行政院環境保護署
Environmental Protection Administration
Executive Yuan, Taiwan

Emissions and Reduction of Methane in Taiwan – The Present and Future

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Environmental Protection Administration

Taiwan

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Outline

I. Major sources of methane emissions in Taiwan

II. Current status of methane emissions in Taiwan

III. Control measures and achievements

IV. Future developments

V. Conclusion

Presenter's Bio

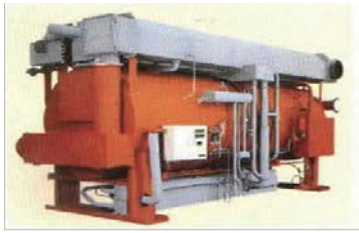
Name	Jin-Wei, Tsai
Current position	Associate Technician , Bureau of Environmental Inspection, Environmental Protection Administration
Education background	Master of Science, The Institute of Environmental Health, National Taiwan University. 2008
Specialty	Environmental sanitation
Experience	● Dec. 2009 ~ Oct. 2011: substitute service in Bureau of Health Promotion, Department of Health; in charge of human health affairs in relation to environmental sanitation, such as the fire of the Sixth Naphtha Cracking Plant of Formosa Plastics, the plasticizer incident, nuclear disaster in Japan and dioxin pollution. ● Dec. 2011 to date: working for the Bureau of Environmental Inspection, Environmental Protection Administration; in charge of landfill management and projects entrusted and to provide technical assistance in energy and resource related projects.

I. Sources of methane in Taiwan

1. Introduction of Methane

(i) Methane is one of the climate change convention greenhouse gases.
(ii) Methane's global warming potential is 24.5 times higher than CO_2
(iii) Methane can be recycled for power generation and transportation fuel.

Heat generation



Chilled water generation

methane

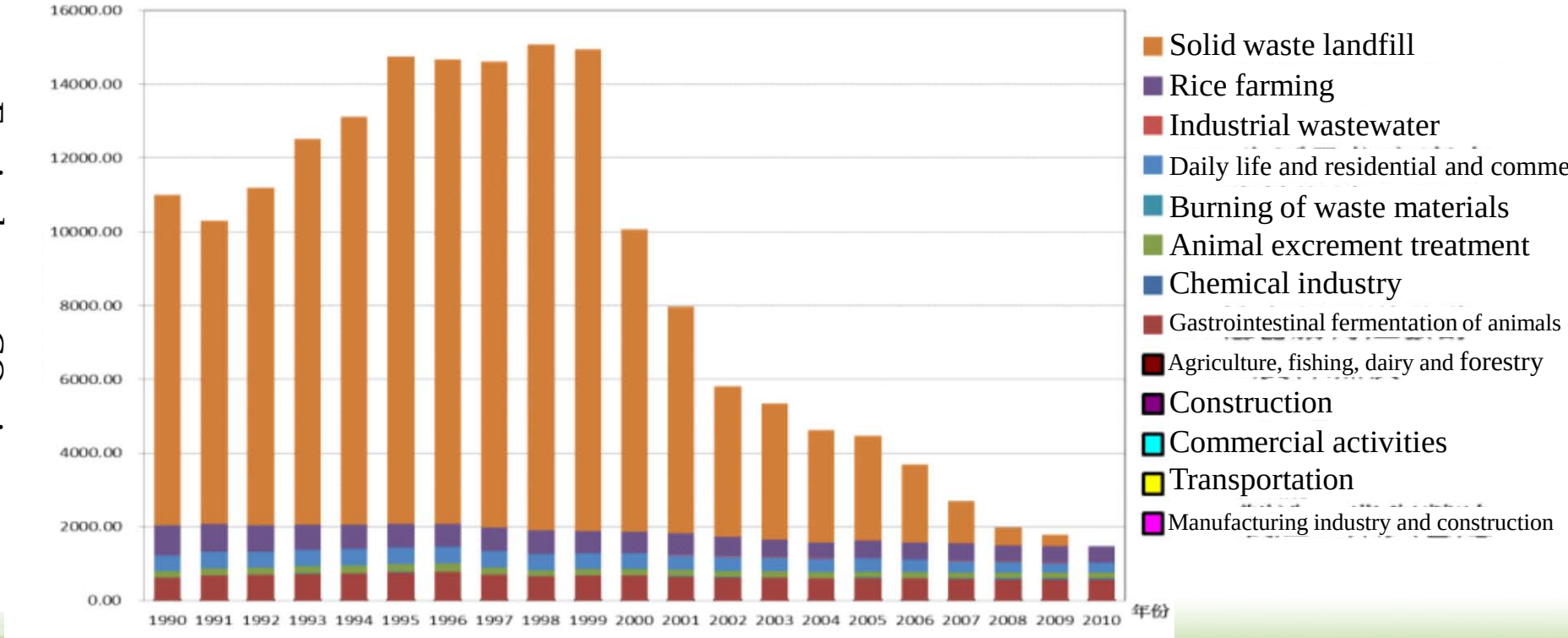
Bio-gas generation

Methane-powered Bus

I. Sources of methane in Taiwan

2. The trend of methane emission from 1990 to 2010

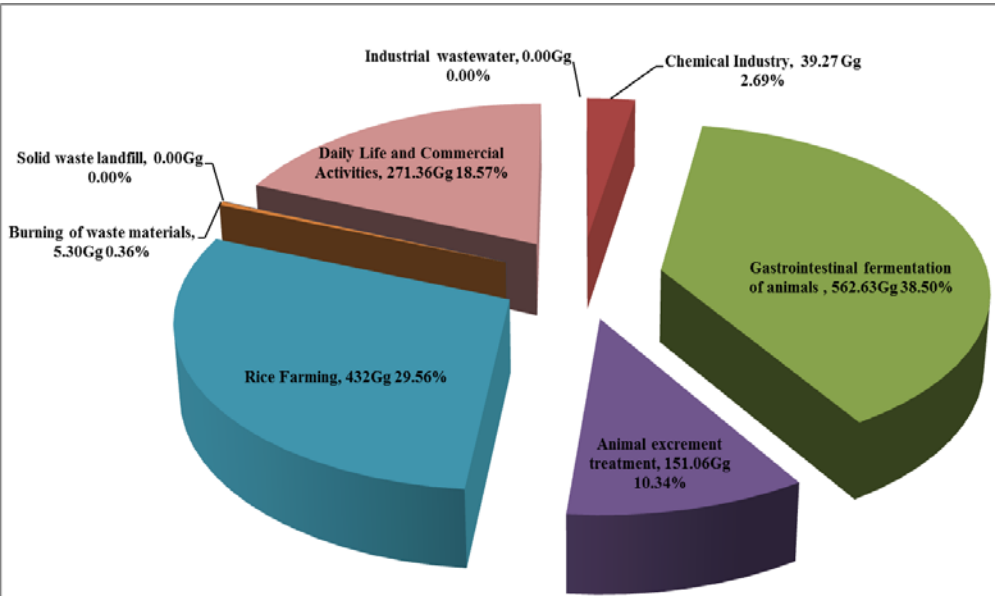
- The amount of methane emission reached a peak in 1995 due to improper waste management and loose regulation of GHG.
- Implementation to the GHG regulations and the policies of waste management led to decreasing emission since 2000.



