Sustainable TRANSPORTATION

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

Fuel & Lubricant Technologies R&D

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DOE Vehicle Technologies Office
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Fuel & Lubricant Technologies R&D

Mission

Enable advanced combustion through improved understanding of fuel-property impacts, evaluate next-generation biofuels & develop efficiency-improving lubricants

Activities

- Chemical and physical fuel property exploitation
- Next-generation biofuel fit-for-service evaluation
- Lubricant additives and base oil development
- Open, bench-scale lubricant testing methodology
- Fully-formulated oil fit-for-service evaluation
- Supporting analytical work

Funding in millions	**FY 2012** Enacted	**FY 2013** Full Year CR	**FY 2014** Request
Fuel and Lubricant Technologies	$17.9*	$17.5**	$17.5***

* FY2012 SBIR/STTR removed.

** FY2013 full year CR inclusive of SBIR/STTR.

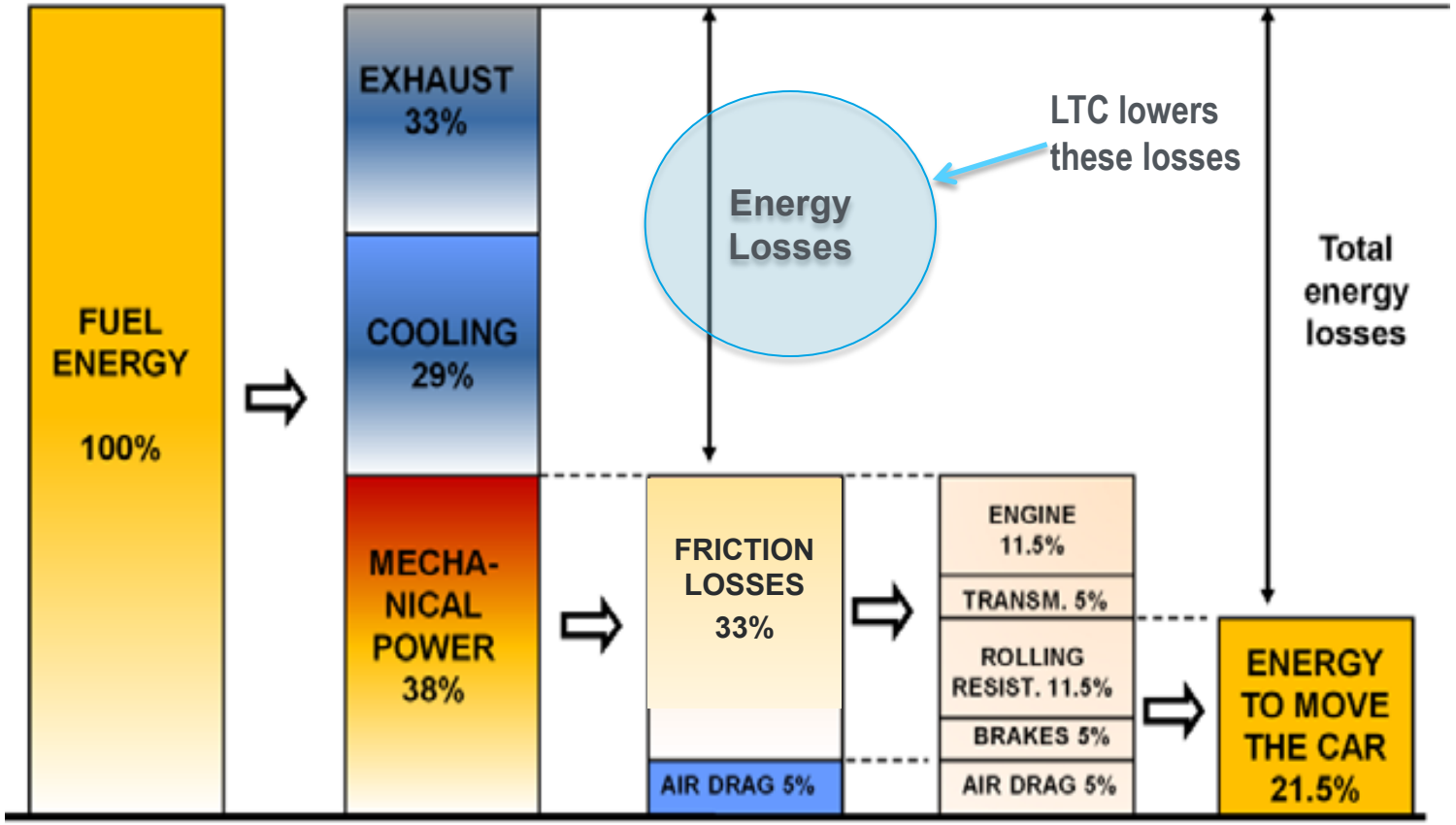
*** FY2014 budget request inclusive of SBIR/STTR.

