Renewable Energy

~~Nova Scotia's~~ Global Imperative

May 13, 2016

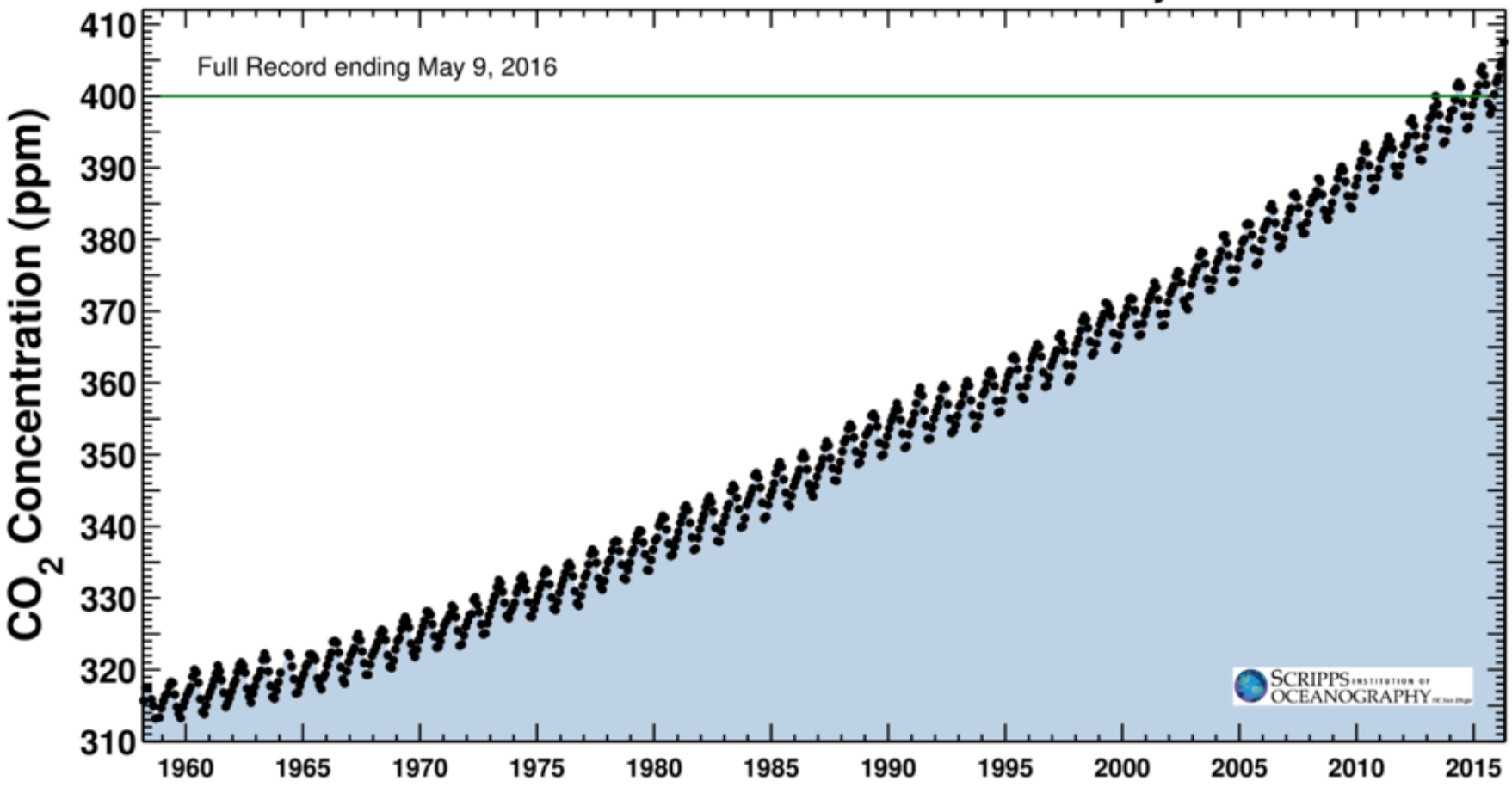
Dr. Alain Joseph

nscc
Applied Research

DALHOUSIE UNIVERSITY
Inspiring Minds

Latest CO_2 reading
May 08, 2016

407.23 ppm



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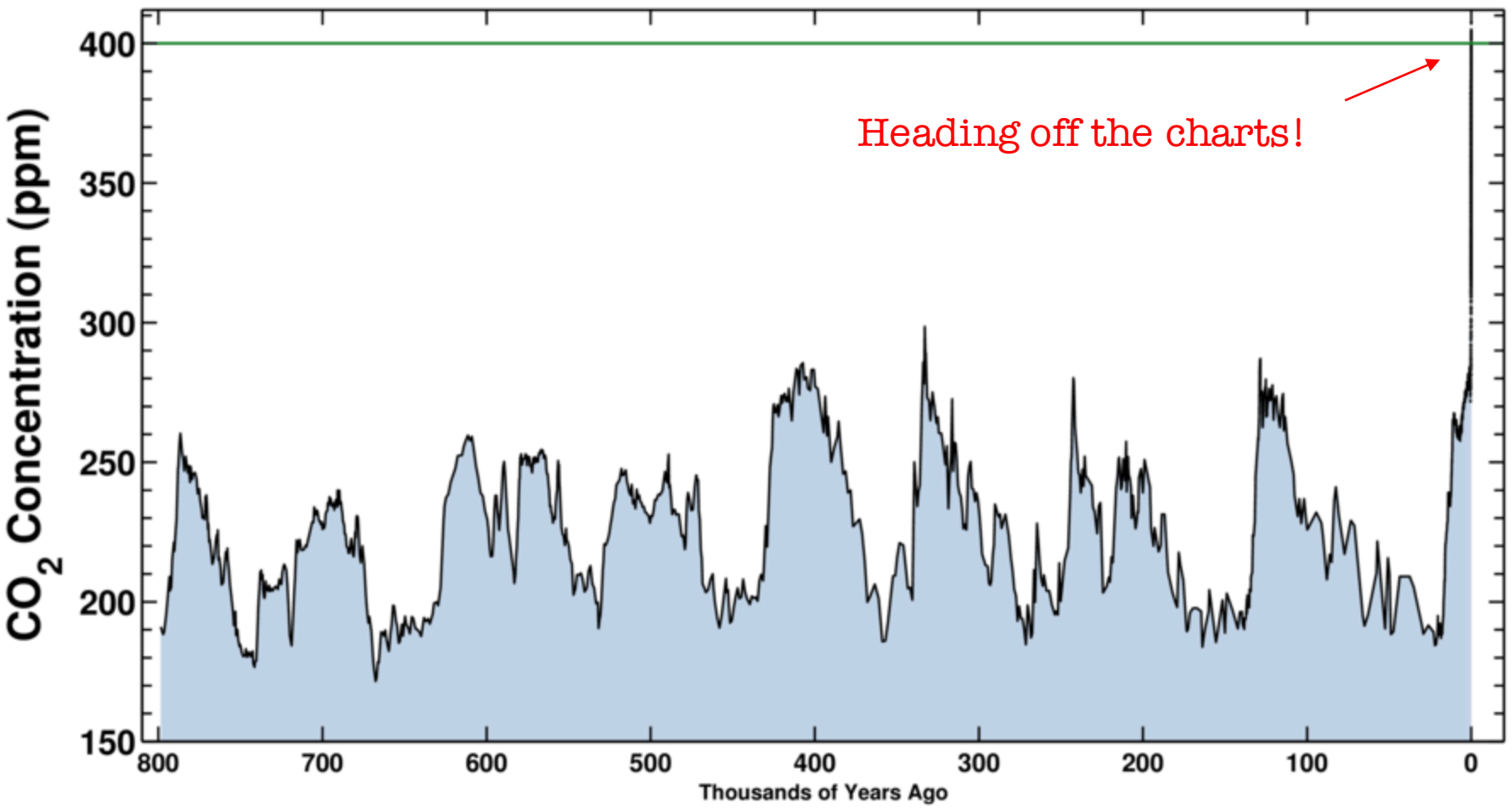


Overview

1. The Big Picture: Why Energy Matters.
2. Energy, Climate, and Society.
3. The Future of Energy:
   In Nova Scotia and Beyond.


Hubble Ultra Deep Field
Hubble Space Telescope • Advanced Camera for Surveys
NASA, ESA, S. Beckwith (STScI) and the HUDF Team
STScI-PRC04-07a

Photo: NASA

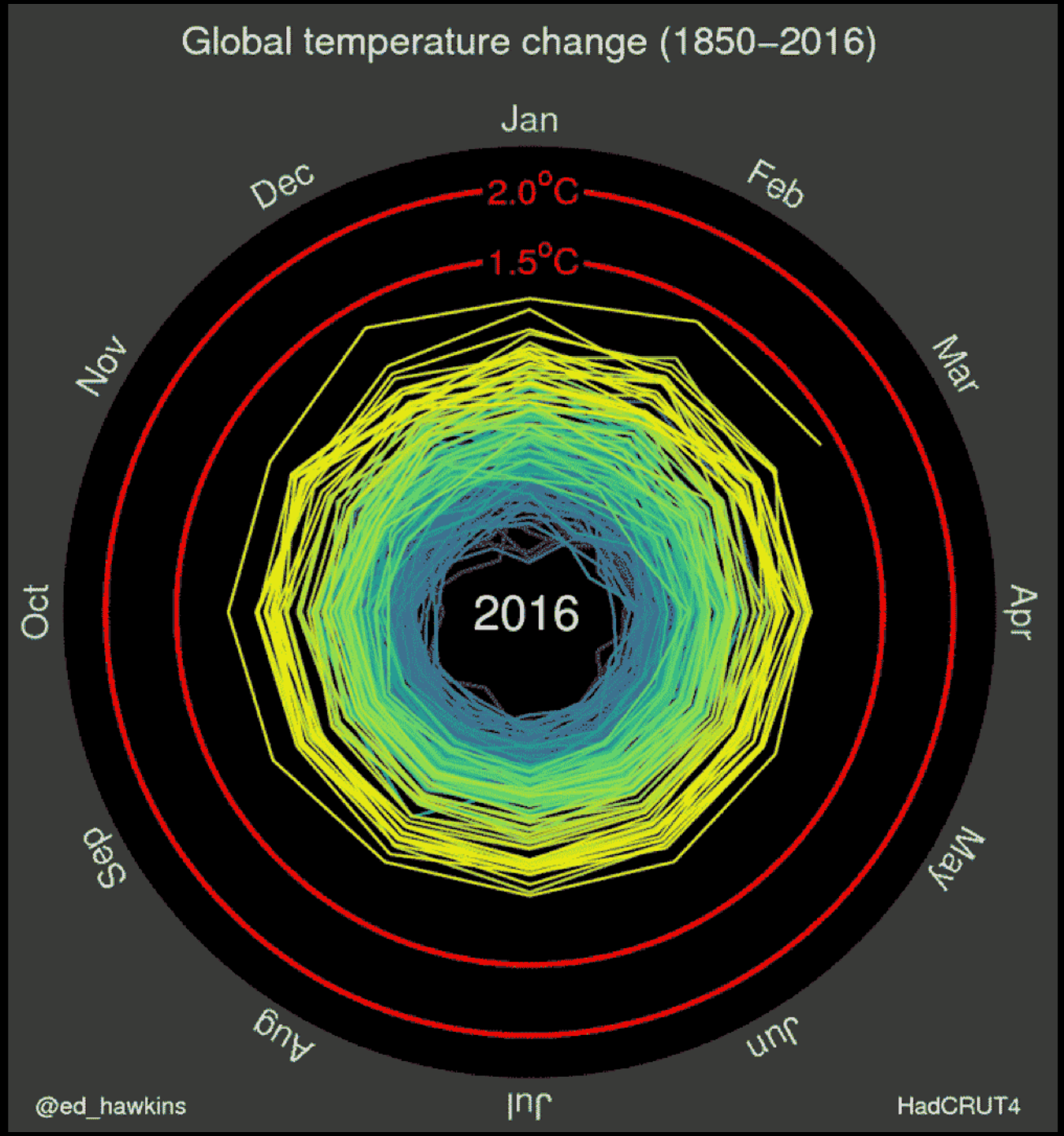
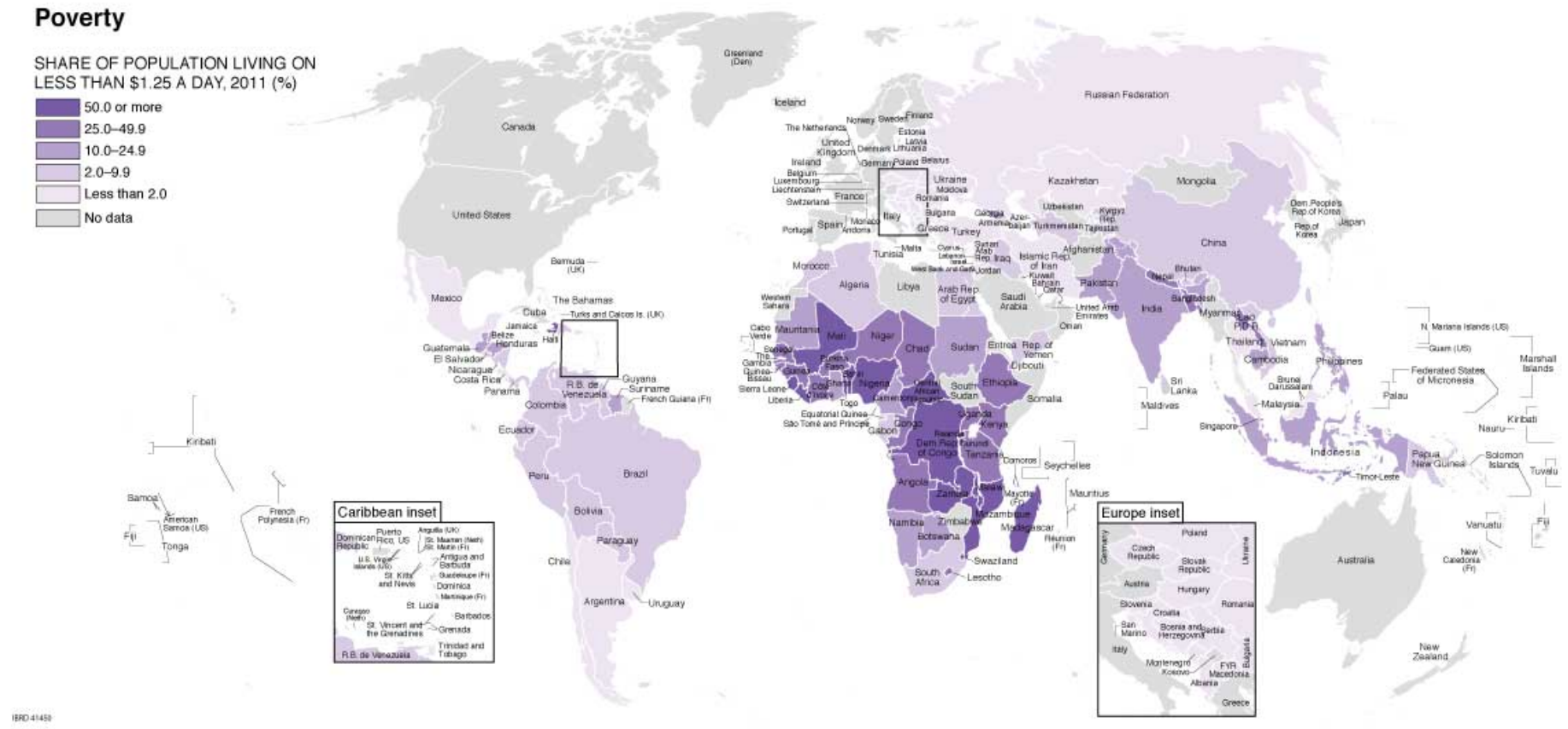


