

# Our Carbon Conundrum

## Personal Practice and Public Policy

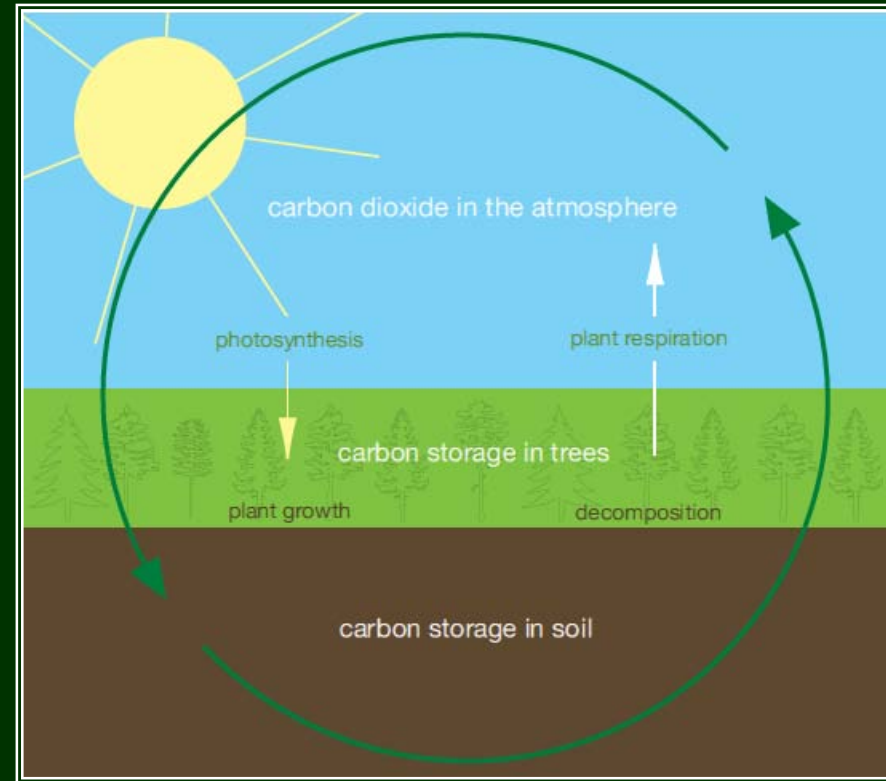
Presented at Net Impact at Stuart School of Business

July 10, 2008

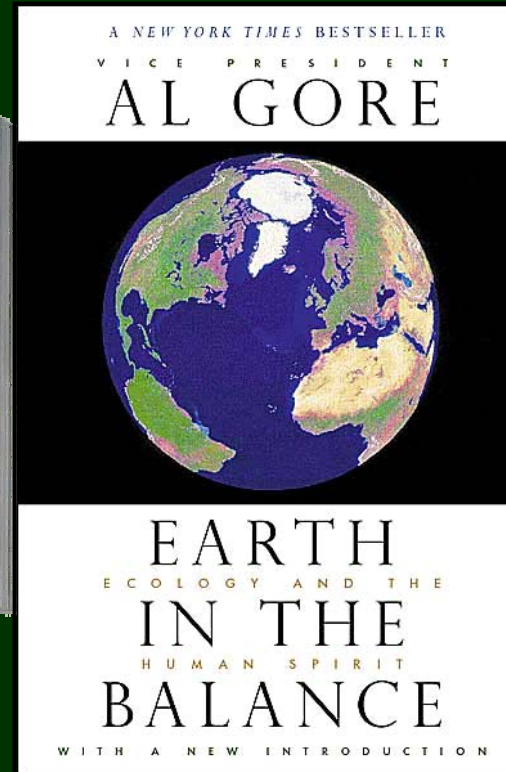
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# The carbon cycle



Carbon is one of the most common elements on earth. It exists in biological materials as carbon (C), and in the atmosphere as carbon dioxide (CO<sub>2</sub>). It is so common, in fact, that life on earth is described as “carbon-based”. Carbon moves naturally between its four major pools—vegetation, soils, fossil fuels, and the atmosphere—in a process known as the carbon cycle. All organisms, whether living or dead, exchange carbon with their surroundings. Trees, for example, absorb carbon dioxide from the atmosphere through photosynthesis, store it as carbon within their tissues and fluids, then return it to the atmosphere as carbon dioxide through respiration. In a natural ecosystem, this process is largely a balanced one. But fossil fuel burning, deforestation, and other human activities have caused massive amounts of stored carbon to be released into the atmosphere very rapidly, amplifying the greenhouse effect and disrupting the Earth’s climate.



