City of Tulare Renewable Biogas Fuel Cell Project

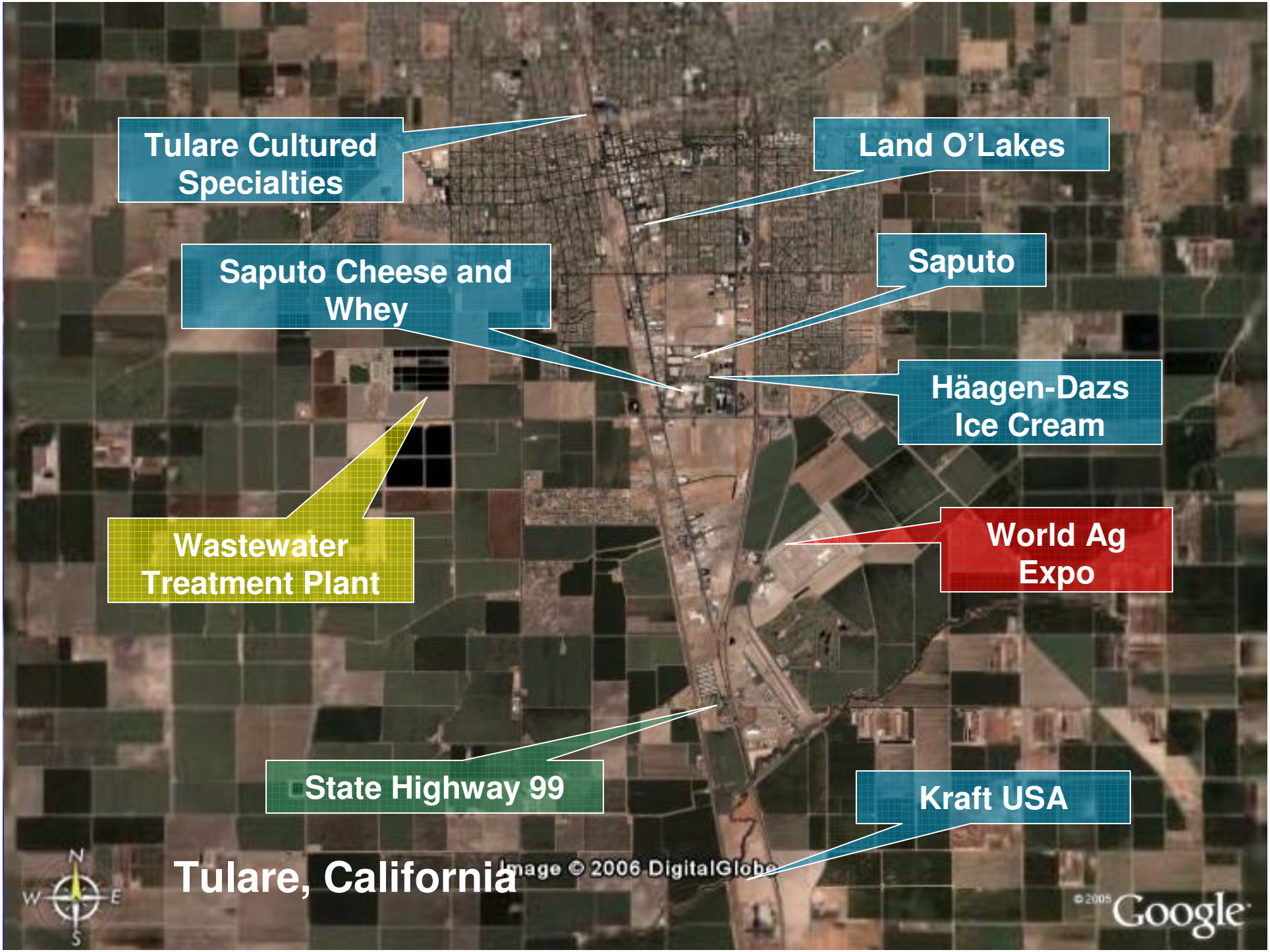
Go Local: Maximizing Your Local Renewable Resources With Fuel Cells

August 16, 2011

Presentation Outline

- Background
- Digester gas fuel cells
- Why fuel cells for Tulare
- Tulare Fuel Cell Cogeneration Project
- Digester gas treatment
- Tulare fuel cell operating experience
- Questions/answers


Fresno
99
Dinuba
Hanford
Visalia
Tulare
5
San Francisco
Sacramento
Fresno
Tulare
Bakersfield
Los Angeles


