

LIFE CYCLE ASSESSMENT (LCA) PROTOCOL FOR HYDROELECTRIC GENERATION STATION PROJECTS IN MANITOBA

**PROVIDED TO THE CLEAN ENVIRONMENT COMMISSION FOR THE
KEYASK GENERATION PROJECT PROCEEDINGS**

Presented by:

James Salazar &

Matt Bowick

NOVEMBER 28, 2013



Presentation Outline

- 1. Primer on Life Cycle Assessment (LCA)**
- 2. LCA in the Environmental Impact Statement**
- 3. Standards for LCA of Hydroelectric Projects**
- 4. Proposed LCA Protocol**



What is Life Cycle Assessment?

The Life Cycle of a Product



Why do an LCA?

- Gain comprehensive environmental life cycle perspective - (identify win-win outcomes)
- Transparent / Standardized / Quantitative
- Demonstrates proactive social responsibility
- Obtaining environmental certification (i.e. LEED)

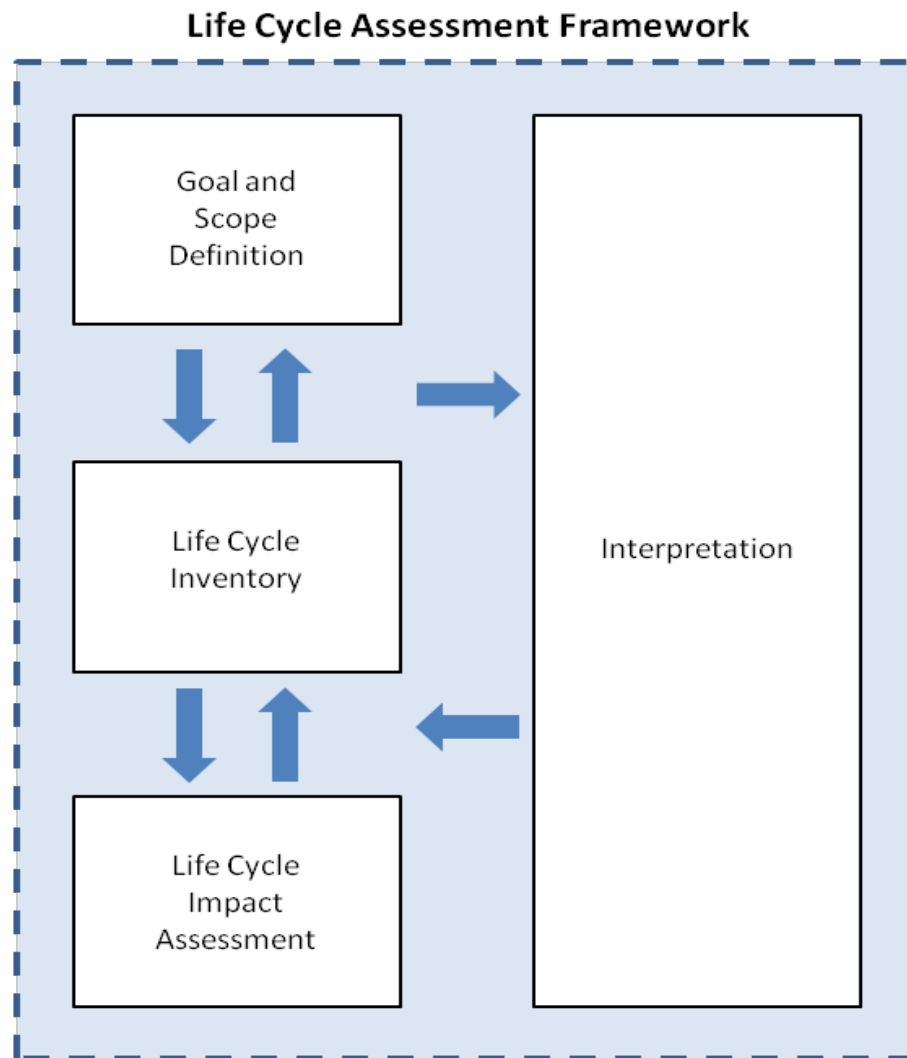
General ISO LCA Standards

ISO/TC 207/SC 5
Environmental Management

ISO 14040: *Life cycle assessment -
- Principles and framework*

ISO 14044: *Life cycle assessment -
- Requirements and guidelines*

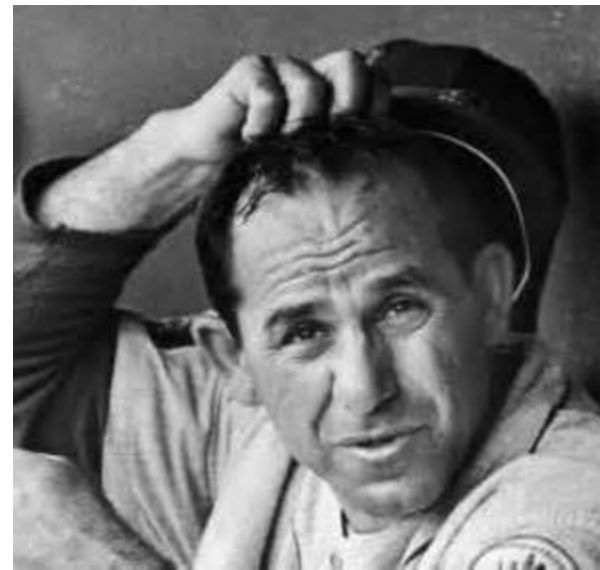
LCA Framework - as per ISO 14040



Goal and Scope Definition

“If you don’t know where you’re going – you might end up someplace else”

- Yogi Berra



Goal Definition

Four goal aspects to be defined:

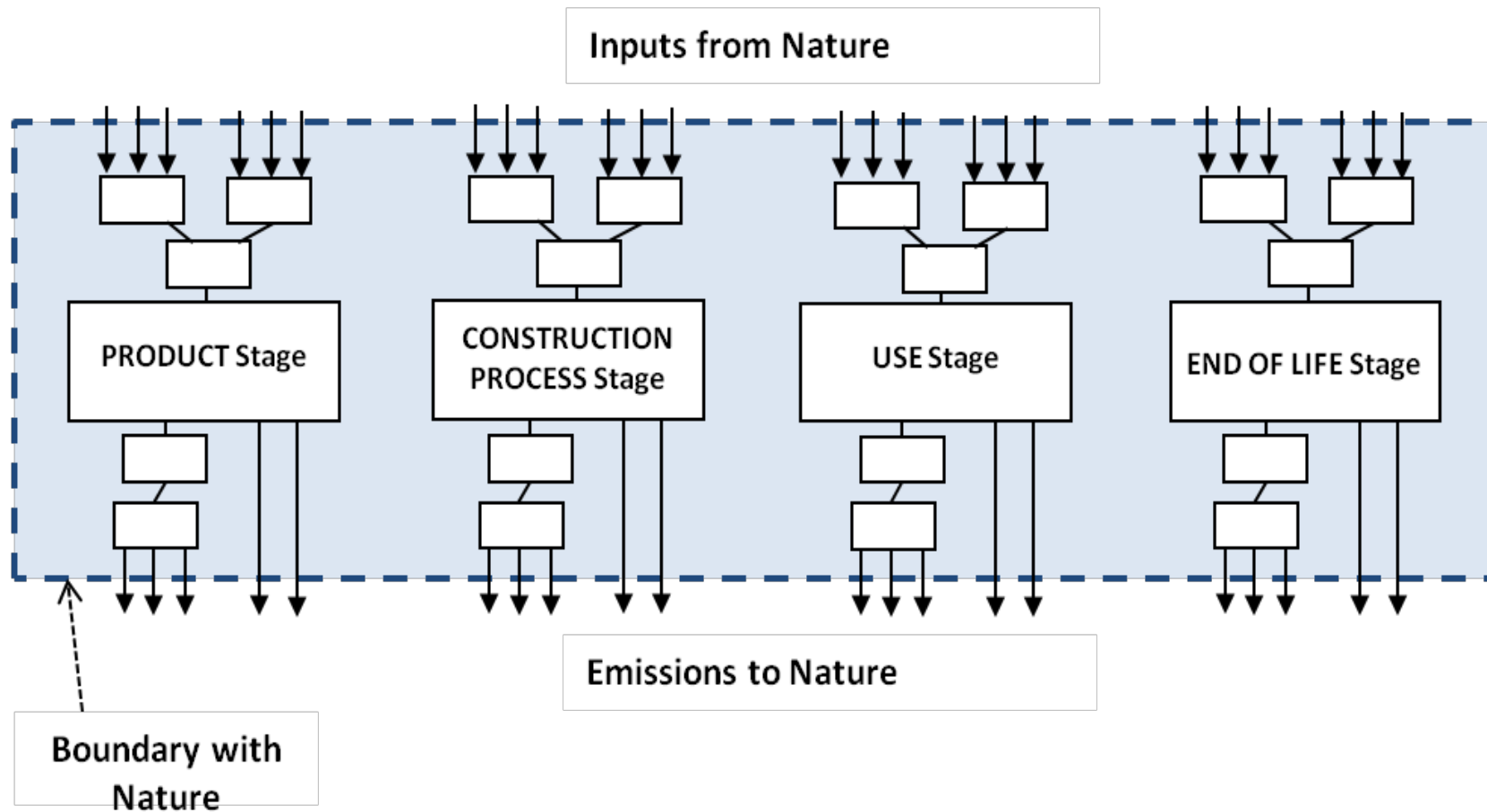
- Reasons for carrying out the study
- The intended application
- The intended audience
- Is the study is intended to be a comparative assertion disclosed to public

Scope Definition – Meeting LCA Goals

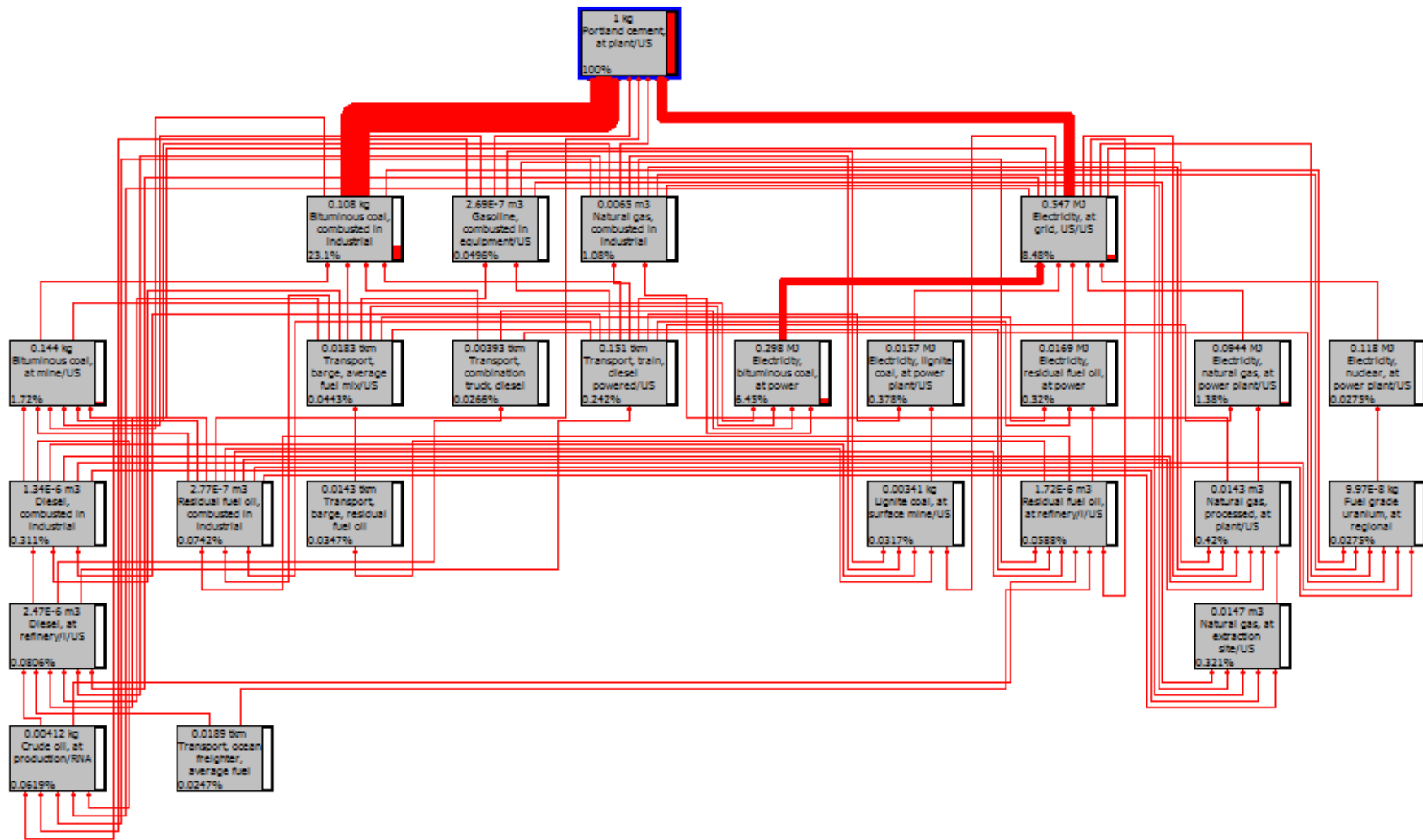
- Relevant standards
- Data requirements
- Impacts that will be calculated
- Limitations and uncertainty
- Type of critical review, if any



