Executive Summary

Anaerobic digestion (AD) of municipal solid waste (MSW) is used in different regions worldwide to:

- Reduce the amount of material being landfilled
- Treat organic material before disposal, thus reducing future environmental impacts from air and water emissions
- Recover energy.

Over the past 20 years, AD of MSW technology has advanced in Europe because of waste management policies enacted to reduce the long-term health and environmental impacts of landfill disposal. This has led to relatively high landfill tipping fees (compared with California or the U.S.), which, in combination with generous prices paid for renewable energy, has created an active commercial market for AD technologies of MSW in Europe.

In some parts of Europe, source separation of the organic fraction of municipal solid waste (OFMSW) is common and even mandatory, which contributes to the growth of biological treatment industries. Other countries are beginning to follow the European model in enacting more stringent regulations on organic waste disposal and new AD plants are being developed as a result.

Although the U.S. has a long history of treating agricultural and municipal wastewater with anaerobic digesters, no commercial-scale solid waste digesters have been built despite several favorable (though economically marginal) feasibility studies and laboratory findings.

In the U.S. and most of California, landfills continue to be seen as the most economic option for treating MSW, since unlike Europe and Japan, space for new landfills is not as scarce and waste management policies are less rigorous. Furthermore, the energy market and regulatory mechanisms for licensing MSW AD facilities in California have not been developed to easily accommodate commercial systems.

Composting of the OFMSW has increased significantly over the past 15 years, particularly for source separated wastes, but by far the majority of the yard and food waste generated in the U.S. still goes to landfills. AD facilities are capable of producing energy and significantly reducing the organic content of the organic waste prior to composting, which reduces emissions of pollutants and greenhouse gases. However, AD facilities represent an additional expense for waste treatment. Therefore, in order for AD to be financially viable, the revenues generated must offset the additional expenses. These revenues can come from the energy produced as well as the environmental and public health benefits achieved. The latter may be monetarily realized in the forms of increased waste tipping fees and green credits, but markets for these products are insecure and underdeveloped or even non-existent at this time.

Many European countries have passed laws mandating that utility companies purchase green energy, whereas in California few of the farms or wastewater treatment facilities that produce excess electricity from biogas have secured contracts with the utilities. Additionally, while European Union directives have called for mandatory pre-treatment and diversion of organic waste from landfills, no equivalent regulations exist in either federal or state codes. However, waste diversion targets have been set in California and many other states in the U.S., and the

OFMSW has been a focus of waste managers and municipalities attempting to achieve the targets.

Despite these hurdles, interest in AD of MSW is growing, and several California municipalities have signed contracts to develop full-scale digesters. The technologies have been used successfully for over ten years in Europe, and new units were built in the last five to ten years in Canada, Japan, Australia and several other countries.

The European market has shown a large preference for single-stage over two-stage digesters and a slight preference for dry digestion systems over wet systems. However, the best AD technology to use depends on the composition of the waste stream and site-specific requirements. The design of any new digester facility should be based on a thorough feasibility study. The following issues that have appeared repeatedly in past attempts at AD of MSW must be addressed for any new facilities in the U.S.:

1. Waste collection
    a. The MSW transportation and processing agencies must decide whether to use source separation or mechanical (or mechanical-biological) separation of the organic fraction
2. Public education
    a. As a new technology, the public must be made aware of the benefits of AD of MSW. If home organic waste collection is implemented, a thorough information campaign will help improve separation efficiency and reduce material handling problems.
3. Material handling
    a. Unlike wastewater and manure digestion, MSW digesters require special handling equipment. Mechanical problems with digesters have primarily come from the material handling equipment.
    b. Even though AD of MSW occurs in enclosed reactors, the digestate must also be treated and well managed. Odor and other emission issues have plagued systems which failed to plan appropriately for digester effluent management.
4. Co-location
    a. To reduce the cost of setting up the first MSW AD facilities in the U.S., the new AD facilities should be located at or near the current waste treatment facilities (e.g. existing composting or material recovery facilities. This will reduce transportation and permitting costs and allow for expense sharing.

Novel technologies are being developed, and several U.S. institutions hold patents on promising high-rate AD technologies. Many U.S. landfills are being built or modified to enhance biological degradation of the OFMSW and collect the resulting biogas, which may provide a stepping stone to full industrial “out-of-ground” AD of MSW. Landfill bioreactors may merit further consideration in their own right, but special attention should be paid to their performance and air/water emissions. In addition to electricity, other value-added product streams from AD systems could provide revenue to help improve the economic viability of organic waste treatment technologies. For example, the gas cleaning technologies for converting biogas to natural gas are developing at a rapid pace, and as technologies for bioprocessing of lignocellulosic materials improve, they will impact AD technologies as well. However, regulatory roadblocks would have to be removed in order to fully capitalize on these product streams.

Overall, using AD to treat OFMSW has many energy, environmental and public health benefits. Current waste disposal practices in landfills should be improved in order to reduce and minimize their environmental impact. A range of policies could be enacted including:

- Restricting the biodegradable fraction of landfill material
- Managing or reducing the per capita disposal amount (either total or biodegradable fraction)
- Increasing landfill fees
- Employing Extended Producer Responsibility (EPR) approaches to products and packaging
- Encouraging source separation
- Providing economic incentives for renewable energy producers (carbon offset credits, renewable energy credits, augmented tipping fees, etc.)

AD technologies have the potential to greatly reduce the environmental impact of waste disposal. As the technologies are being advanced, the installation costs of AD facilities should decrease. The public desire for change in waste management practices will lead to a reduction in landfill availability. As development of MSW AD facilities in the U.S. becomes a reality, it will be important to use the wealth of past experience available in order to reduce potential problems and expedite the future development of organic waste treatment.