SAE J2908:
Hybrid System Power Rating

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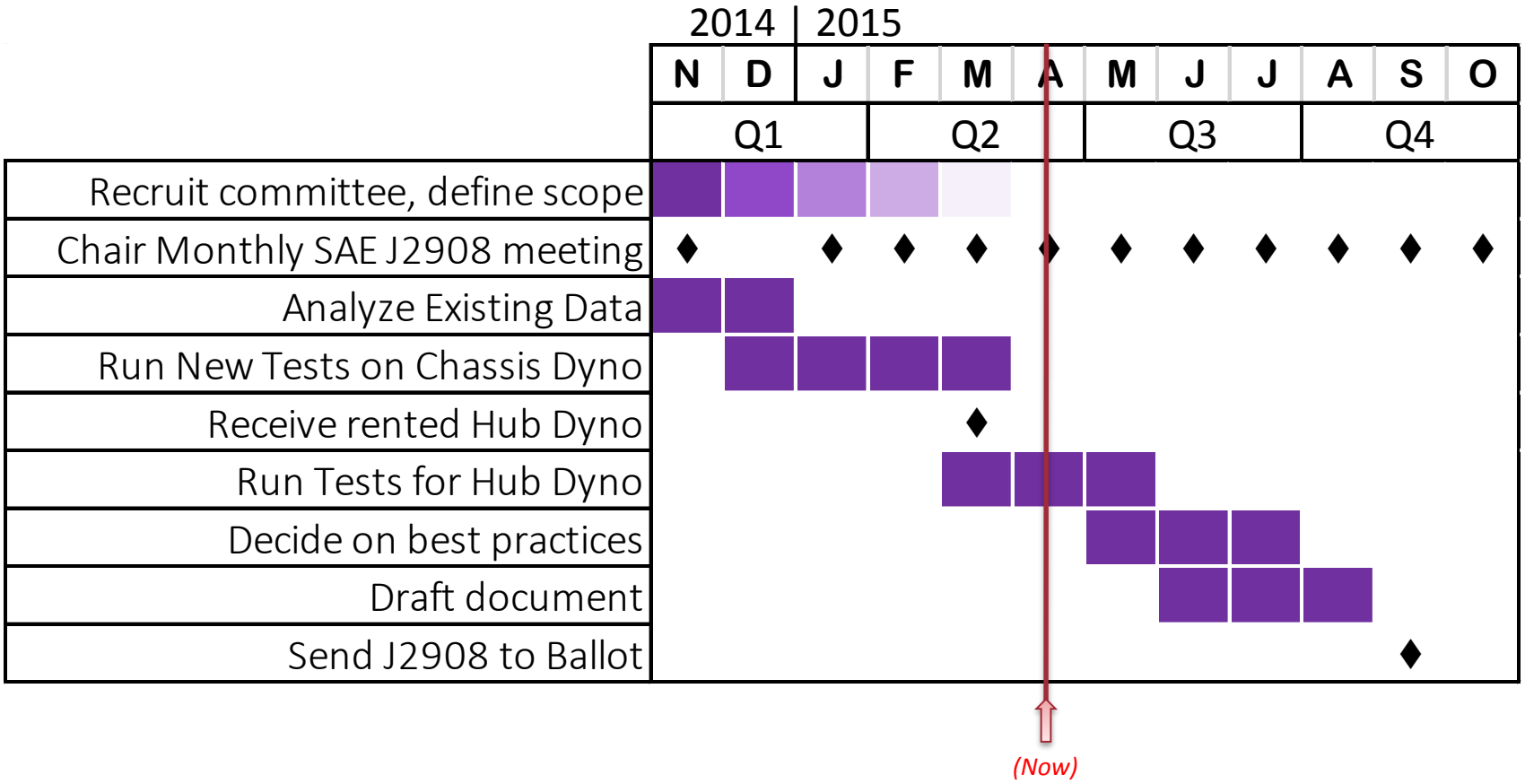
SAE J2908 Timing, Milestones



J2908 Must Satisfy a **Challenging** List of Objectives

1. Describe **Hybrid System Power** in clear, unambiguous terms
2. Avoid **creative interpretation** of procedure → "horsepower wars"
3. If we use **wheel power**, what about current **Engine Flywheel power**?
   - The same "200 HP" car could rate at "162 System HP"
4. Avoid requirement to buy **expensive new dynamometer equipment**
5. Target the needs and perspectives of **both audiences:**
   - **Consumers**
   - **Vehicle Systems Engineers**
6. Provide a procedure **robust** enough to succeed in any powertrain configuration
   - Power-split, series, step transmission, belt CVT, mild HEV, full PHEV, (even BEV?)

