Informational Meeting

Energy Generation and Recycling/Reuse

January 18th, King County Council Chambers

King County

Kathy Lambert, King County Councilmember

- **Introduction-**"Putting our Resource 'WASTE' to work"
- Become R&D Leader for US in Circular Economy, Sustainability and Material Management
- Clean up the Environment and Reduce CO2 Emissions
- Stop Exporting and Develop new Commercial/Industrial Developments & Jobs
- Are a better use of our funds while bringing "Cutting Edge Technologies and Innovations" to the PNW
- This Forum will provide an overview of these concepts and is presented by Key Experts

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Today's Agenda

- **Key Experts for Energy, Solid Waste, and Recycling/Reuse Solutions-** Our Team over the next 1 ½ hr. will provide an overview of environmentally sound and cost effective solutions to these opportunities and will highlight how they have been successfully implemented both in the US and Overseas.
- **Question and Answer Session**
- **Conclusion**
- **Preparation, Orchestration and Long Range Planning:** Tay Yoshitani; Philipp Schmidt-Pathmann, Neomer; Sue Sander, Normandeau Associates, Inc.

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Informational Meeting Presenters

Energy and Solid Waste Specialists:

- Normandeau Associates- COL (ret) Curt Thalken, PE
- CDM Smith- Paul Hauck, PE
- Babcock Wilcox, Inc.- Jim Gittinger, PE
- Garvey Schubert Barer- Scott DuBoff, Esq.

Other Key Specialists:

- DWS-Rene Moeller Rosendal, PE (Solid Waste/Landfill)
- Black Forest/Alba- Sebastian Frisch, PE (Recycle/Reuse)
- Distributed Energy Management- Jimmy Jia, CEO)

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ABOUT US

60 Years

750 million/year

2000 employees

20 states

30 years in energy space

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What We Do

DESIGN, BUILD, OPERATE & MAINTAIN / “MEDP”

ENGINEERING
CONSTRUCTION
FACILITY MANAGEMENT
ENERGY SERVICES

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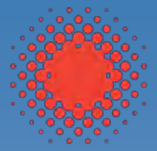
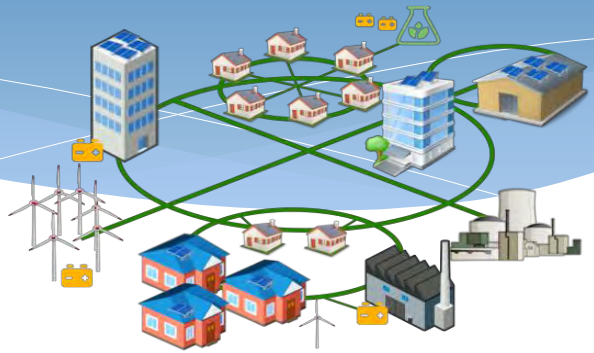


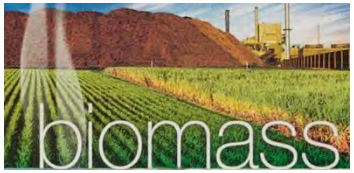
CleanTech Alliance™
WASHINGTON

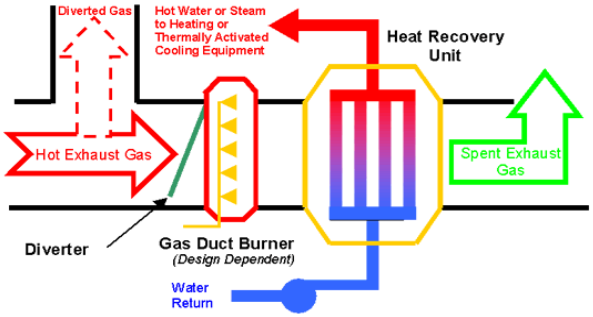
Economic Development Council
of Seattle & King County

Seattle
City Light

McKinstry, Technology & Innovation







CONNECTING THE DOTS….

EFFICIENCY/WASTE
ENVIRONMENT
CLEAN ENERGY
ALTERNATE ENERGY
ECONOMIC DEVELOPMENT
JOBS AND WORKFORCE

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Normandeau Associates, Inc.- Curt Thalken, PE

NORMANDEAU ASSOCIATES

Environmental Consultants

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Normandeau Overview
COO, Curt Thalken, PE

- Founded in 1970 as a science-based environmental consulting firm
- *"One of the largest, most well-known natural resources management companies in the US" (EBJ)*
- With over 250 staff operating from 19 offices nationwide, we have the ability to tackle large & complex projects
- Technical excellence & quality service
- Problem solvers – analytical & innovative approaches to resource issues
- Patented and proprietary technologies
- Remote sensing approaches for real-time monitoring
- 100% Employee Owned (ESOP)

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Technical Expertise

- Aquatic, Marine & Terrestrial Ecologists
- Bat, Bird, Fish & Wildlife Biologists
- Certified Dive Team
- GIS and Technology Specialists
- Hydrologists & Limnologists
- Permitting & NEPA Specialists
- Wetland & Soil Scientists
- Biological Laboratories

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Overview of U.S. Waste To Energy (WTE)

- 4 WTE plants on the West Coast and only one in Spokane, WA.
- Newest- West Palm Beach
- 68 other facilities operating in 16 states in 2015, these 72 WTE facilities generated about 14 million MWH of electricity from MSW, or about 0.3% of total U.S. generation.
- Per the EPA, WTE plants turn 29 million tons of MSW(2010) into energy in us =12% of total domestic MSW; Approximately 34% of MSW was recycled or composted and 54% of MSW was discarded in landfills.
- Connecticut - CRRA

(Source: U.S. Energy Information Administration, *Monthly Electric Generator Report*)

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U.S. Example: CT Resource Recovery Authority (CRRA) (Now the Materials Innovation and Recycling Authority (MIRA)

- Created in 1973
- Mission: modernize state's solid waste system
- Connecticut has evolved from town dumps to trash-to-energy and recycling
- Connecticut has NO active garbage landfills (one open ash landfill)

http://www.crra.org/pages/profile.htm

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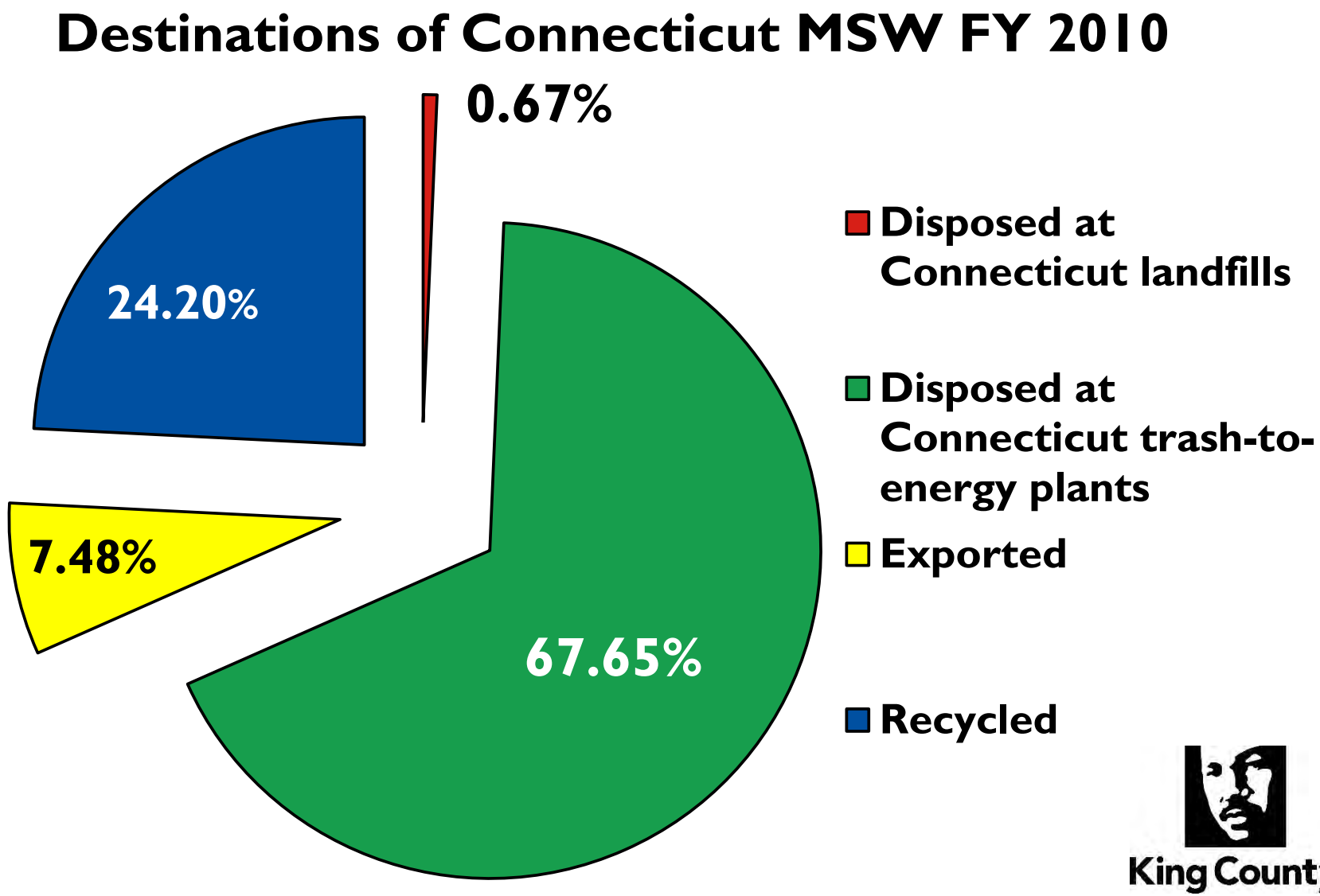
What Is Done With CT's Trash?



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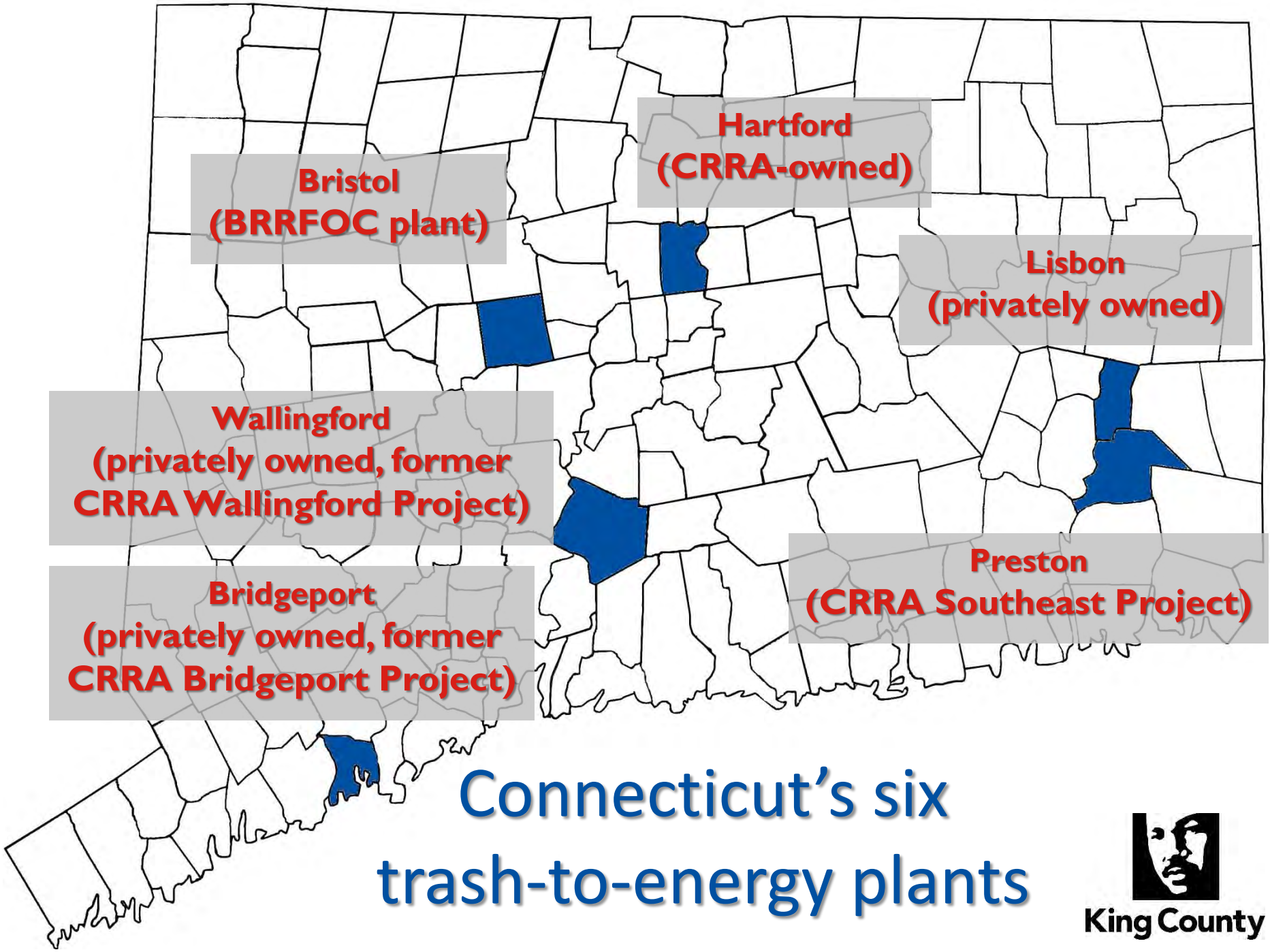

Connecticut's six trash-to-energy plants

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State Solid Waste Entities

CRRA Connecticut Solid Waste System

- Trash-to-energy plant, recyclables processing facility and CRRA Trash Museum in Hartford
- Transfer stations in Essex, Ellington, Torrington and Watertown
- Durham, Litchfield, Manchester, Middlefield, Naugatuck, Salisbury, Sharon, Simsbury and South Windsor deliver trash but not recyclables. Residents may participate in CRRA electronics-recycling and paper-shredding events.

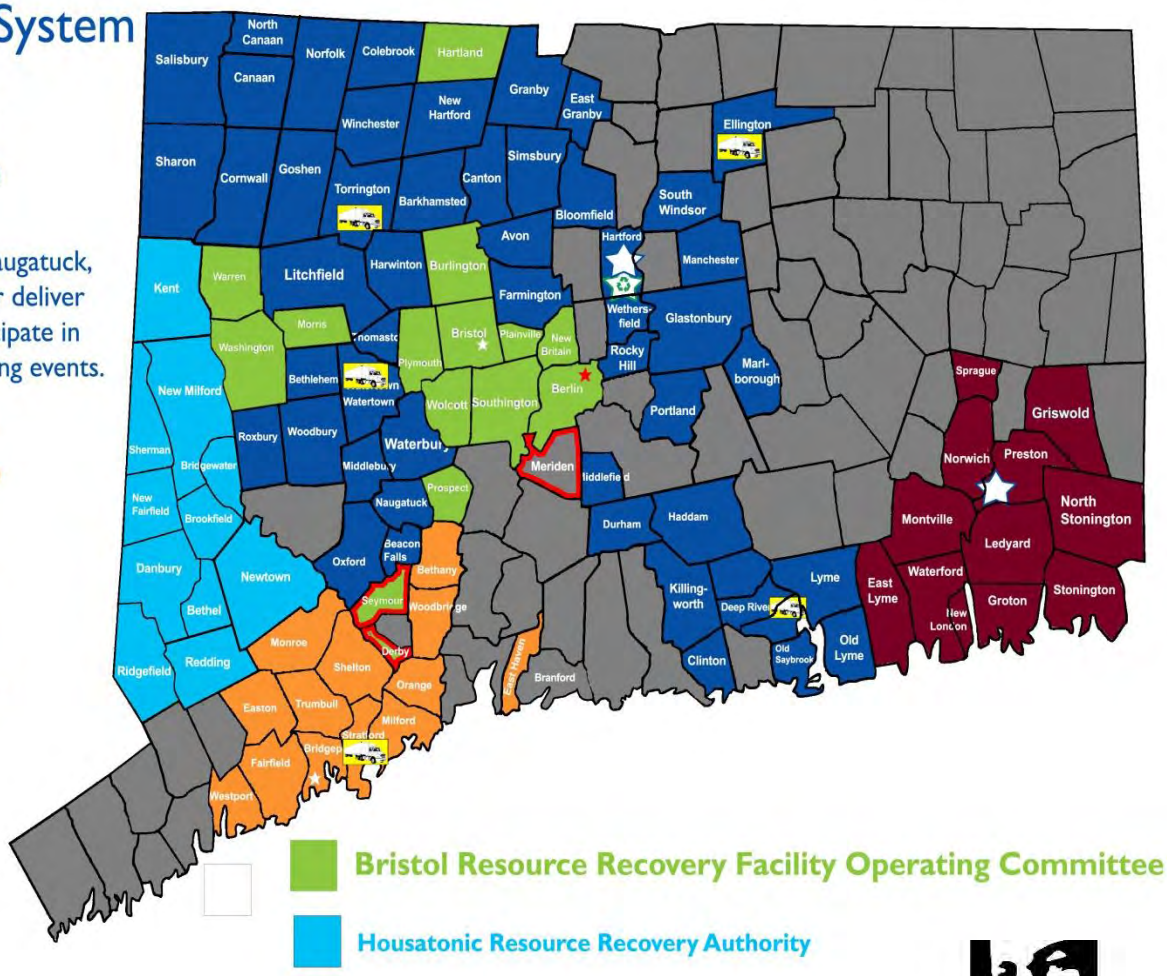
CRRA Southwest Division

- CRRA contracts for towns to deliver trash to Bridgeport trash-to-energy plant
- Recyclables delivered to transloading facility in Stratford and shipped to CRRA Hartford recycling processing center
- East Haven delivers recyclables but not trash; Bethany, Shelton and Trumbull deliver trash but not recyclables