Image: Ed Hawkins

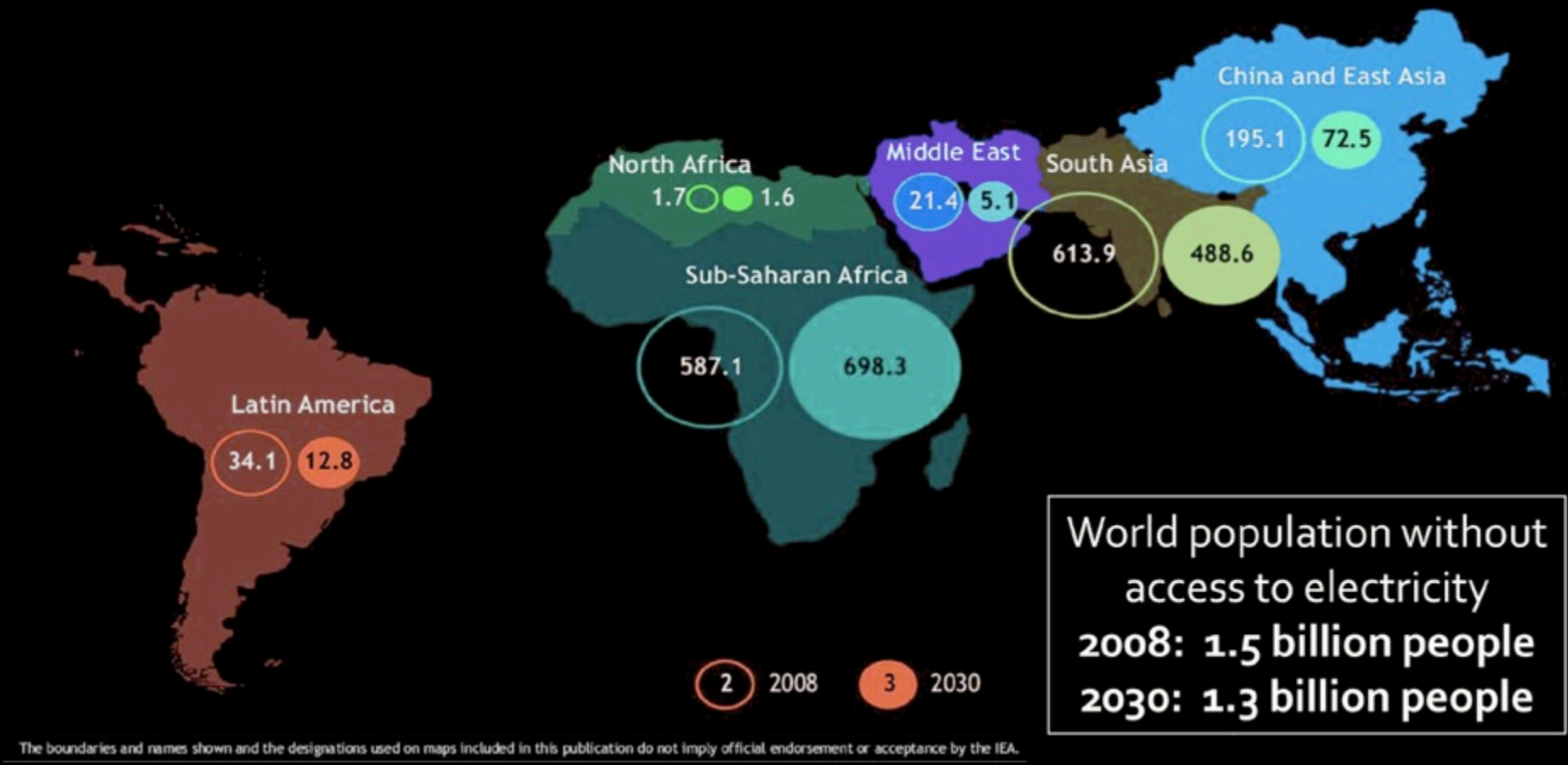
Earth lights from Space

Unequal Distribution of Resources



data.worldbank.org

Millions without electrical energy…

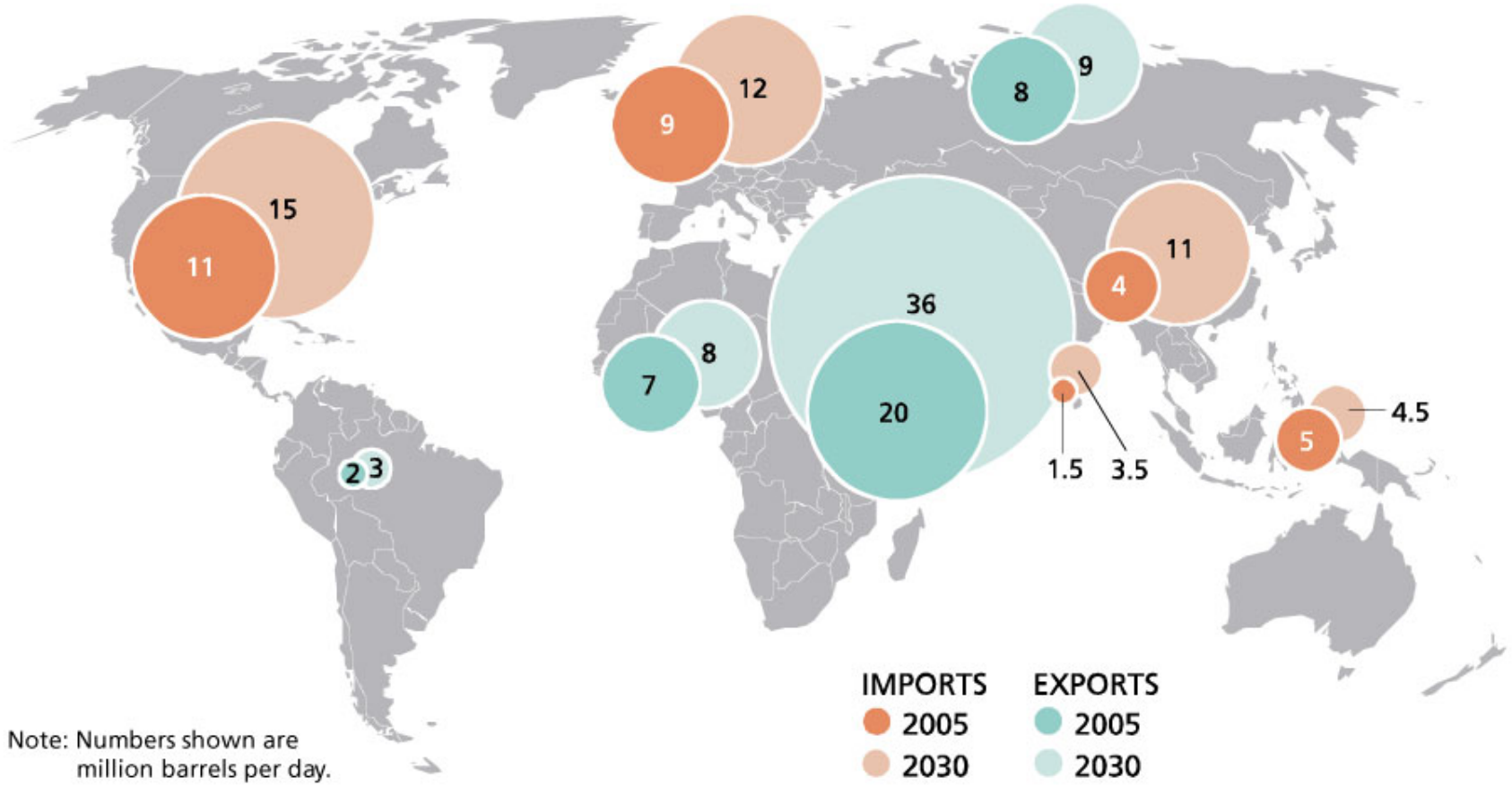


World population without access to electricity

2008: 1.5 billion people

2030: 1.3 billion people

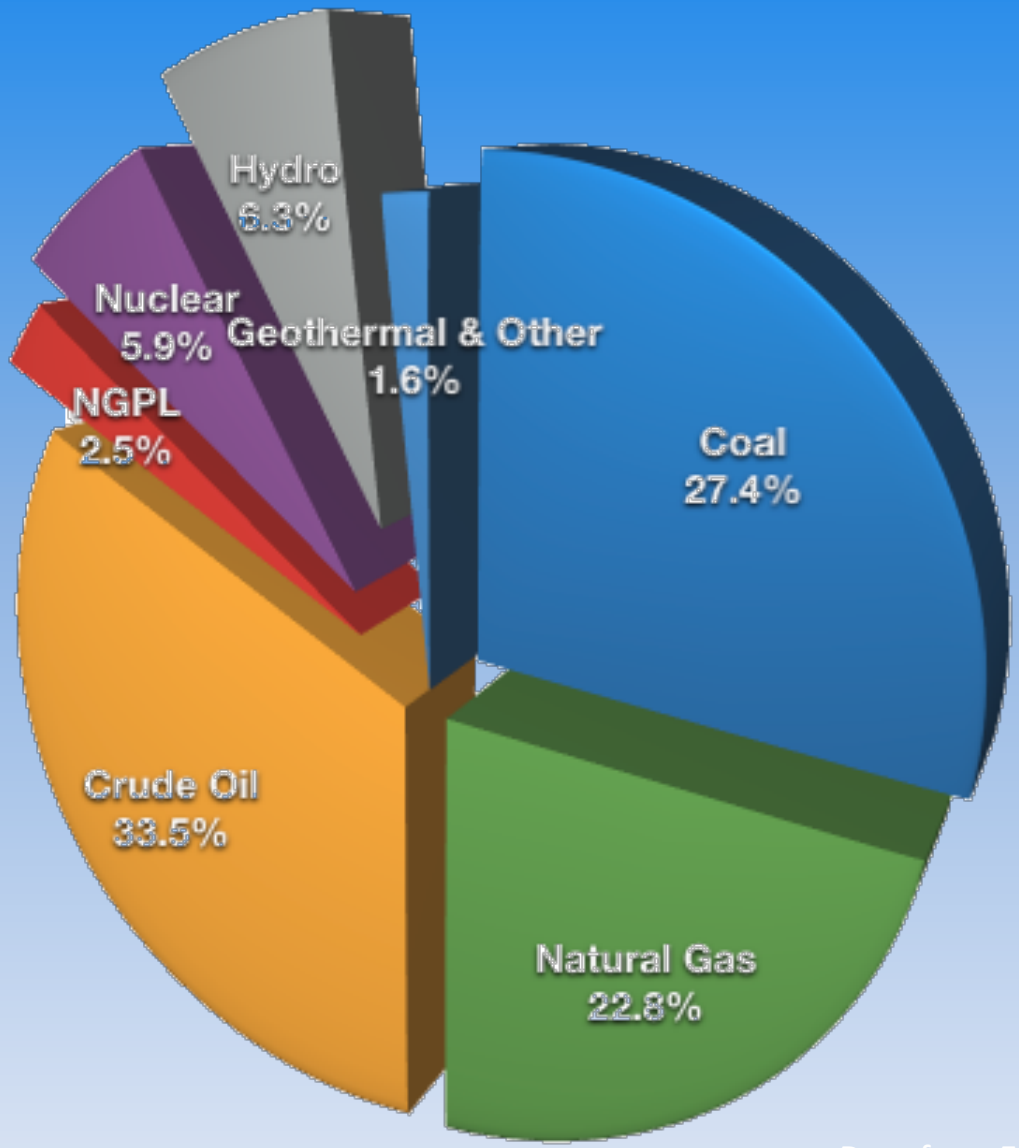
Energy Security?



