URS

Memorandum

Date: June 19, 2012

To: Mr. Matthew Slowik, Senior Associate Planner, San Bernardino County
385 North Arrowhead Avenue, San Bernardino, CA 92415-0182

From: Mr. Matt Dunn, Principal Engineer, URS Corporation
130 Robin Hill Road, Suite 100, Santa Barbara, CA 93117

Subject: **Greenhouse Gas Emissions from the Proposed Agincourt Solar Project, San Bernardino County, California**

1.0 INTRODUCTION

Agincourt Solar, LLC (Applicant) proposes to construct a 10-megawatt (MW) solar energy generation project (Project) on approximately 79 acres of land in San Bernardino County, approximately 24 miles east of Apple Valley. Construction is estimated to start in 2013 and would take approximately eight months to complete. URS quantified greenhouse gas (GHG) emissions resulting from the construction and operation of the Project using construction and operational data provided by project Applicant's engineer, Lincoln Renewable Energy, LLC (LRE). Emission factors and other data are from the CalEEMod California Emissions Estimator Model (successor to planning level emissions estimating software, URBEMIS). This software was used as the GHG quantification tool for this project. LRE estimated project construction activities would occur over an eight month period, while the operational project life is estimated at 30 years. The total project-related average annual GHG emissions from this project were determined to not exceed 3,000 $MTCO_2e$ (metric tons carbon dioxide equivalent) per year. These project GHG emissions are consistent with the County of San Bernardino's September 2011 *Green House Gas Reduction Plan* and would present a less than significant impact for GHG emission.

2.0 METHODOLOGY AND ASSUMPTIONS FOR CONSTRUCTION

2.1 CONSTRUCTION SCHEDULE

The project's construction schedule assumes 10-hour work days and 5 work days per week for the first month with 6 work days per week for months 2 through 8.

2.2 EMISSION FACTORS

Emission factors for off-site emissions from on-road travel (via public highways to the site access) were calculated in California Emissions Estimator Model™ (CalEEMod version 2011.1.1). This software program calculates on-road vehicle emissions based on emission factors from California

specific highway emissions database, the latest version of the California EMission FACtor model (EMFAC2007). Emissions from personal vehicles for worker and vendor commuting, and from trucks for material hauling are based on the number of trips and vehicle miles traveled (VMT) along with emission factors from EMFAC2007. Emissions from mobile sources were calculated by CalEEMod as follows:

$$Emissions_{pollutant} = VMT * EF_{running,pollutant}$$

Where:

$Emissions_{pollutant}$ = emissions (CO_2) from vehicle running for each pollutant
VMT = vehicle miles traveled
$EF_{running,pollutant}$ = emission factor for running emissions

The model was run with the calendar year 2013 selected as the construction and first operational year. Subsequent operational emissions were assumed the same as the first year, this is conservative since 2013 would be less efficient for highway vehicles (more GHG) than subsequent years. The vehicle class selected for worker personal vehicles was a mix of the following categories: Light Duty Auto (LDA), Light duty truck 1 (LDT1), and Light duty Truck 2 (LDT2). The vehicle class for vendors and construction material hauling were selected as Heavy Heavy Duty Diesel Truck (HHDT) to represent offsite travel.

Emission factors for on-site diesel construction equipment were calculated in CalEEMod; the software program calculates the exhaust emissions based on California Air Resources Board (ARB) OFFROAD2007 methodology using the equation presented below.

$$Emission_{DieselEx} = \Sigma_i (EFi = x\ Pop_i\ x\ AvgHp_i\ x\ Load_i\ x\ Activity_i)$$

Where:

EF = Emission factor in grams per horsepower-hour (g/bhp-hr) as processed from OFFROAD2007
Pop = Population, or the number of pieces of equipment
$AvgHp$ = Maximum rated average horsepower
$Load$ = Load factor
$Activity$ = Hours of operation
i = equipment type

