



November 30, 2015 - California Sustainable Freight Action Plan

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2. "Bringing Selective Pre-2010 HHDD Engines into 2010 Emission Compliance"
3. Location of the Projects

American Power Group is proposing to integrate aftermarket emissions technology with their Dual Fuel technology that would bring pre-2010 heavy duty engines into compliance with 2010 emissions standards. This technology can be deployed on Class 8 trucks traveling on California's major international trade highway routes primarily in the following four regions: "San Diego/Border Region, Los Angeles/Inland Empire Region, Central Valley Region, and the Bay Area Region."

The identification of the pre-2010 engines to be targeted for demonstration and verification of the performance of the dual fuel engines will be decided in co-operation with several of the Air Quality Management Districts (AQMDs) in areas of severe non-attainment such as SCAQMD and SJVAQMD. The Districts would be requested to identify their population of pre-2010 engines, still in service, which give them the most concern regarding their total volumes of emissions and which also are on the APG/EPA approval list. This information will help target placement of APG's technology.

It is thought that this test engine identification process would progress in a stepwise fashion, which could conceptually start with the selection of the engine family that is representative of the largest volume contributors to the emissions burden.



4. Executive Summary of Project(s)

American Power Group (APG), in collaboration with the Center for Alternative Fuel Engines and Emissions (CAFEE) at West Virginia University, is proposing to create an affordable and production ready turbocharged dual fuel (aka: bi-fuel) aftertreatment system that will be CARB E.O. certified/verified to meet the Title 13 CCR Section 2025 mandate that pre-2010 HHDD engines be brought into compliance with 2010 emission standards. The new "V6000 Plus" will fulfill several of the alternative fuel and clean air objectives of Executive Order B-32-15 including: a) reduction of On-Road Heavy-Heavy Duty Diesel (HHDD) engine diesel fuel consumption by 45%-60% with natural gas; b) reduction of NOx exhaust emissions levels below 2010 NOx standards on major California international trade highway routes and in key non-attainment regions; c) reduction of fleet operating costs with favorable price spread between natural gas and diesel fuel; and, d) improvement in local economics by driving California's natural gas infrastructure and natural gas tank storage expansion.

APG expects the "V6000 Plus" can experience rapid deployment at an affordable price due to timely integration of proven Dual Fuel and selective catalyst reduction (SCR) aftertreatment technologies. The APG Dual Fuel technology has been U.S. EPA approved on nearly 500 Engine Family Numbers (EFN's) of all major engine brands and is receiving CARB Executive Order (E.O.) approvals on a growing list of 2010 emission compliant engines. A recent market survey reported over 79% of California's registered Class 8 trucks are model year pre-2010 which represents over 150,000 vehicles. Approximately 58% or 113,500 of those registered Class 8 trucks are model year 2006 and older, which when equipped with APG's V5000 Dual Fuel System and Diesel Oxidation Catalyst (DOC), in EPA emission testing, reports NOx reduction of 8,800 to 14,400 lbs per million miles traveled. Similarly 2007-2009 engines, which represents 21% or 40,400 registered Class 8 trucks, when equipped with V5000 Dual Fuel Systems and Diesel Oxidation Catalysts & Diesel Particulate Filter (DOC & DPF), in EPA emission testing reports NOx reduction of 6,600 to 7,400 lbs per million miles traveled. With the addition of the proposed aftertreatment system (which brings the tail-pipe emissions into 2010 standards compliance), the combined effect is an addressable market potential of nearly 1 million tons of NOx reduction per million miles traveled for California HHDD engine equipped pre-2010 vehicles. Tracking of annual reductions can be readily available through telematic logs reporting on miles traveled and diesel displaced with natural gas.



5. How the Project Idea Components Incorporate the Program's Goals

Introduction

American Power Group Inc. (APG) develops, manufactures and markets affordable alternative Dual Fuel technology that allows for 45%-60% substitution of natural gas for diesel fuel in existing diesel engines, typically used in HHDD engines for On-Road and Off-Road applications. The APG Dual Fuel System provides owner/operators an affordable clean alternative fuel option to realize lower cost operation, reduced exhaust emissions, enhanced equipment durability while maintaining OEM level power and torque.

