Engines, Morning Breakout Session

ARPA-E's goals are to

1. Validate or improve our strawman metrics to be technically audacious but possible with sufficient stretching
2. Identify and understand potential new designs, materials, and fabrication processes that could result in dramatically lighter engines 10-15 years from now.

Metrics:

- Long haul truck NG engine power to weight ratio >700 W / kg, 2x that of 2012 long haul truck diesel engines, at 2012 long haul diesel engine scale, 350 kW (500 hp)
- Price <= same $/kW of 2012 long haul diesel engines
- Same safety, crash-testing, maintenance, etc. as 2012 long haul diesel engines

Working assumptions:

- Methane (or a fuel mixture of methane plus carefully controlled additives) has a more uniform burn rate than gasoline
- Methane combustion has reduced pollution compared to diesel or gasoline - SOx and particulate are eliminated but NOx is still present. Maybe a two stroke methane engine can meet emissions requirements.
- engine at half the weight but same power allows for 50 DGE of cheap steel CNG tanks.
- Probably requires clean slate design from scratch to take advantage of fuel burn rate uniformity

Questions:

1. What is the state-of-the-art for diesel and methane engine power-to-weight ratios? What makes these difficult and/or expensive to build?
2. Are our high level strawman techno-economic metrics appropriate to enable commercially successful products? Are our strawman methane engine metrics appropriate to enable commercially successful products or handoffs to OEMs at program end? Have we left out any primary or secondary metrics essential for commercial adoption? Do any numbers need to be adjusted up or down? Is 2x improvement in power to weight ratio too conservative?
3. What advances/breakthroughs have there been in the last 10 years that might make these targets achievable now? Why? (3D printing, high throughput materials screening, improved CFD simulation)
4. What are the fundamental physical limits to engine power to weight ratio? What is the best we could hope for on the 25 year time scale?
5. What novel/unique technical approaches could achieve these goals? What design, materials, and process challenges, if overcome, would make these approaches possible? Which offer the greatest opportunity? Why? Have they been tested at any scale?
6. Is there ARPA-E white space? Are there technology pathways that can put us on new learning curves? Long term, why might these be successful?
7. What can be done with $3-4M, 2-3yrs? What is the largest prototype that could be built under this budget? Is there any value to funding seedlings <$1M? What are appropriate targets 1-yr? 3-yrs?