Overview of SCG RD&D Program

- **presented by**

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California Energy Commission

- **PIER Natural Gas Advisory Committee**

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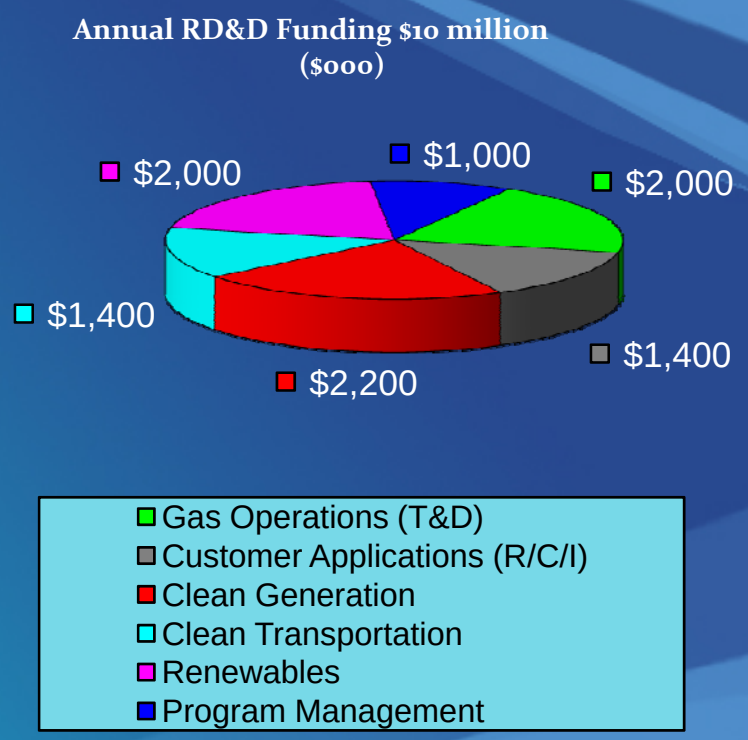
Overview of SCG RD&D Program

- 2008 GRC authorized RD&D funding of $10 million per year
- Proposed request for GRC 2012-2015 is $13 million per year
- SCG RD&D Program is leveraged 6:1 with other utilities, CEC, DOE, Manufacturers, etc,..
- Additional funding of $1 million/yr for the Emerging Technology program



Technology Drivers, Regulatory Mandates, and State Policies

- Comply with Pipeline Safety based regulations (CPUC & PHMSA/DOT)
- Reduce customer natural gas consumption by 175 million therms (CPUC Goals)
- Reduce NOx emissions by 80% to comply with Federal 24-hour Ozone Standard and comply with the new Federal PM 2.5 emission standard
- Reduce state greenhouse gas emissions to 1990 level by 2020, and reduce an additional 80% of 1990 level by 2050 (AB 32)
- Increase the use of alternative fuels consistent with California mandates (Alternative Fuels AB 118)
- Meet accelerated Renewable Portfolio Standards for California – 33% by 2020 (Executive Order S-14-08)
- Increase the production and use of biofuels made from renewable resources to a minimum of 20% within California by 2010, 40% by 2020, and 75% by 2050 (Executive Order S-06-06)
- Achieve “Net Zero Energy (NZE)” homes/buildings by 2020/2030)