Lower Emissions, Lower Carbon Footprint

The APG Dual Fuel On-Road technology has U.S. EPA approval for ~ 500 Engine Family Numbers (EFN's) as a retrofit system and most recently have CARB Executive Order certifications for a series of 2010 compliant engines from Volvo and Mack with Detroit Diesel and Cummins certifications in-process. Certification testing has shown the APG Dual Fuel System operation results in reduced CO2 emissions, reduced NOx emissions and reduced Particulate Matter (P.M.) emissions. APG also has ~100 Off-Road (industrial) applications which meet U.S. EPA Memo 1a criteria for appropriate M.Y. emission standards

Meeting 2010 Standards in Pre-2010 HHDD Engines, Now

APG is proposing to create for On-Road 2004-2009 HHDD engine equipped vehicles, an affordable production ready, CARB E.O. certified/verified, Dual Fuel (Bi-Fuel) and aftertreatment system to meet the Title 13 CCR Section 2025 mandate that all pre-2010 HHDD engines be brought into compliance with 2010 emission standards.

Along with the APG Turbocharged Natural Gas® Dual Fuel System, APG is integrating OEM Tier 1 supplied aftertreatment components, i.e., Selective Catalytic Reduction-Urea, (SCR-U), Diesel Particulate Filters (DPF), Diesel Oxidation Catalyst (DOC), including appropriate sensors, Diesel Emission Fluids (DEF), dosing systems, DPF regeneration injector, an aftertreatment Electronic Control Module (ECM) and aftertreatment control software, as required to reduce pre-2010 HHDD engine tail-pipe emissions to comply with 2010 emission standards. Based on certification testing experience, the APG Turbocharged Natural Gas® Dual Fuel System has been shown to further reduce NOx emissions, to approximately 50% of the 2010 NOx standard and CO2 emissions by up to 10%.

Derivative Green Savings, Transparent to the Operator

The benefits to the fuel and freight infrastructures follow parallel paths in benefits. Dual fuel operation for heavy duty Class 8 trucks has them producing fewer emissions while maintaining their original operation capabilities. As natural gas is transported by pipelines, the on-road diesel delivery infrastructure requirements are reduced, resulting in elimination of emissions from on-road diesel fuel deliveries.

APG CARB Pilot

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Rapidly, Reliably Implemented

The conversion to dual fuel operation of the pre-2010 diesel engines will be performed in their areas of operation in the local districts by local dealerships after technicians are trained and certified by APG. It is anticipated that the local sourcing of the dual fuel conversion upgrades and subsequent maintenance requirements would provide for significant employment in the local districts.

Economic Incentives

Further economic benefits will be realized in the districts by allowing the owner/operators to both continue to use their pre-2010 engines and to bring them into compliance with the 2010 emission standards for about 25%-40% of the cost of a new vehicle. These lower costs of compliance are well within the dollar amounts of the incentive programs, such as the Carl Moyer Program, offered by various regulatory agencies to promote and facilitate diesel engine upgrades for pollution abatement, thus providing additional incentives for the owner/operators to move towards compliance.

The dual fuel operation offers an additional benefit of lower fuel costs. While, the differential between the cost of diesel fuel compared with an energy equivalent quantity of natural gas is not as large as several years ago, it is expected to remain in the favor of natural gas as its price is projected to be stable for at least a decade or more. This stable lowered fuel cost structure made possible by the country's extremely large natural gas resource could improve the cost competitiveness of California's freight system for many years to come.

Market Research on NOx Emissions from Pre-2010 HHDD Engine Applications

An RL Polk market survey presently shows:

- 58%, or 113,500, CA registered trucks are pre-2007; the proposed APG Dual Fuel with proposed upgraded aftertreatment represents a potential NOx reduction of 8,800 to 14,400 lbs per million individual vehicle miles or 500,000 to 817,000 tons for the entire fleet per million vehicle miles.
- 21%, or 40,400, CA registered trucks are M.Y. 2007-2009; the proposed APG Dual Fuel with supplemental aftertreatment represents a potential NOx reduction of 6,600 to 7,400 lbs per million individual vehicle miles or 133,000 to 150,000 tons for the entire fleet per million vehicle miles.



