Using Energy-from-Waste (EfW) for Managing Municipal Solid Waste (MSW) in Asia

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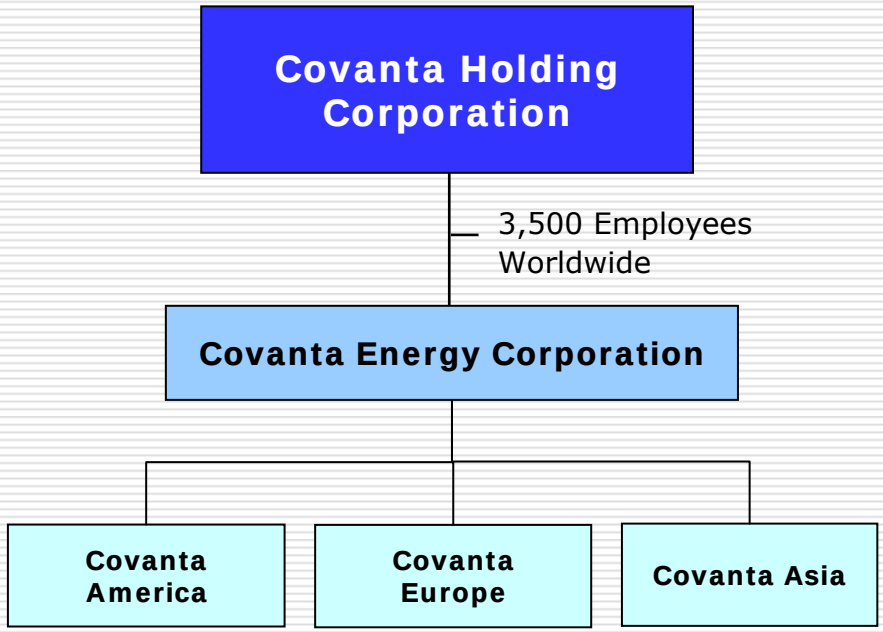
Seminar on Thermal Waste Treatment

Hong Kong, China

March 07, 2008

About Covanta

- **Covanta Holding Corporation is publicly traded on the NYSE (ticker CVA)**
- **Covanta Holding Corp's primary business is:**
  - Ownership and operation of Energy from Waste (EfW) and other renewable energy facilities
  - Managed through its wholly owned subsidiary Covanta Energy Corp
- **Covanta is the largest Developer/Owner /Operator of EfW facilities in the world**
  - Own and/or Operate 37 EfW facilities
  - Process approximately 16 million tons of waste each year
  - Produces approximately 1,100 megawatts of clean renewable electricity
  - Enterprise Value, approximately US$ 5.5 billion



Using Energy-from-Waste (EfW) for Managing Municipal Solid Waste (MSW) in Asia

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I. Worldwide Statistics and Significant Quotes

Developed and Near-Developed Economic Regions

Current Approximation of MSW Management Approaches:

- **50% by landfill (in decreasing trend)**
- **25% by EfW (in increasing trend)**
- **25% by recycling and reuse, including paper recycling, plastic recycling, composting, etc. – (in increasing trend)**

I. Worldwide Statistics and Significant Quotes - EfW Plants in Developed and Near - Developed Countries

Country / Region	MSW Generated (Million Tonnes/yr)	Year of Data	Landfilled wt. %	Lanfilled (Millions Tonnes/yr)	Incinerated by (WTE + Simple Incinerator)		No. of WTE Plants	Average WTE Plant Capacity (Thousand Tonnes/yr)
					wt. %	(Million Tonnes/yr)		
USA	229.20	2001	55.70	127.66	14.70	33.69	97	347
Austria	1.32	1999	51.00	0.67	35.00	0.46	3	154
Belgium	4.85	1997	42.00	2.04	35.00	1.70	17	100
Denmark	2.77	1996	15.00	0.42	56.00	1.55	32	48
Finland	0.98	1997	77.00	0.75	2.00	0.02	1	20
France	48.50	2000	55.00	26.68	26.00	12.61	210	60
Germany	45.00	2000	30.00	13.50	29.00	13.05	59	221
Greece	3.20	1993	93.00	2.98	0.00	0.00	0	N/A
Italy	25.40	1995	85.00	21.59	8.00	2.03	32	64
Luxembourg	0.30	1995	24.00	0.07	48.00	0.14	1	144
Portugal	3.48	1999	65.00	2.26	25.00	0.87	3	290
Span	17.00	1997	85.00	14.45	10.00	1.70	9	189
Sweden	3.80	1999	24.00	0.91	38.00	1.44	30	48
Netherlands	7.95	1997	20.00	1.59	62.00	4.93	11	448
UK	27.20	1999	85.00	23.12	6.00	1.63	17	96
Taiwan	7.84	2004	22.00	1.72	70.00	5.49	27	203
Singapore	2.63	2002	0.00	0.00	92.00	2.42	4	605
Japan	52.40	2000	20.00	10.48	77.00	40.35	233	173
Korea	16.64	1999	45.00	7.49	20.00	3.33	22	151
Total/Average	**500.46**	**N/A**	**51.63**	**258.38**	**25.46**	**127.42**	**808**	**284**

