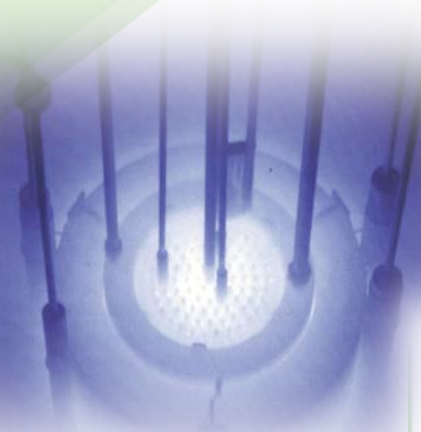
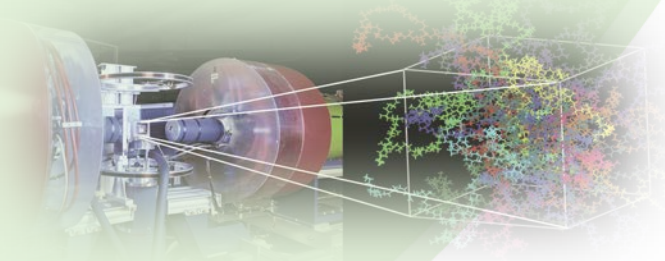


Nuclear; the other clean energy

Neil Alexander,
Executive Director



Medicine.
Materials.
Energy.
Environment.



PARIS2015

UN CLIMATE CHANGE CONFERENCE
COP21·CMP11

Nations Unies
Conférence sur les Changements Climatiques 2015

COP21/CMP11

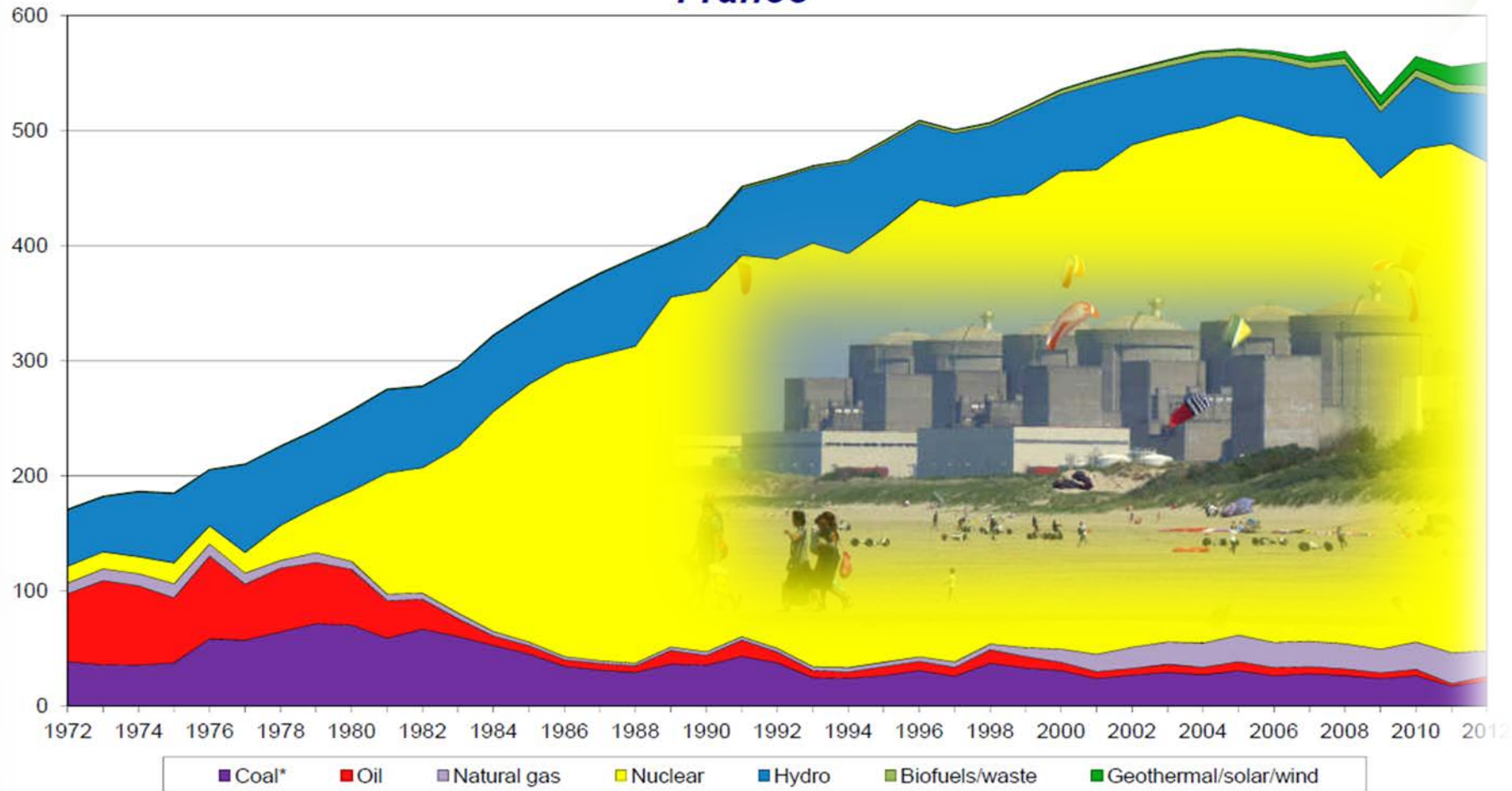
Paris, France





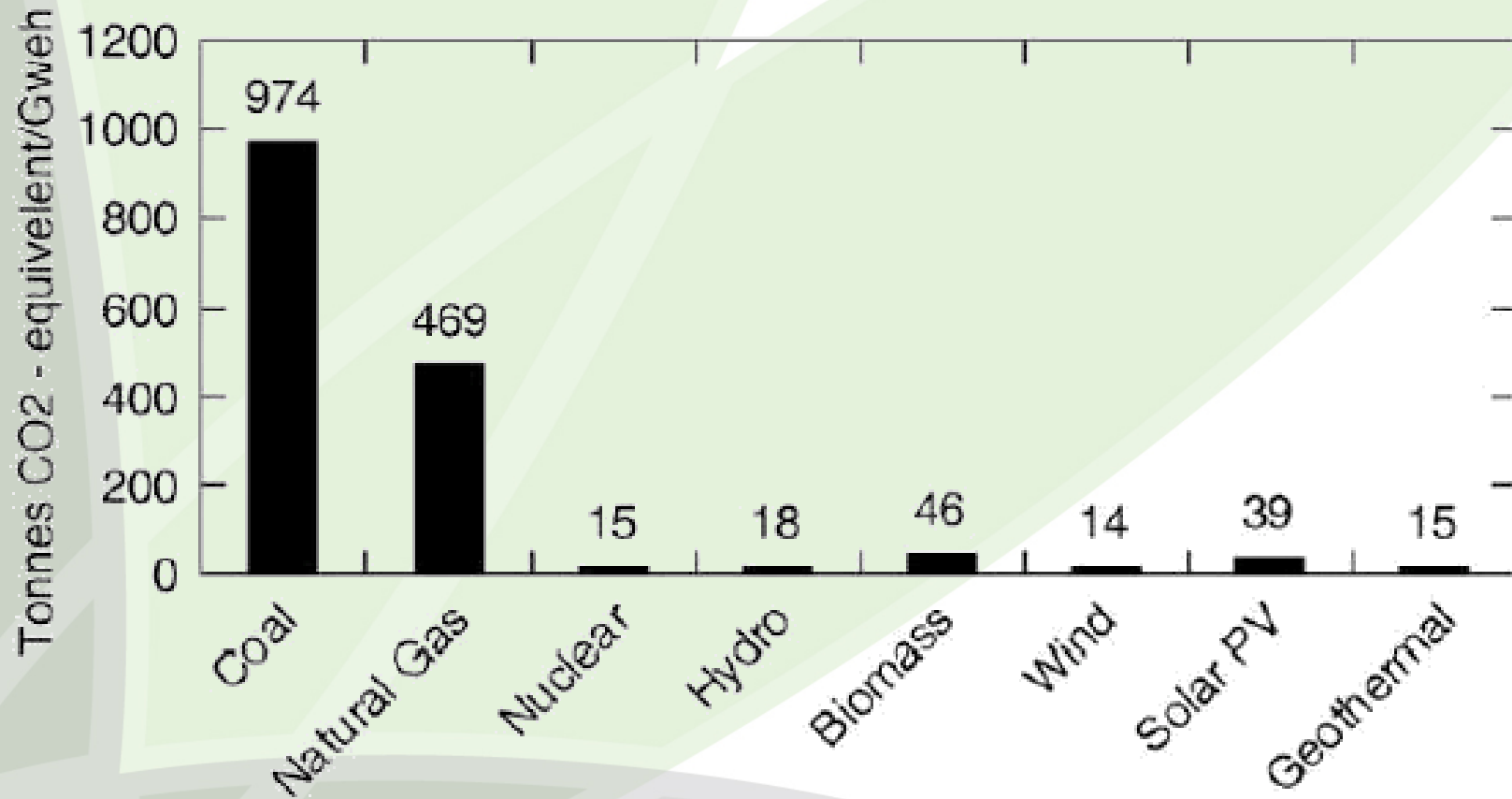
Electricity generation by fuel

France



* In this graph, peat and oil shale are aggregated with coal, when relevant.

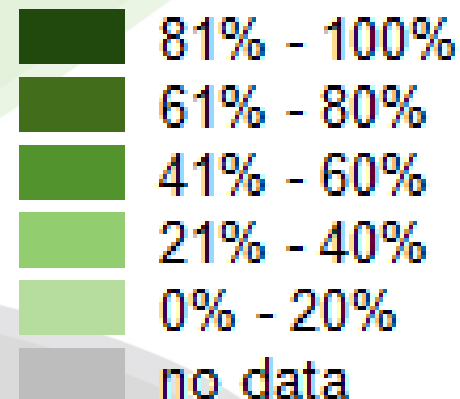
Lifecycle Emissions for Various Electricity Generation Technologies

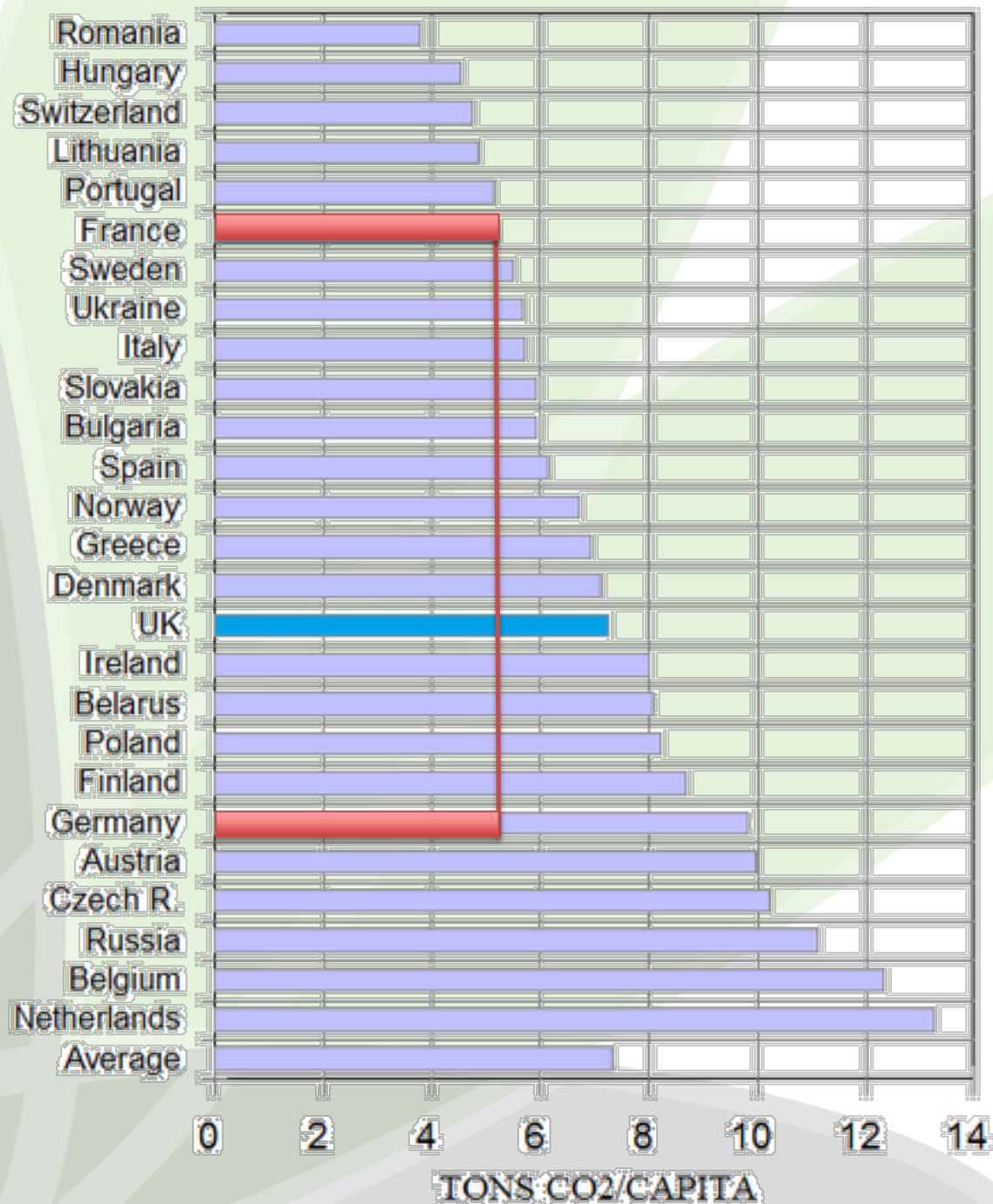


No-carbon electricity generation in Europe (2012)