CRRA Southeast Project

- Trash-to-energy plant in Preston

CRRA transfer station/transload facility



Bristol Resource Recovery Facility Operating Committee

Housatonic Resource Recovery Authority

Towns are not required to join a regional entity

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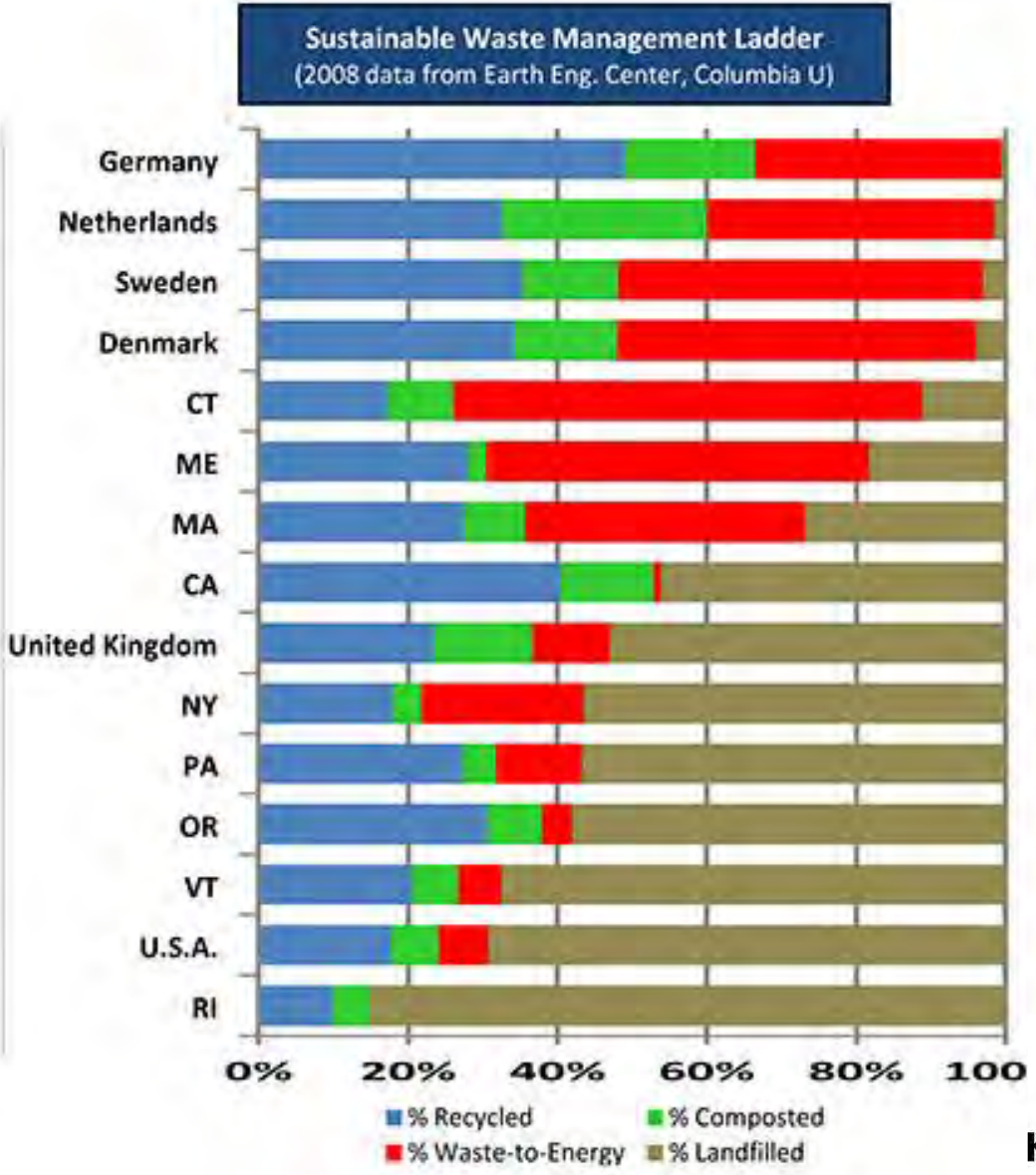
Sustainable Waste Management Ladder
(2008 data from Earth Eng. Center, Columbia U)
Germany
Netherlands
Sweden
Denmark
CT
ME
MA
CA
United Kingdom
NY
PA
OR
VT
U.S.A.
RI
0%
20%
40%
60%
80%
100
% Recycled
% Composted
% Waste-to-Energy
% Landfilled

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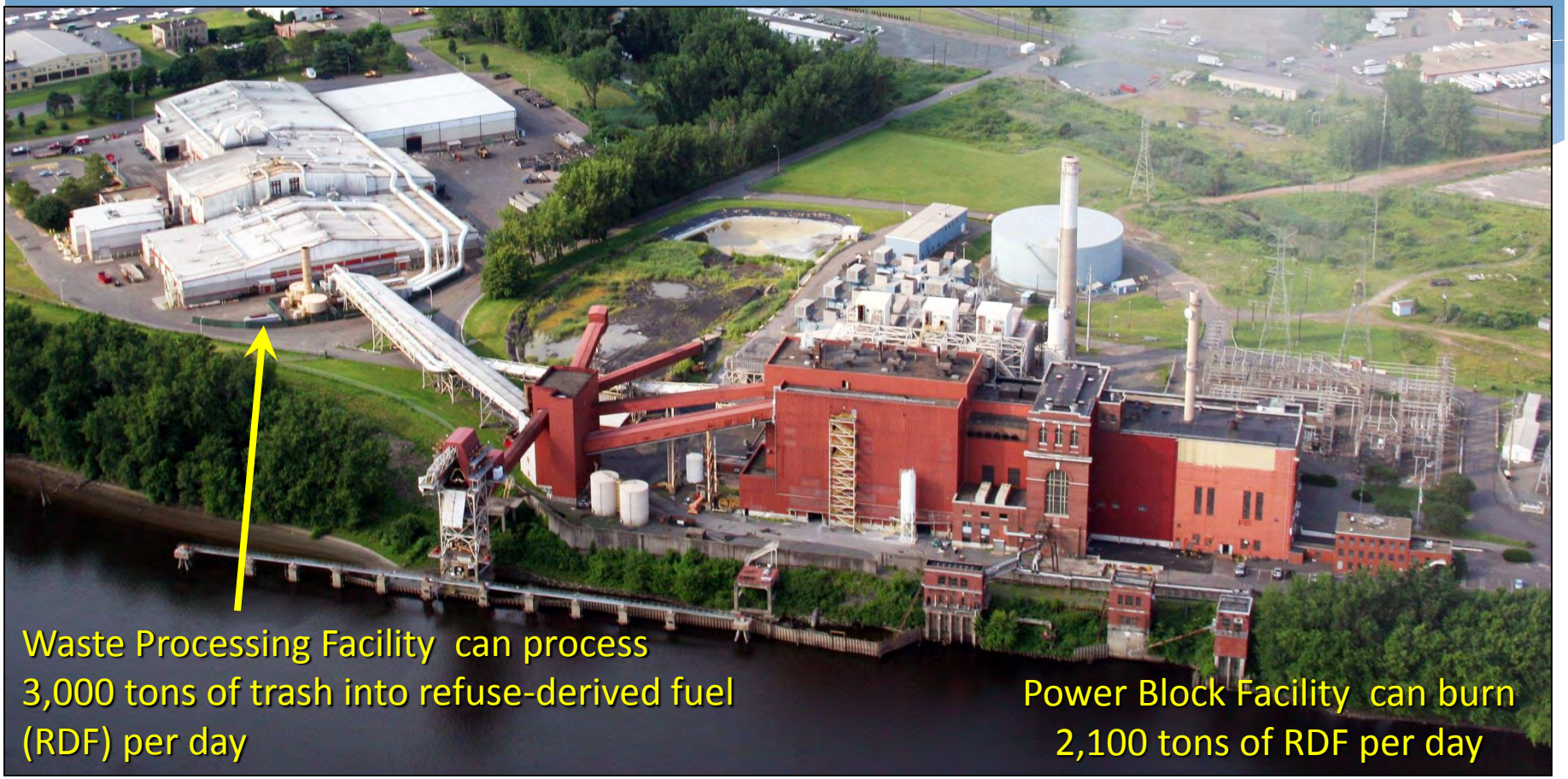
Hartford Trash-to-Energy Plant



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Hartford Trash-to-Energy Plant

- Capacity: 880,000 tons per year
- Acceptance testing completed, official operation began 1988
- Unlike other facilities, CRRA retained ownership when bonds were retired Nov. 15, 2012

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CONNECTICUT WAY FORWARD

- Sep 2016 CT "shortlisted" 3 firms (Covanta Energy, Mustang Renewable Power Ventures, and Sacyr Rooney Recovery Team) to redevelop the aging Hartford plant to extend its life while minimizing the combustion of waste.
- The proposed systems are capable of recovering more than 25 percent of incoming trash, including recovery of recyclable materials and composting of organics.
- All three developers provided preliminary concepts that would significantly reduce greenhouse gas emissions and air quality impacts, reduce truck traffic at the South Meadows site, and preserve or create over 100 jobs.
- Final Selection is anticipated to be made in late 2017

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Integrated Waste Management Systems Anchored by a Modern Waste-to-Energy Facility

Sustainable Waste Management Solutions for the 21st Century

CDM Smith

Presentation to:

King County and Regional Public /Private Organizations

January 18, 2017

Seattle, WA

Paul Hauck, P.E.

CDM Smith's World Waste-to-Energy Experience

DB/DBO Vendor Procurement
Technology Evaluation
Other WTE Projects

British Columbia, Canada, Vancouver

Ontario, Canada, Brampton

Michigan, Kent County, Oakland County
Illinois, DuPage County, Chicago
Minnesota
Hennepin County
Washington, Spokane
Utah, Davis County
California, San Jose
Ohio, Montgomery County
South Carolina, Charleston County
Pennsylvania
Lancaster County, York County
New York
Babylon, Onondaga County, Huntington, Westchester County, New York, Erie-Niagra County, Oyster Bay
New Hampshire
Durham, Manchester, NH/VT SWP
Maine, Auburn, Portland
Canada, Nova Scotia, Halifax
Massachusetts
Fall River, North Andover, Braintree, Saugus, Haverhill
Connecticut
Bristol, Hartford, Wallingford, Windham
New Jersey
Essex County, Bergen County, Mercer County, Middlesex County
Virginia
Fairfax County, Prince William County
Florida
Bay County, Tampa, Dade County Aviation, Key West, Lee County, Palm Beach County, Hillsborough County, Pinellas County, Pasco County, Vero Beach, St. Lucie County

International Experience

Modern WTE Trends...Improved Efficiency and Sustainability, Yet Lower Power Payments!

- Advanced ferrous and non-ferrous metal recovery
- Advanced combustion controls
- Higher boiler/TG availability and gross/net electric generation
- Use of reclaimed water for cooling
- Higher Heating Value (HHV) of MSW
- Compliance with stringent emission limits & GHG reporting
- WTE facility expansions and attention to esthetics/LEED®/innovation
- Evolution of integrated solid waste management/eco-campus

- Air pollution emissions
- Reagent consumption
- Water consumption
- Lower payments for electricity sold to electric grid

High Tech Magnets for Optimized Recovery of Ferrous and Non-ferrous Metals

High Strength Drum Magnet for Ferrous Metals

Samples of Non-ferrous Metals Recovered by Eddy Current Separator

Aluminum, brass, bronze, copper… even gold and silver!

Dense aluminum "nuggets"

Europe Continues WTE Advancements with Recovery of "Fine" Recyclables from Bottom Ash

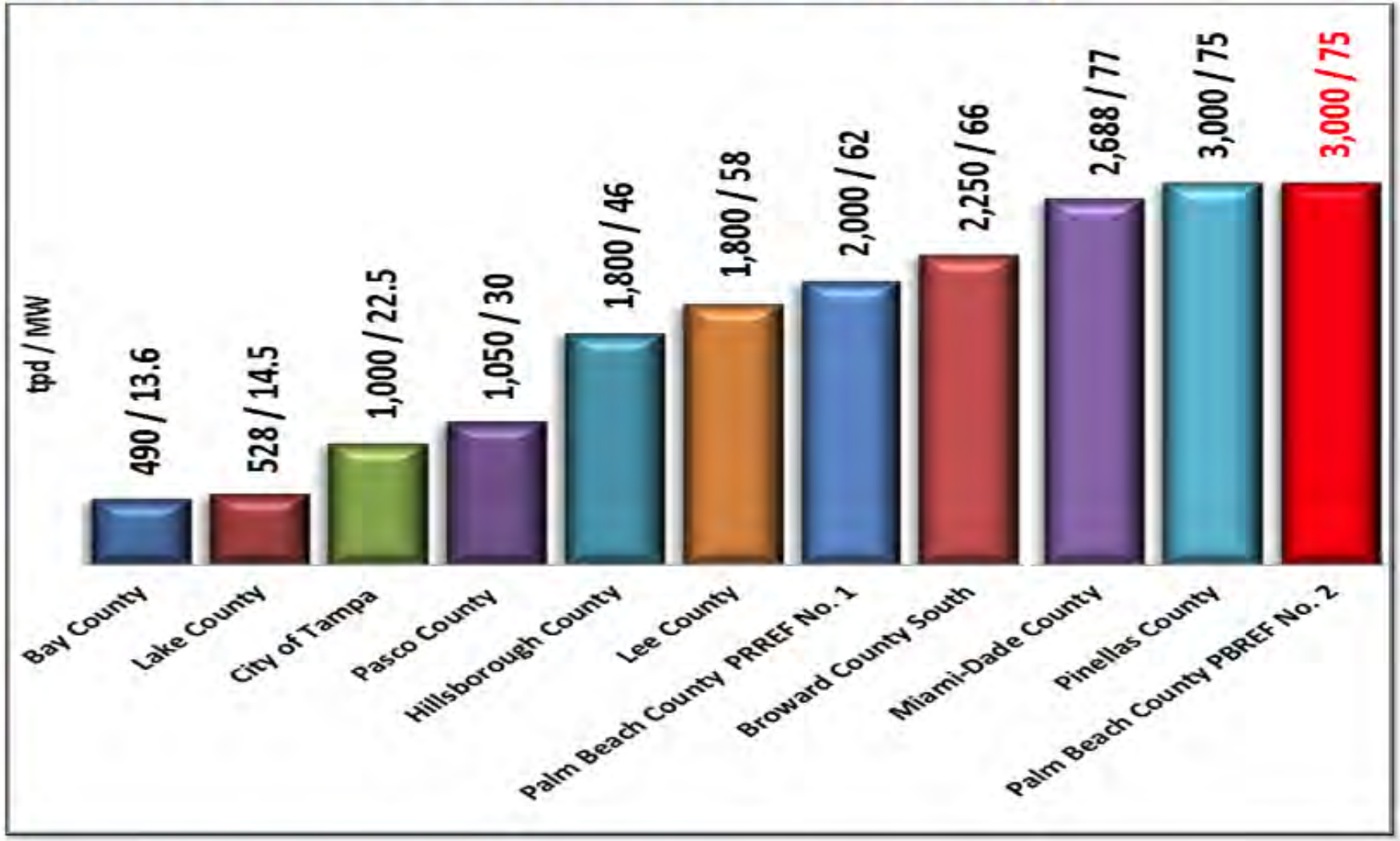
Fine minerals
(< 0.07 inch)

Mineral aggregates
(> 0.07 inch)

Non-ferrous concentrate

Ferrous concentrate

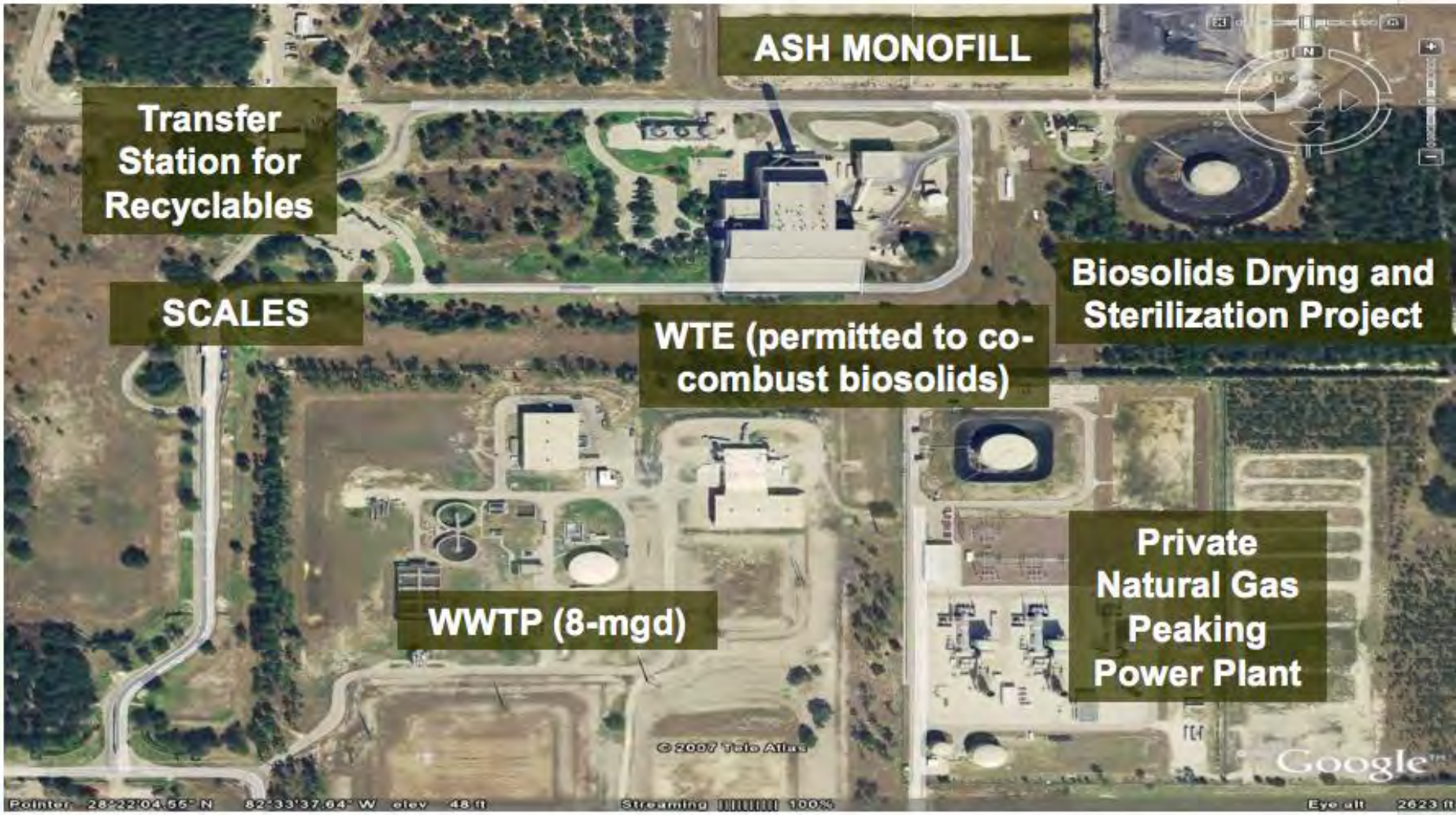
Florida Waste-to-Energy Facilities
11 Facilities and 539 MW of Renewable Electricity
(range of sizes varies from 500 - 3,000 tons per day)



