

WAYNE STATE UNIVERSITY - ENVIRONMENTAL SCIENCE PROGRAM

URBAN ENVIRONMENTAL EXCURSIONS

FALL 2007: ENERGY AND AIR QUALITY

Where does our **GASOLINE** come from?

How is our **ELECTRICITY** made?

What ultimately happens to our **TRASH**?

And how does this impact the **AIR** we breathe?

(The answers may surprise you!)



When: 8am-5pm Friday, October 19, 2007

Depart: from Old Main (bus transportation provided)

Visit:

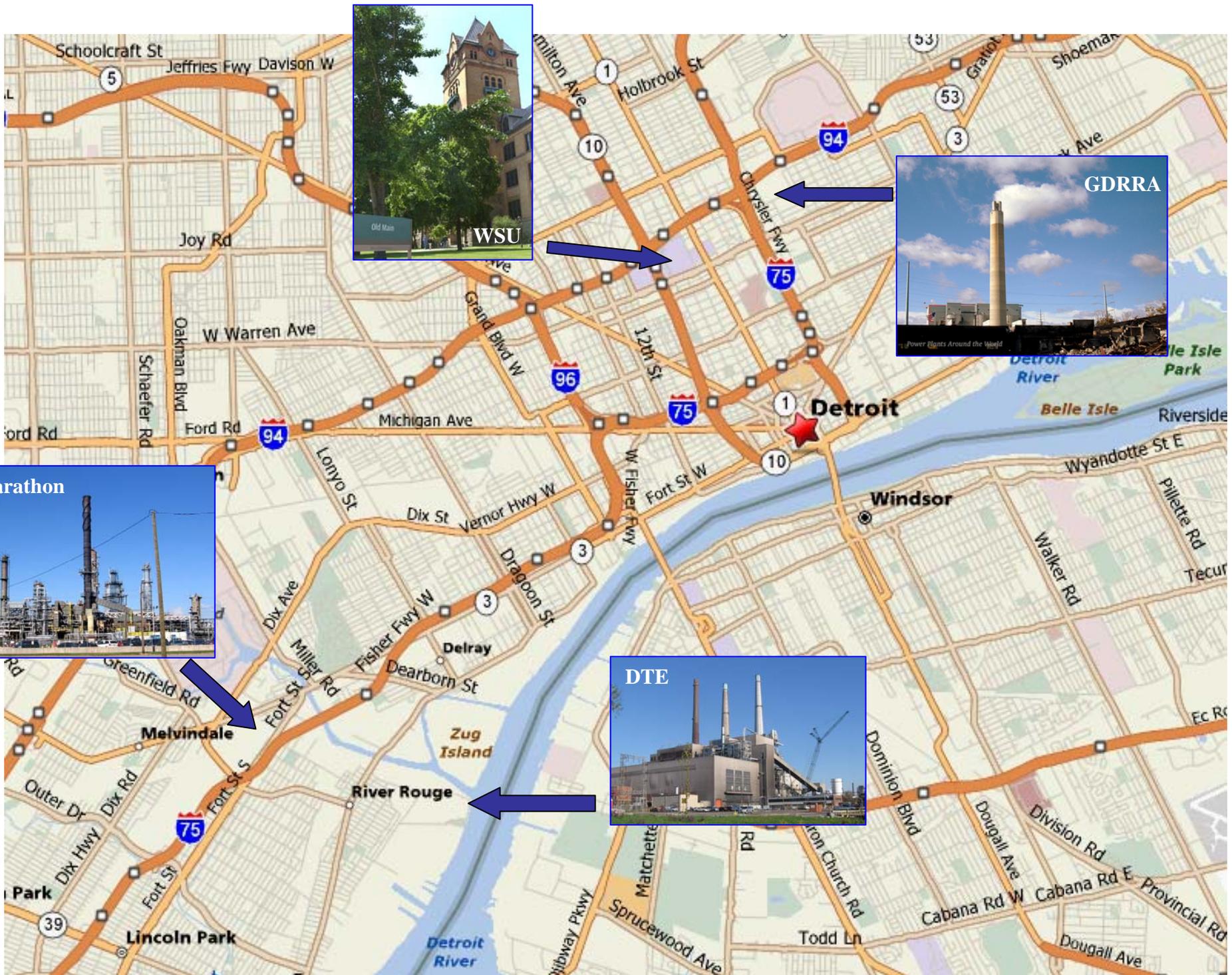
- DTE Rouge River Coal-Fired Power Plant
- Marathon Detroit Petroleum Refinery
- Greater Detroit Resource Recovery Authority

Cost: Free for GEL 1000 and GEL 1010 students

Sign up: Before October 12th in the GEL 1010 lab.