Life Cycle Inventory

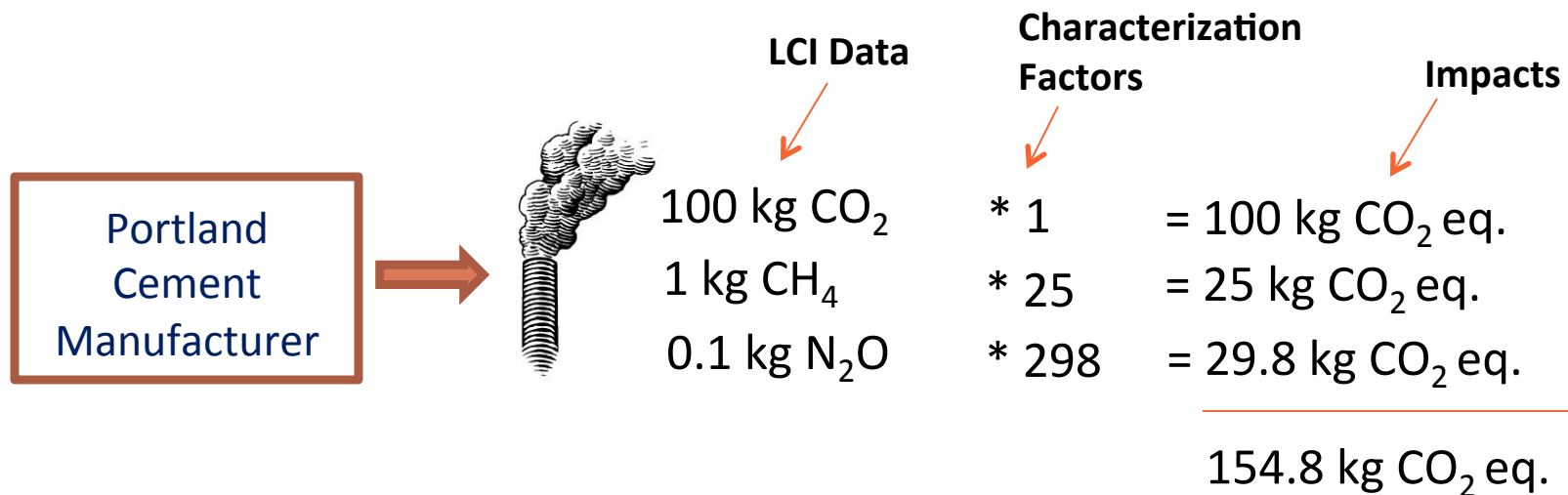


Life Cycle Inventory of Portland Cement



Life Cycle Impact Assessment

Example: Calculate Global Warming Potential



Global Warming



Contributing emissions:

CO₂ CH₄ N₂O

Photochemical Smog



Contributing emissions:

NO_x VOCs

Eutrophication



Contributing emissions:

NO_3 PO_4 NH_3 NH_4 NO_x

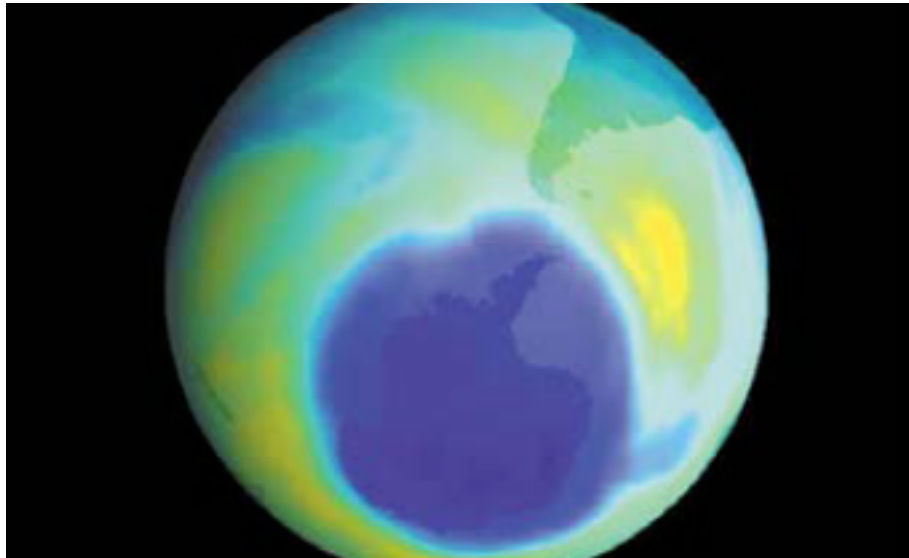
Acidification



Contributing emissions:

SO_x NO_x HCl HF NH₃

Ozone Depletion



Contributing emissions:

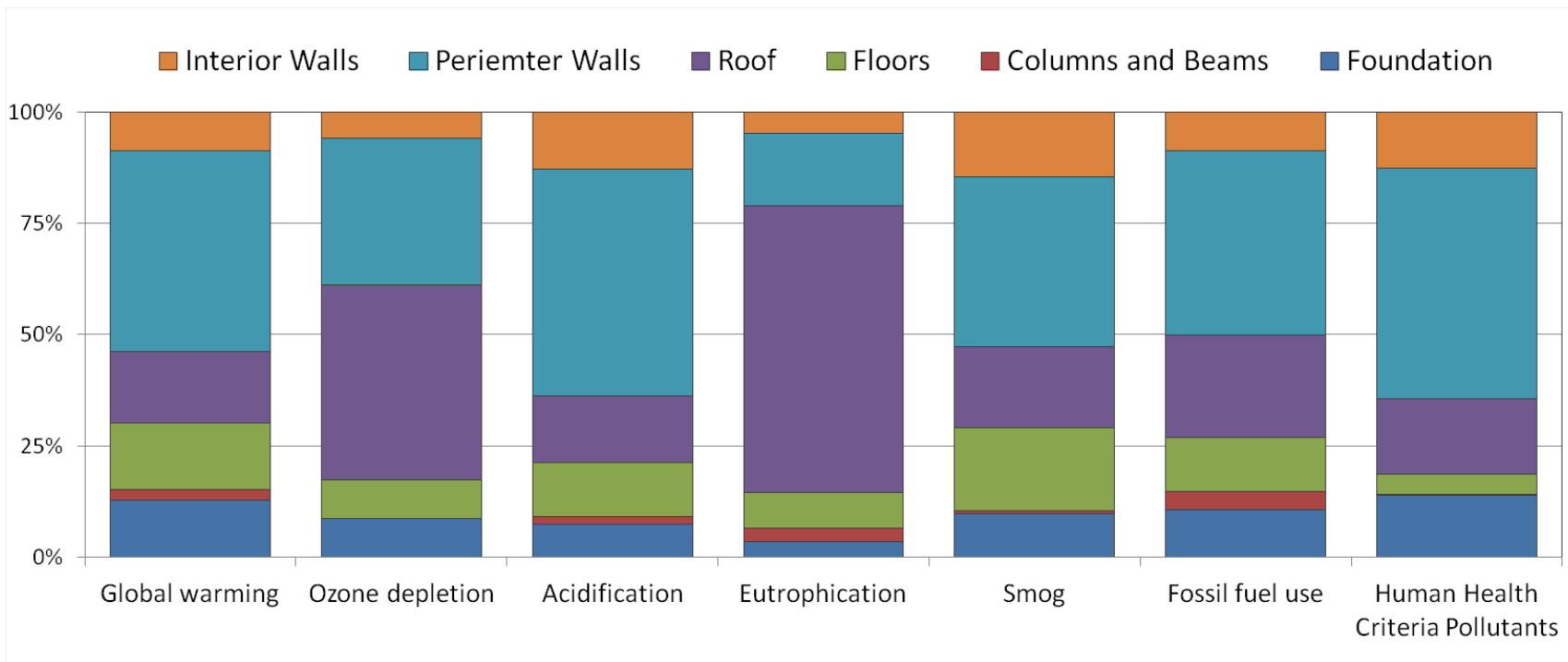
CFCs HCFCs

Fossil Fuel Consumption



**Contributing inputs:
natural gas, coal, crude oil**

Interpretation





How can LCA be used in the Environmental Impact Statement of a Hydroelectric Project?

Environmental Impact Statement Requirements

The EIS is developed in accordance with:

- Canadian Environmental Assessment Agency (CEAA) Environmental Impact Statement Guidelines
- Scoping Document for the Environmental Assessment of the Keeyask Generation Project

Requirement for emissions “description”

The EIS Will Include:

- *A description of atmospheric emissions, liquid emissions, and solid wastes, and plans to manage these emissions and wastes during construction;*
- *A description of i) fuel and dangerous and hazardous products and wastes and ii) plans to manage the fuel, products, and waste during construction.*

- Section 2.3 of the Keeyask Scoping Document

Requirement for air emissions inventory

(The EIS must include) an inventory of all potential sources of air contaminants and emissions from the proposed project: criteria air contaminants, air pollutants on the List of Toxic Substances in Schedule 1 of the Canadian Environmental Protection Act, 1999

Section 8.1 of the CEAA EIS Guidelines

Impact calculation using “appropriate” criteria

The proponent shall identify the Project’s likely adverse environmental effects during construction, operation, maintenance, decommissioning and reclamation of sites and facilities associated with the Project, and describe these effects using appropriate criteria.

Chapter 9 of the CEAA EIS Guidelines

Mitigation of impacts

(The EIS) shall discuss the mechanisms it would use to require its contractors and sub-contractors to comply with these (mitigation) commitments and policies and with auditing and enforcement programs

Chapter 9 of the CEAA EIS Guidelines

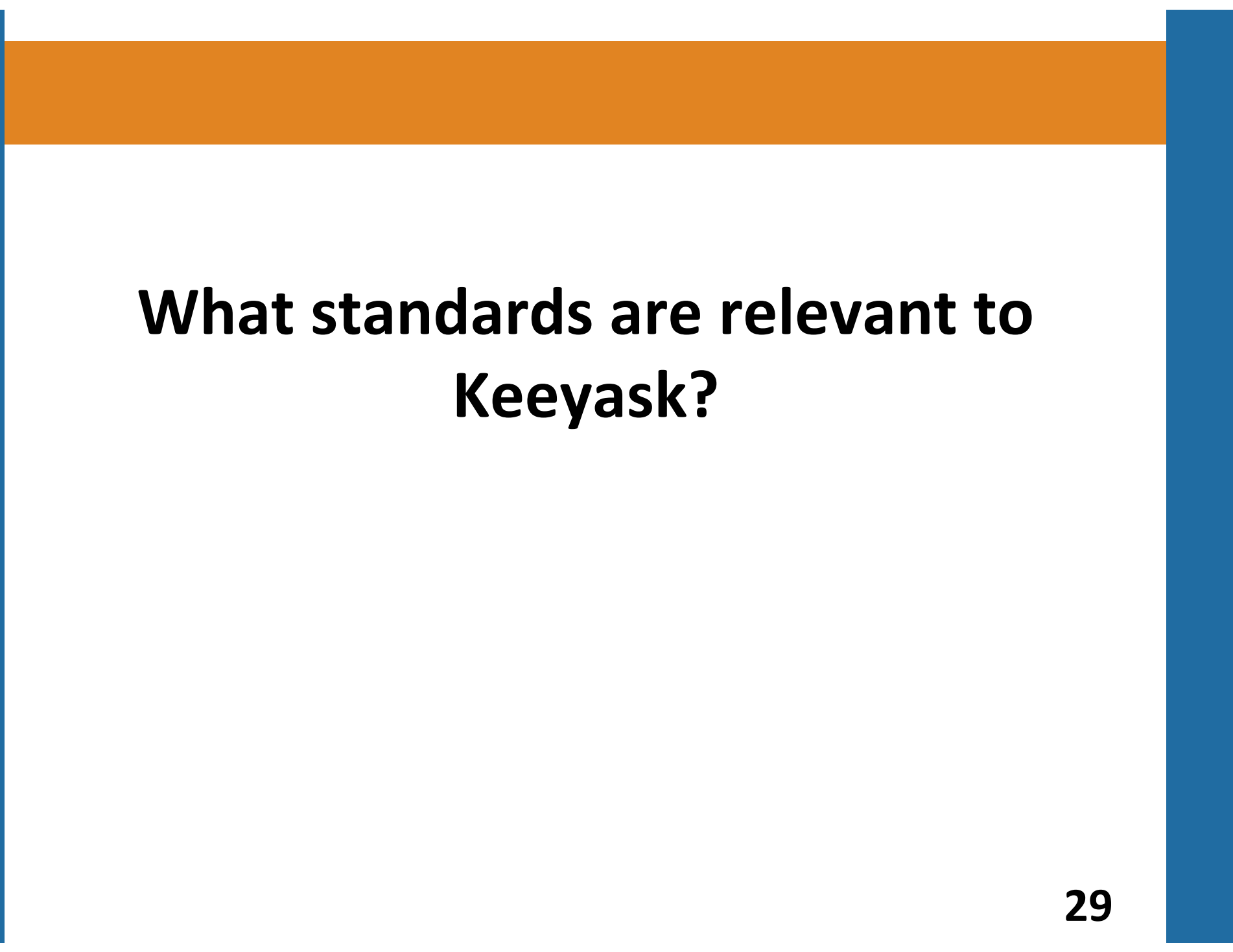
Analysis of alternatives

(The EIS must include) an analysis of alternatives to the Project which describe functionally different ways to meet the project need and achieve the project purpose where analyzed from the perspective of the proponent ... The analysis in this section of the EIS should identify requirements of the proposed purchaser of the power to be produced by the Project.

