



# Integrated Systems Analysis Tech Team (ISATT) Roadmap

April 2023



*This roadmap is a document of the U.S. DRIVE and 21<sup>st</sup> Century Truck Partnerships.*

*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; four utilities – American Electric Power, DTE Energy, Duke Energy Corporation, and Southern California Edison; and the Electric Power Research Institute (EPRI).*

*The [21<sup>st</sup> Century Truck Partnership](#) (21CTP) is a voluntary, non-binding, and non-legal partnership among the U.S. Department of Energy; U.S. Department of Defense; U.S. Department of Transportation; U.S. Environmental Protection Agency; Allison Transmission Inc; Cummins Inc; Daimler Trucks North America LLC; DENSO International America, Inc; Detroit Diesel Corporation; Eaton; Ford Motor Company; General Motors Company; Mack Trucks; Meritor, Inc; Navistar, Inc; Nova Bus Inc; Oshkosh Corporation; PACCAR Inc; Volvo Trucks North America; and the following National Research Organizations: Argonne, Brookhaven, Idaho, Lawrence Berkeley, Lawrence Livermore, Los Alamos, Oak Ridge, Pacific Northwest and Sandia National Laboratories; the National Renewable Energy Laboratory; NASA Ames Research Center and the National Institute of Standards and Technology.*

*The Integrated Systems Analysis Tech Team (ISATT) is a joint U.S. DRIVE/21CTP technical team whose mission is to accelerate the development of pre-competitive and innovative technologies to enable a full range of efficient and clean advanced light, medium and heavy-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.energy.gov/eere/vehicles/us-drive](http://www.energy.gov/eere/vehicles/us-drive) or [www.uscar.org](http://www.uscar.org).*

*For more information about 21CTP, please see the 21<sup>st</sup> Century Truck Partnership Plan, at [www.energy.gov/eere/vehicles/21st-century-truck-partnership](http://www.energy.gov/eere/vehicles/21st-century-truck-partnership).*

## **Mission**

The mission of the ISATT is to leverage the life cycle and systems analysis core competency within both the U.S. DRIVE and 21CTP partnerships 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. grid-transportation) and provide an integrated systems perspective. 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/updates to 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 clean transportation may motivate topics such as battery second-use, matching vehicle energy supply and demand and other aspects of vehicle-grid integration, market segmentation of different low-carbon powertrains (e.g. hydrogen and fuel cells, batteries, internal combustion engines), 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 both Joint Operations Group (JOG) and Executive Management Team (EMT) 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 Partnerships. (Note that this tech team's purpose is distinct but complementary from most other U.S. DRIVE and/or 21CTP technology teams and working groups, 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. This gives the ISATT the ability to compare technologies and their respective impact upon clean transportation solutions.
- 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 both the U.S. DRIVE and 21CTP partnerships 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 the Partnerships 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 Partnerships 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/EMT 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

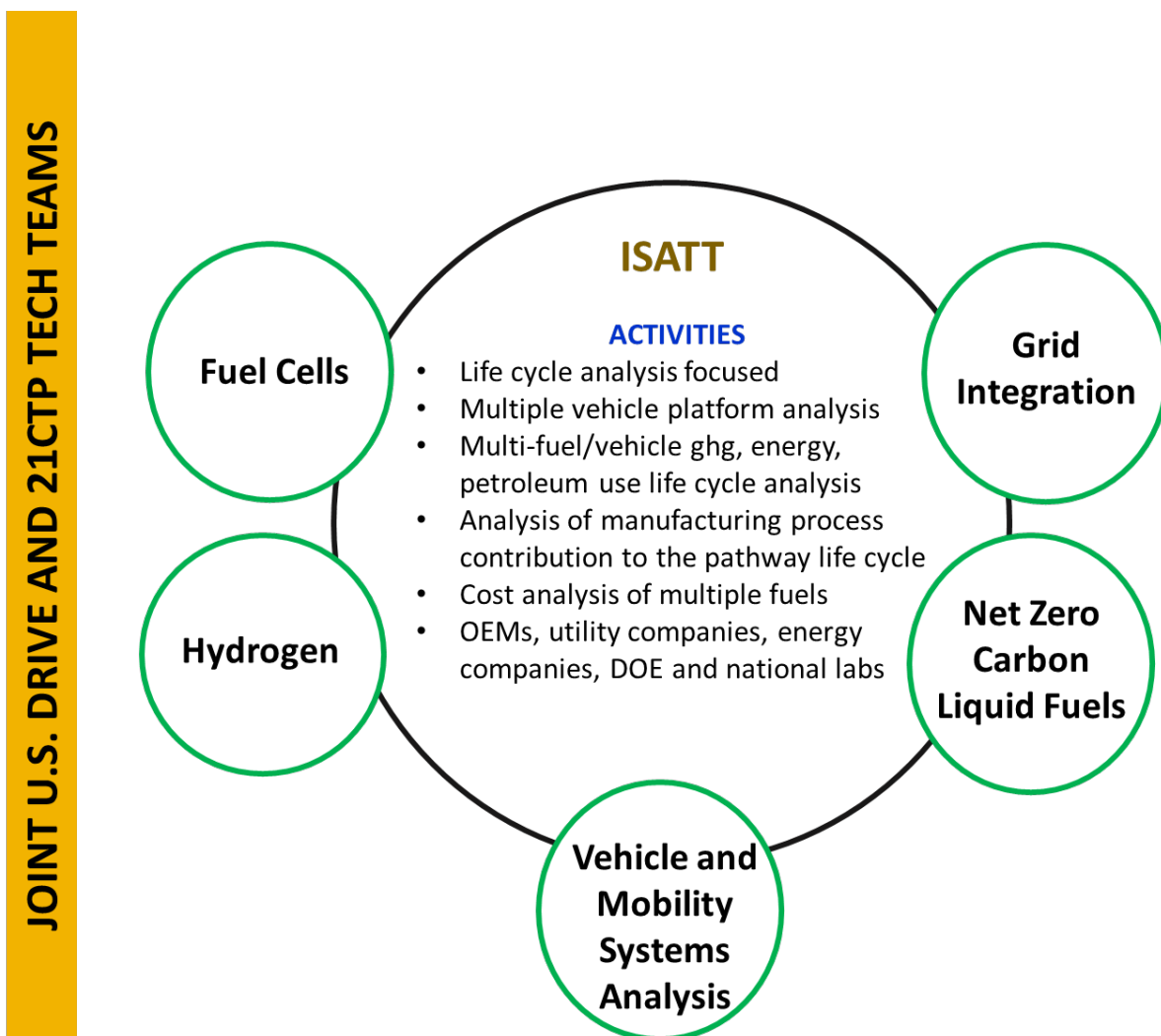
ISATT's primary area of activity is the assessment of current and future vehicle-fuel technology options when integrated systems analysis is required.

