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Addendum 6

PON-08-010

GRANT SOLICITATION APPLICATION PACKAGE

American Recovery and Reinvestment Act of 2009 Cost Share

Alternative and Renewable Fuel and Vehicle

Technology Program

The purpose of this addendum is to:

(1) Clarify the language on page 6 that requires applicants to include in their Final Proposals a copy of the application submitted to the federal government in response to an ARRA funding opportunity announcement. The amended language reads as follows:

o A copy of the Project Management Plan and Biographical Sketch for your project from the application submitted to the federal government in response to an ARRA funding opportunity announcement. The Energy Commission may request additional information if the Project Management Plan and Biographical Sketch do not contain sufficient information to prepare a Work Statement document.

(2) Provide further information about the calculations required by Final Proposal Scoring Criterion 5 (Attachment C).

(3) Establish 70% as the minimum percentage to pass Attachment C.

Methodology for Final Proposal Scoring Criterion 5 (Attachment C).

The Energy Commission will use a Well-To-Wheels (WTW) accounting for measuring greenhouse gas (GHG) emissions performance. The WTW or full fuel cycle analysis takes into account the fuel use in the vehicle. The WTW combines the Well-To-Tank (WTT) portion of the full fuel cycle analysis and the Tank-To-Wheels (TTW) portion (which accounts for the GHG emissions associated with the use of the fuel in the vehicle).

The required tables are in the Energy Commission's *Full Fuel Cycle Assessment: Well-To-Wheels Energy Inputs, Emissions, and Water Impacts*, CEC-600-2007-004-Rev (http://www.energy.ca.gov/2007publications/CEC-600-2007-004/CEC-600-2007-004-REV.PDF). Use the tables for Scenario Year 2012 only.

Customized Pathway Information (for pathways not in the AB 1007 *Full Fuel Cycle Analysis* or the California Air Resources Board's Low Carbon Fuel Standard).

For projects in the following categories that lack a fuel pathway in the AB 1007 Full Fuel Cycle Analysis (FFCA) or the California Air Resources Board's (ARB's) Low Carbon Fuel Standard (LCFS), applicants may use customized pathway information to calculate their GHG benefits for the project categories, following the appropriate instructions. In the absence of applicant-customized information for unique pathways not included in the AB 1007 FFCA or the LCFS, Energy Commission staff will assume similarities between certain pathways to the extent they are thermodynamically similar, and will make GHG performance estimates for applicants' customized pathways (for example, Brazilian sugar cane ethanol could be used to estimate the GHG performance of California sugar cane ethanol by making certain adjustments for transportation distances, electricity mix, and process efficiencies).

Applicants using customized pathway GHG performance must use the following information to be consistent with other projects with pathways in the AB 1007 FFCA or the ARB's LCFS. Applicants should refer to the following Step-by-Step procedure specifically for vehicle deployment, fuel production, and fueling station projects:

Vehicle Deployment

For vehicle deployment projects, the GHG performance will be based on the volume of fuel consumed by the vehicle fleet over annual vehicle miles traveled over an assumed vehicle life. The fuel volume is also a function of fleet average vehicle fuel economy embedded in the grams per mile GHG performance. Applicants do not need the fuel economy information for these calculations. Applicants should assume a nominal 10-year useful life for light duty vehicle deployment projects to determine the total lifetime GHG benefits. Applicants should assume a 12-year useful life for medium- and heavy-

duty vehicle deployment projects to determine the lifetime GHG benefits. These assumptions are applied in the vehicle deployment WTW GHG example calculations for light-, medium- and heavy-duty vehicles that follows this introduction.

Light duty vehicles will use figures A-1 to A-7. For new vehicles, applicants should use the table for “Model Years 2010 and Newer” and assume an annual vehicle miles traveled (VMT) of 15,000 miles per year to calculate their WTW GHG benefits compared to the gasoline baseline. For vehicle conversions, applicants should use the “All Model Years” table. **Use the tables for Scenario Year 2012**.