Discussion APG Dual Fuel/Aftertreatment Proposal

APG is proposing to create for On-Road 2004-2009 HHDD engine equipped vehicles, an affordable production ready, CARB E.O. certified/verified, Dual Fuel (Bi-Fuel) and aftertreatment system to meet the Title 13 CCR Section 2025 mandate that all pre-2010 HHDD engine be brought into compliance with 2010 emission standards.

APG would research appropriate aftertreatment systems, i.e., Selective Catalytic Reduction -Urea, (SCR-U), Diesel Particulate Filters (DPF) and Diesel Oxidation Catalysts (DOC) to integrate the Dual Fuel system aftertreatment systems, conduct CARB appropriate emission testing and verification to achieve CARB E.O. certification and verification.

Conclusion

APG has established itself as the Bi-Fuel/Dual Fuel leader in regulatory approved conversion systems and the Bi-Fuel/Dual Fuel market. APG has full confidence in providing an upgraded aftertreatment system to achieve mandated compliance to 2010 exhaust emission standards. The APG Dual Fuel system provides on-highway NG substitution for diesel fuel of 45%-60% and will further reduced NOx emission to approximately 50% of the 2010 NOx standard, reduced CO2 exhaust emissions and achieve CARB E.O. certification/verification while providing an economically attractive option to pre-2010 HHDD engine equipped vehicle owners.



6. Estimated Costs for Implementation, etc.

Discussion-Proposed Program Cost & Timing

The total program cost for development, verification and validation of APG's Integrated Dual Fuel Emissions Abatement System is \$3,147,000. This amount includes labor, material purchases and travel expenses as well as emissions certification services from West Virginia University. Program costs are tabulated below by category and phase and are highlighted on the timing chart in section 7 below. Note that the development timeline is anticipated to span approximately twenty-four months and will be detailed further during the first phase of the project.