Specific Technology Challenges

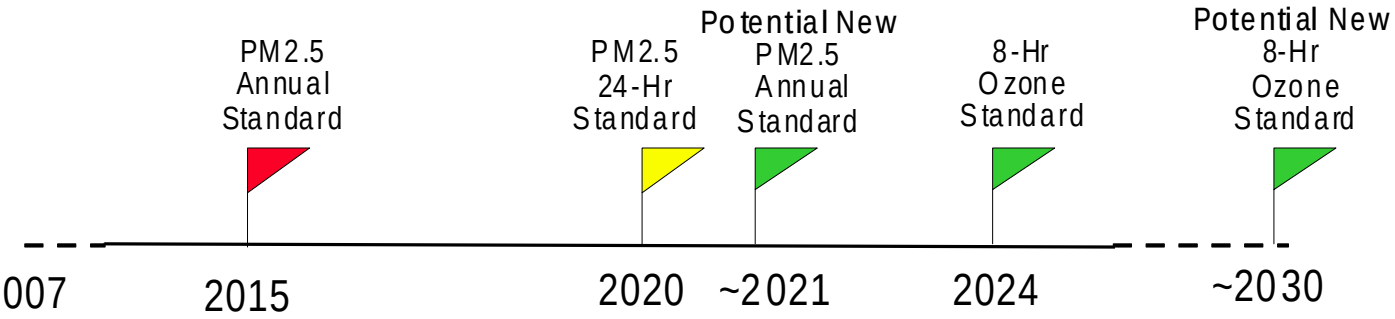
- Meet Low Emissions Regulations
- Develop Cost effective High Energy Efficiency Product
- Meet Net Zero Energy regulations
- High Cost Solar Thermal & Energy Storage
- Achieve Zero Emissions Vehicles
- Develop Cost Effective DG/CHP
- Develop Cost Effective Bio Methane Conditioning and Cleaning

Air Quality Challenges

- EPA's revisions to the Ozone and PM air quality standards are forcing states and air districts to reduce criteria pollutants further
  - SCAQMD will be required to make extreme reductions
  - Ozone: ~90% NOx reduction by 2030
  - PM 2.5: up to 90% NOx reductions by 2021
  - NOx is the primary precursor to both Ozone and PM 2.5
- According to SCAQMD's Peter Greenwald, Sr. Policy Advisor:
  - Need to reduce NOx 75% by 2023 & 90% by 2030
  - Deployment of Zero Emissions Technologies could favor all electric and force out natural gas combustion
- Although 80% reduction in NOx for stationary applications have been achieved in the past 20 years, "extreme" technology/RD&D advancements are needed to meet future challenges

Air Quality Challenges

Federal Air Quality Attainment Dates and Needed NOx Emission Reductions From Today's Levels



	2015	2020	~2021	2024	~2030
NOx Reductions	31%	??%	75-90%	77%	~90%

Status of NOx Reduction Technologies

Gas-Fired Equipment	NOx Levels -Current Products	NOx Levels - Best Products in Market Today	NOx Emission Levels found in Laboratory Today	**Comments / Conclusions**
Residential Water Heater (ppm @ 3% O2)	15 – 60	15	15	Manufacturers released 15 ppm NOx units to market in 2008. SCG has initiated a RDD program in 2011 to develop ultra low NOx residential water heater.
Residential Central Furnace (ppm @ 3% O2)	60	60	20-40	SCAQMD rules require 20 ppm NOx product by 2015. Multiple new development projects will start in 2011.
Commercial Cooking Appliances (ppm @ 3% O2)	30 - 120	30 – 40	30 - 40	Air regulations have not impacted this equipment yet, therefore little to no research has been done to reduce NOx emission levels. Current RDD focused on efficiency improvements.
C/I Boilers (ppm @ 3% O2)	7 - 30	7	< 5	Current NOx emissions requirements are between 5 and 12 ppm depending on boiler size starting January 2013.
Industrial Furnaces (ppm @ 3% O2)	60 - 200	60	30 - 60	NOx levels dependent on process temperature. SCAQMD rules require 30 to 60 ppm by 2016.
IC Engines (ppm @15% O2)	11 - 45	11	2 - 5	SCAQMD DG engine regulations passed in 2008. New products will enter market in 2011 that meet these ultra low NOx levels.
NGV Vehicles (g/bhp-hr)	2.0	0.2	0.05	Currently NGVs have a 1% market share of mobile on road and off road. Vast majority still diesel and the NOx emissions of the most older trucks are exceeding 5g/hph.