Tulare Cultured Specialties
Land O'Lakes
Saputo Cheese and Whey
Saputo
Häagen-Dazs Ice Cream
Wastewater Treatment Plant
World Ag Expo
State Highway 99
Kraft USA
Tulare, California
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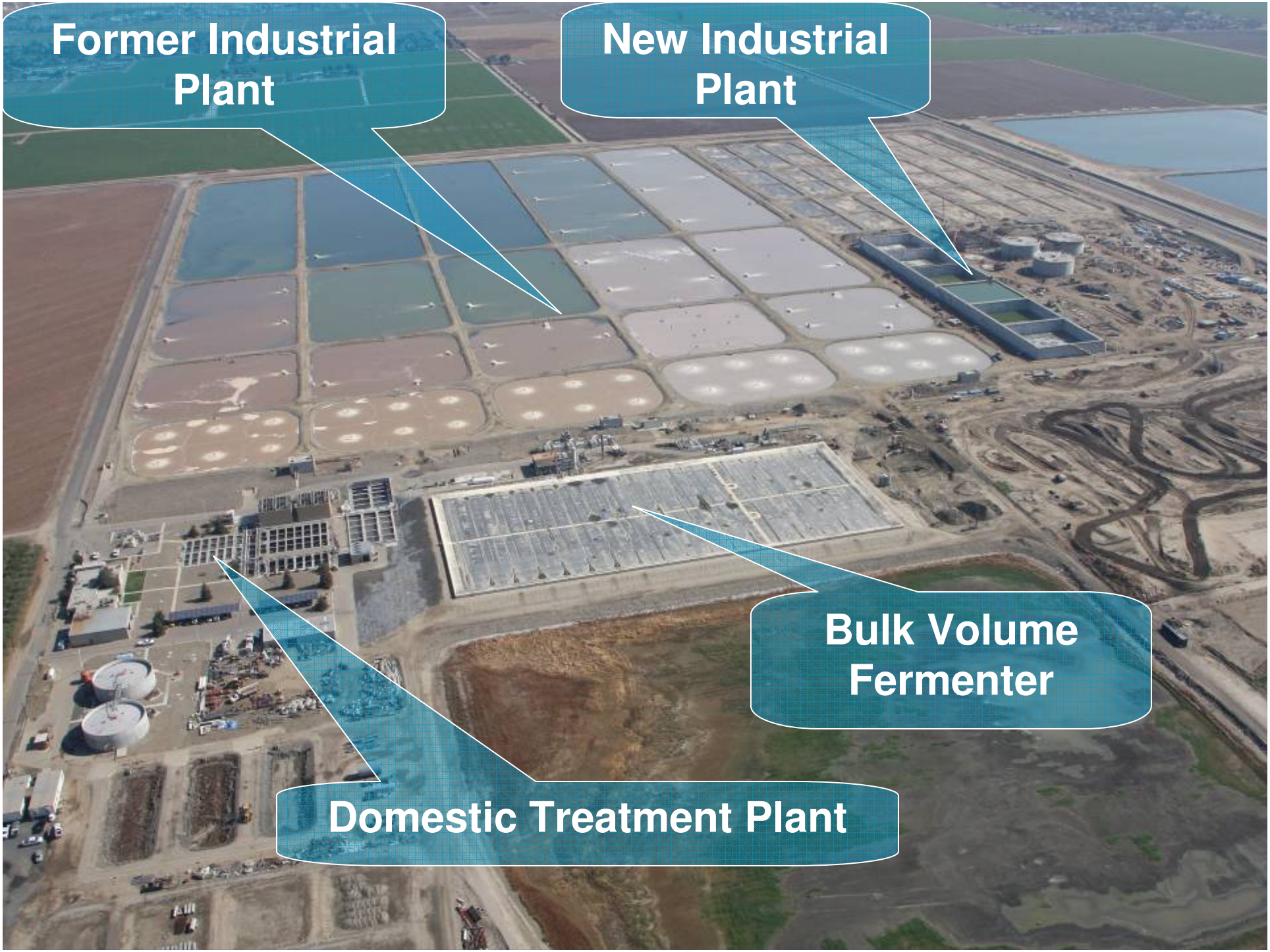
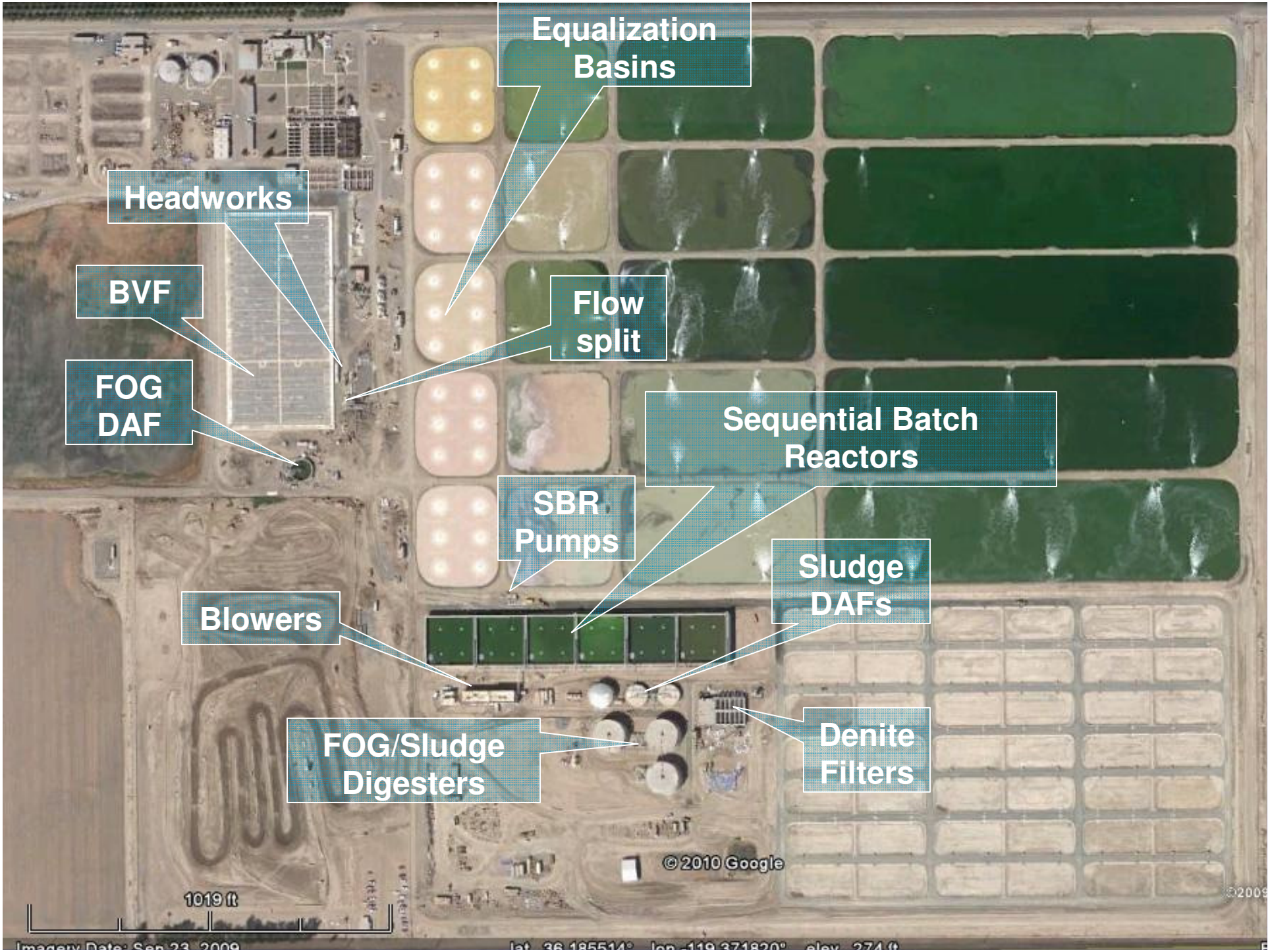