I. Sources of Methane in Taiwan

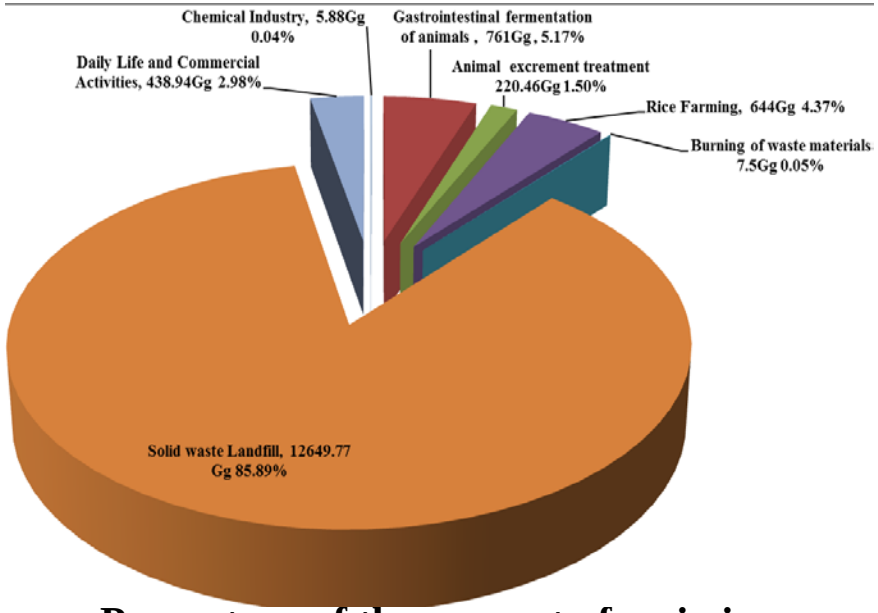
3. The sources and the contribution of methane emissions in 1995 and 2010

The amount of methane emission in 2010



Percentage of the amount of emission from each sector in 2010

The amount of methane emission in 1995



Percentage of the amount of emission from each sector in 1995

Gg：Giga Grams (Thousand metric tons)

Note：the confirmation for the amount of emission from solid waste landfill and industrial wastewater in 2010 is pending.
the confirmation for the amount of emission from industrial wastewater in 1995 is pending.

I. Sources of Methane in Taiwan

4. Comparison of Methane Emissions between 1995 and 2010

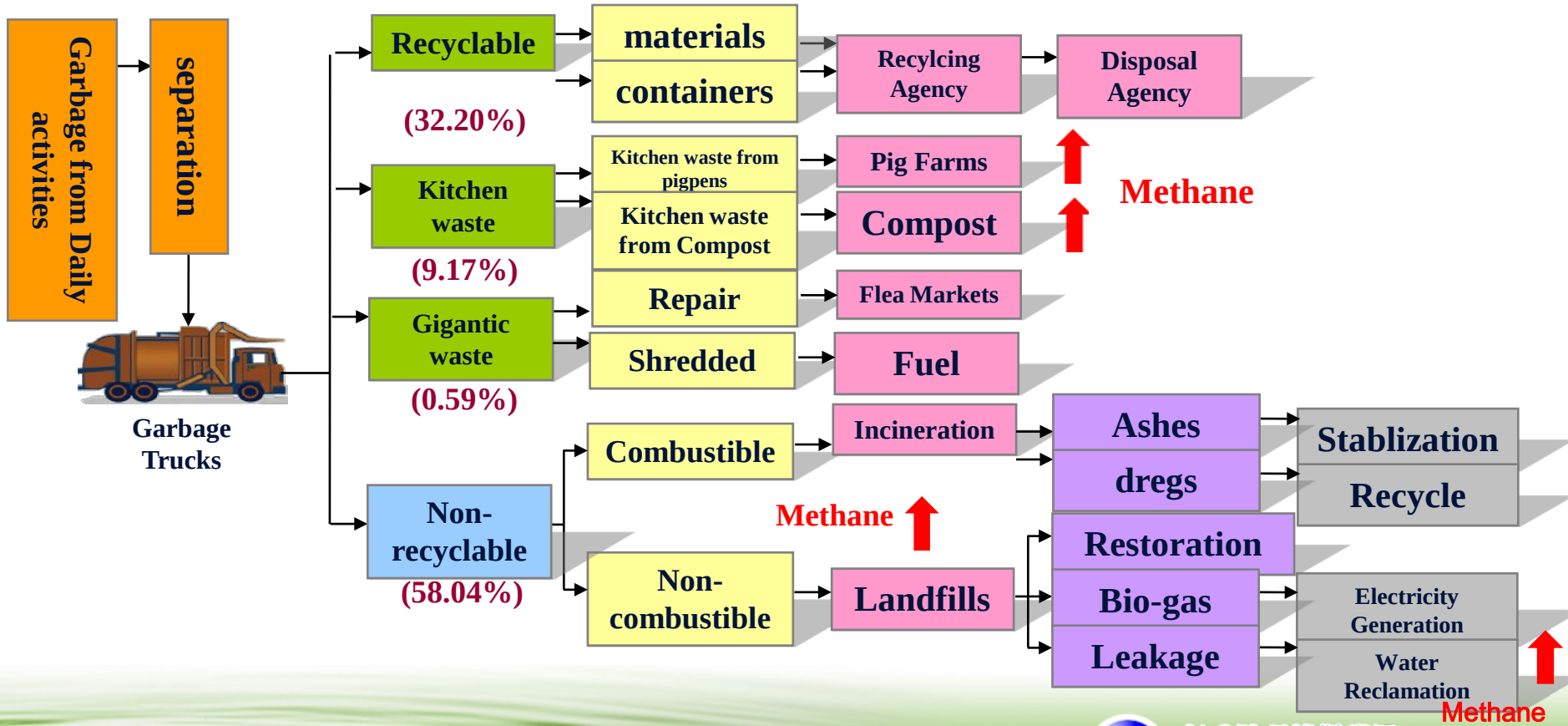
Solid waste landfills Gastrointestinal fermentation of animals	1995 methane		2010 methane	
	Gg	%	Gg	%
Solid waste landfills	12649.77	85.89	325.5 *	0.18 *
Gastrointestinal fermentation of animals	761.2	5.17	562.63	38.49
Emission from rice farming	644	4.37	432	29.56
Wastewater from residential & commercial activities	**438.94**	**2.98**	**271.36**	**18.57**
Burning of waste materials	7.5	0.05	5.3	0.36
Chemical industry	5.88	0.04	39.27	2.69
Industrial wastewater	---	---	18.85 *	0.01 *

Source: Methane Emission in Taiwan, Environmental Protection Administration (2013)
Note: "…": to be confirmed
" * ": number of 2009

