

BIOMASS



Ontario **Power** Generation Biomass Health and Safety

IEA Bioenergy
“Biofuels & Bioenergy: *A Changing Climate*
August 25, 2009
Vancouver B.C.

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Ontario Hydro was restructured April 1, 1999 into 5 successor entities.



1. Ontario Power Generation (OPG) – electricity generator



2. Ontario Hydro Services Company, later renamed Hydro One Inc. with 5 subsidiaries, including Hydro One Networks Inc. - runs most of the transmission and distribution systems for power in Ontario



3. Independent Market Operator (IMO) – later renamed Independent Electricity System Operator (IESO) – administers electricity grid



4. Electrical Safety Authority - enforces electrical safety across Ontario



5. Ontario Electricity Financial Corporation - responsible for servicing the debt and liabilities of the former Ontario Hydro, that were not assigned to the successor companies

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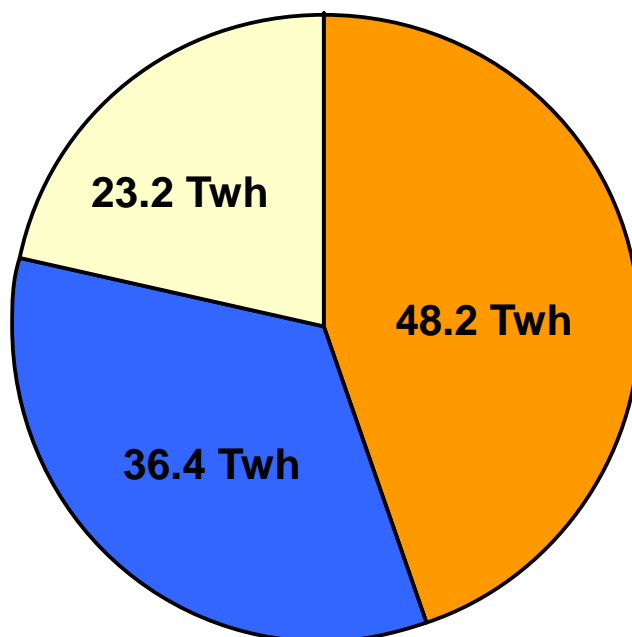
Ontario Power Generation Profile

- Generated 107.8 TWh in 2008
- Produces 70% of Ontario's electricity
- 11,000 employees
- Capacity: 21,000 MW
- OPG average sales price in 2008 was 4.9 cents/kwh





OPG Production Mix 2008



- Nuclear
- Hydroelectric
- Fossil

Total = 107.8 Twh

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OPG Fossil Generation Facilities

5
Fossil-Fuelled
Stations



2
Co-owned
Gas-Fired
Stations



OPG's Fossil generation portfolio as of December 31, 2008 had a total in-service capacity of 8,177 MW.

OPG is also co-owner of the 580 MW Brighton Beach and 550 MW Portlands Energy Centre gas-fired generating stations.



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ATIKOKAN GS

- ◉ Capacity - 230 MW (1 unit)
- ◉ Employs approximately 90 people
- ◉ Uses low sulphur lignite coal from Western Canada
- ◉ Use of coal for energy must cease by 2014
- ◉ The Atikokan unit has achieved MCR on 100% biomass (wood pellets) in testing
- ◉ This station will be the first coal unit in Ontario that is converted to biomass fuelling – Target is 2012. The fuel will be wood pellets.
- ◉ OHSAS 18001 conformed Health and Safety Management System
- ◉ ISO 14001 registered (environmental management)

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Why Biomass at Coal Plants?



Thunder Bay GS



Atikokan GS

- ◉ Renewable energy
- ◉ On demand when you need it
- ◉ No net greenhouse gases
- ◉ Contributes to the transition to lower carbon future
- ◉ Synergy with agriculture and forestry – made in Ontario industry
- ◉ Makes use of existing plants – lower capital costs
- ◉ Timely implementation

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OPG's Approach to Safety – The Basics

1. **Identify the hazard**
2. **Eliminate the hazards wherever practical**
3. **Control the hazards when they cannot be eliminated**
4. **Protect the workers by providing and using personal protective equipment**
5. **Minimize the severity of an injury after an accident has occurred.**

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Atikokan Event

December 1, 2008 explosion:

- No injuries
- Plant safely returned to service within eight weeks
- Final roofing repairs will be completed in good weather

Actions Taken:

- Biomass testing on hold
- OPG incident investigation
- Safe handling and storage





Health and Safety Study

Terms of Reference

- ⦿ Review global industry experience and global standards regarding the process safety and industrial hygiene considerations necessary for the safe storage and handling of biomass (power, forestry etc.)
- ⦿ Identify safety incidents at sites where biomass is stored, handled and/or used as fuel and transfer learnings to OPG
- ⦿ Identify process safety risks and industrial hygiene risks and recommend mitigating actions
- ⦿ Identify specialized fire fighting or safety tooling requirements

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The Biomass Health and Safety Study

