Nuclear Energy in the Education of Sustainable Engineering Practices

Adriaan Buijs,
CNS President

Presentation to CRL and Ottawa Branches of CNS, 21 and 22 February 2011

Outline

- The Concept of Sustainability
- Three Case Studies
- Nuclear Power and Sustainability
- Engineering Education and Sustainability

Sustainability: a Definition

Source: Wikipedia

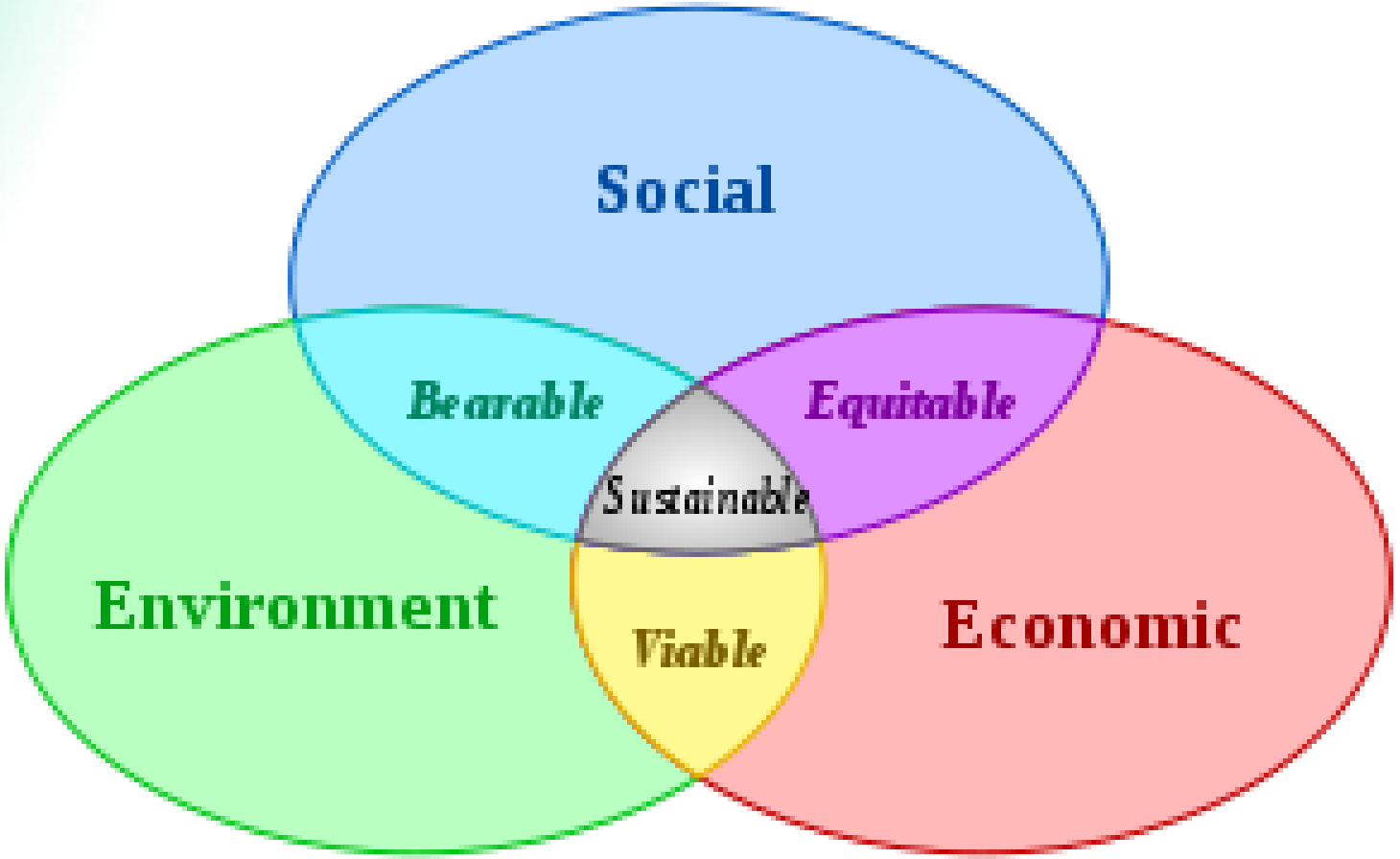
Brundtland Commission of the United Nations, March 20, 1987:

> “Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs.”