II. Current status of methane emissions in Taiwan

1. Current Status of Solid Waste

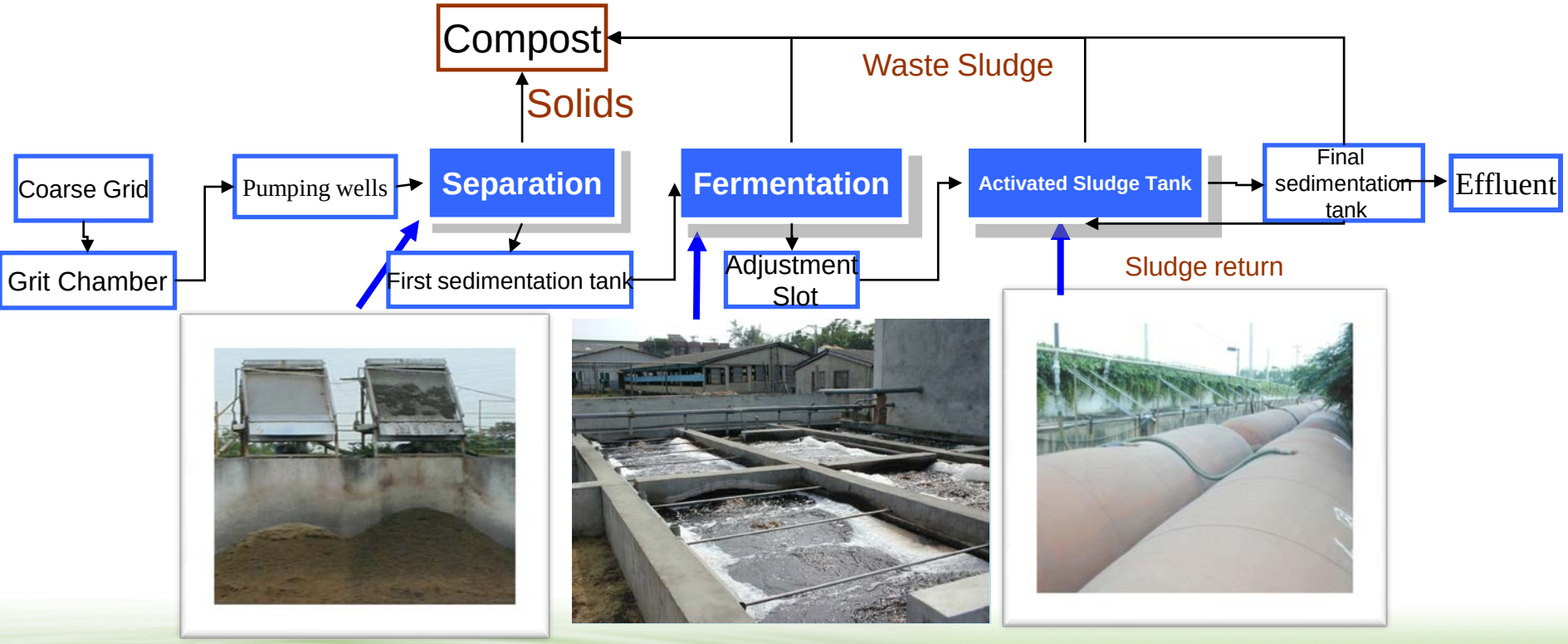
- The amount of waste in Taiwan was 7,500,000 tons in 2010.
- The current disposal management in Taiwan:



II. Current status of methane emissions in Taiwan

2. Current status of animal excrement treatment

- The number of pigs in November of 2012 was about 6 million.
- The daily average is 26,857 tons, and the yearly average of animal manure is 9,802,825 tons.
- More methane comes from conventional 3-stage sewage treatment .



II. Current status of methane emissions in Taiwan

3. Current status of other sources

- **Rice Farming**
  - The area used for rice farming was 450,000 hectares in 1990, and in 2010the area dropped to 243,000 hectares.
  - The amount of methane emission dropped from 644 tons in 1995 to 432 tons in 2010.

- **Wastewater from daily life and residential and commercial activities**
  - The amount of methane in 2012 was 271,360 tons, and it includes materials like detergent, feces and wasted oil, generating methane.

III. Control Measures and Achievements

1. Solid waste reduction control measures and achievements

- **Incineration** is the primary method of waste disposal since 1991 with landfilling as the secondary. No more new landfills were built since 2007. In the same year, EPA prohibited landfilling facilities from dealing with combustible wastes, recyclables, kitchen wastes, hazardous wastes and other wastes specified by competent authorities.

- In 1997, the **"4-in-1 Recycling Program"** was launched. In this program, recycling organizations are formed in local communities, garbage is separated into recyclables and wastes and collected at recycling points. Funding is provided to local cleaning teams and recyclers for processing.

III. Control measures and achievements

1. Solid waste reduction Control measures and achievements

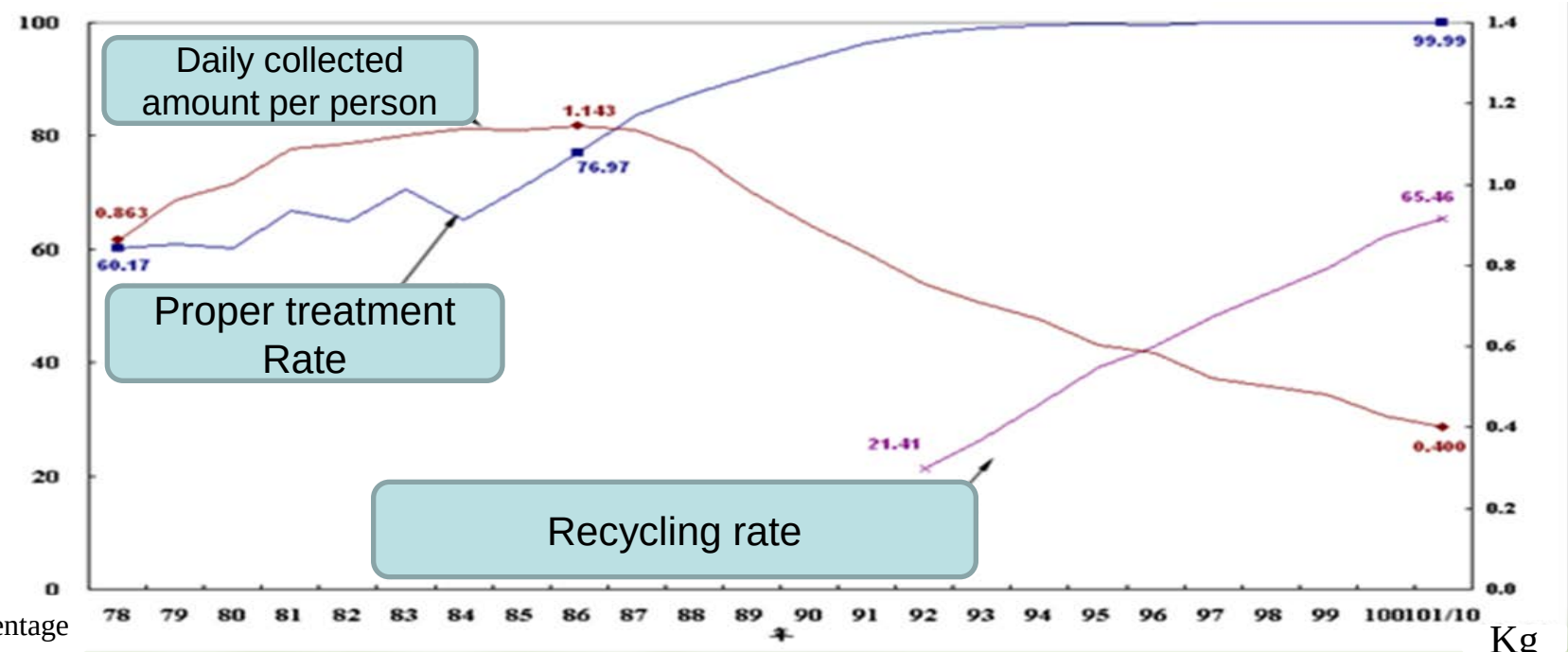
- The Resource Recycling Act has been in force since 2002 to enforce waste reduction from source, resource recycling and reuse, and to establish a complete system of recycling. From here the recycling percentage started to rise and exceeded landfilling percentage in 2004. The recycling of kitchen wastes and large-sized wastes was initiated in 2003 and 2005, respectively.

- In 2005, the EPA started **the compulsory waste sorting project** that aims for the separation of household wastes into **recyclables, kitchen wastes and garbage**. Once kitchen wastes are recycled, raw kitchen wastes can be used for compost, and cooked kitchen wastes for pig feeds or conduct digestion to generate methane.

III. Control measures and achievements

1. Solid waste reduction control measures and achievements

- The amount of daily collected waste dropped from 17,147 tons in 1989 to 9893 tons in 2011.
- The amount of daily collected waste per person dropped from 0.863kg in 1989 to 0.427kg in 2011.
- The rate of recylcing waste rose from 9.78% in 2000 to 52.2% in 2011.