Pasco County, Florida
Integrated Solid Waste and Utility Campus

- 880 Acre Campus
- 1,050 TPD WTE Facility
- Ash Monofill
- Backup Solid Waste Landfill
- Construction & Demolition Landfill
- Citizen Drop-off Facility
  - Recyclables
  - Yard waste and tires
  - Household Hazardous Waste
- Adjacent WWTP (8-mgd)
- WWTP Biosolids Drying Facility

WWTP and Biosolids Treatment Integrated into Pasco County Utility Campus



Pasco County, Florida WTE
1,050 TPD Massburn – 30 MW Net Electrical Output
(serving average needs of 17,000 households)

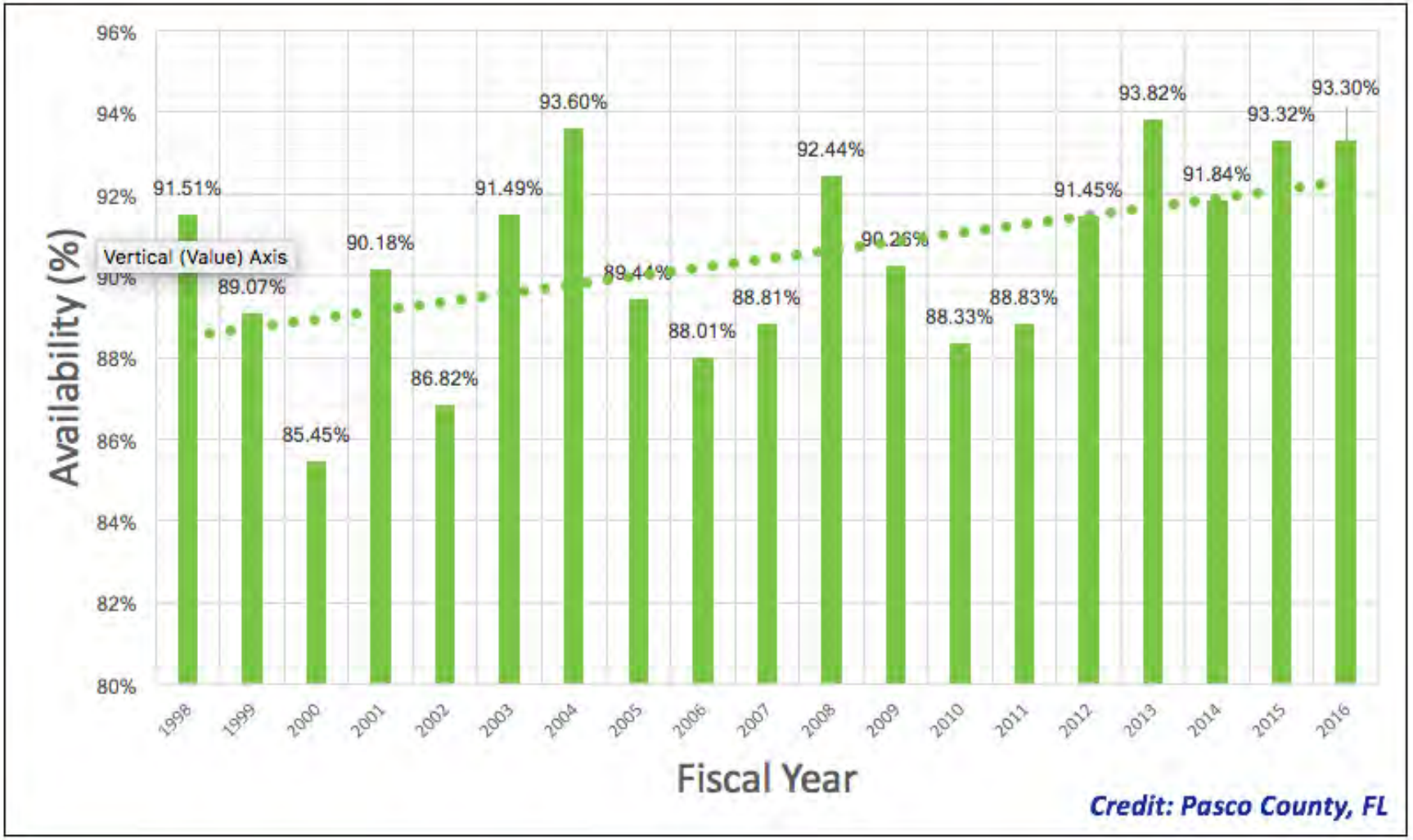
Disposal of WTE Ash Residue from 25+ Years of Operation in Four Lined Ash Monofill Cells

Pasco County Ash Reuse - First in Florida to Receive FDEP Authorization for Beneficial Reuse

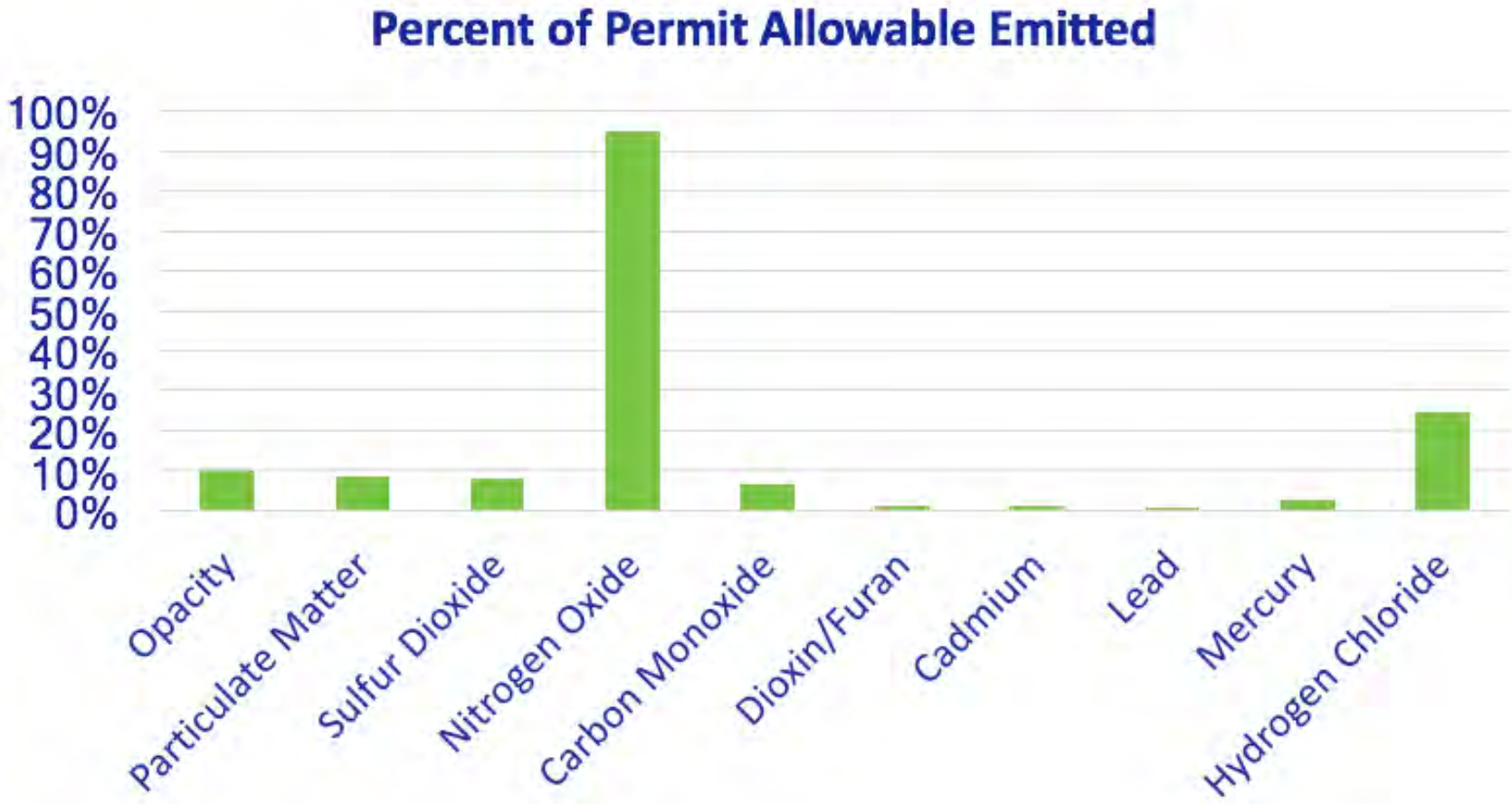
FDEP approved beneficial reuse in December 2014 for three applications

1. Bottom ash as road base
2. Bottom ash as aggregate in asphalt
3. Bottom ash as aggregate in concrete

Pasco County WTE Facility
Continuous Improvement in Facility Availability



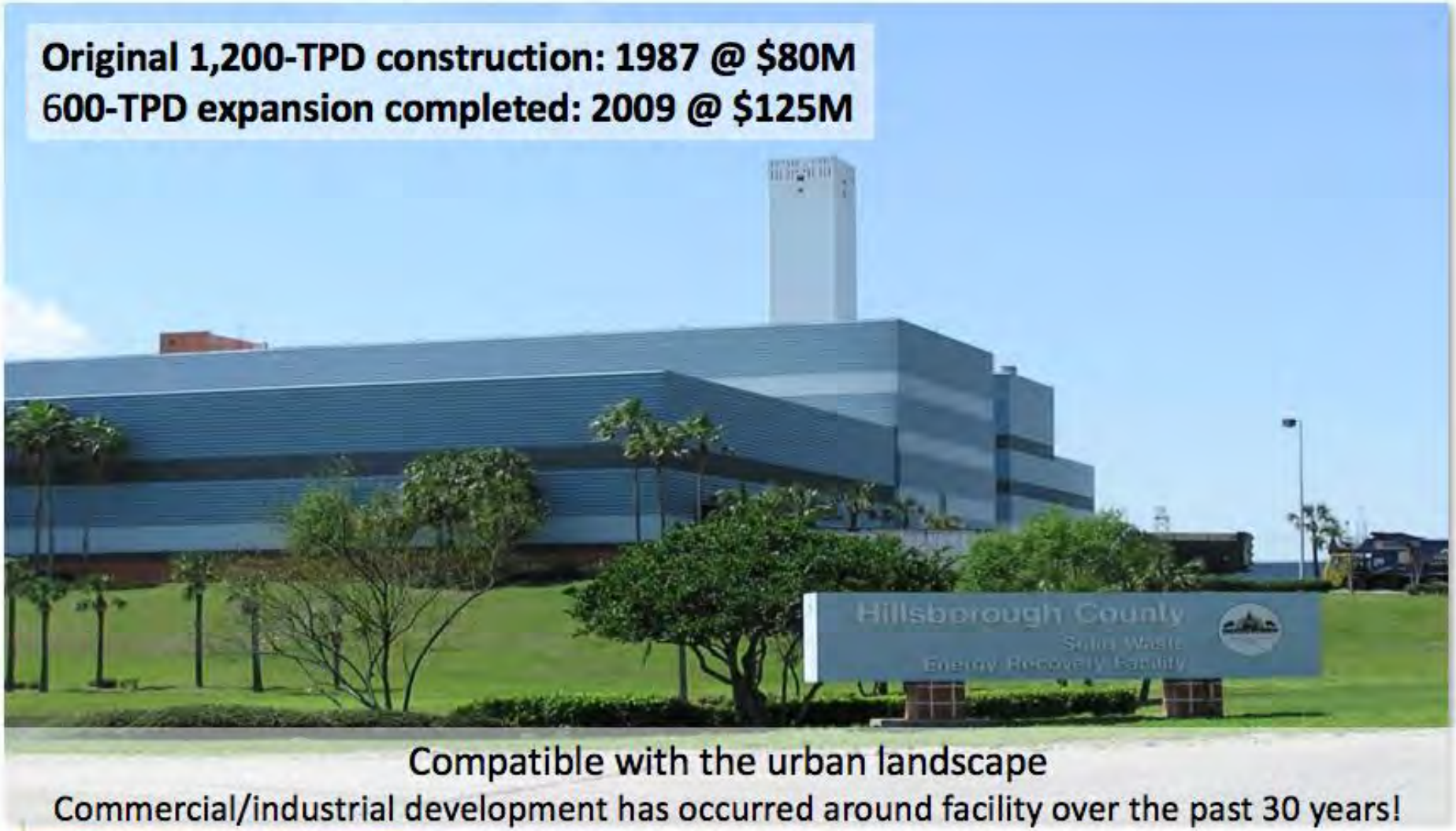
Pasco County WTE Facility Environmental Test Results (2016)



Credit: Pasco County, FL

Hillsborough County Florida WTE

1,800 TPD Massburn – 46 MW Net Electrical Output (serving the average needs of 25,000 households)



Compatible with the urban landscape

Commercial/industrial development has occurred around facility over the past 30 years!

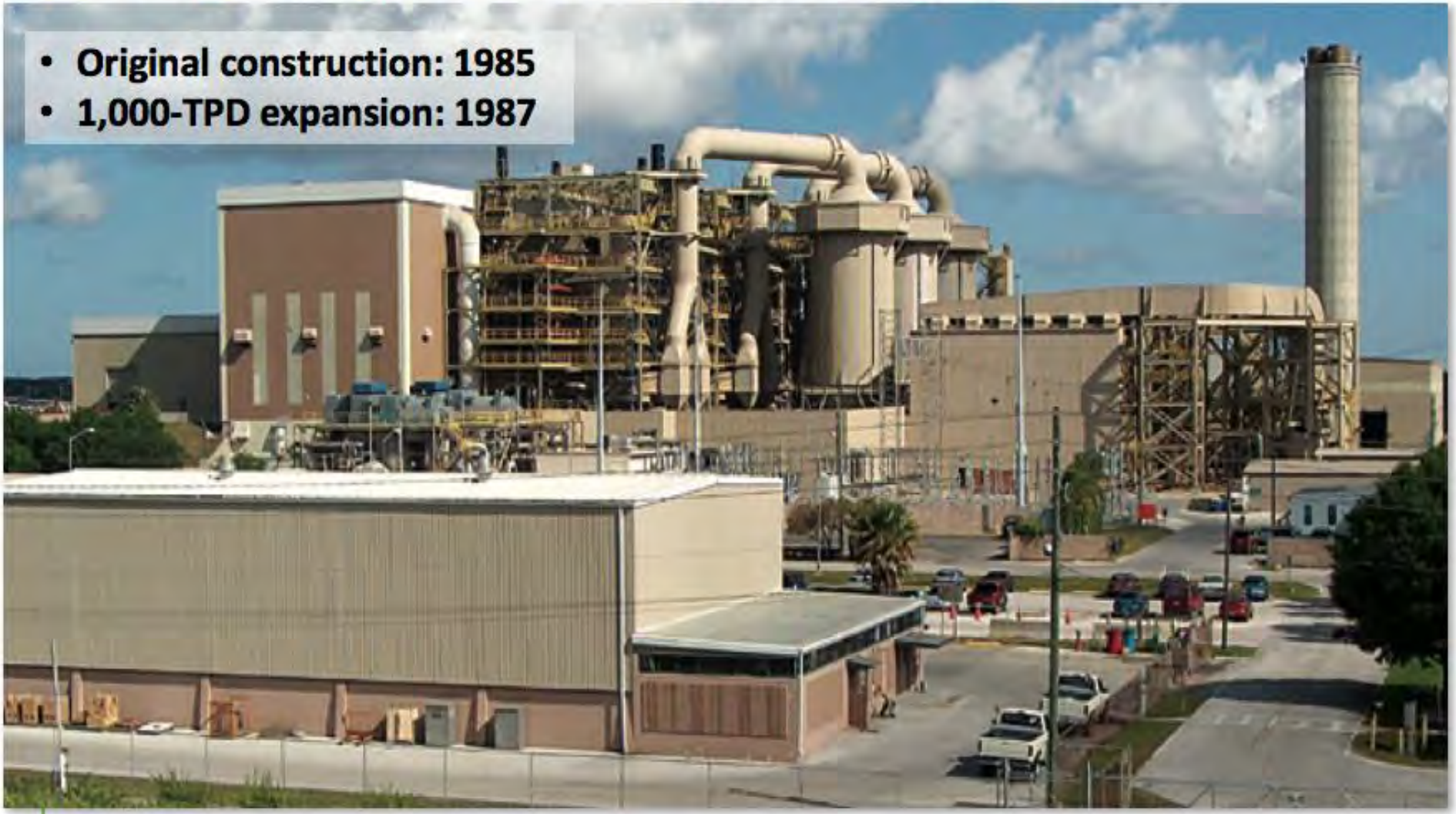
Hillsborough County Florida WTE
1,800 TPD – 46 MW (Located Adjacent to WWTP)
(also permitted to co-combust WWTP Biosolids)

Hillsborough County WTE – First in the US to Internally Power Water Resource Facilities

Hillsborough County WTE
Located on 240 Acre Public Works Campus

Hillsborough County, Florida
Taking Advantage of Former Landfill Sites

Pinellas County Florida WTE
3,000 TPD Massburn – 75 MW Net Electrical Output
(serving average needs of 40,000 households)



Pinellas County Florida

WTE Located on 720 Acre Integrated Solid Waste Campus (35 years in development and still evolving!)