Note: Numbers shown are million barrels per day.

Source: IEA, *World Energy Outlook 2006,* Reference Case.

World Energy Mix

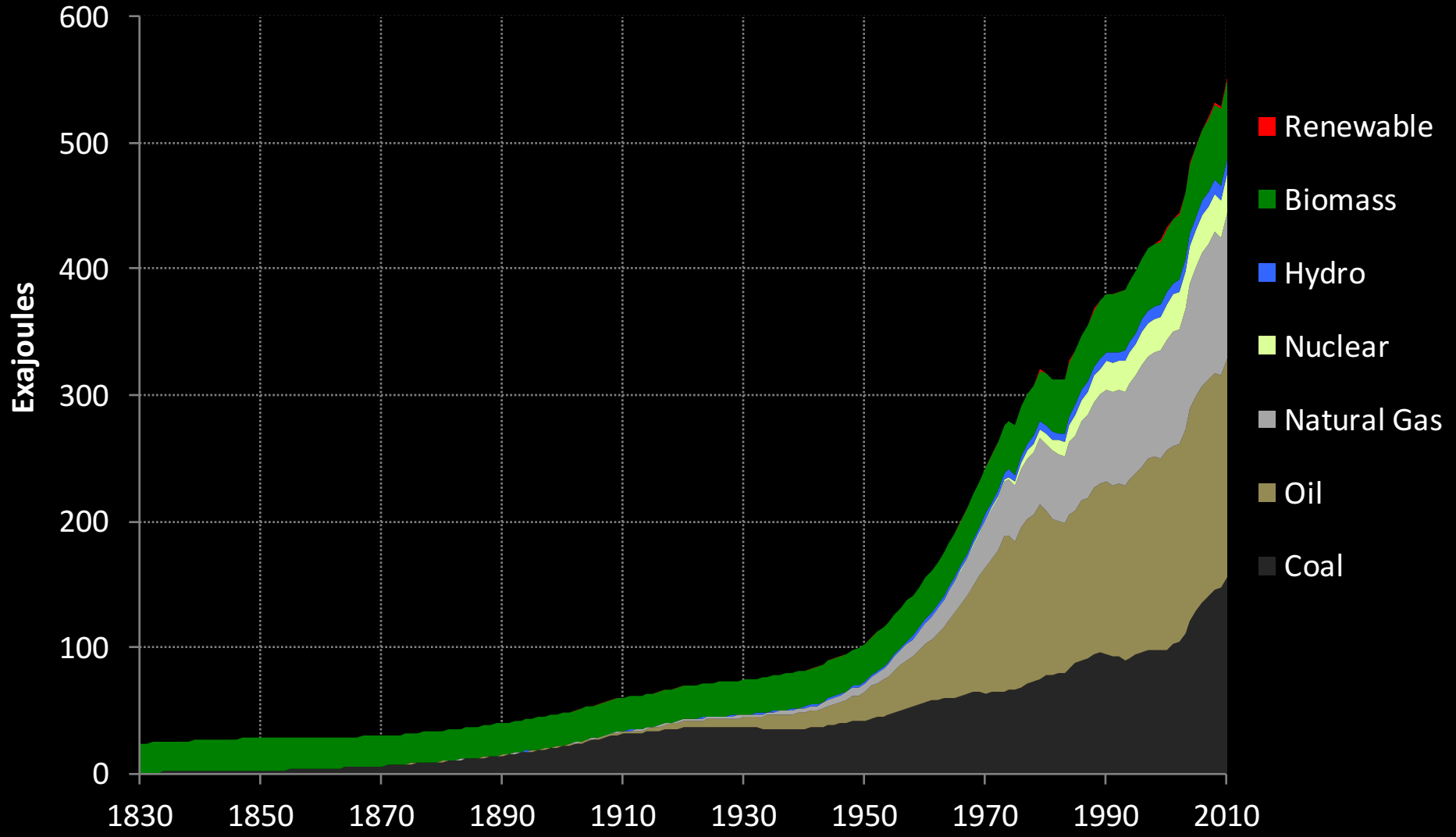


Data from EIA 2009

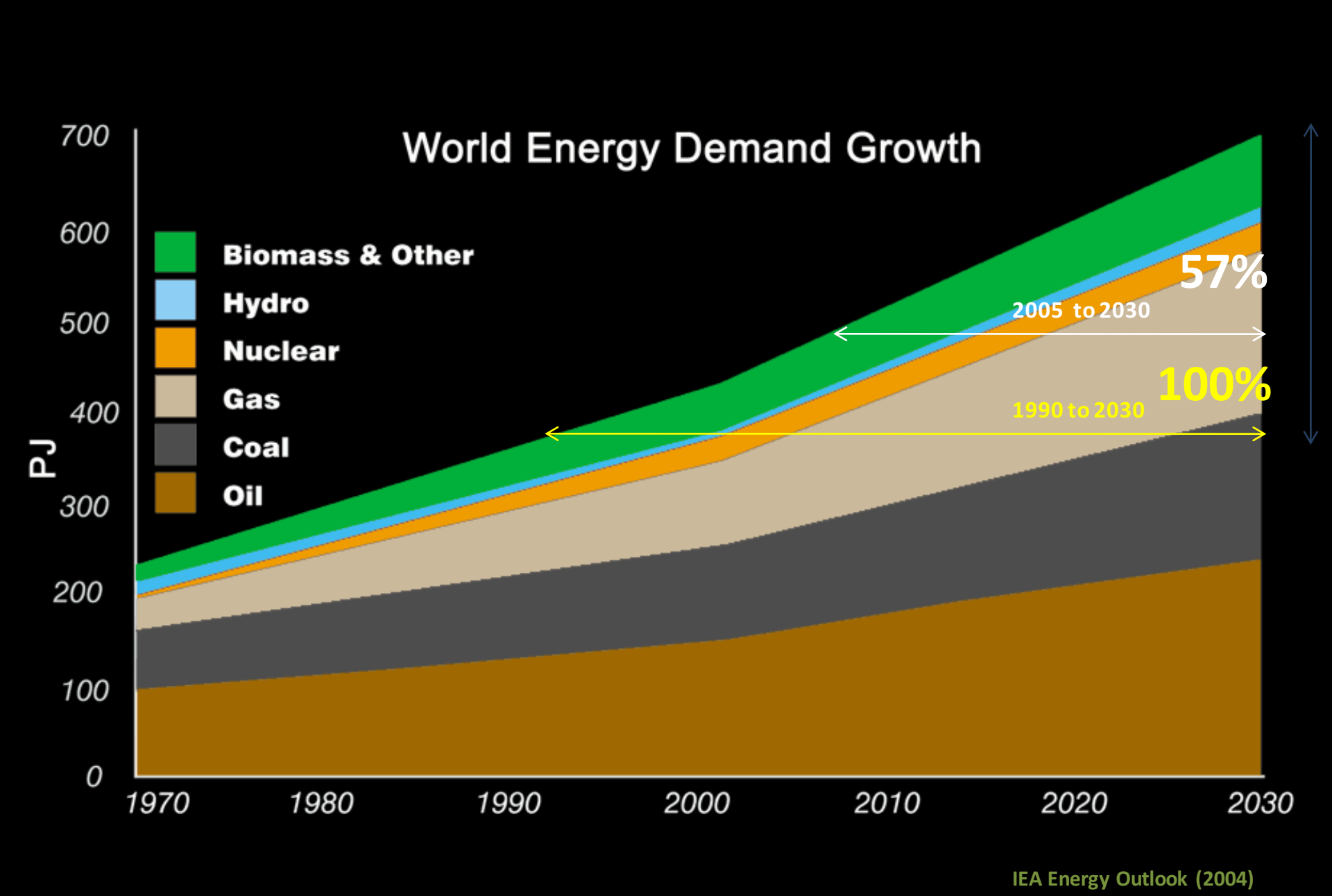
Photo: Stephen Codrington Creative Commons License

Photo: US Coast Guard.

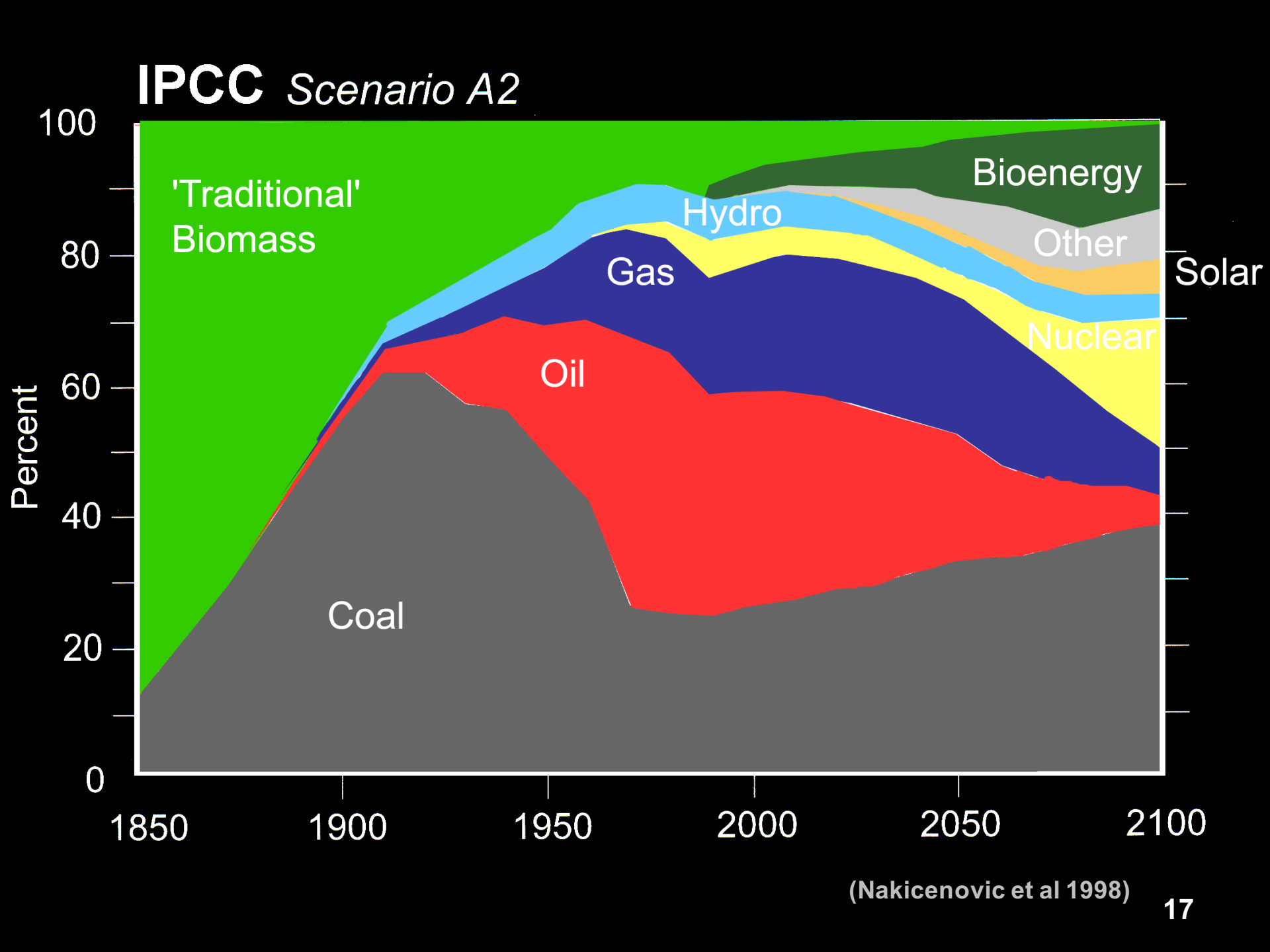
Global Primary Energy Use 1830 - 2010



(Source: Koppelaar 2012)