An Inconvenient Truth – Gore, Al – ISBN: 1594865671 Pub. Date: June 2006

Earth In The Balance - Gore, Al. – ISBN: 0-452—26935-0 Pub. Date: January 1993

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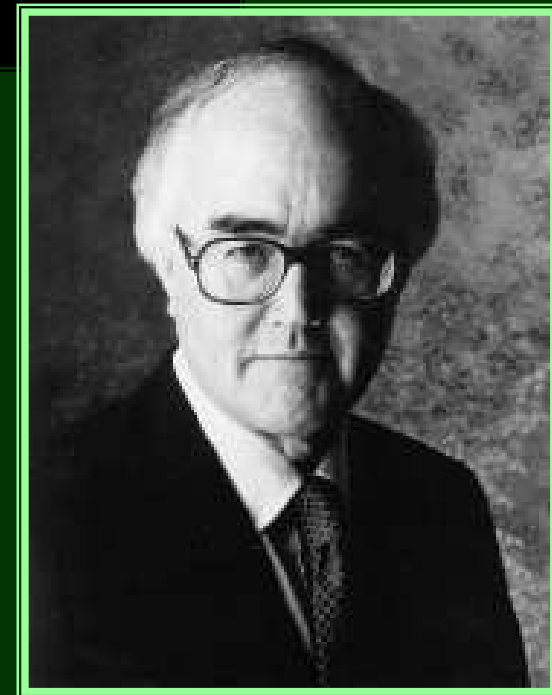
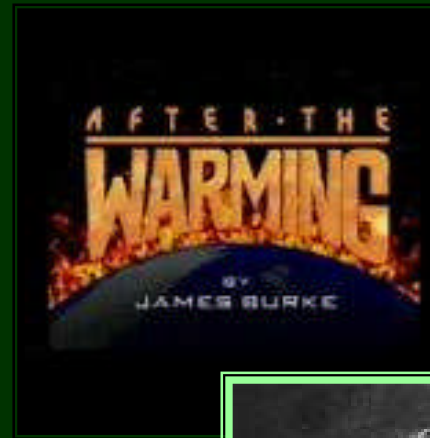
# After the Warming

by James Burke

1989

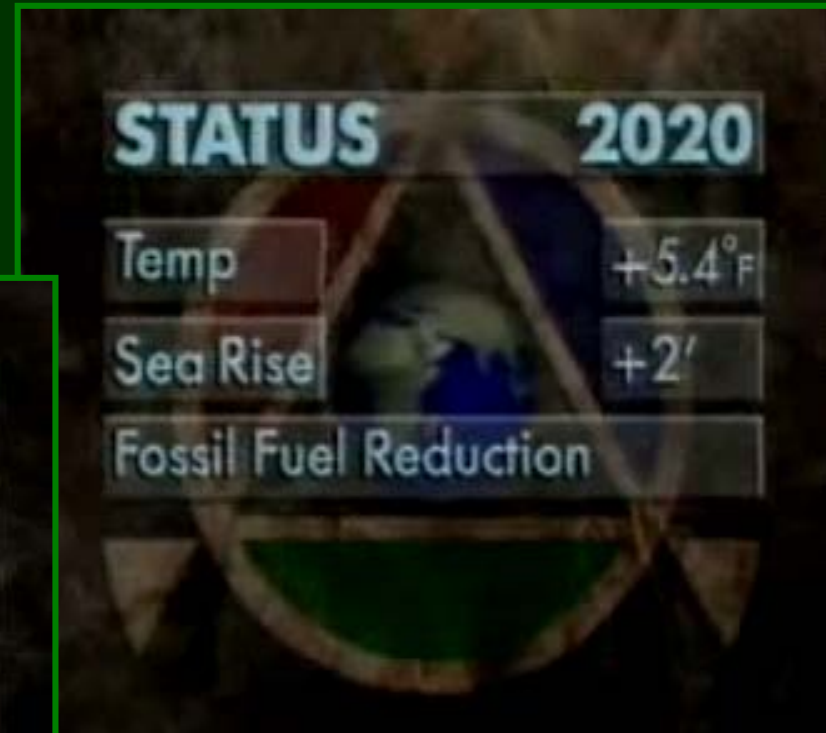
Science historian James Burke produced this engaging program back in 1989. It's sometimes hard to believe this program was made 20 years ago -- so much of it sounds like today's news.

It starts with a scene of New Orleans being evacuated due to sea flooding...  
Really!



<http://video.google.com/videoplay?docid=6514270139930450081>

## Global Weather and Earth Report – The Future?



After the Warming by James Burke BBC 1989

...climate change  
 (“...the earth’s atmosphere traps heat.”)