Modern WTE...Preferred Option for Anchoring an Integrated Solid Waste Management System

- Maximizes production of renewable energy
  - 575 kWh/ton of MSW processed
  - Higher thermal efficiency with Combined Heat and Power (CHP)
- Significantly lower environmental impacts than landfills
  - Stabilized and inert ash disposal volume is minimized (90% volume reduction and 75% weight reduction)
  - Opportunities for recycling ash as aggregates and feedstock for cement
- Greatest economic impact to local economy
  - Long-term careers and high quality jobs
  - Significant impact during construction and long-term operation for purchase of goods and services
- Minimal land use impacts
  - Can meet the current and future needs of a community on 15-45 acres
- **Allows Communities to Responsibly Manage Their Waste!**

Modern WTE Facilities can Help Communities Meet the Goals of "Zero Waste"

- MSW to Landfill

WTE without Metal Recovery

WTE with Metal Recovery

WTE with Metal Recovery and Bottom Ash Recycling

Thank You for the Opportunity to Share!

Paul Hauck, PE
CDM Smith

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Suite 875
Tampa, Florida 33607

Telephone:
813.281.2900

E-mail:
hauckpl@cdmsmith.com

Tampa Bay Area Solid Waste System Rates

County	Population	Collections per Week	Tipping Fee ($/ton)	Collection ($/HH/YR)	Disposal ($/HH/YR)	Overall Cost ($/HH/YR)
Pasco (1,050 tpd)	470,000	2 Trash 1 Recycling No Separate Yard Waste Pickup	$56.70	Open Market ($150 max)	$62.00	$212.00
Hillsborough (1,800 tpd)	950,000	2 Trash 1 Recycling 1 Yard Waste	$68.16	$131.43 (Franchise System)	$91.32	$222.75
Pinellas (3,000 tpd)	925,000	2 Trash EOW Recycling No Yard Waste (St. Petersburg)	$37.50	Varies among 27 Cities $208.00	$95.40	$303

Data for City of St. Petersburg

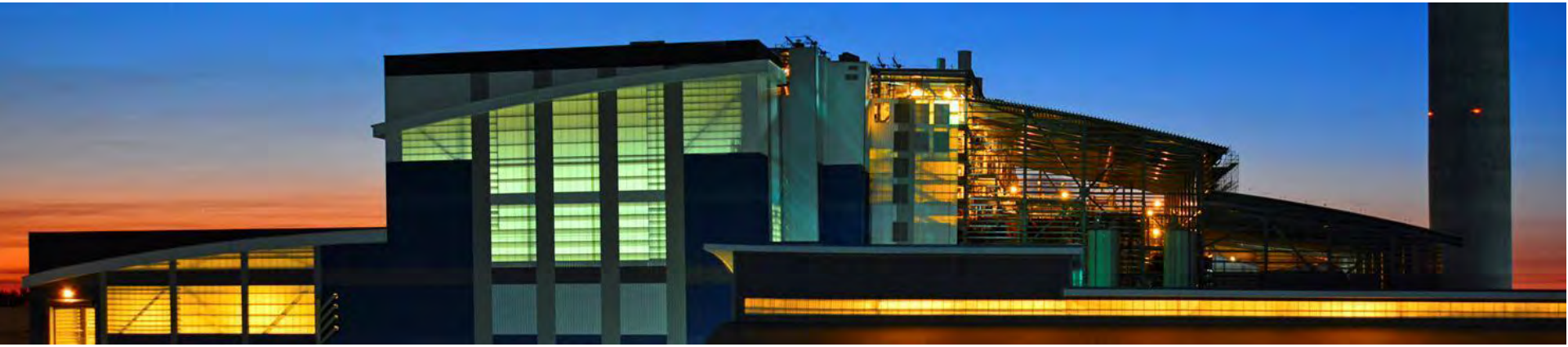
Waste-to-Energy Technology

* January 18, 2017

B&W Company Profile

Headquarters:	Charlotte, NC
Founded:	1867
Employees:	Approximately 5,700 employees, in addition to 2,500 joint venture employees worldwide
Web:	www.babcock.com

- **Global leader in energy and environmental technologies and services for the power and industrial markets**
- **Installed electricity generation capacity of more than 300,000 MW in more than 90 countries**
- **More than 500 WTE/biomass units installed worldwide**
- **Pioneered environmental equipment in the 1970s with most comprehensive suite of products available**
- **Employees in 25 countries**



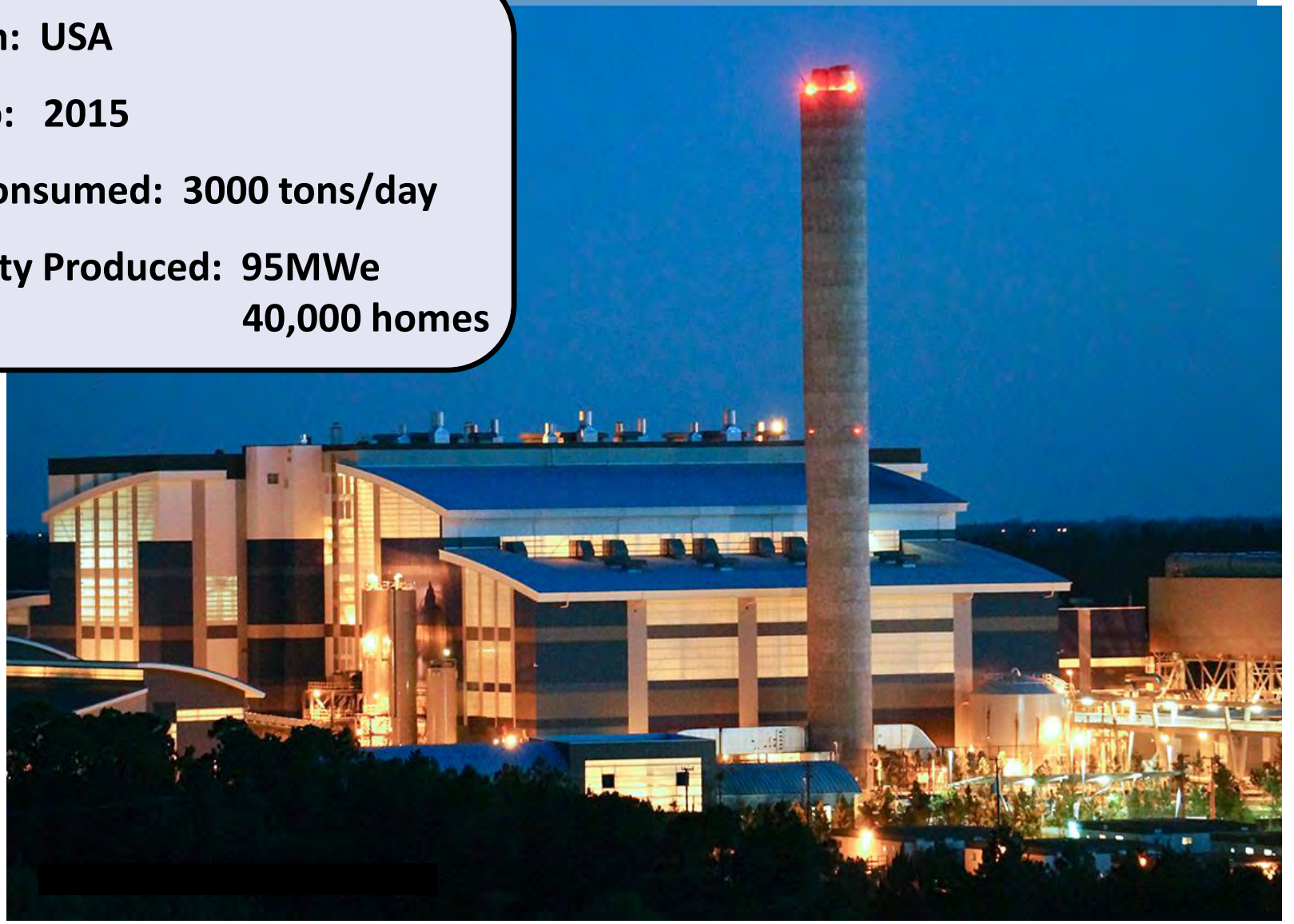
Recent Projects

Location: USA

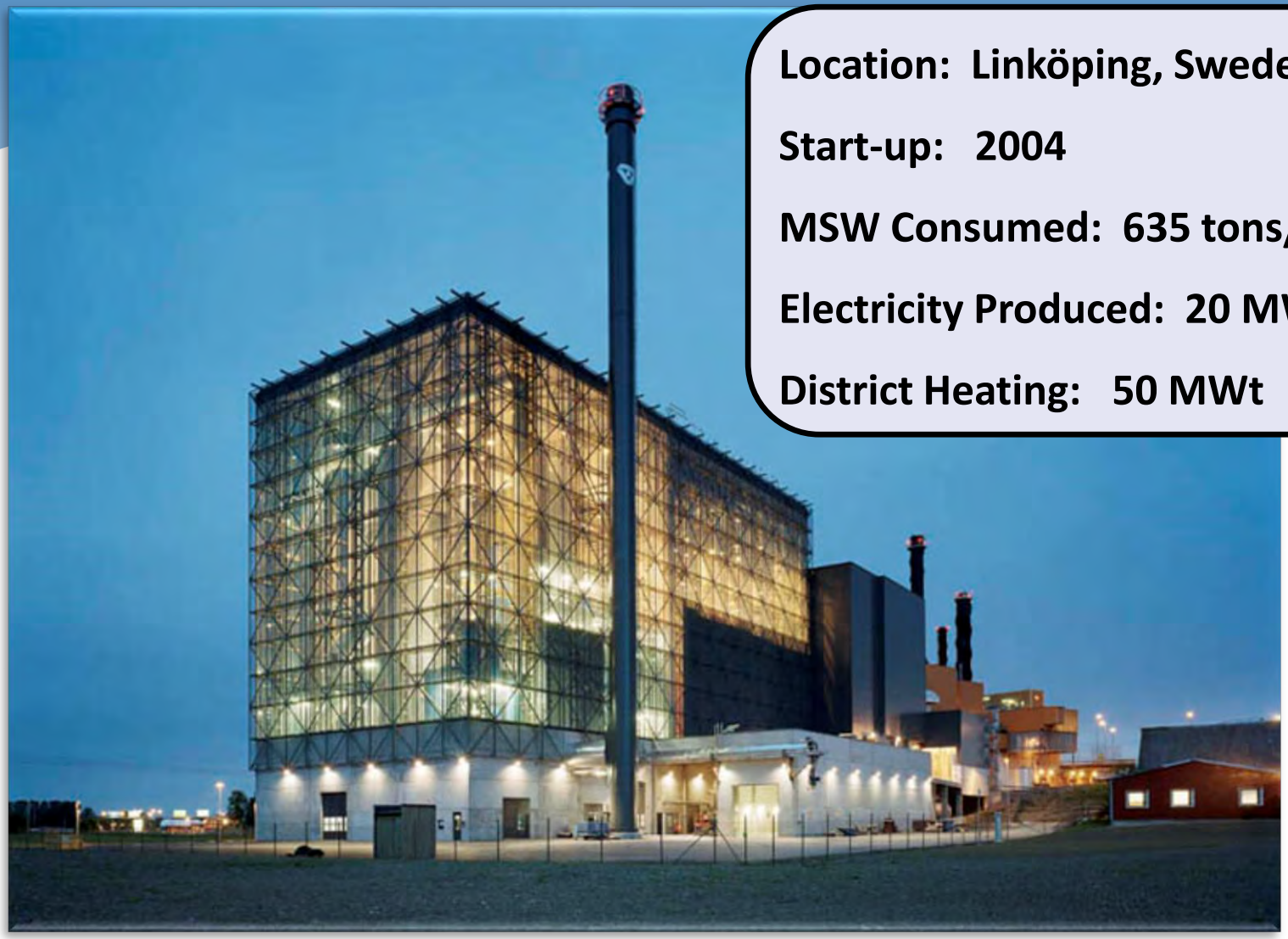
Start-up: 2015

MSW Consumed: 3000 tons/day

Electricity Produced: 95MWe
40,000 homes



Recent Projects



Location: Linköping, Sweden

Start-up: 2004

MSW Consumed: 635 tons/day

Electricity Produced: 20 MWe

District Heating: 50 MWt

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Recent Projects

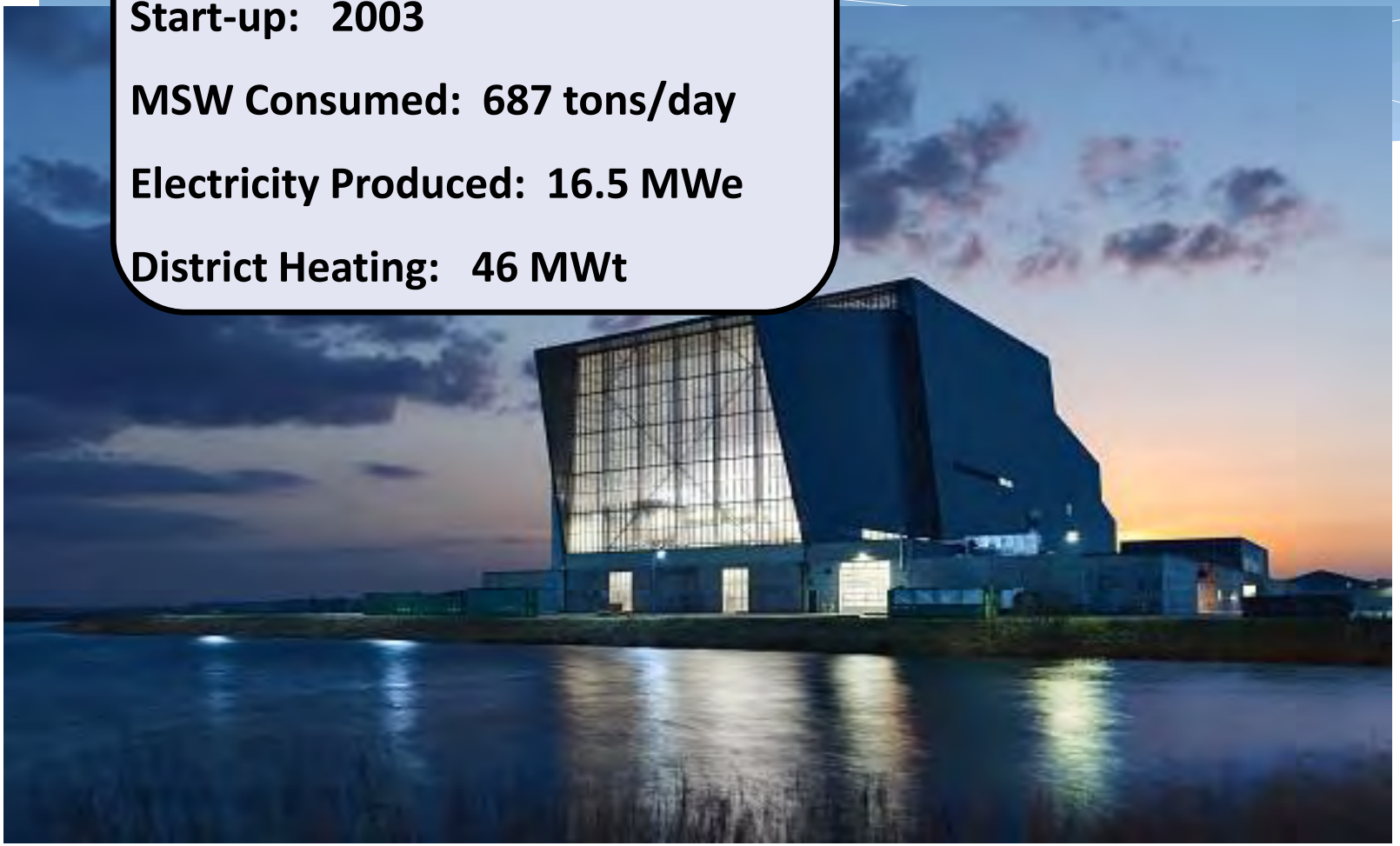
Location: Esbjerg, Denmark

Start-up: 2003

MSW Consumed: 687 tons/day

Electricity Produced: 16.5 MWe

District Heating: 46 MWt



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3000 TPD WTE Facility

Completed Project

Artist's Conception

Plant Overview

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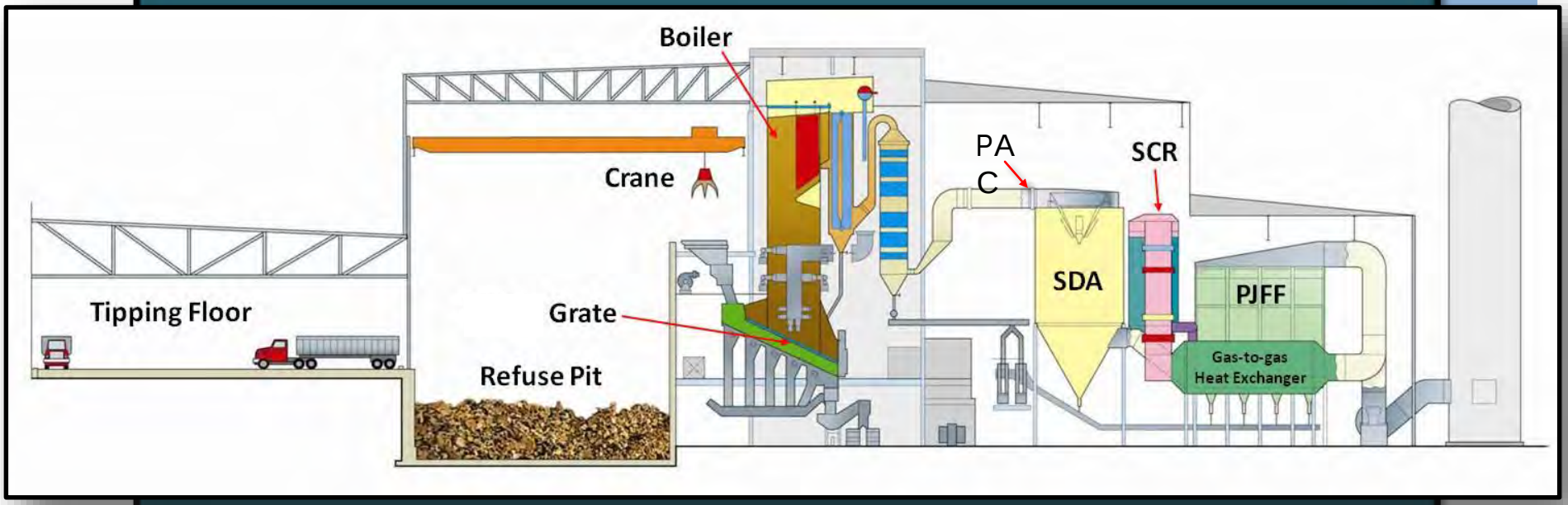
Plant Overview