Two System Power Approaches

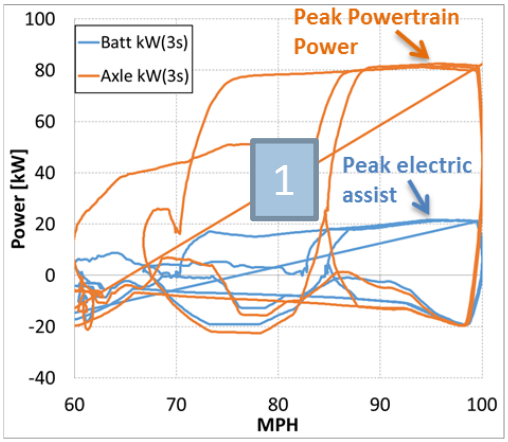
A. Nominal System Power **Rating**
   - Based upon component-level power(s)
   - Similar to current engine power rating, “Catalog Rating”

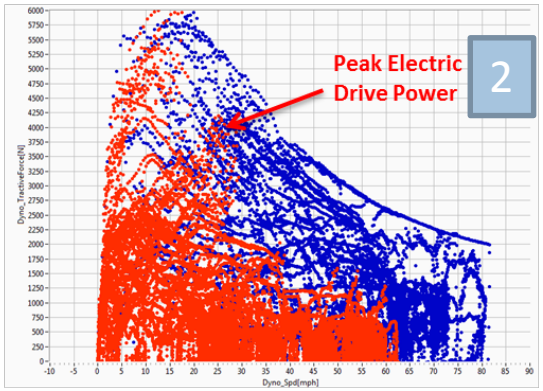
B. System Power **Test**
   - Based upon dyno test
   - Verifiable test for engineers to communicate power levels

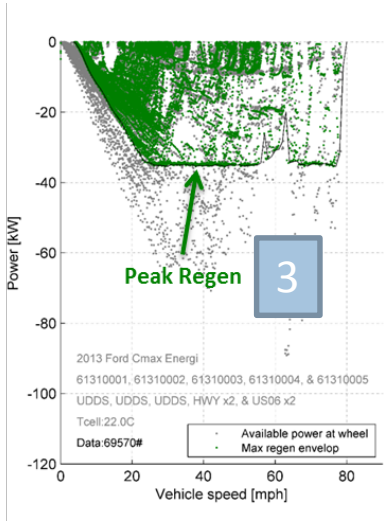
Additional Hybrid System Metrics in J2908

Ratings Will Provide Common Data Benchmarks

1. Electric Assist
   - How much electric power assist is given during maximum total power?
   - Provides an input needed for **Nominal System Power Rating**
2. Electric-only Drive Power (mostly for PHEVs)
   - Maximum electric traction power assist in “EV Mode”
3. Regen Power
   - Maximum electric power going to battery during braking







A. Nominal System Power Rating

- This approach parallels current engine power ratings
  - Rating look at sum of “upstream” component power
  - Powertrain losses downstream of the engine do not diminish peak power.
- Current OEM catalog ratings use this approach. However:
  - → There are **no rules or standards** in how, or in what condition ratings are given.
  - → Added components not consistent: **Motor + Engine? Battery + Motor?**
  - → Claims can not be traced back to standard test for validation

2015 Dodge Challenger Hellcat

Engine: 707 HP

Photo: Wikipedia

2015 Ford Focus 1.0L Ecoboost

Engine: 123 HP

Photo: Wikipedia

2010 Toyota Prius

Engine: 98 HP
Motor: 80 HP
Battery: 36 HP
System Net: 134 HP

Photo: Argonne
Specs: “Toyota Prius Product Information”