The software calculates the exhaust emission factors for each piece of equipment at each horsepower range by back calculating from total daily emissions reported in the model output files using the following formula:

$$Emission\ Factor\ \left[\frac{g}{hphr}\right] = \frac{Total\ Daily\ Exhaust}{Activity\ x\ AvgHP\ x\ LF\ x\ 907184.74}$$

Where:

Total Daily Exhaust = Total pollutant emissions [tons/day]
Activity = Total daily statewide usage of equipment [hours/day]
AvgHP = Average HP of equipment within the horsepower range [HP]
LF = Load Factor of equipment [unitless]
907,184.74 = Conversion factor from tons to grams

Total Daily Exhaust and Activity were obtained from OFFROAD2007 model output, while Avg HP and LF were obtained from input files to the model.

The model was run for calendar year 2013 in the Mojave Desert area of San Bernardino County. The construction activity is assumed to start in January 2013.

Carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O) are the known by-products from fuel combustion that are classified as GHGs. For diesel internal combustion, almost all of the GHG is from CO_2. Emissions of CH_4 and N_2O are multiplied by their Global Warming Potentials (GWP) to arrive at CO_2e. The GWPs applied were 21 for CH_4 and 310 for N_2O. (Typically, the emissions of CH_4 and N_2O are less than 1 percent of the total GHG for diesel internal combustion).

2.3 ON-SITE CONSTRUCTION ACTIVITY

Calculations of GHG emissions due to on-site construction activity were based on information provided by LRE regarding the type and quantity of construction equipment anticipated to operate on-site each month. All onsite construction equipment was assumed to be diesel-fueled. Table 1 details on-site construction equipment, including horsepower (HP). Utilization levels of equipment were preselected by default levels of CalEEMod; this information is based on historical data from ARB and South Coast Air Quality Management District (SCAQMD). Portable toilets are included in the truck visit data used, therefore, there are no sewage derived biological CO_2 emissions. During construction all electricity will be provided onsite by portable diesel fueled generators, therefore, there will be no electrical demand from the grid.

2.4 OFF-SITE TRAVEL DISTANCE

Travel distance assumed a distribution of passenger vehicles for workers commuting between greater Victorville area and the site. Table 2 presents the distribution for construction labor force and material deliveries. Some labor may come from Lucerne Valley but the calculations conservatively assume larger population centers for the craft labor. It was assumed that passenger vehicles for the construction work force transported an average of one passenger. This is conservative considering some workers may carpool. Emissions from passenger vehicles traveling

to and from the sites were based on estimated construction labor force per month as shown in Table 3.

Delivery trucks for material hauling reflect the transport of construction materials within San Bernardino County. For this project it was conservatively assumed that all construction or fabricated materials were produced outside of San Bernardino County and transported into San Bernardino County from Los Angeles County. Emissions from delivery trucks traveling to and from the sites were based upon off-site delivery activity shown in Table 4. Water supplied for construction will be purchased from a local purveyor at an assumed distance of 10 miles away from the project site. Emissions from water truck delivery to site were based on average off-site delivery trips shown in Table 4.

3.0 METHODOLOGY AND ASSUMPTIONS FOR OPERATIONS BASED GHG EMISSIONS

Operational phase emission calculations assumed the facility would be unmanned and several part time employees and security personnel would visit the site periodically. To provide a conservative analysis, the calculations assumed there would be 312 round trips to the site per year for security and part-time workers from the nearest population centers. Several times a year the employees or a contractor also would visit the site to wash the PV panels. It was conservatively assumed panel washing would require approximately 2 acre-feet of water per year. Based on an assumed use of 4,000 gallon diesel fueled water tankers, panel washing would require approximately 163 truckloads (326 truck trips) for delivery of this water. (Note: the number of assumed truck loads used in this analysis is somewhat greater than estimated in the general project description and thus represents a conservative approach for estimating Project-related GHG emissions.) Water used for panel washing would be purchased from a local purveyor at an assumed distance of 10 miles away from the project site. Fifty percent of the workforce for the operational phase was assumed to commute to the site from Apple Valley, and the remaining 50 percent from Victorville. The emissions associated with water supply (i.e., pumping) were calculated in CalEEMod based on the conservative use of 2 acre-feet per year.