Former Industrial Plant
New Industrial Plant
Bulk Volume Fermenter
Domestic Treatment Plant


Equalization Basins
Headworks
BVF
Flow split
FOG DAF
Sequential Batch Reactors
SBR Pumps
Sludge DAFs
Blowers
FOG/Sludge Digesters
Denite Filters
© 2010 Google
1019 ft

City of Tulare WWTP Data

- Plant Flow – 4.4 mgd domestic + 7.1 mgd industrial = 11.5 mgd total
- Digester Gas Production ~ 500,000 scfd
- Most Digester Gas Produced in Bulk Volume Fermentor (BVF)
- Average Electrical Demand – 2,700 kW

Fuel Cells

- Run on wastewater digester gas, previously burned in a flare.
- Air District permits are easy and fast.
- Generate 1,200 kW. Treatment plant uses 2,700 kW. Generate about $3,200 worth of electricity per day.
- Four fuel cells cost $9.39 million.
- Received $4.95 million incentive payment from Southern California Edison.


Fuel Cells
BVF
300’ x 600’ x
25’

Fuel Cells – Greenest Use of Digester Gas

- Highest Efficiency available for power generation equipment (47%)
- Exempt from air permit requirements*
- Reduction of greenhouse gases
- CARB ’07 Certification pending for digester gas

*Exempt is a strong word, and unfortunately, has not been the absolute truth.

Permitting agencies have required permits; although requirements are minor.

Fuel Cells – Other Benefits

- Qualifies for simplified interconnection
  - California Rule 21 Compliant
- Self Generation Incentive Program (SGIP) grant money currently available
  - SGIP currently only for Fuel Cell and Wind Projects
  - $4,500/kW for up to 1MW
    - $2,250/kW for 2nd MW
    - $1,125/kW for 3rd MW