2011 Sonata HEV

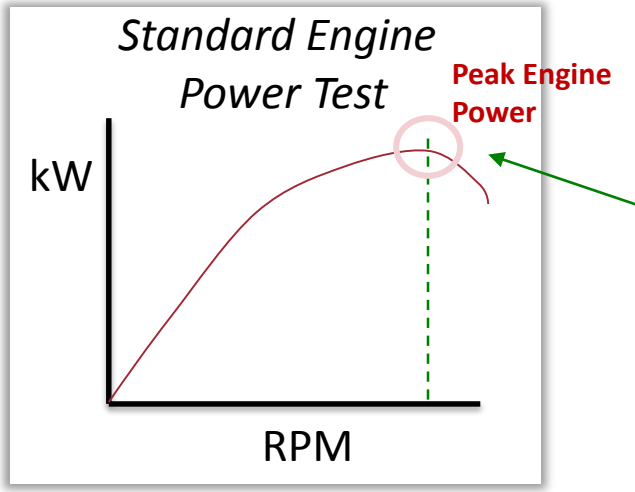
Engine: 166 HP
Motor: 40 HP

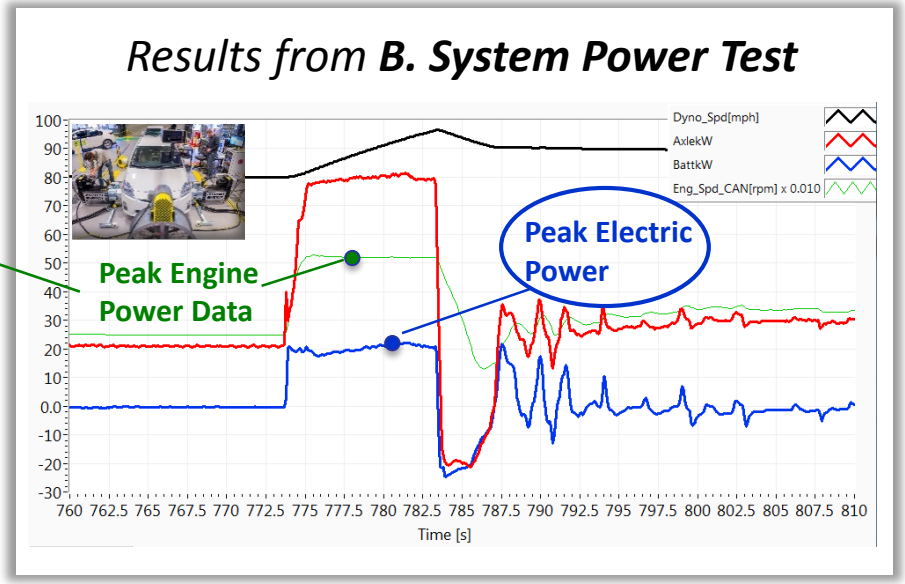
System Net: 206 HP

Photo: Argonne

Progress on Defining **A. Nominal Rating**

Engine Power + Electric Power = Hybrid System Power



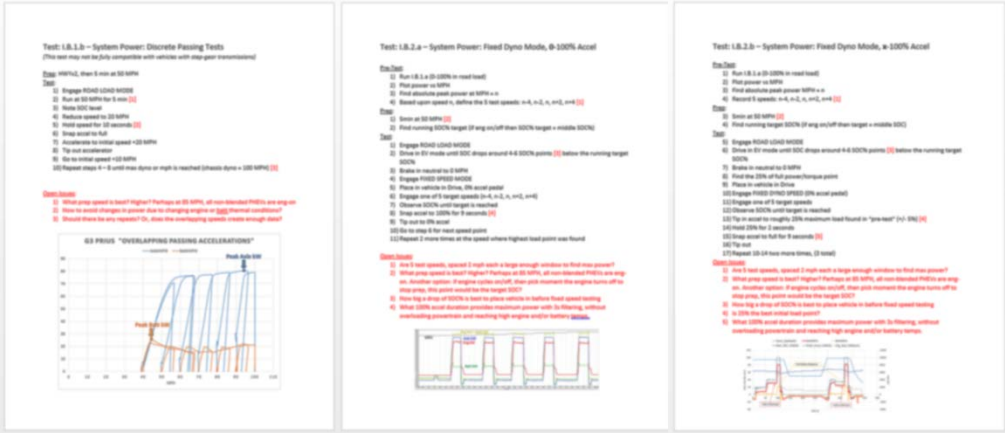


(goal is to agree with JARI/ISO method)