We will tour three local facilities that manufacture energy (gasoline, electricity, and steam) using crude oil, coal, and municipal waste. Each contributes jobs, resources, and pollution to our urban environment. Come and see how these facilities work and learn how they monitor and control their airborne emissions.

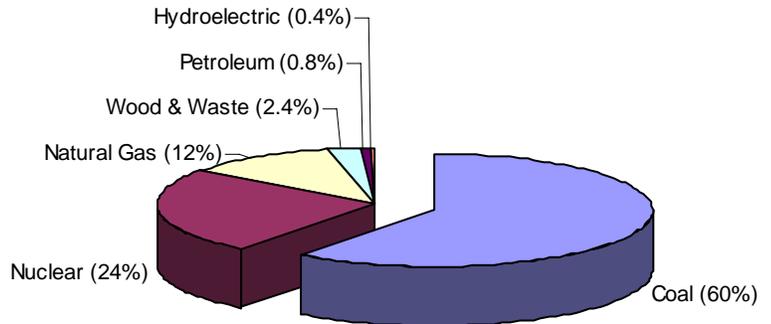






Did you know that...?

- Most of Michigan's electricity is generated from coal.
- DTE generates approximately 80% of its electricity from coal.
- DTE operates 7 fossil fuel and one nuclear power plant in SE Michigan.
- The River Rouge Power Plant was ISO 14001 certified in 2003. (Just what does this mean?)



Michigan Electricity Production (source USDOE)



The DTE River Rouge Power Plant is located on the bank of the Detroit River, just south of Zug Island and the mouth of the Rouge River. The plant has three smokestacks. Each stack has its own furnace, boiler, and turbine system for generating electricity. Two of the three will be operating when we arrive. Can you tell which unit is idle by looking at the smokestack emissions?

How much electricity does the plant generate? Approximately 550 megawatts. That's 550,000 kilowatts per hour – enough electricity to meet the *household* needs of approximately 1.5 million people.

Then why do we need so many electricity plants? Two main reasons: 1) we can't transmit all of the electricity with 100% efficiency (about 10% of it is lost along the way), and 2) municipal, industrial, and commercial users consume lots of electricity too.

Things to consider:

- Why do we use coal instead of other energy sources for electricity?
- Where does all that coal come from? How does coal mining affect the environment?
- How much of the coal's energy content is actually converted to electricity?
- What other resources are used in the plant?
- What gasses are emitted and how do they monitor for them?
- How much CO₂ is released each day?
- How are the ash and other combustion products kept out of the emissions?
- How has the plant found ways to minimize its environmental impact?



How much coal is required to run a 100-watt light bulb 24 hours a day for a year?

We'll start by figuring out how much energy in kilowatt-hours the light bulb uses per year. We multiply how much power it uses in kilowatts, by the number of hours in a year. That gives $0.1 \text{ kW} \times 8,760 \text{ hours}$ or **876 kWh**.

The thermal energy content of coal is 6,150 kWh/ton. Although coal fired power generators are very efficient, they are still limited by the laws of thermodynamics. Only about 40 percent of the thermal energy in coal is converted to electricity. So the electricity generated per ton of coal is $0.4 \times 6,150 \text{ kWh}$ or **2,460 kWh/ton**.

To find out how many tons of coal were burned for our light bulb we divide 876 kWh by 2,460 kWh/ton. That equals 0.357 tons. Multiplying by 2,000 pounds/ton we get **714 pounds (325 kg)** of coal. That is a pretty big pile of coal, but let's look at what else was produced to power that light bulb.