III. Control measures and achievements

1. Solid waste reduction control measures and achievements

- "Incentive Rules for Power Generation Using Bio-Gas Generated from Waste Landfills" specify that EPA may provide subsidies for every kW of power actually sold by bio-gas power generation businesses.
- From 1999 to 2012, the yearly amount of biogas collected from landfills is about 594,000 tons, of which methane is 158,000 tons, so the total amount is equal to 4,170,000 tons of CO_2.

3 Bio-gas generators of Xicingpu provide 4.083MW

1 bio-gas generator of Fudekeng provides1.361MW

2 bio-gas generators of Sanzukhu provide 2.722MW

III. Control Measures and Achievements

2. Animal excrement reduction measures and achievements

- The concentration of solids in pig excrements is increased for better gas production, thus achieving zero discharge of pig farming wastewater, effective improvement water quality in rivers and the benefits from recycling methane gas for energy production.
- In 2012, the number of sanitized pigpens reached to **18,081** and they have collected **2,020 tons of excrements daily** from **452,025 pigs**. It is estimated to have saved 48% of water and more than 38% of manual labor.

Pigpens before and after installation of pig restroom

III. Control measures and achievements

2. Animal excrement reduction measures and achievements

- Agricultural Department has installed sanitized pigpens at Livestock Research Institute at **Xinhua, Tainan City** as well as **bio-gas power generation equipment** for effective reduction of wastewater and excrements.
- Replacement of air conditioning with sun shades and water in animal farming facilities for lower air temperature and energy use and costs
- Improvement of feed efficiency for less production of excrement, or additives in feeds to the reduction of methane generation during food digestion.

Source: EPA

III. Control measures and achievements

3. Reduction measures and achievements for rice farming

- The amount of waste straw was 1,745,000 tons in 2001, and the amount was 1,666,000 tons in 2012.
- **The size of rice farming** was 450,000 hectares in 1990 and dropped to 243,000 in 2010.
- Collection of international GHG estimation specifications and revision of relevant local coefficients to establish the GHG estimation, survey and monitoring system for agricultural sector
- Encouraging the use of farming machines and equipment powered by **clean energy**, such as **solar or wind power**, for better energy conservation and CO_2 reduction through agriculture loan policies

Source：http://rice.ylepb.gov.tw/

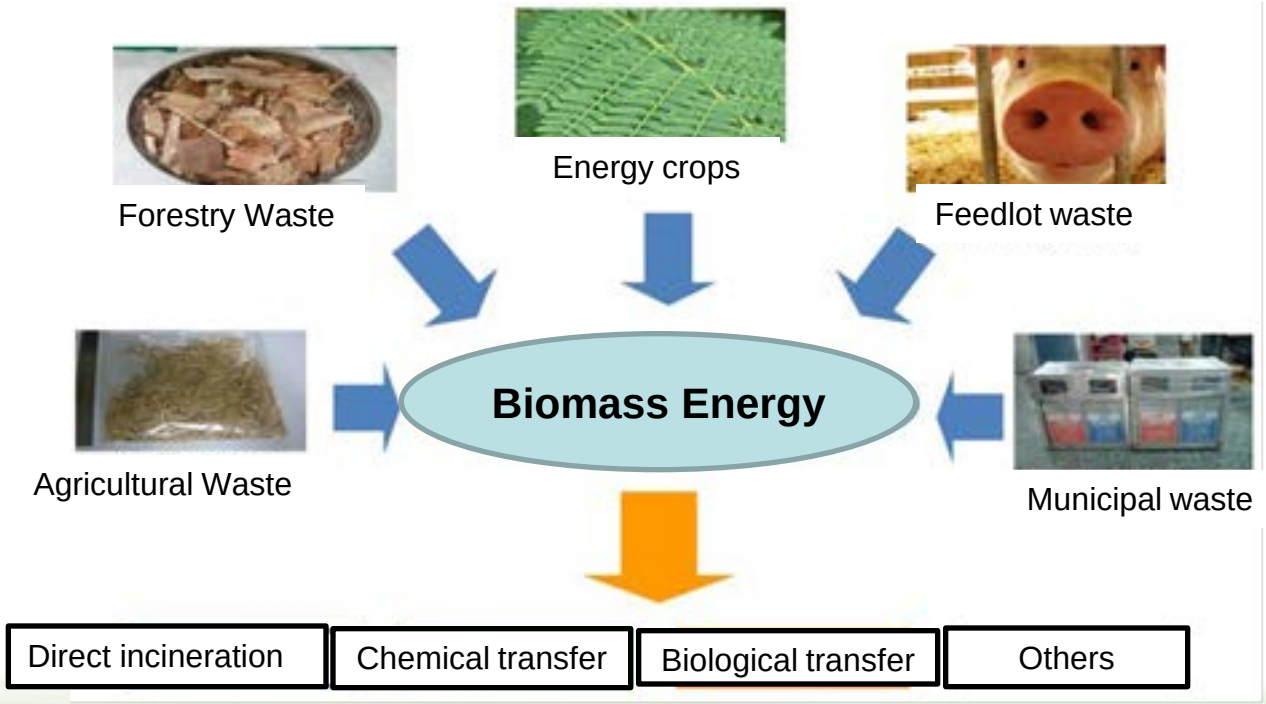
III. Control measures and achievements

4. Other implementations

- In May 9, 2012, "CO_2, **methane**, N_2O, CFCs, SF_6 and CFs **were announced as air pollutants**." the foundation of GHG emission management to encourage all **industrial sectors** to start reduction work as soon as possible.
- **For the energy sector**, the energy conservation and CO_2 reduction policies and measures will contribute to the reduction of methane emission in indirect ways, such as **extended use of natural gases, intensified promotion of renewable energy, reasonable energy prices**, GHG inventories of energy industry and volunteer reduction agreements.
- For industrial manufacturing sector, the primary measures include organized industrial volunteer reduction, small-scale reduction projects, energy-resource integration in industrial parks and carbon information disclosure programs for manufacturing industries.

