full range of efficient and clean advanced light-duty vehicles, as well as related energy infrastructure.

For more information about U.S. DRIVE, please see the U.S. DRIVE Partnership Plan, at www.vehicles.energy.gov/about/partnerships/usdrive.html or www.uscar.org.

Mission

The mission of the ISATT is to leverage the life cycle and systems analysis core competency within the U.S. DRIVE partnership to generate analysis/knowledge and provide insights for decision-making within the Partnership member organizations. ISATT will leverage the technical knowledge and the lifecycle assessment skills within the partner organizations to address projects that span different sectors (e.g. power-transportation) and provide an integrated systems analysis. The target audiences for ISATT work includes decision makers within the Partnership and external stakeholders of the technical community and policymakers. ISATT will document its findings in the public domain, for example in national laboratory reports and/or peer reviewed scientific papers.

Scope

The primary scope of ISATT activities will be "big picture" multi-vehicle platform techno-economic system analysis. Examples include target-setting exercises and extension/updated of the cradle-to-grave assessment of vehicle-technologies. Ancillary programming/work may also be conducted to improve systems analysis models for specific technologies. In all cases, specific projects and tasks will be developed and prioritized to address knowledge gaps, developing new tools and methods where necessary and timely. As an example, the move towards electrification and renewable power may motivate topics such as battery second-use, vehicles for load management, and electro-fuels.

This roadmap structures the overarching multi-year plan for ISATT activities and intended outcomes; however, this tech team revisits Roadmap-identified activities on an annual basis to develop Annual Plans subject to Joint Operations Group (JOG) review and approval.

Purpose and Key Focus Areas

Core Competencies and Value to the Partnership

ISATT's primary purpose is to answer strategic questions that leverage lifecycle analysis expertise that are of timely interest to the Partnership. (Note that this tech team's purpose is distinct but complementary from most other U.S. DRIVE technology teams, whose activities culminate in achieving R&D targets.)

- ISATT is unique as a technology team in that it addresses specific research questions that cut across multiple fuel/vehicle technology pathways, infrastructure technologies, and/or broader macroeconomic trends that impact the transportation space.
- ISATT draws on and complements existing systems tech team expertise and capabilities using an integrated systems research and analysis framework, as is depicted in Figure 1.
- ISATT informs the U.S. DRIVE partnership technology portfolio direction by contextualizing technical targets, assessing transition barriers, and quantifying the potential benefits of longer-term success.

ISATT offers broad value to the Partnership and its respective partners by providing access to community experts and a medium for mutual exchange between and among partners and DOE's national laboratories.

- ISATT, as the partnership's integrated analysis expert community serves to expand Partnership knowledge base via critical discussion and credible screening.
- ISATT's activities are intended to identify and fill gaps or deficiencies in the analysis toolset available to the Partnership based on the best publicly available, up-to-date techno-economic and environmental assessments.

As a result of ISATT discussion and activity in support of the Partnership, the technology team disseminates relevant knowledge and analytical insights beyond the Partnership in the form of external documentation, such as lab reports and peer-reviewed publications.

- Based on consensus in the technical team and JOG endorsement, final results of ISATT analysis are typically published as national laboratory and/or peer reviewed technical reports with authorship offered to, but not required from, ISATT project participants.
- Tools and data sets developed by ISATT may also be published for use by the broader transportation research community

Major areas of activity

ISATT's primary area of activity is the assessment current and future vehicle-fuel technology options when integrated systems analysis is required.

- ISATT considers both end-state and transitional pathways or scenarios in applying its integrated systems analysis approach.

- Specific areas of study warranting regular vehicle-fuel technology assessment include analysis in support of U.S. DRIVE's Partnership Research Targets as well as revisiting and update the seminal Cradle-to-Grave (C2G) analysis.

ISATT also undertakes specific topical analyses to examine tradeoffs and synergies related to light-duty transportation and relevant energy systems.

- Activities are coordinated with other technical teams of the Partnership to promote consistency between analysis and modeling efforts and to ensure effective use of resources.
- Relevant potential intersectional analysis could include the tradeoffs between the fuel cycle and vehicle cycle given the continued evolution of vehicle and fuel technologies, tradeoffs and attribution of energy and environmental outcomes between the power and transportation sectors in an electrified future scenario, and tradeoffs between fuel cell and combustion vehicles given potential upstream changes in hydrogen and hydrocarbon production pathways.

