# ELECTRIFIED VEHICLES TEST PROCEDURE DEVELOPMENT (ANL)


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# ELECTRIFIED VEHICLES TEST PROCEDURE DEVELOPMENT (ANL)

## Timeline

Start date: 6/1/2020
End date: 5/31/2022
50% percent complete

## Budget

- Total $400k (DOE)
- FY 2020: $225k
- FY 2021: $175k

## Barriers and Technical Targets

1. Reducing test burden for electrified vehicles to reduces costs and accelerate progress
2. Further optimization of fuel efficiency and CO2
3. Accurate comparisons among electrified vehicles vs conventional vehicles

## Partners

- Argonne National Laboratory
- SAE Standards Committees
  - All major OEMs
- EPA
- California ARB
- ISO/TC 22/SC 37 Electrically propelled vehicles
- UNECE Electric Vehicle and the Environment International Workgroup

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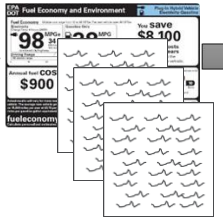
# RELEVANCE

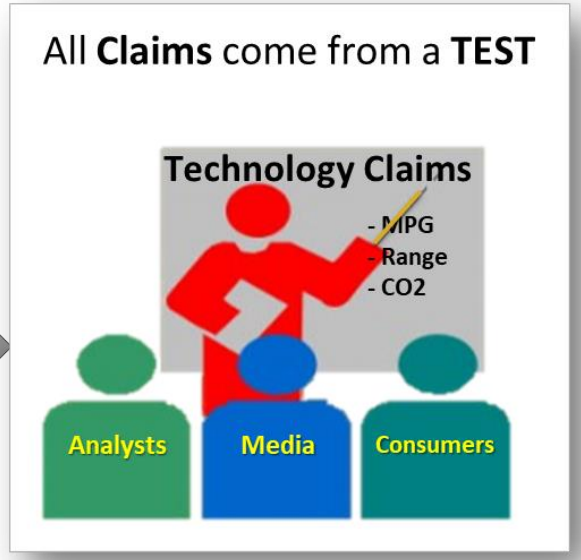
## Test Procedures are Critical to DOE Mission

The SUCCESS of this R&D

Depends on how it's tested here

Reported Results






### Impact

- All performance/economy claims come from a test, test must provide true results
- Reduced test burden will accelerate technology deployment
- Increased fuel economy for hybrids expected. Test allows OEMs to use more aggressive controls to save fuel.

**Over Predict**

- Technology promises too much
- Experience not matching expectations
- Attention not warranted
- Funds are misdirected
- "Poisoned Well" (diesel in USA '80s)

**True Representation**

**Under Predict**

- Technology underrated
- Attention not given
- No adoption, benefits not predicted
- Missed opportunity of benefits

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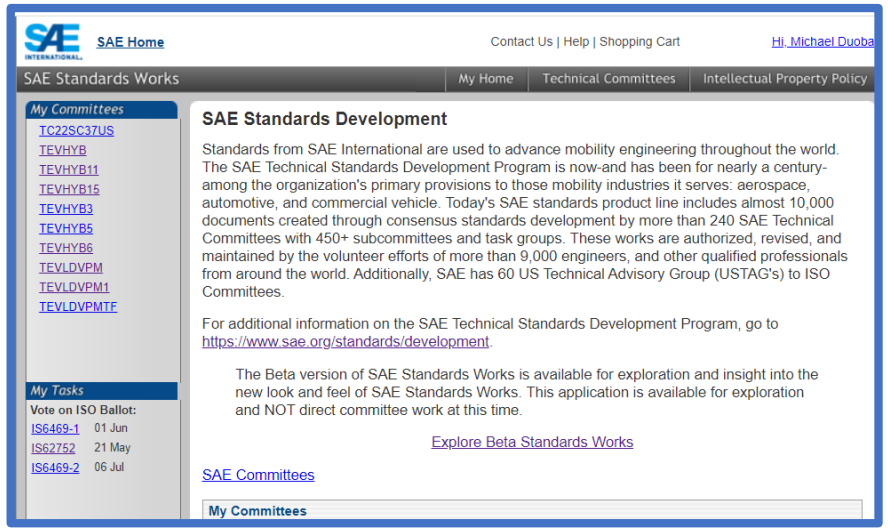
# APPROACH

## Take Leadership in Test Procedure Development by Harnessing 26 Years in xEV Testing Research Experience

- Serve as Chair:
  - **SAE J1711** ***(HEV/PHEV Economy/Emissions Test)***
  - **SAE J2908** ***(HEV/PHEV/BEV Power Test)***
- Use over 20 years of HEV/PHEV/BEV testing data
- Relate experiences, challenges, results
- Pull together a consensus of industry / government
- Balance the needs of the OEMs with the objectives of regulators and DOE

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# TECHNICAL ACCOMPLISHMENTS AND PROGRESS