Project Implementation Methods

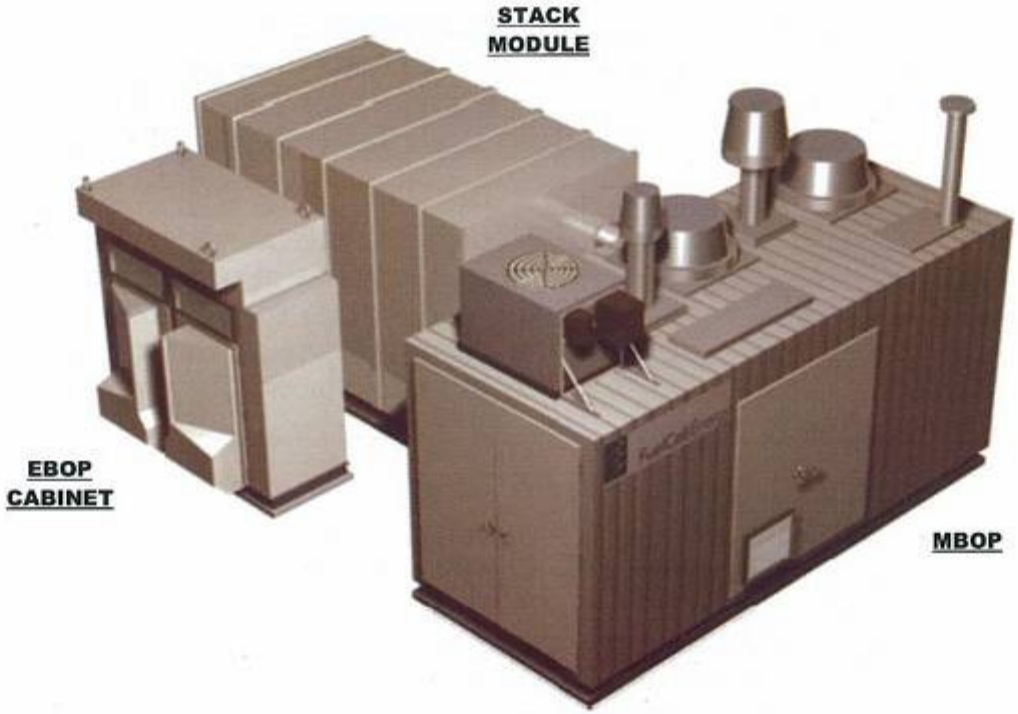
- Design/build
- Conventional – Design – Bid – Build
- Power Purchase Agreement (PPA) by third party Design – Bid – Build – Own – Operate (DBOO)

Design/build method was selected by City of Tulare

Comparison of Design/Build Proposals

kW Rating	Proposed Equipment	Turnkey Cost	Grant	Net Construct Cost	Five-Year Engine Maint	Five-Year Gas Skid Maint	Emission Offsets	Five-Year Cost	Generated Energy Value
750	Fuel Cell Energy DFC 300MA Fuel Cells	5,182,545	3,375,000	1,807,545	1,092,848	500,500	0	3,400,893	727,299
750	Deutz 616 V16 Lean Burner IC Engine	2,567,749	750,000	1,817,749	537,650	765,000	71,943	3,192,342	727,299
848	GE Jenbacher Model JGC316 IC Engine	4,147,000	848,000	3,299,000	458,114	500,500	71,943	4,329,557	776,648
750	Ingersol-Rand 250ST Microturbines	4,493,000	975,000	3,518,000	412,020	500,500	12,000	4,442,520	595,308
750	Ingersol-Rand 250ST Microturbines	5,043,768	975,000	4,068,768	408,924	500,500	12,000	4,990,192	595,308
750	Fuel Cell Energy DFC 300MA Fuel Cells	7,794,757	3,375,000	4,419,757	978,000	500,500	0	5,898,257	727,299

