



UNIVERSITY of TORONTO

Engineering Science
...Engineers for the World

New Initiatives Relating to Energy at University of Toronto

**Introducing the Energy
Systems Option
In Engineering Science**

- Interdisciplinary:
 - ECE, MIE, Civil, Chemical
 - Innovatively address future energy challenges
 - Disappearing talent within energy sector/industry
- Unique program addressing both traditional and renewable forms of energy
- There are no silver bullets to the energy challenges –
 - good reason to remove ALL energy options for they all have some real challenges
 - therefore, making tough trade-offs will be crucial





Division of Engineering Science.....Engineers for the World



- Thermodynamics and its application
- Electromechanical energy conversion
- Electric power system operation and control
 - Operation, grid-interface and control of distributed generation (DG) units: wind power, solar photovoltaic, fuel-cell, battery systems, superconducting energy storage systems, fly-wheel systems
- Dynamic control of dc-dc power supplies
- Operating principles of lighting systems (illumination concepts and light sources)



Interaction of Scales

- At the heart of all modeling, from story telling to art to simulation modelling
 - One thing in another
- At the core of our human ability to conceive, understand and change the world
 - Key to our power - for good or ill
 - Key to our responsibility
 - Emergence



3F Semester

ECE Energy Conversion

MIE Mechanical and Thermal Energy Conversion Processes

CIV Terrestrial Energy Systems

CHE Chemical Processes for Energy Storage & Generation

MIE Economic Analysis and Decision Making



CAUTION

**THIS SIGN HAS
SHARP EDGES**

DO NOT TOUCH THE EDGES OF THIS SIGN



ALSO, THE BRIDGE IS OUT AHEAD



3S Semester

ECE Electric Drives

CIV Design of Hydro and Wind Electric Plants

AER Linear Systems and Control

ECE Energy Systems and Distributed Generation

HSS Energy Policy

ESC Engineering Science Option Seminar





4F Semester

ESC Thesis

ECE Introduction to Lighting Systems

Two of (the actual list is longer) :

AER	Fusion
CIV	Building Science
CHE	Fuel Cells and Electrochemical Conversion Devices
ECE	Advanced Power Electronics
ECE	Passive Photonic Devices
CIV	Environmental Impact and Risk Assessment
MIE	Machine Design
MIE	Alternative Energy Systems
CHE	Modelling in Chemical Engineering
CHE	Electrochemistry
CHE	Aqueous Process Engineering

Free Elective



4S Semester

ESC4XX Energy Systems Capstone Design

Integrating pumped storage into a grid with significant wind

ESC499 Thesis

HS/CSS Elective

Two of:

CHE5

Nuclear Engineering

CHE

Advanced Reactor Design

MIE

Design for the Environment

MIE

Combustion and Fuels

MIE

Fuel Cell Systems

MSE

Nanotechnology in Alternate Energy Systems

CIV

Environmental Impact and Risk Assessment



- Hydro-electric design and analysis, particularly hydraulic issues
- Energy mix and overall metrics for system performance, including public policy questions of things like price and sustainability
- LCA and applications to conservation
- Water-Energy-Environment nexus
 - interactions between supply and energy use



- Celestica, Honeywell Aerospace Systems, Enwave, SNC Lavalin, Bombardier, Saftpower (battery), Automotive industry, MDRobotics, Hatch (consulting firms), OPG, Kinetrics, OPA, Xantrex
- power supply companies, local hydro authorities, electricity wholesale traders
- smaller companies that provide services in
 - high voltage engineering (etc.), mining companies, petrochemical companies (for industrial plant design), building science and architectural services, manufacturing, water supply, construction, and many others
- **RESEARCH**
 - Slide Credit - Power Systems Group in ECE, U. of Toronto



- Concepts are applicable wherever the transformation of electrical energy is involved:
 - Power supply for computers and cell-phones
 - Electric and hybrid vehicles
 - Lighting
 - Machines and drives, including pumps and motors
 - Alternative and renewable energy resources
 - Conventional power systems including generation, transmission, distribution and utilization of power