## HEV/PHEV Fuel Economy Test (J1711)

- Simplified, harmonized, clarified

| Task # | J1711 Component |
|---|---|
| 1 | Review of doc for typos, quick fixes |
| 2 | Definitions Section |
| 3 | J1711 with EPA, CARB (crosscutting task) |
| 4 | EOT Criteria |
| 5 | NEC Tolerance |
| 6 | SOC Calculations |
| 7 | Rcda Calc |
| 8 | Explain how to report all-electric CD |
| 9 | Short-Cut for Long Range PHEVs |
| 10 | *Revisit* Preconditioning / Trasition time |
| 11 | *Revisit* Accuracy |
| 12 | *Revisit* 5-Cycle |
| 13 | *Revisit* Charging (rate, timing, soak) |
| 14 | *Revisit* Speed Trace Tolerance |
| 15 | *Revisit* Range Calculations |
| 16 | Update UF / Harmonize with J2841 |
| 17 | Use CAN data instead of Hioki data? |

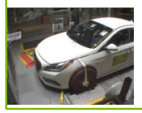
← Systematically addressed "Issues List"

**Task 5: NEC calculation for CD tests**

(used in assigning AC Wh to each cycle)

→ **Change to**: real-time voltage sampling to determine voltage for each cycle

*(For CS tests, keep using Vsys)*



**NOTE**: Original J1711 did not use NEC for CD tests, only SOC (Ah)
Using NEC for CD tests was added by EPA

Task 4: J1711 End of Test (EOT) Criterion

**Options:** Currently in J1711

Only for CS — 1. **NEC Tolerance**: a test for charge-balance ("use 1% of fuel" in CS testing)

Use this — 2. **J1711 Alternative**: a test declaring battery discharging small compared to total discharge in FCT

3. **ECE "break-off criterion"**: a test declaring battery discharge small compared to cycle energy $REEC_i = \frac{|\Delta E_{REESS,i}|}{\frac{1}{3600} \cdot E_{cycle}}$

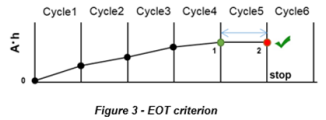
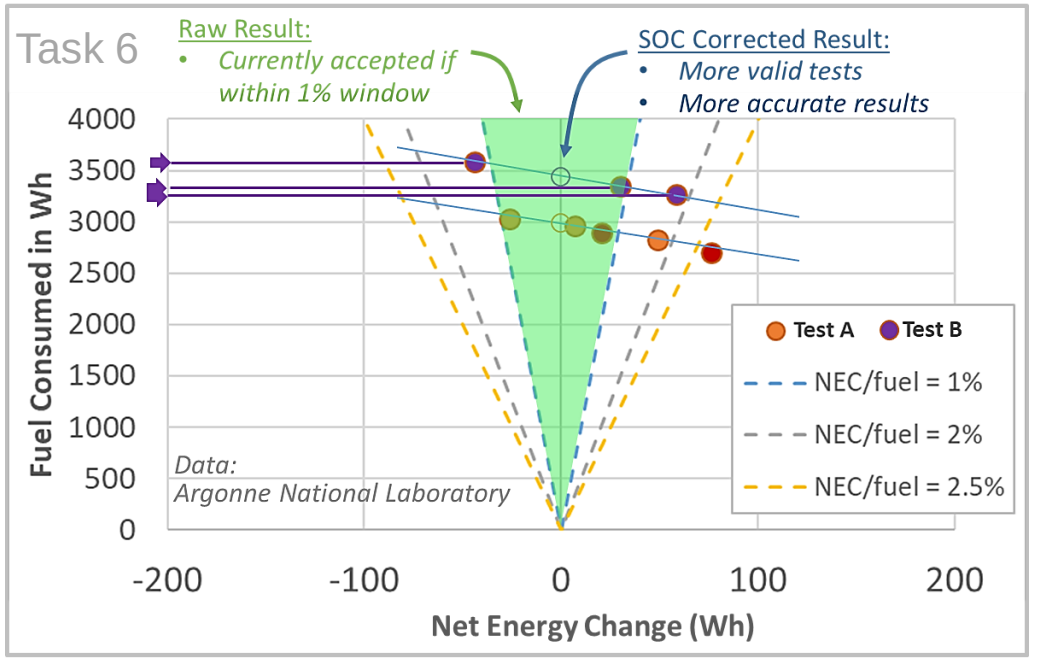



*Figure 3 - EOT criterion*

FCT End-of-Test (EOT) Criterion: $\left|\frac{A \cdot h_2 - A \cdot h_1}{A \cdot h_2 - A \cdot h_0}\right| < 0.02$

- **Novel "SOC Corrections"** will allow:
  - More accuracy
  - Greater optimization by OEMs, harmonized, clarified