I. Worldwide Statistics and Significant Quotes – EfW Plants in Asia

Economic Regions	MSW Generated (Million Tonnes/yr)	Year of Data	Landfilled wt. %	Lanfilled (Millions Tonnes/yr)	Incinerated by (WTE + Simple Incinerator)		No. of WTE Plants	Average WTE Plant Capacity (Thousand Tonnes/yr)
					wt. %	(Million Tonnes/yr)		
Taiwan	7.84	2004	22.00	1.72	70.00	5.49	27	203
Singapore	2.63	2002	0.00	0.00	92.00	2.42	4	605
Japan	52.40	2000	20.00	10.48	77.00	40.35	233	173
Korea	16.64	1999	45.00	7.49	20.00	3.33	22	151
Total/Avera	**79.51**	**N/A**	**24.77**	**19.69**	**64.88**	**51.58**	**286**	**180**
China*	230	2005	53.96	124.1	2	11.06	67	165

***Based on World Bank Report**

I. Worldwide Statistics and Significant Quotes

- **Significant Quotes by Public Leaders**

I. Worldwide Statistics and Significant Quotes by Public Leaders

- ***"Now meeting our renewable targets will also require a number of other changes: more onshore wind farms sited in the right places, greater use of energy derived from waste, a major expansion of energy from biomass, greater use of micro generation, including as costs come down more solar power." --- U.K. Prime Minister Gordon Brown, One Planet Future seminar, November 19, 2007.***

I. Worldwide Statistics and Significant Quotes by Public Leaders

- ***"EfW is a tried, tested and proven technology which is run to strict environmental standards. It also has the added advantage of producing electricity which can be used to power local homes or be sold to the national grid." --- Buckinghamshire council spokeswoman, January 29, 2008***

I. Worldwide Statistics and Significant Quotes by Public Leaders

- ***"The Department for Environment, Food, and Rural Affairs (DEFRA) in the United Kingdom commissioned a comprehensive review of all forms of MSW management. The department found that emissions from the incineration of MSW were lower than those from domestic heating or cooking."***

I. Worldwide Statistics and Significant Quotes by Public Leaders

- ***The German Ministry of the Environment reports that home fireplaces have more than 20 times the dioxin emissions than the 66 modern German EfW facilities combined --- Alyssa A. Lappen and Jack D. Lauber, "The Burning Issue," FrontpageMagazine.com, March 1, 2006.***

I. Worldwide Statistics and Significant Quotes by Public Leaders

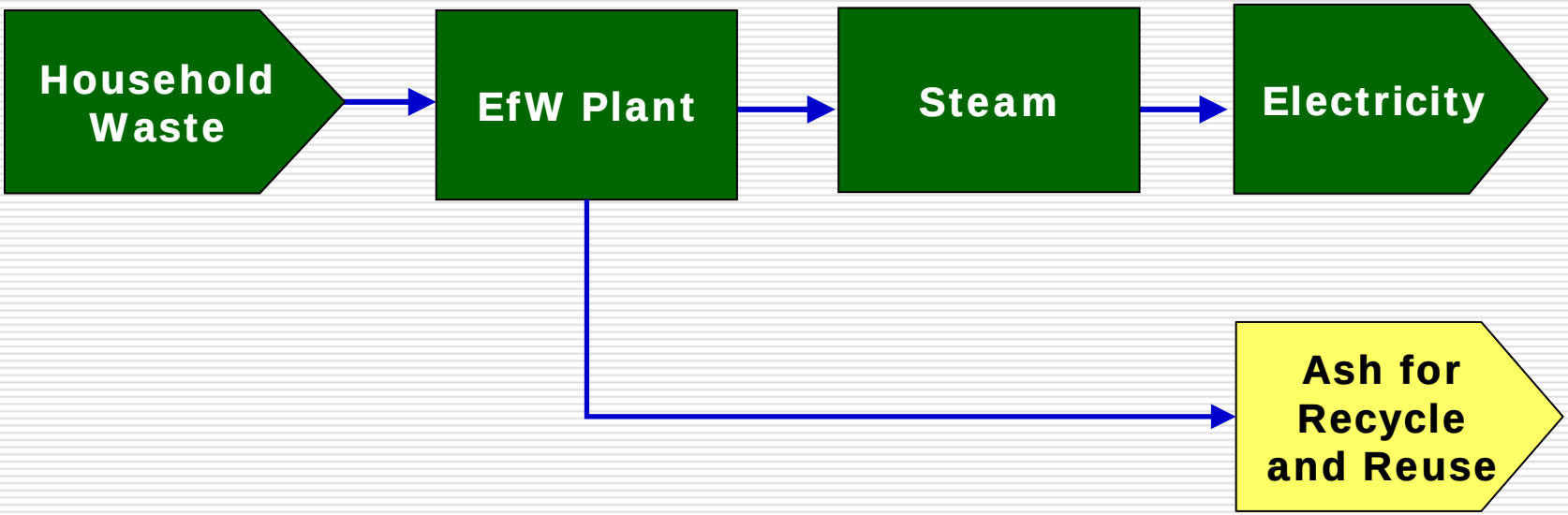
- ***In 2003, the U.S. EPA declared that EfW facilities "enable us to continue to rely on municipal solid waste as a clean, reliable, renewable source of energy" and produce power "with less environmental impact than almost any other source of electricity. --- EPA letter from Marianne Lamont Horinko, Assistant Administrator, Office of Solid Waste and Emergency Response and Jeffrey R. Holmstead, Assistant Administrator, Office of Air and Radiation to Maria Zannes, President, Integrated Waste Services Association, February 14, 2003.***