To estimate the GHG performance of a medium-and heavy-duty vehicle deployment project, applicants should use the representative urban bus vehicle WTW performance. Energy Commission staff will make the required adjustment to the calculations for non-urban bus vehicle categories such as package delivery vehicles, trash trucks or line haul trucks. For medium-duty vehicles, applicants should use the “2010 or newer” vehicle category and assume an annual VMT of 36,000 miles per year to calculate their WTW GHG benefits compared to the diesel baseline. For heavy-duty vehicles, applicants use the “2010 or newer” vehicles and an annual VMT of 67,000 miles in their calculation. Medium and heavy-duty vehicles will use figures A-8 to A-11. For vehicle conversions applicants should use the ‘All Model Years’ figures.

Steps for fleet with 5 light duty passenger vehicles using CNG (*italicized sections indicate an example)*:

1. Determine alternative fuel type based on Figures A-1 to A-7.
2. Choose the WTW GHG (grams per mile) from the highlighted row in the figure under the column that represents the fuel and vehicle technology combination. In this case, we choose Column C1 for North American natural gas. See the example figure.
3. Determine gasoline (or diesel) fuel type. See the example figure in a separate attachment.
4. Choose the WTW GHG (grams per mile) from the highlighted row in the figure under the column that represents the fuel and vehicle technology combination. In this case, we choose the first of the G1 columns for gasoline used in an internal combustion engine vehicle. See the example Figure A-1.
5. Calculate the GHG emissions for the vehicle fleet operating on CNG.

   5 vehicles x 15,000 miles per vehicle x 331 grams per mile = 24,825,000 grams CO2e

6. Calculate the GHG emissions for the vehicle fleet operating on gasoline (or diesel).

   5 vehicles x 15,000 miles per vehicle x 473 grams per mile = 35,475,000 grams CO2e

7. Calculate GHG reductions from using CNG in vehicle fleet. Subtract the GHG emissions for the vehicle fleet running on gasoline from the GHG emissions of the vehicle running on CNG.

   35,475,000 – 24,825,000 = 10.65 million grams of CO2e

8. Report GHG reductions in tons of CO2e by dividing million grams of CO2e by 1,000,000.

   10,650,000 grams of CO2e/1,000,000 grams per metric ton= 10.65 metric tons of CO2e

9. Multiply annual CO2e metric tons by vehicle useful life (We assume negligible emissions performance deterioration.)

   10.65 metric tons/year x 10 years = 106.5 metric tons of CO2e.

Steps for fleet with 5 heavy duty hydrogen fuel cell buses:

1. Determine alternative fuel type based on Figures A8 through A11.
2. Follow steps 2 through 9 in the light duty example except use the diesel fuel for your petroleum comparison. Use 12-year useful life in Step 9.

<u>Fuel Production</u>

For fuel production projects, the GHG performance will be based on the volume of fuel estimated to be produced from the facility (production volume) over the assumed useful life of the production facility project. Applicants should assume a nominal 15-year useful life for fuel production facility projects. To estimate the GHG performance for fuel production projects, applicants should assume a class of vehicles likely to use the fuel from the facility a majority of the time, in this case 70 percent of the time. The class of vehicle use assumption will allow applicants to report their production volume benefit on a WTW basis. Use Table 2: AB 1007 Full Fuel Cycle Analysis-based Carbon Intensity Well-to-Wheels values for 2012- for fuel production projects.

Steps for estimating the fuel production facility WTW GHG performance with predominant demand from light duty passenger vehicles (*italicized sections indicate an example)*:

1. Determine fuel production volume over the facility life. *For example, 10,000 kilograms of hydrogen or 10,000 gallons of gasoline equivalent for a hydrogen production facility (central plant steam methane reforming).*

2. Determine vehicle class and type likely to fuel at the station. *For example, a light duty fuel cell vehicle.*

3. Refer to the Table 2: AB 1007 Full Fuel Cycle Analysis-based Carbon Intensity Well-to-Wheels values for 2012 (derived from the AB 1007 Full Fuel Cycle Analysis for the vehicle technology and class). Identify fuel type and pathway for the project and select the applicable carbon intensity. *(22.2 grams CO2e/MJ)*

4. Convert the gasoline gallon equivalent station fuel throughput to Btu energy units (use 112,500 Btu/gallon for gasoline and 127,500 Btu/gallon for diesel)

   10,000 gge x 112,500 = 1.125 billion gge

5. Convert the gasoline gallon equivalent to joules. Multiply Btus calculated in step 4 to joules by multiplying with a factor of 961. Divide the joules obtained by 1,000,000 to get megajoules (MJ) of energy throughput.

