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California Sustainable Freight Action Plan

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2. Upgrading Existing Off-Road Engines to Tier 4F Emission Standards

3. Location of the Projects

The Off-Road diesel engine population in California can be a significant source of air pollution especially when operating in non-compliant districts with geographical and atmospheric conditions that may prevent dispersion of the emissions. The American Power Group (APG) Conversion System for Pre-Tier 4F Off-Road diesel engines provides an economical and environmental process for the rehabilitation of non-compliant diesel engines into fully functional diesel engines in compliance with the Off-Road Tier 4F standards. At present, APG has EPA approval for their alternative dual fuel conversion of approximately 500 diesel "On-Road" HHDD engines and has met EPA Memo 1A criteria of approximately 100 "Off-Road"(industrial) HHDD engine models for their respective model years.

The identification of the older 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) such as the San Joaquin Valley Air Pollution Control District (SJVAPCD) which has an active ongoing program for upgrading of agricultural pump engines. The Districts would be requested to identify their population of Pre-Tier 4F in-service engines which give them the most concern regarding total volumes of emissions.

4. Executive Summary of Project(s)

American Power Group (APG) has proposed the development of an affordable and production ready turbocharged dual fuel after-treatment system for older Off-Road diesel engines that will be CARB E.O. certified/verified to meet the Tier 4F emission standards. This APG product, the "S6000 Plus" will fulfill several of the alternative fuel and clean air objectives of Executive Order B-32-15 including: a) reduction of HHDD engine diesel fuel consumption by 45%-60% with natural gas; b) reduction of NOx exhaust emissions levels to 2015 Tier 4F NOx standards in major California non-attainment regions; c) reduction of engine 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 distribution.

The present proposal is made to extend the emission compliance capabilities of the "S6000 Plus" technology to Pre-Tier 4F Off-Road diesel engines in use for agricultural operations in some of California's most severely impacted non-attainment air quality districts such as the SJVAPCD. It is APG's objective that the S6000 Plus technology will bring Pre-Tier 4F Off-Road diesel engines into compliance with 2015 Tier 4F standards. While ambient NOx emission mass reduction levels may not have the same magnitude of NOx emission mass reduction levels for converted On-Road diesels engines, the reductions will definitely help the local districts in their efforts to reach attainment of the new ozone standard. For example, the SJVAPCD basin sees a daily NOx load of >80 tpd from farm equipment and Off-Road sources[1]. Conversion of the Off-Road engines to Tier 4F standards can help reduce this daily non-attainment burden

[1] San Joaquin Valley Unified Air Pollution Control District Guidance for Assessing and Mitigating Air Quality Impacts, March 19, 2015

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

American Power Group Inc. (APG) develops, manufacturers 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 Orders 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

Off-Road Engine Emission Standards

In 2003, EPA changed the definition of non-road engines to include Off-Road diesel engines used in agricultural operations in California. The highest level of emission control for Off-Road engines is the Tier 4F category. The evolution of EPA non-road emissions regulations is shown in the Figure[2] below. The Figure also indicates the approximate timeline for introduction of the various Tiers with Tier 4F being the present target for achievement. The California Tier 4[3] standards for NOX for the Off-Road engine population are given in the Table 4 below.

