**Non-$CO_2$ Greenhouse Gases:** Methane

**Source/Sectors:** Agriculture/Manure Management

**Technology:** Anaerobic digestion systems (A.3.2.1)

**Description of the Technology:**
In general, measures to mitigate methane emissions from manure management include livestock reduction, prevention of fermentation during stabling, controlled fermentation of manure, composting, and aerobic digestion. The key reduction option is the capture and use of methane emissions through the use of anaerobic digesters that can be farm scale or centralized for the intensive agricultural zones (Lucas *et al.*, 2006). The technological options for anaerobic digestion include covered lagoons, plug flow digesters, and centralized digesters. Controlled anaerobic digestion can be operated in psychrophilic (10-20 $^{o}$C), mesophilic (20-40 $^{o}$C), or thermophilic (50-60 $^{o}$C) range.

**Effectiveness:** Good

**Implementability:** Anaerobic digestion technologies can be applied at various scales (i.e., farm or centralized) and require separate effluent storage and a gas use device (US Climate Change, 2005).

**Reliability:** Anaerobic digesters are practical and often cost-effective for most large dairy and swine farms, especially those located in warm climates. These systems also reduce foul odor and can reduce the risk of ground- and surface-water pollution (US Climate Change, 2005).

**Maturity:** Good

**Environmental Benefits:** Methane recovery and utilization for energy generation

**Cost Effectiveness:**

| Technology | Lifetime (yrs) | MP (%) | RE (%) | TA (%) | Capital cost | Annual cost | Benefits |
|---|---|---|---|---|---|---|---|
| Covered lagoon, not including lagoon cost (large dairy)[1] | 15 | 70 | 95 | 29 | $42.22 | $5.12 | $14.27 |
| Covered lagoon, including lagoon cost (large dairy)[1] | 15 | 30 | 95 | 29 | $56.30 | $5.12 | $14.27 |
| 2-stage plug flow digester (large dairy)[1] | 15 | 1 | 95 | 100 | $96.38 | $5.12 | $14.27 |
| Plug-flow digester[1] | 15 | 34 | 95 | 100 | $69.27 | $5.12 | $14.27 |
| Covered lagoon, not including lagoon cost (small dairy)[1] | 15 | 70 | 95 | 29 | $145.67 | $5.12 | $14.27 |
| Covered lagoon, including lagoon cost (small dairy)[1] | 15 | 30 | 95 | 29 | $194.09 | $5.12 | $14.27 |
| Centralized digester[1] | 15 | 4 | 95 | 100 | $174.67 | $26.14 | $32.31 |

Note: MP: market penetration; RE: reduction efficiency; TA: technical applicability; costs are in year 2000 US$/$MT_{CO2\text{-}Eq.}$
1: CEC (2005)

**Industry Acceptance Level:** Fair

**Limitations:** Utility policies toward independent power producers delay further development of digestion technologies for power generation. The complexity of operation also impedes the market penetration; a centralized operating structure with dedicated expertise may justify this limitation. Moreover, bio-security issues may reduce the potential of these options (US Climate Change, 2005).

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