Safety of Biogas Power Plants
Comparing experiences in Germany and Thailand
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Alensys Engineering GmbH

• Founded in 2004

• Today more than 30 employees in the Alensys Group

• Business areas:
  Biogas/Biomethane-Engineering and -Investment, Biodiesel- and Bioethanol-Engineering in small-scale plants, Solar power plant developer, Solar Engineering, Solar plant packager
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Alensys Engineering GmbH

• Independent professional planner with over 18 years experience in the field of Biogas and Biomethane technology
• Process design and site development
• Feasibility studies and Economic studies
• Tendering and contracting
• Pre Basic Engineering and Basic Engineering
• Detail Engineering
• Support of implementation planning
• Management
• Commissioning and startup of the plant
• Training and instruction of the personnel of the plant and training praxis on one of our biogas plant
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Open Statements

“No correlation between size and risk”...

“Safety has, will and should be a hot topic!”

“Only standardized resource on biogas safety for agriculture is from Germany!”

„Safety is currently one of the biggest issues. A number of bad accidents have occurred recently“...
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Nucleus and Handshake

- Education + Knowledge
- Economically attractive
- Quality + Safety
- Technically possible
- Biogas Power Plant
- Socially acceptance
- Environmental sustainable
- Education + Knowledge
- Quality

Source/Reference: Alensys Engineering GmbH; 2014
## Biogas in Thailand & Germany (2010)

<table>
<thead>
<tr>
<th>Year</th>
<th>Biogas Production (million m³)</th>
<th>Electricity Sold to Grid (GWh)</th>
<th>Installed Capacity (MW)</th>
<th>Number of Projects</th>
</tr>
</thead>
<tbody>
<tr>
<td>2005</td>
<td>2</td>
<td>2</td>
<td>7</td>
<td>8</td>
</tr>
<tr>
<td>2006</td>
<td>8</td>
<td>10</td>
<td>10</td>
<td>11</td>
</tr>
<tr>
<td>2007</td>
<td>12</td>
<td>14</td>
<td>8</td>
<td>17</td>
</tr>
<tr>
<td>2008</td>
<td>32</td>
<td>83</td>
<td>23</td>
<td>24</td>
</tr>
<tr>
<td>2009</td>
<td>73</td>
<td>60</td>
<td>60</td>
<td>42</td>
</tr>
<tr>
<td>2010</td>
<td>125</td>
<td>214</td>
<td>90</td>
<td>53</td>
</tr>
</tbody>
</table>

**Germany:** ~ 6,000

**MW:** 2,400

Source/Reference: DEDE, EPPO; 2010 - 2012
## Safety of Biogas Power Plants
### Comparing experiences in Germany and Thailand

### Biogas in Thailand 2012

<table>
<thead>
<tr>
<th>Sektor</th>
<th>Energieträger</th>
<th>Kapazität (Ist-Zustand 2012)</th>
<th>Geplante Kapazität in 2021 nach ADEP (Ausbauziele nach NEPC)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Stromerzeugung</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Photovoltaik</td>
<td>75 MW</td>
<td>2.000 (3.000) MW</td>
</tr>
<tr>
<td></td>
<td>Windenergie</td>
<td>7 MW</td>
<td>1.200 (1.800) MW</td>
</tr>
<tr>
<td></td>
<td>Geothermie</td>
<td>0,35 MW</td>
<td>1 MW</td>
</tr>
<tr>
<td></td>
<td>Gezeiten- und Wellenkraft</td>
<td>0 MW</td>
<td>2 MW</td>
</tr>
<tr>
<td></td>
<td>Wasserkraft</td>
<td>86 MW</td>
<td>1.572 MW</td>
</tr>
<tr>
<td></td>
<td>Biomasse</td>
<td>1.752 MW</td>
<td>3.630 (4.800) MW</td>
</tr>
<tr>
<td></td>
<td>Biogas</td>
<td>138 MW</td>
<td>600 (10.000) MW</td>
</tr>
<tr>
<td></td>
<td>Hausmüll</td>
<td>1 MW</td>
<td>160 MW</td>
</tr>
</tbody>
</table>

**Source/Reference:** DEDE, EPPO; 2010 - 2012

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Dipl.-Ing. Tobias Burgstaller CTO international
Dr. Apipong Lamsam – Papop Co., Ltd.
Biogas in Germany 2012

Source/Reference: AGEE-Stat. FVB Stand 05/2104
The anaerobic decomposition of organic substances may be classified into four steps: hydrolysis, acid formation, acetate formation and methane formation. The final product of fermentation is biogas of the following composition (1 Vol.% = 10,000 ppm):