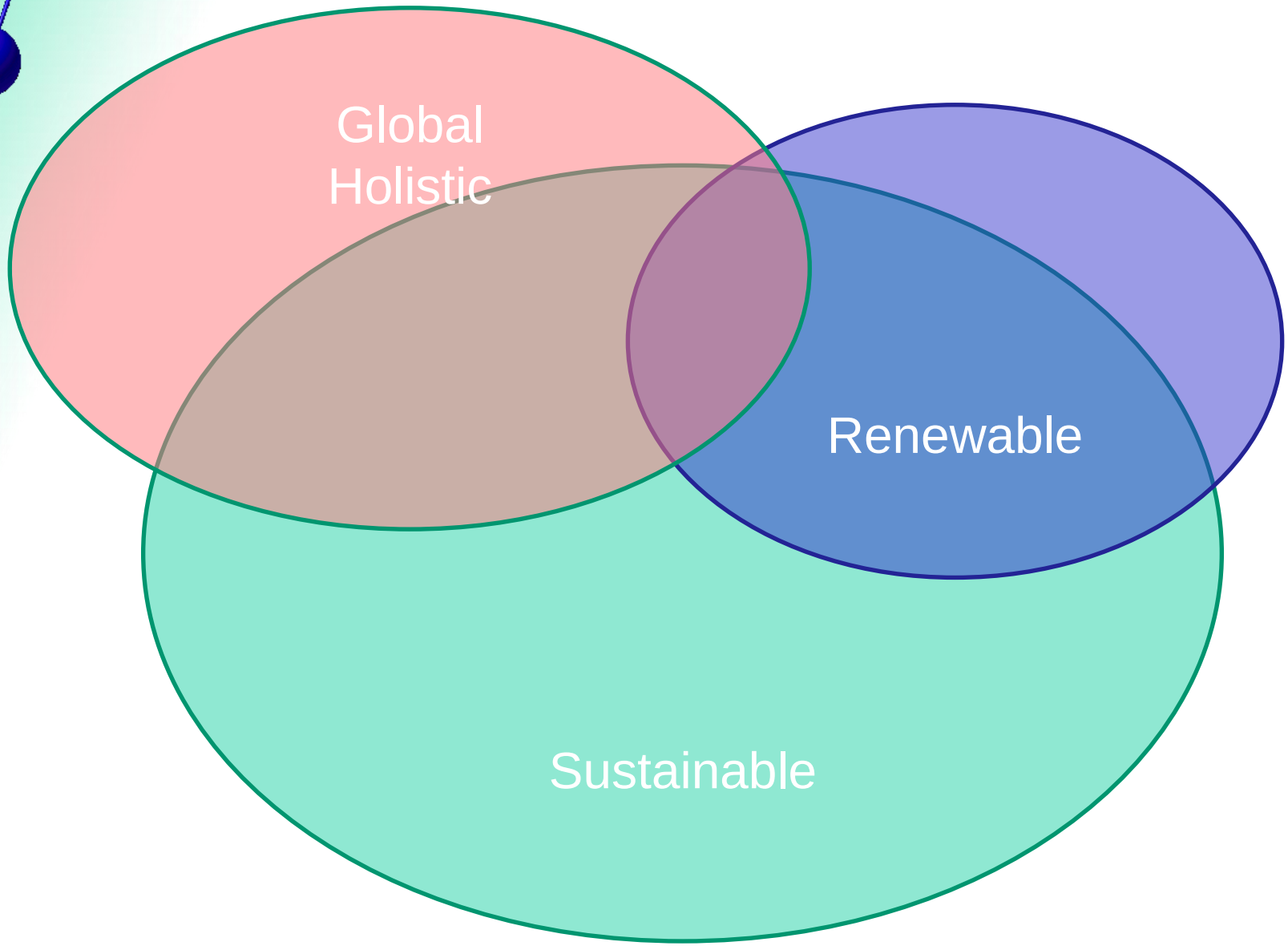
Sustainability: Perceptions

- Wikipedia:
  - Sustainability is perceived, at one extreme, as nothing more than a feel-good buzzword with little meaning or substance, [refs]
  - but, at the other, as an important but unfocused concept like "liberty" or "justice". [refs]
  - It has also been described as a "dialogue of values that defies consensual definition". [refs]