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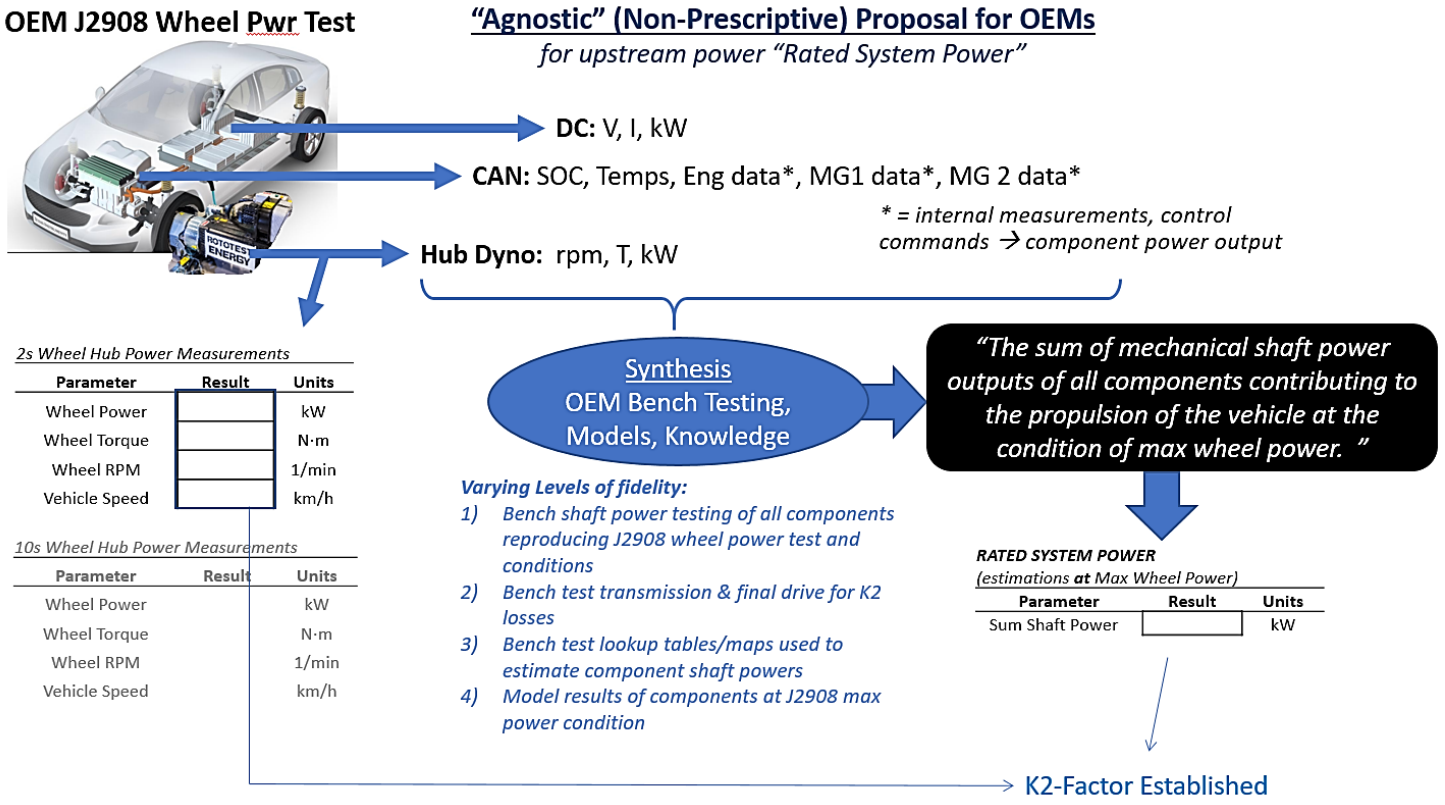
# TECHNICAL ACCOMPLISHMENTS AND PROGRESS

## HEV/PHEV/BEV Power Test (J2908)

- Earlier work on wheel/axle power test
- This update **provided needed framework** for an "Upstream" rating:
  - Compatible with existing wheel/axle test
  - Harmonized with ISO and UN GTR
  - Provides flexibility for markets with no compelled regulatory requirement
  - Provides basis for rating claims



# COLLABORATIONS AND COORDINATION WITH OTHER INSTITUTIONS

In addition to SAE activities:

- Maintained direct, working-level relationships with EPA and CARB since the 1990s
- Direct relationships with OEMS (Ford, GM, FCA, Tesla, among many others)
- Subject Matter Expert on ISO *(relating to both power test and HEV/PHEV economy test)*
- Member of UN EVE IWG *(relating to power test)*

# PROPOSED FUTURE RESEARCH

- Find a way to update PHEV “Utility Factor”
  - Look at fast charging impact for PHEVs
- Ensure emerging technologies are properly addressed by test procedures
  - CAV driving of electrified vehicles
  - Platooning vehicle fuel economy
  - Solar panels on electrified vehicles
  - Dynamic charging of electric vehicles