Electrical components such as switch gear are assumed to have *de minimis* amounts of the greenhouse gas, sulfur hexafluoride (SF_6). The SF_6 gas leakage from components is assumed to be less than 1 $MTCO_2e$ per year.

It was assumed that the plant would generate 24.6 Gigawatt-hours (GWh) of electricity beginning in year 1 of operation, declining by 0.5 percent annually thereafter. Estimated electricity production from the Project was based upon meteorological data for the project site using computer-based solar energy generation models, assuming typical energy conversion efficiency parameters. Annual electricity generation was used to calculate the amount of air emissions avoided by the project through the generation of renewable energy and displacement of grid-supplied electricity. GHG emission avoidance from operation of the project assumed that renewable solar energy was

displacing typical California grid-supplied electricity. The GHG emissions of this electricity correspond to the emission factors of the Western Electricity Coordinating Council (WECC) California subregion of the Emissions and Generation Resource Integrated Database (eGRID 2012). The avoided emissions are approximately 7,000 $MTCO_2e$/year from this project. The annual mass of GHG avoided (a sink) is not accounted for in the GHG calculations conducted for this project for comparison to GHG significance threshold of San Bernardino County. The analysis therefore presents a conservative estimate of Project-related GHG emissions.

4.0 RESULTS AND CONCLUSIONS

Table 5 shows total greenhouse gas emissions from the construction phase and operation phase of the project. In calculating the emissions from projects within the sample population, construction period GHG emissions were divided over 30-years (the average economic life of a development project) to comply with the San Bernardino County Greenhouse Gas Emissions Reduction Plan. This table also presents the San Bernardino County threshold of significance.

Results from the GHG analysis performed for the solar energy project show that construction and operation emissions over 30 years will be approximately 180 $MTCO_2e$ per year. This is far below San Bernardino County's significance threshold of 3,000 $MTCO_2e$ per year. Furthermore, Project operations would result in a net GHG benefit due to displacement of grid-supplied electrical energy and associated air emissions from traditional energy sources.

5.0 REFERENCES

CalEEMod. 2011. (version 2011.1.1) California Emissions Estimator Model. Available online at: http://www.caleemod.com

2007a. EMFAC 2007 (version 2.3) Motor Vehicle Emission Inventory Model. Available online at: http://www.arb.ca.gov/msei/onroad/latest_version.htm.

2006. OFFROAD 2007 (version 2.0.1.2) Emissions Model. Available online at: http://www.arb.ca.gov/msei/offroad/offroad.htm.

County of San Bernardino. Greenhouse Gas Emissions Reduction Plan. Dated September 2012. Available online at: http://www.sbcounty.gov/Uploads/lus/GreenhouseGas/FinalGHG.pdf

eGRID2012. 2012 (version 1.0 Year 2009) GHG Annual Output Emission Rates Available online at: http://epa.gov/cleanenergy/documents/egridzips/eGRID2012V1_0_year09_GHGOutputrates.pdf