- ⦿ Encompassed all OPG coal-burning plants – Thunder Bay, Atikokan, Nanticoke and Lambton
- ⦿ Included site visits and tours at all plants
- ⦿ HAZID workshops conducted at all plants
- ⦿ Strong involvement of plant staff
- ⦿ Study timeline: January – May, 2009
- ⦿ Contracted the study to Worley Parsons which included, on its team, experts in biomass safety, industrial hygiene, storage and handling and power generation
- ⦿ Ideally, a study such as this would be representative of operating conditions but assumptions had to be made as to the conditions that would be in effect during actual operation on biomass, although the consultant was able to draw on past biomass handling and storage experience

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- Despite ongoing work in Europe and, more recently, in North America, there is no mature foundation of standard practices associated with the use of biomass fuels for power generation
- There is a need for a deeper knowledge base and the development of specific standards and practices
- Delivery of fuel accepted only if accompanied by an MSDS
- In general, if an aspect is not fully understood it is automatically assumed to be high risk until it has been fully investigated!

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- ISO standards for Solid Biomass under development (2008-2012)
 - Material Classification (forest and agricultural)
 - Physical and Chemical Testing Methods
 - Quality Assurance (raw material sourcing to delivered fuel)
- IEA Pellet Handbook (late 2009)
- International Best Practice Guidelines (no cohesive standards exist)
 - System Design – application of general guidelines
 - Operational Housekeeping – application of general guidelines
 - Fire Extinguishing Techniques – in preparation - for silo storage



Biomass Characteristics

- ◉ We could assume that biomass is a rugged, innocuous product that can be handled without significant risk ...but
- ◉ Biomass is present in three states - solid, gas and dust
- ◉ Biomass dust particle size can have a direct bearing on health:
 - ◉ Inhalable fractions <100 micrometer AED*
 - ◉ Thoracic fractions <25 micrometer AED
 - ◉ Respirable fractions <10 micrometer AED

*AED – Aerodynamic Equivalent Diameter

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Biomass Dust

- Toxicity of dust is classified by consensus by several international and national authorities (IARC, ACGIH, NTP etc.) as potentially either sensitizing (acute or chronic), suspected or confirmed carcinogenic above certain established concentrations.
- | | | |
|---------------------------------|-------------------------------------|---------------------------|
| Hardwood | Not carcinogenic | TWA 5 mg/m ³ |
| Western Red Cedar | Sensitizing, not carcinogenic | TWA 0.5 mg/m ³ |
| Beech and Oak | Sensitizing, confirmed carcinogenic | TWA 5 mg/m ³ |
| Birch, Mahogany, Teak
Walnut | Sensitizing, suspected carcinogenic | TWA 5 mg/m ³ |



Biomass Hazards

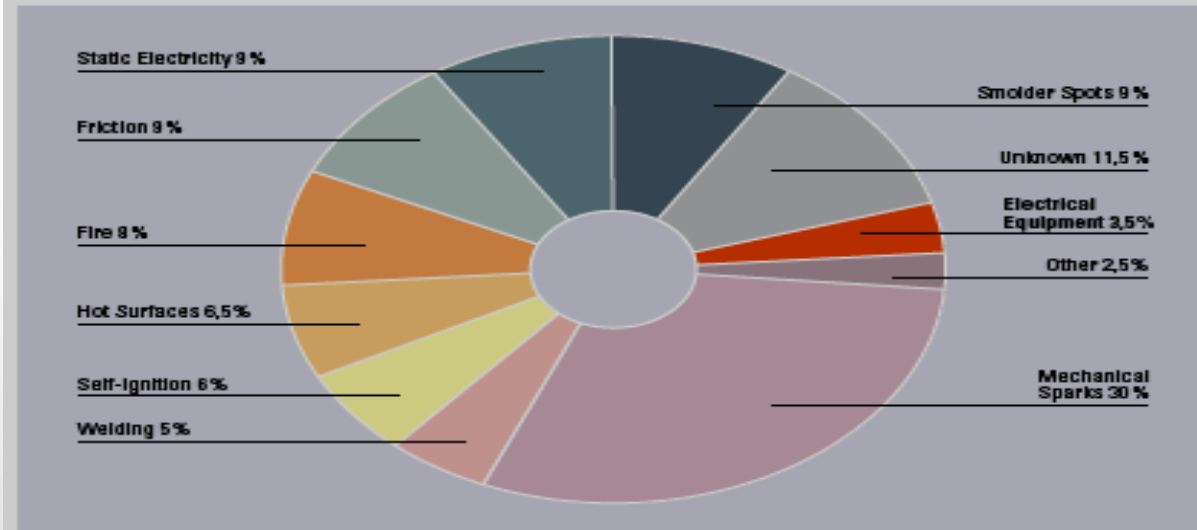
- ◉ Fugitive dust generation and accumulation resulting in explosive atmosphere and fires
- ◉ Mitigation:
 - minimize handling and vertical drops (implement 'soft-handling technology' such as cascade chutes)
 - clean frequently
 - limit oxygen in storage bins (inert atmosphere),
 - install dust extraction systems
 - install explosion suppression systems and vents
 - install fire suppression systems
 - stipulate fuel quality (e.g. Pellets containing bark tend to evolve a dust with smaller, more explosive, particle size and pellets with mixed fibre size may be less durable)
 - train employees to recognize risks is essential