FuelCell Energy



Direct FuelCell®

DFC300MA™

300 kW $480V_{AC}$

333 kVA 50 or 60 Hz

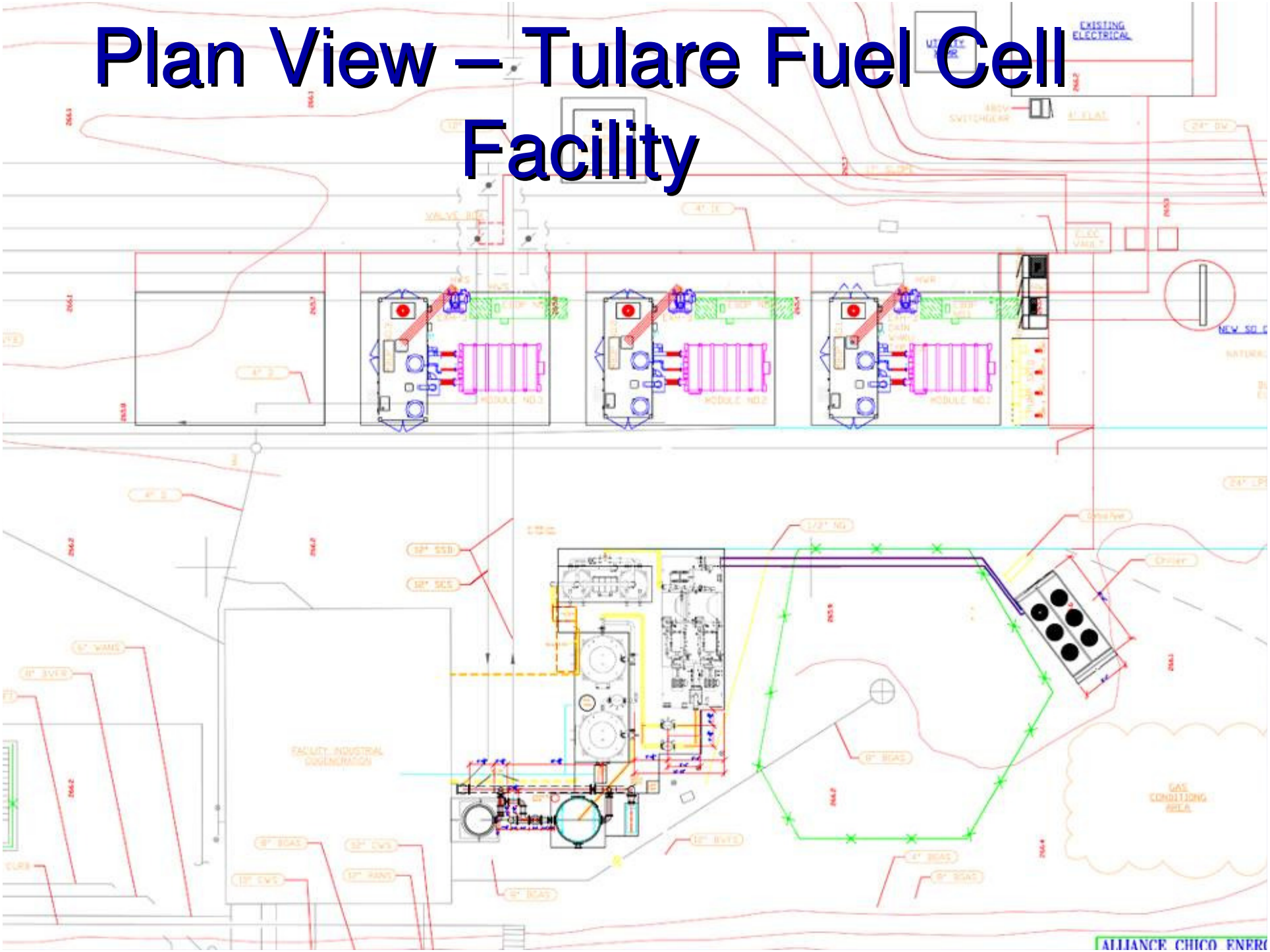
Tulare Fuel Cell Project Summary

- Three 300 kW FCE 300MA units
  - 4th unit is now in operation
- Digester gas treatment system by Applied Filter Technology (AFT), Snohomish WA
  - H_2S, siloxanes, moisture, VOC, etc.
- Electrical interface with utility
- Hot water heat recovery
- Alliance Chico Energy did design/build

