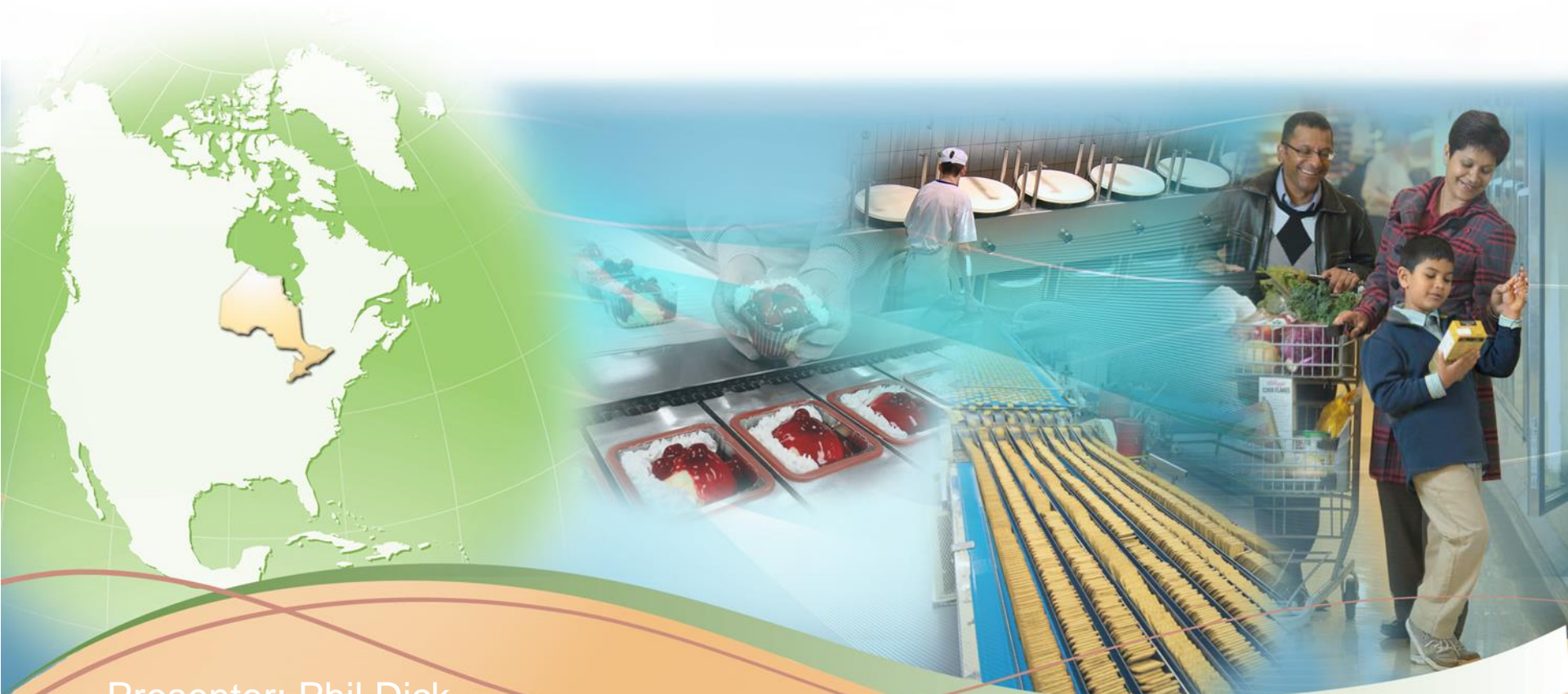


Mass Balance Implications When Defining Circular Opportunities for Zero Waste



Presenter: Phil Dick
May 5, 2017



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

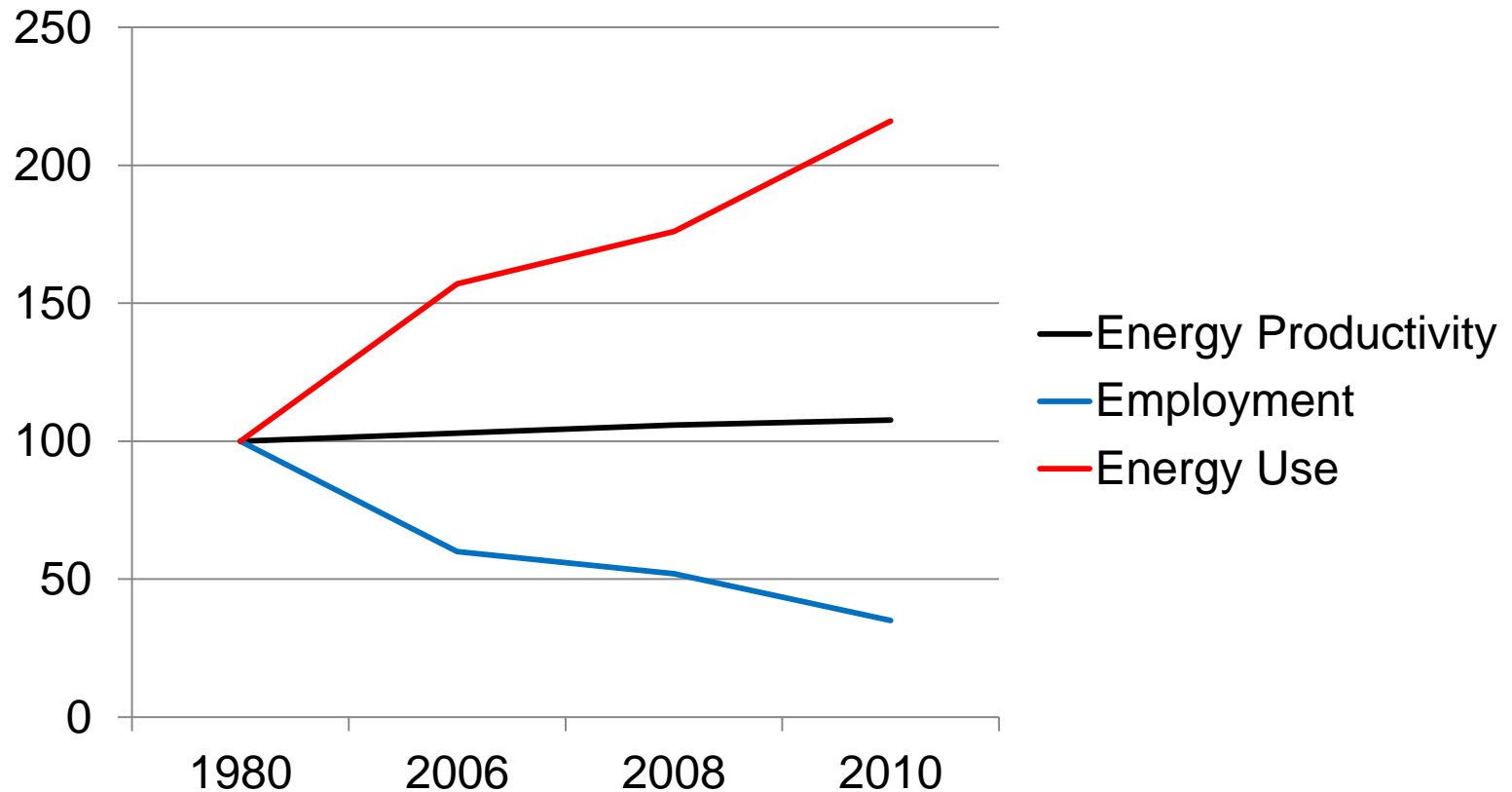
Methodology is based on the analysis of a causal agent, reproducing it and thereafter deducing principles.



- 1168/1175 to Oct 9, 1253
- Influenced Roger Bacon
- 1224 Chancellor of Oxford University
- Bishop of Lincoln, 1235 -1253