Sustainability: Triple Bottom Line



Sustainability and Other Concepts



Sustainability: Energy Supply

- Only one aspect of Sustainability;
- Issues:
  - Supply
  - Environmental Impact
  - Social Impact
  - Economics
- Footnote: population growth

Case Studies

- WWF
  THE ENERGY REPORT: 100% RENEWABLE ENERGY BY 2050
  WWF.panda.org
- David MacKay
  “Sustainable Energy - Without the Hot Air”
  WWW.WithoutHotAir.com
- CNS
  “A Potential Strategy for Sustainable Energy in Canada”
  In preparation

Case Studies: WWF

"By 2050, we could get all the energy we need from **renewable** sources. This report shows that such a transition is not only possible but also cost-effective, providing energy that is affordable for all and producing it in ways that can be **sustained** by the global economy and the planet. The transition will present significant challenges, but I hope this report will inspire governments and business to come to grips with those challenges and, at the same time, to move boldly to bring the **renewable** economy into reality. There is nothing more important to our ability to create a **sustainable** future."

James P. Leape, Director General WWF International

Case Studies: WWF

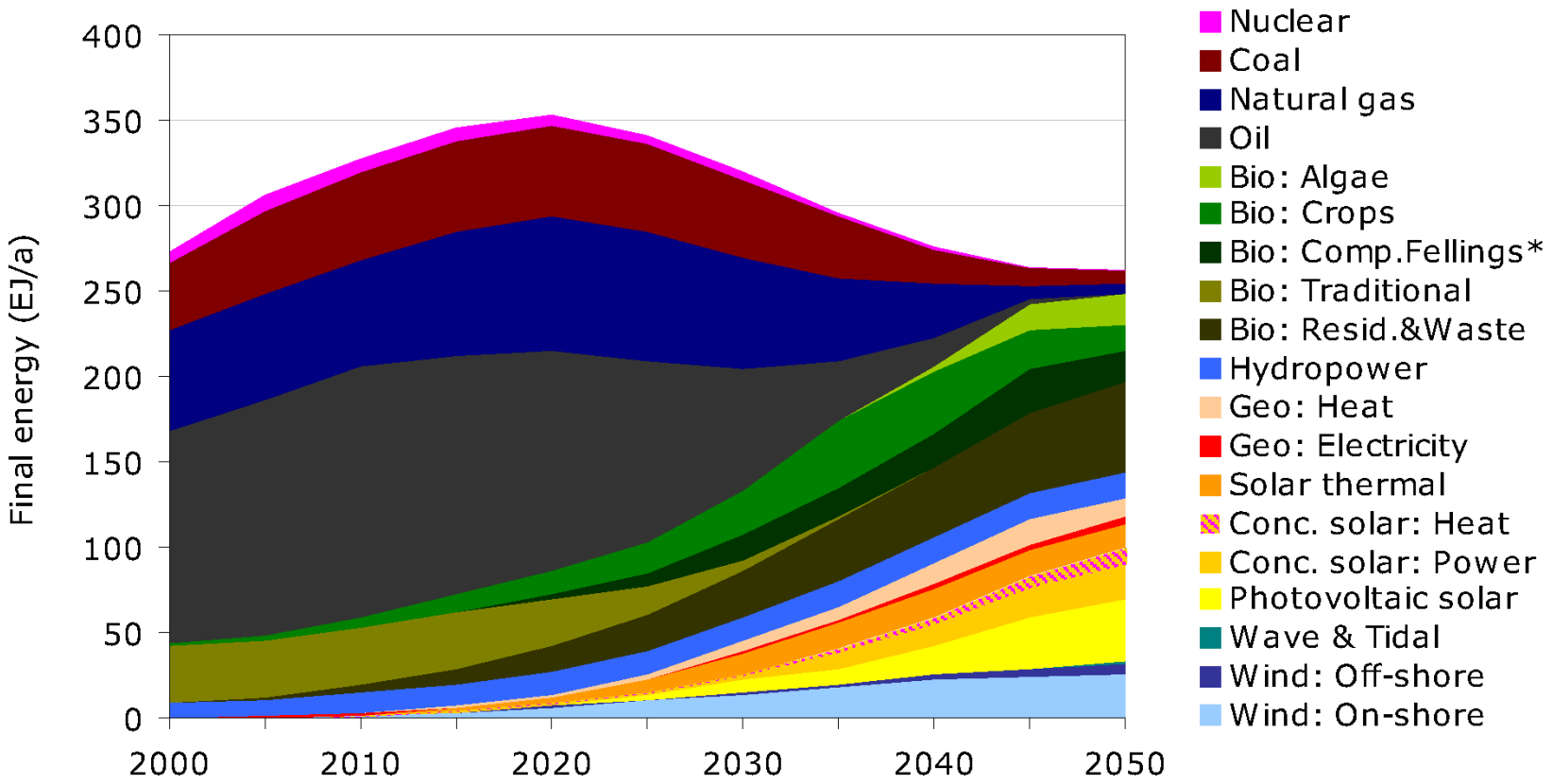


Figure 4 - 2 Global energy supply in the Scenario, split by source. (*Complementary fellings include the sustainable share of traditional biomass use.[25])

Case Studies: WWF

“Nuclear is an unethical and expensive option”

For some, nuclear power is seen to be a part of the solution to the energy crisis. It produces large-scale electricity with low carbon emissions – although mining and enriching uranium is very energy intensive. But we cannot escape the reality that nuclear fission produces **dangerous waste** that remains highly toxic for