

# Appendix F

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Energy Calculation Sheets

# Lindero Pump Station

Last Updated: 2/10/2022

Compression-Ignition Engine Brake-Specific Fuel Consumption (BSFC) Factors [1]:

HP: 0 to 100	0.0588	HP: Greater than 100	0.0529
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*Values above are expressed in gallons per horsepower-hour/BSFC.*

## CONSTRUCTION EQUIPMENT

Construction Equipment	#	Hours per		Load		Construction Phase	Fuel Used (gallons)
		Day	Horsepower	Factor			
Aerial Lifts	1	6	63	0.31		Demolition	103
Concrete/Industrial Saws	1	6	81	0.73		Demolition	313
Excavators	1	6	158	0.38		Demolition	286
Generator Sets	1	6	84	0.74		Demolition	329
Tractors/Loaders/Backhoes	1	6	97	0.37		Demolition	190
Aerial Lifts	1	6	63	0.31		Site Preparation Phase	103
Concrete/Industrial Saws	1	6	81	0.73		Site Preparation Phase	313
Generator Sets	1	6	84	0.74		Site Preparation Phase	329
Tractors/Loaders/Backhoes	1	6	97	0.37		Site Preparation Phase	190
Generator Sets	1	6	84	0.74		Grading Phase	219
Plate Compactors	1	6	8	0.43		Grading Phase	12
Rollers	1	6	80	0.38		Grading Phase	107
Sweepers/Scrubbers	1	6	64	0.46		Grading Phase	104
Tractors/Loaders/Backhoes	1	6	97	0.37		Grading Phase	127
Aerial Lifts	1	6	63	0.31		Building Construction Phase	1,033
Air Compressors	1	6	78	0.48		Building Construction Phase	1,980
Bore/Drill Rigs	1	6	221	0.5		Building Construction Phase	5,257
Cement and Mortar Mixers	1	6	9	0.56		Building Construction Phase	267
Concrete/Industrial Saws	1	6	81	0.73		Building Construction Phase	3,127
Cranes	1	4	231	0.29		Building Construction Phase	2,125
Excavators	1	6	158	0.38		Building Construction Phase	2,856
Forklifts	1	6	89	0.2		Building Construction Phase	941
Generator Sets	1	6	84	0.74		Building Construction Phase	3,288
Plate Compactors	1	6	8	0.43		Building Construction Phase	182
Pressure Washers	1	6	13	0.3		Building Construction Phase	206
Pumps	1	6	84	0.74		Building Construction Phase	3,288
Sweepers/Scrubbers	1	6	64	0.46		Building Construction Phase	1,557
Tractors/Loaders/Backhoes	1	6	97	0.37		Building Construction Phase	1,898
Trenchers	1	6	78	0.5		Building Construction Phase	2,063
Welders	1	6	46	0.45		Building Construction Phase	1,095
Concrete/Industrial Saws	1	6	81	0.73		Paving	313
Generator Sets	1	6	84	0.74		Paving	329
Pavers	1	6	130	0.42		Paving	260
Paving Equipment	1	6	132	0.36		Paving	226
Plate Compactors	1	6	8	0.43		Paving	18
Rollers	1	6	80	0.38		Paving	161
Rubber Tired Loaders	1	6	203	0.36		Paving	348
Surfacing Equipment	1	6	263	0.3		Paving	375
Sweepers/Scrubbers	1	6	64	0.46		Paving	156
Tractors/Loaders/Backhoes	1	6	97	0.37		Paving	190
Aerial Lifts	1	6	63	0.31		Architectural Coating Phase	103
Generator Sets	1	6	84	0.74		Architectural Coating Phase	329
Pressure Washers	1	6	13	0.3		Architectural Coating Phase	21
<b>Total Fuel Used</b>							<b>36,713</b>
							(Gallons)

Construction Phase	Days of Operation
Demolition	15
Site Preparation Phase	15
Grading Phase	10

Building Construction Phase	150
Paving	15
Architectural Coating Phase	15
<b>Total Days</b>	<b>205</b>

**WORKER TRIPS**

Constuction Phase	MPG [2]	Trips	Trip Length (miles)	Fuel Used (gallons)
Demolition	24.1	13	10.8	87
Site Preparation Phase	24.1	10	10.8	67
Grading Phase	24.1	13	10.8	58
Building Construction Phase	24.1	12	10.8	807
Paving	24.1	25	10.8	168
Architectural Coating Phase	24.1	2	10.8	13
<b>Total</b>				<b>1,201</b>