*Jean Baptiste Joseph Fourier*

Born: Auxerre, France, March 21, 1768,

Died: Paris, France, May 16, 1830

In 1822 he published his *Théorie analytique de la chaleur*, in which he bases his reasoning on Newton's law of cooling, namely, that the flow of heat between two adjacent molecules is proportional to the infinitely small difference of their temperatures,

In 1824 he demonstrated that the, earth’s atmosphere traps heat...

or in simple terms “the greenhouse effect.”



# ...climate change (“...carbon dioxide and water traps most of the heat.”)

John Tyndall, Irish Physicist

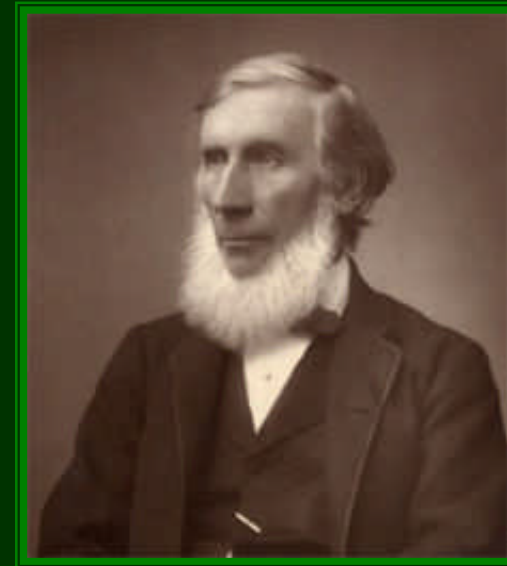
Born: August 2, 1820

Died December 4, 1893

In the 1860s Tyndall constructed the first ratio spectrophotometer which he used to measure the absorptive powers of the gases nitrogen, oxygen, water vapour, carbon dioxide, ozone, hydrocarbons, etc.

He is credited with the first ever atmospheric pollution measurements using infrared and scattering measurement instruments to monitor a city's air quality (in London).

He concluded that water vapor and carbon dioxide are the strongest absorbers of heat in the atmosphere and that water vapor is the principal gas controlling air temperature.

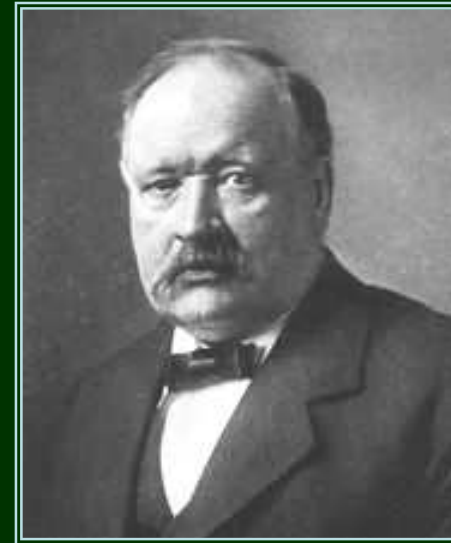


...climate change

(“...burning coal adds to the greenhouse effect.”)

“...if the quantity of carbonic acid increases in geometric progression, the augmentation of the temperature will increase nearly in arithmetic progression. ”

...in simple terms, “...burn coal – heat planet.”