thousands of years – and there is nowhere in the world where it can be stored safely. The United States and Germany alone have accumulated more than 50,000 and 12,000 tonnes respectively, of highly radioactive waste which has not yet been disposed of securely. According to the U.S. Environmental Protection Agency, it will be at least 10,000 years before its threat to public health is substantively reduced.

Equally troubling, the materials and technology needed for nuclear energy can also be used to produce **nuclear weapons**. In a politically unstable world, spreading nuclear capability is a dangerous course to take.

Nuclear is no ‘easy’ technology. It requires a highly sophisticated and trained staff, and only works on a **large scale**, providing power around the clock. It is certainly not a viable way to provide electricity for the 1.4 billion people whom are currently denied it, many of whom live in remote places in fragile states.

Nuclear power is also an **extremely expensive** option.

“…” all on one page.

Case Studies: MacKay

I'm concerned about cutting UK emissions of twaddle – twaddle about sustainable energy. Everyone says getting off fossil fuels is important, and we're all encouraged to "make a difference," but many of the things that allegedly make a difference don't add up.

Twaddle emissions are high at the moment because people get emotional (for example about wind farms or nuclear power) and no-one talks about numbers. Or if they do mention numbers, they select them to sound big, to make an impression, and to score points in arguments, rather than to aid thoughtful discussion.

This is a straight-talking book about the numbers. The aim is to guide the reader around the claptrap to actions that really make a difference and to policies that add up.

