Transportation Fuel Cell Systems Modeling and Analysis

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Objectives and approach

- Objectives
  Use systems modeling to
  - identify key design parameters and operating efficiencies
  - assess design, part-load, and dynamic performance
  - support DOE/PNGV development efforts
- Approach
  - develop, document, and make available an efficient, versatile system design and analysis code
  - develop models of different fidelity
  - apply models to issues of current interest

Milestones

• Modeling to meet DOE/PNGV needs	As needed
• Workshop on high efficiency system packaging and cost trade-offs	04/00 (Targets workshop)

Reviewers' Comments

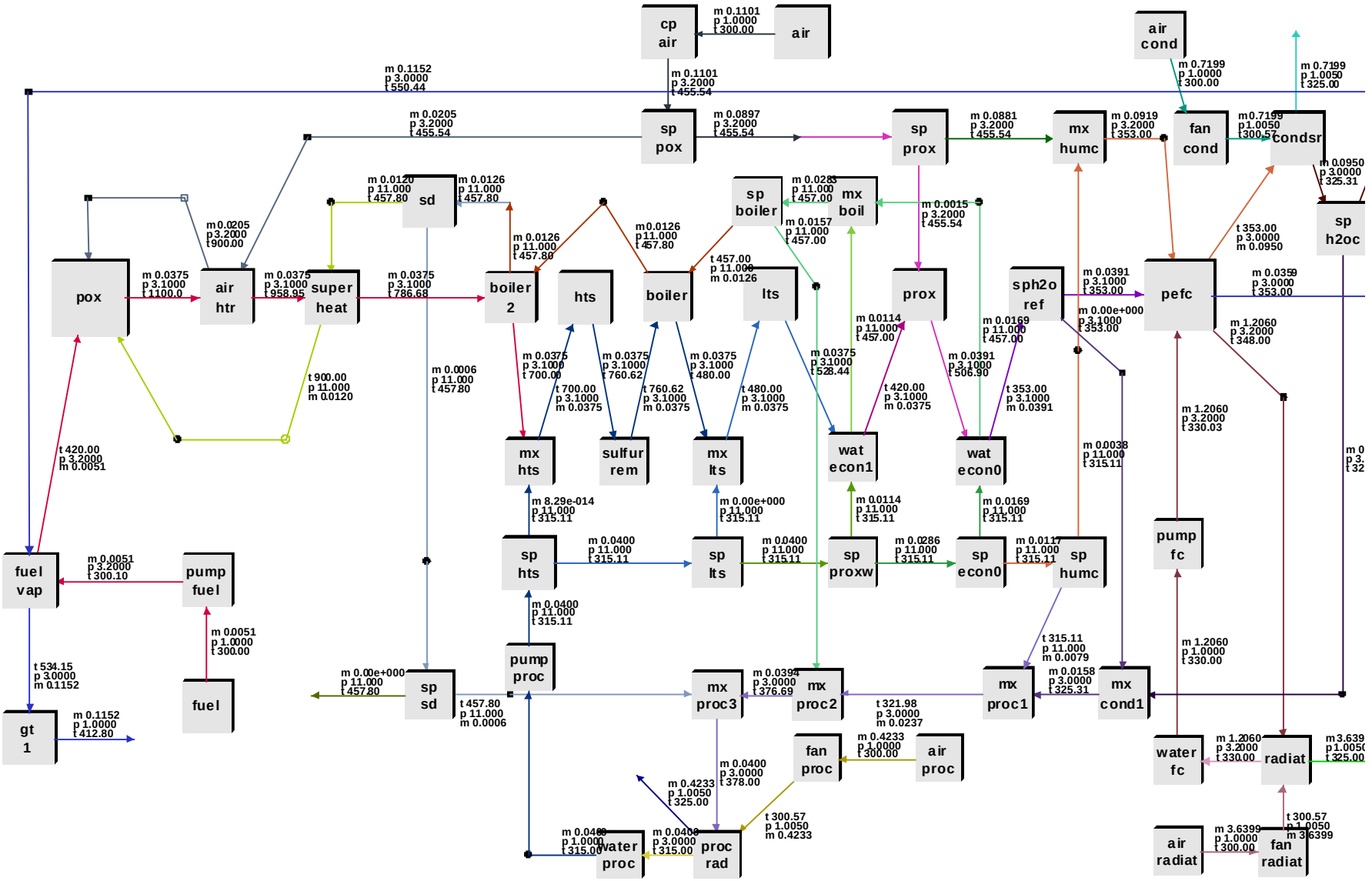
- Use realistic (less optimistic) cell operating parameters
- Validate component-level models
- Perform simulations over driving cycles
- Distribute PC version of GCtool
- Add transient flexibility
- Conduct trade-offs in size/weight/cost

- Using recent LANL data
- Lack data to do this
- Will show results
- Done (10-15)
- Done some
- Continuing