B. System Power Test

- Only valid approach to measure net power is at wheel/hub
  - HEV configurations are too varied
  - Unique system controls regulate component powers for each configuration
- Either Chassis or Hub dyno for test
  - Many labs already own chassis dynamometer
  - **Chassis dynamometer** could limit wheel torque in some tests
  - **Hub dynamometer** allows high torque and less expensive for new installations

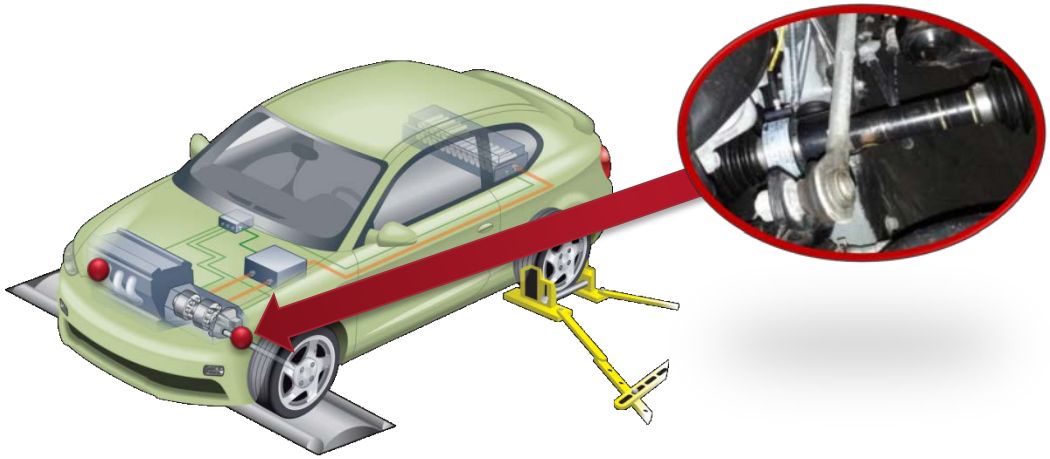
Draft procedure notes for System Power Test



System Power Test Hardware

Chassis Dyno

Using axle torque sensors to directly measure powertrain power



Hub Dyno

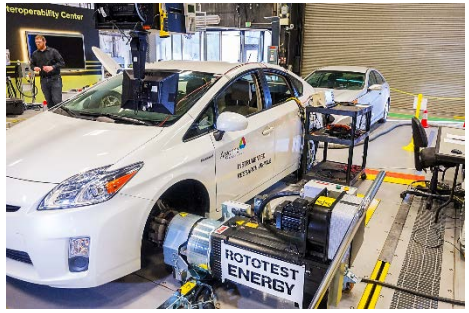
Using two hub dynos to directly measure powertrain power
(very small losses in wheel bearings)

Photo: Argonne

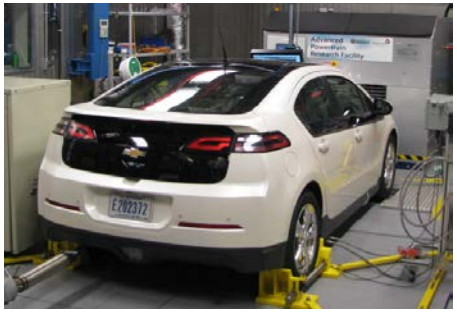
Several Vehicles in Validation Study at Argonne

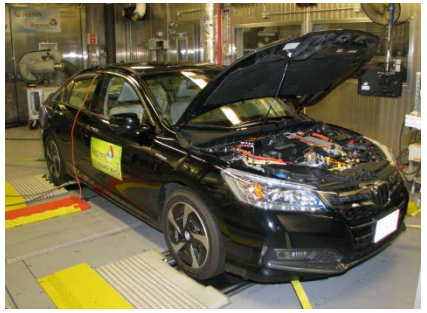
- Tested on both Hub and Chassis dynos
- HEVs (power-split, step transmission, mild HEV CVT), Conventional, BEV
- All vehicle have axle torque sensors for chassis dyno testing