**HAULING AND VENDOR TRIPS**

Trip Class	MPG [2]	Trips	Trip Length (miles)	Fuel Used (gallons)
<b>HAULING TRIPS</b>				
Demolition	7.5	20	20.0	53
Site Preparation Phase	7.5	0	20.0	0
Grading Phase	7.5	250	20.0	667
Building Construction Phase	7.5	0	20.0	0
Paving	7.5	0	20.0	0
Architectural Coating Phase	7.5	0	20.0	0
<b>Total</b>				<b>720</b>

**VENDOR TRIPS**

Demolition	7.5	0	7.3	0
Site Preparation Phase	7.5	0	7.3	0
Grading Phase	7.5	0	7.3	0
Building Construction Phase	7.5	5	7.3	730
Paving	7.5	0	7.3	0
Architectural Coating Phase	7.5	0	7.3	0
<b>Total</b>				<b>730</b>

<b>Total Gasoline Consumption (gallons)</b>	<b>1,201</b>
<b>Total Diesel Consumption (gallons)</b>	<b>38,163</b>

**Sources:**

- [1] United States Environmental Protection Agency. 2021. *Exhaust and Crankcase Emission Factors for Nonroad Compression-Ignition Engines in MOVES3.0.2*. September. Available at: <https://www.epa.gov/system/files/documents/2021-08/420r21021.pdf>.
- [2] United States Department of Transportation, Bureau of Transportation Statistics. 2021. *National Transportation Statistics*. Available at: <https://www.bts.gov/topics/national-transportation-statistics>.

Equipment	Horsepower	Load Factor
Aerial Lifts	63	0.31
Air Compressors	78	0.48
Bore/Drill Rigs	221	0.5
Cement and Mortar Mixers	9	0.56
Concrete/Industrial Saws	81	0.73
Cranes	231	0.29
Crawler Tractors	212	0.43
Crushing/Proc. Equipment	85	0.78
Dumpers/Tenders	16	0.38
Excavators	158	0.38
Forklifts	89	0.2
Generator Sets	84	0.74
Graders	187	0.41
Off-Highway Tractors	124	0.44
Off-Highway Trucks	402	0.38
Other Construction Equipment	172	0.42
Other General Industrial Equipment	88	0.34
Other Material Handling Equipment	168	0.4
Pavers	130	0.42
Paving Equipment	132	0.36
Plate Compactors	8	0.43
Pressure Washers	13	0.3
Pumps	84	0.74
Rollers	80	0.38
Rough Terrain Forklifts	100	0.4
Rubber Tired Dozers	247	0.4
Rubber Tired Loaders	203	0.36
Scrapers	367	0.48
Signal Boards	6	0.82
Skid Steer Loaders	65	0.37
Surfacing Equipment	263	0.3
Sweepers/Scrubbers	64	0.46
Tractors/Loaders/Backhoes	97	0.37
Trenchers	78	0.5
Welders	46	0.45

# Energy Unit Conversion Sheet

## Gasoline

Gallons (gal.)

**2,148.17**

Barrels (bbl.)

**1.00**

Btu

**1.00**

2148.17 gal.  
2.15 Thousand gallons  
0.00 Million gallons  
51.15 bbl.  
0.05 Thousand bbl.  
0.00 Million bbl.  
2536.62 U.S. Therms  
235839351.14 British thermal units (Btu)  
235.84 Million Btu (MMBtu)

42.00 gal.  
0.04 Thousand gallons  
0.00 Million gallons  
1.00 bbl.  
0.00 Thousand bbl.  
0.00 Million bbl.  
49.59 U.S. Therms  
4611019.83 British thermal units (Btu)  
4.61 Million Btu (MMBtu)

0.00 gal.  
0.00 Thousand gallons  
0.00 Million gallons  
0.02 bbl.  
0.00 Thousand bbl.  
0.00 Million bbl.  
0.00 U.S. Therms  
1.00 British thermal units (Btu)  
0.00 Million Btu (MMBtu)

## Diesel

Gallons (gal.)