II. EfW Technology

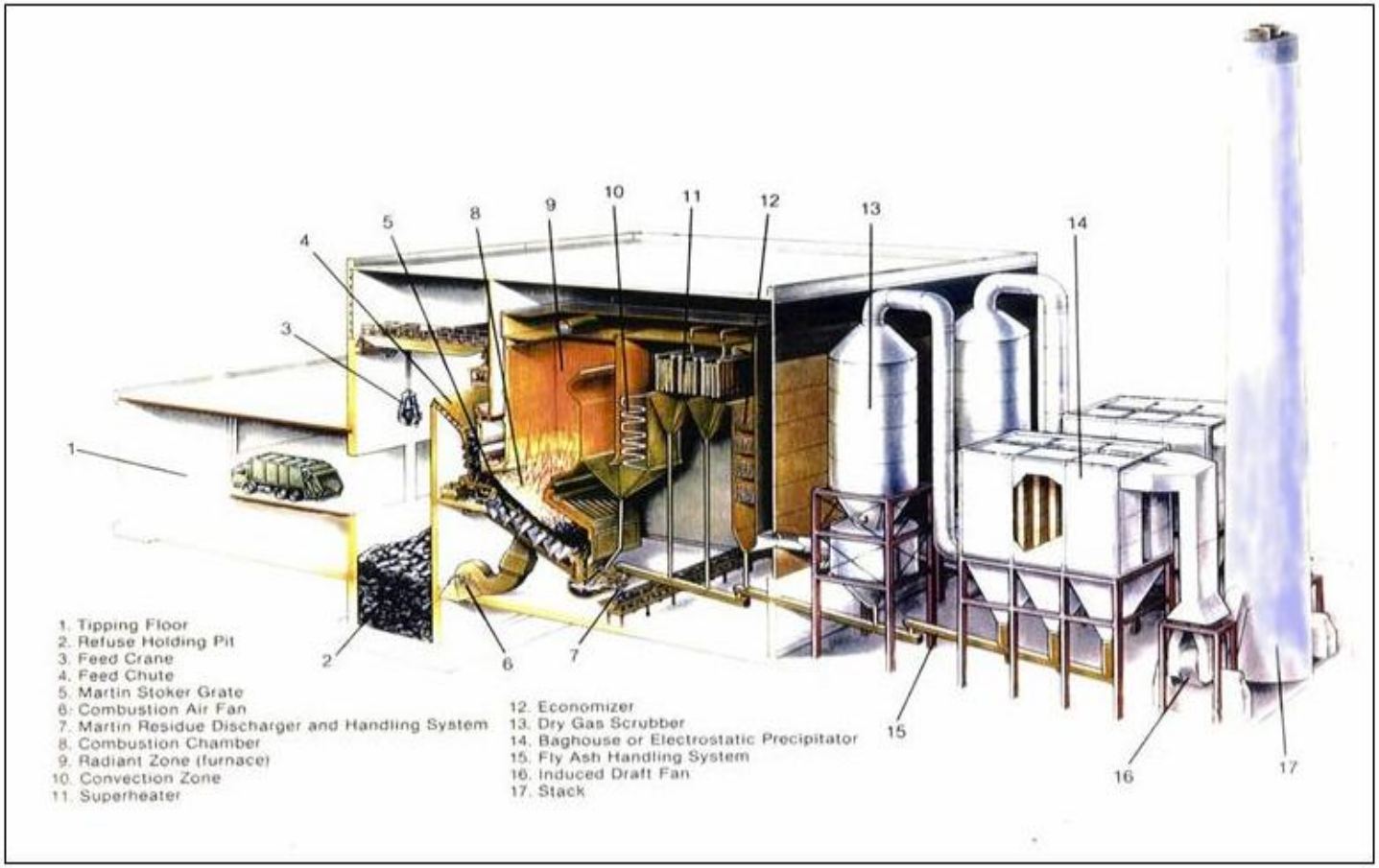
II. EfW Technology

- **Mass Burn EfW Technology is the most commonly used technology for treating MSW while generating energy**
- **Well proven technology with 100 plus years history**
- **Today there are more than 600 mass burn plants operating worldwide, burning more than 130 million tonnes a year