Program Cost Summary & Breakdown

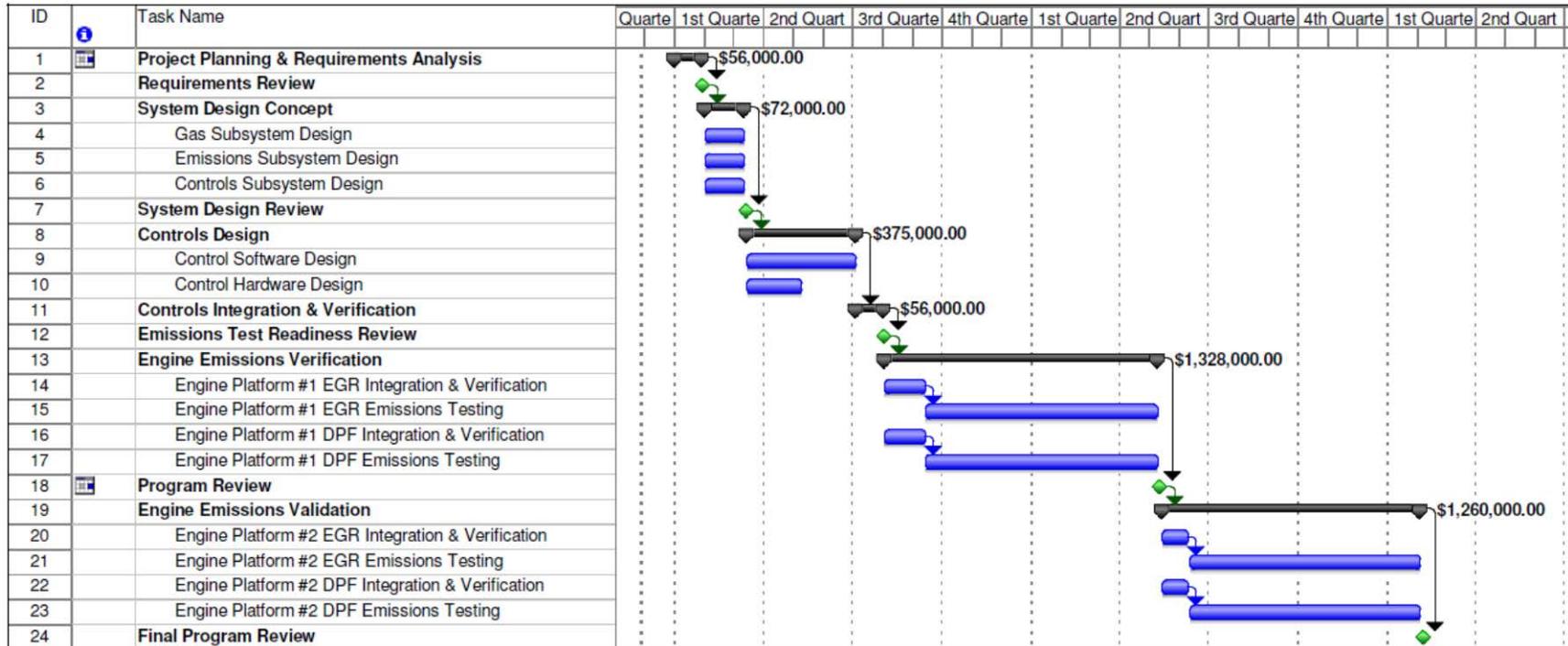
Phase	Objective	Duration (d)	Labor (\$)	Material (\$)	Travel (\$)	Facilities (\$)	Subtotal (\$)	Cumulative (\$)
1	Requirements Analysis	21	\$ 56,000	\$ -	\$ -	\$ -	\$ 56,000	\$ 56,000
2	System Design	31	\$ 72,000		\$ -	\$ -	\$ 72,000	\$ 128,000
3	Controls Design	80	\$ 320,000	\$ 55,000	\$ -	\$ -	\$ 375,000	\$ 503,000
4	Controls Verification	21	\$ 44,000	\$ 12,000	\$ -	\$ -	\$ 56,000	\$ 559,000
5	Emissions Verification	203	\$ 204,000	\$ 233,000	\$ 25,000	\$ 866,000	\$ 1,328,000	\$ 1,887,000
6	Emissions Validation	192	\$ 136,000	\$ 233,000	\$ 25,000	\$ 866,000	\$ 1,260,000	\$ 3,147,000
All	Total	548	\$ 832,000	\$ 533,000	\$ 50,000	\$ 1,732,000	\$ 3,147,000	

Estimates for Emissions Testing / Durability based on the following:

- Initial installation;
- Baseline engine-out emissions testing (no aftertreatment);
- Baseline system-out emissions testing (with aftertreatment);
- 1000 hour aging with 2-day emissions test every 100 hours;
- Final system-out emissions testing (with aftertreatment);
- Reporting: Full emissions both regulated and non-regulated, Monitor NOx both pre- and post-SCR and report SCR efficiency, Gravimetric fuel economy, Gravimetric PM, Particle count both pre- and post-DPF and report DPF efficiency, Regen frequency.

7. Project Timeline

Program Timing





8. Means for Measuring Progress toward Meeting Goals over Time

As depicted within the project timeline in section 7 above, five program reviews will serve to act as project gates for approval of subsequent funds allocation and expenditure:

- Requirements Review;
- System Design Review;
- Emissions Testing Readiness Review;
- Emissions Verification Review;
- Capstone Review.

In addition, APG will host weekly staff calls between APG, WVU and SCR partners.



9. Description of the Potential Roles Each of the Interagency Partners Could Provide to Support the Project's Implementation

A number of the interagency partners will be involved directly or peripherally in significant supporting roles, for the benefit of the people of California, in this Pilot Program Proposal. The introduction of APG's disruptive technology for the movement of freight (or irrigation water pumping) in the major transportation corridors in California will allow for significant reduction of criteria pollutants at an affordable cost and in a time frame much shorter than previously thought possible.

Air Resources Board

The Air Resources Board (ARB) will be the interagency partner most closely aligned with the project proposed in this document as it involves the introduction of a dual fuel technology for upgrade/retrofitting of pre-2010, in service, diesel engine to allow them to operate in compliance with the 2010 emission standards. It is anticipated that ARB will be intimately engaged in virtually all of the steps of engine performance testing, as one of the goals of the program is the ultimate acceptance and certification of APG's Dual Fuel technology for diesel engines.