SCG Strategic Technology Priorities

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Customers

- Low Emissions
- Energy Efficiency
- GHG Reduction
- Smart Premises
- DG/CHP
- Clean Fuel Vehicles

Utility Operations

- Pipeline Inspection
- Pipeline Integrity
- Employee Safety
- Environmental & Gas Quality

Energy Resources

- Solar Thermal
- Biofuels
- CCS

Future End-Use Technology Plans

- Develop technologies to meet the proposed low emissions requirements
- Improved energy efficient products to meet state mandates for reduction in energy consumption and green house gas emission reduction targets
- Expand the use of natural gas as a clean fuel in transportation
- Develop cost effective Fuel Cells, and other CHP technologies
- Develop cost effective Solar-Thermal for water heating, space heating & cooling and industrial processes
- Develop new technologies to clean bio fuels
- Demonstrate the potential of CCS

Future Gas Operations Technology Plans

- Develop new product for pipeline inspection (Advanced Robotics)
- Develop technologies to prevent third party damage to pipelines
- Develop cost effective leak detection and pipe location technologies
- Develop continuous odorant level monitoring
- Assess materials degradation or equipment performance impacts from new gas supplies
- Study biomethane trace constituents
- Develop better methodologies to measure GHG fugitive emission from valves and other components

Appendix

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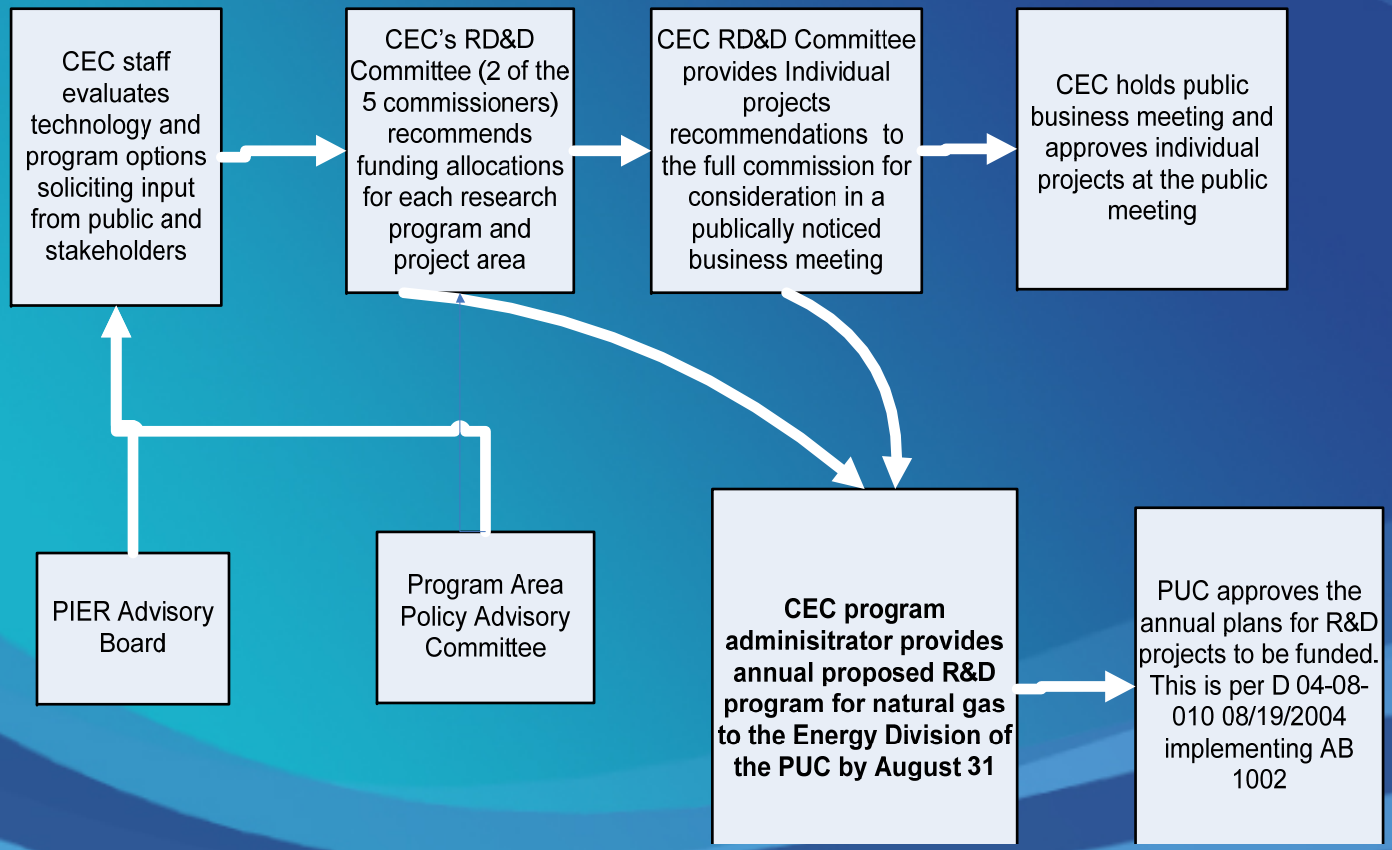
Specific Comments on the PIER NG Program