TABLES

TABLE 1
ONSITE CONSTRUCTION EQUIPMENT (PIECES PER MONTH)
FOR AGINCOURT SOLAR

Equipment Type	Horsepower (HP)	Month 1	Month 2	Month 3	Month 4	Month 5	Month 6	Month 7	Month 8	Total
Grader	175	2	2	1	1	–	–	–	–	**6**
Excavator	175	1	1	2	2	2	2	1	–	**11**
Dozer	250	2	2	2	2	2	2	2	2	**16**
Compactor	120	1	1	2	2	2	2	2	2	**14**
Backhoe/Front End Loader	120	1	1	2	2	2	2	1	1	**12**
Hydraulic Mobile Crane	120	1	2	2	3	3	2	2	1	**16**
Rough Terrain Forklift	120	1	2	3	3	3	3	3	3	**21**
Crawler Trencher	175	1	1	2	2	2	2	1	1	**12**
Manlift	25	–	–	–	–	2	2	2	2	**8**
Pick Up Truck	150	8	8	10	12	12	12	10	8	**80**
Flatbed	220	2	2	3	4	4	4	3	1	**23**
Water Truck, 4,000 gal	220	3	3	3	3	3	3	3	3	**24**
Dump Truck (15cy)	275	2	2	2	–	–	–	–	–	**6**
Concrete Truck	250	–	1	2	2	–	–	1	1	**7**
Cargo Van (on-site transportation)	150	–	1	2	4	4	4	4	2	**21**
ATV with material body	18	6	8	10	10	10	10	10	8	**72**
Pier Driver	75	–	2	2	–	–	–	–	–	**4**
Air Compressor	30	1	1	1	1	1	1	1	1	**8**
Welding Machine	46	1	1	1	1	1	1	1	1	**8**
Water Pump	34	1	1	1	1	1	1	1	1	**8**
Diesel Generators	7	10	10	10	10	10	10	10	10	**80**
Total	–	**44**	**52**	**63**	**65**	**64**	**63**	**58**	**48**	**457**

TABLE 2
DISTRIBUTION OF TRAVEL FOR AGINCOURT SOLAR

	Victorville	Apple Valley	Los Angeles County
Commuters	50%	50%	0%
Construction Deliveries	0%	0%	100%

TABLE 3
CONSTRUCTION LABOR FORCE
(LABORERS PER MONTH WITH SUPERVISION)
FOR AGINCOURT SOLAR

	Month 1	Month 2	Month 3	Month 4	Month 5	Month 6	Month 7	Month 8
Working Hours Per Day	10	10	10	10	10	10	10	10
Working Days per Week	5	6	6	6	6	6	6	6
Workforce Estimates (No. of workers)	25	37	48	56	72	100	92	59

TABLE 4
OFF SITE CONSTRUCTION DELIVERY ACTIVITY (TRIPS PER MONTH)
FOR AGINCOURT SOLAR

Vehicle Type	Month 1	Month 2	Month 3	Month 4	Month 5	Month 6	Month 7	Month 8	Total
Material delivery Trucks[1]	40	192	288	192	144	96	96	96	1,144
Water Truck (average)[2]	814	814	814	814	814	814	814	814	6,516

1 Heavy Duty Diesel (80,000 lbs gross vehicle weight).

2 Assumed 4,000 gallon water trucks. Water used for dust control.

TABLE 5
AVERAGE ANNUAL GREENHOUSE GAS EMISSIONS
ALL SOURCES FOR AGINCOURT SOLAR 10 MW PROJECT

	Bio-CO_2[1]	**NBio-CO_2[1]**	**Total CO_2**	**CH_4**	**N_2O**	**CO_2e[2]**
Total Construction Emissions (MT)	0	4,832	4,832	0.5	0	4,842
Construction/30 years (MT/yr)[3]	–	–	–	–	–	**161.39**
Operational (MT/yr)[4]	0	18	18	0	0	**18**
Operational SF_6 gas (MT/yr)[5]	–	–	–	–	–	**1.00**
				Combined Annual Average (MT/yr)		**180**
				San Bernardino County Threshold (MT/yr)		3,000

[1] Biological derived = Bio-CO_2, Anthropogenic manmade CO2 = NBio-CO_2.

[2] Includes Global Warming Potential (GWP) for CH_4 and N_2O.

[3] Estimated construction emissions divided by project life.

[4] Operational is conservative based on conservative water usage.

[5] Assumed based on scaling of other solar projects and standard leakage rate.