Goals

- By *2020,* demonstrate expanded operational range of advanced combustion regimes to 75% of LD Federal Test Procedure
- By *2015,* demonstrate cost effective lubricant with 2% fuel economy improvement

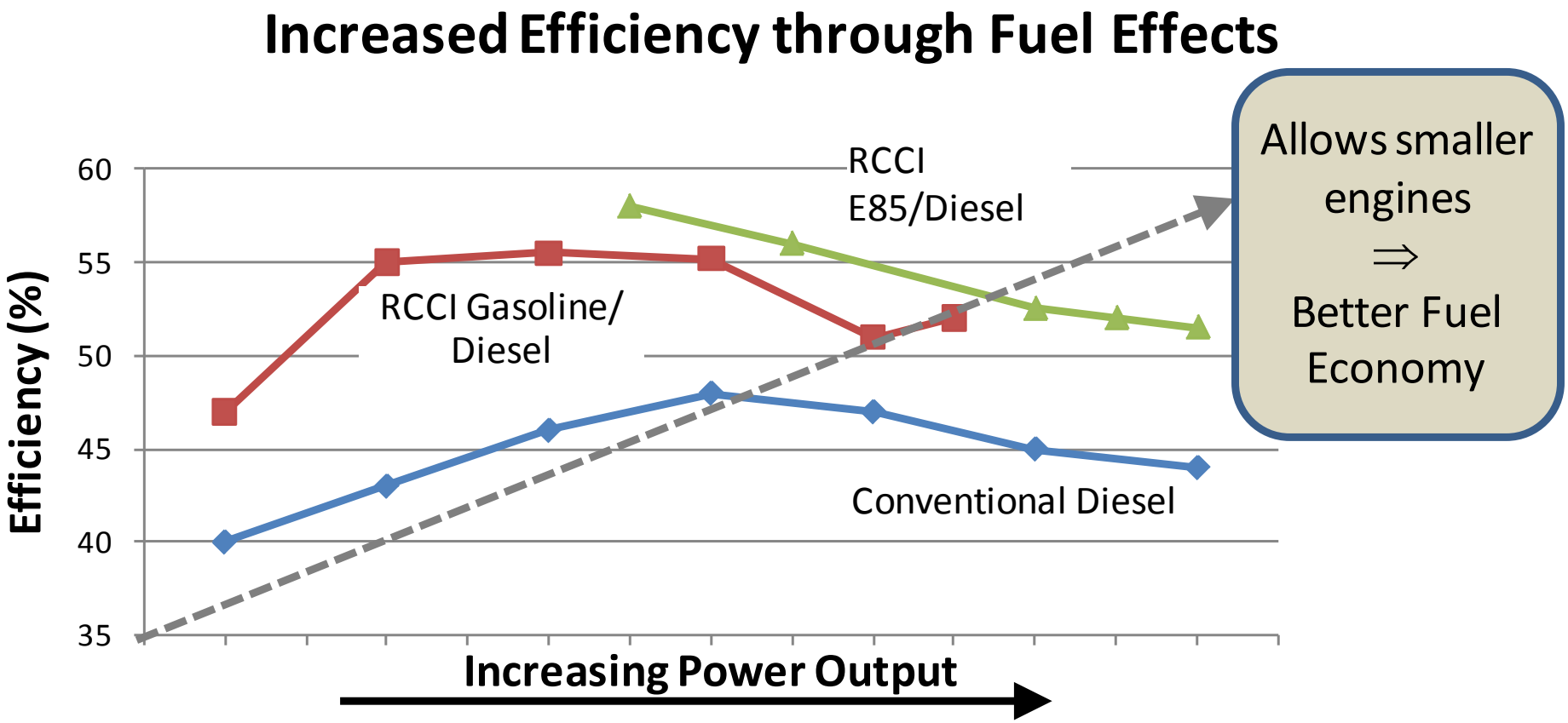
Fuel-energy conversion has room for improvement