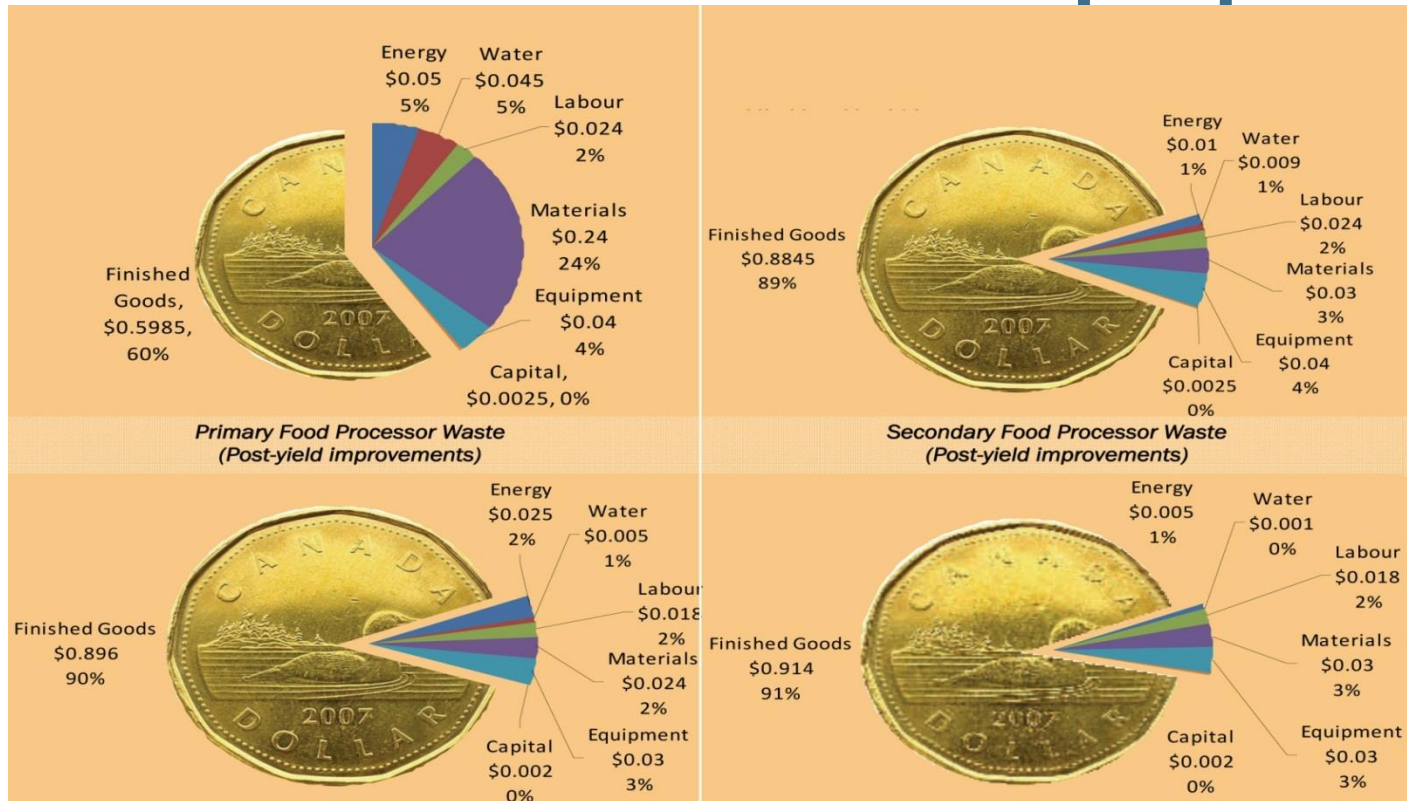
Manufacturing Energy Productivity 1980 to 2010