Highlights of activities in FY 2000

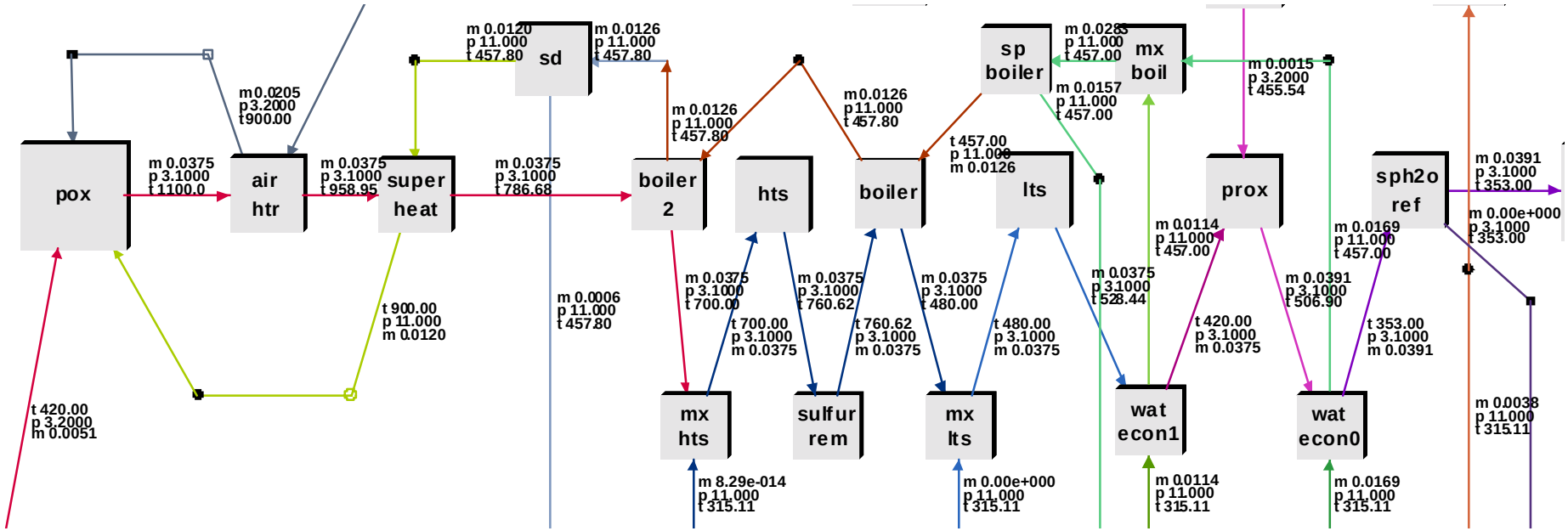
- ANL/ADLittle base case system definition for manufacturing cost study
  - system configuration and component performance
  - operating conditions and state points
- Fuel processor detailed analysis
  - effects of TPOX, steam-to-carbon, operating pressure
  - trade-offs in fuel processor versus system efficiencies
- PNGV Goal 3
  - fuel cell and system operating parameters
  - vehicle simulations over drive cycles to meet 80 mpg