IEA Energy Outlook (2004)


IPCC Scenario A2
100
80
60
40
20
0
Percent
'Traditional' Biomass
Coal
Oil
Gas
Hydro
Bioenergy
Other
Solar
Nuclear
1850
1900
1950
2000
2050
2100
(Nakicenovic et al 1998)

Big Picture = Global Issues

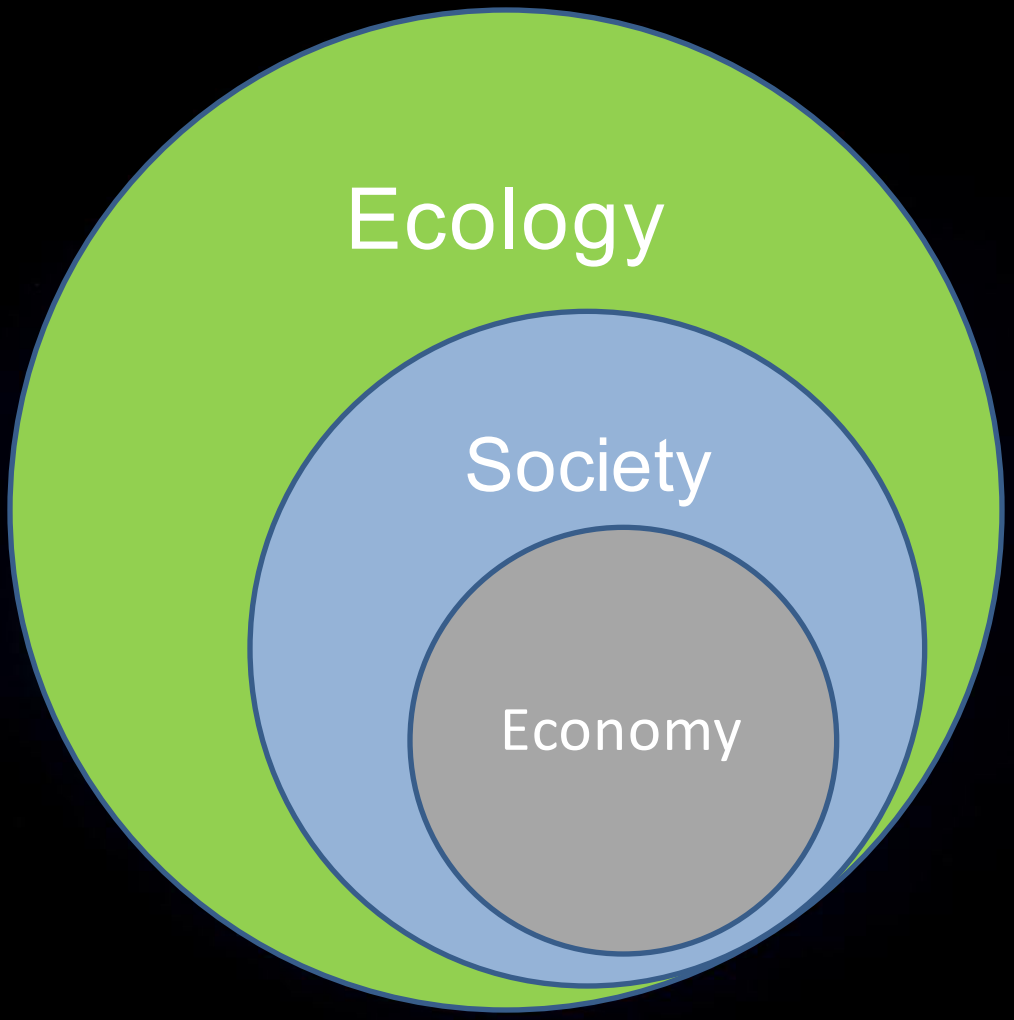
Global community

Global economy

Global sustainability

Global energy resources

Ecological Economics



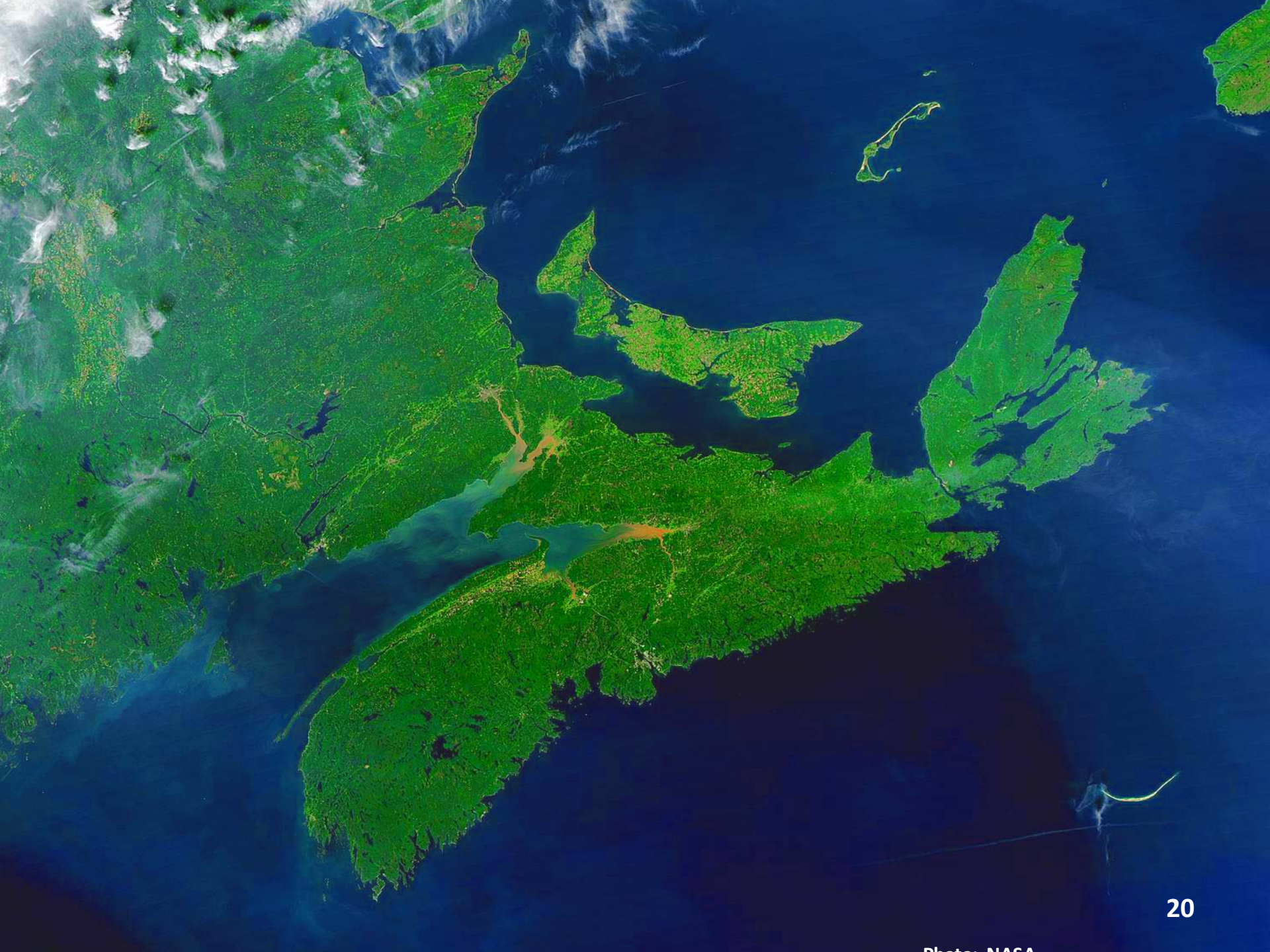
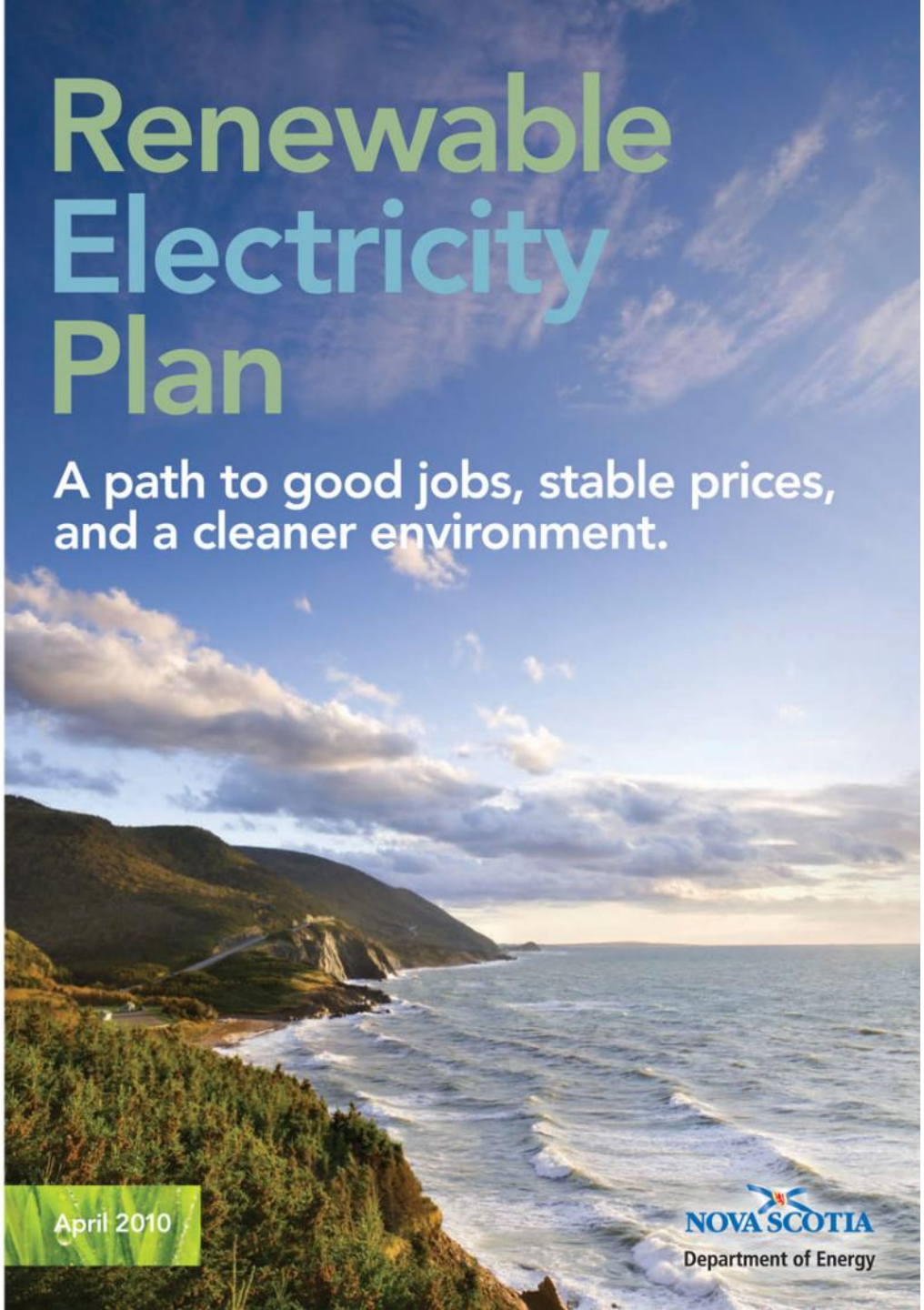


Photo: NASA

Renewable Electricity Plan

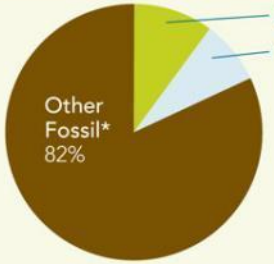
A path to good jobs, stable prices, and a cleaner environment.



