

# Bloom Energy Server

## Biogas Specification

Post cleanup, this biogas specification must be used for proper Energy Server contracting and operation

### Specifications

Hydrocarbon Composition <sup>1,2</sup>	Limit (mol %)
Methane (CH <sub>4</sub> )	Min 50 <sup>3</sup>
Ethylene (C <sub>2</sub> H <sub>4</sub> )	Max 0.1
Ethane (C <sub>2</sub> H <sub>6</sub> )	Max 0.1
Propylene (C <sub>3</sub> H <sub>6</sub> )	Max 0.1
Propane (C <sub>3</sub> H <sub>8</sub> )	Max 0.1
iButane + nButane (C <sub>4</sub> H <sub>10</sub> )	Max 0.1
Sum of C <sub>5+</sub>	Max 0.1

<sup>1</sup> Hydrocarbon composition transients within the above specification ranges will change at less than 1% per hour.

<sup>2</sup> Composition data collected per ASTM D1945 or ASTM D1946 methods.

<sup>3</sup> If O<sub>2</sub> present in the gas: %CH<sub>4</sub> – 0.5 \* %O<sub>2</sub> > 50 mol%

Contaminant	Limit
Siloxanes	< 0.12 mg/m <sup>3</sup>
Arsenic (AsH <sub>3</sub> &/or As)	< 0.05 ppmV
Halogens (CH <sub>3</sub> Cl, HCl, etc.)	< 2.8 µg/m <sup>3</sup>
Mercury	< 2.0 ppmV
Cadmium	< 2.0 ppmV
Zinc	< 2.0 ppmV
Ammonia	< 40 ppmV
Phosphorous/PH <sub>3</sub>	< 2.0 ppmV
Sodium	< 2.0 ppmV

Trace component	Limit
N <sub>2</sub>	No limit, provided %CH <sub>4</sub> – 0.5*%O <sub>2</sub> > 50 mol%
O <sub>2</sub>	No limit, provided %CH <sub>4</sub> – 0.5*%O <sub>2</sub> > 50 mol%
CO <sub>2</sub>	No limit, provided %CH <sub>4</sub> – 0.5*%O <sub>2</sub> > 50 mol%
H <sub>2</sub>	< 1.0 mol%
CO	< 100 ppm

Sulfur Species	Average (ppbV)	Maximum (ppbV)
H <sub>2</sub> S (Hydrogen Sulfide)	1,000	2,000
COS (Carbonyl Sulfide)	200	500
CS <sub>2</sub> (Carbon Disulfide)	50	150
Mercaptans <sup>1</sup>	100	200
Thiophenes <sup>2</sup>	100	200
Others <sup>3</sup>	100	200
Total Sulfurs (sum of all)	1,500	2,000

<sup>1</sup> TBM is the primary Mercaptan

<sup>3</sup> Other sulfides and disulfides

<sup>2</sup> THT is the primary Thiophene

- Contaminant and Sulfur species limits shall be measured by Draeger tubes, bag sampling, or online gas analyzers at site.
- The gas composition requirements of this specification were verified by historical data of site gas sampling per: ASTM D8230 Siloxanes, EPA TO-15 Halogens, EPA29 Arsenic, Mercury, Cadmium, Zinc, NIOSH 6015 Ammonia and ASTM D5504 Sulfur
- The Gas pressure must be in the range of 14-18 psig
- Pressure transients: <0.1 psi/min at steady flow
- Moisture content needs to be less than 278 lbs H<sub>2</sub>O/mmscf

#### NOTES:

- Overall composition of theoretical cleaned gas, wherein cleaned gas is defined as gas composition after removal of sulfur-bearing species, siloxanes and moisture, must still meet the above standards.
- Sufficient gas to be available at all times to allow the system to operate continuously. Emergency flare capable of handling 100% of the biogas to be made available
- All gas polishing media handling and disposal not included in Bloom scope
- Wastewater handling and remediation not included in Bloom scope
- Site permitting, and site construction of gas polishing system not included in Bloom scope
- Customer is expected to provide the hydrocarbon composition during contracting.