ANL/ADLittle reference configuration for cost analysis

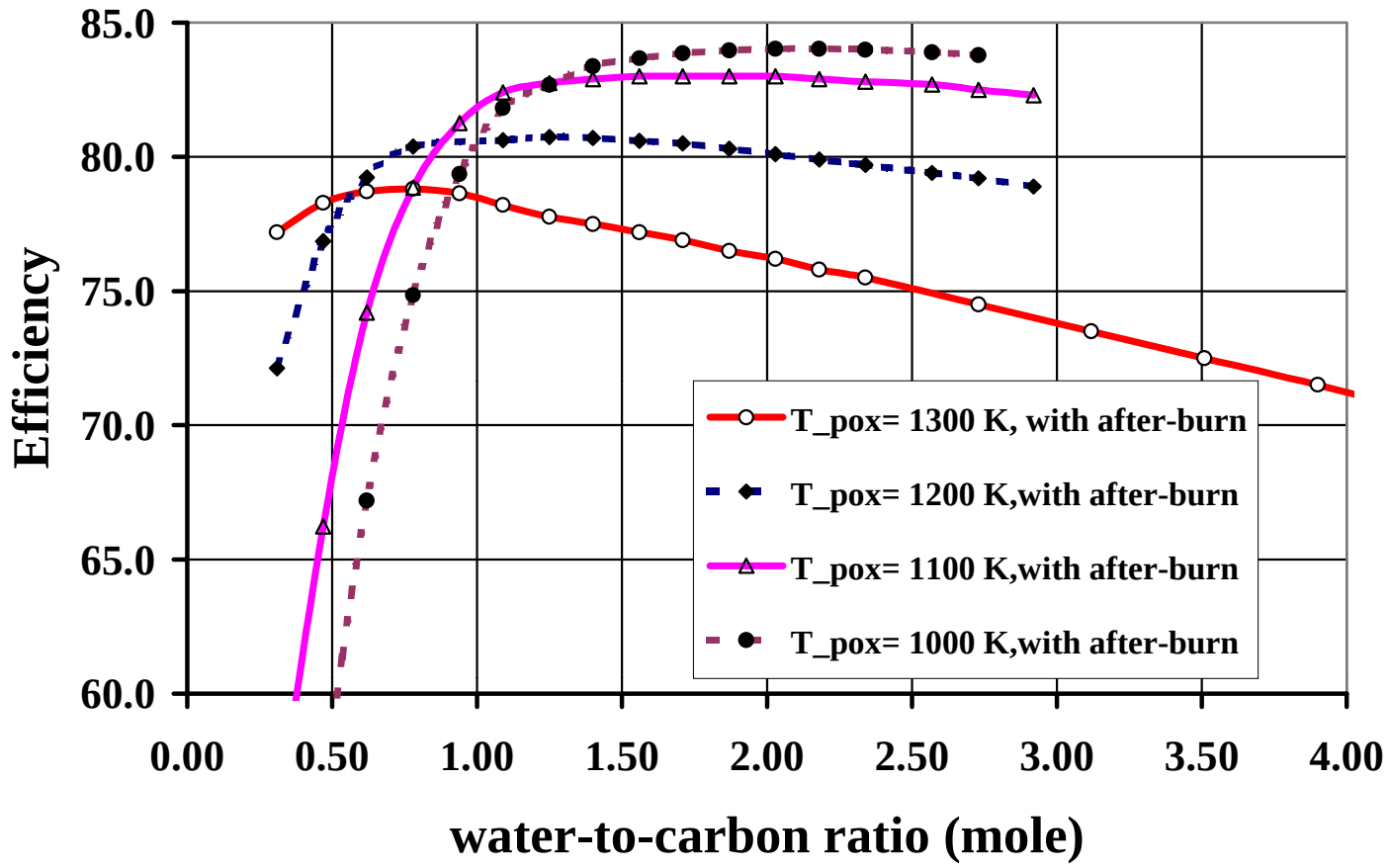


Argonne Electrochemical Technology Program

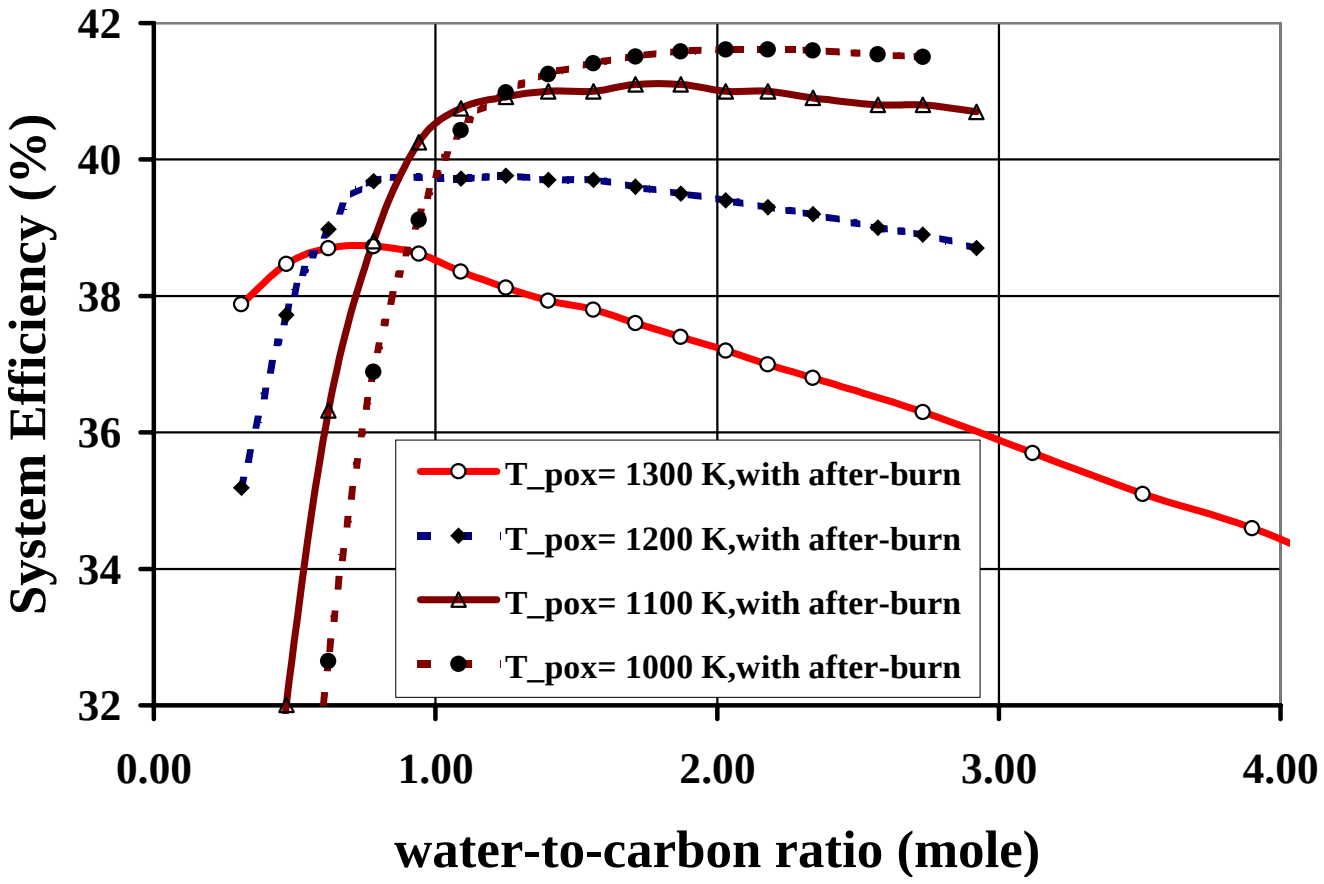
Fuel processor detailed analysis



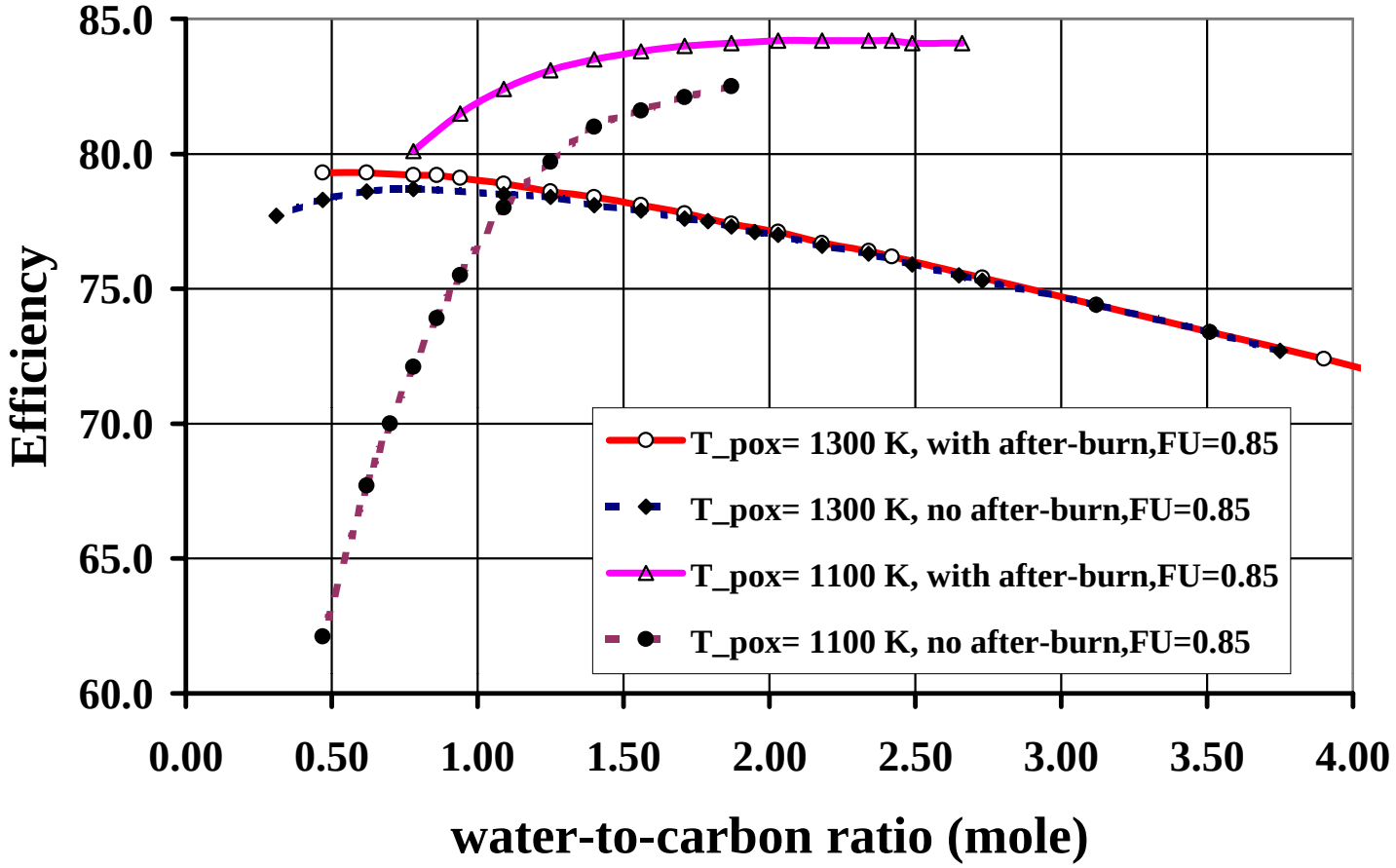
1 atm: fuel processor efficiency with the use of spent-gas burner energy