- Noticed good changes in the past year related to issuing solicitations, focus on product development , leveraging resources, and involvement & coordination with SCG
- SCG is getting some value from the NG PIER program (note SCG funds 50% of the program) such as: Energy Efficiency and Advanced Generation (CHP) programs
- PIER need to provide more value to SCG and its customers for the following areas: Natural Gas Vehicles, Low Emissions Technologies, Solar-Thermal and Bio Fuels

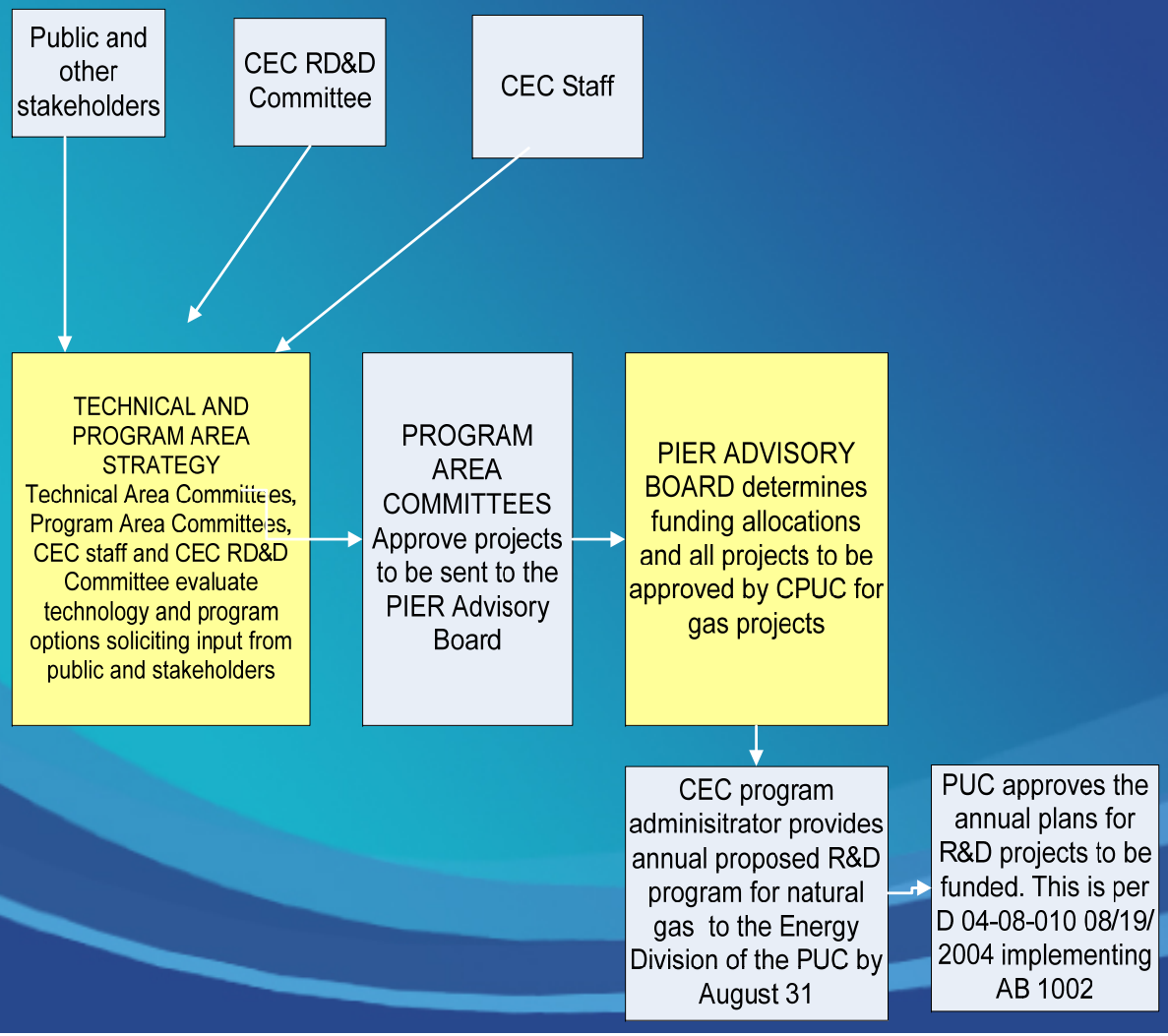
Recommended Changes

- More IOU control over program planning and project selection to ensure tangible ratepayer benefits and focus on state energy goals
- The IOUs collectively have tremendous experience and knowledgeable personnel in the electric and gas business, state energy mandates and can provide significant guidance and efficiency
- Bullet-proof security that funds collected for RD&D will be used for RD&D
- Streamline program management to facilitate quicker project implementation
- Program needs to target more demonstration and real-world application of projects
- Ensure direct participation of IOUs on various advisory committees
- Better information to evaluate the PIER Benefits Methodology
- Clearly distinguish between the NG and Electric PIER Program/Projects

Current PIER Budget and Project Approval Process



Proposed PIER Budget and Project Approval Process



Detail Info on SCG RD&D Program

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Status of SCG-NGV Related RD&D

Technology/ process description	• NG used as a transportation fuel has many advantage • Nearly 87% of U.S. natural gas used is domestically produced • 60-90% less smog-producing pollutants prior 2010 • Less greenhouse gas emissions (29% lower GHG than gasoline and 21% less diesel), • Less expensive than gasoline or diesel (5 to 30% lower)