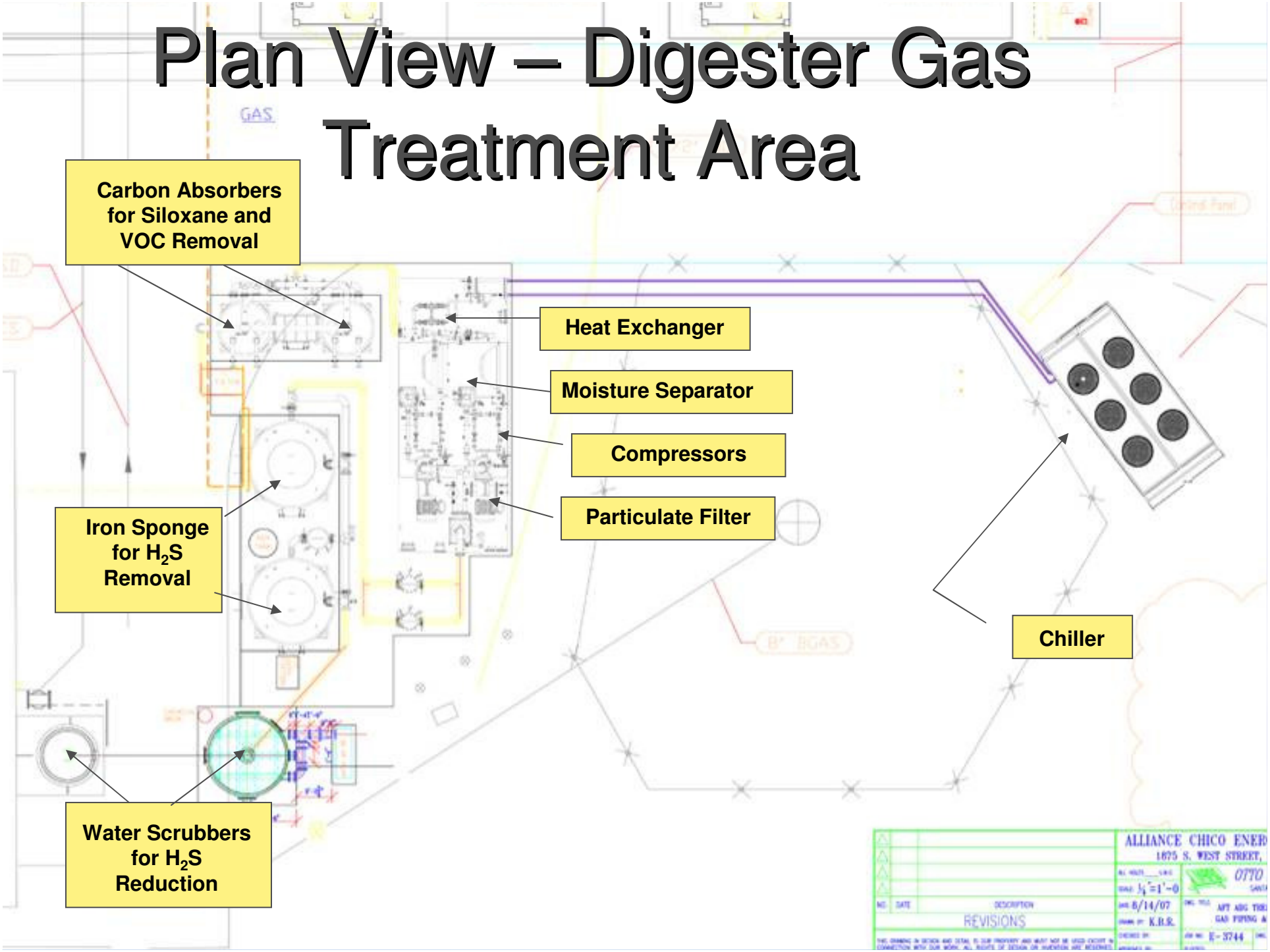
Digester Gas Treatment System

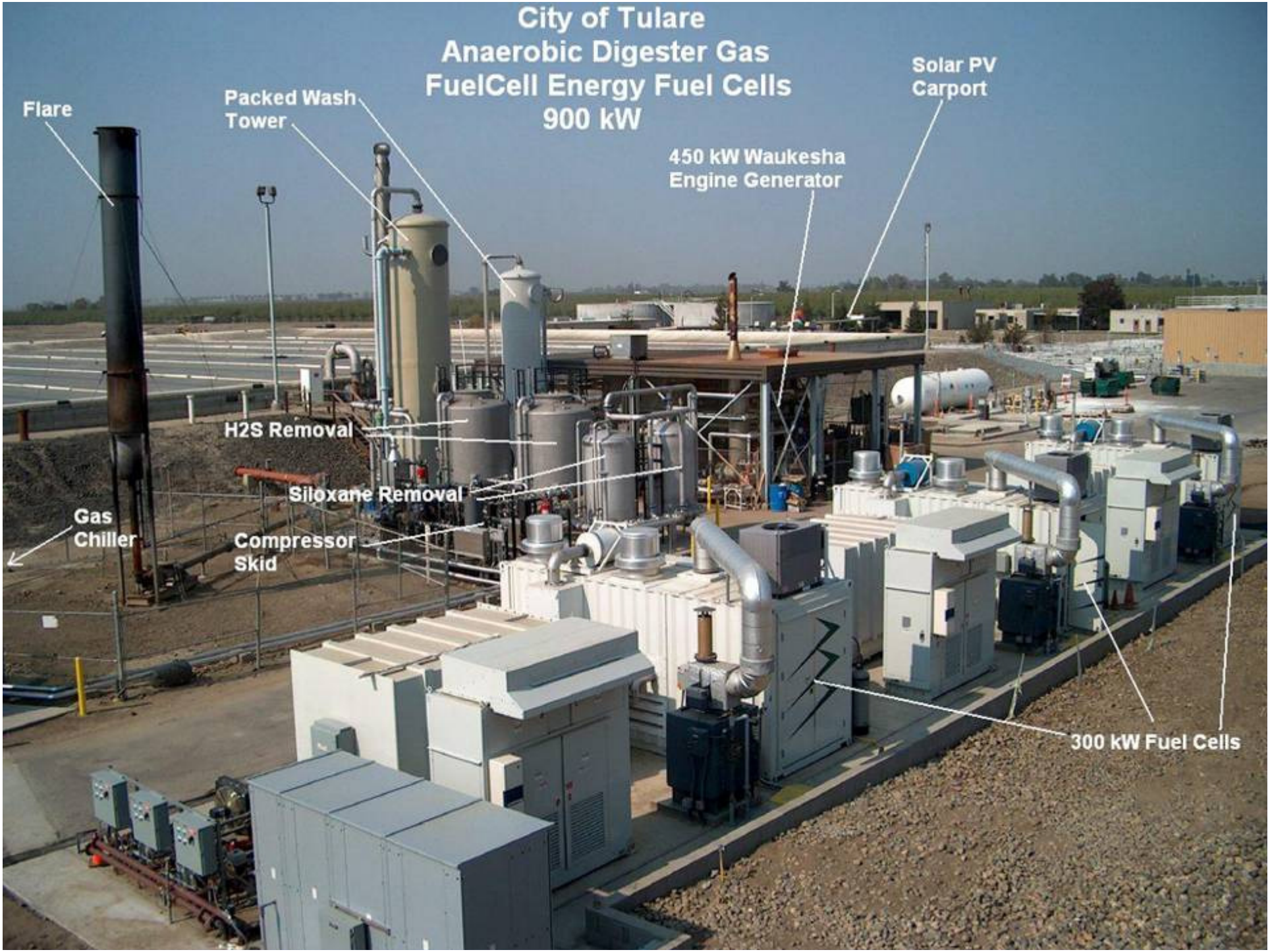
- Packed tower water scrubber for H_2S reduction
- Iron sponge for H_2S removal
- Particulate filter – compressors – heat exchanger
- Chiller – removes water plus some H_2S and siloxanes
- Carbon adsorbers for siloxane and VOC removal