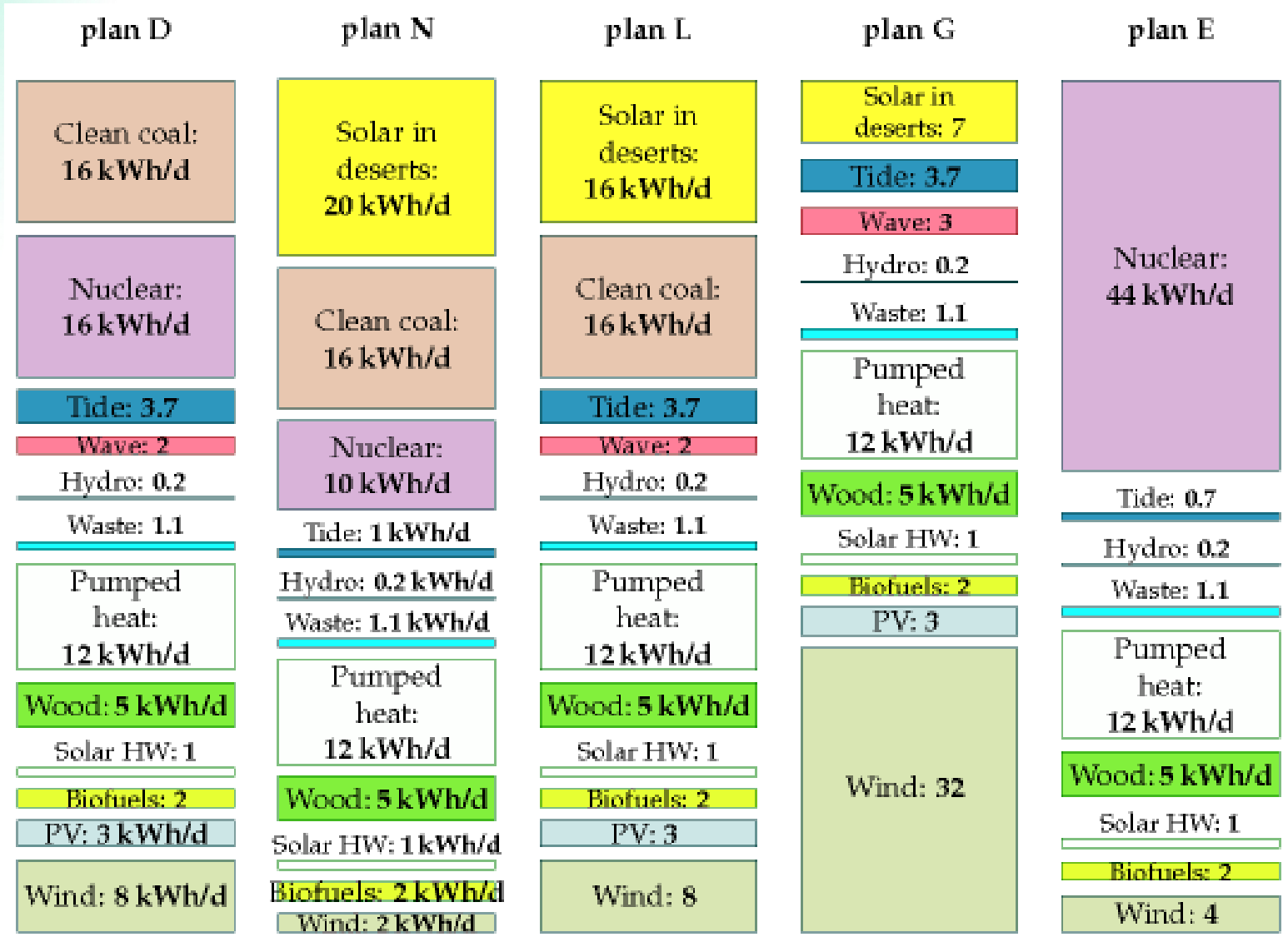
Case Studies: MacKay

- Applies to UK only;
- Considers every possible
  - source of energy,
  - storage of energy,
  - sink of energy.
- Motto: “Numbers, not adjectives”
- Pays little attention to economics;
- Dedicates 16 pages to Nuclear energy, including fusion.

Case Studies: MacKay

- ‘We could invest in nuclear fission. Is current nuclear technology “sustainable”? Is it at least a stop-gap that might last for 100 years?’
- Provides 5 possible plans