   1.125 billion Btu x 961/1,000,000 = 1.08 million MJ

6. Multiply the WTW fuel carbon intensity by the energy throughput to determine the carbon emissions in grams. Divide result by 1,000,000 to convert MJ to metric tons.

   1.08 million MJ x 22.2 grams CO2e/MJ divided by 1,000,000 = 23.98 metric tons

7. Determine the GHG associated with the displaced gasoline.

8. Convert the displaced gasoline volume to energy to energy units (Btus)

   10,000 gge x 112500 = 1.125 billion gge

9. Convert the energy units to MJ by the procedure in Step 5

   1.125 billion gge x 961/1000000 = 1.08 million MJ

10. Multiply the displaced gasoline energy units by the gasoline carbon intensity in the table (93.8 grams CO2e/MJ)

    1.08 million MJ x 93.8 grams CO2e/MJ = 101.3 million grams CO2e

11. Convert the gasoline GHG emissions to metric tons by dividing by 1,000,000.

    101.3 million grams CO2e/1,000,000 grams per metric ton = 101.3 metric tons

12. Subtract the results in 6 from the results in 11.

    Fueling Station Project GHG Benefit: 101.3 metric tons – 23.98 metric tons = 77.32 metric tons.

Steps for estimating the fueling station WTW GHG performance with predominant demand from heavy duty vehicles

1. Determine alternative fuel type and refer to Table 2 for the fuel carbon intensity.
2. Follow the steps in for a fueling station with predominant demand from light duty vehicles in the previous section.
3. Determine the benefits compared to diesel fuel, the default fuel for heavy-duty vehicles.

<u>Fueling Stations</u>

For fueling station projects, the GHG performance will be based on the volume of fuel estimated to be dispensed from the station (station throughput) over the assumed useful life of the station project. Applicants should assume a nominal 10-year useful life for fueling station projects. To estimate the GHG performance for fueling station projects, applicants should assume a class of vehicles likely to refuel at the station a majority of the time, in this case, 70 percent of the time. The class of vehicle use assumption will allow applicants to report their station benefit on a WTW basis. Use Table 2: AB 1007 Full Fuel Cycle Analysis-based Carbon Intensity Well-to-Wheels values for 2012 for fueling station projects.

Steps for estimating the fueling station WTW GHG performance with predominant demand from light duty passenger vehicles (*italicized sections indicate an example)*:

1. Determine fueling station throughput over the station life. *For example, 10,000 gallons of gasoline equivalent.*
2. Determine vehicle class and type likely to fuel at the station. *For example, a light duty CNG vehicle.*
3. Refer to Table 2: AB 1007 Full Fuel Cycle Analysis-based Carbon Intensity Well-to-Wheels values for 2012 of fuel carbon intensities derived from the AB 1007 Full Fuel Cycle Analysis for the vehicle technology and class. Identify fuel type and pathway for the project and select the applicable carbon intensity. *(67.7 grams CO2e/MJ)*
4. Convert the gasoline gallon equivalent production facility volume to Btu energy units (use 112,500 Btu/gallon for gasoline and 127,500 Btu/gallon for diesel)

10,000 gge x 112,500 = 1.125 billion gge

5. Convert the gasoline gallon equivalent to joules. Multiply Btus calculated in step 4 to joules by multiplying with a factor of 961. Divide the joules obtained by 1,000,000 to get megajoules (MJ) of energy throughput.

   1.125 billion Btu x 961/1,000,000 = 1.08 million MJ

6. Multiply the WTW fuel carbon intensity by the energy throughput to determine the carbon emissions in grams. Divide result by 1,000,000 to convert MJ to metric tons.