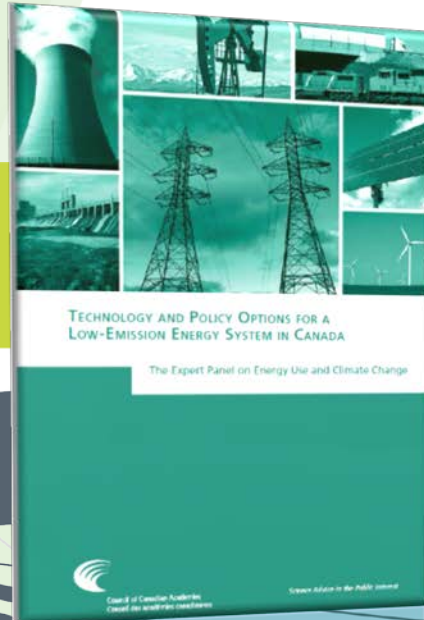
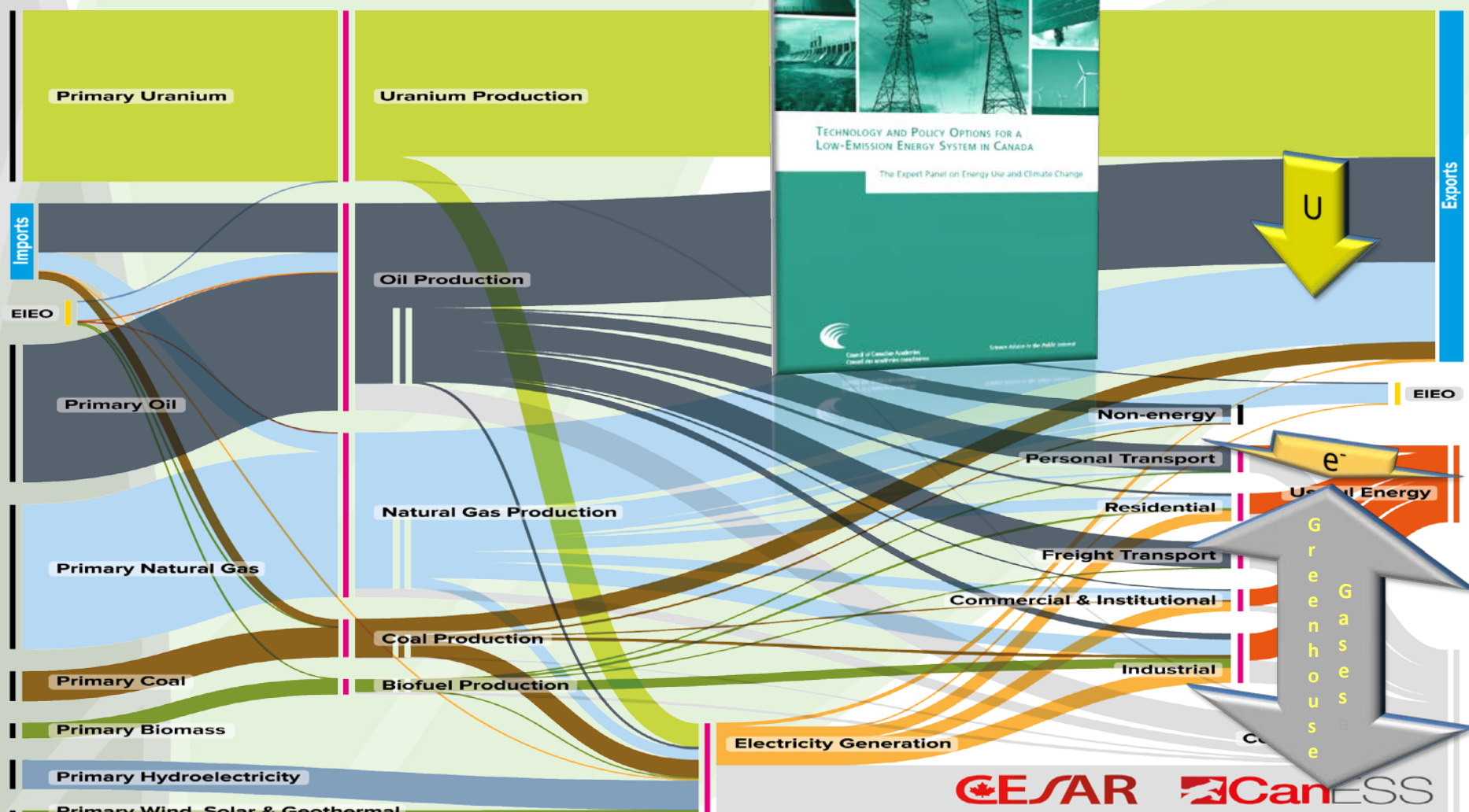
percent of no-carbon generation







Energy Flows in Canada showing the huge contribution Canada makes to the avoidance of greenhouse gas production.



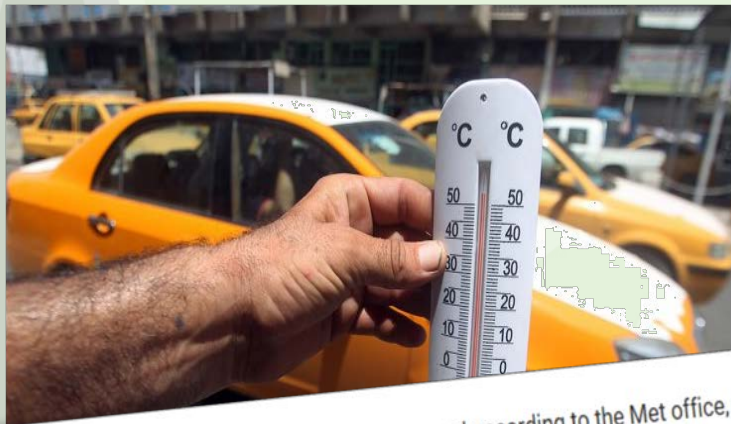
Do we have a problem?

Global warming: 2015 and 2016 will be hottest years ever as climate change grips Earth

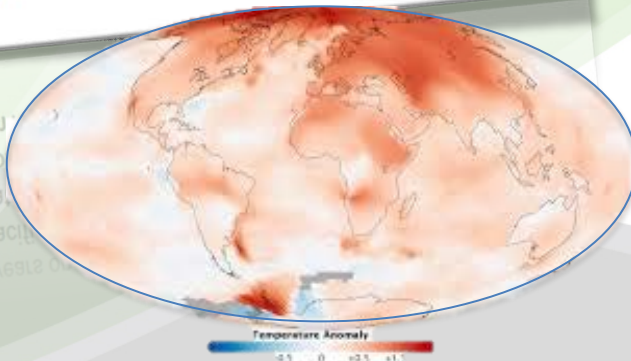


By Callum Paton

September 14, 2015 08:53 BST



2015 and 2016 could be the hottest years on record according to the Met office, as changes to climate systems, particularly in the Pacific and the Atlantic, increase the effects of global warming. The Earth's surface temperature already looks set to **break records for 2015** and is running well over the global average for 1981-2010. The predictions are in keeping with the Met office's forecast in 2014, the hottest on record, of temperatures looking set to increase.



WWF: Oceans turned into watery deserts as half of marine life wiped out in 40 years



By Sean Martin

September 16, 2015 12:14 BST



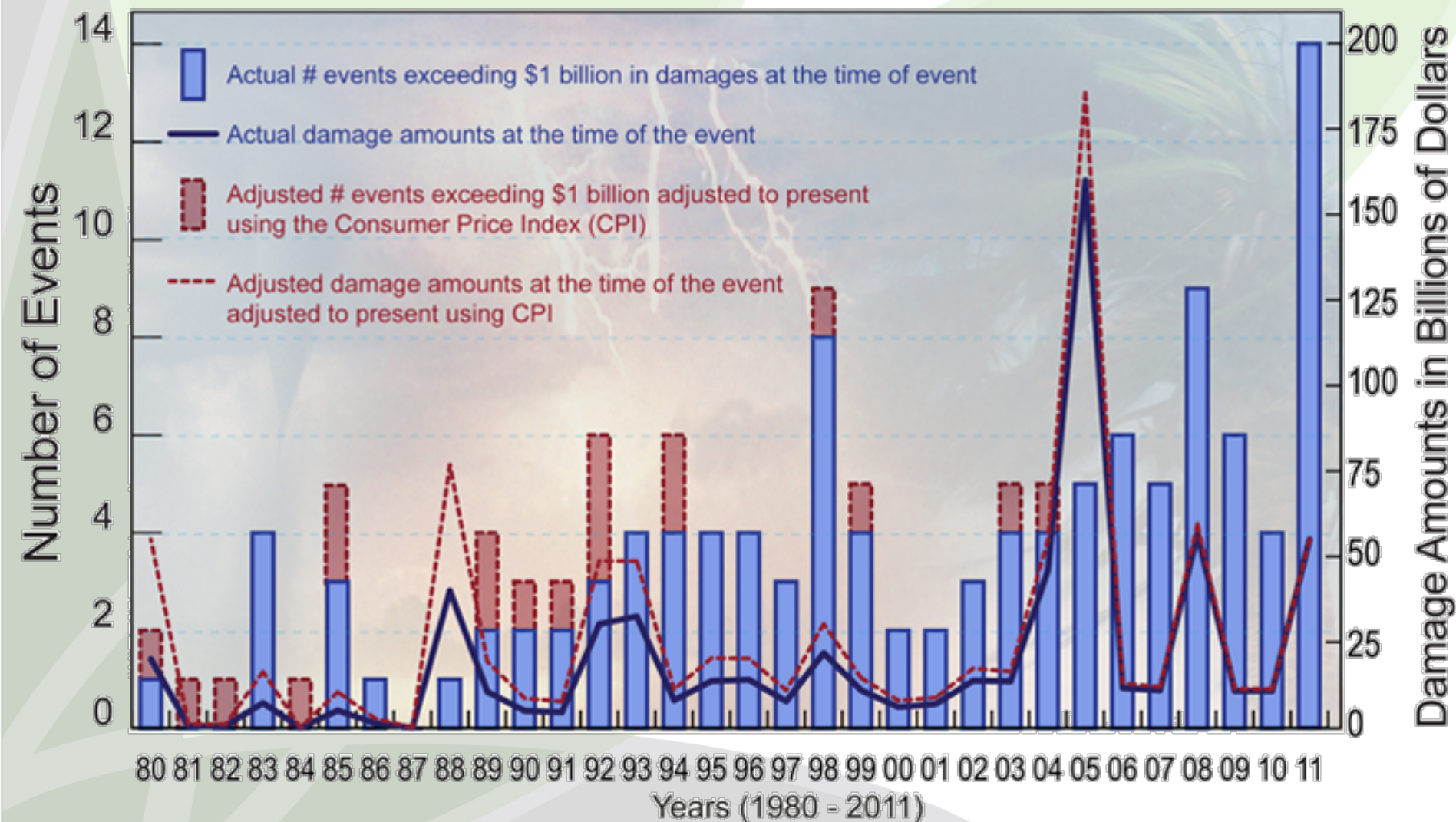
Climate change, pollution and over-fishing has devastated ocean life (André Kunzelmann/UfZ)

Climate change and human interference has taken its devastating toll on ocean life as 49% of marine populations have been wiped out in the past 42 years, according to a new report. The World Wildlife Fund (WWF) and Zoological Society of London study revealed that as global warming worsens and "over-exploiting fisheries" continues, the situation will only be exacerbated.