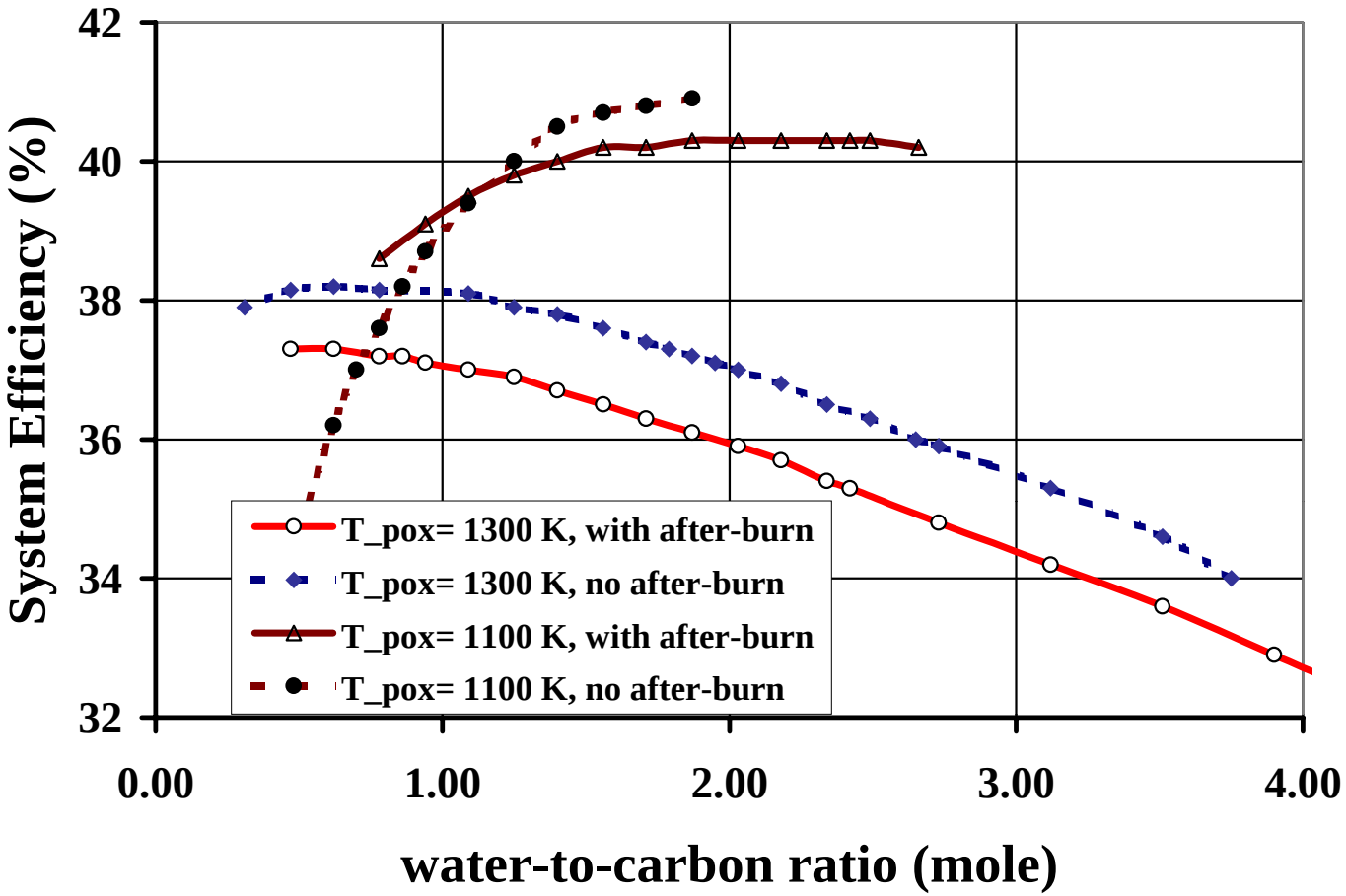
1 atm: system efficiency with the use of spent-gas burner energy