Typical Vehicle



Source: Tribology International, Vol 47, March 2012

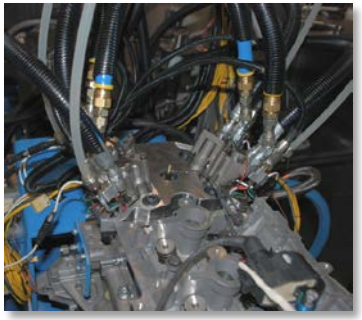
Increased Efficiency Through Fuel Effects



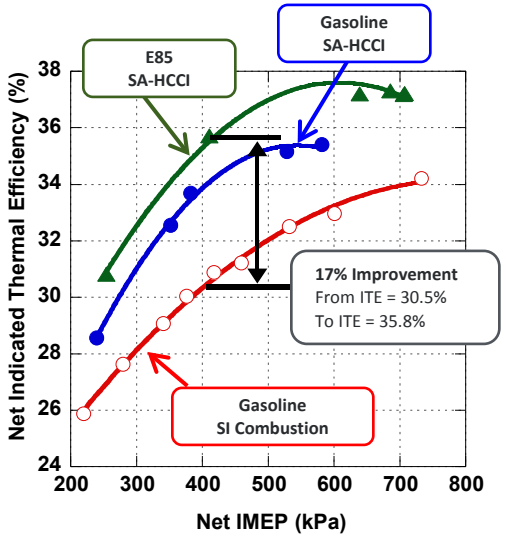
Efficiency and emissions opportunities for enabling low temperature combustion

Enables efficiency improvement and load expansion for Spark Assisted HCCI

- Efficiency improvement attributed to differences in thermochemical properties
- Load expansion attributed to higher octane for more optimized combustion phasing with acceptable pressure rise rates

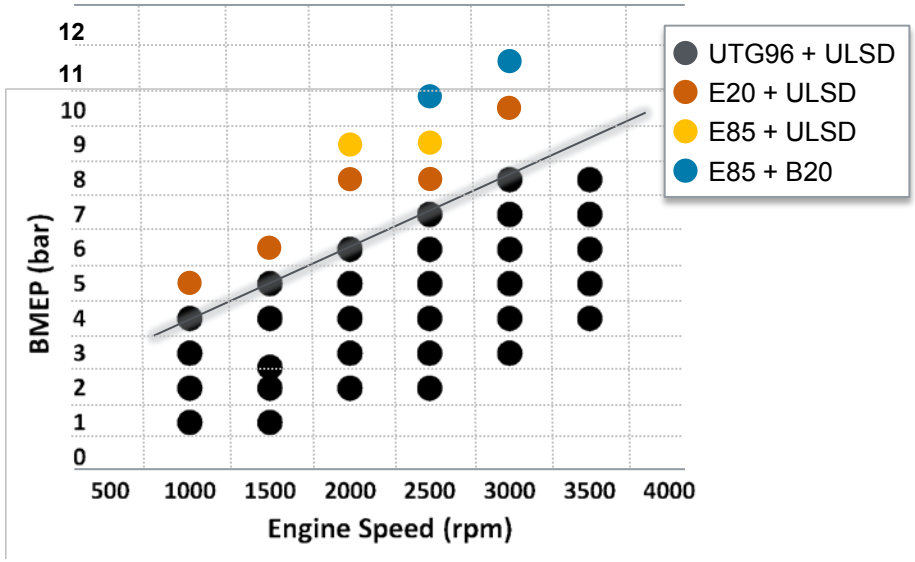


Research engine with fully flexible valve system, boosting, and EGR system.