Plan View – Tulare Fuel Cell Facility



Plan View – Digester Gas Treatment Area




City of Tulare
Anaerobic Digester Gas
FuelCell Energy Fuel Cells
900 kW
Flare
Packed Wash Tower
Solar PV Carport
450 kW Waukesha Engine Generator
H2S Removal
Siloxane Removal
Gas Chiller
Compressor Skid
300 kW Fuel Cells

Fourth Fuel Cell Complete May 2011

San Joaquin Valley APCD Permits

- Permit to construct and permit to operate in lb/MWh

NO_X = 0.02

SO_X = 0.001

PM_{10} = 0.01

CO = 0.05

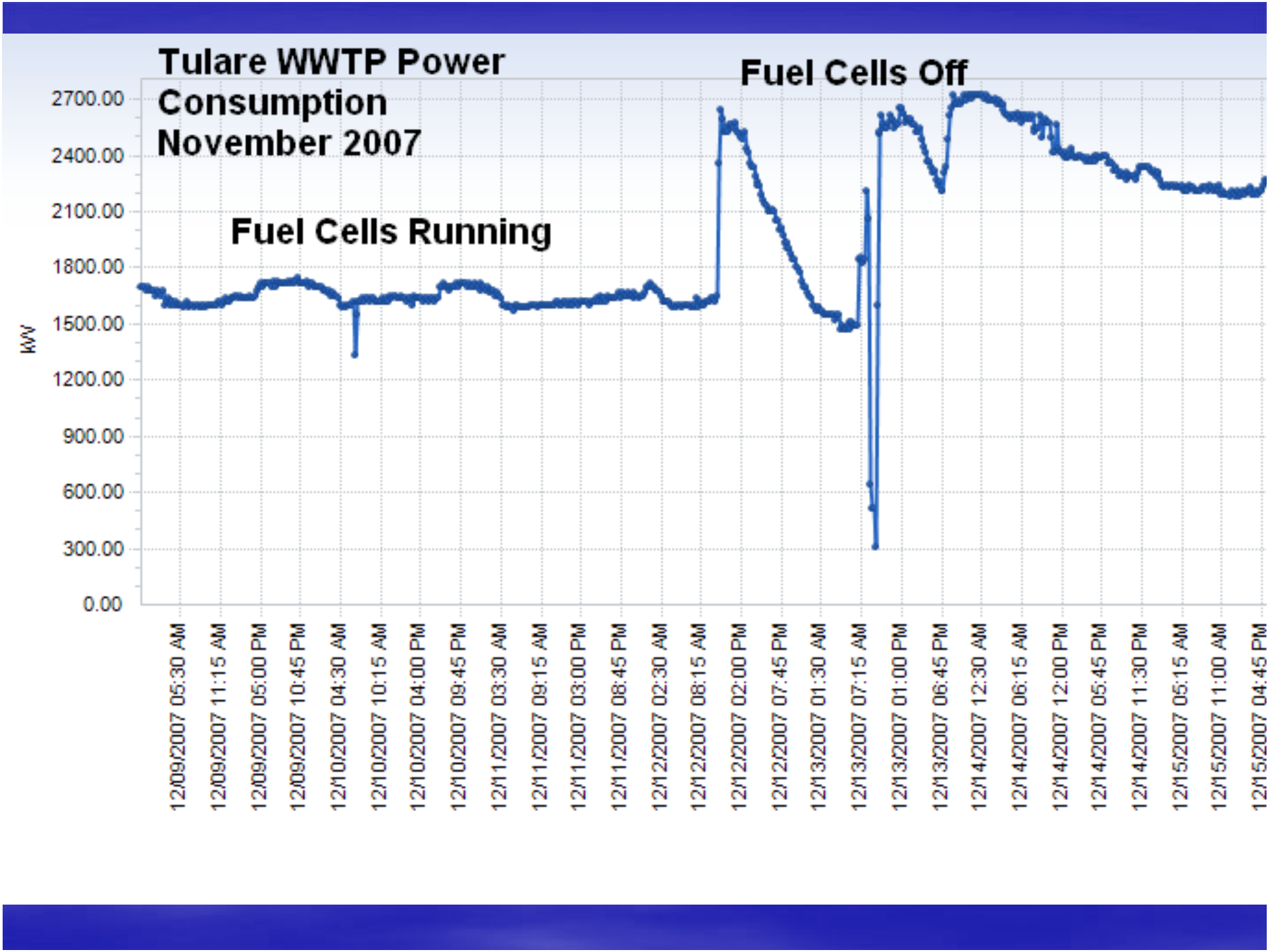
VOC = 0.02

Operating Data

- Actual kW produced

  DC = 335 AC = 300

- Actual fuel cell availability factor in 2010 94.5%


Tulare WWTP Power Consumption November 2007
Fuel Cells Off
Fuel Cells Running
kW
2700.00
2400.00
2100.00
1800.00
1500.00
1200.00
900.00
600.00
300.00
0.00
12/09/2007 05:30 AM
12/09/2007 11:15 AM
12/09/2007 05:00 PM
12/09/2007 10:45 PM
12/10/2007 04:30 AM
12/10/2007 10:15 AM
12/10/2007 04:00 PM
12/10/2007 09:45 PM
12/11/2007 03:30 AM
12/11/2007 09:15 AM
12/11/2007 03:00 PM
12/11/2007 08:45 PM
12/12/2007 02:30 AM
12/12/2007 08:15 AM
12/12/2007 02:00 PM
12/12/2007 07:45 PM
12/13/2007 01:30 AM
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12/14/2007 12:00 PM
12/14/2007 05:45 PM
12/14/2007 11:30 PM
12/15/2007 05:15 AM
12/15/2007 11:00 AM
12/15/2007 04:45 PM

Suggested Maintenance Intervals

Component	Maintenance
Every 3 Months: *(May be performed on-line)	
Water Treatment System (WTS) Brine Tank	Replenish salt
Recycle Blower	Grease motor bearings
WTS Multimedia Filter	Replace (if required)
WTS Carbon Filter	Replace (if required)
EBOP Ventilation Filters	Clean and Inspect (every 3 months for first six months)
Chemical Injection Storage Tank (2-pass RO system only)	Check level and refill (if required)
Every 6 Months: *(May be performed on-line)	
WTS RO Pre-Filter (N/A on 2-pass RO system)	Replace (Also replace if D/P exceeds 22 psig)
Recycle Blower	Replace rotor bearing grease cartridge (if required)
Fresh Air Blower Intake Filter	Replace (Also replace if D/P exceeds 10 IWC)
EBOP Ventilation Filters	Clean and Inspect (every 6 months after the first 6 months)
Every 12 Months: *(May be performed on-line)	