Key challenges	• Limited vehicles & engines availability • Higher vehicle costs -- Light-duty NGVs cost $10,000 more than comparable gasoline vehicles, and heavy-duty NGVs cost more than their counterparts by $70,000 or more • Fuel Storage -- fewer miles on a tank of fuel • High refueling station costs and less readily available than gasoline & diesel • Lack of cost effective home refueling • Various gas quality
SCG activity	• DME to produce liquid fuel • Microturbine Dual Fuels Hybrid Heavy Duty Tractors • Next Generation Near Zero Emissions Trash Haulers and Transit Buses (improved engine out emissions and advanced post combustion treatments) • Advanced Low Pressure Adsorption Fuel Storage • Modular Compact, Self Contained Refueling Stations • Next Generation Home Refueling Appliances

Status of SCG-Residential Space Heating Related RD&D

Technology/ process description	• Current space heaters do not meet the SCAQMD's 14 ng/joules NOx emissions requirements. They must meet this NOx level by 2014 / 2015 • Leading Suppliers: Rheem, Carrier, Trane, York
Key challenges	• SCAQMD may propose to electrify residential space heaters or require a 90% reduction in NOx emissions • High efficiency space heaters are available but not economical in mild climates • Electric heat pump and electric resistance products are readily available but are more expensive to operate than gas-fired products
SCG activity	• Short-term: Partnering with several equipment manufacturers and the SCAQMD on developing and demonstrating new products that can meet the 14ng/j NOx emissions level by 2014 / 2015. • Long Term: Develop and demonstrate lower cost high efficiency space heaters that also emit < 4 ng/j NOx by 2020. • Development of low NOx burners, focused on flame temperature reduction (FIR, staged combustion, swirl, metal / ceramic mesh) offer potential technology solutions for < 4 ng/joule NOx with projected manufacturing costs of $25 to $50