Section 5.2 of the CEAA EIS Guidelines

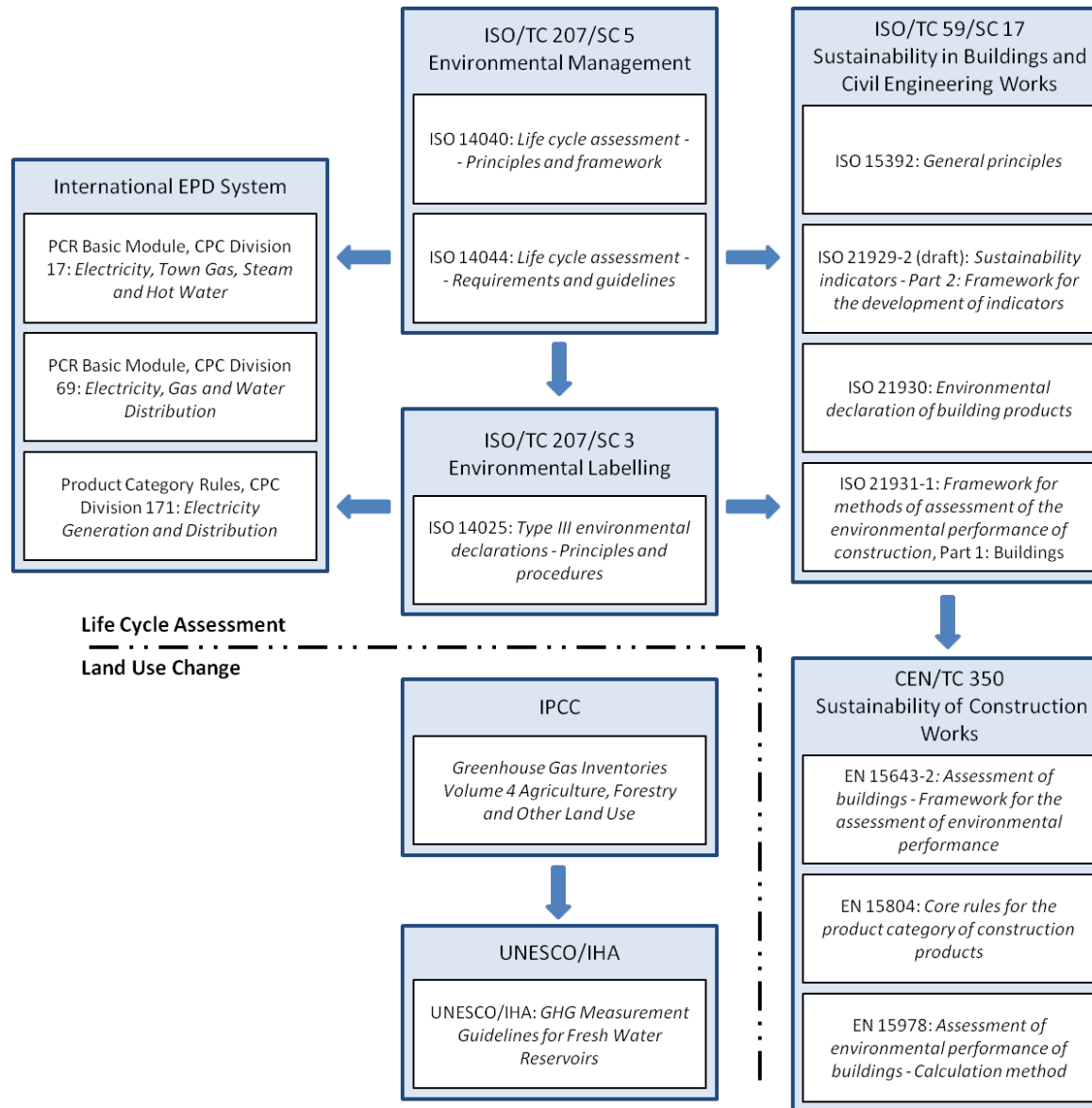
LCA-based Deliverables

- **Detailed LCA** of the hydroelectric project in accordance with ISO 14040/14044
 - Accounts for air, land, and water emissions
 - Calculates “appropriate” impacts
- **Literature Review** of alternative generation technologies
 - Unreasonable to complete ISO 14044 compliant comparative LCA



What standards are relevant to Keeyask?