WTS RO Pump	Replace pump(s)
Every 18 Months: *(Requires a shut-down)	
Fuel Gas Strainer	Clean, inspect, (remove if required)
EBOP Compartments	Clean, inspect
Every 36 Months: *(Requires a shut-down)	
Desulfurizer Afterfilter	Replace (Also replace if D/P exceeds 1.0 psig)
Preconverter/ Deoxidizer	Replace catalyst (if required)
Every 72 Months: *(May be performed on-line)	
WTS Electronic De-Ionization Unit	Replace
WTS Final Polishing Filter	Replace (Also replace if D/P exceeds 15 psig)

Lessons Learned

- Design/build – Get your attorney involved early
- Include a load bank (4th fuel cell) or Advanced Energy Storage (coming) in the design
- Gas treatment system availability is critical. Run on natural gas if gas treatment fails, to keep fuel cells generating.

Three Year Report

Period	(1) Percent System Availability	(2) Percent Fuel Cell Availability	kWhrs Generated	Fuel Cell Maint. Agreement	Gas Skid Maint. Agreement	$ per kWhr	Cost to Purchase Generated kWhr @ $0.11	Operational Savings
1/1/08 12/31/08	86.3	98.5	6,312,550	$252,000	$304,365	$0.088	$694,381	$138,016
1/1/09 12/31/09	76.4	89.4	4,725,000	$257,040	$290,849	$0.116	$519,750	$28,139
1/1/10 12/31/10	94.5	94.5	8,158,800	$262,181	$290,849	$0.068	$897,463	$344,433

(1) No digester gas available for seven weeks while BVF was cleaned in 2009, two fuel cell stacks replaced.

(2) Two fuel cell stacks replaced in 2009 due to frequent unscheduled cool downs caused by gas scrubber, third fuel cell availability was 98.7%.

Summary

- Fuel cell is the cleanest, most efficient cogeneration technology for digester gas
- Financially, fuel cell technology competes well with engines and turbines based on the incentive money available in California. Project cost $9.39 million, SGIP grants of $4.95 million.
- You won't have to worry about the future changes in emissions regulations

Summary (continued)

- Permitting is relatively easy
- Utility coordination for interconnection is relatively simple and quick
- Low operator attention for maintenance
- Run on natural gas if biogas system fails!

GO GREEN!


TULARE
We've Got It.

Questions?

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