A typical 500 megawatt coal power plant produces 3.5 billion kWh per year. That is enough energy for 4 million of our light bulbs to operate year round. To produce this amount of electrical energy, the plant burns 1.43 million tons of coal. It also produces:

Pollutant	Total for Power Plant	One Light Bulb-Year's Worth
Sulfur Dioxide - Main cause of acid rain	10,000 Tons	5 pounds
Nitrogen Oxides - Causes smog and acid rain	10,200 Tons	5.1 pounds
Carbon Dioxide - Greenhouse gas suspected of causing global warming	3,700,000 Tons	1852 pounds

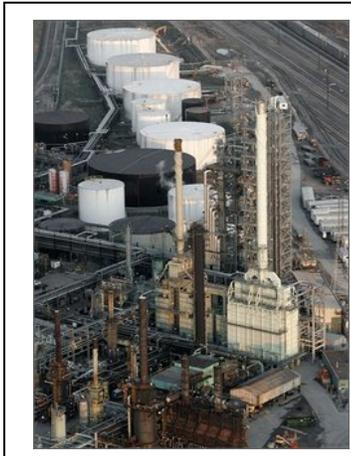
It also produces smaller amounts of just about every element on the periodic table, including the [radioactive ones](#). In fact, a coal-burning power plant emits more radiation than a (properly functioning) [nuclear power plant](#)!

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URBAN ENVIRONMENTAL EXCURSIONS
MARATHON PETROLEUM REFINERY



Did you know that...?

- Marathon operates the only refinery in Michigan.
- Its capacity is 100,000 barrels of crude oil per day.
- 50% ends up as gasoline (~2.1 million gpd).
- The rest becomes diesel fuel, asphalt, and other specialty products.
- Marathon is considering a \$1 billion expansion to the refinery that would boost refining capacity 15,000 barrels a day by 2010 and add more than 900 jobs to the local economy.



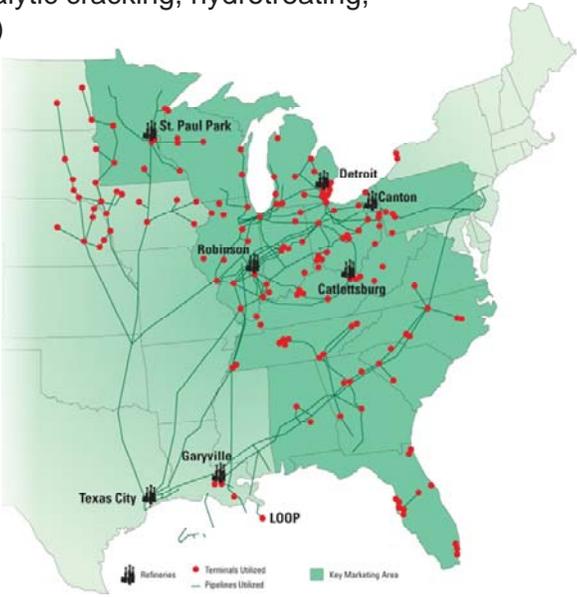
On 9/7/07, the Detroit Free Press reported that “Marathon Petroleum Co. expects to spend \$2 million to install air quality monitoring stations that would warn residents in the area in the event of an environmental problem, as part of its three-year \$1 billion plan to increase refinery production in Detroit by 15%.”

- What air emissions come from a refinery?
- Are they potentially dangerous?
- How are they monitored?
- How are they controlled?
- What safety issues are associated with a crude oil refinery?

Operations at the refinery include crude fractionation, catalytic cracking, hydrotreating, reforming, alkylation and sulfur recovery. (What are these?)

Things to consider:

- Where does the crude oil come from?
- How does the crude oil get to the refinery?
- How is the refined gasoline transported from the refinery?
- Is the refined gasoline sold under any brands other than Marathon?
- How does this refinery’s capacity compare to Michigan’s average gasoline demand of approximately 14 million gpd?
- Does the presence of salt mining operations near or beneath the refinery pose any environmental risks?



Marathon to spend \$2 million on air monitors at refinery

September 7, 2007

BY ALEJANDRO BODIPO-MEMBA
FREE PRESS BUSINESS WRITER

Marathon Petroleum Co. expects to spend \$2 million to install air quality monitoring stations that would warn residents in the area in the event of an environmental problem, as part of its three-year \$1 billion plan to increase refinery production in Detroit by 15%.

The owner of Michigan's only refinery is seeking from the board of directors of its parent company Marathon Oil Corp. to increase refinery production from 100,000 barrels to 115,000 barrels a day. Marathon Petroleum Co. is a unit of Houston-based Marathon Oil Corp.

As part of that plan, Marathon told the Free Press Thursday that it will erect at least five ambient monitoring stations around the Detroit refinery to measure concentrations of air pollutants along the perimeter of the facility's fence line in Southwest Detroit. The company estimates it would take about \$200,000 a year to do the monitoring.

