Biogas on dairy farms in CA

Introduction and methane synthesis

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Hot or not
Still cheap?
Change is needed

[Graph showing an alarming increase in Energy price and Temp, indicated by a skull and crossbones symbol.]
Any solutions?
A Solution
A Solution
A solution

\[
\begin{align*}
\text{where } -\text{Ar}- \text{ is } & \\
\text{or mixture thereof, and } R \text{ is } &
\end{align*}
\]
Remember Gallo?
Remember Gallo?
Gallo system or not?

Covered Lagoon
Low investment cost
Low maintainance

Gas Engine
Low investment cost
Low maintainance
Lower efficiency
Combined Cycle instead of Gas Engine

How many of you have seen a steam turbine before?

Combined Cycle 50-60% Efficiency <-> Gas Engine 30-40% Efficiency

Better Power/fuel ratio – Less Heat production – More power generation
Average electricity use in a US household pr. person pr. year: 11232 kWh/year
Power production on power plant pr. day: 39600 kWh/day

In one day we provide power for a whole year of power for around 3½ households in US.

Efficiency: 57%
Power production: 1650 kW
Yearly production: 14454 MWh (1200 US households)
Why is this idea so good?

- Combine 3 technologies in power cycle to lower the heat loss
- Combine 2 technologies for capturing Methane
- Use the most efficient power cycle on the market
- Using new technology in form of ORC cycle

- After Gas turbine the temperature is 600 C
- After Steam turbine the temperature is 250 C
Where does the milk come from?

CA 21 %
Concentration of dairy’s

<table>
<thead>
<tr>
<th>County</th>
<th>Number of dairies</th>
<th>Average cows</th>
<th>% of total CA Cows</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tulare</td>
<td>332</td>
<td>1450</td>
<td>28%</td>
</tr>
<tr>
<td>Merced</td>
<td>312</td>
<td>843</td>
<td>15%</td>
</tr>
<tr>
<td>Stanislaus</td>
<td>301</td>
<td>621</td>
<td>11%</td>
</tr>
<tr>
<td>Kings</td>
<td>166</td>
<td>1076</td>
<td>11%</td>
</tr>
<tr>
<td>Kern</td>
<td>55</td>
<td>3137</td>
<td>10%</td>
</tr>
<tr>
<td>Fresno</td>
<td>115</td>
<td>1050</td>
<td>7%</td>
</tr>
</tbody>
</table>
17% of the US milk production.
1.4 million Cows!
Biogas

- Agriculture
- Environment
- Energy production
- Surrounding community.
legislations

- **Air Quality – Regarding biogas**
  - Permitting – SB 700
  - AB 32 - California Air Resources Board
  - Best Available Control Technology

- **Water Quality**
  - Leakage from lagoons?

- **NOx restrictions in California**
  - EGR
  - SCR
Current installations

- Dairy Power Production Program
  - Fourteen approved
    - Teen build
      - Six in operation
- Regulations has short down several the last year
Economy

1 kWh with our system ➔ $0.075

<table>
<thead>
<tr>
<th>NEM Bio Net Metering Rate, $/kwh</th>
<th>PG&amp;E</th>
<th>SCE</th>
<th>SDG&amp;E</th>
</tr>
</thead>
<tbody>
<tr>
<td>Off-Peak</td>
<td>2.2 – 2.3 $</td>
<td>3.1 $</td>
<td>6.5 $</td>
</tr>
<tr>
<td>Mid-Peak</td>
<td>3.1 – 3.2 $</td>
<td>6.9 – 8.4 $</td>
<td>6.5 $</td>
</tr>
<tr>
<td>On-Peak</td>
<td>3.6 $</td>
<td>11.6 $</td>
<td>8.9 $</td>
</tr>
</tbody>
</table>
Economic analysis

![Graph showing economic analysis with various parameters and their changes.](image-url)
Discussion

- Energy is so cheap
- Electricity production is the main income
- Combined cycles possibilities
- Biogas has lot of potential
Conclusion

- Mature technology in California
- Reducing greenhouse gas
- Minor trade off in NOx
- Flexibility in boards