Status of SCG-Residential Water Heating Related RD&D

Technology/ process description	• Residential water heaters sizes are less than 100 gallons and consume less than 75,000 btu/hr. • Residential space heaters consume less than 175,000 btu/hr • Current water heaters meet the SCAQMD 10 ng/joules (or 15 ppm) NOx emissions requirements • New water heaters must have “Flame Vapor Ignition Resistance” and must meet higher future efficiency standards • Instantaneous or tankless water haters are gaining market share • Leading suppliers: AO Smith, Rheem, Bradford White • Solar water heating are available and they qualify for rebate from CSI
Key challenges	• SCAQMD may propose to electrify residential water heaters or require a 90% reduction in NOx emissions • ng water heaters are more energy efficient but are not currently economical • Future reduction in NOx emissions might require the use of Power Burners (vs. atmospheric). In southern California, most water heaters are located in the garage or in a closet and do not have any power source
SCG activity	• Partner with major equipment manufacturers to continue to develop and demonstrate lower emission products • Development of low NOx burners, focused on flame temperature reduction (FIR, staged combustion, swirl, metal / ceramic mesh) offer potential technology solutions for < 6 ppm NOx with projected manufacturing costs of $25 to $50 • Develop and demonstrate lower cost condensing (more efficient) water heaters • SCG is currently co-funding related development projects at GTI through the UTD

Status of C/I Boilers Related RD&D

Technology/ process description	• Boilers generate steam for direct use such as providing heat or for power generation • C/I Boilers varies in sizes, 2 to 200 MMBtu/hr or 100 to 3,000 HP • There are two types of boilers: Firetube and Watertube • Boilers used in commercial facilities such as: hospitals, hotels, schools and buildings • Boilers used in industrial facilities such as: food processing, paper, manufacturing, chemicals and refineries • Most boilers operate for many hours and consume large amount of energy and potentially produce high level of CO2 emissions • Current NOx emissions requirements are between 5 and 12 PPM (depending on the boiler size) • Average boiler efficiency is in low 80% • Adding an economizer can add about 5 to 6% in energy efficiency gain
Key challenges	• Expect the SCAQMD to reduce the NOx emissions requirements to below 5 PPM • That will require new types of combustion (i.e., catalytic) and/or exhaust gas treatment to be developed and demonstrated • Electric boilers are available up to 500 Hp but are more expensive to operate and have a higher first cost
SCG activity	• Continue our current effort to develop less than Low NOx burners that can achieve < 5 PPM • Continue to develop alternative and cost effective exhaust heat recovery

Status of Industrial Processes Related RD&D

Technology/ process description	• There are multiple types of industrial process equipment. They include ovens, dryers, heaters, melting furnaces, oxidizers, incinerators, kilns, etc. • They can provide heat from 200F (for drying applications) to over 3000F (glass melting) • Higher temperature equipment produce more NOx emissions • Burner technologies already exist to meet current emission regulations, although ultra low emission technologies have not been widely deployed and many existing burner systems will require retrofitting • The cost of mitigating environmental regulations to existing industrial customers is increasing and could force many of them to move to other States or outside the country
Key challenges	• Currently, SCAQMD has begun implementation of Rule 1147, which requires all equipment types to meet 30-60 ppm NOx by 2016 • Newer technologies to reduce NOx (i.e., catalytic combustion, oxy-combustion, recuperation) and to treat exhaust gases need to be cost effective • Due to variety of types of equipment, development of individual solutions for each type is necessary • Electric alternatives are available and are cheaper, for equipment first cost. However, operating and installation costs are greater due to the switch gear needed
SCG activity	• Concentrate the RD&D efforts to treat exhaust gases to reduce emissions and recover the heat to reuse or to generate power • Development of cost-effective ultra low NOx and oxy-combustion technologies for high temperature processes