- 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 both U.S. DRIVE's and 21CTP's Partnership Research Targets as well as revisiting and updating key Cradle-to-Grave (C2G) analyses, the most recent of which was published in 2022 for LD vehicles.

ISATT also undertakes specific topical analyses to examine tradeoffs and synergies related to 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 (i.e. emissions associated with producing and transporting fuels, as well as emissions associated with manufacturing and operating vehicles) given the continued evolution of vehicle and fuel technologies, tradeoffs and attribution of energy and environmental outcomes between the electricity and transportation sectors in an electrified future scenario and related infrastructure, 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 Joint U.S. DRIVE and 21CTP Tech Teams

## Strategy 2023–2025

The Integrated Systems Analysis Tech Team (ISATT) will support both the U.S. DRIVE and 21CTP Partnership by addressing the following research projects and/or any other projects as directed by the JOG/EMT.

### 2023

- **C2G Analysis of Medium- and Heavy-duty Vehicles:** The ISATT will complete a C2G analysis of the GHG emissions of at least three classes of medium- and heavy-duty vehicles with battery, fuel cell, combustion engine, and hybrid powertrains. Results will be documented in a technical report that will be published by Argonne National

Laboratory report pending JOG/EMT approval. (Similar analysis of C2G emissions of light-duty vehicles was published in 2022.)

- **Analysis harmonization study: compare C2G, etc. with existing literature:** The ISATT will survey literature similar to the 2022 LD Vehicle C2G report, for data assumptions, baselines, and methodologies associated with the light duty and medium- and heavy-duty vehicle sectors. 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, to inform future drafts of the C2G report.
- **Infrastructure requirements for MDHDVs:** ISATT will review and provide feedback on results from DOE analyses on infrastructure requirements for zero emission MDHDVs, including the design and cost of charging infrastructure and hydrogen fueling infrastructure.

## 2024

- **Analysis of recycling potential of battery and fuel cell technologies:** The ISATT will conduct an analysis to identify potential for battery second-use and the potential for recycling to reduce C2G emissions and improve sustainability of battery and fuel cell transportation. Analysis will leverage ongoing DOE efforts in this space, and results will be incorporated into the GREET model as appropriate.<sup>1</sup> With JOG/EMT approval the results may also be documented in an Argonne National Laboratory Report and a peer reviewed journal publication.
- ISATT will conduct technical reviews of DOE-funded tools and analysis reports intended to characterize the cost of light- medium- and heavy-duty transportation assuming current technologies and potential future advancements. Feedback from ISATT may be used to enhance the accuracy and breadth of these tools, such as ANL's Autonomie and BEAN models.

## 2025

- **Cradle-to-Grave:** revisit and update previous Cradle-to-Grave (C2G) analysis based on updated assumptions about vehicles and fuels. In 2025, ISATT will identify key scenarios and core assumptions to use in the report, and ANL will begin analysis, targeting completion in 2026.

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<sup>1</sup> GREET has been developed and maintained by Argonne National Laboratory for over 20 years, and is accessible here: <https://greet.es.anl.gov/>





## Acknowledgements

### ISAJTT Organizational Members

Allison Transmission  
Argonne National Laboratory  
Chevron  
Cummins  
Eaton  
Electric Power Research Institute  
ExxonMobil Corporation  
Ford  
General Motors  
National Renewable Energy Laboratory  
Navistar  
Phillips 66 Company  
Shell  
Stellantis  
U.S. Department of Energy  
U.S. Environmental Protection Agency

### ISATT Co-Chairs

Raphael Isaac, U.S. Department of Energy  
Neha Rustagi, U.S. Department of Energy  
Ian Sutherland, General Motors

## Team Member Roles

Team members follow roles as defined in the [U.S. DRIVE Partnership Plan](#) and the 21CTP Partnership Plan.