of MSW and recovered more than 84,500,000 Mw-hr of electricity (equivalent to 20,000,000 household electricity needs) – [as of 2003]**

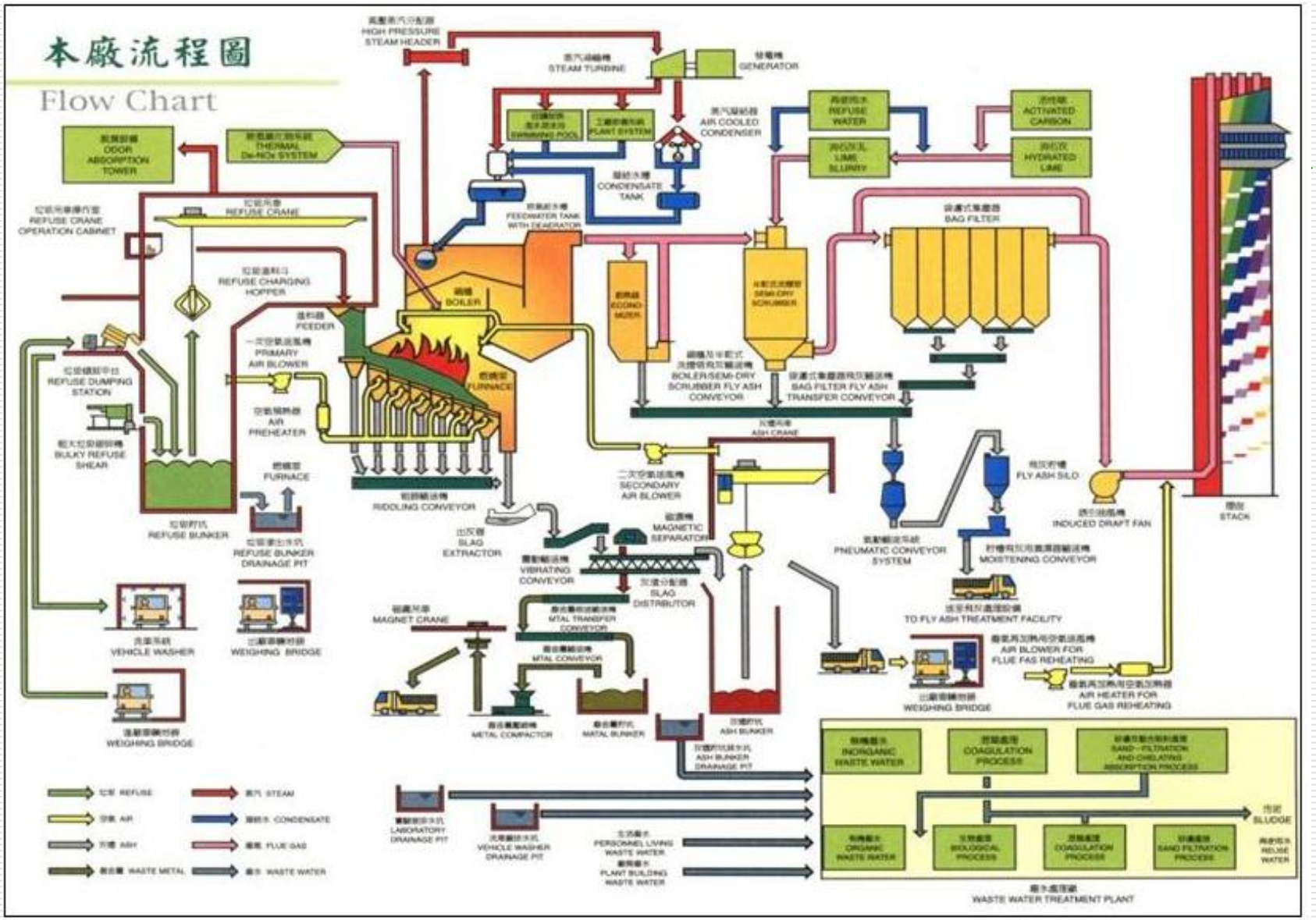
II. EfW Technology



II. EfW Technology – A Typical Mass Burn EfW Plant



EfW Plant Flow Chart



Pa-Li WTE Plant (1,350 mt/day), Taipei County

Tainan City WTE Plant (900 mt/day)