   1.08 million MJ x 67.7 grams CO2e/MJ divided by 1,000,000 = 73.12 metric tons

7. Determine the GHG associated with the displaced gasoline.

8. Convert the displaced gasoline volume to energy to energy units (Btus)

   10,000 gge x 112500 = 1.125 billion gge

9. Convert the energy units to MJ by the procedure in Step 5

   1.125 billion gge x 961/1000000 = 1.08 million MJ

10. Multiply the displaced gasoline energy units by the gasoline carbon intensity in the table (93.8 grams CO2e/MJ)

    1.08 million MJ x 93.8 grams CO2e/MJ = 101.3 million grams CO2e

11. Convert the gasoline GHG emissions to metric tons by dividing by 1,000,000.

    101.3 million grams CO2e/1,000,000 = 101.3 metric tons

12. Subtract the results in 6 from the results in 11.

    Fueling Station Project GHG Benefit: 101.3 metric tons – 73.12 metric tons = 28.18 metric tons.

Steps for estimating the fueling station WTW GHG performance with predominant demand from heavy duty vehicles:

1. Determine alternative fuel type and refer to Table 2 for the fuel carbon intensity.

2. Follow the steps in for a fueling station with predominant demand from light duty vehicles in the previous section.

3. Determine the benefits compared to diesel fuel the default fuel, for heavy-duty vehicles.

Step 3: Choose petroleum fuel (gasoline or diesel) and vehicle technology

Step 1: Choose alternative fuel and technology.

Figure A-1. LDA Vehicle Class: All Model Years (Gasoline, E10, Diesel, LPG and CNG)

Scenario Year 2012: LDA Vehicle Class: All Model Years (blend)

WTT Case ID		**G1**	**G1**	**G1**	**G1/e2**	**G15**	**G15**	**G0**	**E10**	**E10**	**D2**	**P1**	**P2**	**C1**	**C2**
WTT Description		RFG, Marginal	RFG, Marginal	RFG, Marginal	Electricity, NG/RPS, Night	RFG, Tar Sands	RFG, Tar Sands	RFG, 0 Oxygen	E10, Corn, MW EtOH	E10, Corn, MW EtOH	Diesel, CA ULSD	LPG, Petroleum	LPG, Natural Gas	CNG, NA Natural Gas	CNG, LNG, Remote NG
Vehicle Type		G Av ICE	G FFV	G HEV	PHEV	G new	G HEV	G new	G new	G HEV	ULSD	LPG	LPG	CNG	CNG
Vehicle Technology		ICEV	FFV	HEV	PHEV	ICEV	HEV	ICEV	ICEV	HEV	ICEV	ICEV	ICEV	ICEV	ICEV
Fossil	MJ/mi	6.27	6.27	4.65	3.38	7.08	5.25	6.37	6.19	4.59	4.89	5.68	5.49	5.46	6.02
Petroleum	MJ/mi	5.52	5.52	4.09	2.21	5.59	4.14	5.72	5.36	3.97	4.47	5.23	0.08	0.02	0.07
Natural Gas	MJ/mi	0.74	0.74	0.55	1.17	1.25	0.93	0.65	0.80	0.60	0.42	0.45	5.39	5.44	5.96
Coal	MJ/mi	0.02	0.02	0.01	0.01	0.25	0.18	0.00	0.03	0.02	0.00	0.00	0.02	0.00	0.00
Non Fossil	MJ/mi	0.21	0.21	0.16	0.20	0.03	0.02	0.01	0.37	0.27	0.01	0.02	0.00	0.03	0.00
WTT	MJ/mi	1.43	1.43	1.06	1.07	2.06	1.52	1.32	1.51	1.12	0.85	0.79	0.59	0.58	1.12
TTW	MJ/mi	5.05	5.05	3.74	2.51	5.05	3.74	5.05	5.05	3.74	4.04	4.91	4.91	4.91	4.91
GHGs (weighted)															
WTT	g/mi	96	96	71	92	166	123	100	93	69	67	63	54	51	100
TTW	g/mi	377	377	282	153	377	282	377	377	282	309	326	326	280	280
TOTAL	g/mi	473	473	353	245	543	405	477	470	350	375	389	380	331	380
Criteria, Total															
VOC	g/mi	0.394	0.351	0.333	0.042	0.341	0.326	0.345	0.356	0.337	0.220	0.621	0.472	0.176	0.183
CO	g/mi	3.004	2.750	2.719	0.192	2.716	2.693	2.719	2.774	2.736	0.823	2.700	2.701	2.674	2.714
NOx				0.460	0.142	0.408	0.360	0.524	0.557	0.471	1.685	0.359	0.411	0.254	0.577
PM10				0.533	0.336	0.835	0.705	0.550	0.644	0.563	1.548	0.397	0.409	0.349	0.450
Criteria															
VOC				0.300	0.019	---	---	0.306	0.307	0.300	0.191	0.590			
CO	g/mi	2.885	2.631	2.631	0.138	---	---	2.631	2.632	2.631	0.758	2.632			
NOx	g/mi	0.248	0.234	0.231	0.014	---	---	0.233	0.235	0.232	1.467	0.235			
PM10 (x10)	g/mi	0.338	0.337	0.336	0.227	---	---	0.337	0.337	0.336	1.388	0.336			
Urban Toxics, (weighted)															
Benzene	g/mi	2.8E-02	2.3E-02	2.3E-02	1.1E-03	---	---	2.3E-02	2.3E-02	2.3E-02	1.7E-02	3.1E-05	5.4E-05	1.0E-04	1.0E-04
1-3 Butadiene	g/mi	3.1E-02	2.6E-02	2.6E-02	8.4E-04	---	---	2.6E-02	2.6E-02	2.6E-02	9.5E-03	1.7E-05	1.5E-04	2.5E-04	2.6E-04
Formaldehyde	g/mi	2.9E-03	2.2E-03	2.2E-03	4.5E-04	---	---	2.2E-03	2.2E-03	2.2E-03	2.6E-02	2.2E-03	2.2E-03	2.8E-03	2.8E-03
Acetaldehyde	g/mi	3.0E-04	2.2E-04	2.2E-04	2.4E-05	---	---	2.2E-04	2.2E-04	2.2E-04	5.8E-03	2.2E-04	2.3E-04	2.5E-04	2.5E-04
Diesel PM	g/mi	2.3E-02	2.3E-02	1.7E-02	9.3E-03	---	---	2.0E-02	2.6E-02	1.9E-02	5.7E+00	7.3E-03	5.1E-02	0.0E+00	1.7E-02