IV. Future Developments

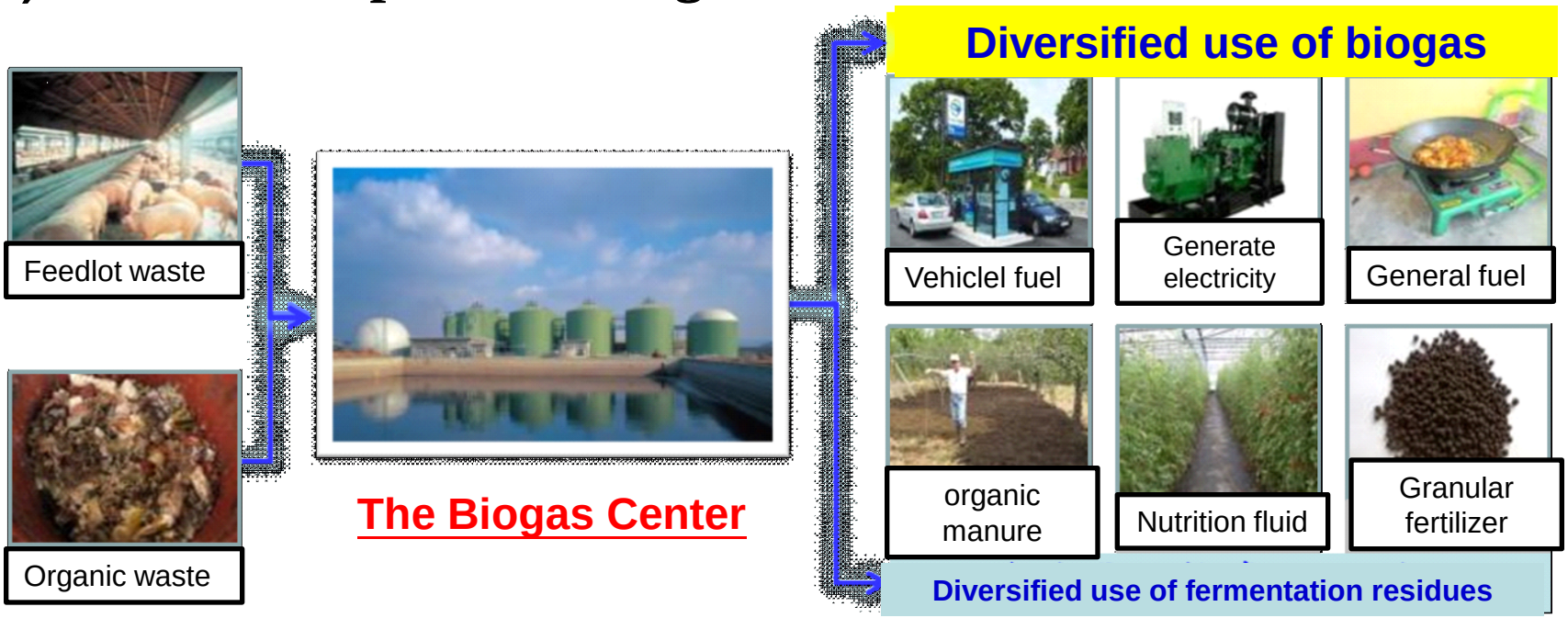
- In July 8, 2012 the Ministry of Economic Affairs promulgated the "**Regulations for Renewable Energy Development**" to promote the use of renewable energy, increase energy diversity, improve environmental quality, facilitate relevant industries and enable the sustainable development of the country
- "**Bio-energy**" is energy generated by directly using or processing from agricultural and forestry products, bio-gas and organic wastes produced domestically. The power generation from bio-energy in Taiwan is expected to reach 1,030MW in 2020



IV. Future Developments

1. The Biogas Center

（1）Continue to promote biogas centers in Taiwan



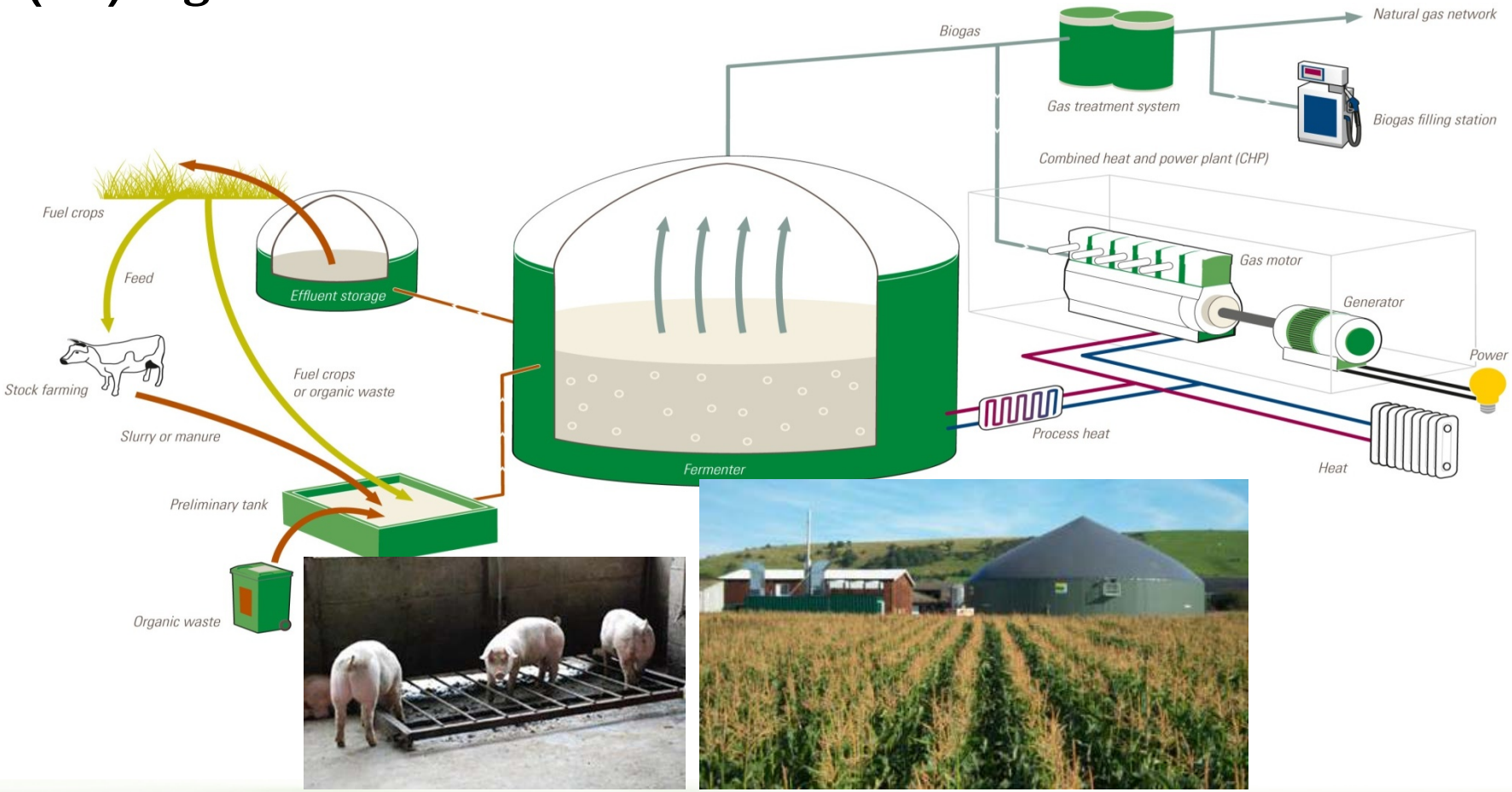
Future of animal excrement bio-gas centers