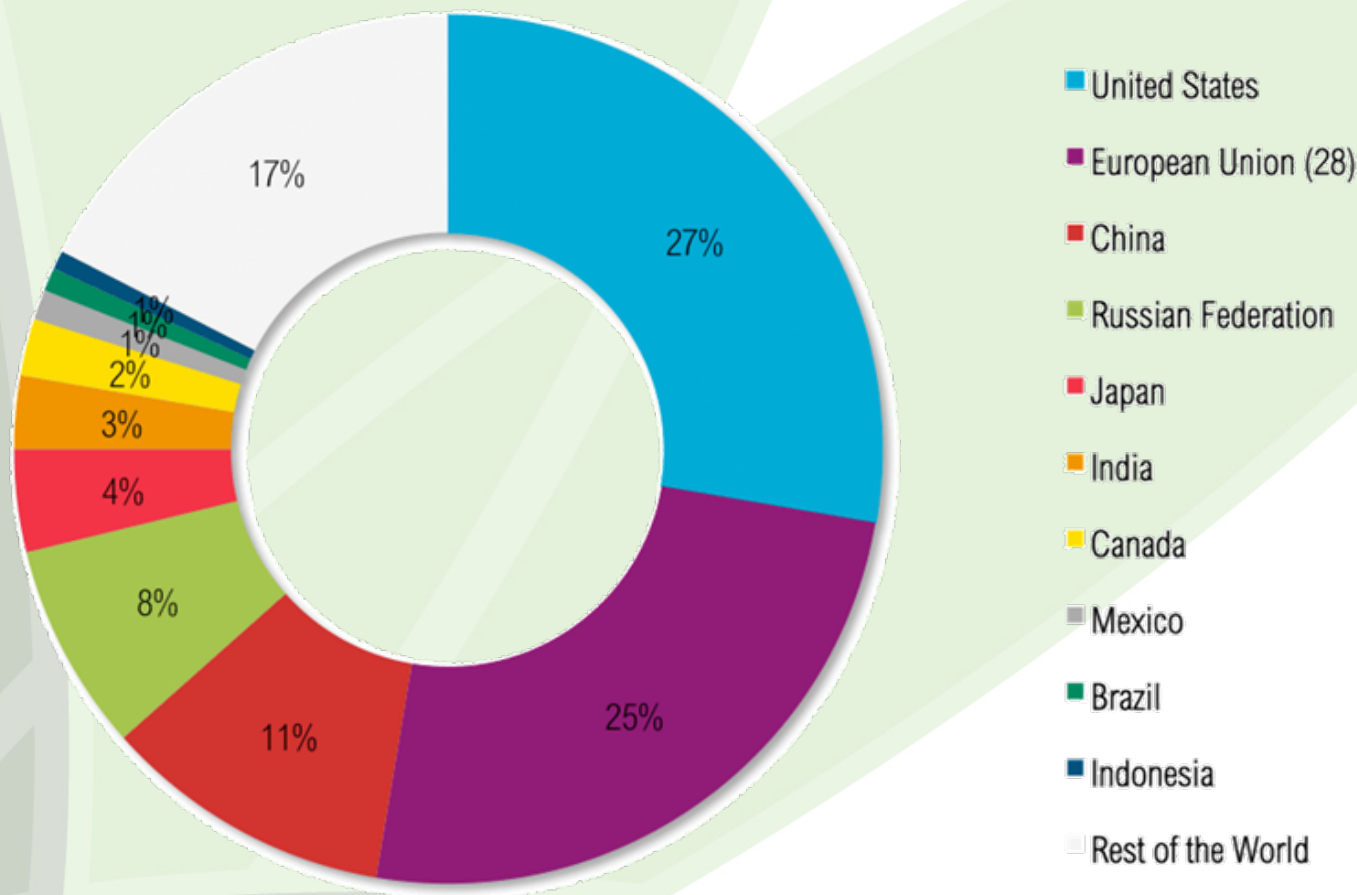
Yes we do !



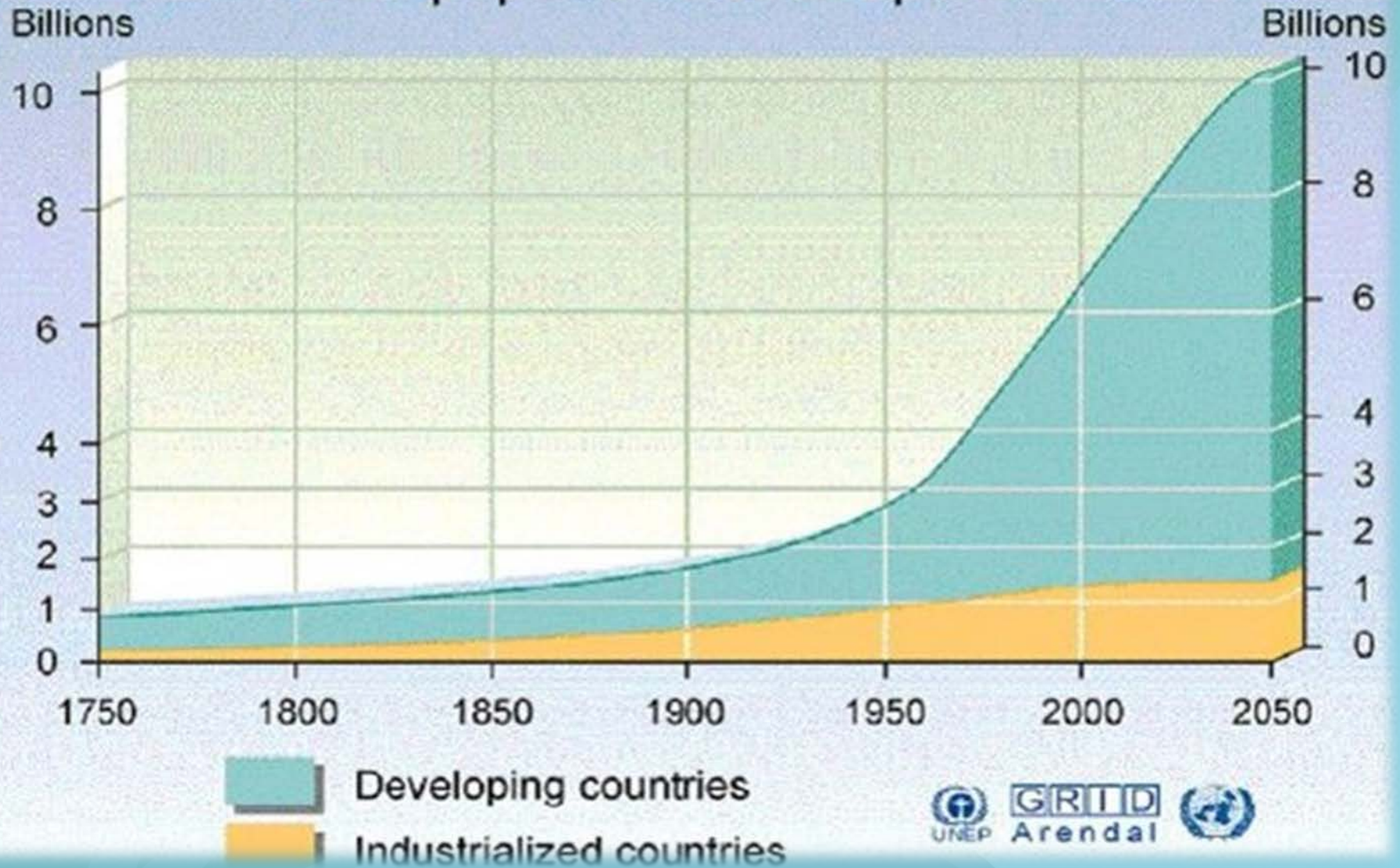
Billion Dollar Weather/Climate Disasters 1980 - 2011 NOAA/NESDIS/NCDC



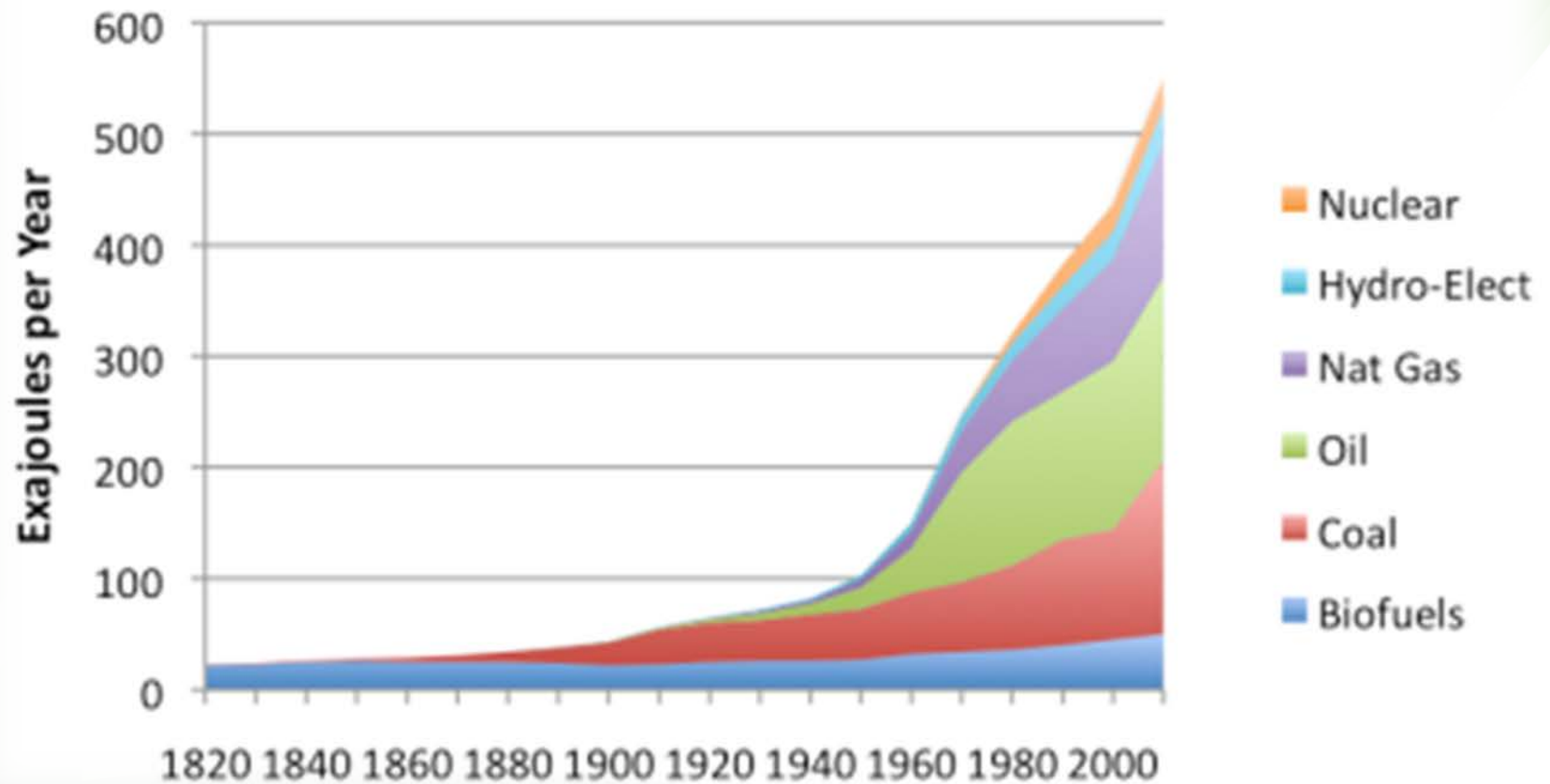
Cumulative CO₂ Emissions 1850–2011 (% of World Total)



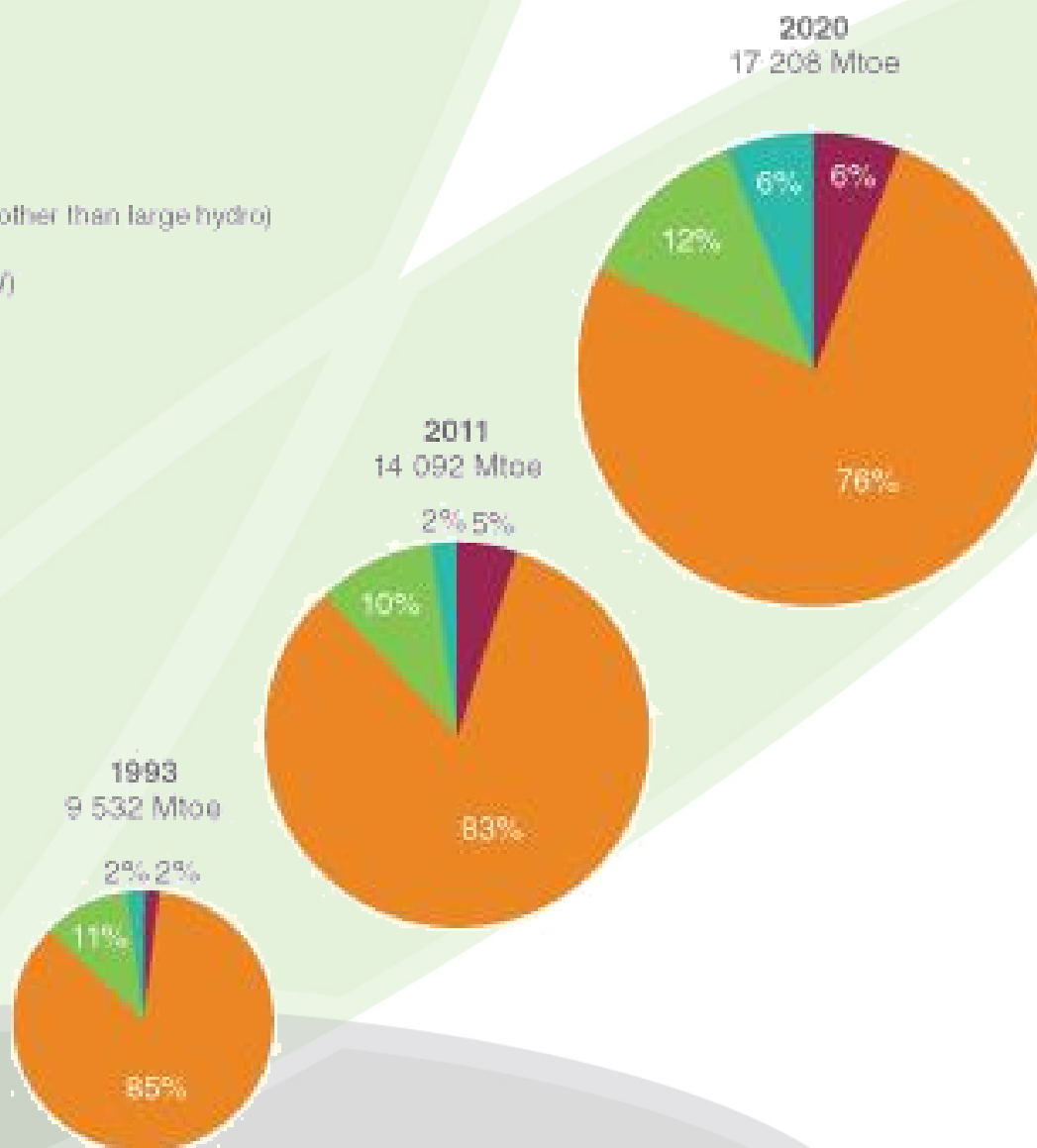
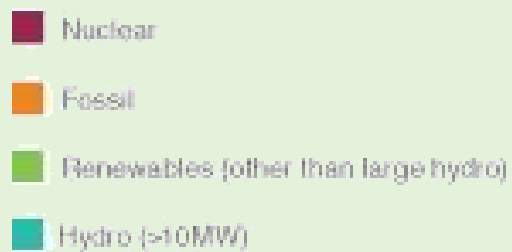
World population development