Status of SCG-DG/CHP Related RD&D

Technology/ process description	• Waste heat to power generation or combined heat and power is commonly used in commercial and industrial facilities • MicroCHP are systems that produce < 15KW using microturbines, Stirling engines or IC engines and produce hot water and electricity simultaneously • Conventional CHP systems: steam boilers, steam turbine and electric generator; Organic Rankin Cycle (ORC); Kalina Cycle (using Ammonia) and Engines or Microturbines power generators and hot water or chiller secondary energy use • The reduction in NOx and CO2 is a function of therms savings as a result of not burning fuel somewhere else. The NOx and CO2 credits would be determined by calculating the therms saved and multiplying those therms savings by the following factors: NOx = 0.013 lbs./therm - CO2 = 11.7 lbs./therm
Key challenges	• In February 2008, SCAQMD adopted new standard that requires NOx emissions below 0.02 g/bhp-hr (approx. 2 PPM) for DG applications • Non-DG applications such as water pumping, engines must meet NOx levels below 0.15 g/bhp-hr NOx (New source Review) • OEMs for rich burn engines don't produce engines that can meet CA emissions requirement, They depend on third party packagers to add Air/Full Ratio control and exhaust gas treatment such as 3-way catalysts. • Added equipment cost, and ORC and Therm-Electric are low efficient systems
SCG activity	• Several technologies are being developed for rich burn engines, such the CEC/SCG initiative to develop low emissions control for Rich-Burn engines • Continue to develop and demonstrate new technologies that can meet SCAQMD DG NOx levels. Continue to develop and demonstrate cost effective CHP systems

Status of SCG-Fuel Cell Related RD&D

Technology/ process description	• Electrochemical, non-combustion device that combines hydrogen and oxygen to produce high quality electricity, heat, and water • Natural gas, reformed to hydrogen, is most common feedstock • Ultra low emissions of NOx and CO2 • In CHP applications total efficiency > 80% • High power quality and potential base load application • Heat output can be used for boilers, domestic hot water, space heating, industrial processes, absorption chillers, etc.
Key challenges	• "Main stream" adoption is in early stages (similar to PV 5 years ago) • Still high initial cost, need for incentives is critical • Stack life (critical component) is improving steadily with warranties of 5 years and beyond increasingly common, but remain challenging to extend over 10 years
SCG activity	• Monitor emerging technologies, market, support industry consortia • Conduct business case review to explore possible opportunities • Active demonstration effort , current projects include: ✓ CFCL 1.5 kW demonstration at the SCG Energy Analysis Center (EAC) ✓ 300 kW Fuel Cell Energy project at the Orange County Sanitation District ✓ 300 kW Fuel Cell Energy/Absorption Chiller project at UC Irvine ✓ Plug Power advanced PEM demonstration project – 6 units installation in 2011 ✓ SDG&E Sustainable Communities funding UTC 400 kW demonstration at J&D Labs ✓ ClearEdge 5 kW unit demonstration at the San Diego Boy's and Girl's Club. Installation of another 5kW unit in planning for SCG service site

Status of SCG-Biofuel Related RD&D

Technology/ process description	• Conversion of any organic material into heat, electricity and biofuels directly by burning or indirectly by bio-gasification • Next-generation technologies include: ✓ Advanced bio-energy conversion techniques ✓ Development of economically optimal feed-stocks and algae-base biofuels ✓ Lower process cost using enzymes, bacteria and fungi
Key challenges	• Scaling down of gasification and conditioning technologies • Virtually no subsidies for biogas in place in spite of great potential • Need for improved digester yields, more cost-effective conditioning equipment and more advanced gasification techniques
SCG activity	• Actively developing biogas conditioning projects; looking at digester projects • Pursuing demonstration projects for algae fuels and gasification to methane systems

Status of SCG-CCS Related RD&D

Technology/ process description	• Diversion, capture and storage of CO_2 from electric generation systems for storage in geologic formations, soils, vegetation, or other environmentally friendly forms • Next-generation technologies include: ✓ Oxy-combustion ✓ Post-combustion ✓ Algae sequestration
Key challenges	• Cost & technology risks • CO_2 transport infrastructure • Environmental concerns about injecting large amounts of CO_2 into oil wells
SCG activity	• RD&D investment in Clean Energy Systems (pre-combustion); first-generation power block components are ready for deployment