**4,010.00**

Barrels (bbl.)

**1.00**

Btu

**1.00**

4,010.00 gal.  
4.01 Thousand gallons  
0.00 Million gallons  
95.48 bbl.  
0.10 Thousand bbl.  
0.00 Million bbl.  
5,497.39 U.S. Therms  
511,114,600.00 British thermal units (Btu)  
511.11 Million Btu (MMBtu)

42.00 gal.  
0.04 Thousand gallons  
0.00 Million gallons  
1.00 bbl.  
0.00 Thousand bbl.  
0.00 Million bbl.  
57.58 U.S. Therms  
5,353,320.00 British thermal units (Btu)  
5.35 Million Btu (MMBtu)

0.00 gal.  
0.00 Thousand gallons  
0.00 Million gallons  
0.02 bbl.  
0.00 Thousand bbl.  
0.00 Million bbl.  
0.00 U.S. Therms  
1.00 British thermal units (Btu)  
0.00 Million Btu (MMBtu)

## Electricity

Kilowatt-Hours (kWh)

**1,974,179.00**

U.S. Therm

**1.00**

Btu

**1.00**

1,974,179.00 Kilowatt-Hours  
1,974.18 Megawatt-Hours  
1.97 Gigawatt-Hours  
72,449.27 U.S. Therms  
6,735,898,748.00 British thermal units (Btu)  
6,735.90 Million Btu (MMBtu)

27.25 Kilowatt-Hours  
0.03 Megawatt-Hours  
0.00 Gigawatt-Hours  
1.00 U.S. Therms  
92,974.00 British thermal units (Btu)  
0.09 Million Btu (MMBtu)

0.00 Kilowatt-Hours  
0.00 Megawatt-Hours  
0.00 Gigawatt-Hours  
0.00 U.S. Therms  
1.00 British thermal units (Btu)  
0.00 Million Btu (MMBtu)

## Natural Gas

Thousand Cubic Feet (Mcf)

**1.00**

U.S. Therm

**1.00**

Btu

**1.00**

1,000.00 Cubic Feet (cf)  
1.00 Thousand Cubic Feet (Mcf)  
0.00 Million Cubic Feet (MMcf)  
11.15 U.S. Therms  
1,037,000.00 British thermal units (Btu)  
1.04 Million Btu (MMBtu)

89.66 Cubic Feet (cf)  
0.09 Thousand Cubic Feet (Mcf)  
0.00 Million Cubic Feet (MMcf)  
1.00 U.S. Therms  
92,974.00 British thermal units (Btu)  
0.09 Million Btu (MMBtu)

0.00 Cubic Feet (cf)  
0.00 Thousand Cubic Feet (Mcf)  
0.00 Million Cubic Feet (MMcf)  
0.00 U.S. Therms  
1.00 British thermal units (Btu)  
0.00 Million Btu (MMBtu)

### Sources:

U.S. Energy Information Administration (EIA). May 2017. "Frequently Asked Questions: What are Ccf, Mcf, Btu, and therms? How do I convert natural gas prices in dollars per Ccf or Mcf to dollars per Btu or therm?" <https://www.eia.gov/tools/faqs/faq.php?id=45&t=8>. (accessed February 5, 2018).

Schrepf, Gordon. 2017. Senior Fuels Specialist, California Energy Commission. Personal communication via phone and email regarding fuel consumption in California by County and by source with Lance Park, Associate Planner, Rincon Consultants, Inc. August 22, 2017.

Table 1: California Transportation Energy Use During 2013<sup>1</sup>

	Fuel		Diesel	Biodiesel	Renewable		Natural Gas	Electricity	Totals
	Gasoline	Ethanol	Fuel		Diesel	Propane	Gas		
	MM Gallons	MM Gallons	MM Gallons	MM Gallons	MM Gallons	MM Gallons	MM Therms	Mwhs	
BTUs <sup>2</sup>	13,079.4	1,460.9	3,293.7	49.0	135.8	35.0	174.4	841,346	
MM GGE Units	113,927	76,330	129,488	119,550	122,887	84,250	92,974	3,412,000	
	13,079.4	978.8	3,743.6	51.4	146.5	25.9	142.3	25.2	18,192.9