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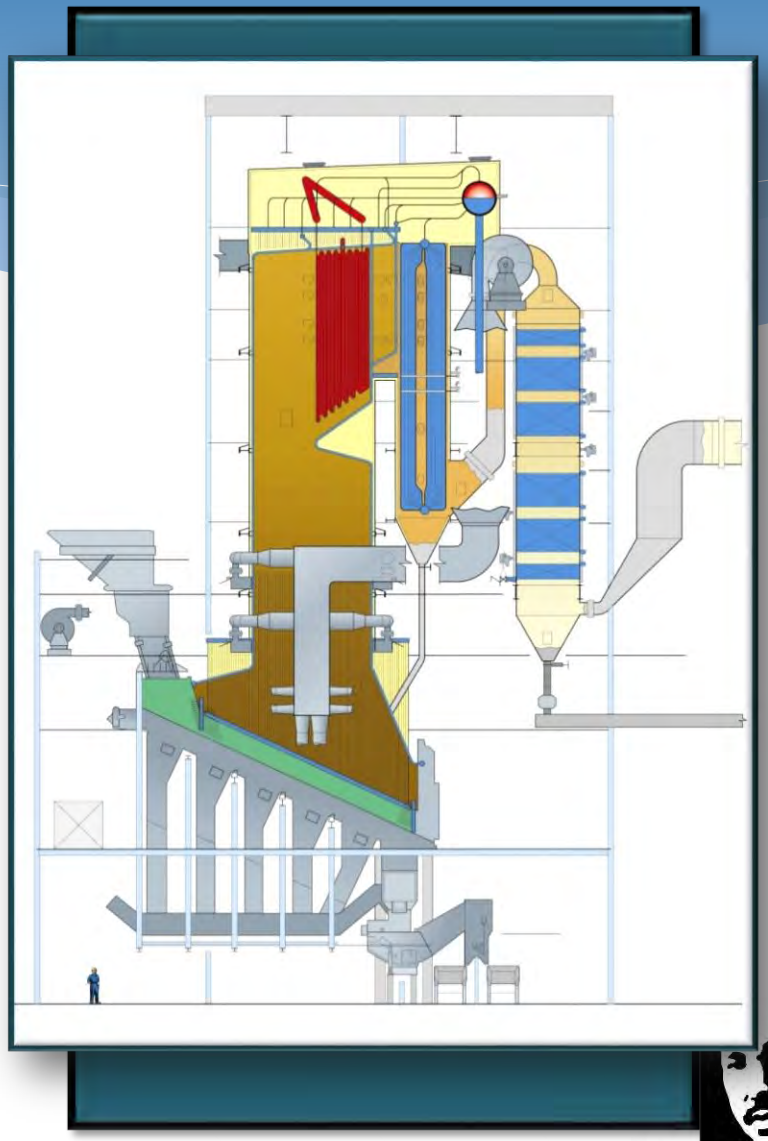
Grate & Boiler Technology

- Up to 1,000 TPD mass burn combustion and emission control lines
- B&W Volund Dynagrate™ Combustion Grate
- Combines the best U.S. and European experience
  - Total furnace weld overlay
  - Refractory area minimized
  - Water-cooled wear zone
  - PrecisionJet™ OFA system
  - No flue gas recirculation (FGR)
  - Specialized superheater design



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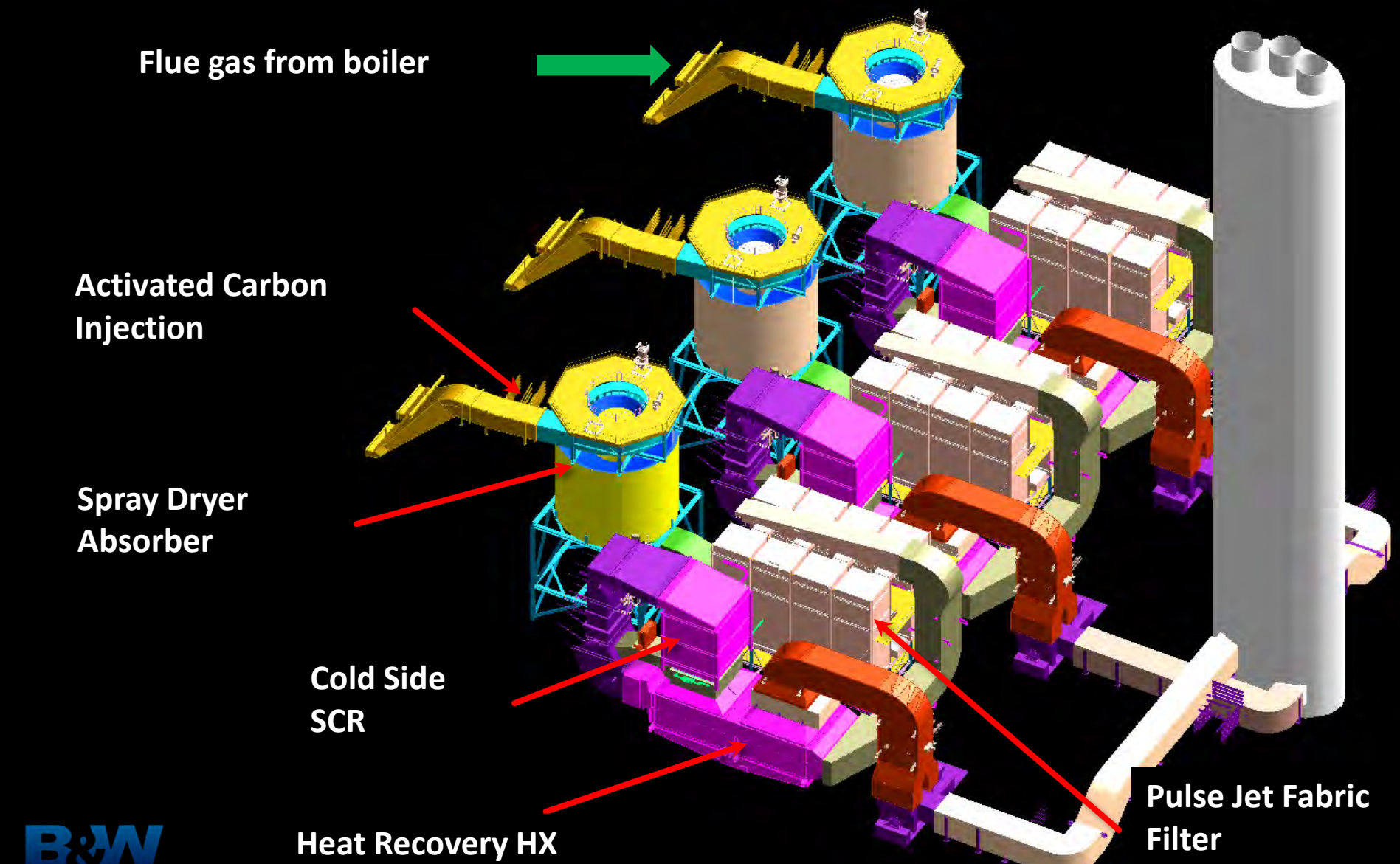
Emission Control Technology

(Three equipment trains depicted)



Emissions Control Technology

Control Technology	Pollutant
Selective Catalytic Reduction (SCR)	NO_X
Spray Dryer Absorber (SDA) with Fabric Filter	SO_2
	HCl
Fabric Filter	PM, PM_{10}, $PM_{2.5}$ and MWC Metals
	Lead
Design and Good Combustion Practices	CO
	VOCs
	MWC Organics (as Dioxins / Furans)
Activated Carbon Injection with Fabric Filter	Mercury

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Permit vs. Actual Emissions

Pollutant	USA Project Emissions Permit	USA Project Actual Emissions Test**
Nitric Oxide	<50 PPM	< 35 PPM
Nitrogen Dioxide	Included above	Included above
Carbon Monoxide	<100 PPM	< 30 PPM
Sulfur Dioxide	<24 PPM	< 21 PPM
Sulfur Trioxide	Not required	Not Detectable/Trace
Unburned Hydrocarbons	< 7 PPM	< 3 PPM
Particulate Matter	12 MG/DSCM	< 3 MG/DSCM

* All Data Shown For Typical Concentration (Parts Per Million Volume) Except Where Noted

** Actual emission test conducted during compliance test three 4 hr. test per unit – 9 total test with range showing high and low measurement under stable full load testing

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Natural Gas vs. WTE Emissions

Pollutant	Natural Gas Turbine Exhaust*	USA WTE Permit Limits
Nitric Oxide	20 - 220 PPM++	<50 PPM
Nitrogen Dioxide	2 - 20 PPM	Included above
Carbon Monoxide	5 - 330 PPM	<100 PPM
Sulfur Dioxide	Trace – 100 PPM	<24 PPM
Sulfur Trioxide	Trace – 4 PPM	Not required
Unburned Hydrocarbons	5 - 300	< 7 PPM
Particulate Matter	Trace – 25 PPM	12 MG/DSCM

* All Data Shown For Typical Concentration (Parts Per Million Volume) Except Where Noted

* Natural Gas Data Source: *Gas Turbine Emissions and Control, GE Power Systems White Paper*

++ If non attainment area, then SCR required

B&W

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Post Combustion Metals Recovery
3000 TPD Facility

Recycling metals reduces GHG emissions from fossil fuels

2000 Tons/month of post combustion Ferrous metals recovered

- **56% savings in energy in recycle of Steel vs. virgin ore**
- **Each ton of steel recycle saves 1400 lbs of coal and 120 lbs of limestone**
- **Yearly savings of 18.4 tons of coal and 15.8 tons of limestone**
- **Demonstrated 97.2% ferrous capture rates post combustion**

150 tons/month of post combustion Non-Ferrous metals recovered

- **92% savings in energy in recycle of Aluminum vs. virgin ore**
- **Each ton of non-ferrous recycle conserves the energy equivalent to 1234 gallons of gasoline**
- **Yearly energy savings of approximately 2.325 million gallons /year based**
- **Demonstrated 88.6% non ferrous capture rates post combustion**

Thank You

Scott DuBoff

- Garvey Schubert Barer represents local governments throughout the U.S. in a broad range of WTE-focused contractual, environmental and other regulatory and public policy matters
- This includes environmental licensing of WTE facilities as well as two national coalitions of local governments, one of which focuses exclusively on regulatory and legislative issues confronting public sector WTE facilities

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America's Need for Clean, Renewable Energy: THE CASE FOR WASTE-TO-ENERGY

- WTE: one of the most environmentally protective sources of renewable energy
- The World Economic Forum: WTE is one of eight "key renewable energy sectors" and "particularly promising in terms of . . . abatement potential" for carbon emissions
- Admiral Dennis McGinn, March 6, 2013: "The United States is the Saudi Arabia of trash"
- But in the U.S., WTE is a largely untapped resource – only 7.6% of our municipal solid waste (MSW) is directed to WTE while 63.5% is landfilled.
- It doesn't have to be that way…

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Modern WTE Facilities – True "Green" Technology – Here are the facts

WTE's status as a very clean and efficient energy source is evident on many bases:

- NREL: WTE facilities employ the most advanced emissions control technology, and their emission limits are among the most stringent in the world
- EPA analysis shows that WTE yields the best results (compared to landfills) in terms of maximum energy recovery and lowest GHG and criteria pollutant emissions
- WTE's efficiency and reliability are clear as well:
  - WTE recovers approximately 600 kWh of electricity per ton of waste – approximately 10 times the electric energy recoverable from a ton of landfilled waste

King County

True Green – Here are the facts (cont'd)

- While landfilling results in the loss of a vast amount of valuable energy, WTE recovers the energy equivalent of one barrel of oil per ton of MSW processed
- In addition, WTE is the paradigm example of "distributed generation" that serves nearby load without the need for new long-distance transmission lines
- WTE is also base-load generation, available 24/7 and unaffected by days that are cloudy or calm

- EPA's hierarchy for "integrated waste management" recommends waste combustion with energy recovery over landfilling (as does the European Union)

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True Green – Here are the facts (cont'd)

- Not surprisingly, The Nature Conservancy ranks WTE as one of the most environmentally protective alternative energy sources – http://www.wiwmd.org/documents/Climate_Change_and_Renewable_Energy.pdf http://www.nature.org/science-in-action/science-features/ask-the-conservationist-august-2011.xml
- Strong WTE supporter: Municipal Waste Management Association (environmental affiliate of the U.S. Conference of Mayors)

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WTE Encourages Recycling

WTE is also entirely compatible with recycling:

- WTE communities routinely outperform non-WTE communities in recycling, with recycling rates typically well in excess of the national average and in some cases lead the nation in recycling – http://energyrecoverycouncil.org/wp-content/uploads/2016/03/ERC-2014-Berenyi-recycling-study.pdf
- Although recycling rates are driven by state policies that apply equally to WTE and non-WTE communities, WTE communities' recycling rates are typically higher than the overall recycling rates for their respective states
- European experience is the same:

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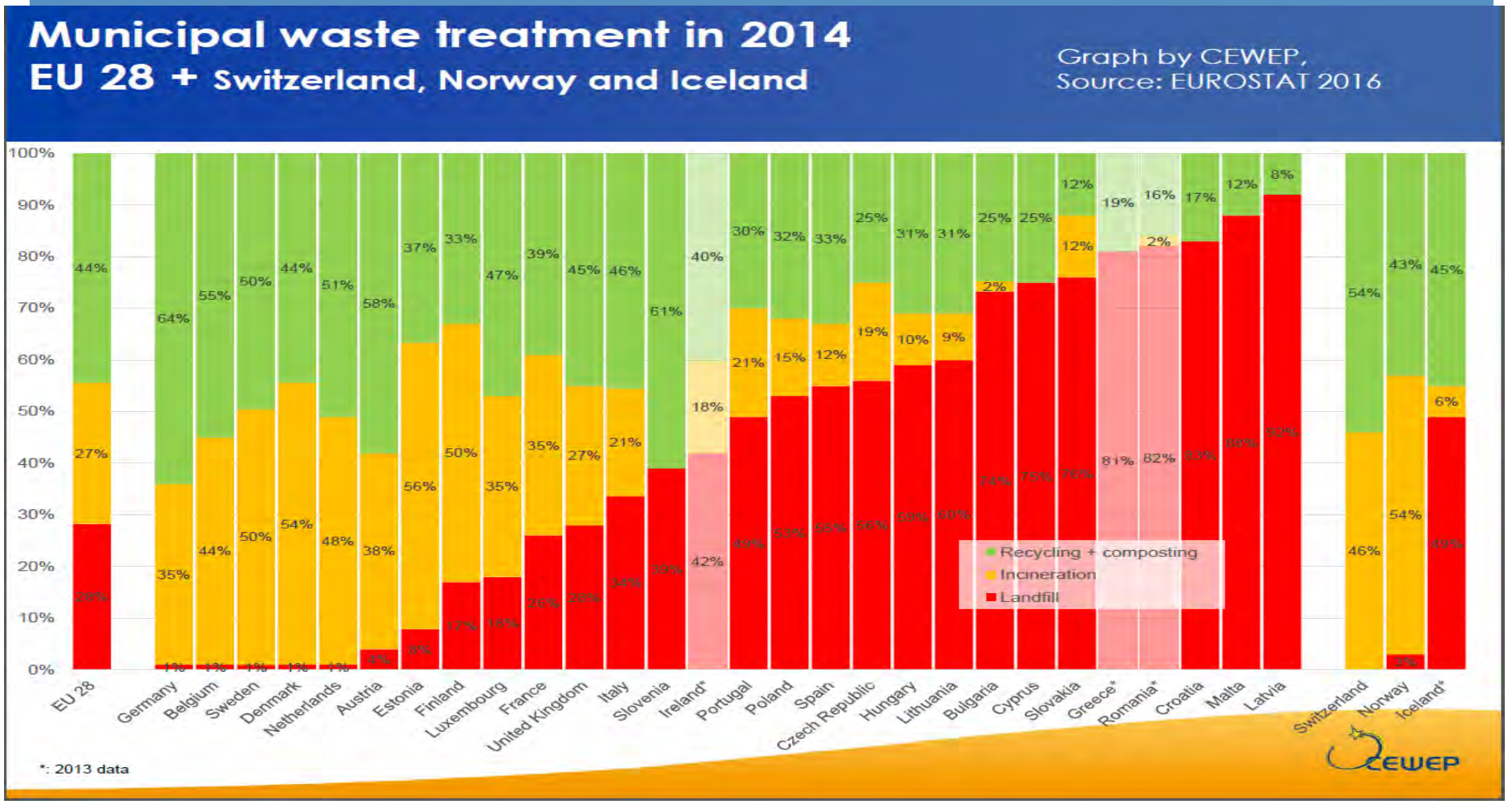
WTE Encourages Recycling (cont'd)



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WTE Encourages Recycling (cont'd)

- WTE and recovery ferrous and non-ferrous metals
  - Only about 1/3 of ferrous and non-ferrous are captured through source-separated (curbside) recycling
  - Conventional technology allows WTE facilities to recover ferrous and nonferrous metal fragments greater than 12 millimeters from WTE ash
  - Emerging technology allows recovery of much smaller metal particles (as small as 0.5 millimeters)
  - The Lancaster County, PA Solid Waste Management Authority is implementing one of these new technologies and expects a 46% increase in metal recovery
- This is another way in which WTE can play a significant role in achieving County Executive Constantine's 80% recycling goal

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WTE Mitigates Climate Change

- Widespread recognition that "because of its potency as a GHG and its atmospheric life, reducing methane emissions is one of the best ways to achieve a near-term beneficial impact in mitigating global climate change" – 79 Fed. Reg. 41772, 41774/1 (July 17, 2014)
- Given that context, the Intergovernmental Panel on Climate Change (IPPC) and the Kyoto Protocol both emphasize WTE's dual benefits of (i) avoided landfill methane emissions and (ii) offsetting fossil fuel combustion

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WTE Mitigates Climate Change (cont'd)

- In addition, the United Nations' November 2011 report, *Bridging the Emissions Gap*, concludes that waste sector GHG emissions can be reduced 80% if there is significant diversion of currently landfilled waste to WTE – http://www.unep.org/pdf/UNEP_bridging_gap.pdf
- WTE reduces GHG emissions in three ways by:
  - Generating electricity and/or steam without using fossil fuels
  - Avoiding the methane emissions that would result if the same waste was landfilled
  - Recovering ferrous and nonferrous metals, which avoids the additional energy consumption that would be required if the metals were produced from virgin ores

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WTE Mitigates Climate Change (cont'd)

- Using the IPPC's most recent Global Warming Potential (GWP) data and EPA's model for determining life-cycle GHG emissions from alternative MSW management methods, shows that every ton of MSW directed to WTE rather than landfilled avoids between 1.62 and 4.1 tons of GHG emissions
- WTE's GHG reduction benefits can also be evaluated based on an equivalent reduction in automobile emissions:
  - If the U.S. increased its use of WTE from the current 7.6% to the average rate of the EU 28 (27%), the additional reduction in annual CO_2equivalent emissions in the U.S. would be 122 million to 309 million tons (range is based on the difference between a methane GWP of 34 vs. 86)

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WTE Mitigates Climate Change (cont'd)

- This is equivalent to removing 23,000,000 to 58,500,000 passenger cars from the nation's roads
- Calculation based on the 2011 MSW landfill disposal volume of 247 million tons and EPA data for annual CO_2-equivalent emissions per passenger car (5.29 tons)
- King County – Seattle: the equivalent to 300,000 vehicles (and perhaps even more)
- A big boost for the County's GHG reduction goal

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One More Thought…

"We have observed that a synergy has developed across the world, unstated and perhaps unintentional, created through the combination of the energies of proponents of recycling and composting to achieve zero waste and the economic power of the lucrative landfilling industry. The former seek a laudable, but unrealizable goal, of 100% reduction/recycling/composting of waste. The latter, quietly continue their landfilling business, investing in new and bigger units, and thus showing with their investment capital that they believe a high level of landfilling will continue well into the foreseeable future so long as the status quo is maintained. This synergy has locked most jurisdictions into that status quo: landfilling over 60% of the MSW generated."