Case Studies: MacKay



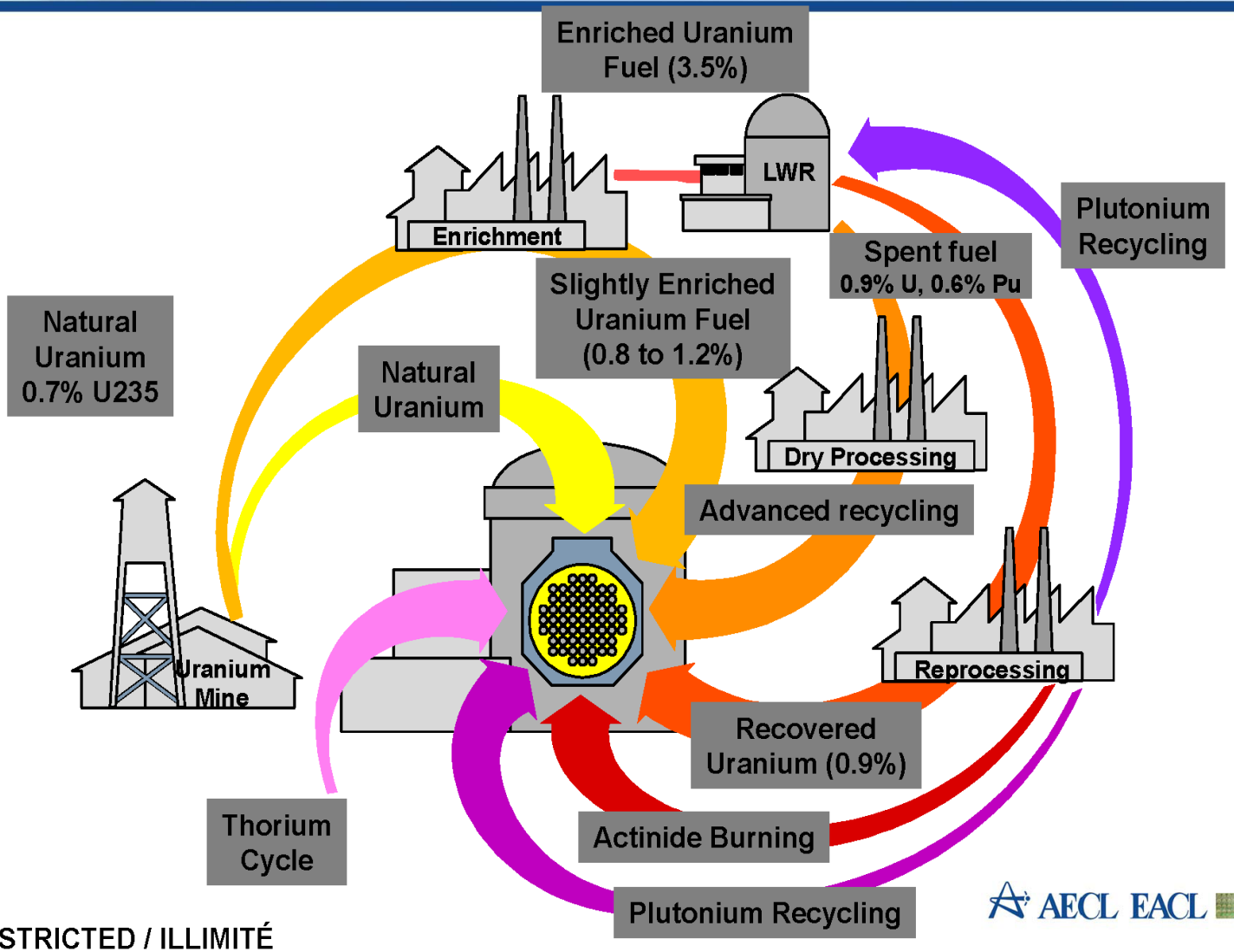
Case Studies: CNS

- Position Paper in preparation by Blair Bromley.

Nuclear Power and Sustainability

- Need to check nuclear power against definition of sustainability and the triple bottom line:
  - ✓Current needs;
    - ➢50% of Ontario's current electricity supply
  - ✓Future needs:
    - ➢Supply limited (not renewable) but large
    - ➢Breeder reactors
    - ➢Thorium-based fuel
    - ➢Recovered uranium
    - ➢Spent fuel

CANDU Advanced Fuel Cycles



Nuclear Power and Sustainability

Triple bottom line

- Economic
  - ✓Not “too cheap to meter”, but competitive;
  - ✓Need to include all costs
  - ✓Cradle to cradle
- Environment
  - ✓Low on CO_2
  - ✓ Spent fuel management technically feasible
  - ✓Cradle to cradle

Nuclear Power and Sustainability

Triple bottom line continued

- Social
  - √ Non-Proliferation. Needs to be managed in any case.
  - √ Access to nuclear power for all.
  - √ Acceptance; not a societal issue in the sense of sustainability, but an issue that needs to be addressed.