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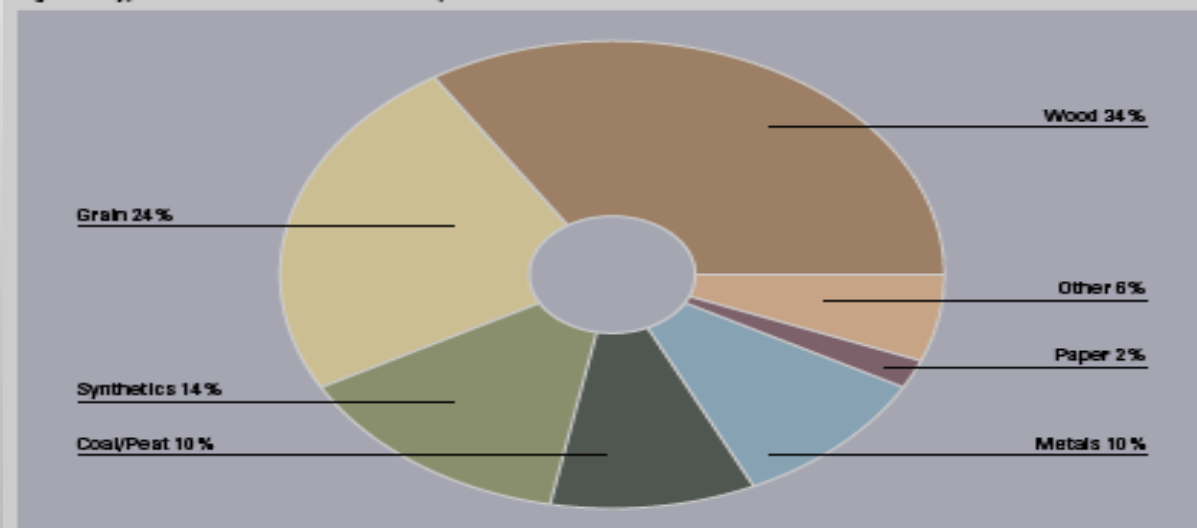
Ignition Sources of Dust Explosions

Figure 2: Ignition Sources of Dust Explosions



Types of Dust involved in Dust Explosions

Figure 3: Types of Dusts Involved in Dust Explosions





BIOMASS HAZARDS

- Build-up of static charge
- Mitigation:
 - *grounding of equipment*
 - *appropriate belt lining etc.*

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BIOMASS HAZARDS

- Self Heating of Wood Pellets, a source of ignition and fires
- Mitigation:
 - *understand the weather profile in the area where storage is located and ventilate and monitor temperature accordingly*
 - *special fire-fighting techniques may be required as fires in pellet storage areas are difficult to extinguish. Wet media should not be used as pellets expand 3.5x in water. Combustion gases may be present well before the fire is detected deep in a storage pile*
 - *employee training and awareness is critical.*



BIOMASS HAZARDS

- Carcinogenicity of wood dust. People have been employed in the forest industry and exposed to wood dust throughout history. The hazard can be managed.
- Mitigation:
 - *minimize the generation of dust*
 - *use clear signage*
 - *train employees*
 - *use respiratory protection*
 - *minimize skin contact,*
 - *minimize the use of materials where the dust has been clearly linked to cancer in humans*



BIOMASS HAZARDS

- Off-gassing of hydrocarbons such as carbon monoxide, CO₂ and methane and oxygen depletion in areas of storage
- Mitigation:
 - *install ventilation*
 - *conduct continuous area monitoring*
 - *use personal individual CO monitors*
 - *employee training and awareness*
 - *clear signage*



BIOMASS HAZARDS

- Proliferation of fungal growth contributing to an unhealthy atmosphere and allergic reactions.
- Mitigation:
 - *conduct regular surveillance by trained and competent personnel*
 - *minimize moisture ingress during storage and handling*
 - *optimize material storage time and temperature.*

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GLOBAL EXPERIENCE IN THE USE OF BIOMASS

- In facilities that have converted from coal to producing electricity with biomass they have required among other items, retrofitting of storage silos, conveyors, and burners, and the installation of filters, hammer-mills, and various safety devices.
- There have been serious accidents and fatalities as a result of off-gassing during the shipment of biomass

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Health and Safety and the Atikokan GS Biomass Conversion

- Health and Safety management is a priority at OPG
- All the identified health and safety and industrial hygiene hazards are being considered by the Project Team that is undertaking the conversion of Atikokan GS to biomass fuelling
- Equipment and employee training will be engineered, installed and implemented to mitigate the hazards associated with biomass
- The evolving body of knowledge related to biomass will be monitored

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Ontario **Power** Generation Biomass Health and Safety

Thank you!