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DWS-René Møller Rosendal, MSC, Partner

Danish Waste Solutions
Waste - Resources - Environment

King County

Danish Waste Solutions

- Consulting company offering expert services for the management of waste and resources (landfilling and landfill mining, recycling of C&D, residues from WTE-plants and classification of hazardous waste).
- R&D projects for industry/waste management companies and public authorities in more than 20 countries.
- Currently, we are working on:
  - National tool for calculation of the leachate source term and estimation of the length of the aftercare period for landfills (Danish EPA)
  - Developing Future Landfill Strategies (Sustainable Landfill Network)
  - Landfill Mining Demonstration Project (Danish EPA)
  - Biocover projects to reduce landfill gas mitigation (Danish EPA/ Government)
- Read more at: http://www.danws.dk/index-uk.html

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Reduce landfilling and move toward a circular economy

- Landfilling of waste is not the best solution.
- A necessity to phase out landfilling as the primary method to reduce future groundwater contamination and greenhouse gas emissions.
- A need to improve green energy such as: WTE, windpower, and move away from using fossil fuels.

- **Facts about Denmark (DK):**
  - Population = 5.7 millions, Area = 43.098 km^2
  - Landfilled 4 % (Ban on landfiling of biodegradable waste since 1997)
  - Enough landfill capacity for more than 200 years and very short transportation distances
  - Landfilling in DK is the most expensive method (**avg. Gate-fee of 55 USD + 68 USD landfill tax** in order to promote recycling and prevention and stop waste from going to landfills
  - 28 WTE plants in operation – cover 5 % of the total electricity production and 28% of the total district heating in 2015.

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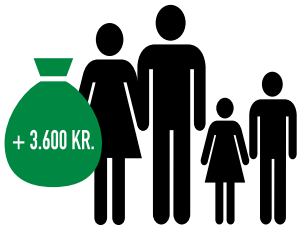
WTE vs Landfilling

- High recycling rates mean WTE overcapacity and waste is imported from UK to divert waste from landfills
- Environmental and economic benefits to transport and incinerate waste in Denmark instead of landfilling in the UK (*LCA and **socioeconomic analysis)
- Import of **1 ton** of waste from UK to a WTE facility in Denmark benefits the climate:
- Waste import of 400.000 tonnes for WTE provide a **$514 USD** annual saving for a family of 4

340 KG.	- 740 KG.	= 400 KG. CO_2 EMISSION
Landfil	**Energy**	**= Benefit**



***Life cycle assessment** is a technique to assess environmental impacts associated with all the stages of a product's life from raw material extraction through materials processing, manufacture, distribution, use, repair and maintenance, and disposal or recycling.

****Socio Economic Analysis =** How it benefits the economics

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Environmental Impacts of Landfills

- Some rather large costs associated with landfilling of waste.
- The biggest problem of landfilling is the environmental impact associated with an exponentially growing high cost, not only in the short term, but specifically in the **long term*** that will be a huge burden to the population/taxpayers in the future.
- Even the best landfills (and transportation) cause pollution to the local environment by contaminating the groundwater and aquifers, contaminating the soil, and producing methane, that is 25 times more powerful than carbon dioxide (CO_2).
- Greenhouse gasses are the leading cause of global warming.
- An aftercare period of 30 years is not a sufficient time to reach a final storage quality (FSQ) - *where active environmental protection measures are no longer necessary and the leachate is not acceptable in the surrounding environment*

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Long Term Environmental Impacts

- Landfill liners will fail - the question is how soon!
- Adequate landfill gas and leachate treatment systems for landfills are extremely expensive – more expensive than alternatives to landfilling as they have to be operational for 1000s of years (or until final storage quality is reached)– that is why Denmark and EU legislation is moving away from this and started to phase out landfilling.
- Leaching can occur tomorrow, in 20, 50 years, maybe in 100. Once it reaches groundwater it will be too late and too expensive to remediate.
- Who will pay for it? Society? The Polluter?

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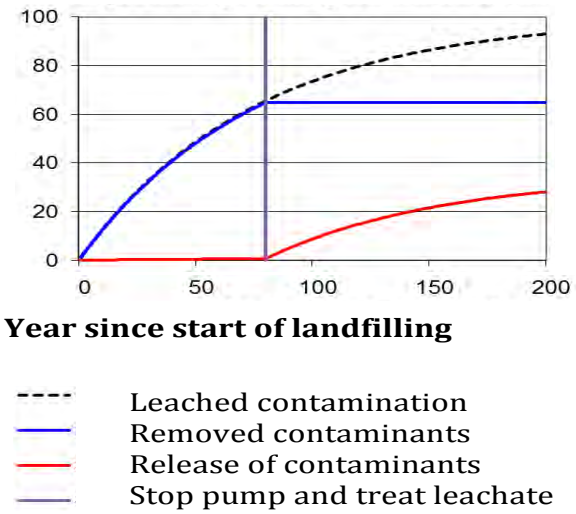
Addressing leaching time (1)

- During a landfills active period (when filled) leachate is treated and collected (no release of contamination).
- During the aftercare period (typical 30 years) leachate is collected, treated, and monitored.
- If capped no infiltration!!! – not a final solution but only a delay or pause.
- After the end of aftercare period – no monitoring and they will only work until the liners fails (Bathtub effect).
- Release of contamination will happen eventually – its just a question of time and mobility of substances (1000 of years)
- Aftercare period of 30 years is not enough
- Not even 100 years!



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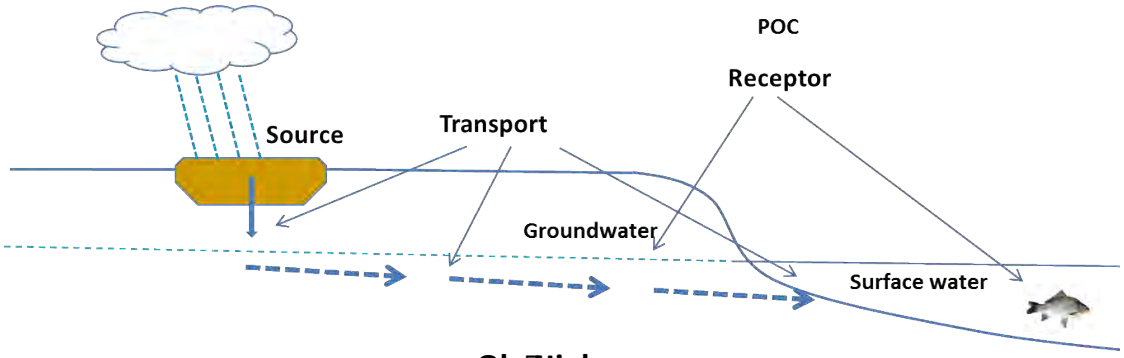
Udvikling af metodik til risikovurdering ved deponering af affald
Kildestyrkeprojektet (COWI og DanWS)
Nogle konsekvenser af valg og manglende data forhold til metodikken

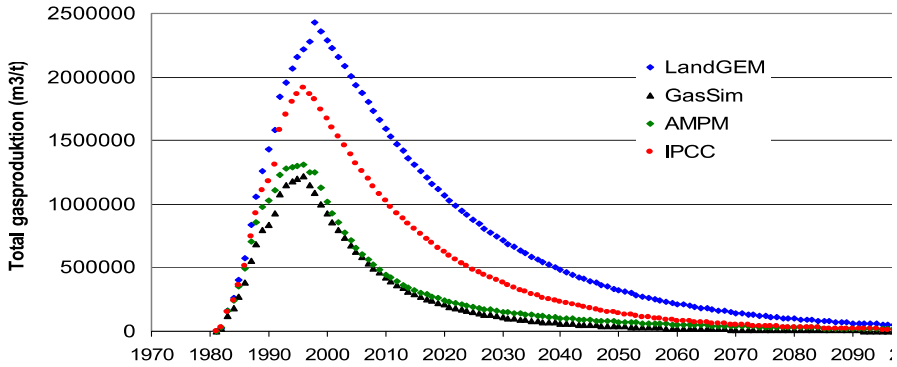


Ole Hjelmar
Danish Waste Solutions ApS

Møde DepoNet den 16. december 2016 Aalborg

Modelling of gas production efficiency

- LandGem and other LFG models do not supply a reliable tool to estimate methane emissions from an individual landfill.
- Models need to be supplemented with for example mobile plume measurement technology that gives an estimation of the methane emission of a complete landfill site.
- No difference between US and European LFG extraction systems regarding how they are working and managed.
- And yet, European LFG efficiency rates are **30-40%** and US are **90-95%** !!!



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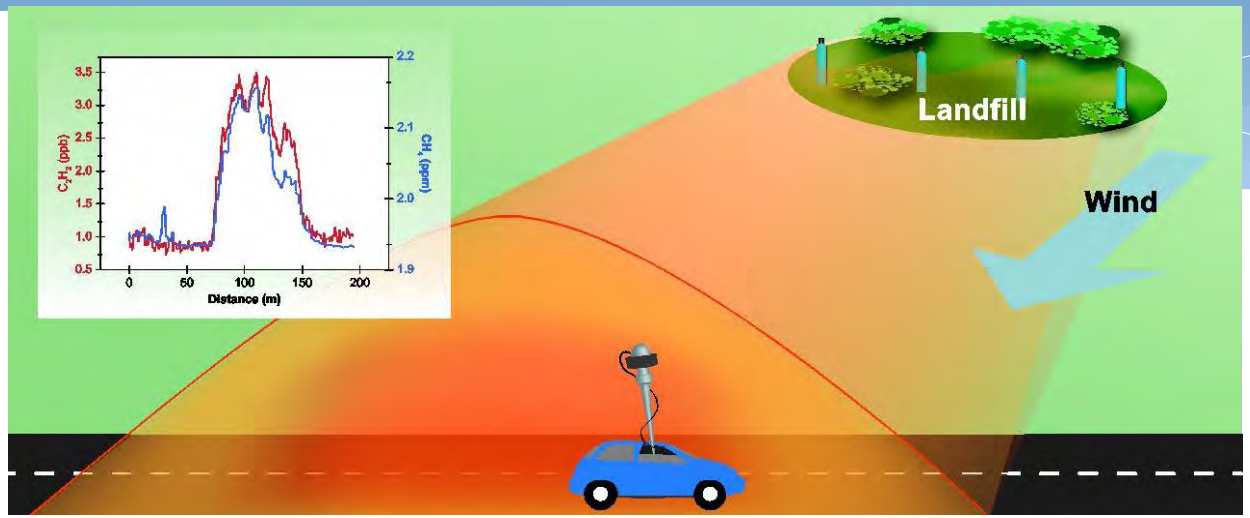
kan man udlede en kendt mængde af en sporgas samme sted som metankilderne på et deponi og efterfølgende måle koncentrationen af sporgas og metan så langt fra kilderne i vindens retning, at deponiet kan betragtes som en punktkilde. Forholdet mellem koncentrationen af metan og sporgas på målestedet vil være det samme som forholdet mellem udledningen af sporstof og metanemissionen. Princippet bag den dynamiske sporgasmetode er illustreret i Figur B1, og er gældende for alle metankilder, der emitterer nok metan til, at man kan måle koncentrationsforskellen langt fra kilden (f.eks. biogasproduktion i rådnetanke (Yoshida et al., 2014). Metoden har været brugt til måling af metan fra flere Danske deponier (Mønster et al., 2015).

Measuring all methane emissions of a landfill site



Figur 1. Kort over Glatved deponi. Rød markering viser relative metan koncentrationer

Figur 2. Metankoncentrationen på udvalgte områder af Glatved deponi. Farvekoden

Conclusive remarks and way forward (1)

- Landfilling is the cheapest process, but not the best solution.
- Waste is always moving to the cheapest options and currently landfill gatefees are too low and do not encourage other better, more efficient and sustainable treatment options.
- Landfilling of waste is associated with many long term environmental impacts, which will be very expensive for future generations to try to fix.

How:

- First we need to focus on moving away from generating waste in the first place - but that takes time and is a long way into the future.
- Next we need to reduce, reuse, recycle, and incinerate (most reliable thermal treatment process) as much waste as possible.
- We still need landfills - but the way forward is to avoid their environmental impact by only landfilling inert, pre-treated household and biodegradeble waste. Even good quality slag/bottom ash should be used in lieu of primary resources moving towards a circular economy.
- Develop and Implementing alternatives to landfilling improve the economics of managing resource waste significantly, which can be observed with great success in many European countries.

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Conclusive remarks and way forward (2)

Why:

- Benefits the environment - local and globally,
- Creates American jobs,
- Huge export potential of innovation, Know-How, equipment and technology
- There is a significant recycling industry and global markets would attract investments into such US infrastructure developments that provide important capital and economic benefits to the country.
- Only 1/4 of all recycable material from DK is exported to treatment facilities outside the country

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BlackForest / ALBA / Interseroh

Sebastian Frisch, Dipl.-Ing.

BLACKFOREST

SOLUTIONS

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Company Overview

- **BlackForest Solutions GmbH is acting on behalf of ALBA Group plc, the second largest German waste management company and within the Top10 leading environmental service providers globally. BlackForest Solutions is a legally independent spin-off from the ALBA Group.**
- Family owned ALBA Group was founded 1968 in West Berlin and has an actual turnover of US$ 3 billion; 8,000 employees and 200 treatment sites worldwide.
- https://www.youtube.com/watch?v=ChrWomJx_qk

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Recycling

Conditions for recycling (of municipal solid waste), implemented in Germany since 2005:

- Zero Waste starts with the regonition that landfilling, especially of untreated waste, is a major obstical for zero waste objectives
- Legal framework: no untreated waste allowed to landfill. Treatment must result in low concentration of organics. Only inert material to landfill.
- Legal framework: extended producer responsibility for packaging. Producer of packaging must pay into a take-back program. This fund is administered by a clearing authority. This authority is tendering the collection of packaging waste on behalf of the packaging producer.

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Recycling -2-

- Implementation of a source segregation collection of municpal solid waste: a) resource bin (packaging, recyclables), b) mixed bin (residual), c) paper/cardboard – as an option d) bio/food waste e) glas waste
- Separate collection of municipal hazardous waste.