KH City Central WTE Plant (900 mt/day)

Chia-yi City WTE Plant (300 mt/day), Chia-yi City, Taiwan

Lu-Tsao WTE Plant (900 mt/day), Chia-Yi County, Taiwan

Pu-Xi WTE Plant, Shanghai, China

Pu-dong WTE Plant, Shanghai, China

Sanfeng Covanta Tongxing EfW Facility
三峰卡万塔同兴垃圾焚烧发电厂

Sanfeng Covanta is an owner-and–operator of the Chongqing Tongxing Energy-from-Waste facility treating 1,200 metric tons per day of MSW and generating 24 Mw electricity.

三峰卡万塔是重庆同兴垃圾焚烧发电厂的股东和运营商，该电厂日处理垃圾量为1,200吨，发电装机量为24兆瓦

EfW Conceptual Rendering

Covanta Hillsborough, Inc. (Florida, 1,200 tons/day, 29 Mw)

Covanta希尔斯伯如弗公司（弗罗里达，1200吨/日，29Mw）

Covanta Pasco, Inc.
(1,050 tons / day, 31 Mw)
Covanta帕斯科公司 （1050吨/日，31Mw）

Covanta Pasco, Inc.
Spring Hill, Florida

The Pasco County Solid Waste Resource Recovery Facility began commercial operation in May 1991, serving the residents of Pasco County. The facility processes up to 1,050 tons per day of solid waste, generating 31.2 megawatts of renewable energy that is sold to Florida Power Corporation. The facility uses secondary sewer treatment effluent from a nearby wastewater treatment plant for part of its process water make-up. In addition, as part of the waste-to-energy facility, there is a public drop-off center where local residents can bring non-hazardous household items for disposal.

帕斯科郡固体垃圾资源回收工厂从1991年5月开始商业运营，服务于Pasco郡的居民。这个工厂每天可处理1050多吨固体废物，并将其转化成31.2兆瓦可再生能量，卖给佛罗里达电力公司。该工厂使用来自附近污水处理厂的二级污水处理流出物作为部分处理水。此外，这里有一个公众“丢弃”中心，成为变废为能工厂的一个部分，居民可以将他们的无害家庭用品到此处理。

帕斯科郡固体垃圾资源回收工厂

The Pasco County Solid Waste Resource Recovery Facility

Covanta Stanislaus, Inc.
(800 tons / day, 22.5 Mw)
Covanta斯坦尼斯洛斯公司 (800吨/日，22.5Mw)

Covanta Stanislaus, Inc.

Crows Landing, California

The Stanislaus County Resource Recovery Facility began commercial operation in January 1989, serving the City of Modesto and the County of Stanislaus in north central California. The facility processes 800 tons per day of solid waste, which generates up to 22.5 megawatts of renewable energy that is sold to Pacific Gas and Electric Company. The facility is a zero water discharge plant which means that all wastewater generated on-site is treated and reused in the process.

The facility is located in the southwest corner of the county in the community of Crows Landing, about 25 miles from Modesto in the farmlands of California's central valley.

斯坦尼斯洛斯资源回收工厂从1989年1月开始商业运营，服务于加里福尼亚中心北部的莫蒂斯托市和斯坦尼斯劳斯郡。该工厂每天可处理800吨固体废物，产生多达22.5兆瓦的可再生能源，将其卖给太平洋煤电公司。该工厂是“零废水排放”工厂，这意味着现场产生的所有污水都可以得到处理并在处理过程中得以重新利用。
工厂坐落在Crows Landing社区斯坦尼斯劳斯郡的东南角，距离加里福尼亚中部河谷农场的莫蒂斯托大约25公里。

斯坦尼斯洛斯资源回收工厂

The Stanislaus County Resource Recovery Facility

Covanta Hillsborough, Inc.
(1,200 tons / day, 29 Mw)
Covanta希尔斯伯如弗公司（1200吨/日，29Mw）

希尔斯伯如弗郡资源回收工厂

The Hillsborough County Resource Recovery Facility began commercial operation in October 1987. The facility processes 1,200 tons per day of solid waste, while generating up to 29 megawatts of renewable energy. The facility is owned by Hillsborough County, which supplies all the waste. This facility uses secondary sewer treatment effluent from the adjacent wastewater treatment plant for part of its process water. Installation of new emissions control equipment to comply with Clean Air Act amendments was completed on August 25, 2000.