<table>
<thead>
<tr>
<th>Component</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>50 – 75 Vol.% Methane (CH₄)</strong></td>
<td>a high flammable component, odorless, colorless, lighter than air</td>
</tr>
<tr>
<td><strong>25 – 45 Vol.% Carbon Dioxide (CO₂)</strong></td>
<td>inert component and non-combustible, but can be toxic, suffocating effects, odorless, heavier than air</td>
</tr>
<tr>
<td><strong>2 – 7 Vol.% Water (H₂O)</strong></td>
<td>in combination with H₂S very corrosive</td>
</tr>
<tr>
<td><strong>&lt; 2 Vol.% Oxygen (O₂)</strong></td>
<td>makes CH₄ explosive if it is in right ratio</td>
</tr>
<tr>
<td><strong>&lt; 2 Vol.% Nitrogen (N₂)</strong></td>
<td>inert component, suffocating effect</td>
</tr>
<tr>
<td><strong>&lt; 1 Vol.% Ammonia</strong></td>
<td>inert component, but can be toxic, very corrosive with condensate</td>
</tr>
<tr>
<td><strong>&lt; 1 Vol.% Hydrogen Sulphide (H₂S)</strong></td>
<td>very corrosive with condensate or water vapor, very toxic and poisonous, physiological damaging effects, highly flammable, heavier than air, odorless in lower and odors in higher concentration</td>
</tr>
</tbody>
</table>
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Direct and Indirect Dangers (BPP)

1. Incorrect operation based on human mistakes and human factors
2. Managing risks
3. Incorrect or missing personal protective equipment
4. Biological contamination
5. Uncontrolled gaseous emissions
6. Surface and groundwater contamination
7. Environmental biohazard
8. Life and health risk of suffocation
9. Global technical faults in design, material or control
10. Corrosion of material and instability of construction
11. Risk of drowning, e.g. no fence around plant and ground tanks
12. Mechanical hazards, e.g. risk of falling, contusion and amputation
13. Electric shock
14. Fire of general unsuitable and flammable materials
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Direct and Indirect Dangers (BPP)

15. Explosion of flammable gas-air mixtures
16. Explosion of flammable dust-air mixtures
17. Explosion of flammable gas-dust-air mixtures
18. Pipe failures, because of expansion and UV-radiation
19. Pipe failures, because of wrong medium
20. Damage caused by long downtimes
21. Damage caused by overloading
22. Risk of fire and explosion due to internal and external influences
23. …
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Top 6 Analysis of Dangers

Source/Reference: KAS 12, KAS 23; 2011
Pool of Thailand Manuals for BPP

Department of Industrial Work (DIW) Biogas design and safety manual

Manual - Biogas production and use in farm

Manual - Biogas production and use in factory and MSW
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Pool of German Rules and Standards for BPP
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Pool of German Rules and Standards for BPP
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Comparing experiences in Germany and Thailand

Pool of German Rules and Standards for BPP

More than 88 individual standards, rules and acts applicable to Biogas Power Plants and Biomethane Power Plants in Germany!
Extreme Scenarios – Deflagration of Biogas

Source/Reference: [www.feuerwehr-riedlingen.de](http://www.feuerwehr-riedlingen.de); 2014
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Extreme Scenarios – Leaked Digestate

Source/Reference: www.polpix.sueddeutsche.com; 2014
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Extreme Scenarios – Deflagration of Biogas

Source/Reference: www.polpix.sueddeutsche.com; 2014
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Extreme Scenarios – Explosion and Fire

Source/Reference: www.polpix.sueddeutsche.com; 2014
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Extreme Scenarios – Overpressure or Expl.

Source/Reference: www.bilshausen.de; 2014
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Extreme Scenarios – Explosion

Source/Reference: www.feuerwehrmagazin.de; 2014
Safety of Biogas Power Plants
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Extreme Scenarios – Fire

Source/Reference: www.20min.ch; 2014
Safety of Biogas Power Plants
Comparing experiences in Germany and Thailand

Extreme Scenarios – Explosion

Source/Reference: www.lsv.de; 2014
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Comparing experiences in Germany and Thailand

Universal and Elementary Laws

- Motivation and interest!
- Avoidance of routine!
- Constant questioning of facts!
- Understanding and implementing of regulations!
- Continuing education and training!
- Sustainable monitoring and reviewing!
- Independent control and verification!
- Accepting that each biogas plant is different!
- Strict and continuing evaluation of regulations, laws, acts, ...

and

- Cooperation with the best and leading Biogas-Specialists of the world!
Comparing Experiences – Clamping Membrane

Source/Reference: Alensys Engineering GmbH; 2013
Comparing Experiences – Membrane

Thailand

Germany

Source/Reference: Alensys Engineering GmbH; 2013
Comparing Experiences – Release Valves

Thailand

Germany

Source/Reference: Alensys Engineering GmbH; 2013
HD-PE is preferred over PVC, due to strength of PVC can decrease from heat and frequent expansion and contraction.