Step 4: Choose petroleum fuel and vehicle grams per mile GHG performance.

Step 2: Choose alternative fuel and vehicle grams per mile GHG performance

Table 2: AB 1007 Full Fuel Cycle Analysis-based Carbon Intensity Well-to-Wheels values for 2012.

Table for Fuel Production and Fueling Station Projects

This table is developed based on the California Energy Commission's "Full Fuel cycle Assessment: Well-To-Wheels Energy Inputs, Emissions, and Water Impacts", CEC-600-2007-004-Rev.
Life cycle carbon intensity values are estimated from the AB 1007 FFCA using CA-GREET 1.7. These values may be updated.
Note: There will be differences in the sample numbers reported by the Air Resources Board because ARB is using GREET 1.8 and they have updated some data values. Also the ARB's data is not as extensive as the AB 1007 FFCA.

Step 2: Identify Vehicle Class and Type likely to fuel at station or use fuel from production facility.

Step 3: Select WTW Carbon Intensity Value.

2012

Light Duty Vehicles (Mid-size Passenger Vehicles)

Fuel	**Feedstock**	**Feedstock Origin**	**Processing Characteristic**	Veh. Technology Type	WTW (gm/MJ) Adjusted
Gasoline	RFG, Marginal	Crude Oil, SE Asia	Refining/Catalytic Cracking	Gas Ave. ICEV	93.8
	RFG, Marginal	Crude Oil, CA Mix	Refining/Catalytic Cracking	Gas FFV	94.6
	RFG, Marginal	Crude Oil, VZ	Refining/Catalytic Cracking	Gas HEV	66.2
	Electricity, NG/RPS, Night	North American NG, W	NG Processing	PHEV	42.4
	RFG, Tar Sands	Tar Sands, Canada	Refining/Catalytic Cracking	Gas New ICEV	106.6
	RFG, Tar Sands	Tar Sands, Canada	Refining/Catalytic Cracking	Gas HEV	108.3
	RFG, 0 Oxygen	Crude Oil, SE Asia	Refining/Catalytic Cracking	Gas ICEV	94.6
	E10, Corn, MW EtOH	Crude Oil, SE Asia	Refining/Catalytic Cracking	Gas New ICEV	93.1
	E10, Corn, MW EtOH	Crude Oil, VZ	Refining/Catalytic Cracking	Gas HEV	93.8
Diesel	Diesel, CA ULSD	Crude Oil, VZ	Refining/Catalytic Cracking	ULSD ICEV	93.1
LPG	LPG, Petroleum	Crude Oil, VZ	Refining/Catalytic Cracking	LPG ICEV	79.4
	LPG, Natural Gas	North American NG	NG Processing	LPG ICEV	77.6
CNG	CNG, NA Natural Gas	North American NG	NG Processing	CNG ICEV	67.7
	CNG, LNG, Remote NG	Remote LNG	NG Processing	CNG ICEV	77.6
Electricity	Electricity, NG/RPS	North America	NG w/ renewables	BEV	27.6
	Electricity, NG/RPS, Night	California	NG w/ renewables	BEV	27.4
	Electricity, CA NG SCCT	California	NG Single Cycle Combustion	BEV	57.8
	Electricity, Coal IGCC, CCS	North America/Nevada	Coal IGCC w/ CCS	BEV	16.2
	Electricity, Woody Biomass	U.S.	Combustion/gasification	BEV	3.9