Source: EPA

IV. Future Developments

1. Anaerobic Digestion

（2）Agricultural Waste Treatment in the future

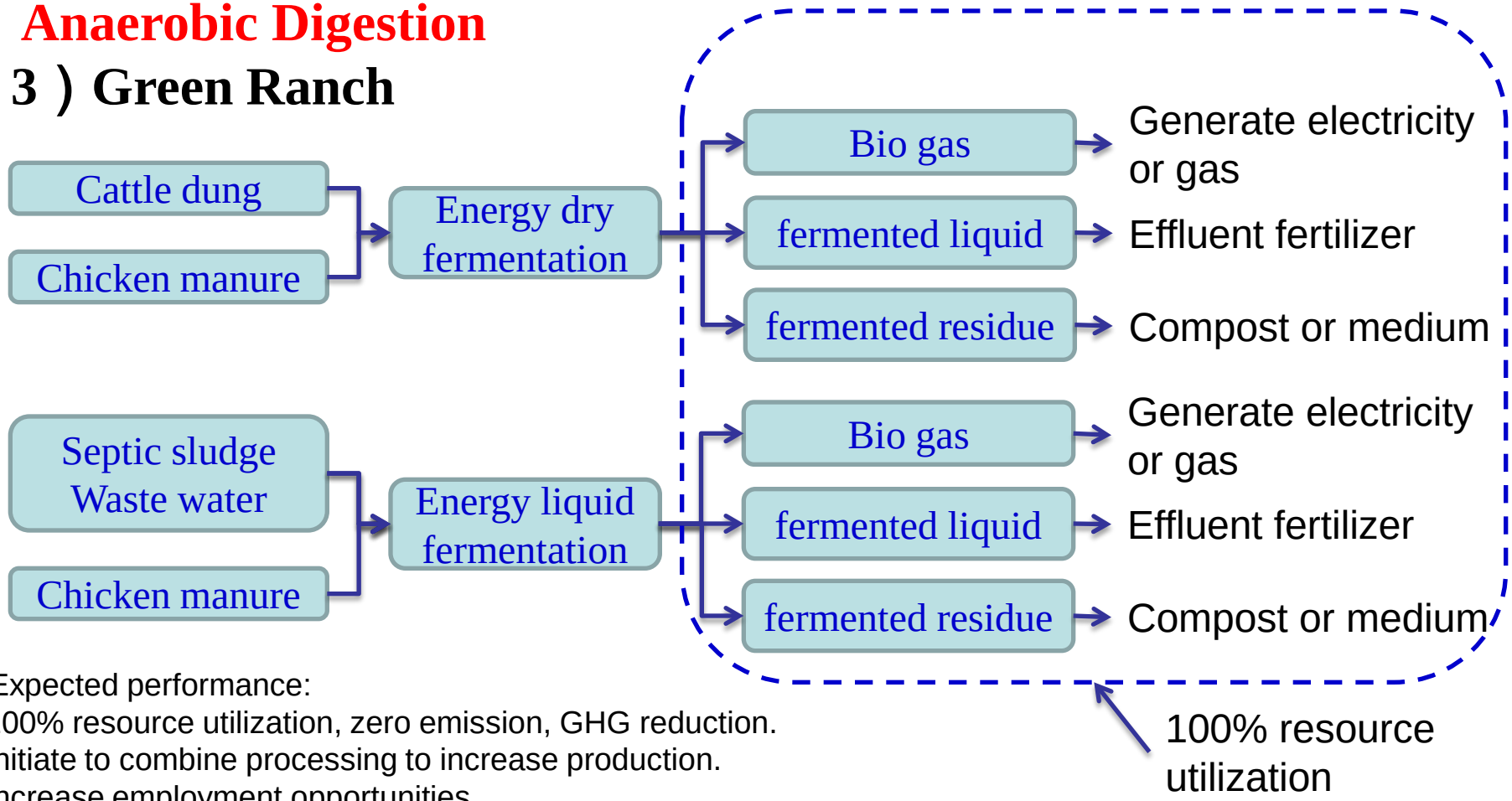


Source: http://www.tetaproject.co.uk/en/biogas.html

IV. Future Developments

1. Anaerobic Digestion

（3）Green Ranch



- Expected performance:
  100% resource utilization, zero emission, GHG reduction.
  Initiate to combine processing to increase production.
  Increase employment opportunities.

Source:Wei Chuan Corp.

IV. Future Developments

1. Bali co-digestion pilot project

(4) Bali Wastewater Treatment Plant: To determine the feasibility of developing anaerobic co-digestion of kitchen wastes and other organic wastes and revitalize the egg-shaped digestion tanks of Bali Wastewater Treatment Plan in New Taipei City, a pilot plan was developed to make good use of the redundant capacity of these tanks

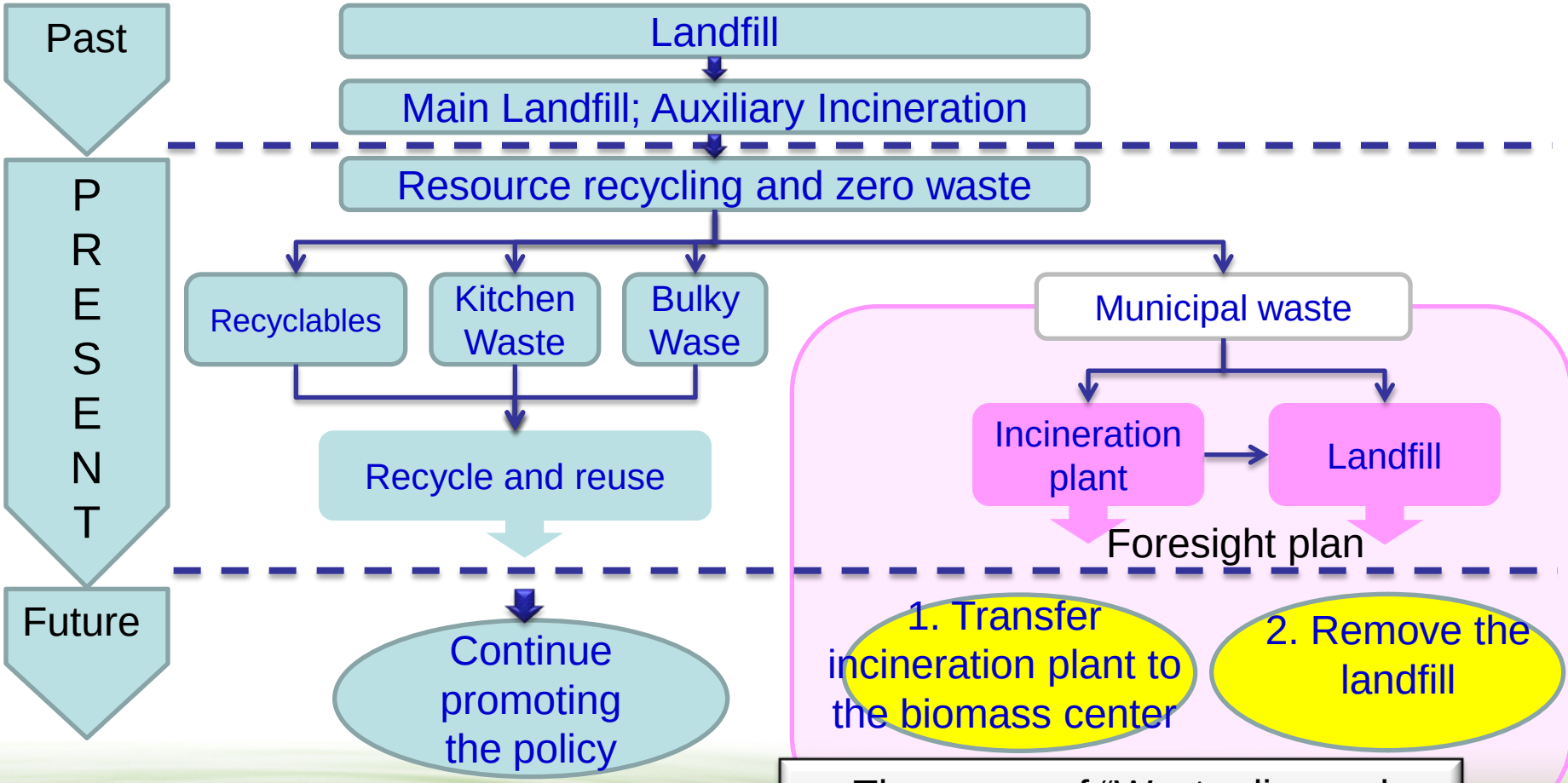
Bali Co-digestion Pilot Project

- Goal: Mix 150 T kitchen waste with 300 T primary sludge for co-digestion daily (starting with 20 T)
- Generated methane to be used for electricity generation
- Expected benefits: reduce 7350 T GHG emissions, generate 170 MWh electricity (per month)
- Status: Ongoing