Enables load expansion with RCCI combustion in a multi-cylinder engine

- Higher reactivity stratification for reactivity controlled compression ignition (RCCI) multi-fuel approaches
- Demonstrated efficiency, emissions, and load expansion improvements with ethanol and bio-diesel blends



DOE NG Engine Projects

DOE Vehicle Technologies Program

California Energy Commission

South Coast Air Quality Management District

R&D Project Integration

Subcontracts

Cummins Westport Incorporated

- **CWI ISX12 G (11.9L): production began April 8, 2013**
- CWI separately integrated the engine with multiple truck OEMs (not funded through this program)
- Conduct extensive on-road development and demonstration program

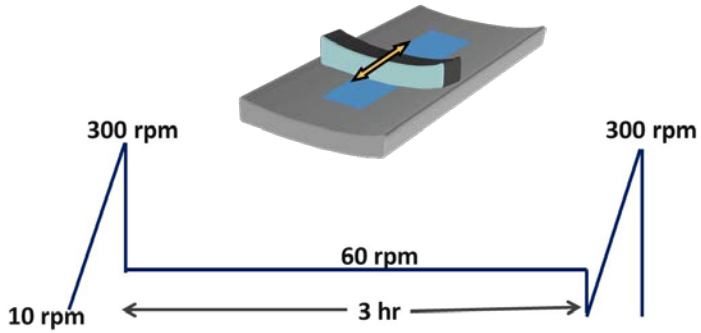
Lubrication Strategies/Tasks

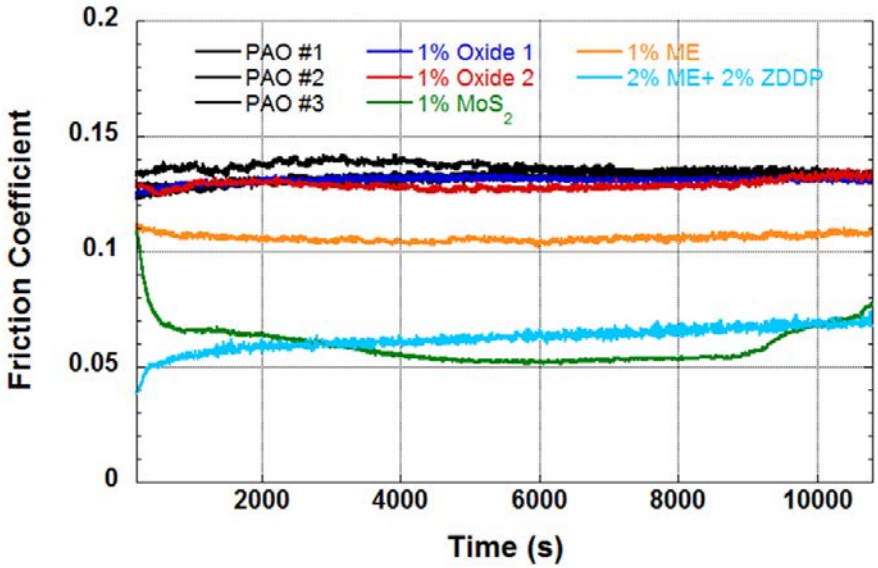
1. **Predictive modeling -** Integration of (continuum) component parasitic friction loss models into subsystems and vehicle level packages – 'what if' parametric studies
2. **Develop Science/Mechanistic Based Models** of Parasitic Losses and Durability/Reliability
3. **Lubricant Technology Development** – Develop advanced lubricants (basefluids and additives) that reduce frictional losses while maintaining or exceeding other performance metrics (durability, reliability, corrosion, deposits, etc.
4. **Engineered Surface Technology** Development – Develop advanced engineered surfaces (textures, designs, materials and coatings) that mitigate parasitic losses from a systems approach. Go beyond current ferrous based tribological systems.
5. **Validation of Modeling and Technologies** – Develop protocols to improve the fidelity of models and technologies. Improve correlation between labscale tests and engine/vehicle tests. Develop high fidelity databases for models and simulation of parasitic losses. Lab-Rig-Engine-Vehicle Validation Studies