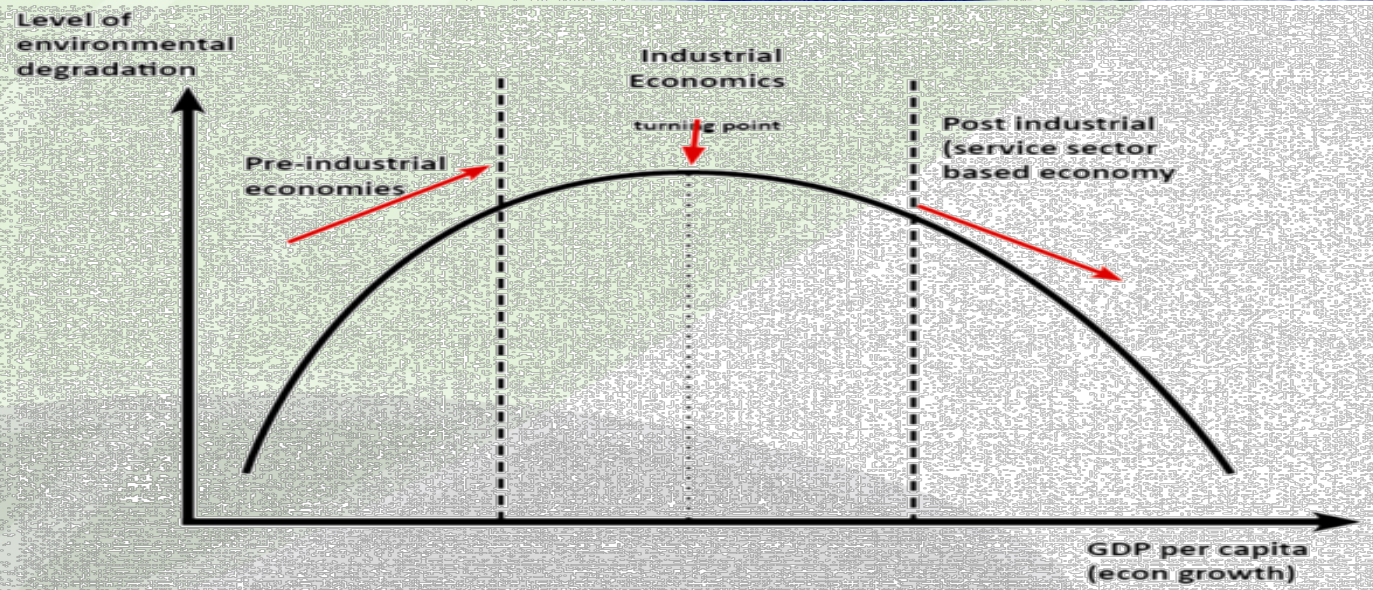
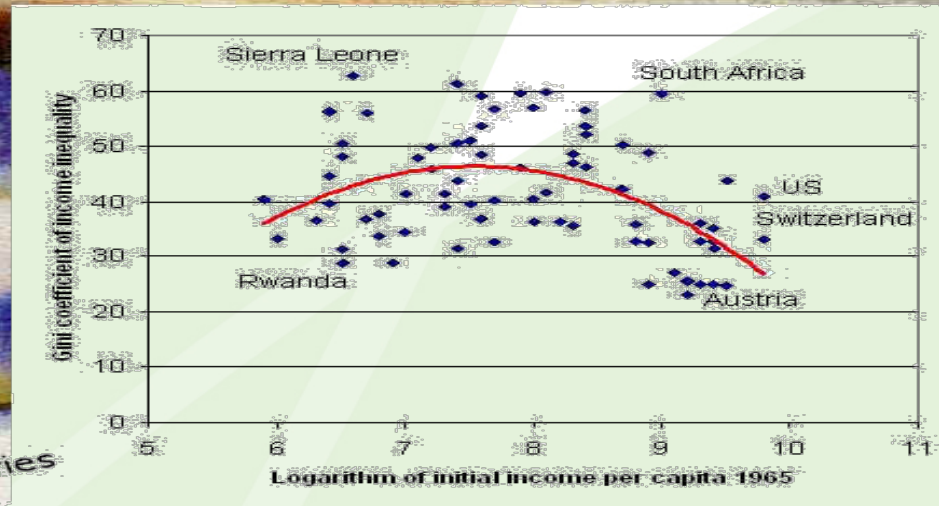
World Energy Consumption



Energy by source history and projected.



The Kuznets curve



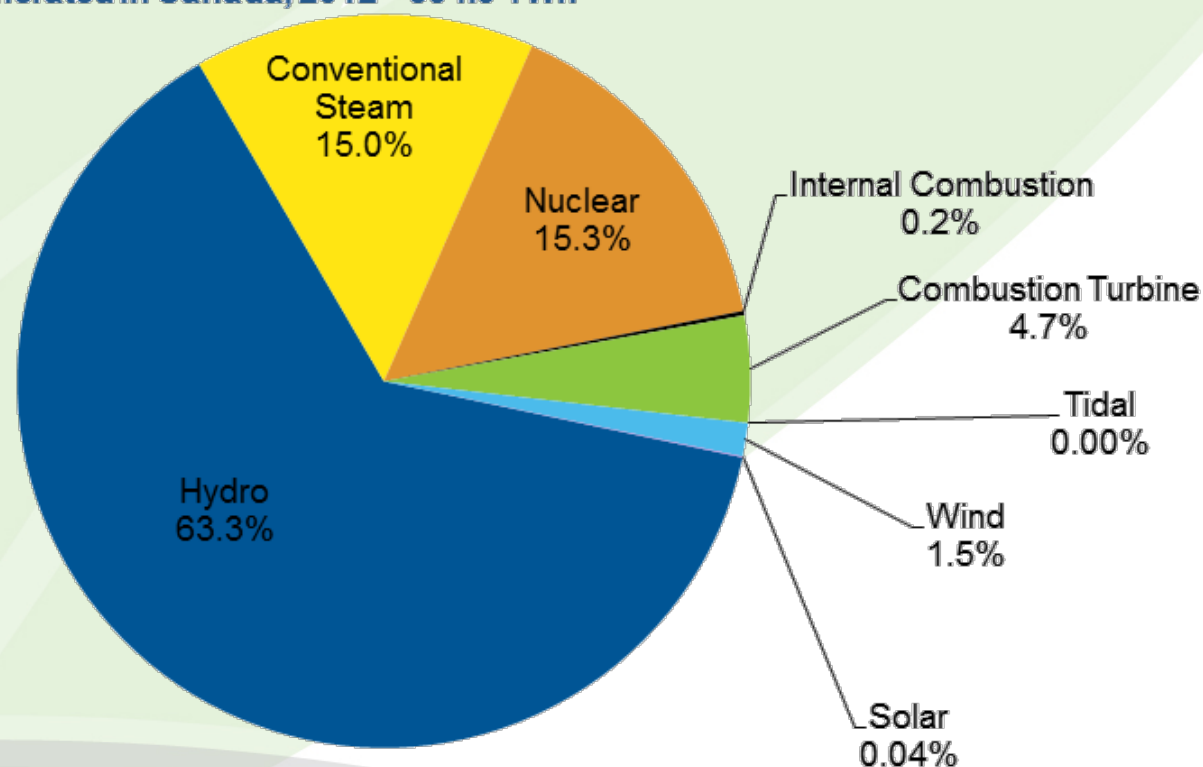






Electricity Generation in Canada by Fuel Type, 2012

Total Electricity Generated in Canada, 2012 = 594.9 TWh



*Numbers may not sum to 100 percent due to rounding.