	Electricity, Nuclear	North America	Nuclear Fission	BEV	0.7
	Electricity, NG/RPS	North American NG, Sc	NG w/ renewables	PHEV	56.8
	Electricity, NG/RPS, Night	North American NG, Sc	NG w/ renewables	PHEV	56.5

	Electricity, CA NG SCCT	North American NG	NG Single Cycle Combustion	PHEV	97.1
	Electricity, Coal IGCC, CCS	North America/Nevada	Coal IGCC, CCS	PHEV	41.6
	Electricity, Woody Biomass	California	Combustion/gasification	PHEV	25.2
	Electricity, Nuclear	North America	Nuclear Fission	PHEV	20.9
Hydrogen	H2, NG SR, LH2	North American NG	Steam Methane Reforming (SM	H2 ICEV	108.7
	H2, NG SR, LH2	North American NG	Steam Methane Reforming (SM	H2 FCV	40.2
	H2, NG SR, LH2, Ren Power	North American NG	Steam Methane Reforming (SM	H2 FCV	23.1
	H2, Coal, Sequestration	North American Coal	Gas Synthesis w/ CCS	H2 FCV	12.6
	H2, NG SR, Pipeline	North American Coal	Steam Methane Reforming (SM	H2 FCV	26.1
	H2, Biomass, Pipeline	North American NG	Combustion/gasification	H2 FCV	5.3
	H2, Onsite NG SR	North American NG	Steam Methane Reforming (SM	H2 FCV	25.9
	H2, Onsite NG SR, Ren Power	North American NG	Steam Methane Reforming (SM	H2 FCV	22.2
	H2, Grid Electrolysis	North American NG	Electrolysis	H2 FCV	41.7
	H2, 70% Renewable, Electrolysis	California	SMR, Ren Power	H2 FCV	21.0
Ethanol	Ethanol, Corn, MW Ave	U.S. Midwest	Cellulose conversion	E85 FFV	82.7
	Ethanol, Corn, MW Coal	U.S. Midwest	Cellulose conversion	E85 FFV	111.5
	Ethanol, Corn, MW NG	U.S. Midwest	Gasification Fermentation	E85 FFV	76.8
	Ethanol, Corn, MW NG, Wet Feed	U.S. Midwest	Starch fermentation	E85 FFV	70.1
	Ethanol, CA Corn, Wet Feed	U.S. Midwest	Starch fermentation	E85 FFV	62.3
	Ethanol, Brazil Sugar Cane	Brazil	Cellulose conversion	E85 FFV	31.1
	Ethanol, CA Poplar, Cellulose	California	Cellulose conversion	E85 FFV	27.5
	Ethanol, CA Switch Grass	California	Cellulose conversion	E85 FFV	40.5
Diesel	Diesel, CA ULSD	Crude Oil, SE Asia	Refining/Catalytic Cracking	ULSD ICEV	92.8
	E-Diesel, Ave. MW EtOH	U.S. Midwest	Fermentation	ULSD ICEV	94.3
Biodiesel/F	BD, Canola	California/Canada	Transesterification	BD 20 ICEV	26.1
	BD, MW SoyBean	U.S. Midwest	Transesterification	BD 20 ICEV	33.2
	BD, CA Mustard	California	Transesterification	BD 20 ICEV	40.3
NERD	Ren. Diesel Canola	California/Canada	Thermal Cracking	FTD 30 ICEV	30.3
	Ren. Diesel Palm Oil	Malaysia	Thermal Cracking	FTD 30 ICEV	33.6
XTLs	GTL, Remote NG	Persian Gulf	SR, FT Desal	FTD 30 ICEV	96.9
	BTL, CA Poplar	California	Cellulose conversion	FTD 30 ICEV	67.8
	CTL, Coal CCS	North America/Nevada	Gasification, Synthesis	FTD 30 ICEV	97.0