April 2010

NOVA SCOTIA
Department of Energy

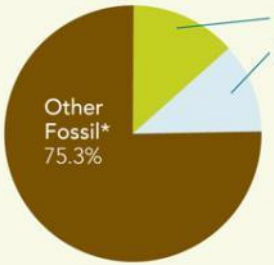
Energy Mix 2001



*includes coal, pet coke, oil, diesel, non-renewable imports

**includes hydro, wind, biomass, tidal

Energy Mix 2009



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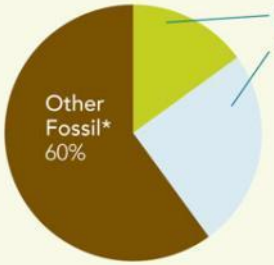
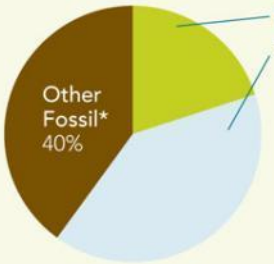
Potential Energy Mix 2015



*includes coal, pet coke, oil, diesel, non-renewable imports

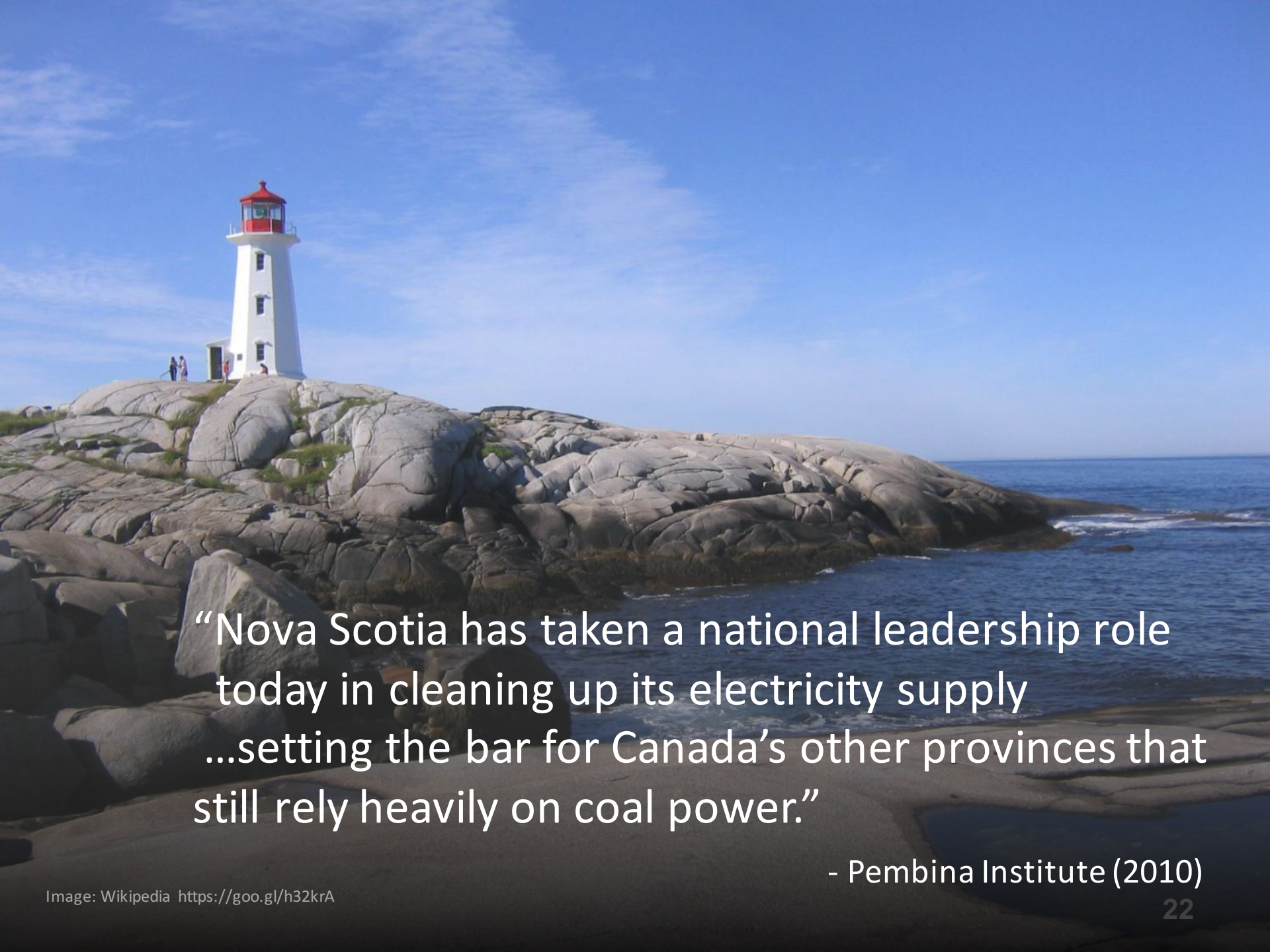
**includes hydro, wind, biomass, tidal

Potential Energy Mix 2020



*includes coal, pet coke, oil, diesel, non-renewable imports

**includes hydro, wind, biomass, tidal



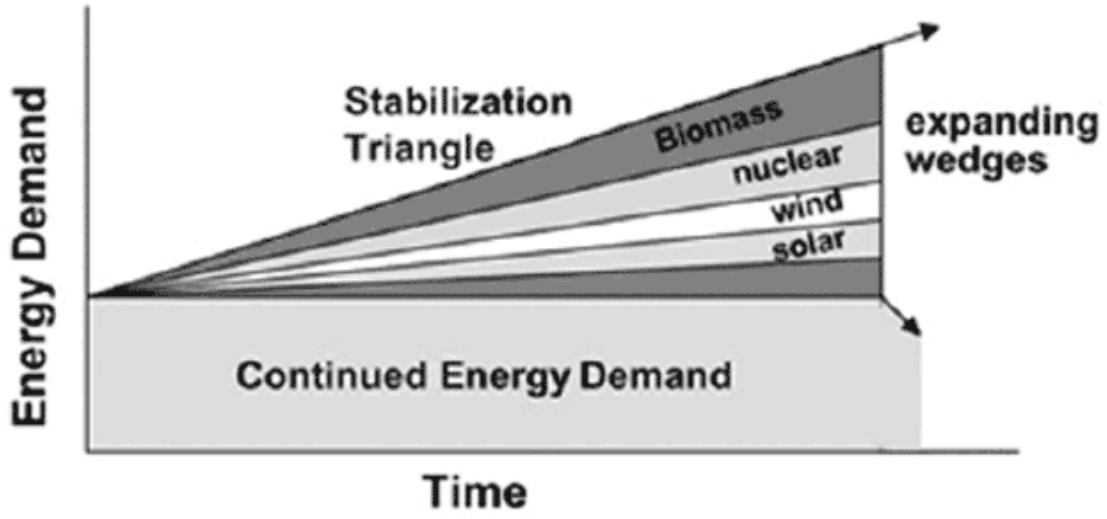
"Nova Scotia has taken a national leadership role today in cleaning up its electricity supply …setting the bar for Canada's other provinces that still rely heavily on coal power."

- Pembina Institute (2010)

Image: Wikipedia https://goo.gl/h32krA

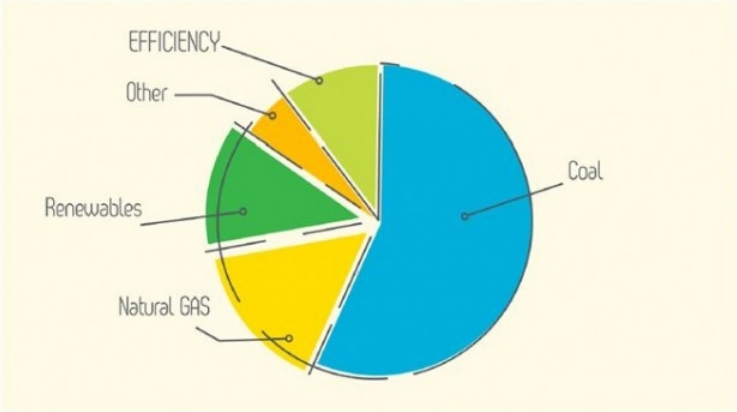
Climate-Energy Solutions

- Technology or Conservation?
- Use a combined approach
- Feasible with present day technology



Energy Efficiency and Conservation

Today, efficiency has grown to be almost **seven per cent** of our electricity mix



Enough energy to power nearly **78,000** homes

efficiency NOVA SCOTIA

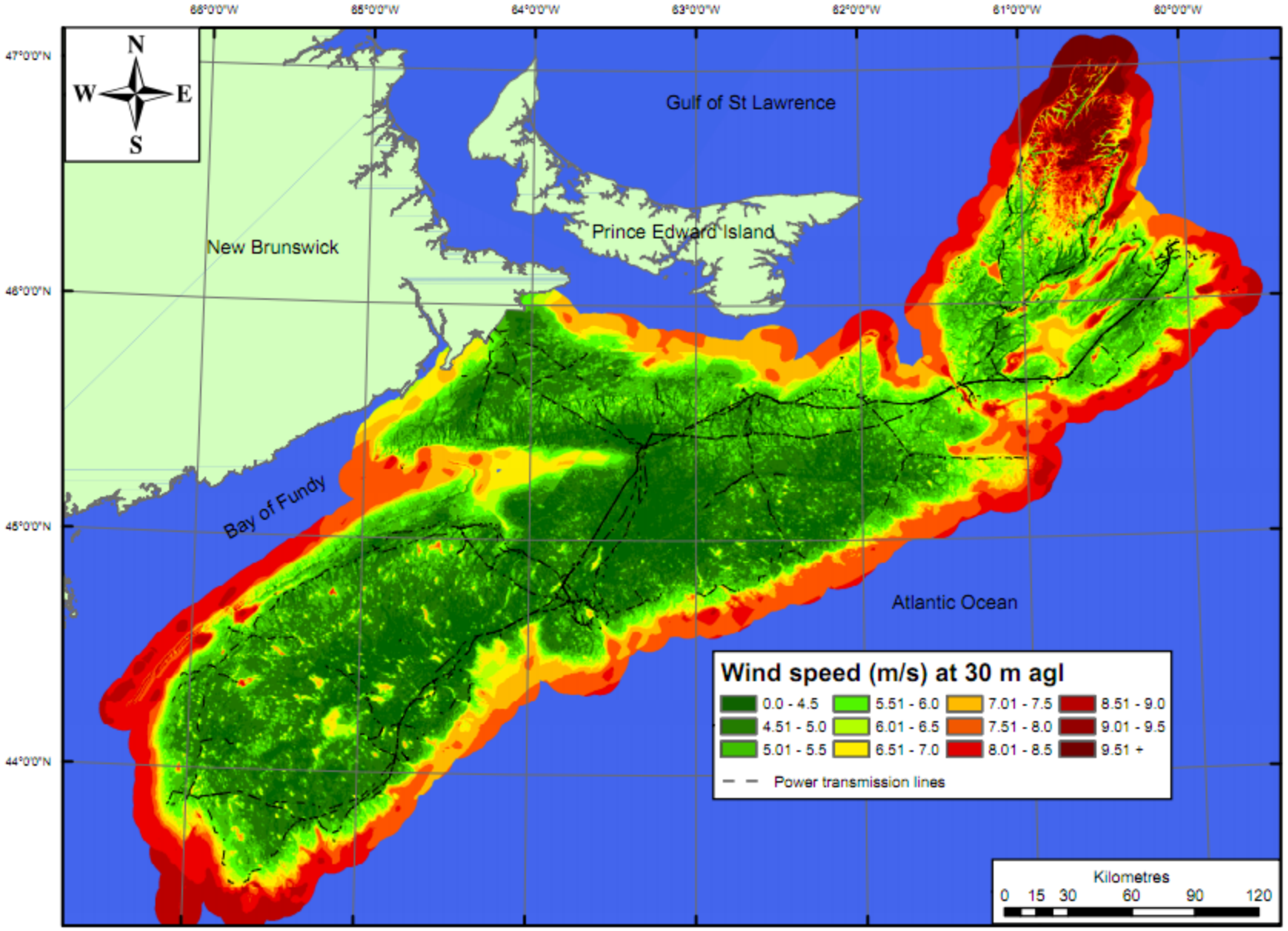
Energy efficiency has reduced Nova Scotia's annual need for electricity by **6.6%**

Energy efficiency has prevented carbon dioxide emissions equivalent to taking **130,000** cars off the road.