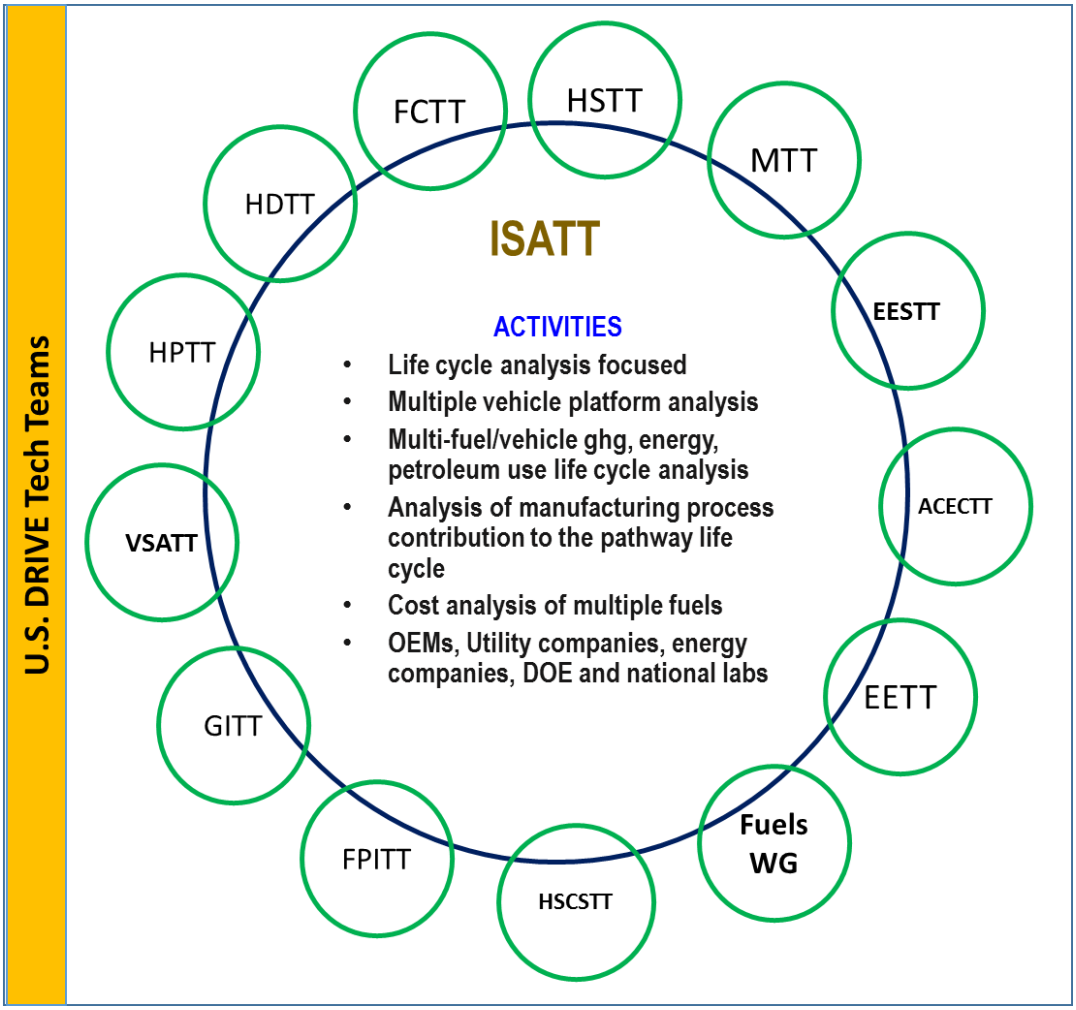

Figure 1. ISATT in the context of U.S. DRIVE Tech Teams

Strategy

The Integrated Systems Analysis Tech Team (ISATT) will support the U.S. DRIVE Partnership by addressing the following research projects and/or any other projects as directed by the JOG.