Lubricant Additive Studies

Developing common set of test protocols to evaluate frictional behavior of advanced additives (friction modifiers)

- Common test protocols to evaluate frictional behavior of low-friction additives using ring-on liner configuration



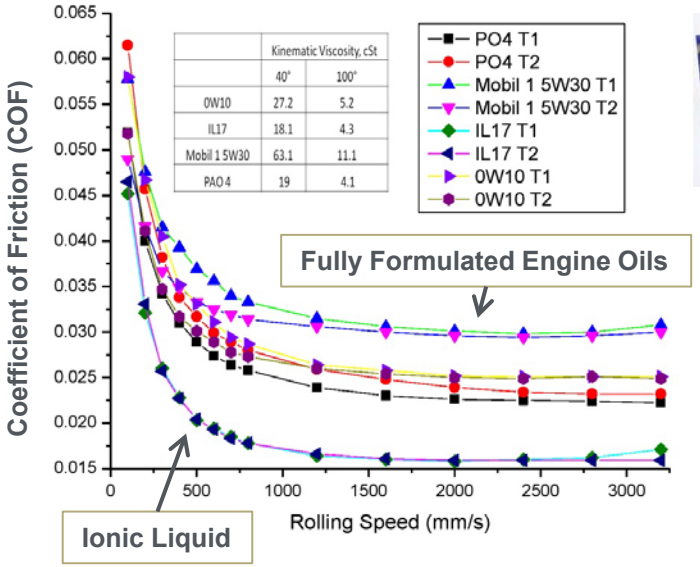


- Comparison of nanoparticulate additives and chemical additives show significant impact on friction response
- Characterization of surfaces in-progress to determine differences in surface finishes and formation of tribofilms

New Lubricant Technologies

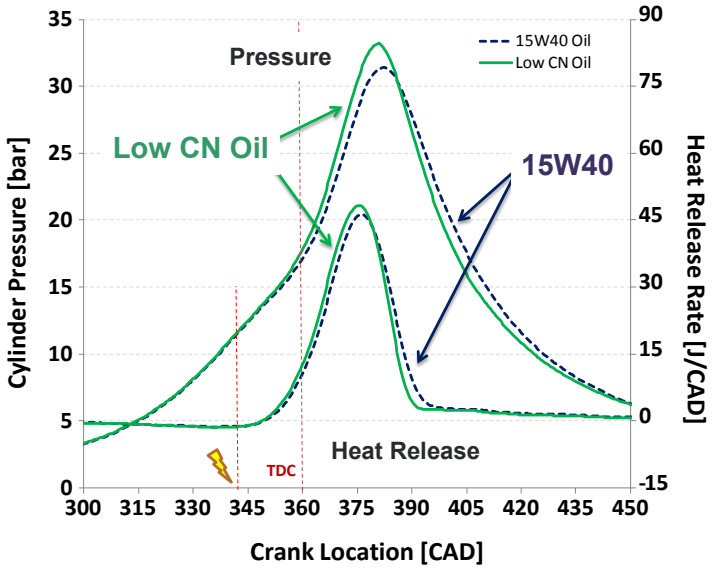
New classes of lubricants and additives based on ionic liquids (IL)

- More effective boundary lubrication – up to 40% friction reduction compared to fully formulated oils (lab scale)
- Enhanced engine durability due to superior functionality via forming a protective surface boundary film
- GM CRADA, FOA-239 with Shell



Low reactivity lubricants for more efficient operation

- Shown to mitigate spark-ignition gasoline engine knock
  - Allows for improved combustion phasing at higher loads
  - Use of higher compression ratio
- CRADA under development with Southwest Research Institute



Data courtesy of SwRI (Alger, 2012)