Source: California Energy Commission

1. Excludes fuel consumed for aviation and most marine vessel activities.

2. Units are in Btus per gallon, except for natural gas (Btus/therm) and electricity (Btus/Mwh).

**2016 CA GREET 2.0 Value**

**1) Specifications of Fuels**

Fuel	Heating Value Calculation: LHV
<b>Liquid Fuels:</b>	<b>Btu/gal</b>
Crude oil	129,670
Synthetic crude oil (SCO)	135,085
Dilbit	145,313
Diluent	128,449
Gasoline blendstock	116,090
CARBOB	113,300
Gasoline	112,194
CA gasoline	109,786
U.S. conventional diesel	128,450
CA conventional diesel	127,460
Diesel for non-road engines	128,450
Low-sulfur diesel	127,460
Petroleum naphtha	116,920
Conventional Jet Fuel	124,307
ULS Jet Fuel	123,041
NG-based FT naphtha	111,520
Residual oil	140,353
Bunker fuel for ocean tanker	140,353
Methanol	57,250
Ethanol	76,330
Butanol	99,837
Acetone	83,127
E-Diesel Additives	116,090
Liquefied petroleum gas (LPG)	84,950
Liquefied natural gas (LNG)	74,720
Dimethyl ether (DME)	68,930
Dimethoxy methane (DMM)	72,200
Methyl ester (biodiesel, BD)	119,550
Fischer-Tropsch diesel (FTD)	123,670
Renewable Diesel I (SuperCetane)	117,059
Renewable Diesel II (UOP-HDO)	122,887
Renewable Diesel III (PNNL-HTL)	123,542
Renewable Gasoline	115,983
SPK (FT Jet Fuel/HRJ)	119,777
Liquid hydrogen	30,500
Methyl tertiary butyl ether (MTBE)	93,540
Ethyl tertiary butyl ether (ETBE)	96,720
Tertiary amyl methyl ether (TAME)	100,480
Butane	94,970
Isobutane	90,060
Isobutylene	95,720
Propane	84,250
Natural gas liquids	83,686
n-Hexane	105,125
Still gas (in refineries)	128,590
<b>Gaseous Fuels (at 32F and 1atm):</b>	<b>Btu/ft3</b>
Natural gas	983
Pure Methane	962
Gaseous hydrogen	290
Carbon Dioxide	
Still gas (in refineries)	982
<b>Solid Fuels:</b>	<b>Btu/ton</b>
Coal Mix for Electricity Generation	19,474,169
Bituminous coal	22,639,320
Subbituminous coal	16,085,444
Lignite coal	10,805,183
Synthetic coal	22,639,320
Waste coal	9,945,646
Pet Coke	26,949,429
Tire Derived Fuel	26,664,354
Coking coal	24,599,422
Willow	15,396,000
Poplar	15,929,000
Switchgrass	14,447,000
Miscanthus	15,342,000
Corn stover	14,716,000
Forest residue	17,289,000
Sugarcane straw	13,454,049
Sugarcane bagasse	12,381,771
Bio-char	18,916,911
Grain sorghum bagasse	12,781,599
Sweet sorghum bagasse	14,409,931
Forage sorghum bagasse	14,409,931
Municipal solid waste (defined by EISA)	11,209,639
Convertible municipal solid waste	14,155,275

California GREET 2.0 Fuel Specifications				
	LHV		HHV	
	Btu/gal	Btu/gal	Btu/gal	Btu/gal
CA gasoline	109,786		117,852	
Low-sulfur diesel	127,460		133,075	
	Btu/ft3		Btu/ft3	
Natural gas	983		1,089	

**Sources:**

U.S. Energy Information Administration [EIA]. May 2017. "Frequently Asked Questions: What are Ccf, Mcf, Btu, and therms? How do I convert natural gas prices in dollars per Ccf or Mcf to dollars per Btu or therms?" <https://www.eia.gov/tools/faqs/faq.php?id=45&t=8>. (accessed February 5, 2018).

Schremp, Gordon. 2017. Senior Fuels Specialist, California Energy Commission. Personal communication via phone and email regarding fuel consumption in California by County and by source with Lance Park, Associate Planner, Rincon Consultants, Inc. August 22, 2017.