Heavy-duty Vehicles (Urban Buses)

2012					
Diesel	Diesel, CA ULSD	Crude Oil, CA Mix	Refining/Catalytic Cracking	ULSD ICEV	91.0
	Diesel, CA ULSD	Crude Oil, CA Mix	Refining/Catalytic Cracking	ULSD ICEV/HEV	91.1

	E-Diesel, Ave. MW EtOH	U.S. Midwest	Refining/Catalytic Cracking	ULSD ICEV	92.5
	E-Diesel, Ave. MW EtOH	U.S. Midwest	Refining/Catalytic Cracking	ULSD ICEV/HEV	92.6
Biodiesel	BD, Canola	California/Canada	Transesterification	BD 20 ICEV	24.3
	BD, MW SoyBean	U.S. Midwest	Transesterification	BD 20 ICEV	31.4
	BD, CA Mustard	California	Transesterification	BD 20 ICEV	38.5
	Ren. Diesel Canola	California/Canada	Thermal Cracking	FTD 30 ICEV	28.5
	Ren. Diesel Palm Oil	Malaysian Palm Oil	Thermal Cracking	FTD 30 ICEV	31.8
XTLs	GTL, Remote NG	Persian Gulf	SR, FT Desal	FTD 30 ICEV	95.1
	GTL, Remote NG	Persian Gulf	SR, FT Desal	FTD 30 ICEV	92.8
	BTL, CA Poplar	California	SR, FT	FTD 30 ICEV	66.0
	BTL, CA Poplar	California	SR, FT Desal	FTD 30 ICEV	63.7
	CTL, Coal CCS	North America/Nevada	Gasification, Synthesis	FTD 30 ICEV	95.1
	CTL, Coal CCS	North America/Nevada	Gasification, Synthesis	FTD 30 ICEV	92.8
CNG	CNG, NA Natural Gas	North American NG	NG Processing	CNG ICEV	66.1
	CNG, LNG, Remote NG	California	NG Processing	CNG/LNG ICEV	76.0
LNG	LNG, Remote NG	Persian Gulf	Liquefaction	LNG ICEV	76.7
	LNG, Pipeline Liquefier	North American NG	Liquefaction	LNG ICEV	73.0
DME	DME, Remote NG	Persian Gulf	SR, Synthesis	DME ICEV	93.4
	DME, CA Poplar	California	Solvent extraction	DME ICEV	5.8
	DME, Coal CCS	North America/Nevada	Gas Synthesis w/ CCS	DME ICEV	96.7
Methanol	Methanol, Remote NG	Persian Gulf	SR, Synthesis	MeOH FCV	39.0
	Methanol, CA Poplar	California	Gasification, Synthesis	MeOH FCV	2.1
	Methanol, Coal CCS	North America/Nevada	Gasification, Synthesis	MeOH FCV	39.4
Hydrogen	H2, NG SR, LH2	North American NG	Steam Methane Reforming (SM	H2 FCV	64.3
	H2, NG SR, LH2, Ren Power	North American NG, Sc	SMR, Ren Power	H2 FCV	36.9
	H2, Coal, Sequestration	North America/Nevada	Gas Synthesis w/ CCS	H2 FCV	20.1
	H2, Onsite NG SR	North American NG	SMR	H2 FCV	41.4
	H2, 70% Renewable, Electrolysis	North American NG, Sc	SMR, Ren Power	H2 FCV	33.7