- Need to be checked and maintained regularly
- Need to replaced every 5 years

**Source/Reference:** Papop; 2013
Safety of Biogas Power Plants

Comparing experiences in Germany and Thailand

Comparing Experiences – Electro Installation

Source/Reference: Alensys Engineering GmbH; 2013

Dipl.-Ing. Tobias Burgstaller CTO international
Dr. Apipong Lamsam – Papop Co., Ltd.

Alensys Engineering GmbH - Zum Wasserwerk 12 - 15537 Erkner/Berlin - Germany - www.alensys.com
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Comparing Experiences – Fall Protection

Source/Reference: Alensys Engineering GmbH; 2013

Thailand

Germany
Comparing Experiences – Pipe Bridge

Thailand

Germany

Source/Reference: Alensys Engineering GmbH; 2013
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Comparing experiences in Germany and Thailand

Comparing Experiences – Leading in Pipe

Thailand

Germany

Source/Reference: Alensys Engineering GmbH; 2013
Safety of Biogas Power Plants
Comparing experiences in Germany and Thailand

Comparing Experiences – Piping

Thailand

Germany

Source/Reference: Alensys Engineering GmbH; 2013
Safety of Biogas Power Plants
Comparing experiences in Germany and Thailand

Comparing Experiences – Safety Valve

Source/Reference: Alensys Engineering GmbH; 2013
Comparing Experiences – Lightning Protection

Thailand

Source/Reference: Alensys Engineering GmbH; 2013
Comparing Experiences – Safety on Site

Thailand

Germany

Source/Reference: Alensys Engineering GmbH; 2013
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Comparing experiences in Germany and Thailand

Comparing Experiences – Biogas Power Plant

Thailand

Source/Reference: Rotech; 2013
Possible Causes and what we find so far

- Bad design
- Bad construction
- No or minimal maintenance
- Operator/owner lack of knowledge/awareness on biogas
- Very few factories apply hydrogen sulfide scrubber system
- Maintenance of PVC/HDPE cover sheet is very limited
- Biogas leaks
- Not sufficient safety equipment e.g. valves, release valves, anti-explosive devices, alarms
- …
Possible Causes and what we find so far

- No/Less guidelines and manuals available
- Apply engineering judgment/safety design
- No safety standard
- No regulation to control/monitor
- No enforcement

- Department of Industrial Works (Ministry of Industry)
- Department of Alternative Energy Development and Efficiency (Ministry of Energy)
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The Master Plan – What we have to do now!

With the help of German Experts and German supporters, Thailand has to ...

1. ... create **communication channels** between the different parties.
2. ... develop a “**biogas sector**” structured around commonly accepted technical answers and sharing of experiences.
3. ... develop “**Safety Rules**” and “**Quality Standards**” as reference documents.
4. ... **implement German knowledge in the existing manuals** in the case of local condition and costs of application.
5. ... **create checklists** for environmental and social risk assessment of Biogas and Biomethane Power Plants.
6. ... **analyze the safety culture** of biogas operators and the risk perception in the public and develop an appropriate risk communication.
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The Master Plan – What we have to do now!

With the help of German Experts and German supporters, Thailand has to...

7. ... **demonstrate of the safety technology** and get public acceptance
8. ... support the development of a **harmonized and cost effective** regulatory framework
9. ... **monitor the projects** (past, present and future)
10. ...
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Summary and Motivation for the Future

Why it is necessary for Thailand to have safety rules and guidelines for Biogas/Biomethane Plants and/or parts of Biogas/Biomethane Plants:

1. To protect the environment
2. To protect the worker and save the workers life
3. To safe the life of all other persons living and working next to the biogas plant
4. To hold and cover social responsibilities
5. To have the same comparable quality standards
6. To have the same comparable safety standards
7. To have comparable binding rules
8. To ensure from the beginning a high controlled quality
9. To ensure from the start accurate technique
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Summary and Motivation for the Future

Why it is necessary for Thailand to have safety rules and guidelines for Biogas/Biomethane Plants and/or parts of Biogas/Biomethane Plants:

10. To guide the requirements for the construction and operation of biogas systems in terms of the general quality, safety and health
11. To be able to compare different systems and to evaluate different technologies
12. To have good press and acceptance
13. To be the leader in Asia from the beginning
Thank you very much for your attention!