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Recycling -3-

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Examples

- Practical example for solutions for the resource bin (yellow and orange bin): ALBA LVP Recycling:
- https://www.youtube.com/watch?v=CDGAhVb4r1w
- And consequently following an integrated upcycling solution and closed-loop:
- https://www.youtube.com/watch?v=0rsidi-2gnk

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Examples -2-

- Practical example for solutions for the mixed bin (grey/black bin): ALBA Green Coal (RDF):

- https://www.youtube.com/watch?v=gUQhLeJrKoQ

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Comparison: German and US Systems

Type	USA	Germany
Resource/Recycling Bin	MRF***	LVP*
Output of MRF/LVP	Only basic Recycling and 80% of „recyclables“ are exported to Asia	Closed-loop Upcycling and significant lower quantities are exported to Asia
Mixed Bin/Garbage Bin	Landfill	RDF**/Green Fuel/W2E
Food/Yard Waste Bin	Compost, landfill	Biogas/Waste to Energy/fertilizer

*LVP = Light Weight Packaging Waste
**RDF = Residual Derived Fuel
***MRF = Material Recovery Facility

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Opportunities Moving Forward

- Is the quality of the output of the MRF comparable with the output of LVP?
- Is the efficiency of the MRF process comparable with the efficiency of the LVP?
- **King County's MSW recycling rate:**
  - **54% (vast majority exported to Asia)**
- **Germany's Recycling Rate:**
  - **68% (significantly reduced export to Asia).**
- **It is much more challenging to increase the recycling rate from for example 65% to 68% than from 50% to 60%.**

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Opportunities Moving Forward -2-

- Quality of the Upcycling in US? Usage in food/toy applications? What percentage can be used in closed-loop applications (quality and efficiency of the MRF process vs LVP process)?
- New Upcycling products in US?
- Substantially more local and regional jobs are created by keeping high quality materials in the local economy
- Setting up closed-loop recycling and Upcycling facilities in the US and adding extrusion and injection molding behind the lines
- **How much secondary raw material can be generated in the US instead of exporting treated waste to Asia?**

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Conclusion

Waste is too expansive to be wasted:

- Avoidance of landfilling through improved collection through source separation
  - Taking a close look at the materials flowing through the MRFs and replacing /adding LVP technology will increase in the recycling rate significantly
- Creation of many additional local and regional (American) jobs through a real circular economy
- Significant increase in revenues through additional recycling and adding upcycling technology
- Reduced dependence on raw materials
- Cost offset by revenues and improved environmental performance

King County

Distributed Energy Management
Jimmy Jia, CEO

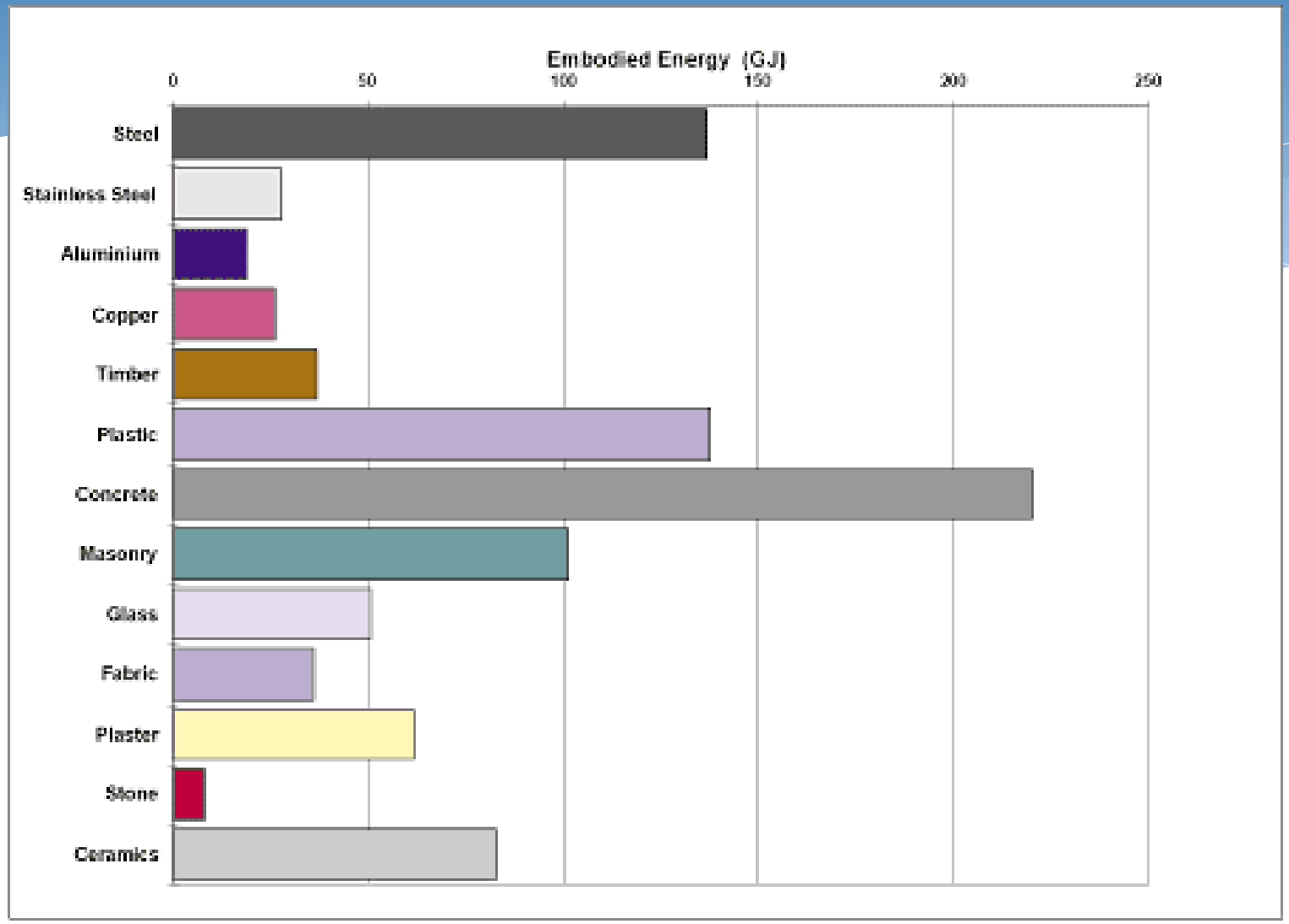
DISTRIBUTED ENERGY MANAGEMENT

King County

Which view is waste?

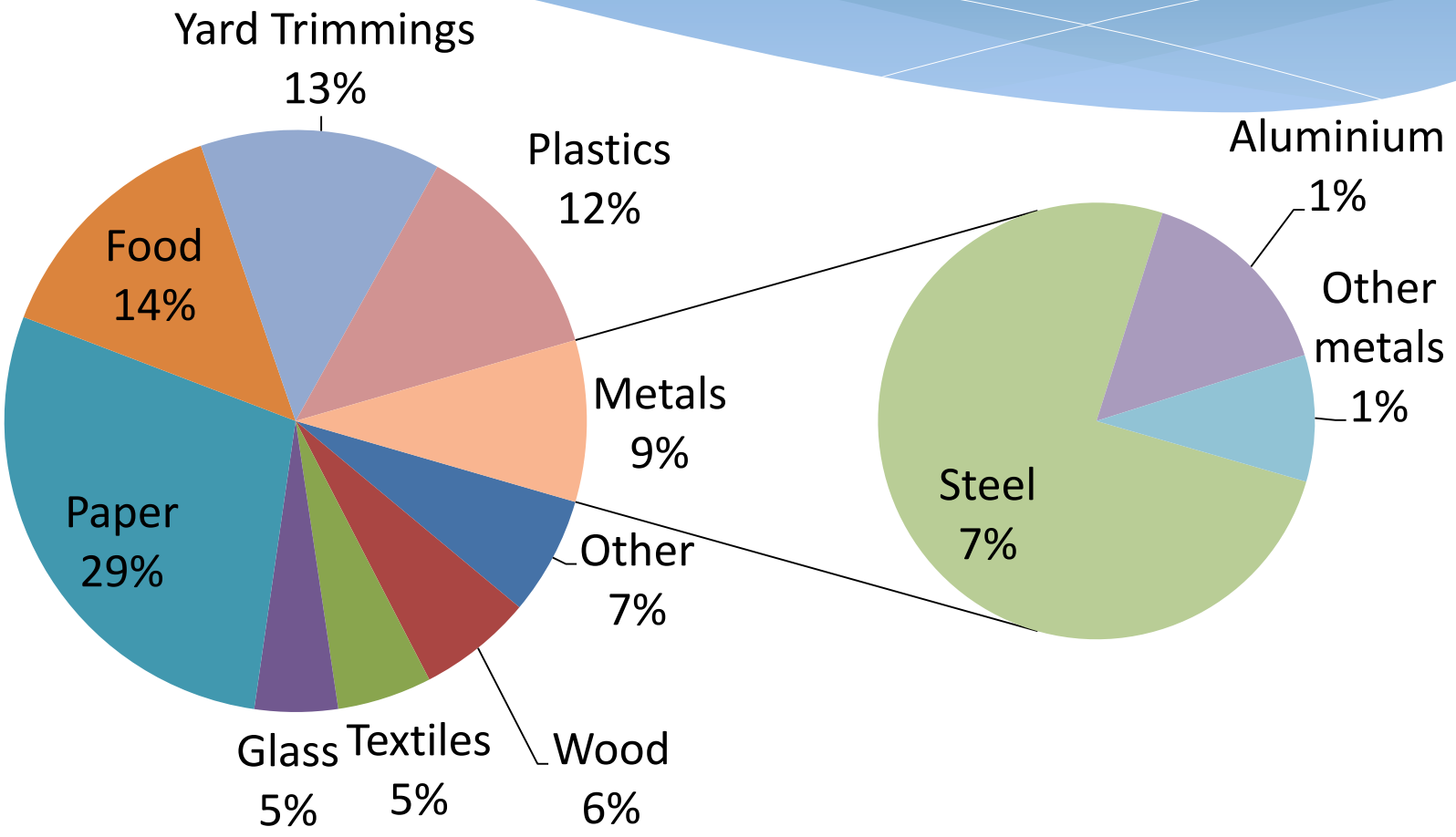
95% of everything we buy is thrown away at some point

Embodied energy of a house

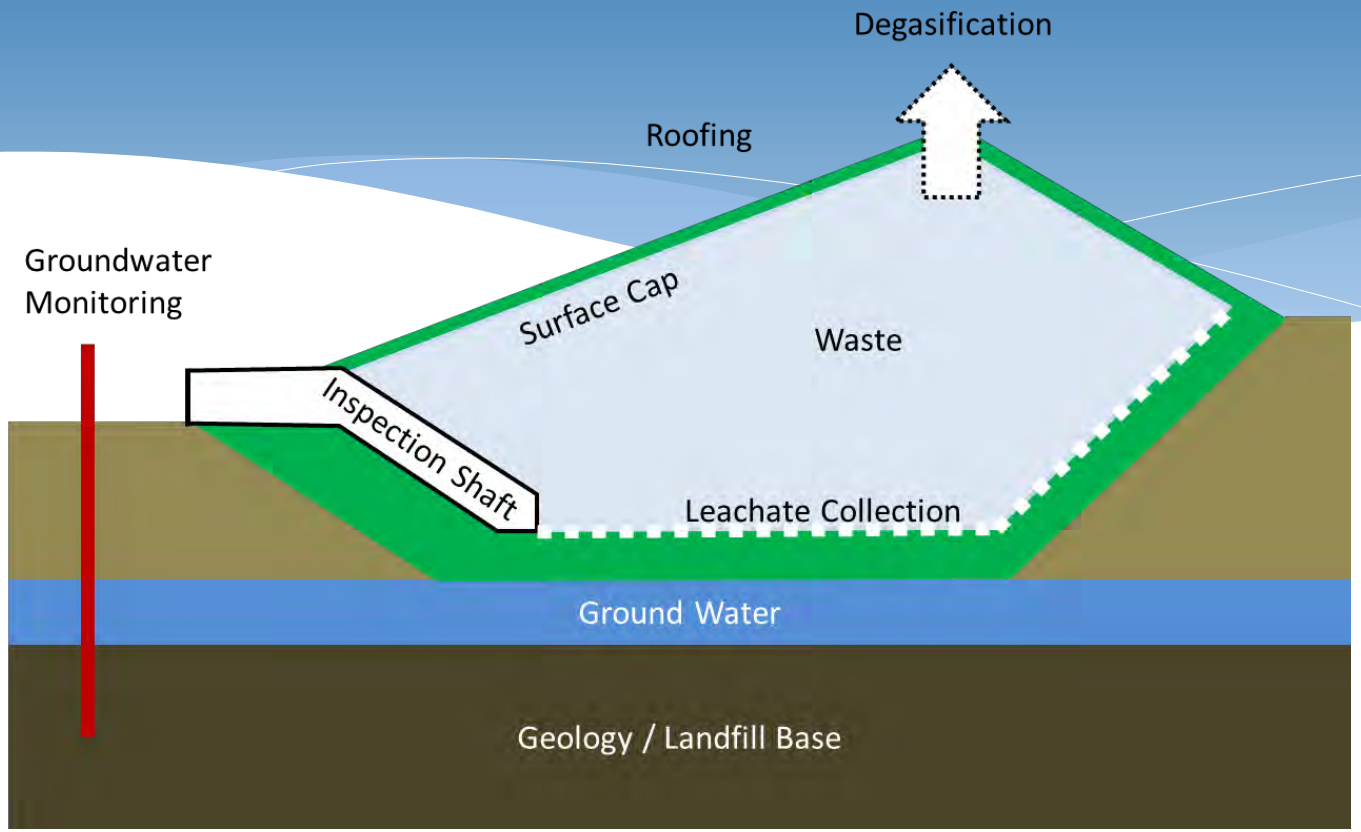


http://www.epa.vic.gov.au/agc/r_emissions.html#page-4/!

Composition of Waste in the USA



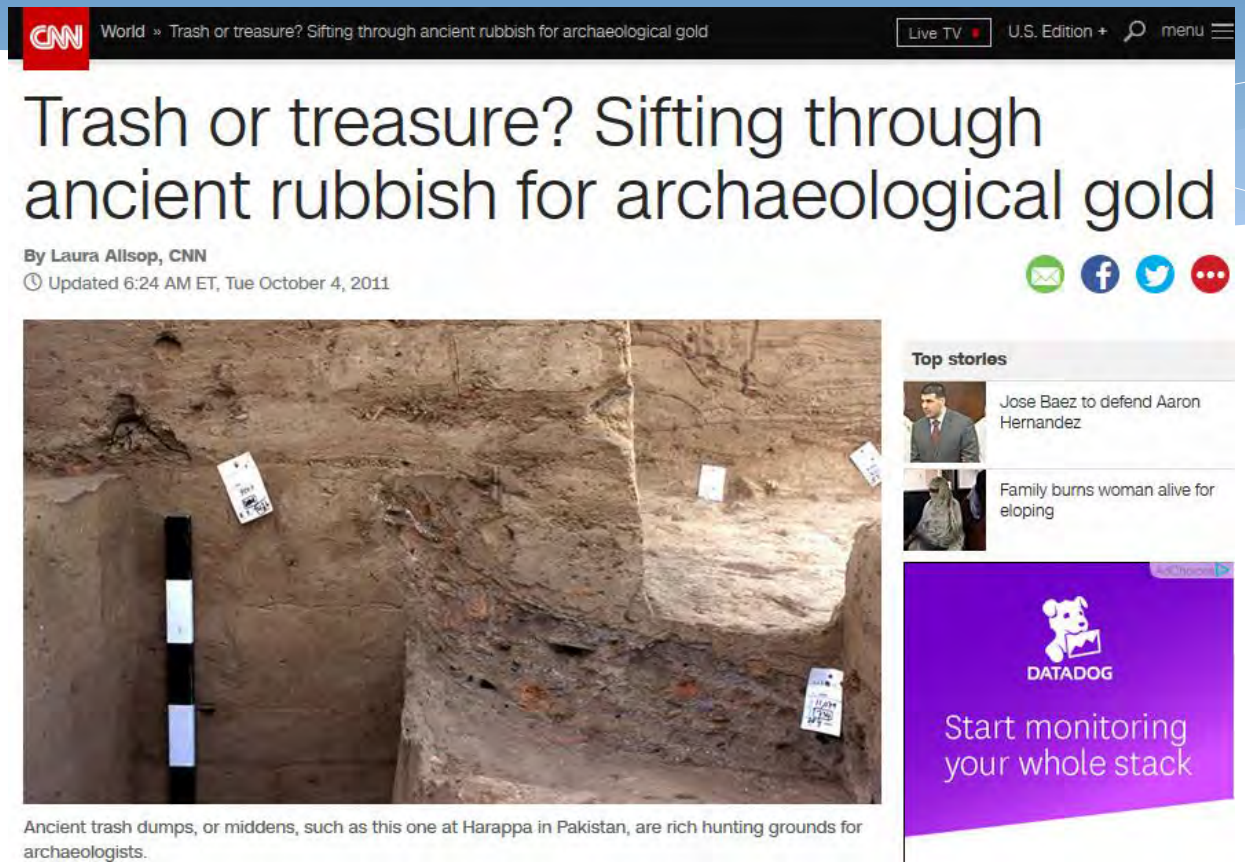
Landfill Option



* Operational Life Expectancy: 30-50 Years
* Monitoring after closure: ~30 Years

How long does a landfill last for?

Middens



CNN World » Trash or treasure? Sifting through ancient rubbish for archaeological gold Live TV U.S. Edition + menu

Trash or treasure? Sifting through ancient rubbish for archaeological gold

By Laura Allsop, CNN

Updated 6:24 AM ET, Tue October 4, 2011

Ancient trash dumps, or middens, such as this one at Harappa in Pakistan, are rich hunting grounds for archaeologists.

Top stories

Jose Baez to defend Aaron Hernandez

Family burns woman alive for eloping

Oldest ~140,000 years old (mid Paleolithic era)

http://www.cnn.com/2011/10/04/world/europe/archaeology-ancient-trash/

Recycling

Reduction of:	Aluminum	Steel	Paper	Glass
Energy Use	95%	60%	50%	20%
Air Pollution	95%	85%	74%	20%
Water Pollution	97%	76%	35%	-
Water Use	-	49%	58%	50%

