California Advanced Reciprocating Internal Combustion Engines Collaborative - Purpose, Mission, Goals and Targets, and Action Plan

Avtar Bining

California Energy Commission

7th Diesel Engine Emissions Reduction Workshop

Portsmouth, VA

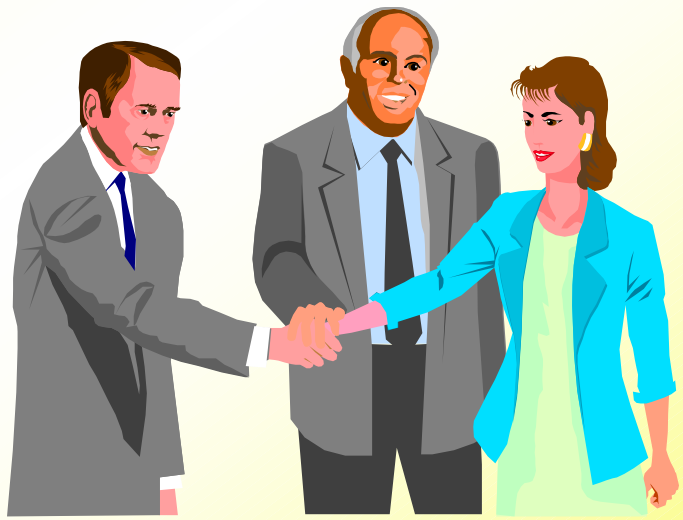
August 5-9, 2001

California has Established a $62M/yr Public Interest Energy Research Program (PIER)

Vision Statement

The future electrical system of California will provide a clean, abundant and affordable supply tailored to the needs of "smart", efficient customers and will be the best in the nation.

Tailored, clean, abundant, affordable supply



Smart, efficient customers

Funded Program Areas

(in millions through June 2001)

Supply **Renewables, EPAG**	**$74**
Demand **Buildings, Ind/Ag/Water**	**$48**
Strategic, Environmental	**$47**

Technology Partnerships are Critical for Overall Success of the Program

- **Collaborative Funding**
  - USDOE
  - EPRI
  - Industry
- **Collaborative Management**
  - UC Institutions
  - EPRI
- **Other Partnerships**
  - Other CEC initiatives, Cal/EPA, USEA, other federal agencies
  - ASERTTI, other states, national labs

Reciprocating Internal Combustion Engines

- Mature technology used for standby emergency power
- 3,000 MW capacity for 300+ kW systems
- Major Problem: Poor atmospheric emissions

Goal: Can we develop substantively cleaner systems to add to our portfolio of modular energy technologies

Purpose

The purpose of the California Advanced Reciprocating Internal Combustion Engines Collaborative is to take a leadership role in facilitating the research and development (R&D) of advanced reciprocating internal combustion engine (ARICE) systems that are super-efficient and ultra-clean for distributed, mobile, emergency and other power generation and stationary applications throughout California.

Mission Statement

The mission of the California Advanced Reciprocating Internal Combustion Engines Collaborative is to promote research and development of ARICE components and systems as a means toward reducing or eliminating criteria air pollutants and greenhouse gas emissions, increasing energy efficiency, promoting energy diversity and independence, promoting clean fuels for ARICE applications, and realizing a sustainable energy future in California

Key Goals

- Facilitate the research, development, demonstration, deployment,and commercialization of ARICE technologies by funding projects in partnership with stakeholders;
- Facilitate the development of emission tests protocols that would establish common testing and evaluation criteria applicable to various parameters, such as alternative fuel, engine modification, add-on components, or combination of parameters.
- Implement an independent and continuing inter-departmental policy in California to utilize efficient and clean ARICE distributed power generation technologies in distributed generation, emergency power, and other stationary applications (e.g. coordination with ARB's Distributed Generation activities); and
- Work with utilities and regulators to adopt policies that encourage the use of ARICE systems for power generation where size and suitability are compatible.

Industry Issues and Concerns

- efficiency,
- emissions/environmental concerns,
- fuel flexibility,
- operating and maintenance (O&M) cost,
- reliability, availability, maintainability, durability, usability (RAMDU)

Advanced Reciprocating Internal Combustion Engine (ARICE) systems should do one or more of the following:

- meet or exceed current and future California atmospheric emissions requirements and have other desirable environmental attributes;
- improve fuel-to-electricity conversion efficiency;
- increase the overall energy use efficiency through combined heat and power systems;
- lower or maintain current capital cost, installation cost, operation and maintenance cost, and/or life cycle costs;
- enhance reliability, availability, maintainability, durability, and usability;
- promote development of clean (alternative, renewable, and distillate) fuels;
- have multi-fuel use capabilities;
- support integration and aggregation of distributed (both Mobile and Stationary) generation and on-site generation with the power grid;
- in general, lead to the adoption and use of the improved ARICE technologies within California.