希尔斯伯如弗郡资源回收工厂从1987年10月开始商业运营。该工厂每天可处理1200吨固体废物，并将其转化成29兆瓦可再生能源。这家工厂归希斯柏洛夫郡所有，希斯柏洛夫郡为其提供所有的废料。该工厂使用来自附近废水处理厂的二级污水处理流出物作为其部分处理水。为满足“空气清洁法修正案”要求，新的排放控制设备已于2000年8月25日安装完成。

Covanta Honolulu Resources Recovery Venture
(2,160 tons / day, 57 Mw)
Covanta火奴鲁鲁资源回收公司 （2160吨/日，57Mw）

Covanta Honolulu Resource Recovery Venture

Kapolei, Hawaii

Covanta Honolulu Resource Recovery Venture, also known as HPOWER, began commercial operation in May 1990. The facility is owned by the City and County of Honolulu.

Located on the Island of Oahu, it serves the municipal waste disposal needs of more than 850,000 residents and more than six million visitors to this island each year. The facility is capable of processing 2,160 tons per day of municipal solid waste into refuse derived fuel (RDF) for combustion, while generating up to 57 megawatts of energy from this renewable resource.

HPOWER also culls both ferrous and non-ferrous metals from the received solid waste stream and then recycles these products through local metal dealers.

Covanta火奴鲁鲁资源回收公司，也称H电力，从1990年5月开始商业运营，该工厂由火奴鲁鲁郡所有，座落在瓦胡岛上。这个工厂每年可以满足逾85万居民和600万游客的废物处理需求，每天可处理2160吨城市固体废物，将其转化为废弃物衍生燃料（RDF）加以燃烧，从中产生高达57兆瓦的能量。
H电力还从固体废物流中收集铁金属和非铁金属，然后通过当地金属处理机将它们回收再利用。

Covanta火奴鲁鲁资源回收工厂

Covanta Honolulu Resource Recovery Venture

III. Modern EfW Facility Meet all Emission Standards

III. Modern EfW Facility Meet all Emission Standards – Truthful Answer to Community General Questions

- **Will EfW cause air pollution?**
  - **Modern EfW plants are designed with the best combustion system and APC system that is cleaner than any fossil fuel fired power plants and steel, chemical and other process plants**
- **Will EfW cause water pollution?**
  - **Modern EfW plants are designed with total recycle and reuse of the wastewater and are "Zero Water Discharge" plants**
- **Will the MSW storage pit generate bad odor gases and spread out to adjacent communities?**
  - **Pit is designed and operated under negative pressure therefore no bad smell gases will leak out**

III. Modern EfW Facility Meet all Emission Standards – Truthful Answer to Community General Questions

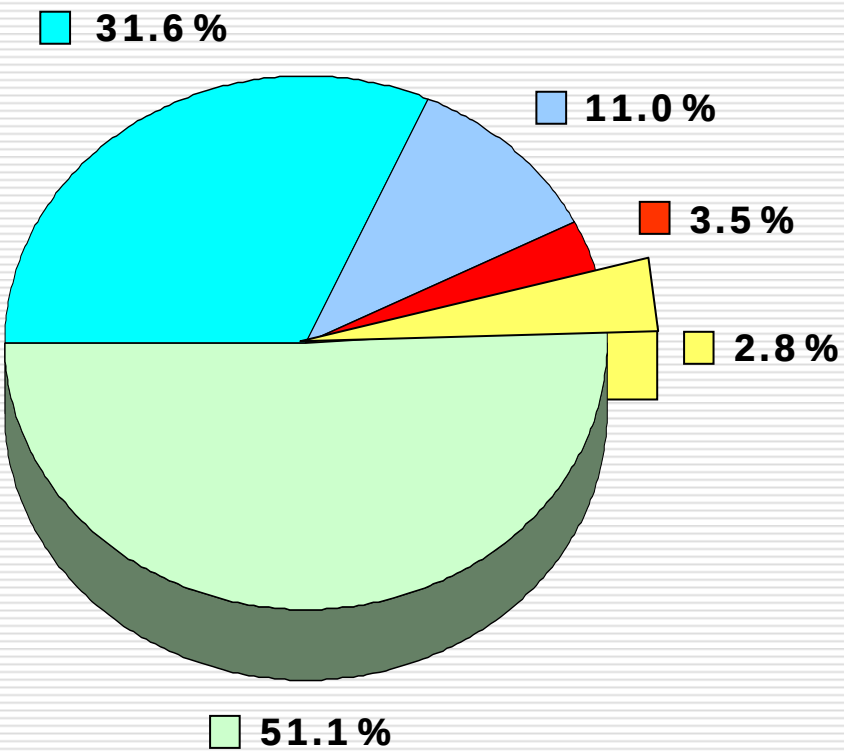
- **How about ashes after combustion?**
  - Bottom slag can be recycled and reused as road paving and construction material (see video presentation)
  - Fly ash is either solidified and chemically fixed before landfill or recycled and reused for cement production (see video presentation)