# Energy Unit Conversion Sheet

## Gasoline

Gallons (gal.)	Barrels (bbl.)	Btu
<b>1.00</b>	<b>1.00</b>	<b>1.00</b>
1.00 gal. 0.00 Thousand gallons 0.00 Million gallons 0.02 bbl. 0.00 Thousand bbl. 0.00 Million bbl. 1.18 U.S. Therms 109786.19 British thermal units (Btu) 0.11 Million Btu (MMBtu)	42.00 gal. 0.04 Thousand gallons 0.00 Million gallons 1.00 bbl. 0.00 Thousand bbl. 0.00 Million bbl. 49.59 U.S. Therms 4611019.83 British thermal units (Btu) 4.61 Million Btu (MMBtu)	0.00 gal. 0.00 Thousand gallons 0.00 Million gallons 0.02 bbl. 0.00 Thousand bbl. 0.00 Million bbl. 0.00 U.S. Therms 1.00 British thermal units (Btu) 0.00 Million Btu (MMBtu)

## Diesel

Gallons (gal.)	Barrels (bbl.)	Btu
<b>3,820.00</b>	<b>1.00</b>	<b>1.00</b>
3,820.00 gal. 3.82 Thousand gallons 0.00 Million gallons 90.95 bbl. 0.09 Thousand bbl. 0.00 Million bbl. 5,236.92 U.S. Therms 486,897,200.00 British thermal units (Btu) 486.90 Million Btu (MMBtu)	42.00 gal. 0.04 Thousand gallons 0.00 Million gallons 1.00 bbl. 0.00 Thousand bbl. 0.00 Million bbl. 57.58 U.S. Therms 5,353,320.00 British thermal units (Btu) 5.35 Million Btu (MMBtu)	0.00 gal. 0.00 Thousand gallons 0.00 Million gallons 0.02 bbl. 0.00 Thousand bbl. 0.00 Million bbl. 0.00 U.S. Therms 1.00 British thermal units (Btu) 0.00 Million Btu (MMBtu)

## Electricity

Kilowatt-Hours (kWh)	U.S. Therm	Btu
<b>1.00</b>	<b>1.00</b>	<b>1.00</b>
1.00 Kilowatt-Hours 0.00 Megawatt-Hours 0.00 Gigawatt-Hours 0.04 U.S. Therms 3,412.00 British thermal units (Btu) 0.00 Million Btu (MMBtu)	27.25 Kilowatt-Hours 0.03 Megawatt-Hours 0.00 Gigawatt-Hours 1.00 U.S. Therms 92,974.00 British thermal units (Btu) 0.09 Million Btu (MMBtu)	0.00 Kilowatt-Hours 0.00 Megawatt-Hours 0.00 Gigawatt-Hours 0.00 U.S. Therms 1.00 British thermal units (Btu) 0.00 Million Btu (MMBtu)

## Natural Gas

Thousand Cubic Feet (Mcf)	U.S. Therm	Btu
<b>1.00</b>	<b>1.00</b>	<b>1.00</b>
1,000.00 Cubic Feet (cf) 1.00 Thousand Cubic Feet (Mcf) 0.00 Million Cubic Feet (MMcf) 11.15 U.S. Therms 1,037,000.00 British thermal units (Btu) 1.04 Million Btu (MMBtu)	89.66 Cubic Feet (cf) 0.09 Thousand Cubic Feet (Mcf) 0.00 Million Cubic Feet (MMcf) 1.00 U.S. Therms 92,974.00 British thermal units (Btu) 0.09 Million Btu (MMBtu)	0.00 Cubic Feet (cf) 0.00 Thousand Cubic Feet (Mcf) 0.00 Million Cubic Feet (MMcf) 0.00 U.S. Therms 1.00 British thermal units (Btu) 0.00 Million Btu (MMBtu)

**Sources:**

U.S. Energy Information Administration (EIA). May 2017. "Frequently Asked Questions: What are Ccf, Mcf, Btu, and therms? How do I convert natural gas prices in dollars per Ccf or Mcf to dollars per Btu or therm?" <https://www.eia.gov/tools/faqs/faq.php?id=45&t=8>. (accessed February 5, 2018).

Schremp, Gordon. 2017. Senior Fuels Specialist, California Energy Commission. Personal communication via phone and email regarding fuel consumption in California by County and by source with Lance Park, Associate Planner, Rincon Consultants, Inc. August 22, 2017.