Commitments

- Public: R&D Funds, Policies, Public Benefits
- Private: R&D Resources and Match Funds, Priorities & Targets

The potential public benefits will need to be clear and significant for the public sector's sustained interest in supporting an ARICE R&D program for California

Short-Term (Less than 1 year) Tasks:

Short Term Task	Completion Date
Collaborative Plan	May, 2001
Identify and confirm Core Group	May 31, 2001
Identify and confirm Advisory Group	May 29 – June 8, 2001
Workshop Invitations	June 1, 2001
Summer Workshop with Industry	July 10, 2001
RFP/Solicitation	September 2001
Projects Selected	December 15, 2001
Contracts Awarded	January 31, 2002

Current Diesel and Natural Gas Engines Data[1]

	Electric Efficiency (LHV)	Size (MW)	Footprint (sqft/kW)	Installed cost ($/kW)	O&M Cost ($/kWh)	Availability	Hours between overhauls	Start-up Time	NOx emissions (lb/MW-hr)	CHP output (Btu/kWh)
Diesel Engine	30-50%	0.05-5	0.22	800-1500	0.005-0.008	90-95%	25,000-30,000	10 sec	3-33	3,400
Natural Gas Engine	24-45%	0.05-5	0.22-0.31	800-1500	0.007-0.015	92-97%	High Speed: 24,000-60,000 Medium Speed: 60,000-80,000	30 sec	2.2-2.8	1,000-5,000

[1] *The market and Technical Potential for Combined Heat and Power in the Commercial/Institutional Sector.* ONSITE SYCOM Energy Corporation, prepared for Energy Information Administration (EIA). U.S. DOE, January 2000 (Revision 1), Washington, D.C.

US DOE's Distributed Energy Resources (DER) Program

The DER program has set goals to achieve 20% plus of new electricity additions by 2010 with a suite of distributed energy technologies that will have increased efficiency and reliability with reduced costs and emissions.[2] U.S. electricity generation is expected to increase by 30% through year 2020.[3] Natural gas ARES systems are expected to increase efficiency to >50% and decrease emissions to <0.1 g/bhp-hr (≈0.3 lb/MW-hr) NOx by 2010

Performance Targets for Solicitation
Advanced Reciprocating Internal Combustion Engines (Draft)

Parameter	2003	2005	2007	2010
Efficiency				
Brake Thermal Efficiency	40%	42%	45%	>50%
Fuel-to-Electric Efficiency*	38%	40%	43%	50%
Overall Efficiency (CHP)	85%	>85%	>86%	>88%
Emissions – *shaft power (g/bhp-hr)*				
Oxides of Nitrogen (NOx)	0.15	<0.15	0.015	≈0.01
Carbon Monoxide (CO)	1.77	<1.77	0.02	<0.02
Volatile Organic Compounds (VOCs)	0.3	<0.3	0.006	<0.006
Particulate Matter (PM10)	0.01	<0.01	<0.01	<0.01
Emissions – *power generation (lb/MW$_e$hr)*				
Oxides of Nitrogen (NOx)	0.5	<0.5	0.05	≈0.03
Carbon Monoxide (CO)	6.0	<6.0	0.08	<0.08
Volatile Organic Compounds (VOCs)	1.0	<1.0	0.02	<0.02
Particulate Matter (PM10)	0.03	<0.03	<0.03	<0.03
Cost				
Complete Installed Cost ($/kW$_e$)	800	750	700	600
O&M Cost ($/kW$_e$h)	0.06	0.05	0.05	0.04
Availability & Durability				
Availability	88%	90%	92%	95%
B10 Durability (hours)	8,000	9,000	10,000	12,000
Mean Time Between Major Overhaul (hours)	35,000	40,000	45,000	50,000

Recent Activities:

- Developing a California ARICE Collaborative Plan
- Forming a Core Group
- Forming Advisory Committees
- Held first California ARICE Collaborative Workshop on July 10, 2001 in Sacramento, CA
- Preparing an RFP for release on September 4, 2001
- Proposals will be due in November and will be evaluated in December 2001
- Contracts will be awarded in January 2002

California ARICE Collaborative General Consensus is:

- Industry is very willing to work in/with the California ARICE Collaborative for meeting aggressive emission reduction (to <0.1 g/bhp-hr NOx) and efficiency improvement (10-20 percent over the current) goals with flexibility to choose engine system (fuel, engine, exhaust treatment etc.) technologies to make it happen, and these goals are reachable in the near-term (3-5 years);
- To achieve low NOx (0.1g/bhp-hr and less), exhaust treatment technologies (SCR etc.) are needed and this will require low-sulfur fuels also for SCRs to work efficiently and cost-effectively;

Continued….

- Synergy among different R&D programs (such as public and private, stationary and mobile etc.) would be very beneficial to reap maximum results/benefits and avoid duplication; and
- A collective and concerted effort from public organizations (federal, state, and local), engine manufacturers, national labs, universities/academia, private R&D industry, emission control manufacturers, fuel producers/suppliers, utilities, users, and environmentalists is needed to reach at our common goal of providing efficient, affordable, clean, reliable and sustainable distributed generation (electricity) in California.

For more information, please visit
California ARICE Collaborative webpage at:

http://www.energy.ca.gov/distgen/arice/index.html

Thank You!