Nuclear Power and Sustainability

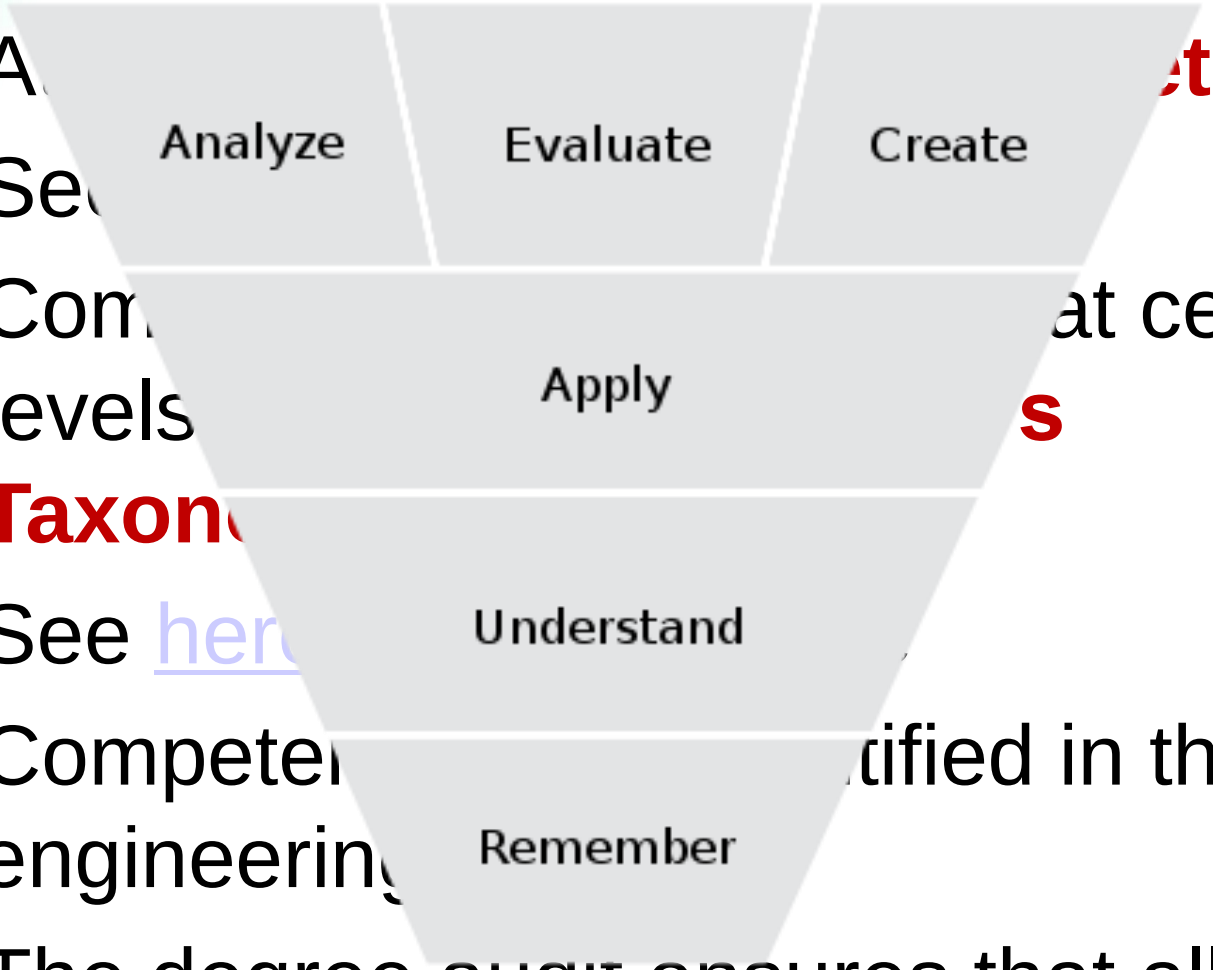
- Sustainability is a useful concept, threatened by ideology;
- Nuclear power is clearly part of a practical sustainable development;
- CANDU reactors are especially well suited.
- There is a strong need to stay on message:
  - Proper definition of sustainable, not to be confused with renewable;
  - Why nuclear power must be part of it.

Sustainability in Engineering Education

- Most universities have a sustainability program.
- Some mention nuclear, some don’t.
- As engineering is considered to be building the future, McMaster University decided to integrate sustainability in the engineering program.
- McMaster Engineering program is built around **Attributes**
- Upon graduation, students must have demonstrated to have these attributes.

Sustainability in Engineering Education

- A
- Se
- Com
- See her
- Competer
- The degree audit ensures that all competencies are acquired.



Sustainability in Engineering Education

- Sustainability is one of the attributes for engineering at McMaster
- McMaster has a long nuclear tradition;
- Nuclear is seen as an integral part of the sustainability.
- Instructors now need to work the sustainability aspect into the nuclear engineering courses.
- Also, need to define a measure for success.

Summary

- It is to the benefit of the Society to:
  - ✓ Define sustainability properly.
  - ✓ Showcase nuclear energy as sustainable.
  - ✓ In particular CANDU reactors
- As a technical society, the CNS can and ought to contribute to this discussion.
- McMaster University is integrating sustainability into its engineering curriculum.
- Nuclear is part of it at Mac