Compost / Fermentation

Diagram of Composting

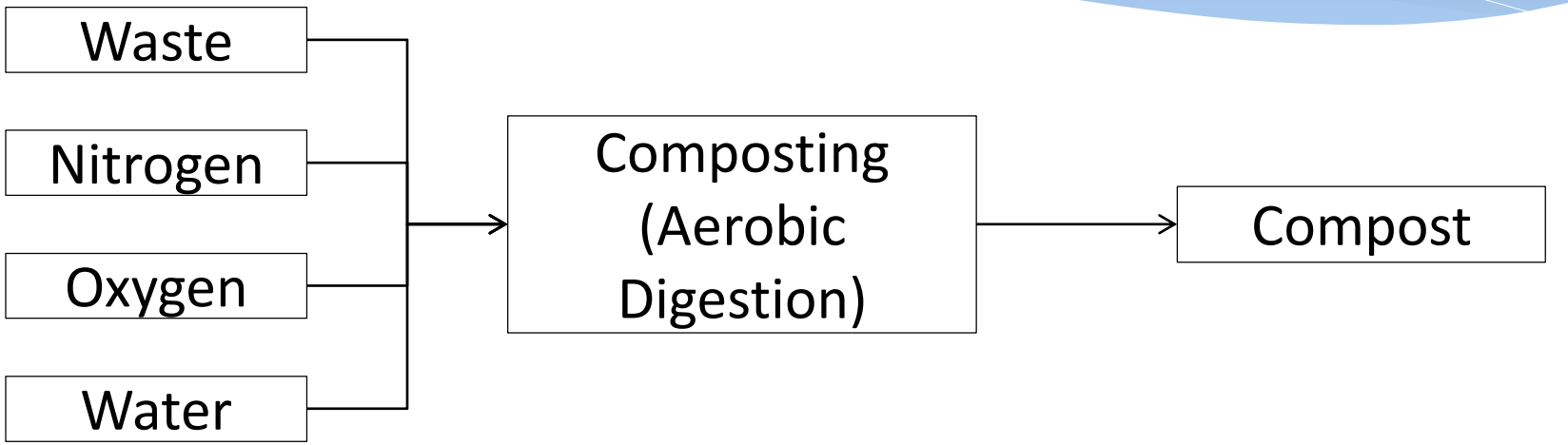
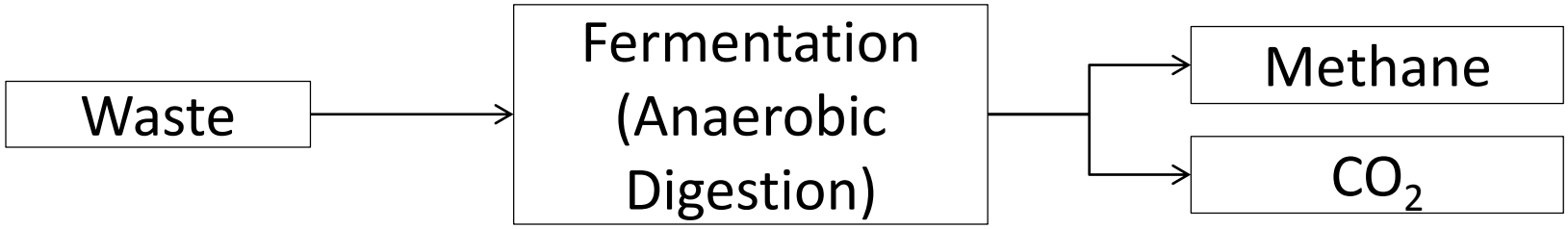
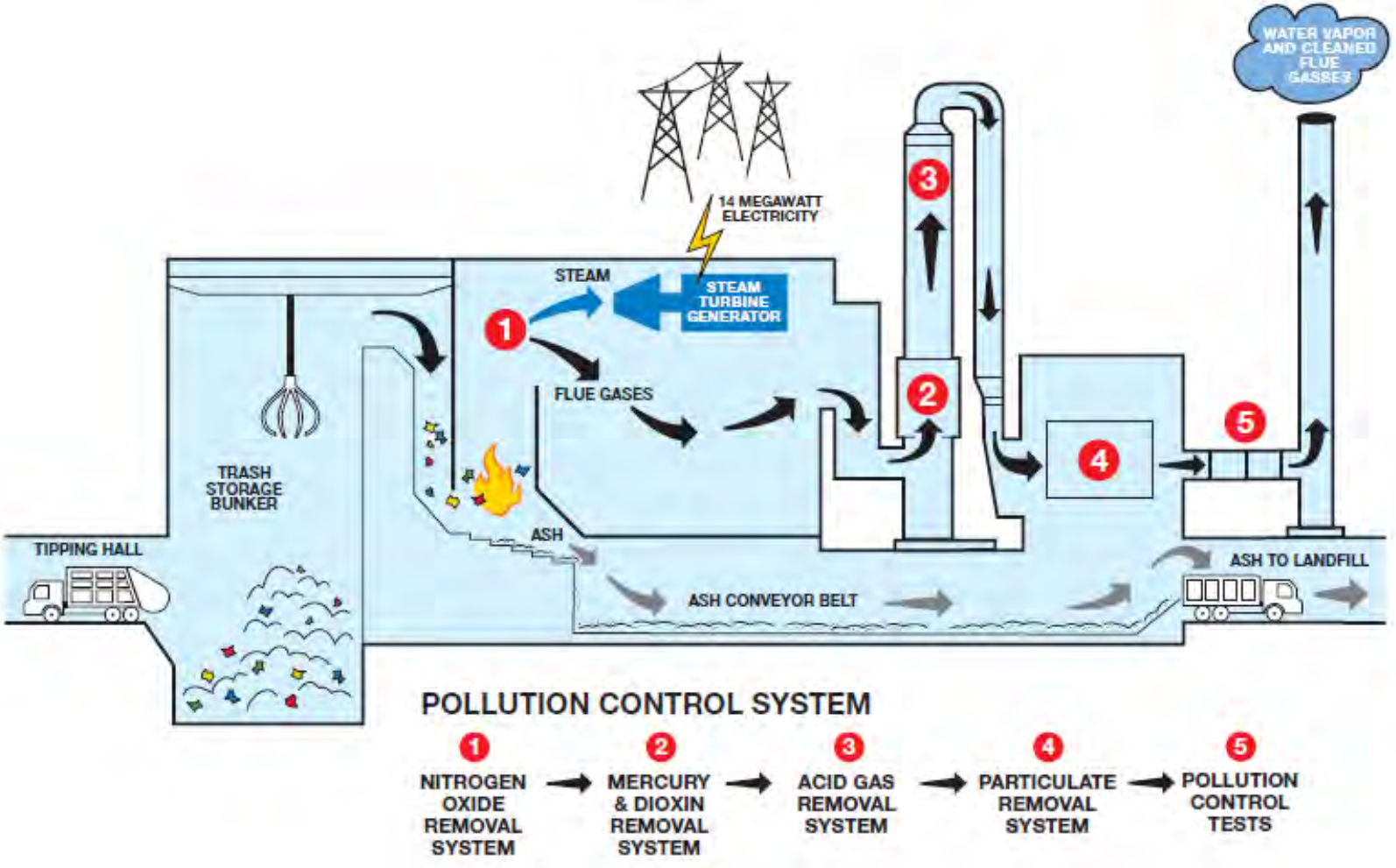


Diagram of Fermentation



Waste-to-Energy



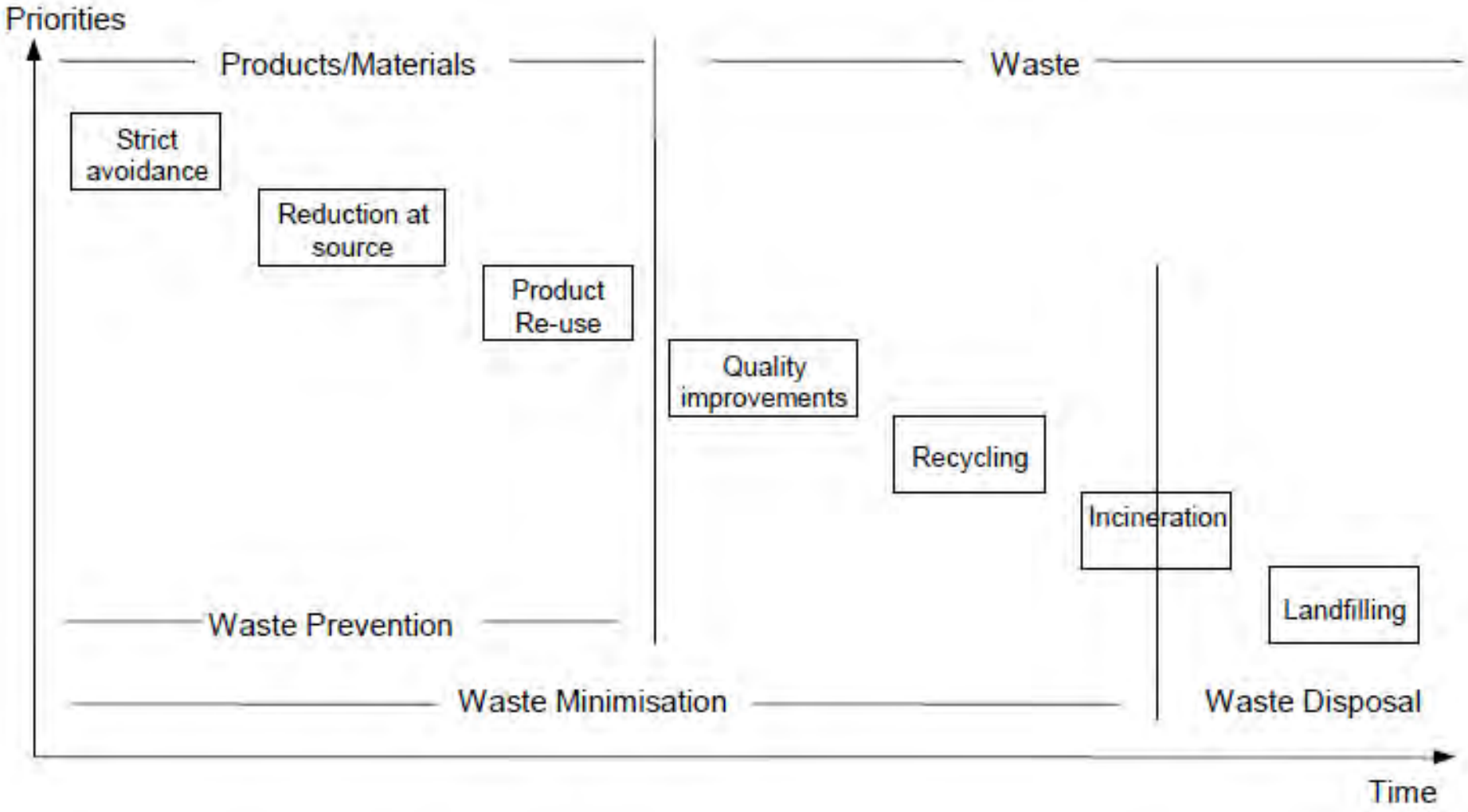
Outcomes

Germany:
Disposal Cost:
$294: 4 Person Household

USA - King County:
Disposal Cost:
$300: 4 Person Household

	1990's	2010
MSW Generation	50.9 M Tons	49.2 M Tons
Composting	13 %	17 %
Recycling	26 %	46 %
Waste-to-Energy	18 %	37 %
Landfill	43 % →	0.4 %
MSW Generation	208 M Tons	250 M Tons
Composting	2 %	8.1 %
Recycling	14 %	26 %
Waste-to-Energy	14 %	12 %
Landfill	70 % →	54 %

Waste Prioritization in Germany



Economic:

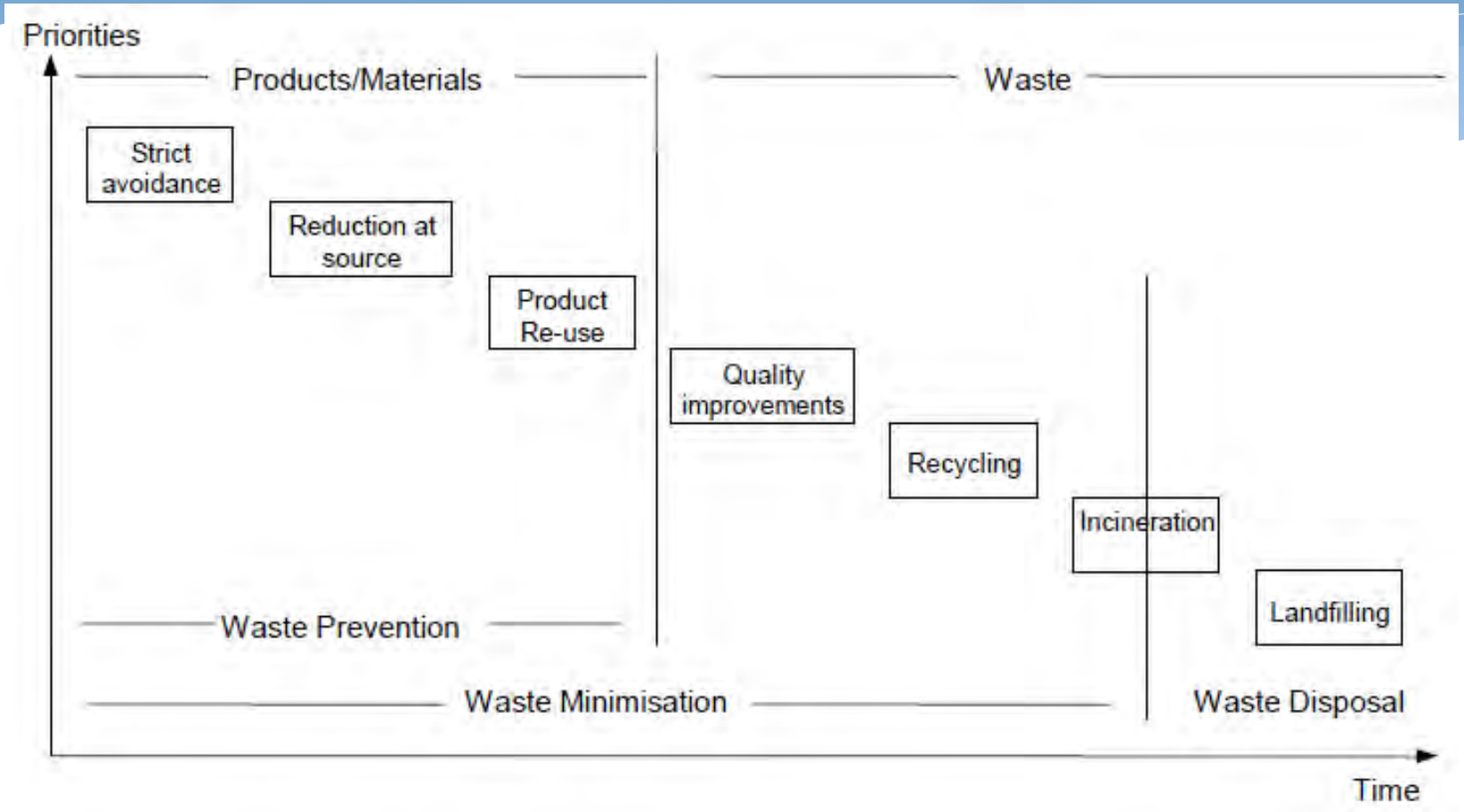
Germany:

* Created 200,000 jobs to manage waste
* Generates €75 Billion contribution to GDP

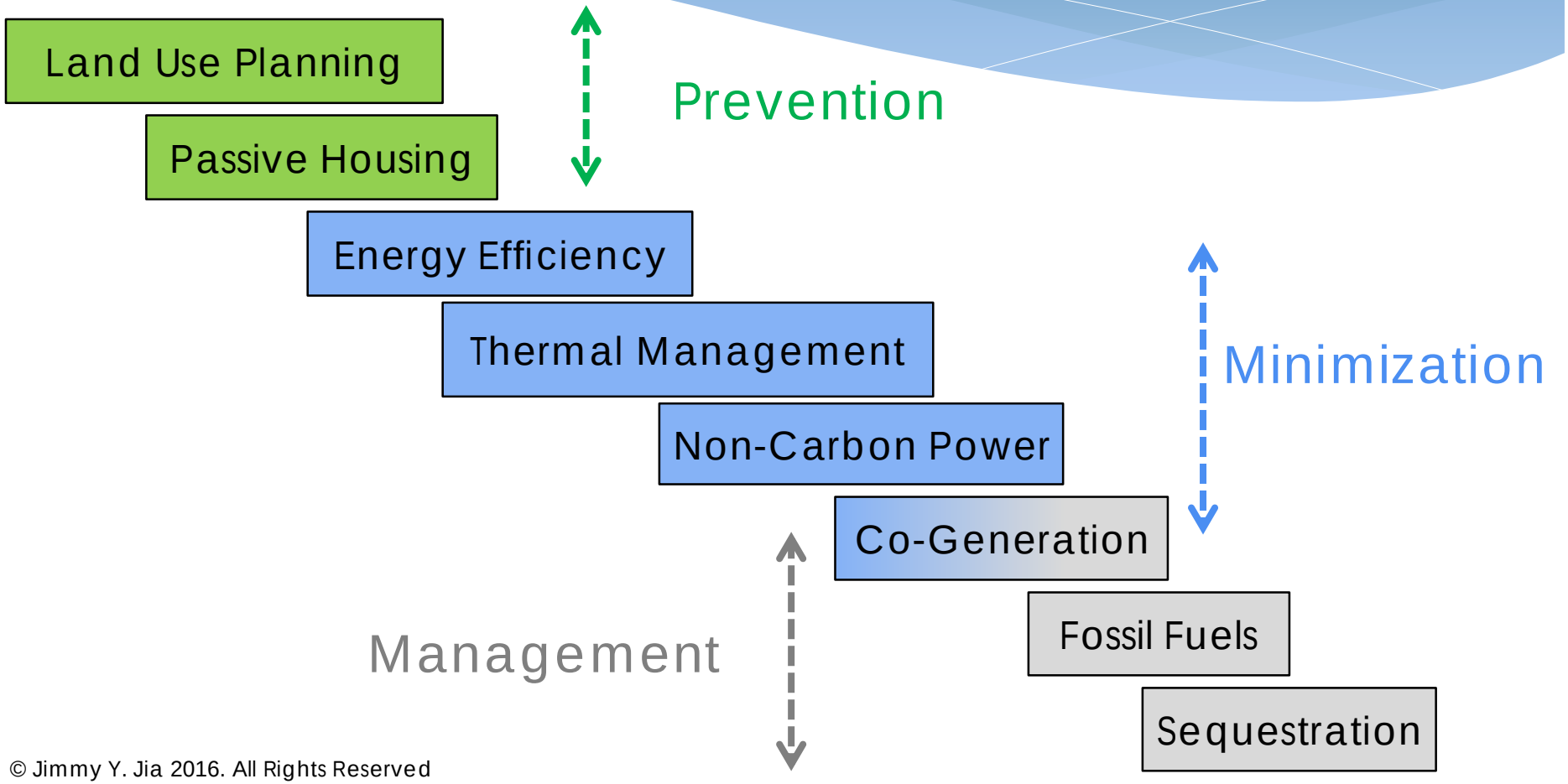
USA Equivalent:

* “Bury” $250-375 Billion in economic value in landfills every year (GDP Opportunity cost)

Waste Prioritization



Carbon Prioritization



Additional Comments

Tay Yoshitani

“As a long-time business executive with experience in both the private and public sectors, I know how rare it is to identify an opportunity with so many important public benefits packaged into one project. I believe a waste to energy project in King County is one of those rare opportunities to do enormous good for the neighboring communities.

Tay Yoshitani cont.

A waste to energy facility, properly designed and built incorporating best available technologies and operated using best practices, would ***reduce harmful emissions***, create ***sustainable family-waged jobs***, and ***generate energy*** from materials that would otherwise be discarded into landfills.

Tay Yoshitani cont.

In addition to these benefits, communities would gain the opportunity to make land use decisions consistent with their values.

A Waste to energy approach is not technology that has yet to be proven, nor is it pioneering. It is being successfully adopted in several other parts of the world. We in King County should be adopting a similar approach.” January 12, 2017

Conclusions

Our Goal is to:

- Move forward and engage new waste management concepts for the Pacific Northwest including state of the art recycling, upcycling and Waste-to-Energy Resource Recovery,
- Development of Solutions that will Remediate, Enhance and Restore the Environment,
- Develop new Commercial and Industrial businesses, and
- Create jobs and Provide Revenue producing alternatives for our Region.

King County

Question and Answer Session

King County