Source: Statistics Canada, Survey 2151, 2012

Retrieved April 22, 2013

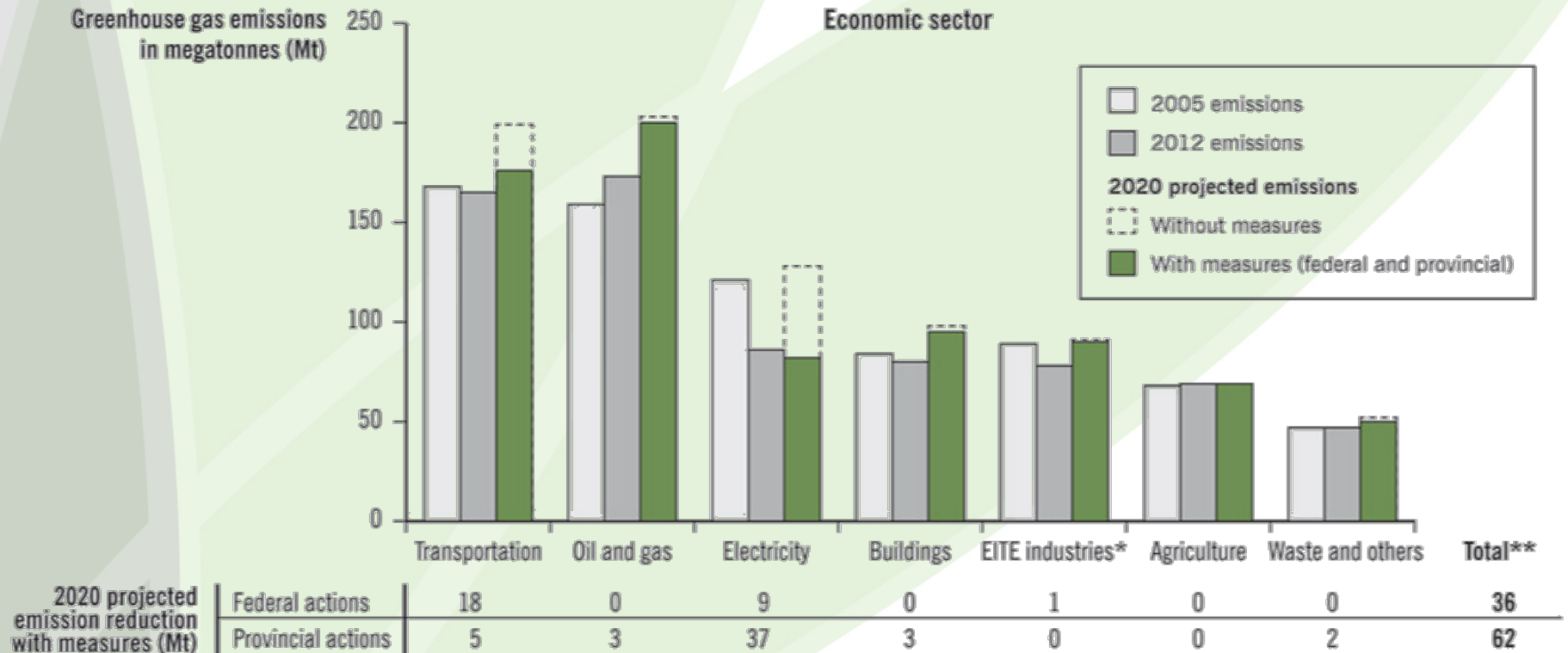


How the public think electricity is generated



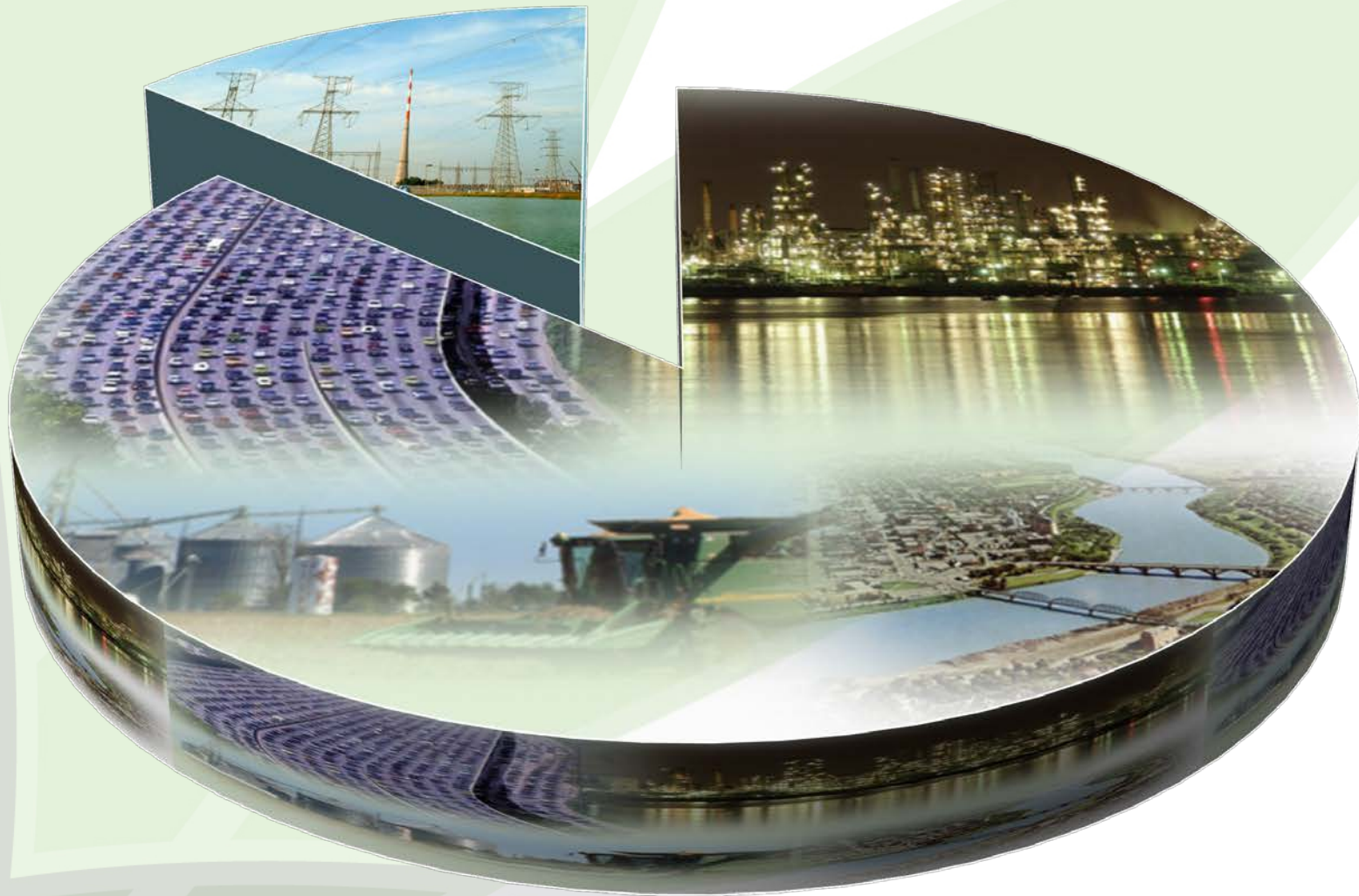
CANADA'S GREENHOUSE GAS EMISSIONS

Current federal measures are projected to have little effect on Canada's emissions by 2020.

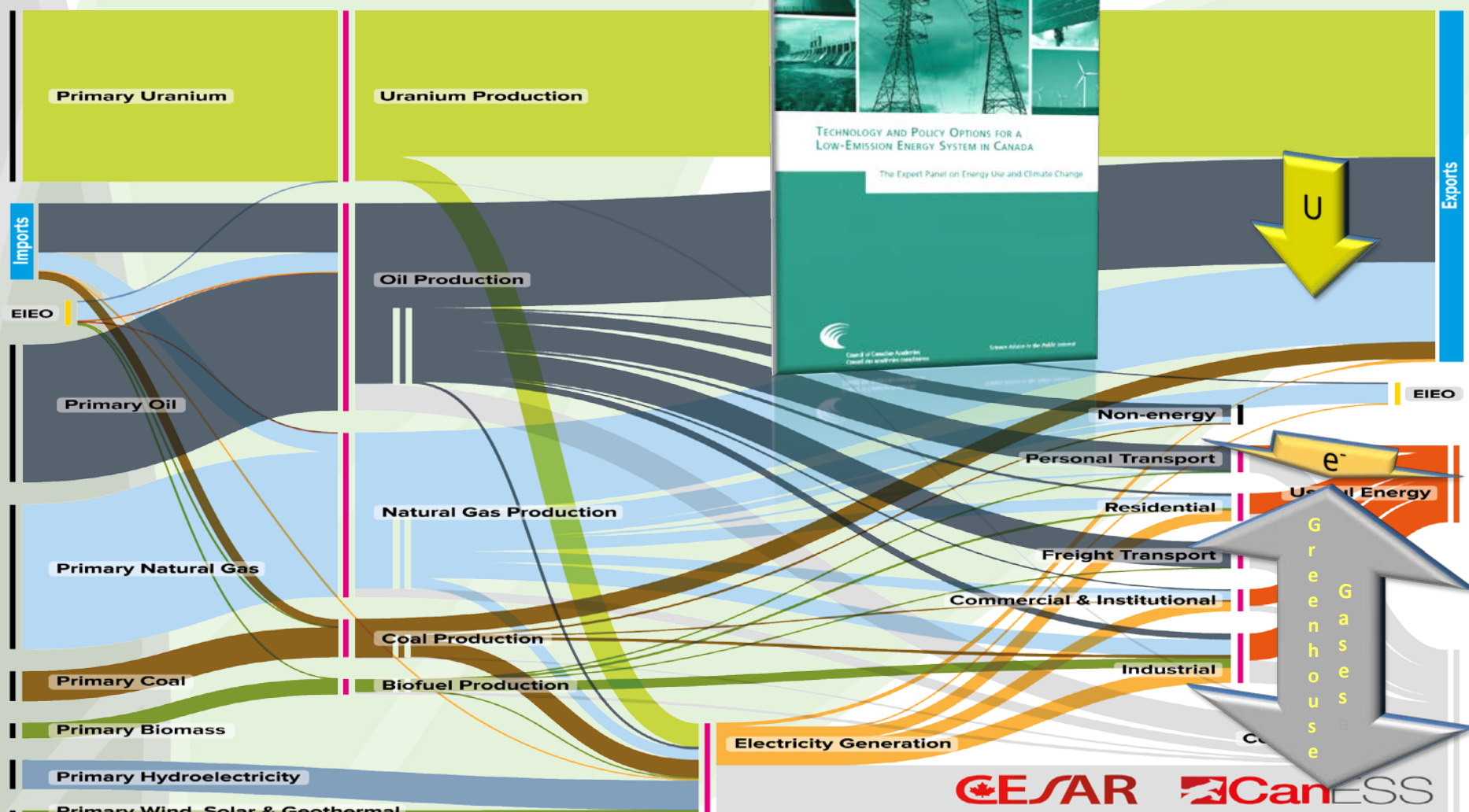


* EITE: emission-intensive trade-exposed industries ** Total emission reductions also include cross-cutting measures, which are estimated to be 8 Mt at the federal level, and 13 Mt at the provincial level. Cross-cutting measures are measures that affect more than one sector, such as the federal eco-efficiency programs or British Columbia's carbon tax.

Canadian CO2 production



Energy Flows in Canada showing the huge contribution Canada makes to the avoidance of greenhouse gas production.



Energy flows

Crude oil	Natural gas	Coal
Hydroelectricity	Uranium	End-use energy
Renewable energy	Electricity	Conversion losses

Processes

Primary energy	Imports & exports
Harvesting and conversion	Energy in for energy out (EIEO)



Creating a safe,
sustainable, scalable
energy solution.

[Learn More »](#)



Credit: TED / James Duncan Davidson

TerraPower aims to develop a sustainable and economic nuclear energy technology using:

- Next-generation safe, affordable, clean and secure technologies
- Advanced materials for more durable metallic fuels
- World-class leadership for dynamic reactor engineering and innovation
- Supercomputing for reliable and comprehensive modeling



CAREERS

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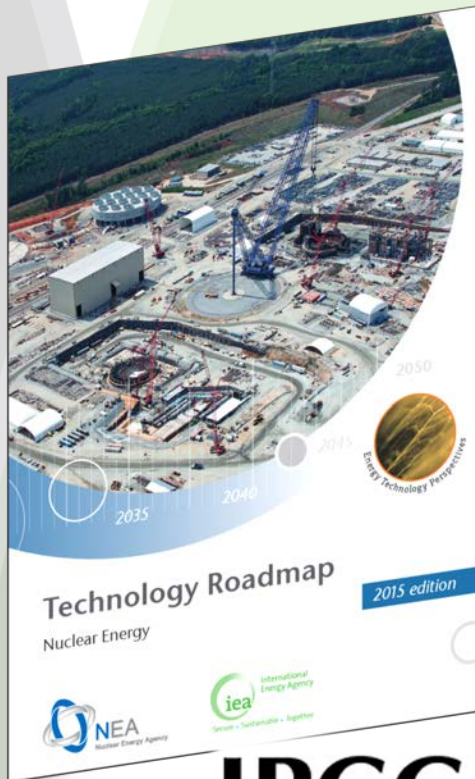
SUPPLIERS

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TERRAPOWER UPDATES

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IPCC
INTERGOVERNMENTAL
PANEL ON
CLIMATE CHANGE



"The life cycle GHG emissions per kWh from nuclear power plants are two orders of magnitude lower than those of fossil-fuelled electricity generation and comparable to most renewables ... Hence it is an effective GHG mitigation option, especially by way of investments in the lifetime extension of existing plants."

Key findings:

- Nuclear power is the largest source of low-carbon electricity in OECD countries and second at global level. Nuclear can play a key role in lowering emissions from the power sector, while improving security of energy supply, supporting fuel diversity and providing large-scale electricity at stable production costs.
- In the 2D scenario, global installed capacity would need to more than double from current levels of 396 GW to reach 930 GW in 2050, with nuclear power representing 17% of global electricity production.



Image courtesy of CNN

MIT Atmospheric Scientist Kerry Emanuel—along with climate and energy scientists James Hansen, Ken Caldeira, and Tom Wigley—released an open letter Sunday calling on world leaders to support development of safer nuclear power systems.

"... there is no credible path to climate stabilization that does not include a substantial role for nuclear power."

News story

5 reasons why we are backing Hinkley Point C

From: Department of Energy & Climate Change
First published: 12 March 2016
Part of: Climate change international action and UK energy security

5 reasons why we are backing Hinkley Point C, as part of our plan to tackle a legacy of under-investment in the UK's energy infrastructure and build a system fit for the 21st century.



- New nuclear is the only proven low carbon technology that can provide continuous power, irrespective of whether the wind is blowing and the sun is shining, giving hardworking families and businesses year-round energy security.
- Hinkley will give a boost to our energy supply and our economy, bringing in billions of pounds of investment into the UK and creating 25,000 jobs during construction. This is about British security and British jobs.
- Hinkley will power close to six million homes, twice as many as the whole of London, for nearly 60 years, providing 7% of UK electricity. There is no question that new nuclear is cost competitive. Offshore wind cleared at over £110 / MWh in the last auction for renewables. New gas could cost around £65 / MWh and new nuclear has all the advantages of providing low carbon, baseload power for decades. In addition, we're getting 60 years of power from Hinkley but we're only paying for 35.
- Hinkley will be safe. It will need to comply with the UK's robust nuclear regulations (overseen by the independent Office for Nuclear Regulation) – one of the most stringent and safest in the world.
- Hinkley will be a significant step forward in our transition to a low-carbon future, a milestone in our efforts to reduce emissions and to meet our climate change commitments in the most cost-effective way.