NOVA SCOTIA
NOUVELLE-ÉCOSSE
Energy
Énergie

Wind Resource Map of Nova Scotia (30 m)

http://www.nswindatlas.ca



Projection: NAD 1983 UTM Zone 20N

Date: September 18, 2007

nscc

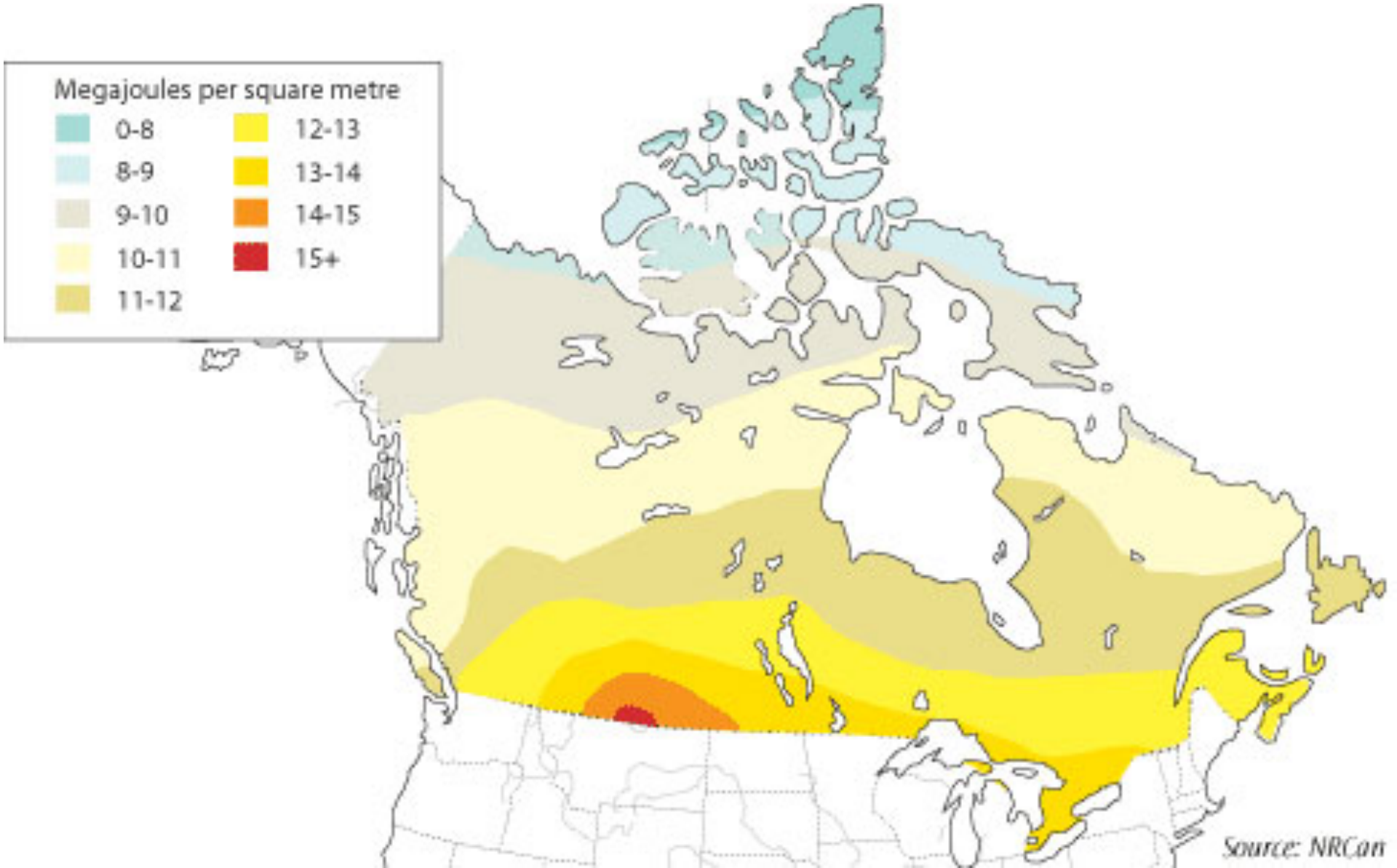
This map describes the wind resource of the Province of Nova Scotia at the elevation indicated above the ground level (agl) at a resolution of 200 m based on the Canadian Wind Energy Atlas (2004) data at 5 km resolution (www.windatlas.ca) and Anemoscope 1.5.5 model. Although it is believed to represent an accurate overall picture of the wind resource, estimates

René Thibault and Yves Gagnon
K. C. Irving Chair in Sustainable Development
Université de Moncton

David Colville and Steven Bird

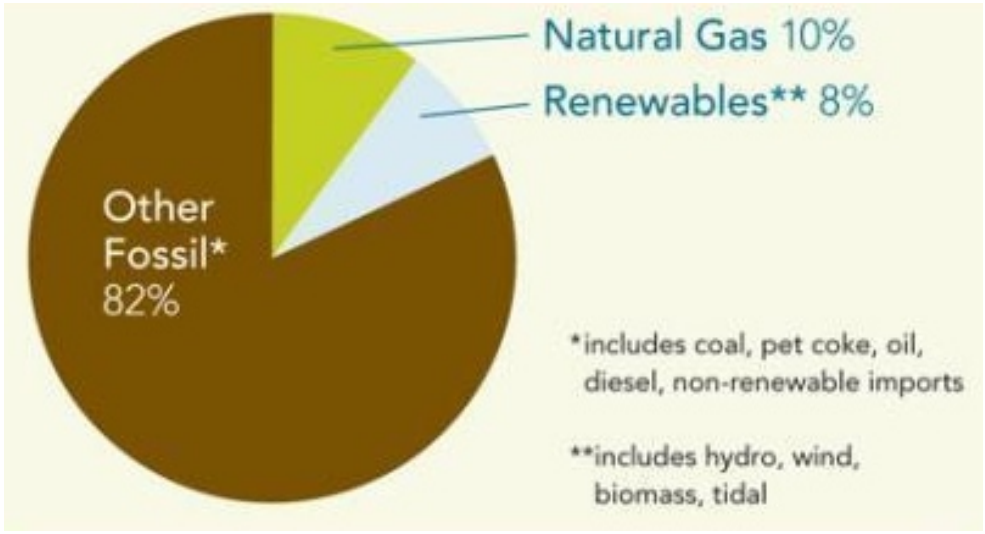
UNIVERSITÉ DE MONCTON
EDMUNDSTON MONCTON SHIPPAGAN

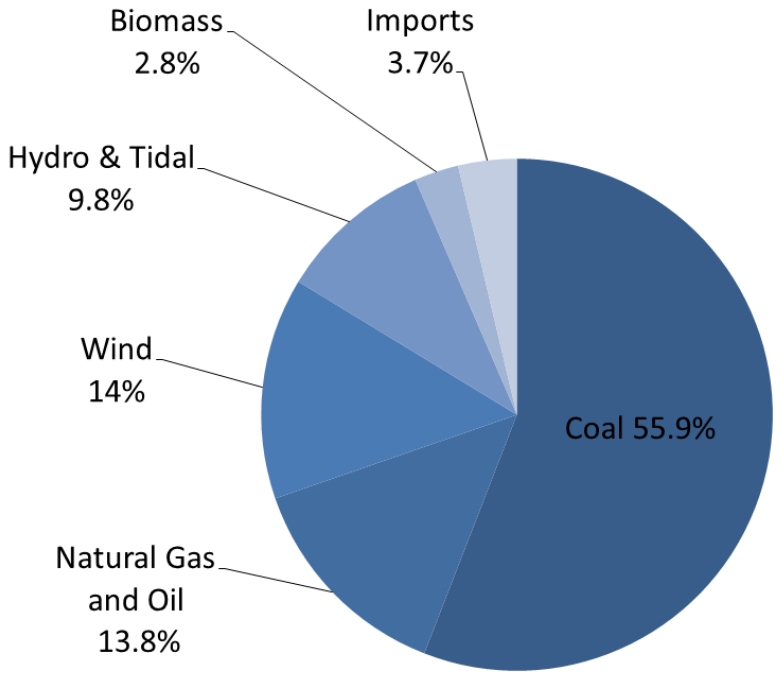
Average Annual Daily Solar Radiation in Canada



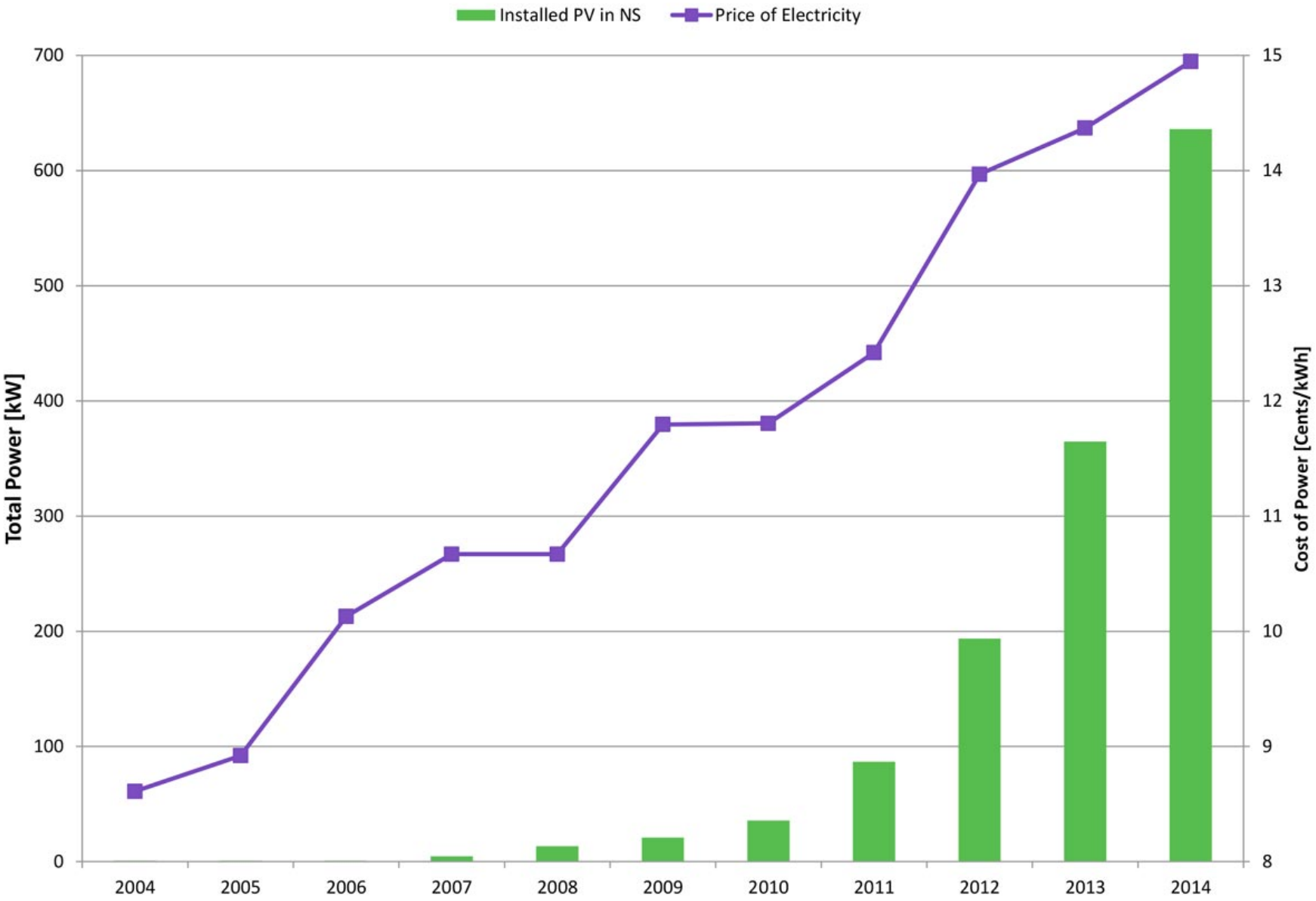

Interpretive Centre
Open 10am - 6pm
Annapolis Tidal
Generating Station
NORTH AMERICA'S ONLY TIDAL POWER PLANT
RENEWABLE ENERGY SINCE 1984
energy everywhere.
NOVA SCOTIA
POWER
An Emera Company

Nova Scotia Electricity: 2001 vs 2015





Cumulative Power Capacity of Grid-Tied PV Systems in Nova Scotia



Source: NSP 2014 Net-Metering Submission to NS-UARB

The Benefits of the Community Feed-In Tariff Program

Economic

- 5-10x the local benefits
- $1 invested = 3x multiplier within community
- Geographic distribution of industry
- Less reliant on energy imports
- More predictable energy costs
- Promotes NS industry
- Provides jobs

Social

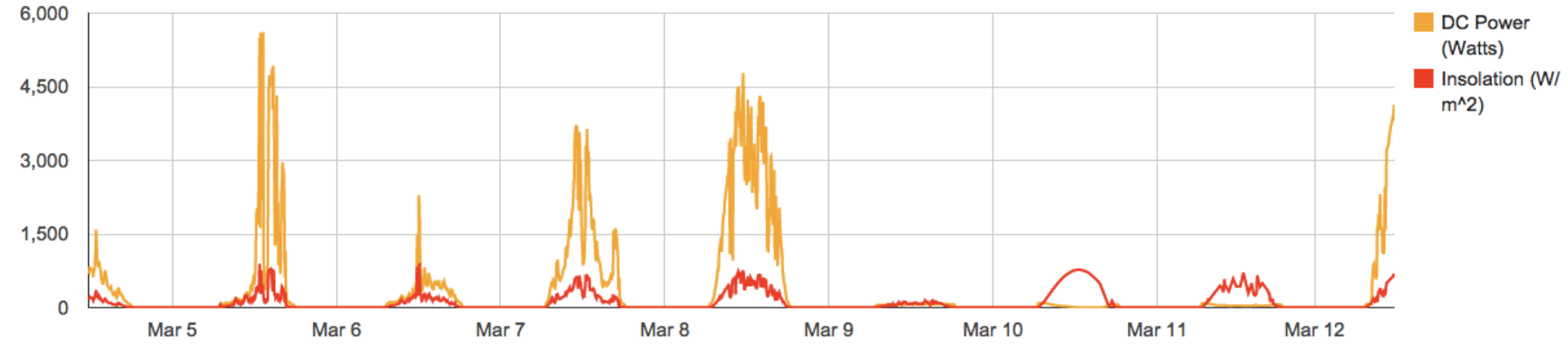
- Empowers the local level
- Promotes sustainability initiatives
- Encourages "Socially Responsible Investing"
- Employment and investment in communities
- Spur more local investment
- Utilize community-based expertise