- **How about the noise?**
  - EfW plants are enclosed in cement concrete building which effectively reduce the noise down to ambient level of quietness

III. Modern EfW Facility Meet all Emission Standards

- **NOx – controlled by urea or ammonia injection**
- **Dioxin and heavy metals – removed by activated carbon injection**
- **HCl and SOx – removed by lime injection**
- **Air born particulates – removed by bag filter**
- **Zero water discharge – through complete in-plant recycle and reuse of the wastewater**
- **Fly ash – solidified and chemically fixed**
- **Bottom ash – recycled and reused**

III. Modern EfW Facility Meet all Emission Standards – Dioxin Sources



- Industrial Raw Materials and Process (51.1%)
- Nature-Born and Wood Burning (31.6%)
- Transportation, Coal & Fossil Fuel Fired Power Plants (11.0%)
- Medical and Hazardous Waste Incineration Facilities (3.5%)
- 27 EfW Facilities Combined (2.8%)

Information Source: Taiwan EPA

III. Modern EfW Facility Meet all Emission Standards

Comparison of EU and USA Limits Using English Units for Comparison

Reference Information		EU Metric Units (g)(e)		EU English Equivalent		New USA Limits		
Pollutant	Units (a)	24 hr mean	30 min mean	24 hr mean	30 min mean	EPA	FLDEP	Comment
CEM Criteria								
PM	mg/dscm/7	10	30	13.1	39.2	20	12	
VOCs as CH4	ppmdv7	10	20	19.7	39.4	---	---	
HCl	ppmdv7	10	60	8.6	51.8	25	25	or 95 %
HF	ppmdv7	1	4	1.6	6.3	---	---	
SO2	ppmdv7	50	200	24.6	98.4	30	26	or 80 %
NOx as NO2)	ppmdv7	200	400	136.9	---	150	90	
NH3	ppmdv7	--	--	18.5	---	---	30	
CO	ppmdv7	50	100	56.2	---	100	80	
Manual Methods								
Cd	mg/dscm/7	--	0.05	---	0.065	0.01	0.01	(d)
Hg	mg/dscm/7	--	0.05	---	0.065	0.05	0.05	or 85 %
Zn	mg/dscm/7	--	---	---	6.542	---	---	
Pb	mg/dscm/7	--	0.5	---	0.654	0.14	0.14	(c)
PCDD/F TE Equi	ng/dscm/7	--	0.1	---	0.131	0.26	0.26	(b)
PAHs	mg/dscm/7	--	---	---	0.013	---	---	(f)

III. Modern EfW Facility Meet all Emission Standards

Commenting notes to previous slide

(a) English units referenced to 7 % O2, dry gas basis.

(b) USA standard for PCDD/F is as total tetra thru octa instead of toxic equivalent value used by EU. The EPA limit of 13 ng/dscm/7 is equivalent to a range of 0.26 ng TEQ (50 factor) to 0.43 ng TEQ (30 factor).

(c) The EU limit includes - Sb+As+Pb+Cr+Co+Cu+Mn+Ni+V+Sn e composti

(d) The EU limi includes Tl.

(e) All units as mg/NM3 at 11 % O2, 1013 mbar and 273Kexcept PCDD which is as ng/NM3.

(f) PAHs are an "optional" pollutant for specific permits.

(g) 2000/76/EC Dec. 2000.