The information gathered by the company would be shared with the Michigan Department of Environmental Quality (MDEQ), as well as local emergency response units and local residents.

"We're spending more than \$300 million for pollution controls at the Detroit refinery," said James Wilkins, Manager of the Refining Environmental & Safety division.

The Marathon project also holds the promise of easing price volatility in the Detroit area's gasoline market, boost production of Canadian crude oil into fuel and the addition of 800 construction jobs starting early next year through 2010.

The proposed expansion could help stabilize fuel prices for Michigan motorists, by adding about 630,000 gallons of gas a day to the Michigan market.

Marathon's plan for growth calls for the use of so-called "heavy crude" oil that comes from Canada's tar sands, primarily in northern Alberta. Unlike the light-sweet crude from Saudi Arabia and other places, heavy crude has a higher sulfur content and is more difficult to process cleanly.

To accommodate the environmental challenges, Marathon said it plans to build additional sulfur extraction units, including a new delayed coker unit, at the refinery.

Marathon admits that the new project will likely result in as much as 30% greater air emissions (carbon monoxide and particulates) than current levels. But the nation's fourth-largest oil company said it plans to buy credits for particulates from other industrial companies to further offset the impact of the increase.

"In terms of air quality, there will be greater particulate (matter) and carbon monoxide emitted," Wilkins said. "But our emissions will be lower than what is required and there is a lot of environmental investment that we're putting into this project."

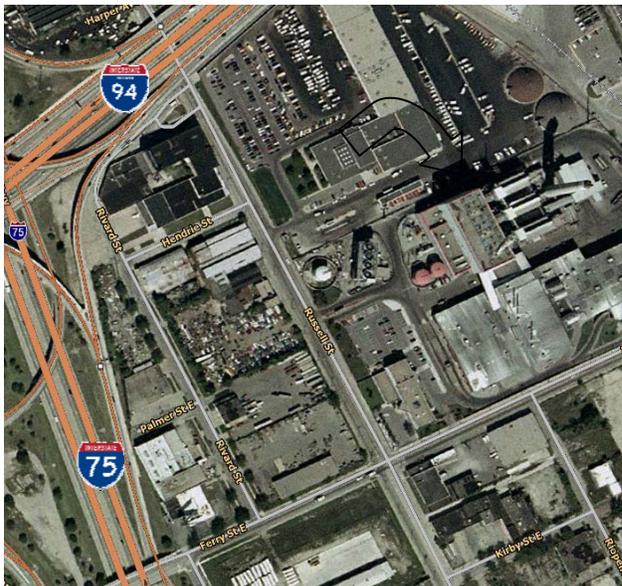
Officials at Marathon said they have already submitted their air quality permit application with MDEQ and expect to have a final decision by the end of 2007.

Contact ALEJANDRO BODIPO-MEMBA at 313-222-5008 or abodipo@freepress.com.

WAYNE STATE UNIVERSITY - ENVIRONMENTAL SCIENCE PROGRAM
URBAN ENVIRONMENTAL EXCURSIONS
GREATER DETROIT RESOURCE RECOVERY FACILITY

Did you know that...?

- Residents of the City of Detroit generated 376,000 tons of municipal solid waste in 2005.
- Instead of burying this waste in a landfill, it was incinerated at the Resource Recovery Facility (RRF).
- The Waste-to-Energy (WTE) process makes electricity and steam, which reduces the amount of fossil fuels we burn and reduces methane emissions from landfills.
- However, the WTE process also creates air pollution and ash, which must be buried in a landfill.



Who's Who at the RRF. The RRF is managed by the Greater Detroit Resource Recovery Authority (GDDRA), which was established by the cities of Detroit and Highland Park. The site on which the RRF is located is owned by the City of Detroit and leased to GDDRA. GDDRA in turn subleases the site to the RRF owners: Philip Morris Capital Corporation and General Electric Capital Corporation. The RRF is operated by Covanta Michigan Waste Energy, Inc., which sells the electricity and steam it generates to Detroit Edison (DE) (a subsidiary of DTE Energy). DE sells the steam to Detroit Thermal, LLC, (DT) which supplies the steam to heat and cool Detroit's downtown steam loop customers. The City of Detroit purchases about 10% of DT's steam.