Relevant Standards



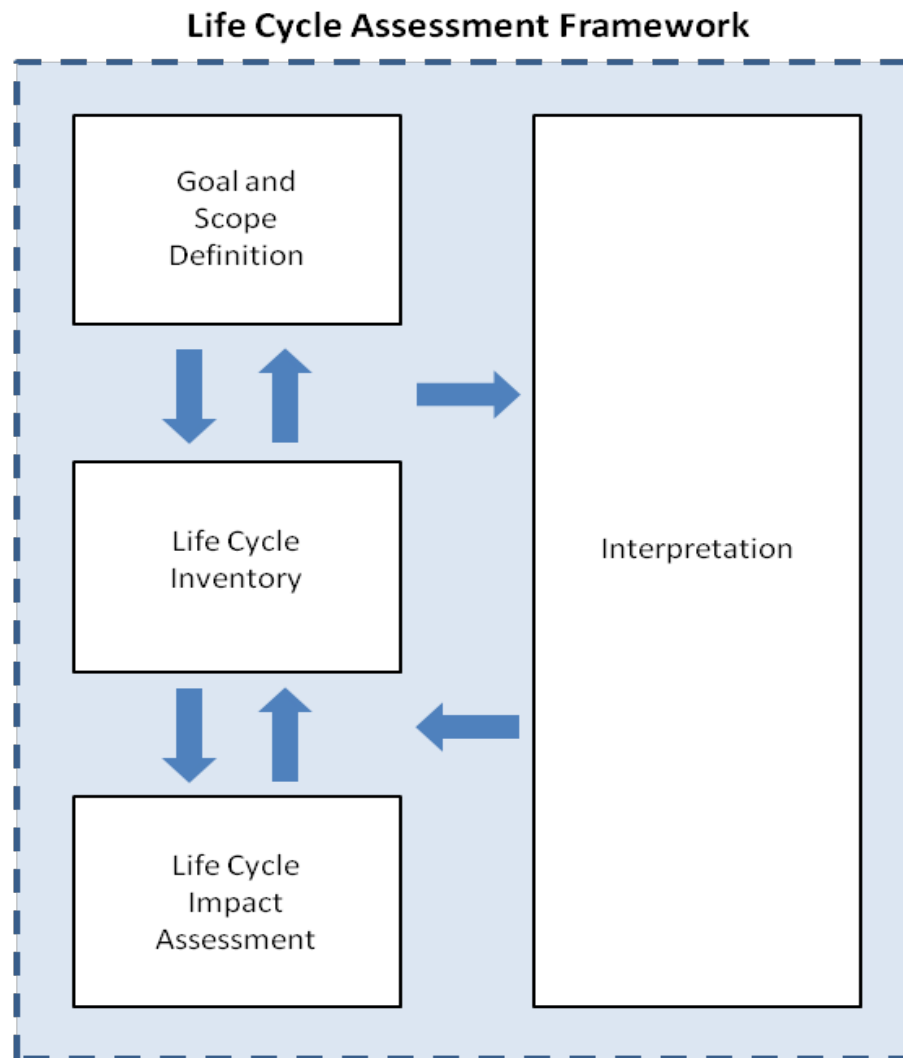
General ISO LCA Standards

ISO/TC 207/SC 5
Environmental Management

ISO 14040: *Life cycle assessment -
- Principles and framework*

ISO 14044: *Life cycle assessment -
- Requirements and guidelines*

ISO 14040 Framework



ISO Building and Civil Engineering Standards

ISO/TC 59/SC 17
Sustainability in Buildings and
Civil Engineering Works

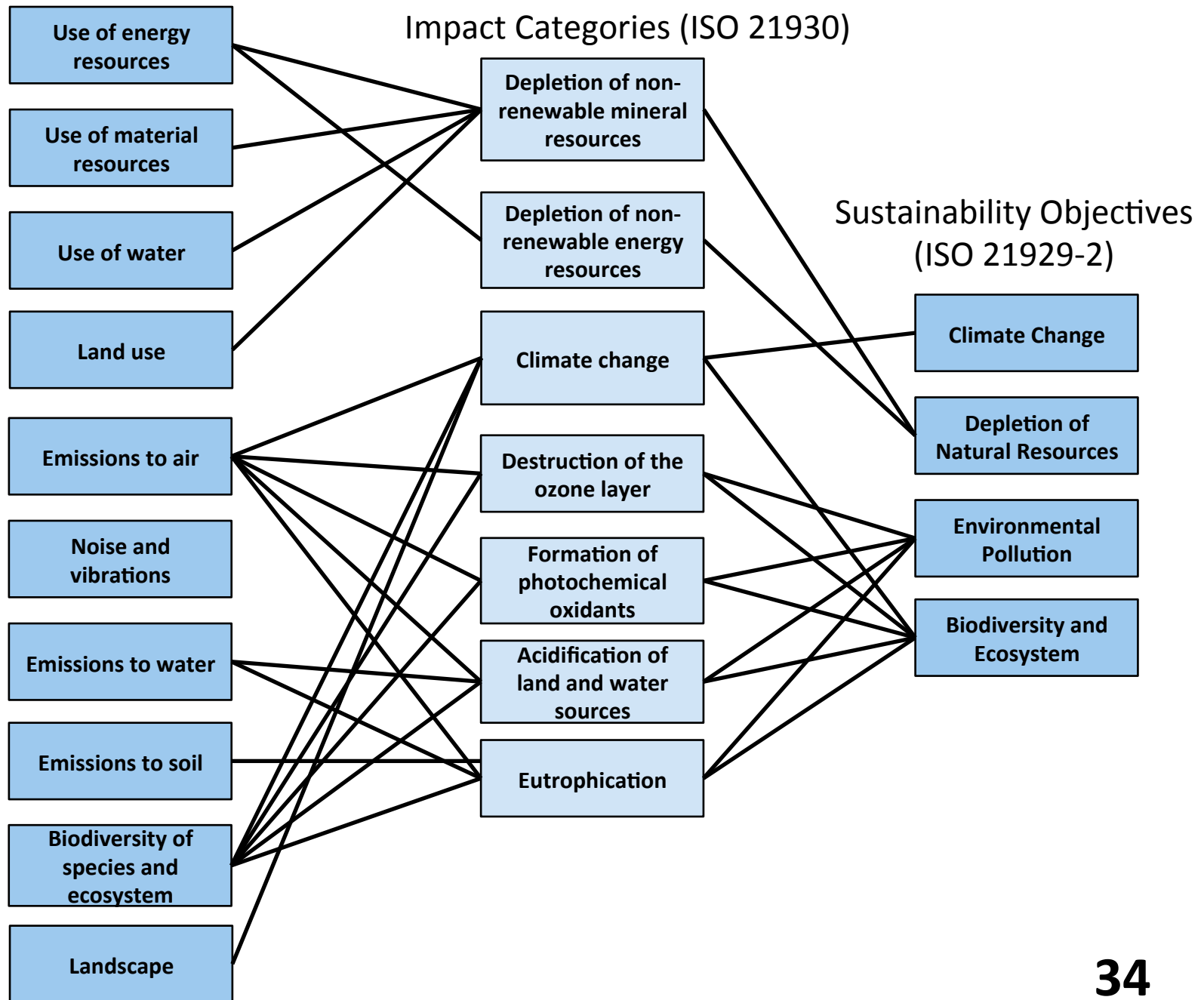
ISO 15392: *General principles*

ISO 21929-2 (draft): *Sustainability
indicators - Part 2: Framework for
the development of indicators*

ISO 21930: *Environmental
declaration of building products*

ISO 21931-1: *Framework for
methods of assessment of the
environmental performance of
construction, Part 1: Buildings*

Life Cycle Inventory (ISO 21929-2)