Sonata HEV



Prius HEV


Volt PHEV


Accord PHEV


Gen 2 Insight HEV

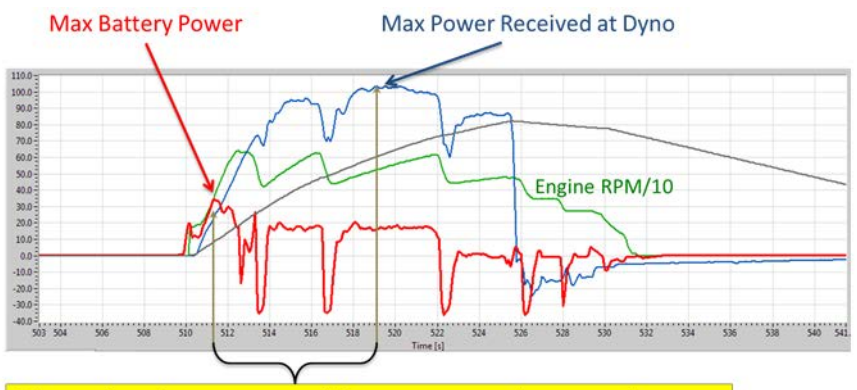
Fusion Conventional


Focus BEV

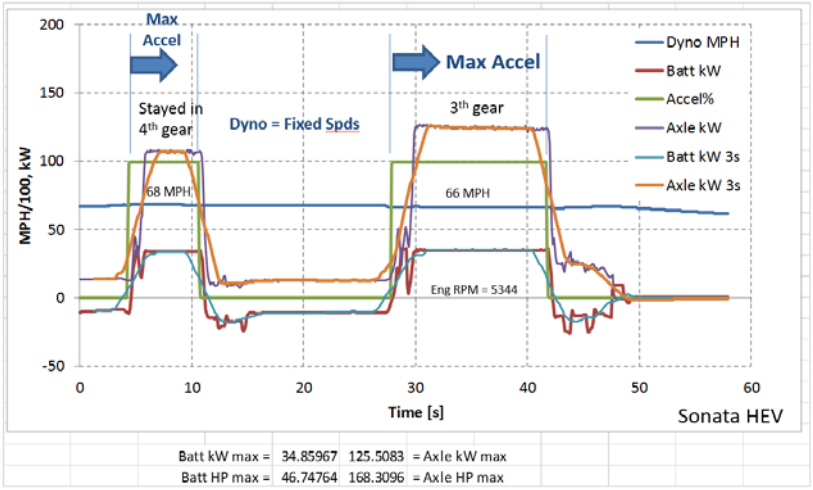
All Photos: Argonne

Findings Are Ensuring Test Works for All HEV Types

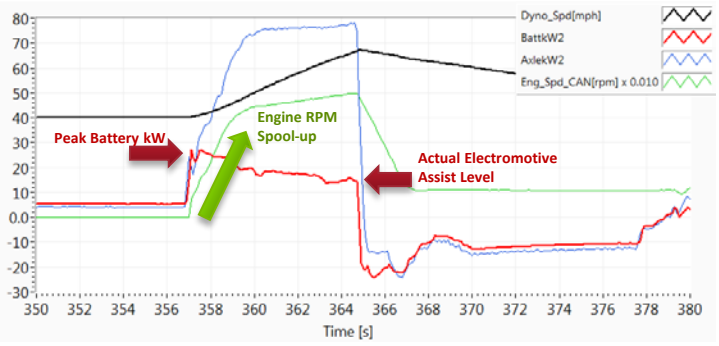
Peak battery power not always during peak total power



