Mass Balance Implications When Defining Circular Opportunities for Zero Waste





Is Mass Balance Important?

- Waste occurs with use and has measurable properties:
 - Cost (Inputs, Process and Outputs)
 - Calories (Gigajoules, kWh, BTU's, HP)
 - Carbon (Volume)
- Net Zero is a financial constraint



Why do we Measure?

Robert Grosseteste – the father of modern scientific inquiry

Methodology is based on the analysis of a causal agent, reproducing it and thereafter deducing principles.



1168/1175 to Oct 9, 1253

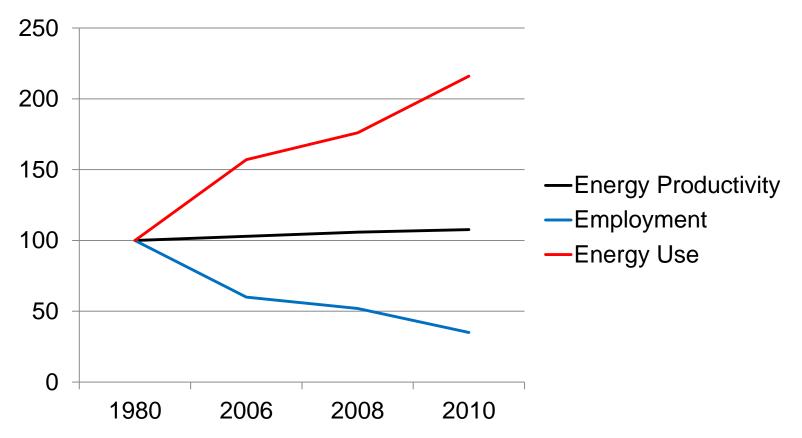
Influenced Roger Bacon

1224 Chancellor of Oxford University

Bishop of Lincoln, 1235 -1253



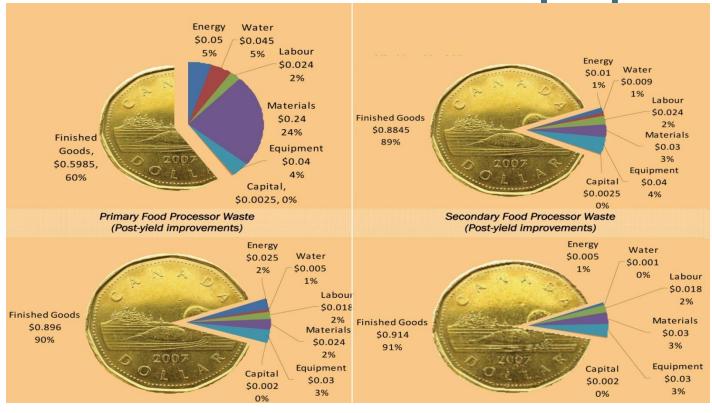
Manufacturing Energy Productivity 1980 to 2010



Sources: Annual Survey of Manufacturers and NRCan 1990-2012



Scale Determines Closed Loop Options



Bottom line, mass balance efficiency means you can make \$1.2M worth of goods with \$1M



Mass Balance Begins with Input Management

Ideal

80% of waste is avoidable with digital automation

Carbon negative where closed loop systems can be implemented

Improved Cost
Control and OEE

Waste can be more than 40% of output

Reality

Increased Food and Packaging Waste

Higher Transportation Costs

Increased Maintenance and Labour

ERP, LEAN and Integrated Metering

Lack of Utility Management



It Matters Where You Start

End-of-process management is capital-intensive

Upstream
efficiency reduces
downstream risks
(cost)



Sequence: Input, Process and Output Control

By-products affect margins three ways

Bio-energy from food waste is a process and transportation input.

Nutrients extracted from food waste are agricultural inputs

Inputs	Process	Outputs
Power Quality	Leak Reduction	Energy Recovery
Integrated Metering	By-Product Recovery	Closed Loop Energy
Enterprise Resource Planning	Bottleneck Reduction	Nutrient Extraction