Share this page



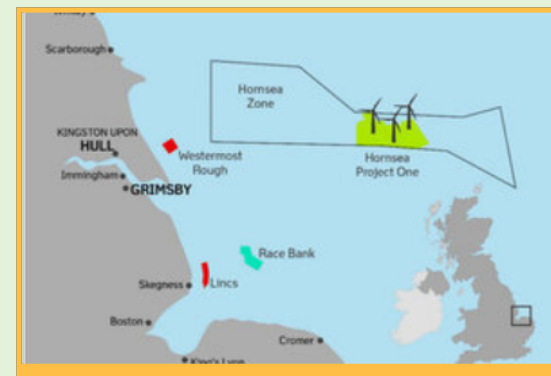
From:

Department of Energy & Climate Change

Published:

12 March 2016

- ✓ Only proven continuous power low carbon technology
- ✓ Jobs
- ✓ Cost competitive
- ✓ Safe
- ✓ Achieves climate change objectives



3 February 2016 — News story

World's largest offshore wind farm to be built in the UK

DONG Energy confirms a positive Final Investment Decision for Hornsea One offshore windfarm off the coast of Grimsby in Northern England

Stages of Development

Reactors
being built
today

Chernobyl

Three Mile Island
Fukushima

Generation IV

Revolutionary
Designs

Generation III+

Evolutionary Designs

Generation III

Advanced LWRs

Generation II

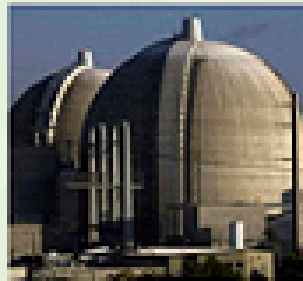
Commercial Power

Generation I

Early Prototypes



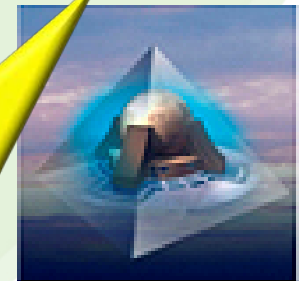
- Shippingport



- PWRs
- BWRs



- CANDU 5
- System 80
- AP600



- Safer
- Sustainable
- Economical
- More Proliferation Resistant and Physically Secure

Small Modular Reactors





Based in Corealis Oregon – but supply chain not established yet

Thermal capacity – 160 MWt

Electrical capacity – > 50MWe (gross)

Capacity factor – >95 percent

Dimensions – 80' x 15' cylindrical containment vessel module containing reactor and steam generator

Weight – ~ 650 tons as shipped from fabrication shop

Transportation – Barge, truck or train

Cost – Numerous advantages due to simplicity, off-the-shelf standard items, modular design, shorter construction times, <\$5,000/KW

Fuel – Standard LWR fuel in 17 x 17 configuration, each assembly 2 meters (~ 6 ft) in length; 24-month refueling cycle with fuel enriched less than 4.95 percent








STARCORE

NUCLEAR

- Montreal registered
- Triso fuelled High Temperature Gas (helium) Cooled Reactor
- 10MWe per unit
- Fuel remains intact at highest temperature if all coolant lost

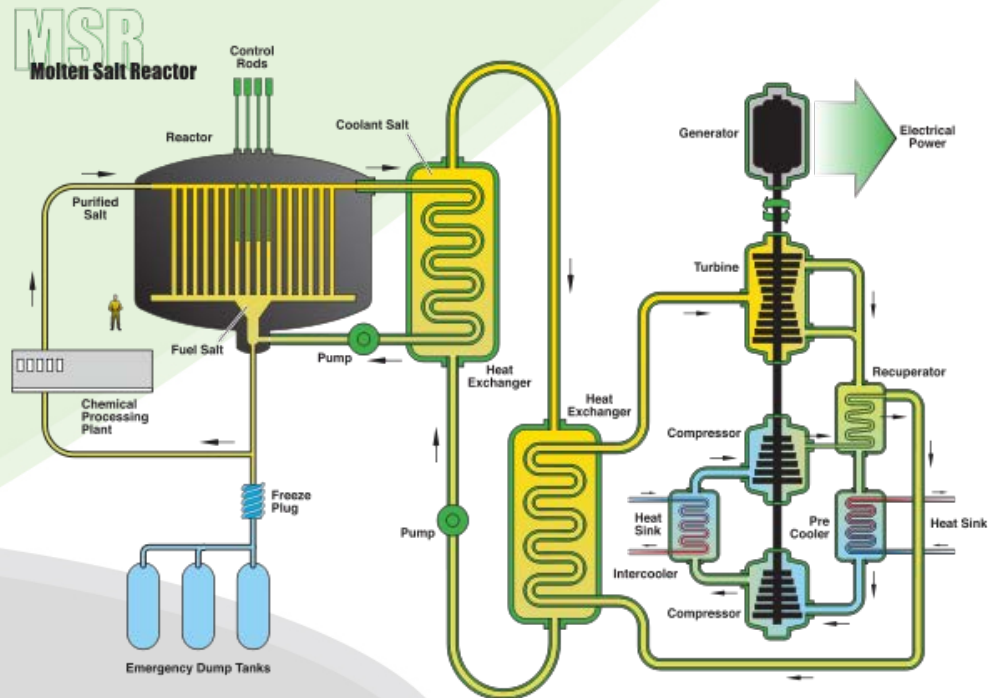


TERRESTRIAL ENERGY

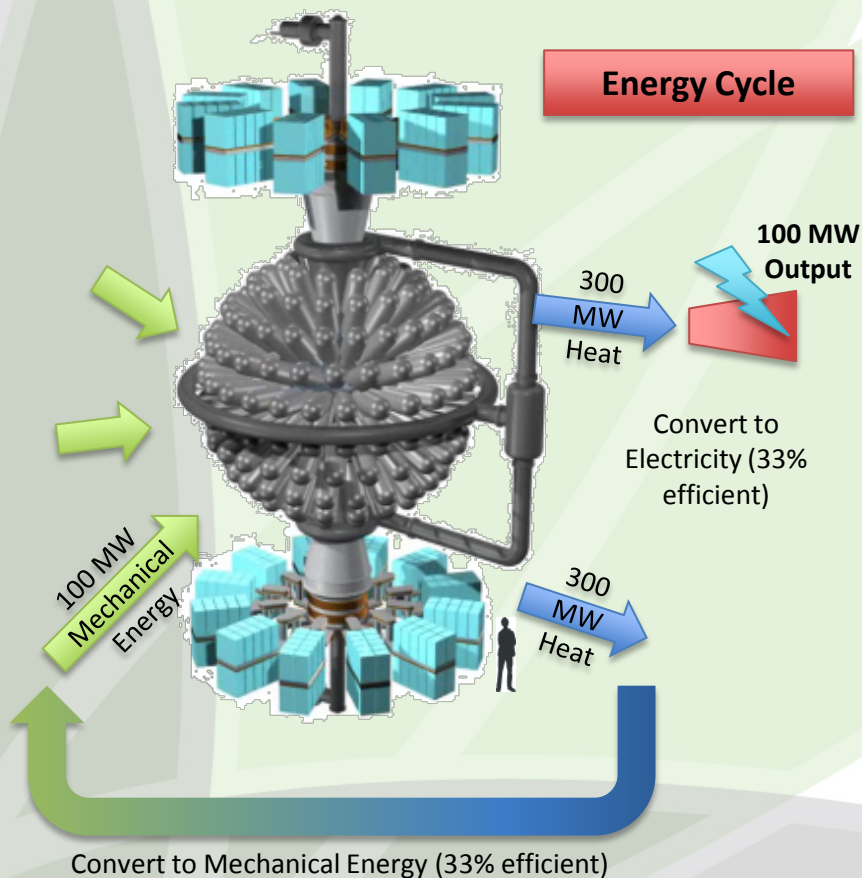
-  Mississauga HQ
-  Integrated Molten Salt Reactor
-  Scaleable 80-600MWth
-  Atmospheric Pressure
-  7 year core life



Aircraft Reactor Experiment ORNL

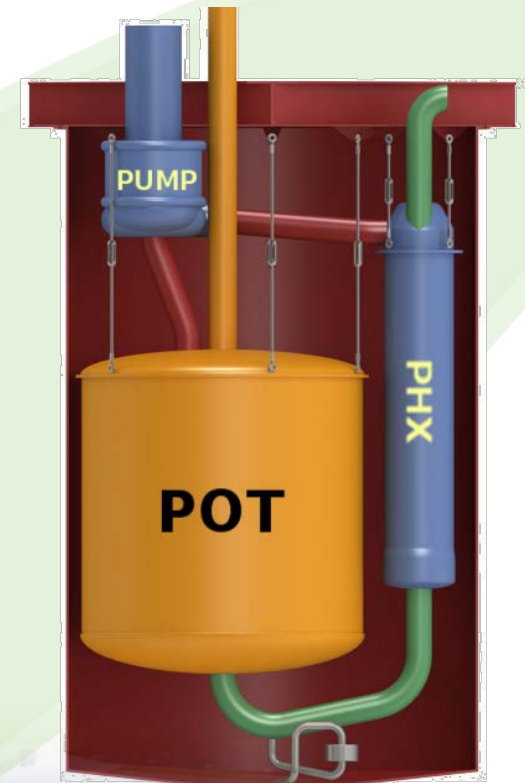
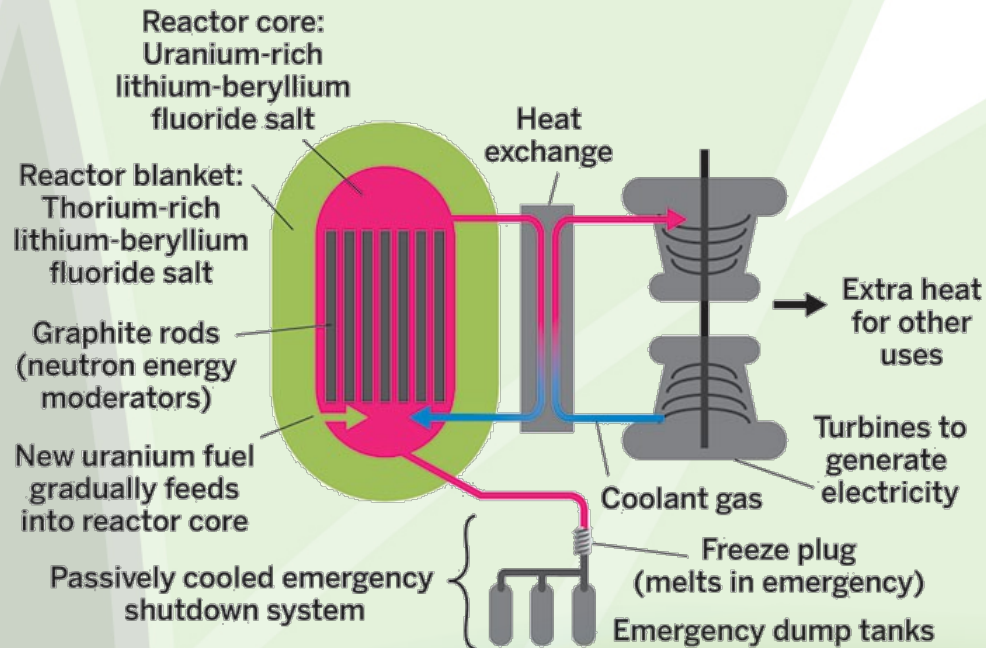


general fusion



- Modular 100 MWe power plant
- Heat converted to electricity with a straightforward steam turbine
- Capital cost of plant: ~\$1,900/kW
 - Fuel only \$0.00001/kWh
 - Limited fuel use each year: deuterium (18 kg/yr) & lithium (60 kg/yr)
- Levelized cost: ~\$0.07/kWh
- Balance of plant similar to coal generation