3 atm: fuel processor efficiency with and without using spent-gas burner energy

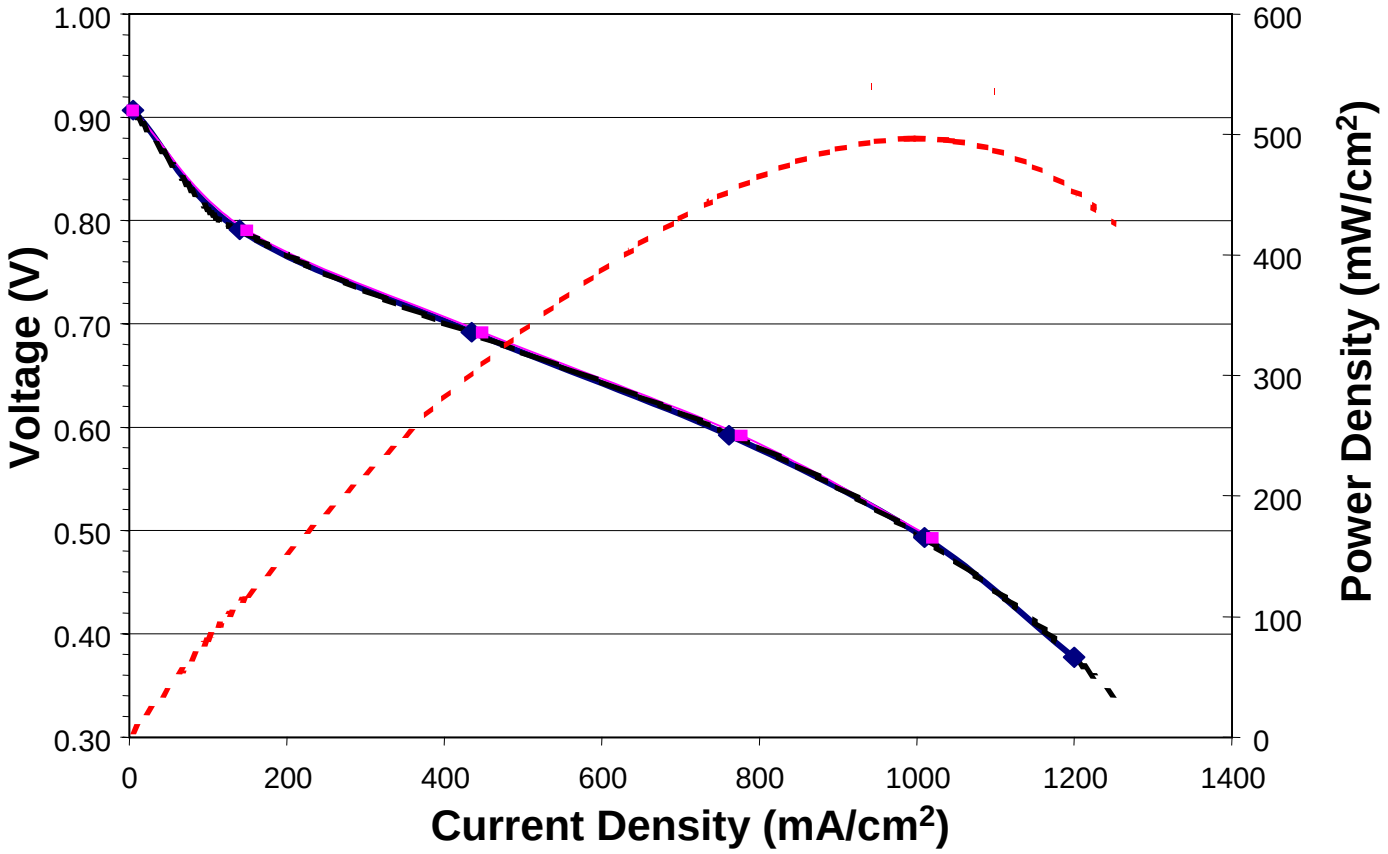


3 atm: system efficiency with and without using spent-gas burner energy



PNGV Goal 3: obtained “realistic” cell polarization curve from Los Alamos

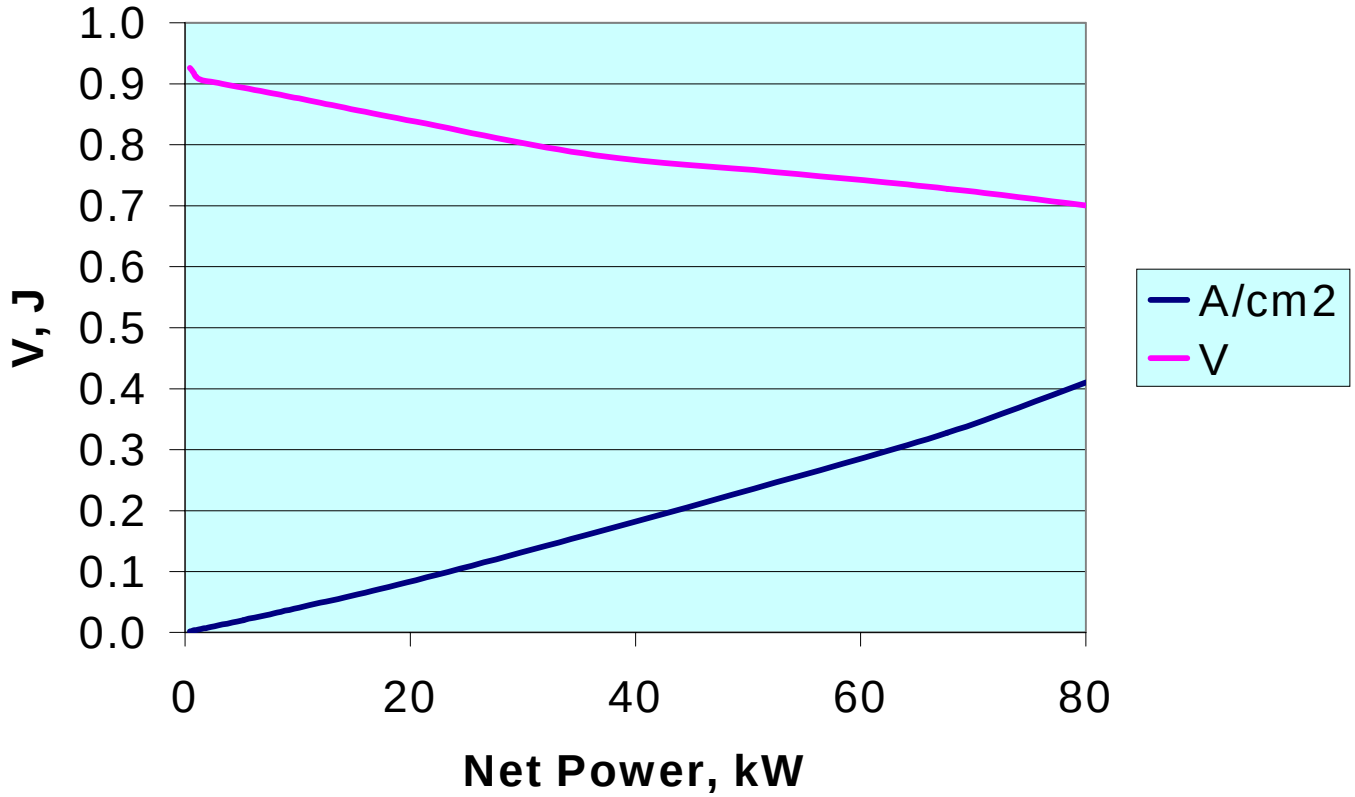
- Data from Los Alamos National Laboratory, plot from A.D. Little