Potential Careers in:

- All forms and employers involved in e. generation
- Transportation: Automotive and Automation industry (electric and hybrid vehicles)
- Aerospace: electric aircrafts, satellites
- Environmental and Lighting industry - manufacturing and architectural design, building science
- Mining, semiconductor and petrochemical industries
- Renewable and alternative energy sector: wind, solar, biomass, fuel-cells, small scale hydro etc.
- Consulting firms, utilities and manufacturers
- Government and NGO public policy advisors

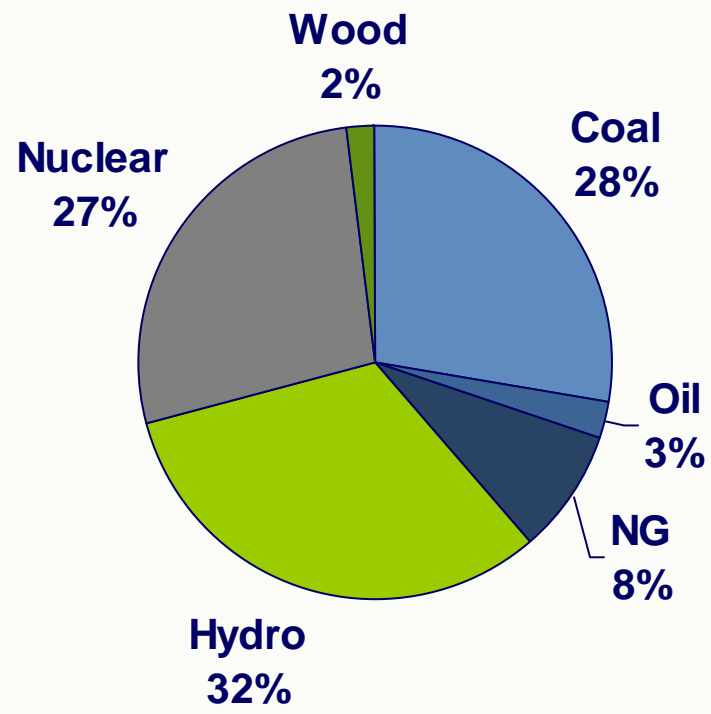


Mark Dal Bianco: "Burning Dinosaurs vs Achieving Sustainability"





Electricity Production in Canada by Source (2006, National Resources Canada)



Total = 3900 PJ

Wind
= 2250 MW (2008)
= 69 PJ (24 hr/day)
= 1.8 %

Solar
= 26 MW (2007)
= 0.16 PJ (5 hr/day)
≈ 0 %





I SAY A DAY
WITHOUT DENIAL
IS A DAY YOU'VE
GOT TO FACE.



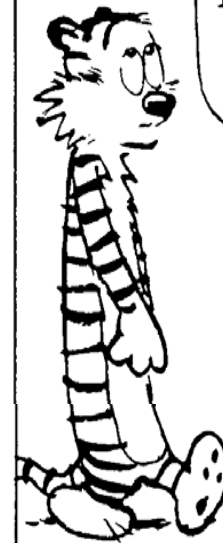
FROM NOW ON,
I'M NOT GOING
TO THINK ABOUT
ANYTHING THAT'S
UNPLEASANT.



ISN'T THAT A PRETTY
SELF-DECEIVING WAY
TO GO THROUGH LIFE?



I'M NOT GOING
TO THINK
ABOUT THAT.



WATZEM





**If we don't change direction
soon, we will end up where
we are going.**

Irwin Corey

Slide Credit: Leo Gohier





8 RULES OF SUSTAINABLE ENGINEERING

1. Design these systems better
2. Build them better
3. Operate them better
4. Maintain them better
5. Monitor them better
6. Rehabilitate them better
7. Rebuild them better
8. MIP: Understand things better

Slide credit: 1,2, 4-8 from Leo Gohier