IV. Future Developments

2. Transformation of incinerators

(1) Bio-energy Centers

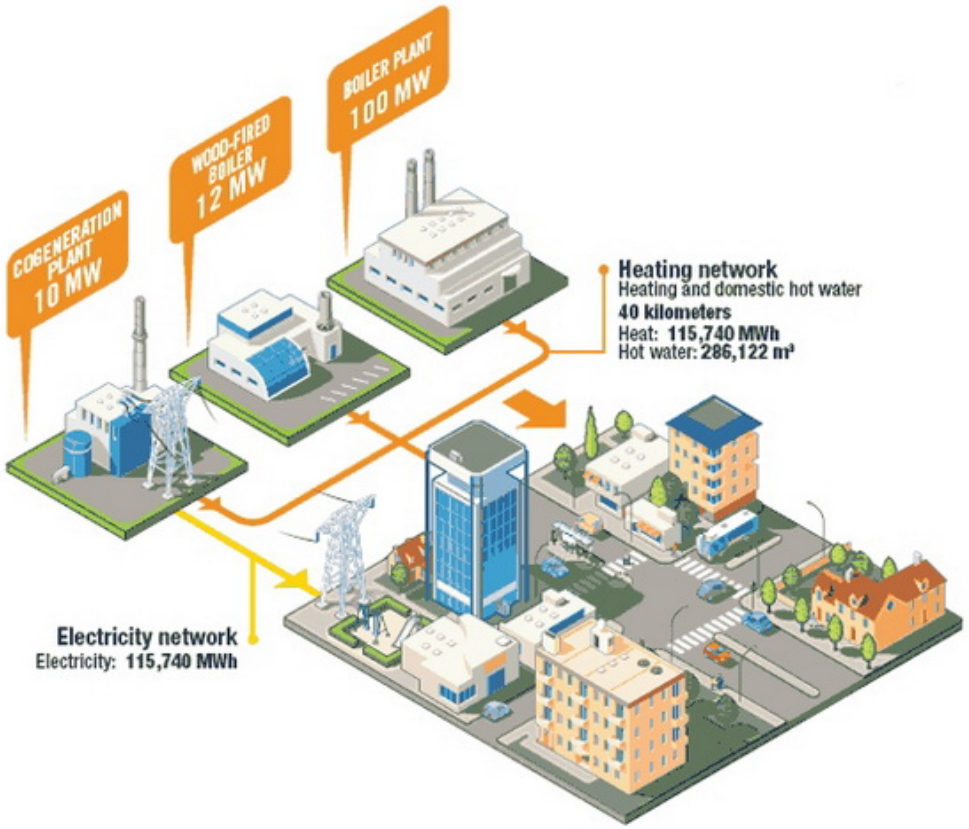


The scope of “Waste disposal policy” environmental assessment

IV. Future Developments

2. Transformation of incinerators

(2) C H P (Combined Heat and Power System) recycle exhausted heat. Recover 30%~50% of heat from industry to achieve 80% of fuel efficiency.

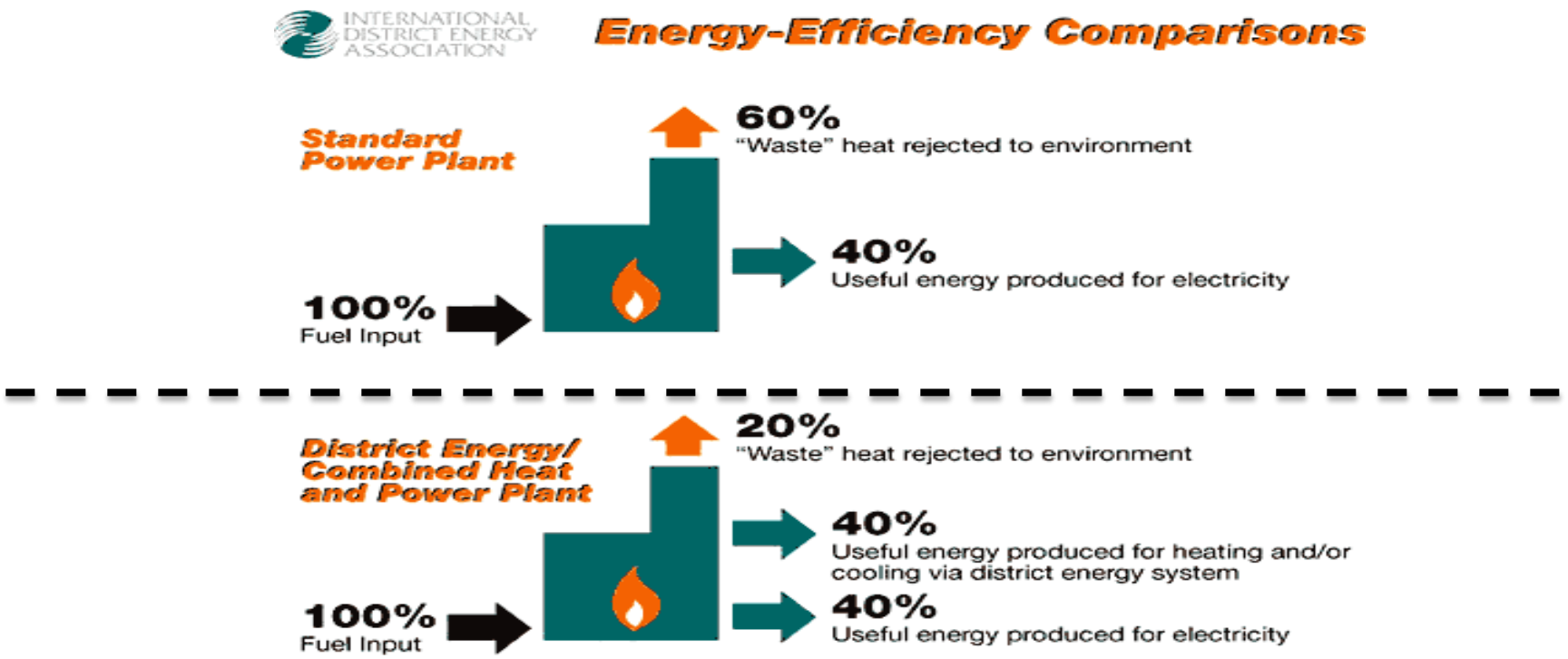


Source: General Hispano ROMGAS http://reparacionescalefaccion.es/romgas/calefaccion-de-distrito/

