



# Compressors and Vehicle Refueling

ARPA-E NG Vehicles Workshop  
Morning Breakout

1/26/2012

# Session Readout, Group 2: Compressors and Vehicle Refueling

## Suggested FOA Metrics

- Price of compression:
  - <\$1k/scfm (at-home) (roughly)
  - <\$0.5k/scfm (station) (roughly)
  - For filling station: a matrix of different customer needs vs. performance and cost is necessary
- Compression efficiency is >60% vs. theoretical minimum
  - Efficiency is not a primary metric, considered as a trade off with CapEx
- Compression without lubrication (both at-home and station); though lubrication is permissible with a filter
- Vehicles filled to >95% capacity, though depends on filling speed
- Refueling rates
  - >0.5 GGE/hr (at-home, >1scfm)
  - >10 GGE/min (station), though dependent on customer need
- Low cost 500 PSI compressor is not an ARPA-E hard problem, 3600+ PSI is

## Potential Technology Pathways (in order of interest)

1. Isothermal compressor
2. Rotary compressor (> 3600 PSI)
3. Combustion friendly lubricant
4. Dry seal methods
5. Free piston (non crankshaft, linkage free)
6. Acoustic techniques
7. Integrated drive NG compressor (combustion driven compression)
8. Systems modeling
9. Bucket Brigade system (sequential pressure increases with same stage)
10. Hydro pneumatic methods
11. Combination rotary piston comp
12. Liquid piston compressors
13. Linear Motion driven compressors (subset of free piston)
14. Chemical techniques
15. Supersonic compression (shock)

# Session Highlights, Group 2: Compressors and Vehicle Refueling

- **Additional Comments on Technical Areas of Interest**
  - Higher isothermal compression ratios per stage can reduce cost.
  - You can get to higher capacity filling with a slow fill, it is not just a compressor problem
- **Additional Comments on Potential Metrics**
  - Some customers will demand much higher filling rates (25 gal/min)
  - Better (and harder) to be small and cheap than big and cheap. Is modular the way to go, even for high fill rates? (several compressors filling same vehicle)
- **Key Question to Ask**
  - Which is better? Natural gas powered compression OR electric?
  - LNG/LCNG is an alternative since it overcomes intermittent compression
- **Additional Areas to Consider**
  - Role of auxiliary tanks at both filling station and home
  - Compressors are also important for LNG/LCNG infrastructure.

## Readout Questions, Group 2: Compressors and Refueling

What advances in the last 10 years might make these targets achievable now? Why?

- Advances in engine/generator technology generally can be ported over to compressors and systems

What can be done with \$3-4M in 2-3 yrs?

- Funding performance improvements (higher compression ratio per stage or new dry sealing techniques)