Sources: Annual Survey of Manufacturers and NRCan 1990-2012



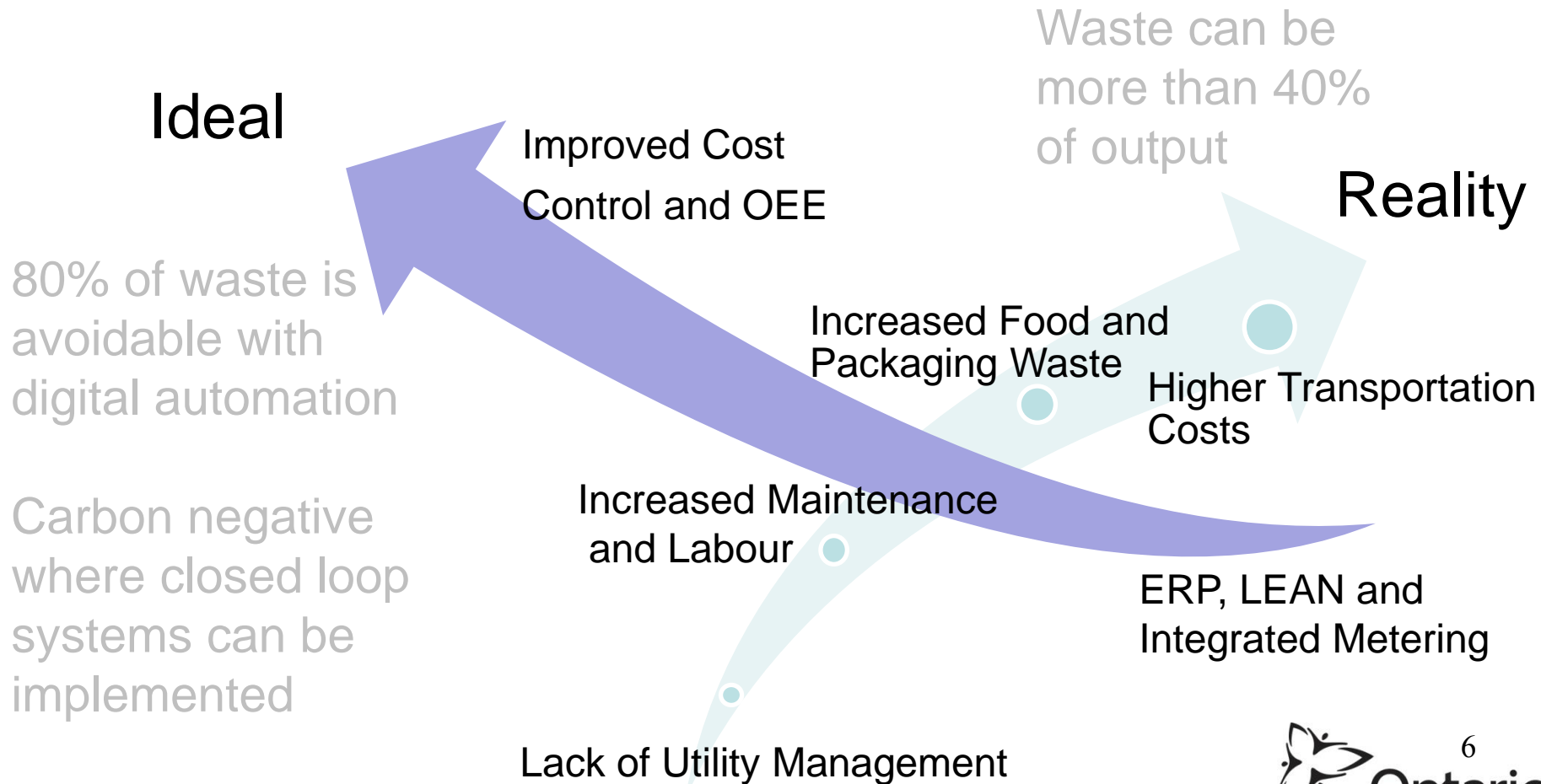
Scale Determines Closed Loop Options



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



Mass Balance Begins with Input Management

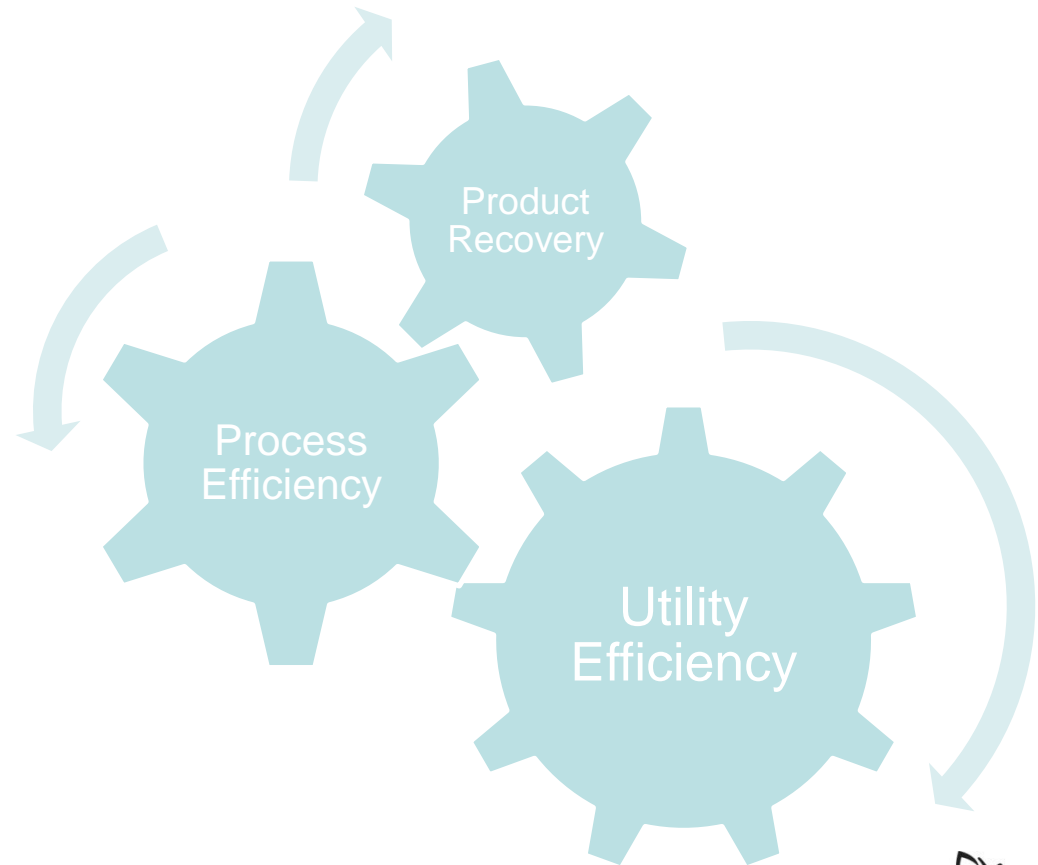




It Matters Where You Start

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