Considered three fuel cell vehicles for this analysis

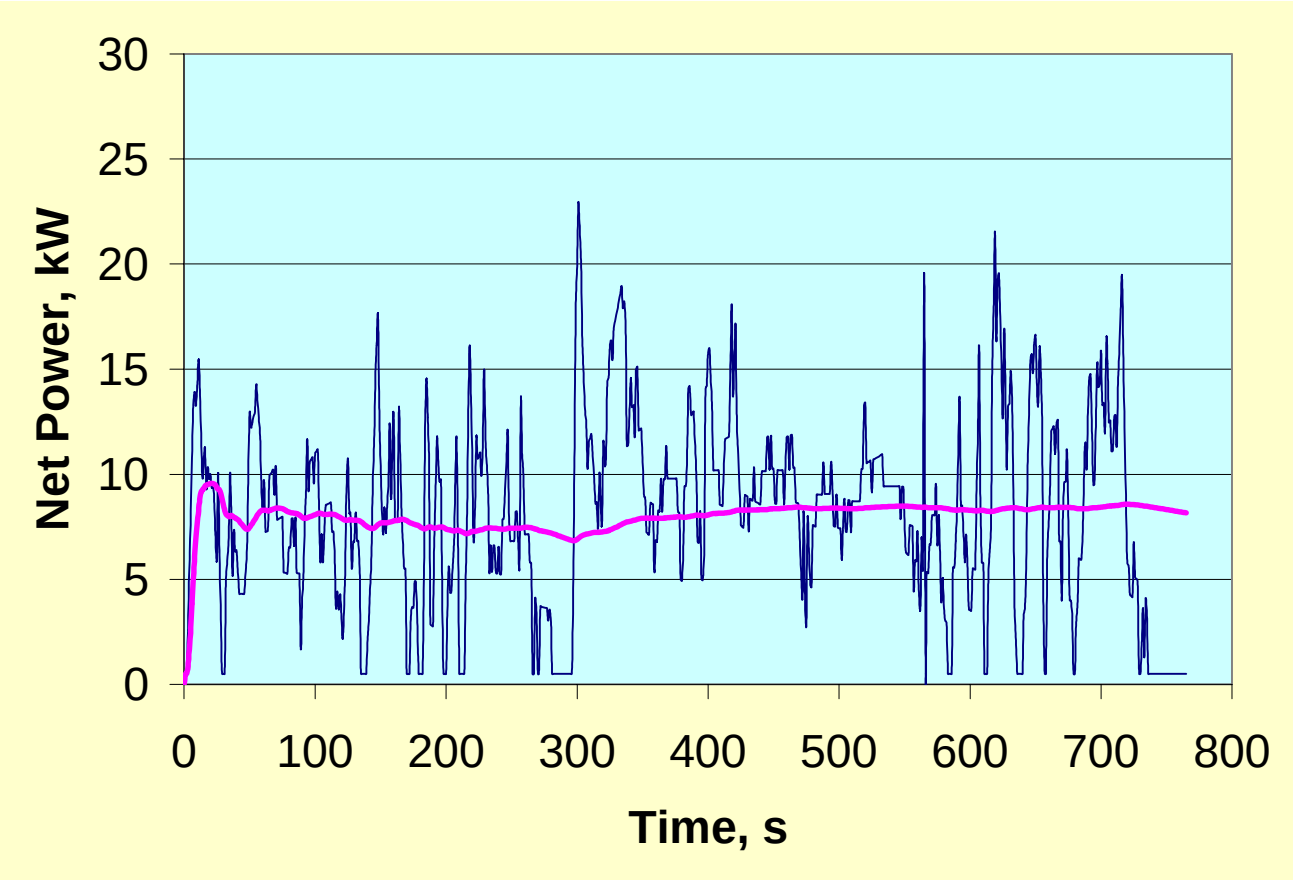
Vehicle / Parameter	P2000	Precept	Precept-Light
Weight (kg)	1043	1379	1043
Frontal area (m2)	2.18	2.18	2.18
Drag coefficient	0.25	0.163	0.163
Rolling resistance	0.0064	0.0064	0.0064
Wheel radius (mm)	326	326	326
Auxiliary power (kW)	0.5	0.5	0.5
Max (Avg) accel kW	74.6 (33.7)	93.5 (43)	72.8 (33.3)
Max (Avg) FUDS kW	27.7 (3.97)	35.2 (4.54)	27.3 (3.77)
Max (Avg) Highway kW	22.9 (8.17)	28.7 (7.68)	22.4 (6.75)