European Building and Civil Engineering Standards

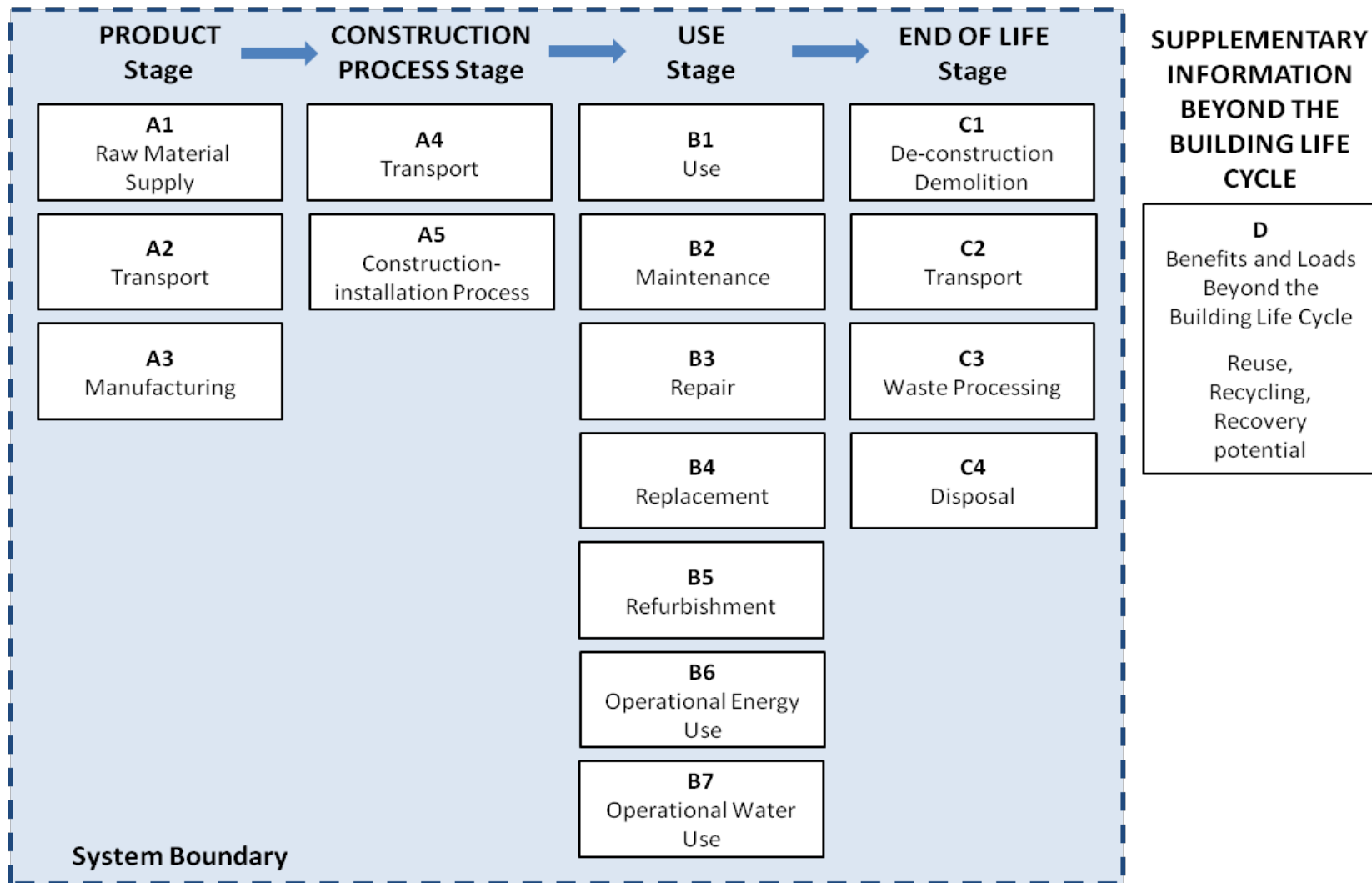
CEN/TC 350 Sustainability of Construction Works

*EN 15643-2: Assessment of
buildings - Framework for the
assessment of environmental
performance*

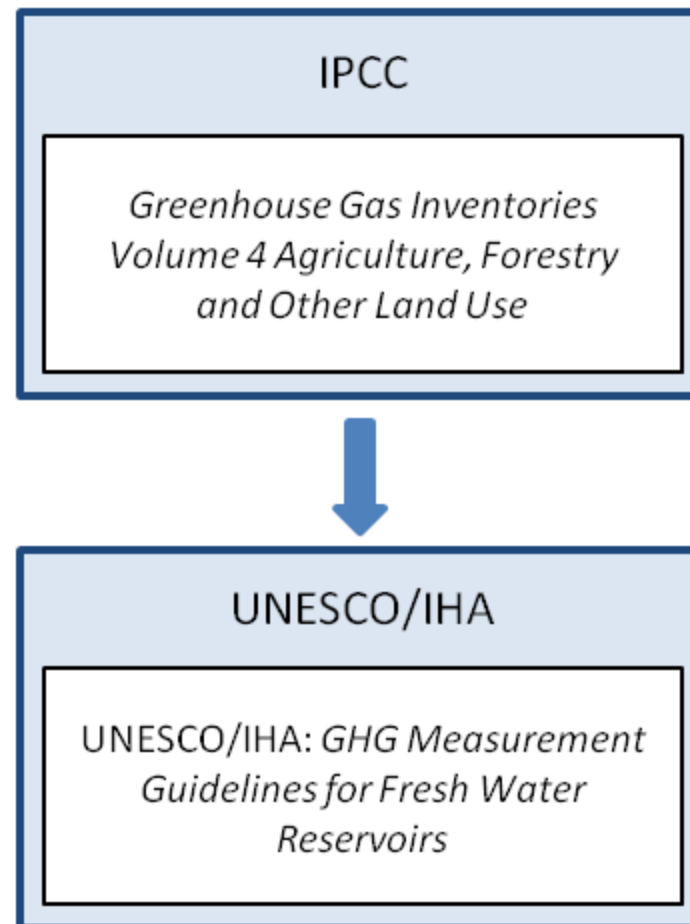
*EN 15804: Core rules for the
product category of construction
products*

*EN 15978: Assessment of
environmental performance of
buildings - Calculation method*

European Building and Civil Engineering Standards



Land Use Change Standards



Environmental Product Declarations

International EPD System

PCR Basic Module, CPC Division
17: *Electricity, Town Gas, Steam
and Hot Water*

PCR Basic Module, CPC Division
69: *Electricity, Gas and Water
Distribution*

Product Category Rules, CPC
Division 171: *Electricity
Generation and Distribution*



Proposed LCA Protocol (finally)

Goal and Scope Definition

Study overview:

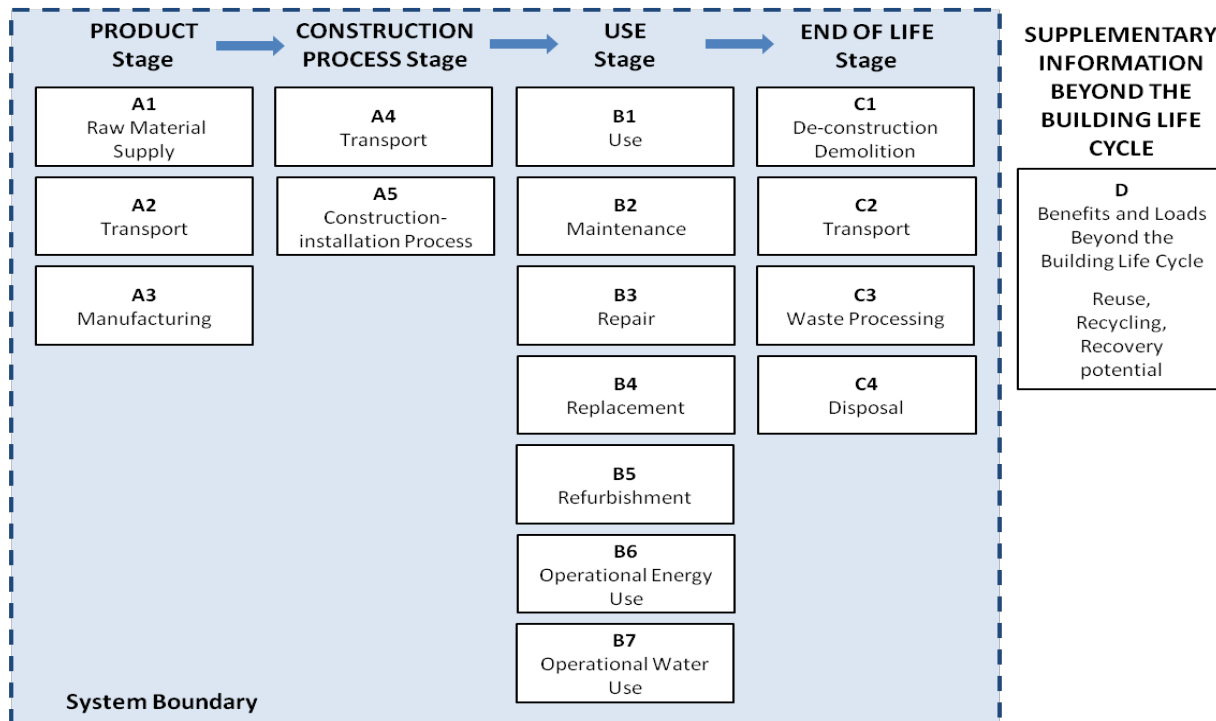
- Includes air, water, and land emissions
- Calculates appropriate impacts
- Facilitates impact mitigation

*LCA complies with relevant standards
(ISO 14040/14044, ISO 21929-2/21930)*

Goal and Scope Definition

Scope Definition:

- Aligns with Project Description
- Aligns with EN 15978 Modularity



Life Cycle Inventory

Example data collection spreadsheet

Organized based on Keeyask GS EIS Project Description Volume

| EIS Project Description Section | Scope of Assessment | Site-mixed Concrete | | |
|--|--|---------------------|-------|-------|
| | | Mix 1 | Mix 2 | Mix 3 |
| | | m3 | m3 | m3 |
| 2.3.1 Powerhouse Complex | Powerhouse, service bay, and control building structure and envelope | | | |
| | Parking lot | | | |
| | Trash racks and gates | | | |
| | Hoists and cranes | | | |
| | Turbines | | | |
| | Generators | | | |
| | Transformers | | | |
| | Other mechanical equipment | | | |
| 2.3.2 Spillway | Overflow structure | | | |
| | Vertical lift gates | | | |
| | Stoplogs | | | |
| | Hoists and monorail | | | |
| | Structural steel support | | | |
| | Road bridge | | | |
| | Downstream side bridge | | | |
| 2.3.3 Powerhouse and Spillway Channels | Powerhouse intake channel | | | |
| | Tailrace channel | | | |
| | Spillway channel | | | |
| 2.3.4 Wing Walls | 5 concrete gravity walls (A through E) | | | |

Life Cycle Inventory

- **Estimation is OK at conceptual design stage**
- **Life Cycle Inventory should be designed to allow refinement**

Life Cycle Impact Assessment

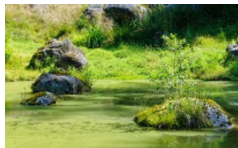
Full range of life cycle impacts



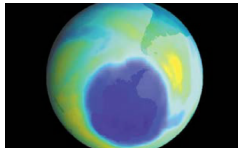
Global warming



Acidification



Eutrophication



Ozone depletion



Smog



Fossil fuel consumption

Life Cycle Impact Assessment

| EN 15978 Environmental Indicator | Methodology | Unit |
|---|---------------------------------------|------------------------|
| Environmental Impacts | | |
| Global warming potential, non-biogenic | TRACI v2.1* | kg CO ₂ eq. |
| Global warming potential, biogenic | TRACI v2.1* | kg CO ₂ eq. |
| Depletion of the stratospheric ozone layer | TRACI v2.1* | kg CFC-11 eq. |
| Acidification potential of land and water | TRACI v2.1* | kg SO ₂ eq. |
| Eutrophication potential | TRACI v2.1* | kg N eq. |
| Formation potential of tropospheric ozone photochemical oxidants | TRACI v2.1* | kg O ₃ eq. |
| Abiotic resource depletion potential for elements | CML 2002* | kg S _b eq. |
| Abiotic resource depletion potential of fossil fuels | TRACI v2.1* | MJ surplus |
| Resource Use | | |
| Use of renewable primary energy excluding energy resources used as raw material | CED* | MJ |
| Use of renewable primary energy resources used as raw material | CED* | MJ |
| Use of non-renewable primary energy excluding resources used as raw material | CED* | MJ |
| Use of non-renewable primary energy resources used as raw material | CED* | MJ |
| Use of secondary material | Sum of LCI flows | kg |
| Use of renewable secondary fuels | <i>not recommended to be included</i> | |
| Use of non-renewable secondary fuels | <i>not recommended to be included</i> | |
| Net use of fresh water | Sum of LCI flows | m ³ |
| Waste Categories | | |
| Hazardous waste disposed | Sum of LCI flows | kg |
| Non-hazardous waste disposed | Sum of LCI flows | kg |
| Radioactive waste disposed | <i>not recommended to be included</i> | |
| Output Flows Leaving the System | | |
| Components for re-use | Sum of LCI flows | kg |
| Materials for recycling | Sum of LCI flows | kg |
| Materials for energy recovery (not being waste incineration) | Sum of LCI flows | kg |
| Exported energy | Sum of LCI flows | MJ |

Interpretation

- **Contribution analysis**
- **Benchmarking**
Calculation of impacts by component to inform procurement
- **Dynamic carbon footprinting**

Thank You!

James Salazar
Director of Industry Services
james.salazar@coldstreamconsulting.com

Matt Bowick
Director of Building Services
matt.bowick@coldstreamconsulting.com