RRF Fast Facts:

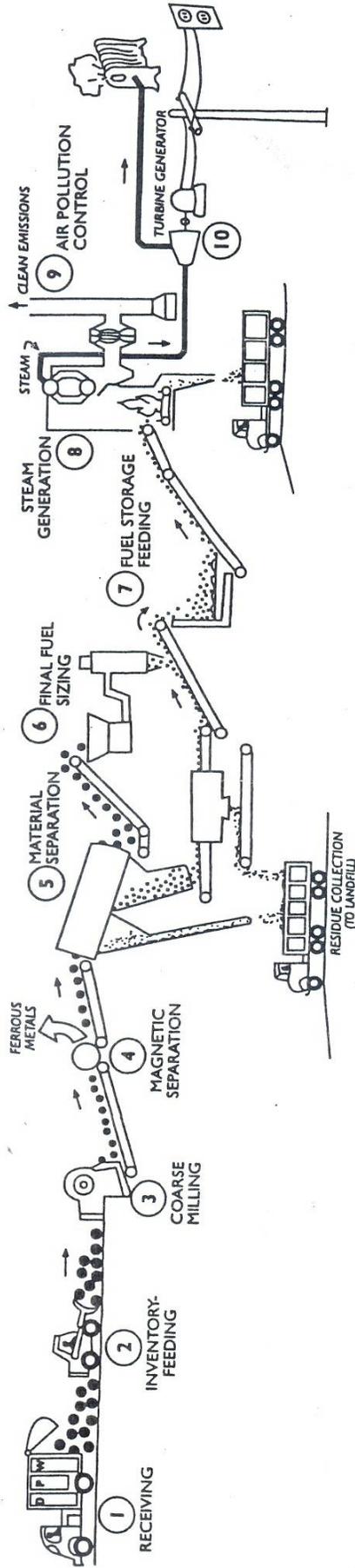
- Rated Capacity 3,300 tons of trash per day (1.2 million tons per year)
- Energy Generation at rated capacity:
 - 68 megawatts electricity plus 550,000 lbs steam/hr
- 2006 waste processed: 800,000 tons
- 2006 ferrous and non-ferrous metals recovered: 45,000 tons
- 2006 energy sales: 210,000 Mwhr; 2,700,000 M-pounds steam
- 2006 ash production: 205,000 tons



Things to consider:

- How does the amount of electricity generated compare with DTE River Rouge Power Plant?
- What extra challenges does the burning of waste entail?
- What other resources are used in the plant?
- According to the USDOE, Michigan ranked 8th in the generation of electricity with non-hydro renewable energy (wind, geothermal, biomass, and solar) in 2001.
- The City of Detroit is currently considering alternatives to the RRF because its operating agreements begin to expire in December, 2008.

Greater Detroit Resource Recovery Facility



- 1) Certified scale system is computerized. All waste deliveries are prescreened and pre-identified.
- 2) Municipal solid waste (residential and commercial) is mixed and managed on enclosed tipping floor, which is the size of a football field.
- 3) Solid waste is shredded in a flailmill to size, mix and expose "fuel" for further processing.
- 4) Ferrous metal (magnetic) is removed and recycled. A total of 35,000 tons of steel was recycled last year.
- 5) Material separation and processing creates a semi-homogenous fuel.
- 6) The nominal size of waste fuel is 4" x 4" x 4".
- 7) Waste material to be burned is known as RDF or Refuse Derived Fuel. RDF is 1/3 as hot as coal, approximately 5000 BTUs.
- 8) The fuel is burned at 1800°F in municipal waste combustion boilers in which waterwall tubes flash water into steam.
- 9) Air quality control is achieved by the time, temperature and turbulence of the burning process followed by spray lime scrubbers and fabric filters for fine particle dust management. This facility achieves all U.S. Environmental Protection Agency emission standards.
- 10) The facility is a self-sufficient power producer. Last year the facility provided 50% of Detroit Edison's steam for its central heating system and 50 MW of electricity.

Waste receiving and processing occurs Monday through Friday. Power is produced 365 days a year. The inert ash byproduct is buried in a monocell at a Wayne County landfill. Ash consumes 90% less landfill space (volume) than regular solid waste.

The Advantages of Waste-to-Energy:

- Resource Recovery saves landfill space.
- Resource Recovery saves fossil fuel.
- Resource Recovery productively reuses waste.

RESOURCE RECOVERY MISSION

The mission of the Greater Detroit Resource Recovery Authority is to provide efficient, environmentally responsible waste disposal services to the residential, commercial and industrial sectors of Detroit.



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