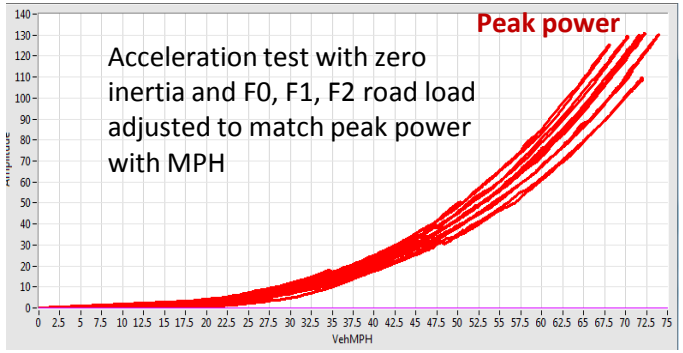
Fixed speed test fails with step transmissions



Peak battery power ≠ peak electric assist (lost power in engine spool-up)

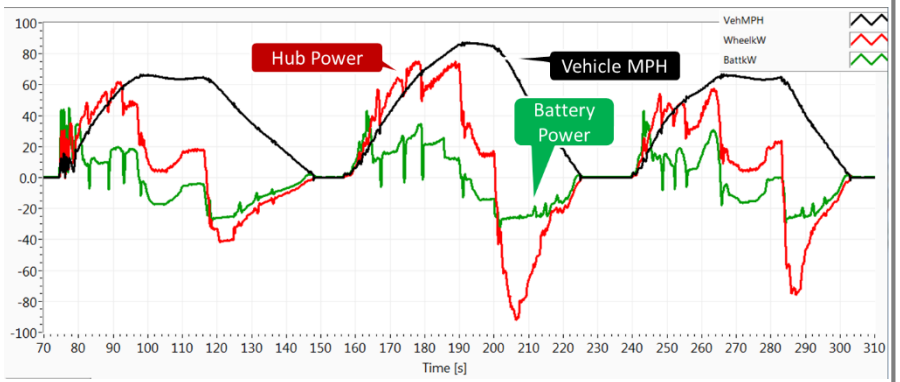


New Terminal Velocity test method invented- very promising

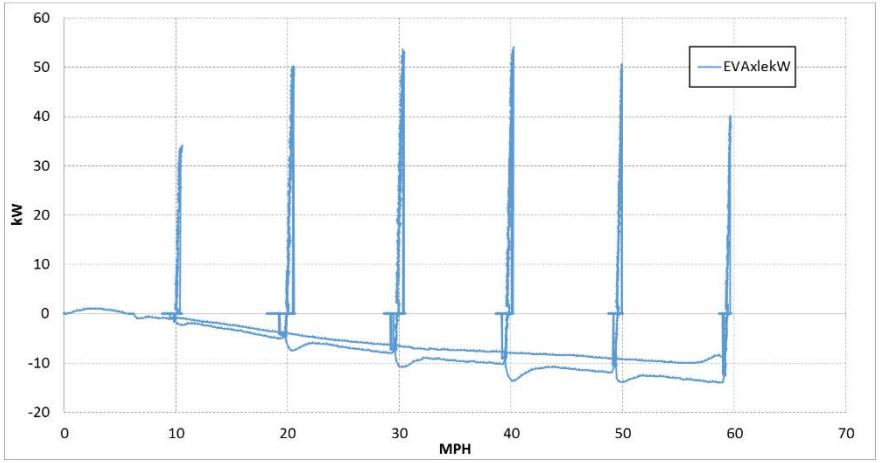


Additional Tests for J2908 Accomplishments

Developed test cycle for finding Regen Power



Successful Fixed-Speed EV Drive Power Procedure



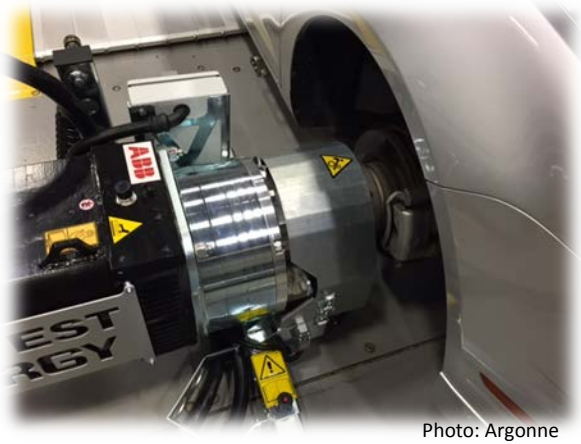


Photo: Argonne

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The End