ThorCon Power



Electricity Generating Plants

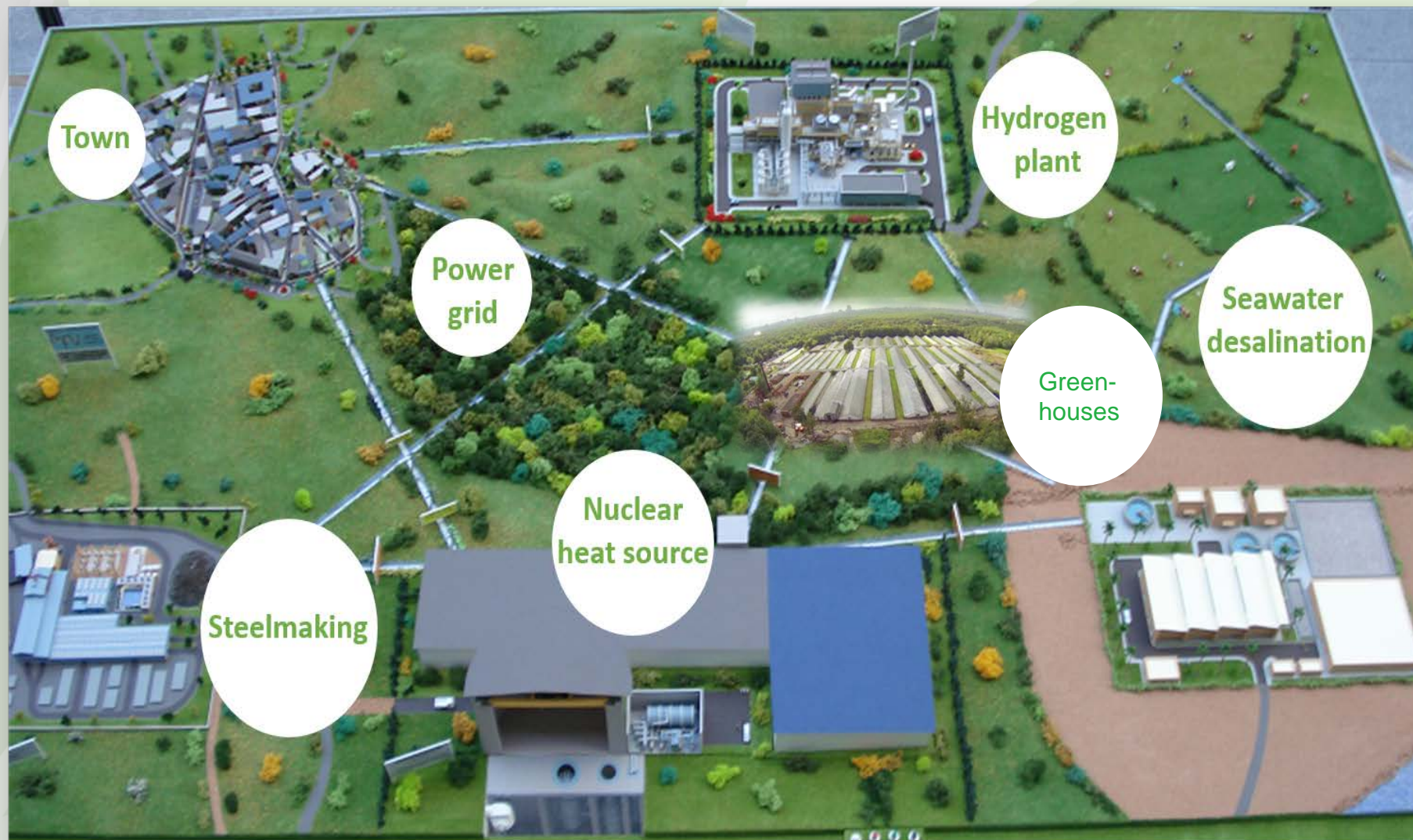
93% Less than
500MWe

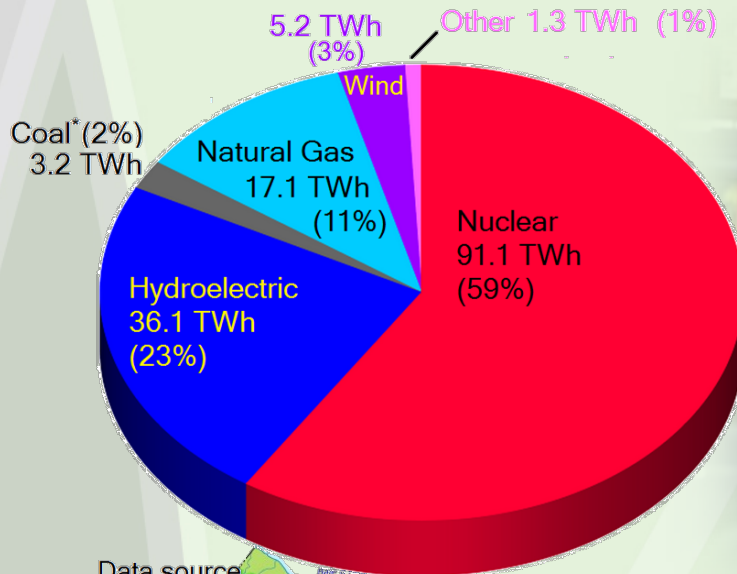
56% have
Capacities
below 50 MWe

20% Less than
1 MWe



Community Energy Units





Data source
<http://www.ieso.ca/Pages/Power-Data/Supply.aspx>

*Use of coal discontinued in 2014



The 4 wins for Canada



True Climate change leadership



A real contribution to developing nations



A new “knowledge economy” with massive export potential



Increased sales of natural resources.

Overall Impression of Nuclear Power in Saskatchewan

Percentage of those expressing an opinion



University of Regina | Faculty of Science

Bushwacker
BREWING COMPANY

SCIENCE PUB SERIES 2016
MARCH 24TH

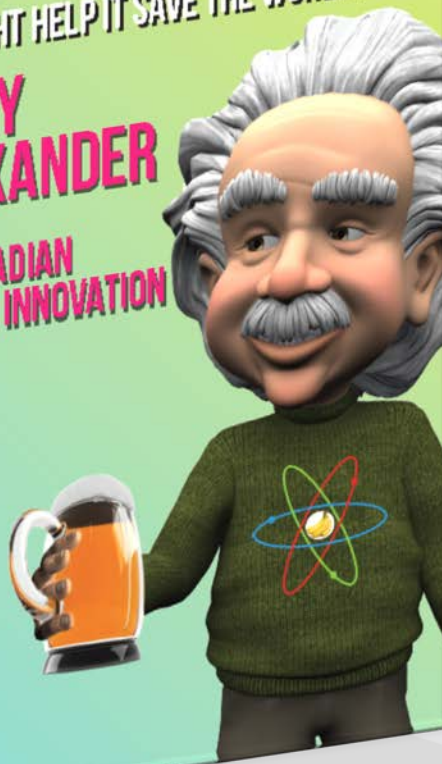
BANNING BANANAS FROM THE GREAT LAKES AND OTHER GREAT IDEAS:
SOME NEW IDEAS ON COMMUNICATING ABOUT NUCLEAR POWER THAT MIGHT HELP IT SAVE THE WORLD!

PRESENTED BY DR. NEIL ALEXANDER

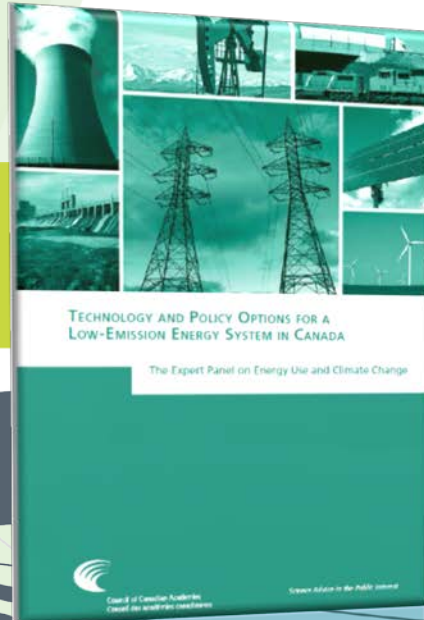
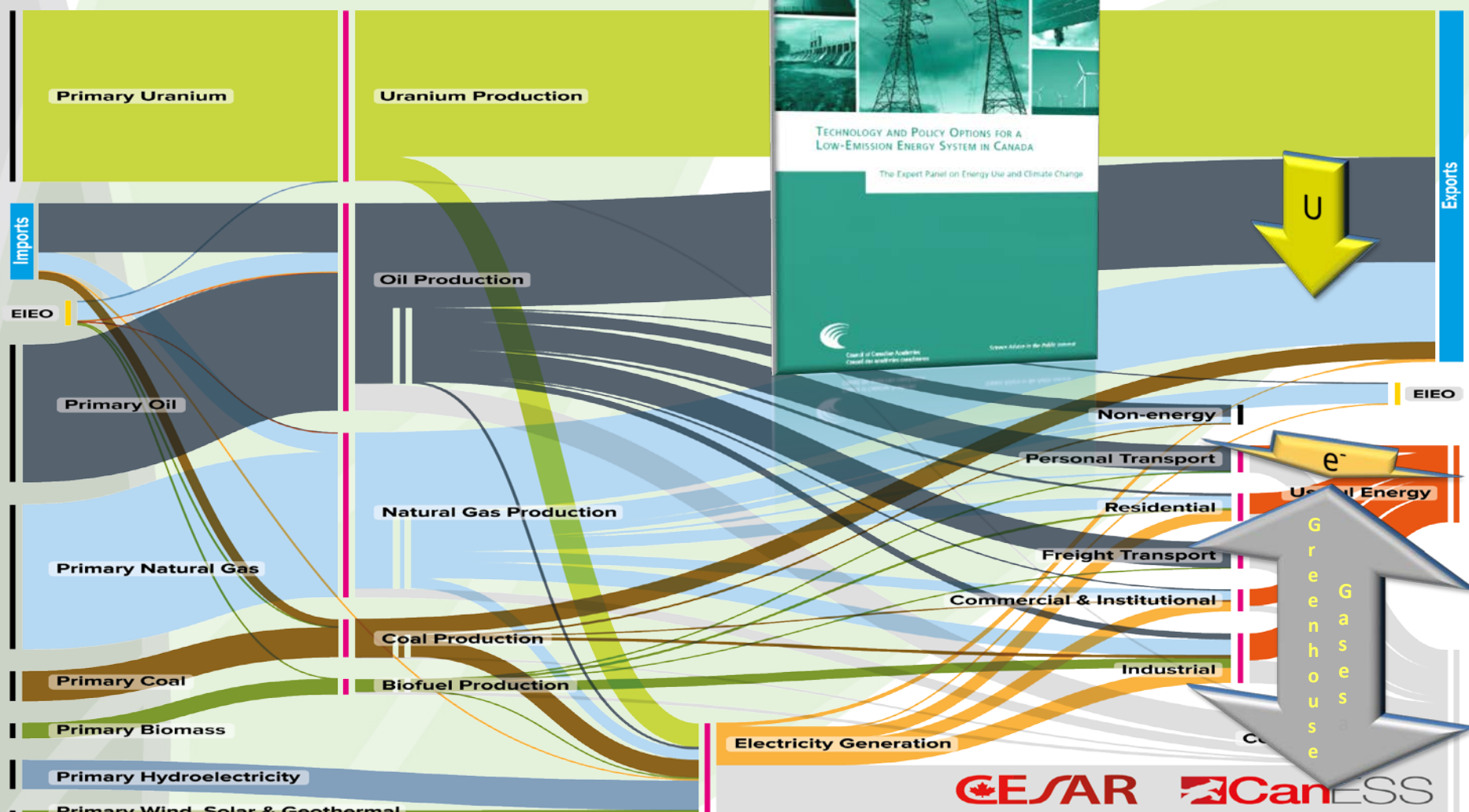
SYLVIA FEDORUK CANADIAN CENTRE FOR NUCLEAR INNOVATION

THURSDAY
MAR. 24, 2016
7:00 PM

THE BUSHWACKER BREWPUB
2206 DEWDNEY AVENUE
REGINA, SASK
FREE ADMISSION
ONLY 50 SEATS AVAILABLE



Energy Flows in Canada showing the huge contribution Canada makes to the avoidance of greenhouse gas production.



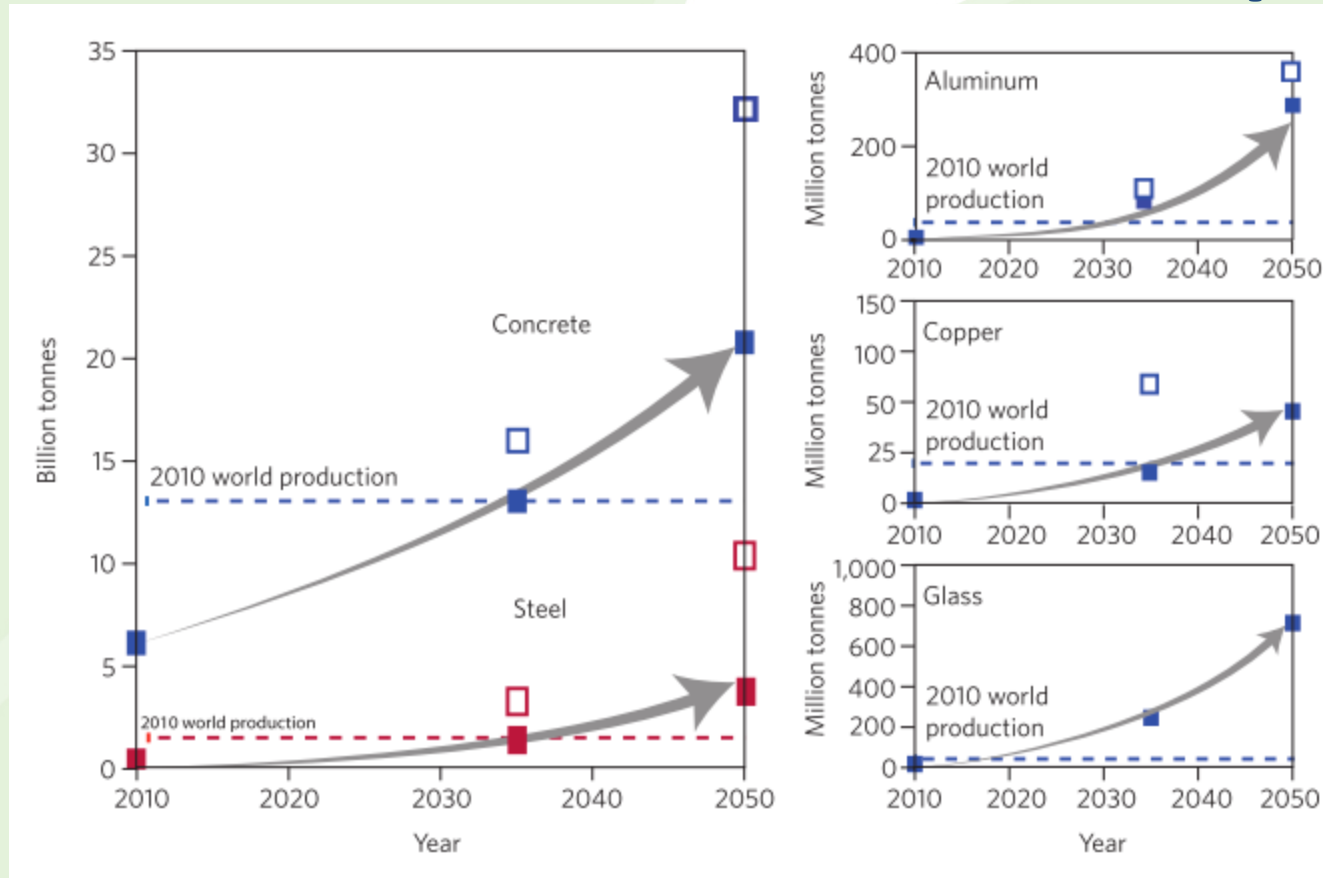
Energy flows

Crude oil	Natural gas	Coal
Hydroelectricity	Uranium	End-use energy
Renewable energy	Electricity	Conversion losses