[2] www.conexpoconagg.com/con-agg-2014

[3] http://www.arb.ca.gov/diesel/documents/finalreg2011.pdf

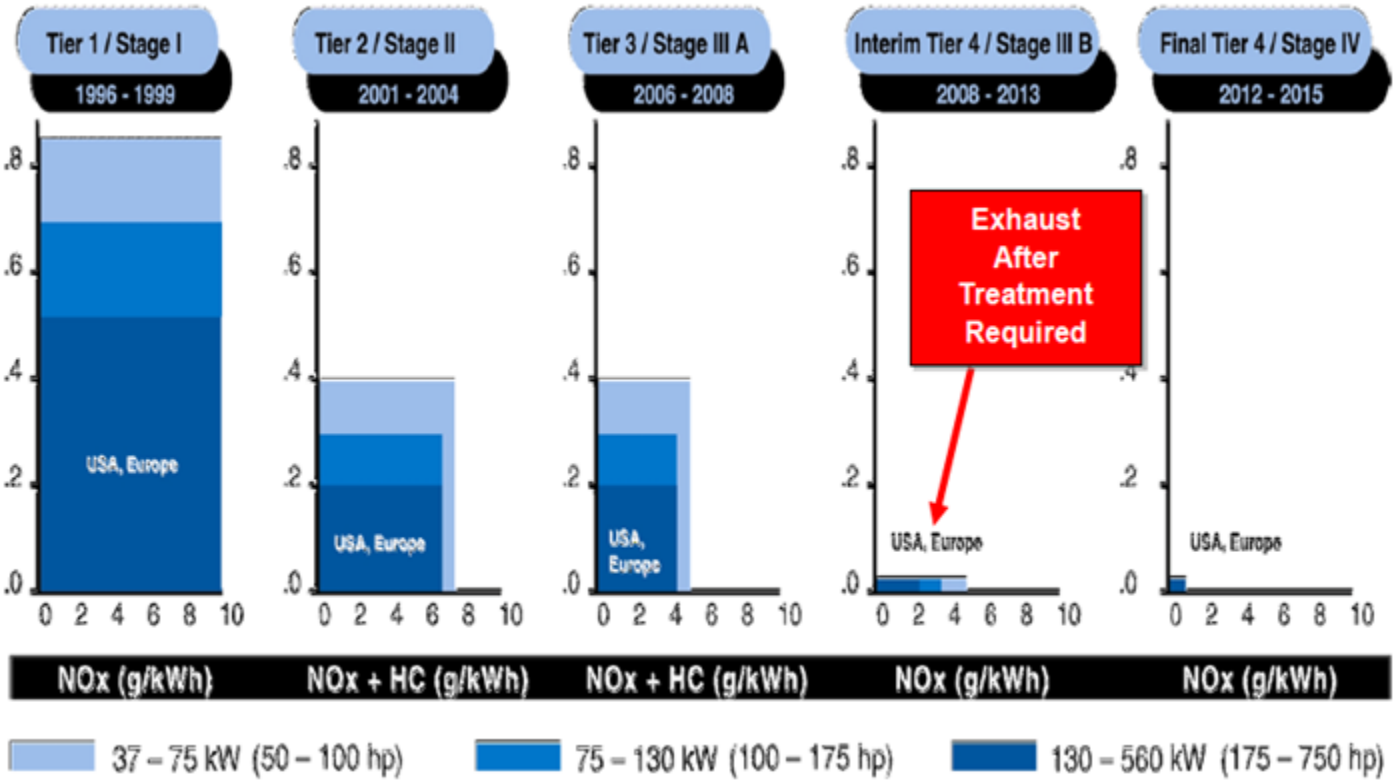


Table 4: Emission Standards for New Stationary Prime Diesel-Fueled CI Engines > 50 BHP g/bhp-hr (g/kW-hr)[1]						
Maximum Engine Power	Model year(s)	PM	NOx	NMHC+NOx	NMHC	CO
50 ≤ HP <75 (37 ≤ KW <56)	2007	0.01 (0.02)		5.6 (7.5)		3.7 (5.0)
	2008-2012	0.01 (0.02)		3.5 (4.7)		3.7 (5.0)
	2013+	0.02 (0.03)		3.5 (4.7)		3.7 (5.0)
75≤ HP <100 (56≤ KW <75)	2007	0.01 (0.02)		5.6 (7.5)		3.7 (5.0)
	2008-2011	0.01 (0.02)		3.5 (4.7)		3.7 (5.0)
	2012-2014	0.01 (0.02)	2.5 (3.4)		0.14 (0.19)	3.7 (5.0)
	2015+	0.01 (0.02)	0.30 (0.40)		0.14 (0.19)	3.7 (5.0)
100 ≤ HP <175 (75≤ KW <130)	2007-2011	0.01 (0.02)		3.0 (4.0)		3.7 (5.0)
	2012-2014	0.01 (0.02)	2.5 (3.4)		0.14 (0.19)	3.7 (5.0)
	2015+	0.01 (0.02)	0.30 (0.40)		0.14 (0.19)	3.7 (5.0)
175 ≤ HP < 750 (130≤KW<560)	2007-2010	0.01 (0.02)		3.0 (4.0)		2.6 (3.5)
	2011-2013	0.01 (0.02)	1.5 (2.0)		0.14 (0.19)	2.6 (3.5)
	2014+	0.01 (0.02)	0.30 (0.40)		0.14 (0.19)	2.6 (3.5)
750<HP≤1,207 (560<KW≤900) Gen. sets	2007-2010	0.01 (0.02)		4.8 (6.4)		2.6 (3.5)
	2011-2014	0.02 (0.03)	2.6 (3.5)		0.30 (0.40)	2.6 (3.5)
	2015+	0.02 (0.03)	0.50 (0.67)		0.14 (0.19)	2.6 (3.5)
HP > 1,207 (KW > 900) Gen. sets	2007-2010	0.01 (0.02)		4.8 (6.4)		2.6 (3.5)
	2011-2014	0.02 (0.03)	0.50 (0.67)		0.30 (0.40)	2.6 (3.5)
	2015+	0.02 (0.03)	0.50 (0.67)		0.14 (0.19)	2.6 (3.5)