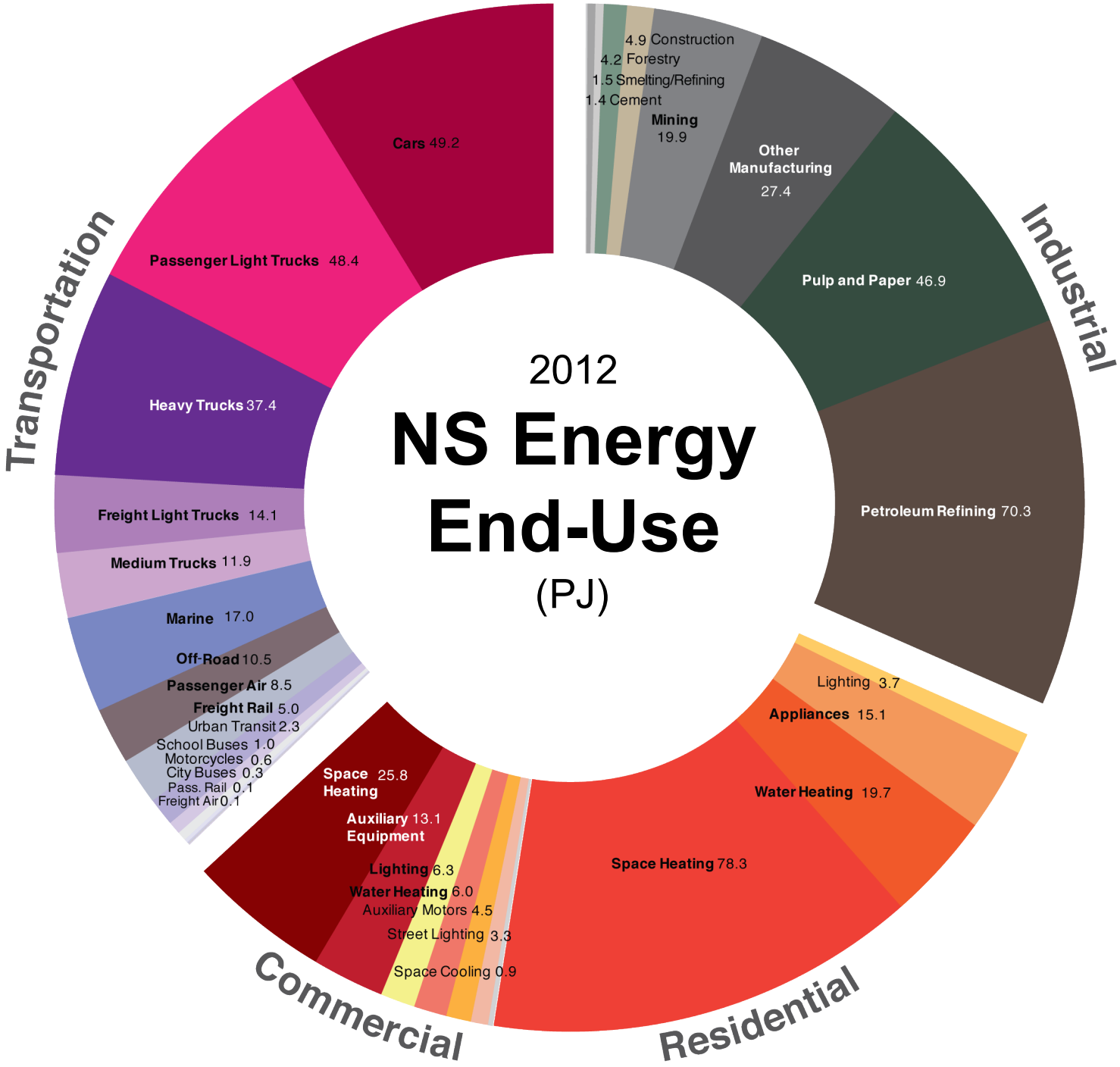
Environmental

- Offset use of fossil fuels, including coal
- Reduce GHG emissions
- Cleaner technologies implemented in NS
- Diversified supply of energy
- Electrical grid efficiency
- Potential to produce 100MW of renewable electricity by 2020

Image: NSDOE

Applied Energy Research Solar Data




2012
NS Energy End-Use
(PJ)
Transportation
Cars 49.2
Passenger Light Trucks 48.4
Heavy Trucks 37.4
Freight Light Trucks 14.1
Medium Trucks 11.9
Marine 17.0
Off-Road 10.5
Passenger Air 8.5
Freight Rail 5.0
Urban Transit 2.3
School Buses 1.0
Motorcycles 0.6
City Buses 0.3
Pass. Rail 0.1
Freight Air 0.1
Industrial
4.9 Construction
4.2 Forestry
1.5 Smelting/Refining
1.4 Cement
Mining 19.9
Other Manufacturing 27.4
Pulp and Paper 46.9
Petroleum Refining 70.3
Commercial
Space Heating 25.8
Auxiliary Equipment 13.1
Lighting 6.3
Water Heating 6.0
Auxiliary Motors 4.5
Street Lighting 3.3
Space Cooling 0.9
Residential
Lighting 3.7
Appliances 15.1
Water Heating 19.7
Space Heating 78.3

Applied Energy Research

Dartmouth Waterfront Campus,
Centre for the Built Environment

Data Analytics for Energy Management

Measurement to better manage energy systems

Smart Electricity Grids

Smart grids add intelligent control + communication, and distributed generation and energy storage.

Getting ‘Smarter’

2014-19 NSERC CCIE: EnergyDATA $2.2 million /5 yr

Energy Analytics, Product Development, and Testing

Smarter Buildings

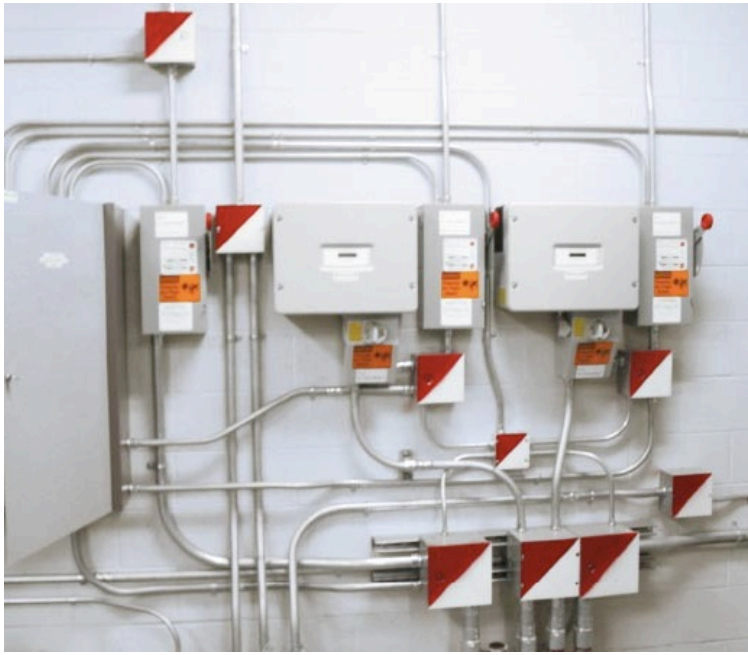
Integrating systems

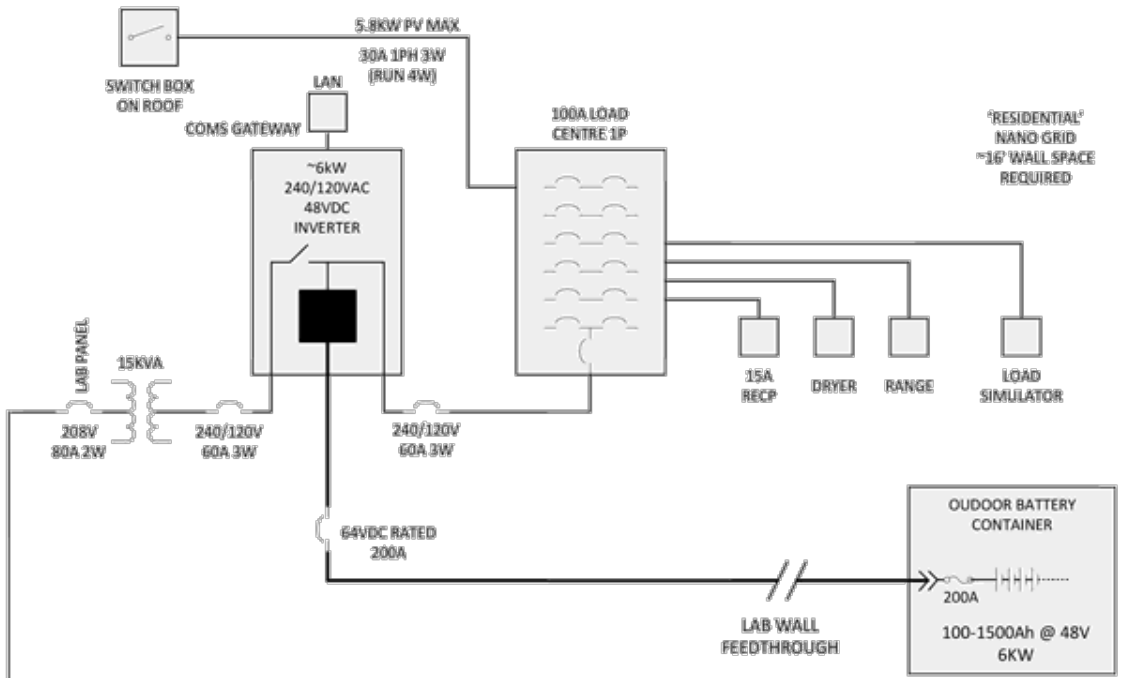
Hardware meets IT

Solving real problems

Micro+Nanogrid

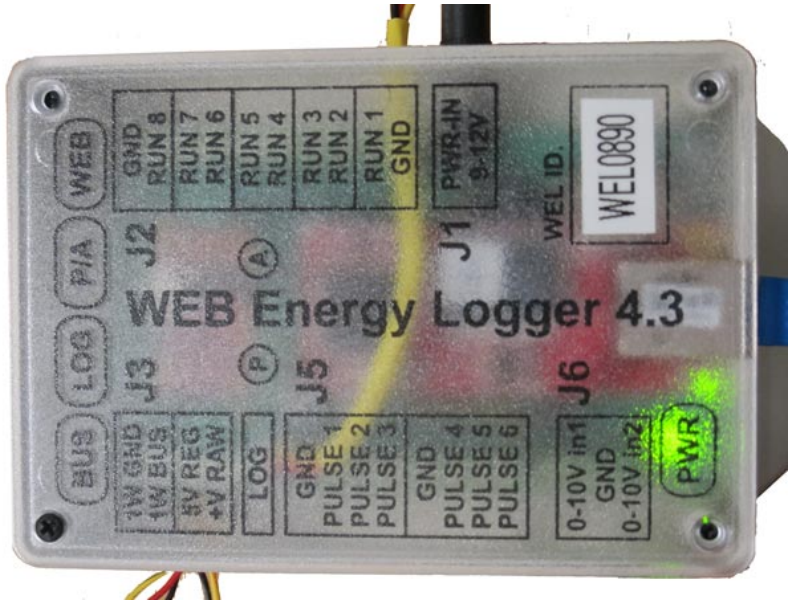
- Grids within grids
- Islanded & interconnected
- R&D test environment

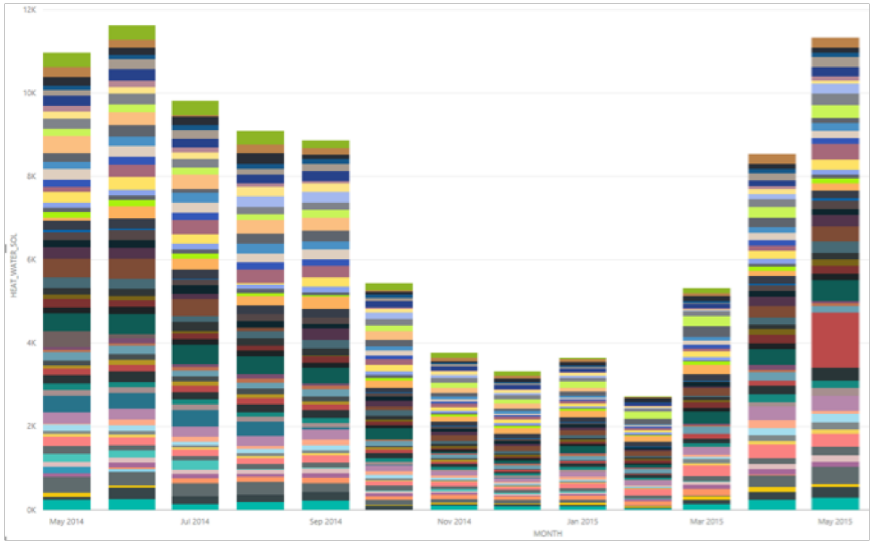




Solar Analytics

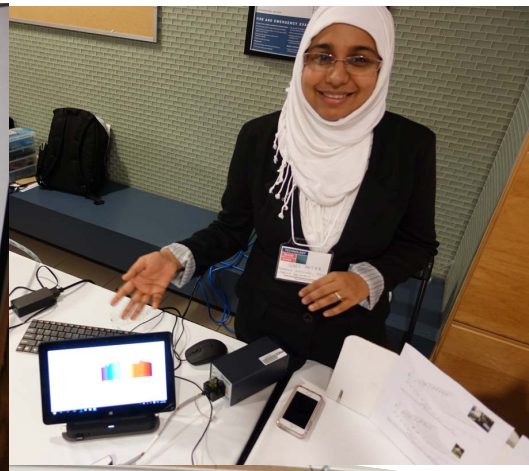
Adding Intelligence to existing products and services.