Cell voltage and current density at part-load for an 80-kW system

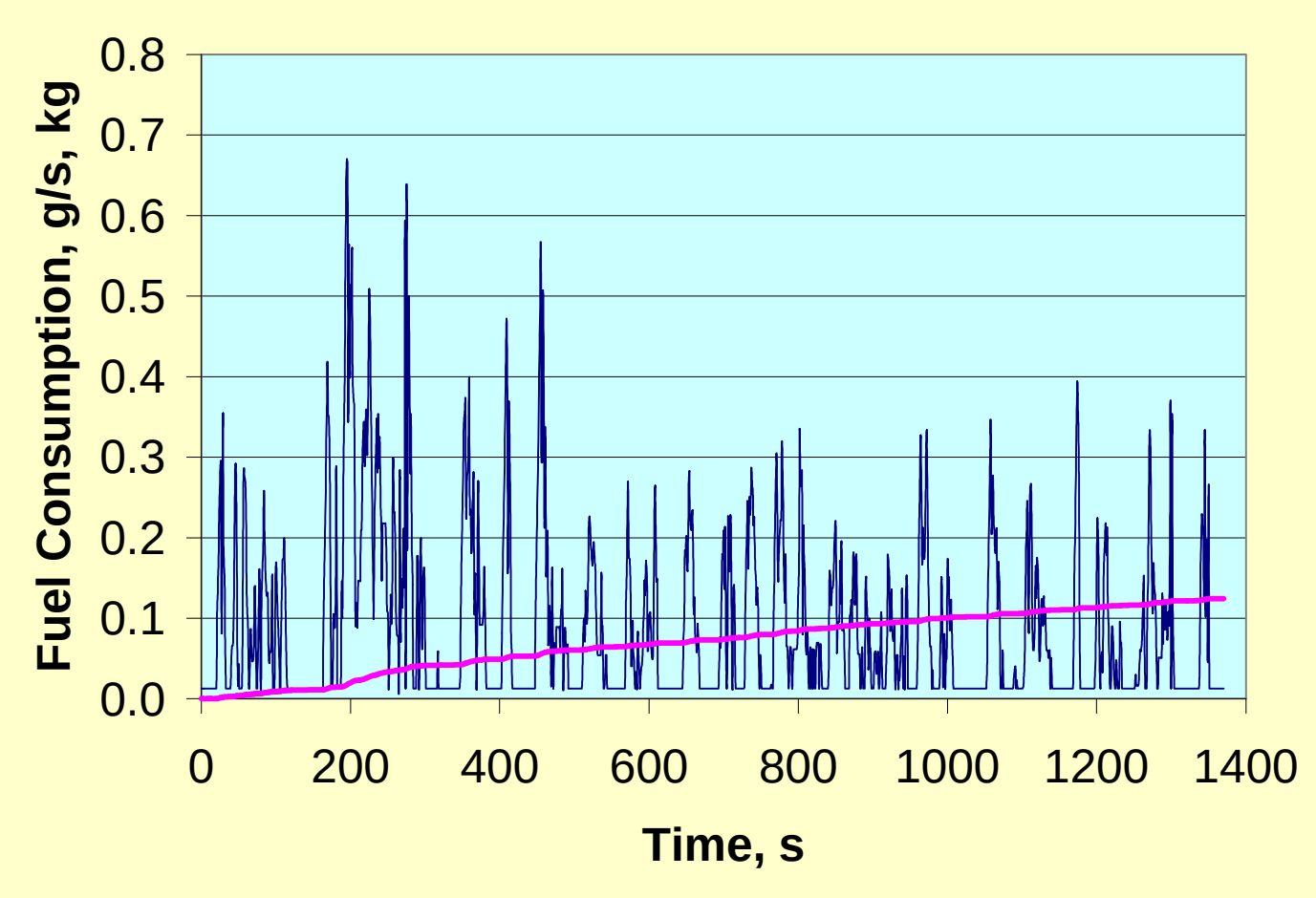


P2000 highway cycle instantaneous and average net power requirement

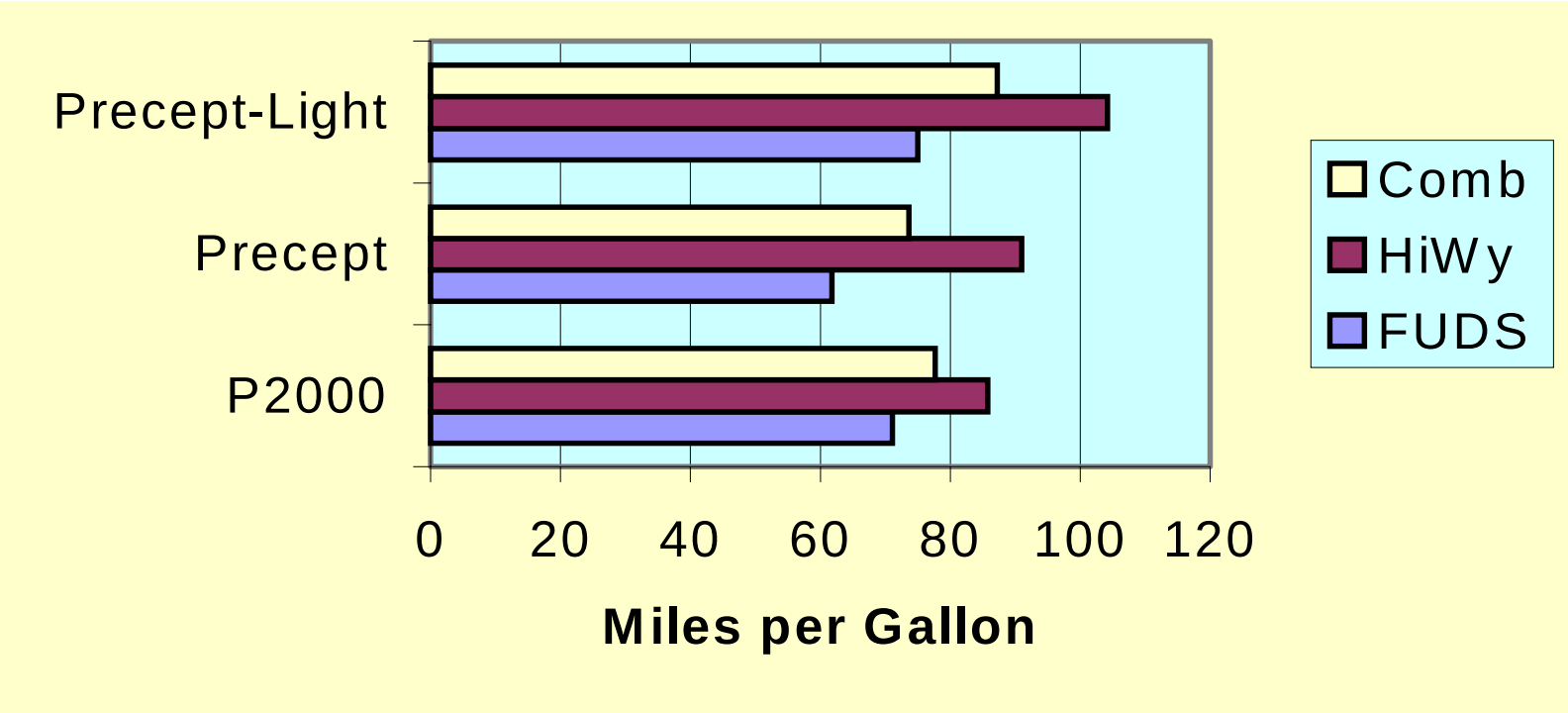
- Maximum 22.9 kW, average 8.17 kW



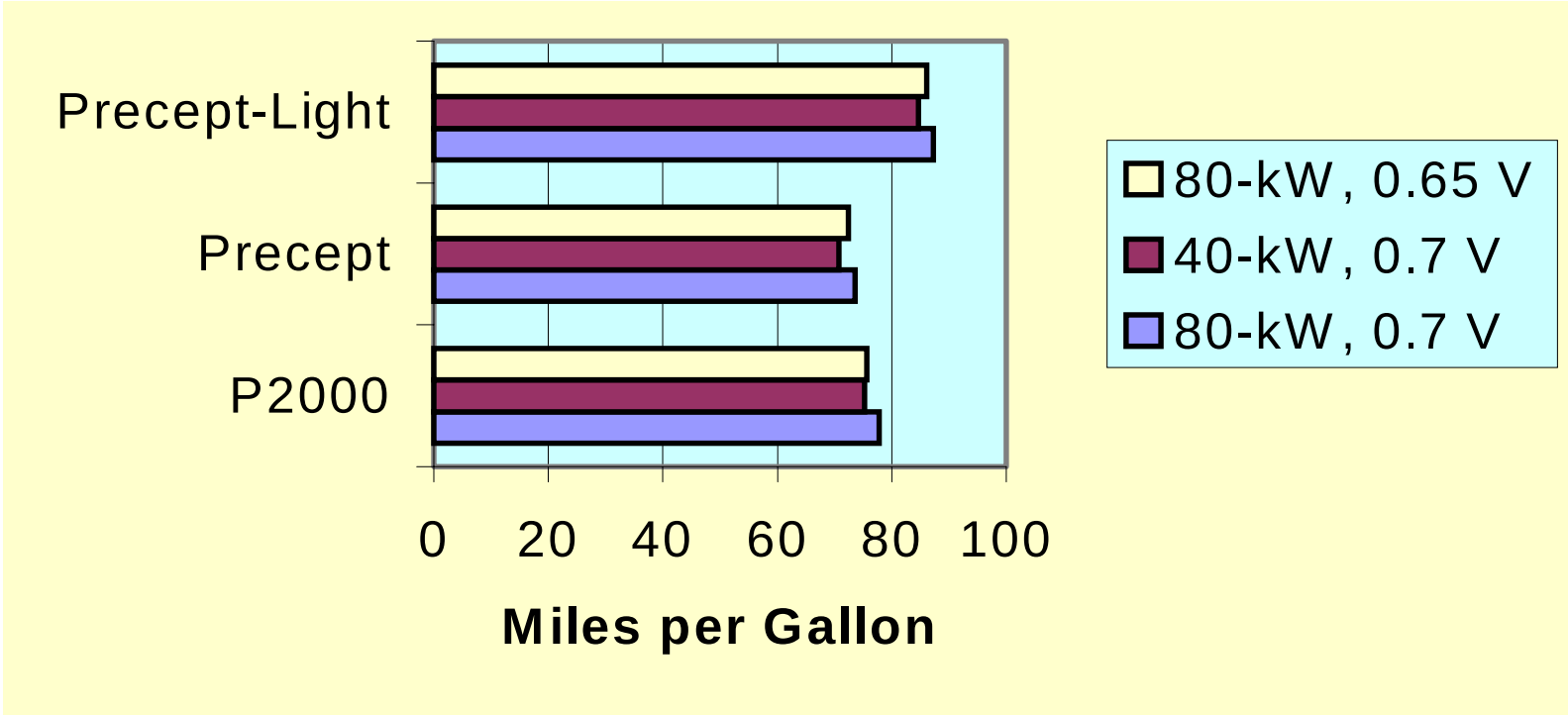
P2000 FUDS fuel consumption (80 kW system)



Fuel economy: 80-kW fuel cell system, 0.7 V/cell at rated power



Effect of system size, design cell voltage on combined cycle fuel economy



Current and future work:

- Influence of vehicle weight and other parameters on on-board fuel storage requirements
  - today's and tomorrow's vehicles
- Effects of revising CEM performance targets
- Design issues for high ambient temperatures
- Component weight and volume tradeoffs versus system parameters and efficiency
- Additional tradeoffs with respect to cost