Based upon the historically demonstrated performance of the APG Dual Fuel System, the company anticipates that ARB will be more than pleased with the test results of this project and will entertain a mutually rewarding partnership to bring this criteria pollutant reduction technology to the freight corridors of California in a timely manner.

The company eagerly looks forward to working together with ARB personnel on this exciting and worthwhile project. We expect that the relationship between the company and ARB to be one which will be mutually beneficial with each party benefiting from the information exchange inherent with the hands-on interactive project described in this proposal.

California Energy Commission

The California Energy Commission (CEC) has exhibited a high level of interest in the Sustainable Freight Action Plan with the ongoing programs put forward under the aegis of Commissioner Janea Scott, the designated Lead Commissioner for Transportation. This interest is evidenced by her sponsorship of the upcoming merit workshop on "Medium and Heavy-Duty Vehicle Project Success being presented in Sacramento on December 2.

Commissioner Scott is also the Lead Commissioner overseeing the Proceedings concerning the 2016-2017 Investment Plan for the Alternative and Renewable Fuel and Vehicle Technology Program. This program was initiated by AB 118 and authorizes CEC to develop alternate fuels and advanced technologies to meet the states goals on GHG emission reduction in the transportation sector. The company is gratified to note that the thrust of this endeavor is parallel with the objectives of APG's Dual Fuel technology.



Further evidence of the interest in CEC for the Sustainable Freight Action Plan was given by the fact that the formal presentation of the Pilot Project Program was made by Andre Freeman, a staff member of CEC's Fuels and Transportation Division. It is anticipated that CEC's staff will be involved in the Pilot Project program on an on-going basis as the program has high visibility at CEC. The company would invite an interactive dialogue with the staff at CEC as an information exchange opportunity, which will allow CEC to expand upon their transportation expectations for the future and, for APG, to demonstrate how the company will significantly contribute to achievement of their goals.

Caltrans

Caltrans is one of the leaders in promoting the establishment of the CNG vehicle infrastructure along California's highways. The successful deployment of the company's technology for meeting the goals of the Governor's Executive Order will need the further development of the CNG infrastructure which Caltrans has been working on and funding for a couple of decades.

The company would desire to see future configurations of fueling stations for heavy duty diesel trucks and heavy duty dual fueled diesel trucks to have the availability of truck operators to fuel with both diesel and CNG at the same fueling stop. This duality of the fueling station would be of great utility to the dual fuel truck operators such that, with simultaneous fueling, the time and effort for fueling would be minimized.

The company looks forward to working with Caltrans to establish such fueling stations along the major freight corridors especially in the non-compliant AQMD districts to further facilitate adoption of the APG technology which will significantly reduce the transportation emissions in these impacted areas.

Office of the Governor

The Governor, through Executive Order B-32-15, directed towards bringing the freight transportation system of California into a more user and environmentally friendly structure. The Executive Order set some ambitious goals for reduction of GHG emissions in the transportation sector, all modes of goods movement were included: ports, railroads, highways and roads used for freight transportation. The Order had another boundary condition, in equal importance, such that compliance with the pollution reduction measures should also produce a sustainable transportation system that enhances the viability of the economy of California which is highly dependent upon the transportation sector.

The influence of the Governor was evidenced by the presentation of key points of the Executive Order by a senior advisor to the Governor at the kick-off Pilot Project Program. Further, indication of the interest of the Governor was noted by the inclusion of the major talking points of the Executive Order in the several other presentations at the kick-off meeting.



The urgency present in the Governor's order was shown by the tight schedule in the establishment of the Pilot Project Program such that state review of the proposals is to begin in December 2015, with presentations of the selected project ideas at a January 2016 workshop.

All of the projects will have a high visibility in the Governor's office. The company anticipates making very favorable presentations in July that will show both the ability to meet reductions in GHG and criteria emissions with an affordable system capable of near term deployment. The APG system will also bring economic opportunities along the freight corridors as company trained locally based technicians will be employed for installation and maintenance functions. The company's goals and objectives are aligned with the Governor's Executive Order.