Monthly solar energy delivered to auxiliary heaters for a sample group of installations.

Education is the key…



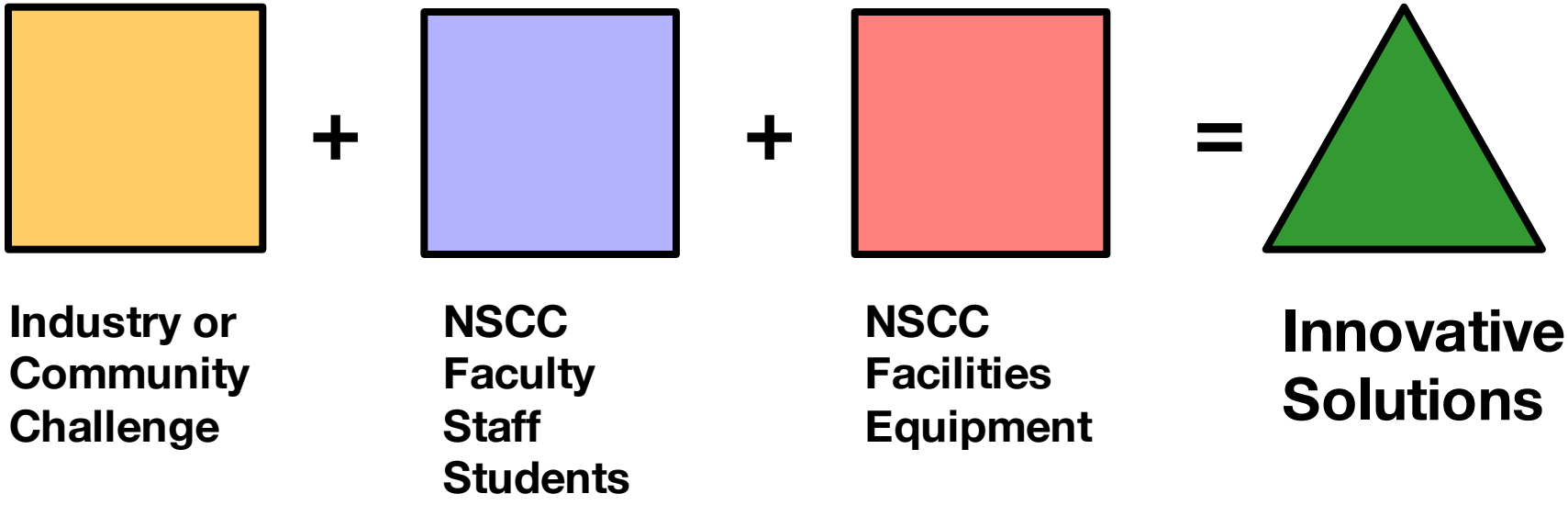
Research **A**s a **F**orm of **T**eaching

RAFT Places students in direct contact with:

a) Subject matter and b) A problem to solve

Creates opportunities for:

Idea-expression, Innovation, Reflection




ITT Bell & Gossett

NSCC campus a model of sustainability

A living laboratory gives students hands-on access to green technology

By Emily Goreham
Special Features Writer

Electrical engineering technology student Cory Manuel was inspired when he first saw the Centre for Built Environment at the Nova Scotia Community College's Waterfront campus.

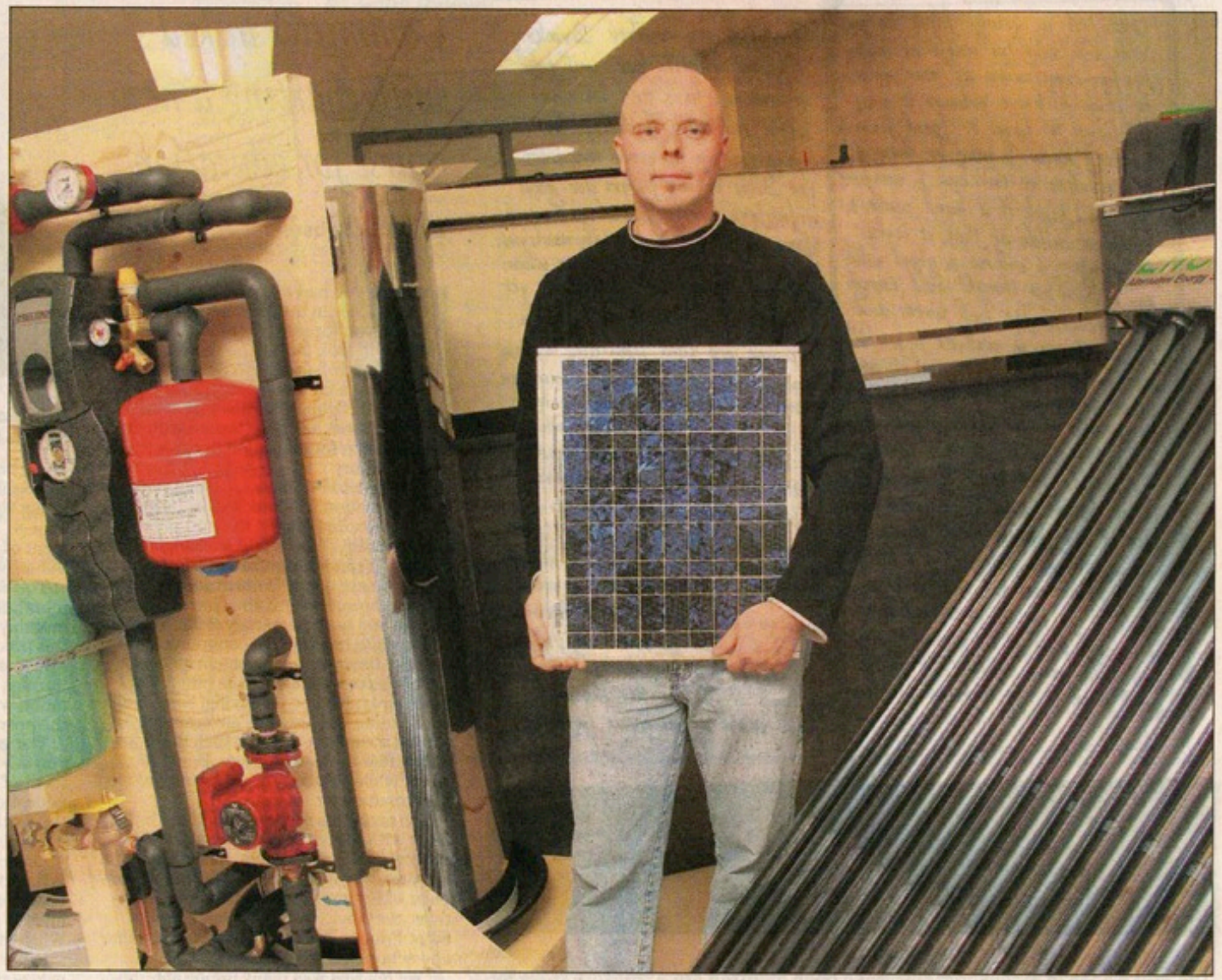
"Just walking in and seeing the wind turbines — it's the whole reason I went back to school."

Manuel, a self-employed Halifax electrician with almost 15 years experience, returned to school in September to focus on renewable energy and green construction technology. The Centre for Built Environment fit the bill perfectly.

"It's a beautiful building," he says of the centre, which is heated, cooled and ventilated by a system of solar and geothermal energy. Two interior walls are planted to filter the air. A planted roof, and the only exterior planted wall east of Vancouver and north of New York help control interior temperature and storm run-off.

The centre also features five kinds of wind turbines that supply electricity to the college, as well as a system of recycling and recovering water for heating and toilet flushing.

The sustainable energy features were initially more expensive



Bonnie Bobryk Photography

Cory Manuel was inspired when he first saw the Centre for Built Environment at the NSCC's waterfront campus.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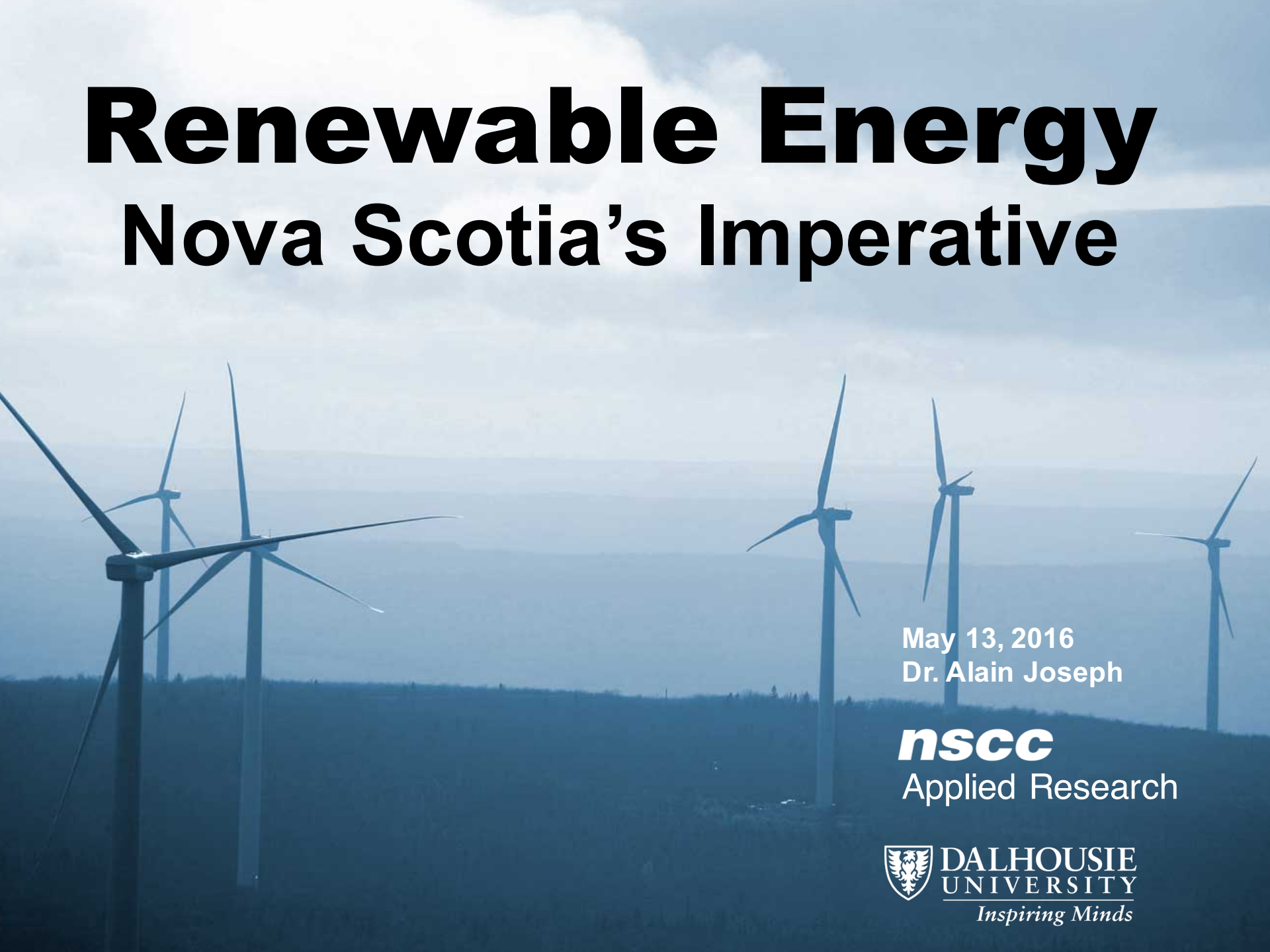

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Inspiring Minds