Processes

Primary energy	Imports & exports
Harvesting and conversion	Energy in for energy out (EIEO)

Renewable: Non-renewable inputs

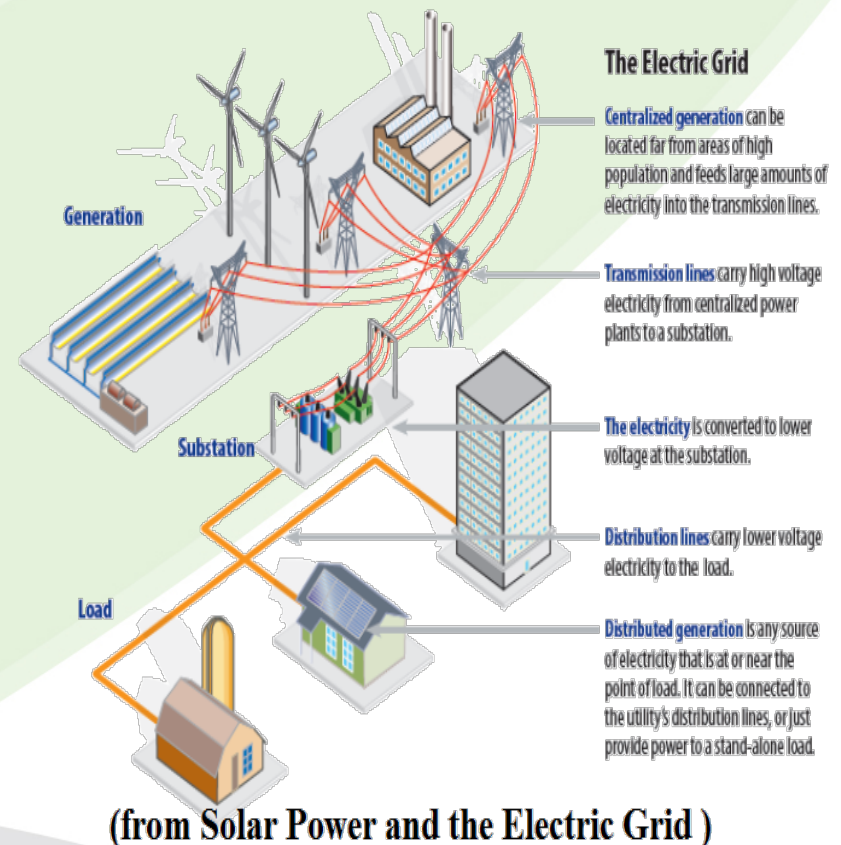


Vidal, Goffé and Arndt (2013)

Sustainable

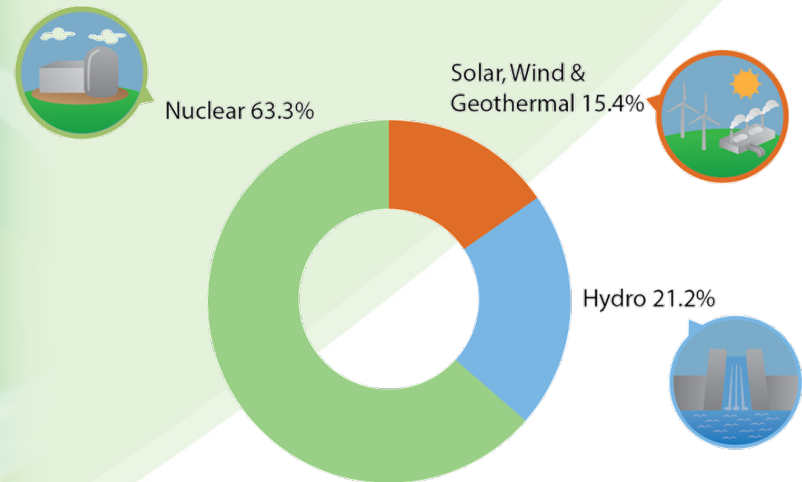
Balance between criteria:

- ✓ Environmental impacts across lifecycle
- ✓ Economic growth
- ✓ Safety, health and well-being
- ✓ Social acceptance
- ✓ Global development



Sustainable = Diverse

Sources of Emission-Free Electricity 2013



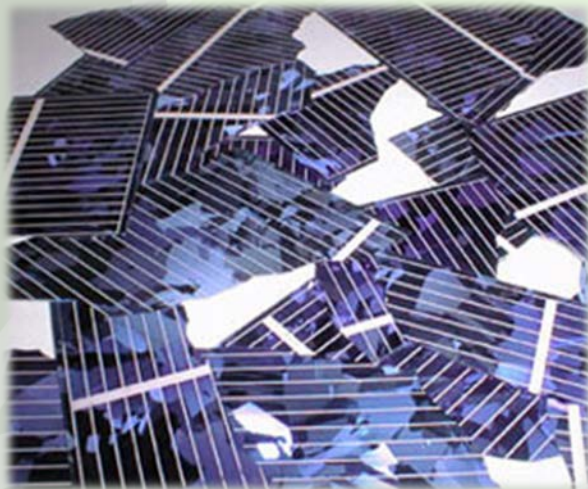
NEI, 2015

It's not easy being clean

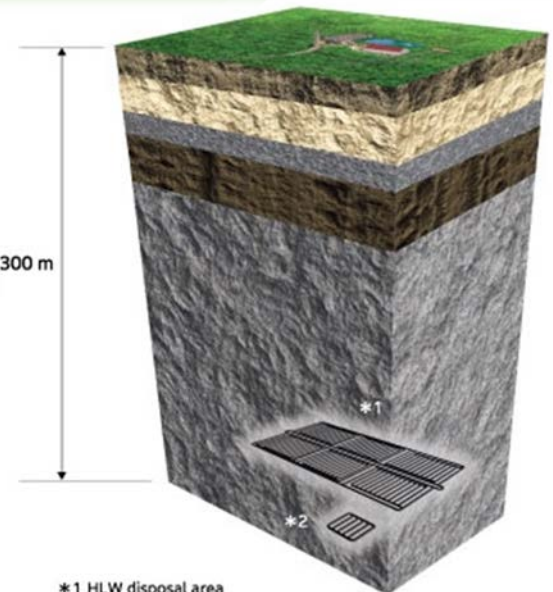








Over 300 m
deep



*1 HLW disposal area
*2 TRU waste disposal area

Who wouldn't want to be green?

BP

Launching
"Beyond Petroleum"
Worldwide



JACQUELYN A. OTTMAN

THE NEW RULES OF GREEN MARKETING

Strategies, Tools, and Inspiration
for Sustainable Branding



Copyrighted Material

Renewable: time scale



England 90 % forest in 1000 BC



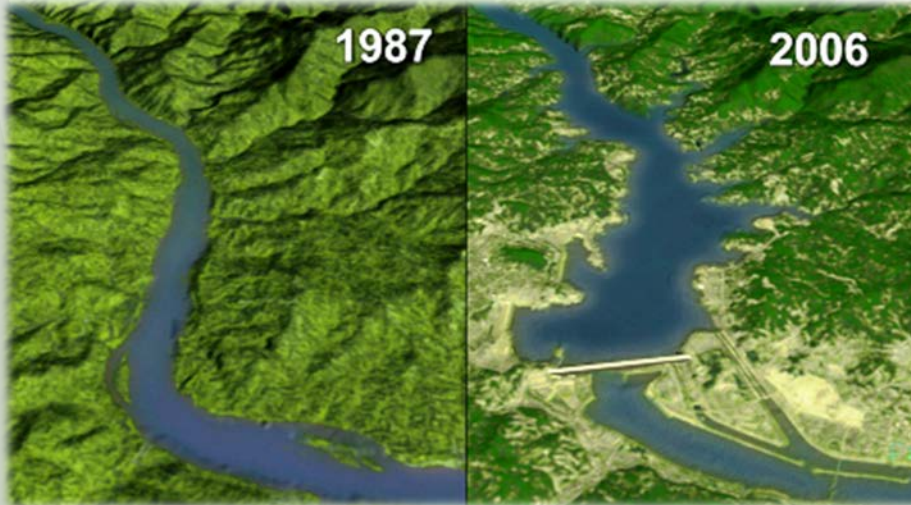
England <17 % forest in AD 1500



Easter Island

Renewable: Other environmental impacts

American.edu



Clean, Green and Renewable are adjectives

Sustainable is an objective

Mental Associations



with an official stamp

cancer a s

a malignant growth or tumor
uncontrolled cell division
growth or tumor.





THE NEW YORKER

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MAY 12, 2015

SCIENTISTS: EARTH ENDANGERED BY NEW STRAIN OF FACT-RESISTANT HUMANS

BY ANDY BOROWITZ



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REPORT



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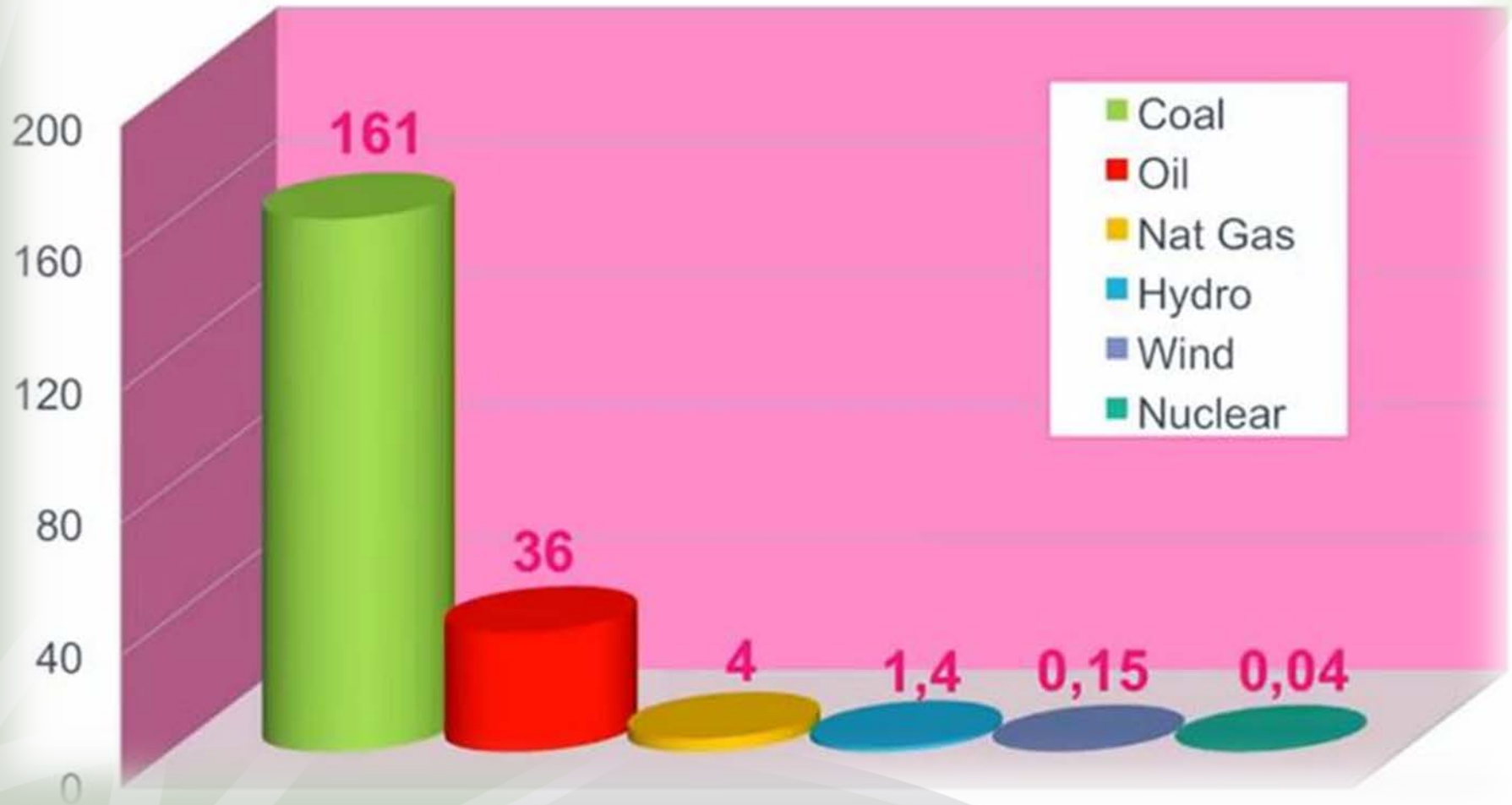
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Deaths per TWh by energy source



What does renewable mean?