III. Modern EfW Facility Meet all Emission Standards

Air Emission Limits in China (11/27/2007)

Pollutant	Unit	National Standard (GB18485-2001)	Nanjing City, Jiangsu (2006)	Yangzhou, Jiangsu (2007)	Nansha, Guangdong (2007)	Guangzhou, (Likeng I) Guangdong (2003)	Yixing, Jiangsu (2005)	Changsu, Jiangsu (2004)	Suzhou, Jiangsu (2004)
Particulates	Mg/m^3	80	< 30	30	10	10	18*	30	30
Opacity	Lingerman blackness, grade	1	-	-	-	1	1	-	-
CO	mg/m^3	150	< 100	100	50	100	150	50	-
NOx	mg/m^3	400	< 400	350	200	240	300	400	350
SO_2	mg/m^3	260	< 260	150	50	100	91*	260	300
HCl	mg/m^3	75	< 50	50	10	≦50	≦50	75	30
Hg	mg/m^3	0.2	< 0.1	0.1	0.05	0.1	0.2	0.2	0.1
Cd	mg/m^3	0.1	< 0.1	0.1	0.05	0.1	0.1	0.1	0.1
Pb	mg/m^3	1.6	-	1.6	0.05	0.5	1.6	1.6	1
Total heavy metals	mg/m^3	N/A	< 6	6	N/A	N/A	N/A	N/A	N/A
Dioxin	ng TEQ/Nm^3	1.0	< 0.1	0.1	0.1	0.1	0.1	0.1	0.1

*for annual average

Note: 1. All numbers are referring to gas condition corrected to 11% O2 on dry basis
2. Opacity is measured based on 1-hour average, and any measurements shall not exceed the limit in any 5-minute intervals.
3. All numbers are based on one hour interval and arithmetic averages of at least 3 samples.

IV. EfW – Additional Advantages

MSW volume reduction -

- **MSW volume reduction by 90 %**
- **Extend landfill life by using it for disposal of ash only**

Higher Land Use Efficiency

IV. EfW – Additional Advantages

Energy recovery and saving energy resources –

- **Recover 75% of the energy in the waste as steam**
- **Further recover 30% of the energy in the steam by converting into electricity**
- **Thermal treatment of one ton MSW equivalent to saving 1.2 to 1.6 barrel of oil**

IV. EfW – Additional Advantages

Flexibility of co-disposal of various kind of wastes -

- **EfW plant can treat commercial wastes**
- **EfW plant can treat non-hazardous industrial wastes**
- **EfW plant can thermally co-disposal of up to 10 % of the sewage sludge**

IV. EfW – Additional Advantages

Ash recycling and reuse -

- **Bottom ash can be recycled and reused as road paving material and construction raw material**
- **Fly ash can be recycled and reused for making gypsum board, raw material for cement production**

IV. EfW – Additional Advantages

Reduce Global Warming Impact by -

- **Avoided global warming methane gas generation from landfills**
- **Avoided using fossil fuel for power generation and reduced total CO_2 emission to atmosphere**

V. Sustainable Management and Long Term Service

V. Sustainable Management and Long Term Service

- **Partnership Spirit**

  Government and private service providers are partners but not just owner and subcontractor relationship; the spirit of partnership is important to the sustainability of the project

- **Project Life Begins After Plant is Constructed**

  Private service providers must have an experience in EfW development and long term operation to make a project sustainable - it is more than just designing and building the plant

V. Sustainable Management and Long Term Service

- **Unique Design Tailored to Asia Application**
  - **Waste quality, design, construction and operation are different between the Western World and Asia**
  - **In Asia**
    - **Waste is more complex**
    - **Waste quality is constantly changing**
    - **Site is limited in size and require compact design**

V. Sustainable Management and Long Term Service

- **Key Points in Implementing EfW Projects**

✓ **Need more combustion knowledge to burn wastes than burning any other kinds of fuels**

✓ **Design and build the plant as flexible as possible – especially in Asia**

✓ **Build in plenty of margin in the plant**

V. Sustainable Management and Long Term Service

- **Government's Role**
  - **Waste disposal act and relevant regulations must be in place to support waste collection, transportation, disposal and operation**
  - **Need to have certain level of law enforcement to maintain the sustainability of waste disposal system of WTE plants by private operators**
  - **With law and regulations in place to support power sales by private operators**

V. Sustainable Management and Long Term Service

- **Private Sector (Developer / Sponsor)**
  - **Must possess sufficient knowledge in development, financing, design, construction and long term operation in the very beginning. EfW is not a kind of project you can learn along with the project life.**
- **Bridge between Government and Private Sector**
  - **Waste delivery agreement**
  - **Power off-take (Purchase) agreement**
  - **Ash disposal agreement**
  - **Overall concession agreement**

V. Sustainable Management and Long Term Service

Qualification of Service Contractor

- **Have good knowledge, models and tools for maintenance, repair, major overhaul, chemicals and consumables to meet all environmental emissions, etc.**
- **Have the knowledge to truly understand your equipment's capability and efficiency and their changes along with time**
- **Have sufficient combustion knowledge to operate the plant not just the knowledge of machines and people**

VI. EfW Video – Example of a Modern EfW Facility

- **Beitou EfW Plant – Taipei, Taiwan**
  - **Process and Technology**
  - **Community Friendly Facilities**