Meeting the Off-Road Emission Standards in Pre-Tier 4F Engines

As noted above, APG's Dual Fuel S6000 Plus technology, when applied to Pre-Tier 4F diesel engines, will bring the operation of these engines into compliance with the 2015 standards.

The operational lifetime for Off-Road diesel engines in agricultural service is found to have a large timespan, with some engines in California being over 40 years old. Thus, the population of diesel engines suitable for retrofit with the APG Dual Fuel technology is not as universal as found in the On-Road population of engines. The cut-off date for suitable engines is assumed to be the pre-2006 M.Y.s. For the engines, which meet APG's criteria, the installation of the Company's dual fuel technology and an after-treatment system will allow the engines to meet, or exceed, the Tier 4F emission standards. The assurance can be made based upon APG's demonstrated ability to have engines with the Company's dual fuel technology meet or exceed the On-Road diesel engine emission standards.

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 diesel engines produce fewer emissions while maintaining their original operation capabilities. As pipelines transport natural gas, the on-road diesel delivery infrastructure requirements are reduced, resulting in elimination of emissions from on-road diesel fuel deliveries.

Rapidly, Reliably Implemented

The conversion to dual fuel operation of the pre-Tier 4F 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-Tier4F engines and to bring them into compliance with the Tier 4F emission standards for about 25%-50% of the cost of a new engine. These lower costs of compliance are well within the dollar amounts of the incentive programs, such as the Carl Moyer Program.

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 a year 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 Off-Road engine systems for many years to come.

Discussion: APG Dual Fuel/Aftertreatment Proposal

APG is proposing to create for pre-Tier 4F Off-Road diesel engines, an affordable production ready, CARB E.O. certified/verified, Dual Fuel (Bi-Fuel) and after-treatment system that meet the Tier 4F emission standards.

Along with the APG Turbocharged Natural Gas® Dual Fuel System, APG is investigating integration of OEM utilized after-treatment components. These OEM utilized components can include; 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, purpose designed after-treatment Electronic Control Module (ECM) and software, as required to reduce diesel tail-pipe emissions to Tier 4F standards.

Conclusion

APG has established itself as the Bi-Fuel/Dual Fuel leader in regulatory approved conversion system and in the Alternative-Fuel market. APG has full confidence in providing natural gas substitution for diesel fuel in the 45%-60% range, managing the after treatment system to achieve mandated compliance to Tier 4F exhaust emission standards, reducing CO2 exhaust emissions, and achieving CARB E.O. certification while providing an economically attractive option for pre-Tier 4F diesel engines for owner/operators.