- **LCA for future new mobility scenario analysis:** The ISATT will conduct life cycle assessments of the energy use, emissions, and costs for new mobility scenarios including connected autonomous vehicles and shared mobility services in the 2030-2035 time frame. The results will be compared to those for conventional technologies. This study will build on the existing C2G analysis and will use, and add to, the GREET model as appropriate. An overview of the results will be compiled and a report will be prepared and presented to the JOG. With JOG approval the results will be documented in an Argonne National Laboratory Report and a peer reviewed journal publication.
- **EV analysis and upstream analysis of movement towards renewable energy, battery second-use, vehicles for load management, electro-fuels:** ISATT, in coordination with other relevant technical teams, will examine questions at the intersection of electric vehicles, manufacturing, and the grid, such as "how much battery manufacturing is needed?", "how much power generation?", and "how much charging?" Additionally, The ISATT will conduct an upstream analysis of costs and scalability of renewable electricity generation and fuel production, battery second-use, use of vehicle batteries for grid load management, and/or electro-fuel production (gaseous or liquid chemical fuels synthesized using renewable electricity) in 2020 and 2030-2035. Data will be taken from GREET model and literature sources as appropriate. An overview of the results will be compiled and a report will be prepared and presented to the JOG. The results will be incorporated into the GREET model as appropriate. With JOG approval the results will be documented in an Argonne National Laboratory Report and a peer reviewed journal publication.
- **Analysis harmonization study: compare C2G, etc. with existing literature:** The ISATT will survey literature similar to the 2016 C2G report for data assumptions, baselines, and methodologies associated with the light duty vehicle sector. The information from these previous studies will be analyzed with the C2G methodologies to harmonize the results of the previous studies with the results of the C2G study to understand key differences. An overview of the harmonized literature data will be compiled and a report will be prepared and presented to the JOG. With JOG approval the results will be documented in an Argonne National Laboratory Report and a peer reviewed journal publication.

- **Vehicle modeling harmonization study: compare DOE/Partnership estimates of PEV/vehicle performance and characteristics vs. actual market:** The ISATT will use actual vehicle characteristics and operating data from actual PEVs and use the ANL Autonomie model to prepare an analysis of harmonized vehicle performance with a common set of assumptions based on DOE and Partnership estimates. The results of the vehicle performance analysis will be compiled and synthesized into a report which will be presented to the JOG. With JOG approval the results will be documented in an Argonne National Laboratory Report and a peer reviewed journal publication.

- **Target-Setting:** conduct analysis and make recommendations to U.S. DRIVE R&D tech teams regarding updating Partnership Research Targets

- **Cradle-to-Grave:** revisit and update previous Cradle-to-Grave (C2G) analysis based on updated assumptions about vehicles and fuels.

- **Future of ICE:** The ISATT will conduct a study of the future for internal combustion engine vehicles in the 2030-2035 time frame in the context of rapid electrification of vehicle powertrains. The costs, energy efficiencies, emissions, and performance attributes of HEV, PHEVs, and BEVs will be compared to ICEVs. The full range of vehicle classes will be considered from subcompact cars to class 8 trucks. An overview of the results will be compiled and a report will be prepared and presented to the JOG. The results will be incorporated into the GREET model as appropriate. With JOG approval the results will be documented in an Argonne National Laboratory Report and a peer reviewed journal publication.

- **Emissions and cost of battery manufacturing "Pathways" to "green manufacturing" (and comparison with manufacturing abroad):** The ISATT will use the C2G methodology which includes the GREET model for analysis of the emissions and the life cycle cost model to assess the cost of battery manufacturing pathways. Also, literature related to foreign battery manufacturing will be surveyed for data, assumptions, baselines, and methodologies associated with the light duty vehicle sector will be analyzed with the C2G methodology to harmonize the analytical results. The information from these analyses will be will be compiled and a report will be prepared and presented to the JOG. With JOG approval the results will be documented in an Argonne National Laboratory Report and a peer reviewed journal publication.

- **Water-Energy Analysis of Vehicle-Fuel Pathways**: Recognizing that different alternative fuel pathways involve differences in both energy and water use implications and cycles, ISATT will undertake a lifecycle analysis of water

consumption associated with relevant integrated vehicle-fuel pathways. The GREET model will be employed and augmented, where/when appropriate.

Acknowledgements

ISATT Organizational Members
U.S. Department of Energy
ExxonMobil Refining & Supply Company
Phillips 66 Company
Shell Oil Products US
Chevron Corporation
FCA US LLC
Ford Motor Company
General Motors
National Renewable Energy Laboratory
Argonne National Laboratory

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Marcus Alexander, Electric Power Research Institute
Steve Barnhart, FCA US LLC
Timothy Wallington, Ford Motor Company
Ian Sutherland, General Motors

Team Member Roles

Team members follow roles as defined in the U.S. DRIVE Partnership Plan.