

IEA-Advanced Motor Fuels ANNUAL REPORT 2024

Task 65



Task 65: Powertrain Options for Non-Road Mobile Machinery

Project Duration	November 2023–November 2025
Participants	Austria, Canada, Denmark, Finland, Germany, Sweden, and USA
Task sharing	
Cost sharing	Possibly Sweden to Canada, will be decided later
Total Budget	EUR 1,327,000 (USD 1,438,724)
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Purpose, Objectives, and Key Question

This Task will explore the potential of energy and powertrain options and the feasibility for non-road mobile machinery (NRMM) applications in different use cases. NRMM comprises a wide selection of different kinds of machinery operating in different environments. We will explore questions about what kind of powertrain and energy options offer the best fit for each application without adversely affecting the productivity, usability, and security of supply.

The Task will address the following main topics:

- Energy and powertrain options for NRMM.
- Implications for the use of new carbon-neutral and low-carbon powertrains on the security of supply and on productivity.
- End-use perspective of alternative powertrains (fuels and other energy carriers).
- Local air pollutant emissions associated with NRMM, especially NRMM operating in urban areas.
- Perspectives for CO₂ regulation in different countries.

Activities

Canada's Task-sharing contribution

- Regulation of NRMM around the globe, including air pollutants and CO₂.
- National inventory of existing machinery.
- Real-driving emissions testing of all-terrain vehicles (ATVs) and snowmobiles and comparison to certification testing results.

Denmark's Task-sharing contribution

- Report from an ongoing project on construction machinery, including the following:
 - Emission measurement during actual work by NRMM fueled by biofuel (hydrotreated or hydrogenated vegetable oil (HVO) and battery electric vehicles (BEVs).
 - Development of digital twin models using measurement data.
- Report from an ongoing project for airport ground-handling machinery.
- Report from portable emissions measurement sampling (PEMS) testing results from agriculture tractor.
- Project on greener fuel options for generator sets.
- Facilitation of snowmobile and ATV real driving emissions testing at Sisimiut municipality.

Finland's Task-sharing contribution

- NRMM heavy-duty (HD) engine testing data covering different fuel options for spark-ignition (SI) combustion. Engines are tested on a non-road steady cycle (NRSC) and other steady-state operation points covering full-load and partial-load conditions.
- Testing data for an NRMM HD SI engine run with neat ethanol and methane, as well as with RE85 and a mixture of ethanol and methane.
- Testing data for a direct-injected SI-hydrogen (H₂) engine.

- Contribution through Government-funded project related to NRMM energy options and powertrains that includes information about and analyses of the potential of different energy and powertrain options in mining and forestry applications; analyses include both simulation and experimental methodologies.
- Development of a simulation model for analyzing energy and powertrain options for NRMM applications, including H₂ fuel-cell power production and ethanol and methane internal combustion engine (ICE) power production in generator and hybrid powertrain concepts.
- Development of a tool to evaluate machinery-level power generation options depending on use case and available energy options.

Sweden's Task-sharing contribution:

- National inventory of existing machinery (described in the previous NRMM annex in AMF and AMF Task 50).
- Availability of zero-emission construction equipment.
- Identification of the need for advanced motor fuel technologies within the construction equipment sector.
- Strategies and visions for zero emissions in different counties (with focus on road and rail authorities).

In addition, Sweden and Canada are interested in emission testing of snowmobiles and possibly ATVs. If testing arrangements are possible, this task would be a joint task with Canada. Sweden is also willing to cost-share emission measurements for different technology pathways for snowmobiles (and possibly ATVs).

USA Task-sharing contribution:

- Assessment of the following NRMM applications in the United States with their associated energy use and greenhouse gas (GHG) emission contributions: agriculture, mining, construction, locomotive, and marine applications.
- Assessment of the applicability of different low-carbon fuels and powertrains (including ICEs, hybrid configurations, battery EVs, and hydrogen fuel cells).
- Results of life-cycle analysis (LCA) and techno-economic analysis (TEA) of different fuel/powertrain combinations.
- Exploration of the impacts of GHG reductions, air pollutant reductions, and energy use reductions.

The U.S. contribution will be leveraged with a study by the U.S. Department of Energy in multiple national labs. If needed, the United States will assemble its industry stakeholders to present their visions and activities to decarbonize the NRMM sector in the United States and globally.

New task members

During 2024, Task 65 welcomed two new countries onboard, Austria and Germany. The Task contribution for these countries is stated as follows.

Austria's Task-sharing contribution:

- To generate a comparison of requirements considering Pressure Regulation Directive (PRD for NRMM), UN ECE R 134 (Automotive) and other proper hydrogen ISO standards.
- To establish and strengthen an argumentation for an interim compliance solution without adoptions in the PRD:
 - With reference to the knowledge of step 1, lining out in position papers (policy documents) that relevant requirements of the R 134 are sufficient also for NRMM where the wheel loader is just the reference machine.
 - Outlining in these position papers that out of the technical point of view the R 134 requirements are more practical for hydrogen machinery components than the PRD requirements.

Germany's Task-sharing contribution:

- Import national data from NRMM of the agricultural sector.
- Assess the availability of alternative drive technologies for agricultural machinery, incl. biofuel approval, series produced NRMM, retrofitting technology and battery electric drives.

- Contribute with a strategy/vision for decarbonisation of agricultural NRMM according to KTBL working group “Antriebssysteme für landwirtschaftliche Maschinen.”
- Distribute relevant information about the national regulatory framework (regarding targets, approvals, taxes, incentives).
- Report real driving emission and fuel consumption data for different agricultural tractors (exhaust stage IV and V) operated with various biofuels (e.g. HVO 100, FAME 100, Pure Rapeseed Oil 100) of already finished and ongoing PEMS measurement projects.
- Report PTO test stand data (limited exhaust emissions, fuel and urea consumption, efficiency) for different agricultural tractors (exhaust stage IV and V) operated with various biofuels (e.g. HVO 100, FAME 100, Pure Rapeseed Oil 100) of already finished and ongoing measurement projects.

Task status

During 2024, Task 65 held three joint task progress meetings. The task progress meetings focused on aligning and planning the content and work within given work packages. Additionally, methodologies and options on how to efficiently manage and merge the data that would be collected from relevant sources/partners by country were discussed. The collected data will be merged based on work package deliverable and data type during 2025. Task 65 work packages are defined as follows:

WP1: Task management

WP2: Review of alternative powertrains deployment and regulatory framework

WP3: Testing

WP4: Modelling and simulation

WP5: Cooperation with other IEA TCPs

Furthermore, a workshop related to decarbonization options and implementation of sustainable, alternative powertrain options is planned for 2025.

Expected Results / Deliverables

The task will provide a synthesis of the potential of different energy/fuel options and powertrains for NRMM applications and an investigation of the emissions performance of current technologies compared with possible future regulatory frameworks.

The Task will result in a written Final Report that includes the following:

- Engine dynamometer and in-use NRMM test data: regulated emissions, energy consumption, CO₂ emissions, and alternative energy/fuel options assessed using the well-to-wheel approach.
- Discussion of the feasibility of different energy and powertrain options in NRMM depending on use case, location, available energy sources, and regulation.
- Review of regulatory environment in selected countries.
- National inventories of NRMM and strategies for adapting zero- and low-carbon NRMM in use.