IV. Future Developments

2. Transformation of incinerators

（3）Recycling of the exhaust heat from incinerators



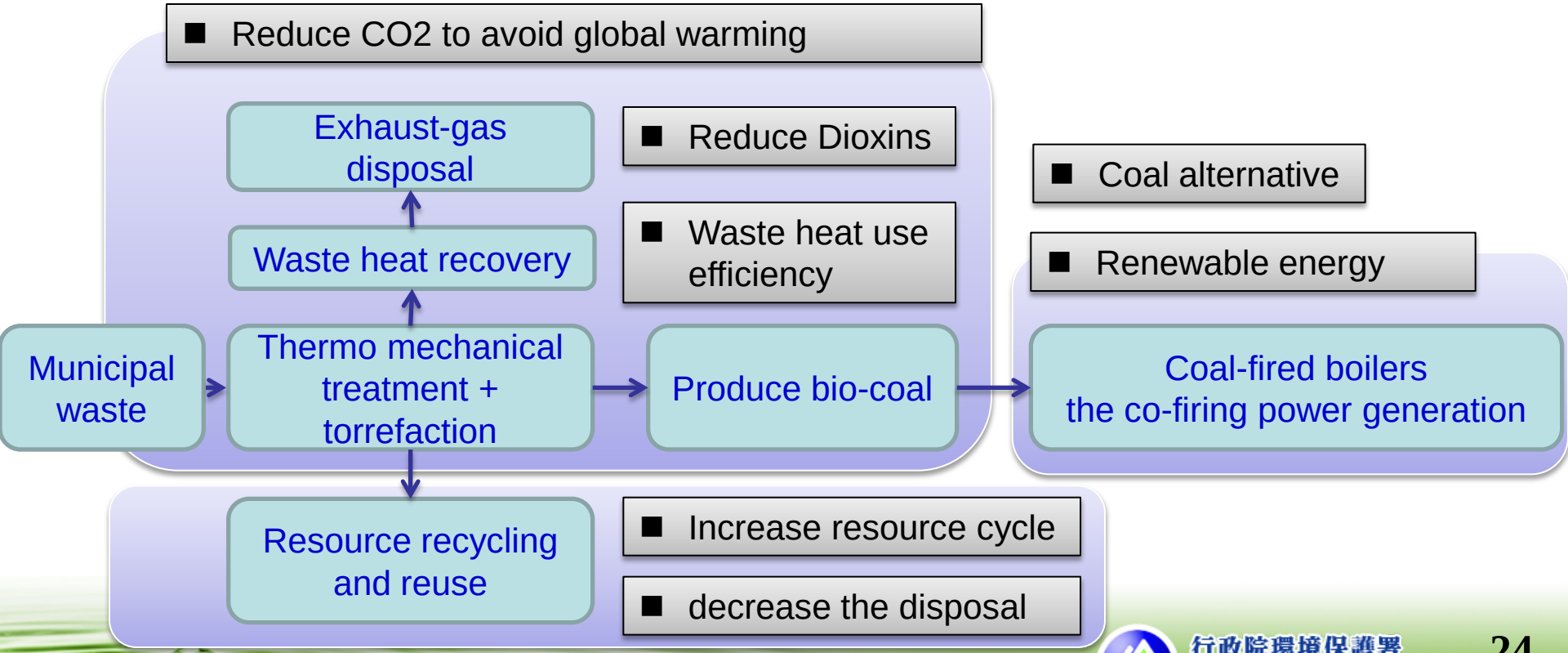
Source: http://www.ecy.wa.gov/climatechange/cat_twg_comments0507.htm

IV. Future Developments

2. Transformation of incinerators

（4）Potential benefits from incinerator transformation

Reuse energy resources to keep up with the trend of energy conservation and carbon reduction



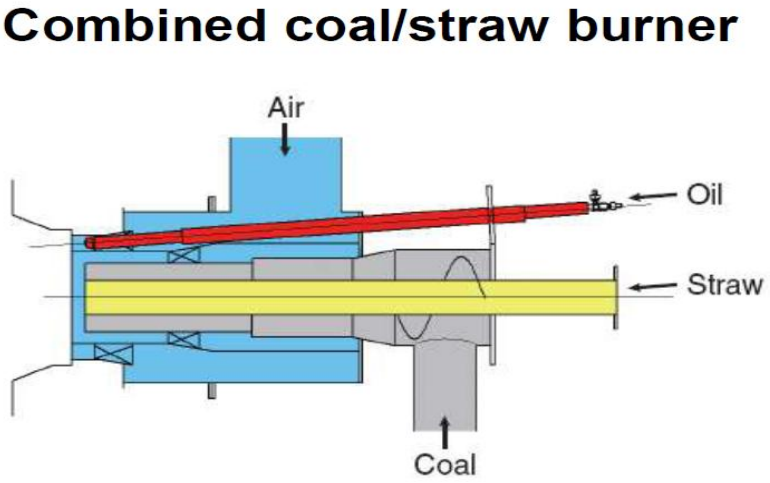
IV. Future Developments

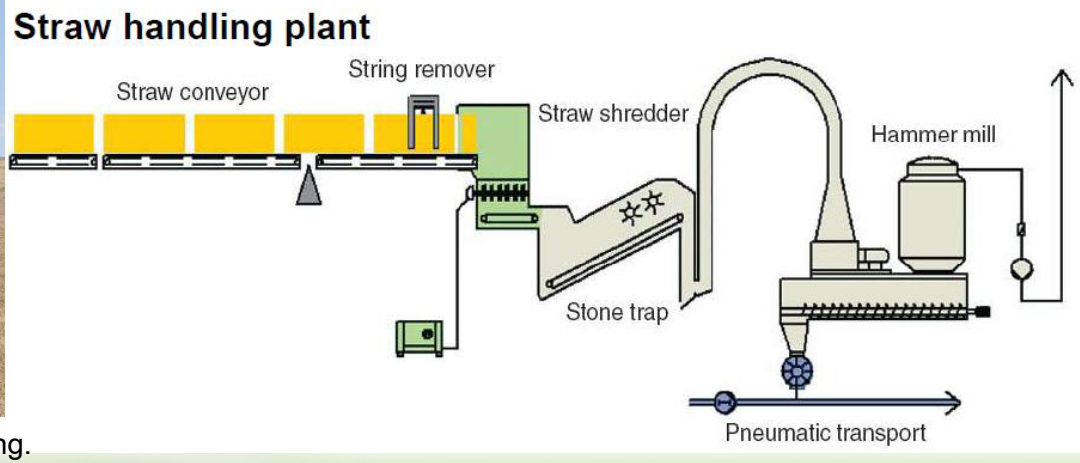
3. Methane-powered Vehicles

- It is now being approved by converting a **diesel-fueled vehicle** in use into **natural gas** fueled , assisting the applications and promoting the effective use of methane gas.

IV. Future Developments

4. Pelletizing

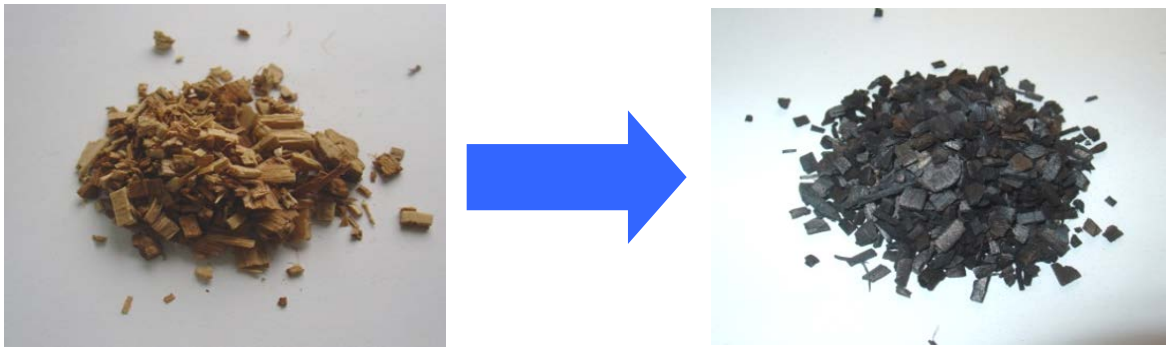




Source: 2012 Conference on Renewable Heating and Cooling.

IV. Future Developments

4. Torrefaction : It's processed under regular pressure and hypoxia within 200-300 ℃ to reduce the volume and water, etc., so heating value becomes higher to increase the effectiveness of storage and transportation.



V. Conclusion

Future Objectives:

- Continue the research of carbon reduction and recycling technologies of methane, analyze the advanced technologies around the world , and introduce new processing technologies and investment.
- Strengthen economic incentives and the Greenhouse Gas reduction strategy to benefit energy conservation and carbon reduction.
- Promote the applied technologies and create a better future for future generations by combining the efforts of government and industry.

Future Cooperation

- Offer Taiwan’s experiences and lessons
- Exchange technical knowledge
- Welcome capacity building opportunities
- Assist with organizing events
- Cooperate in research projects

EPAT partnership with US EPA through American Institute in Taiwan

Information available at: www.epa.gov/oita

Thank You