6. Estimated Costs for Implementation, etc.

Discussion-Proposed Program Cost & Timing

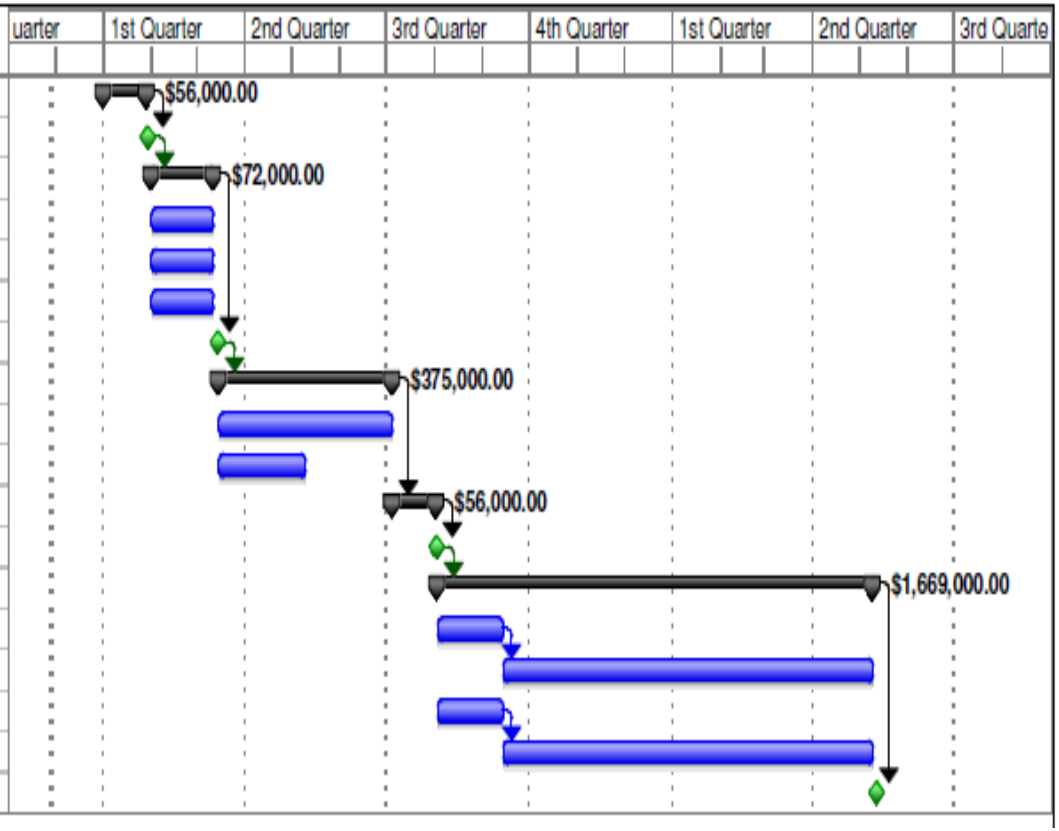
The total program cost for development, verification and validation of APG's Integrated Dual-Fuel Emissions Abatement System is $2,228,000. This amount includes labor, material purchases and travel expenses as well as emissions certification services from West Virginia University. Program costs are tabulated 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 eighteen 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	$ 540,000	$ 25,000	$ 900,000	$ 1,669,000	$ 2,228,000
All	**Total**	**356**	**$ 696,000**	**$ 607,000**	**$ 25,000**	**$ 900,000**	**$ 2,228,000**	

7. Timelines

ID	Task Name
1	**Project Planning & Requirements Analysis**
2	**Requirements Review**
3	**System Design Concept**
4	Gas Subsystem Design
5	Emissions Subsystem Design
6	Controls Subsystem Design
7	**System Design Review**
8	**Controls Design**
9	Control Software Design
10	Control Hardware Design
11	**Controls Integration & Verification**
12	**Emissions Test Readiness Review**
13	**Engine Emissions Certification**
14	Engine Platform #1 Integration & Verification
15	Engine Platform #1 Emissions Testing
16	Engine Platform #2 Integration & Verification
17	Engine Platform #2 Emissions Testing
18	**Program Review**



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 older, in service, diesel engines to allow them to operate in compliance with the Tier 4 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 these Off-Road 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 air quality impaired AQMDs. 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 air quality pollution reduction 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 expansion of the CNG fueling stations will concomitantly increase the range of the natural gas infrastructure. This increase in natural gas availability will help reduce the cost of fueling the dual fuel Off-Road engines devoted to agricultural irrigation use in the non-compliant AQMD districts. The adaption of the APG technology for Off-Road engines will significantly reduce their emissions as well as transportation emissions through reduced diesel fuel on-road deliveries 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 bas well as freight dependent industries in the AQMD non-attainment areas, such as agricultural operations with their Off-Road diesel engines. The Order had another boundary condition, in equal importance, such that compliance with the

pollution reduction measures should also produce a sustainable system that enhances the viability of the economy of California, which is highly reliant upon the transportation or transportation dependent sectors.

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 July 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.