Svante Arrhenius – 1896

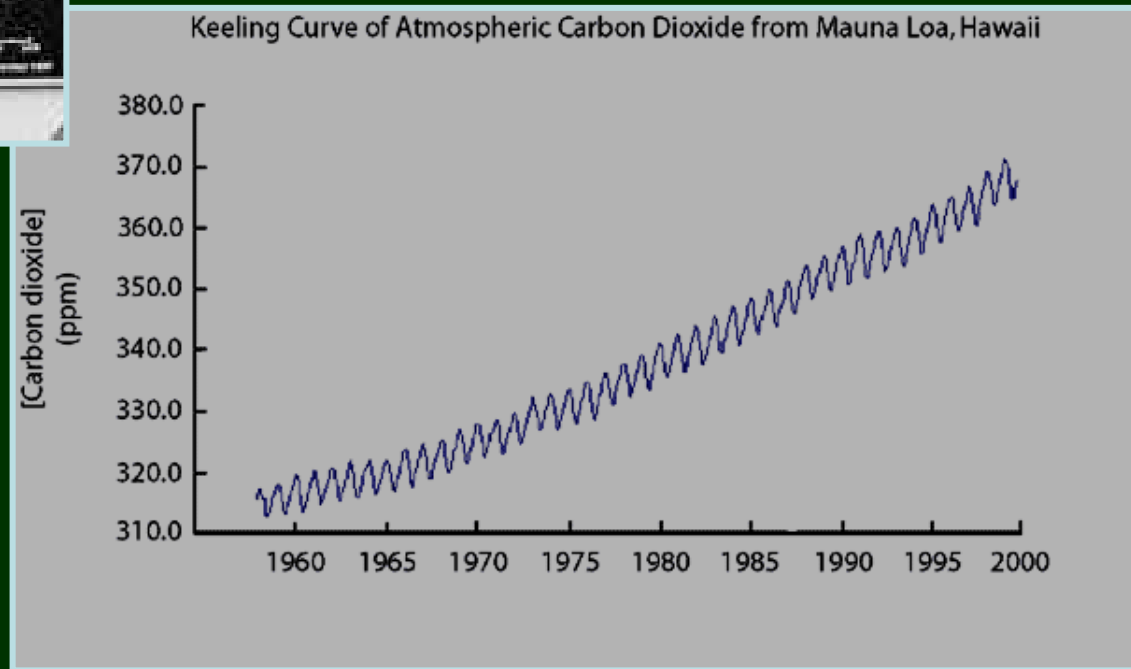
...first formulated the idea that changes in the levels of carbon dioxide in the atmosphere could substantially alter the surface temperature through the greenhouse effect.

*On the Influence of Carbonic Acid in the Air Upon the Temperature of the Ground",  
Philosophical Magazine 1896(41): 237-76*

*Arrhenius, Svante*



...climate change  
 (“...temperature and carbon dioxide are increasing together.”)



*Charles Keeling at the dedication of the Keeling Building, Mauna Loa Observatory, Hawaii.*

...climate change  
 (“...climate is a part of a living earth system.”)



The Gaia Theory, 1972

The Revenge of Gaia,  
Earth's Climate Crisis and the Fate of Humanity,  
2006...

“... it is much too late for sustainable development;  
what we need is a sustainable retreat.” \*

*Watson, A.J. and J.E. Lovelock, 1983. Biological homeostasis of the global environment: the parable of Daisyworld . Tellus 35B, 286-289.*

*Lovelock invented the electron capture detector, which ultimately assisted in discoveries about the persistence of CFCs and other chemicals*

Lovelock, James E. **Gaia: A New Look at Life on Earth**. Oxford University Press, 1972.

Lovelock, James E. **The Ages of Gaia**. New York: W. W. Norton. 1988.

\*Lovelock, James E. **The Revenge of Gaia**. New York: Basic Books, . 2006.

## The carbon bomb

(reverse of sequestration. methyl hydrate, permafrost methane)

Forest fires, insect outbreaks, permafrost melting, and logging in Canada's Boreal Forest have the potential to worsen global warming, while industrial development has the potential to weaken the Boreal's resistance and resilience in the face of global warming's intensifying impacts.

If left unchecked, this situation could culminate in a catastrophic scenario known as "the carbon bomb".

The carbon bomb describes a massive release of greenhouse gasses into the atmosphere, driven, for example, by a widespread outbreak of forest or peat fires. As Greenpeace first warned in its 1994 report, *The Carbon Bomb*, because Canada's Boreal Forest contains 186 billion tonnes of carbon - 27 times the world's annual fossil fuel emissions—a rapid release of its carbon into the atmosphere could cause a disastrous spike in emissions.

*Turning Up the Heat: Global Warming and the Degradation of Canada's Boreal Forest - 2008*

## The domino effect

The Boreal, the Amazon, the Congo, the Paradise forests of Asia-Pacific—in a changing climate, the fates of all these great forests are linked. Forest ecosystems currently store about one-and-a-half times as much carbon as is present in the atmosphere. As the climate warms and deforestation and forest degradation accelerate, more and more of this stored carbon is being released into the atmosphere, driving feedback loops that compromise the survival of all the world's forests.

*Turning Up the Heat: Global Warming and the Degradation of Canada's Boreal Forest*

*Greenpeace, Canada - 2008*

*Published by Greenpeace Canada*

*March 2008*

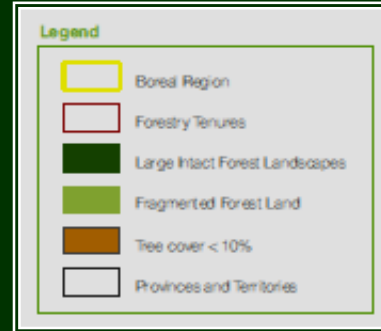
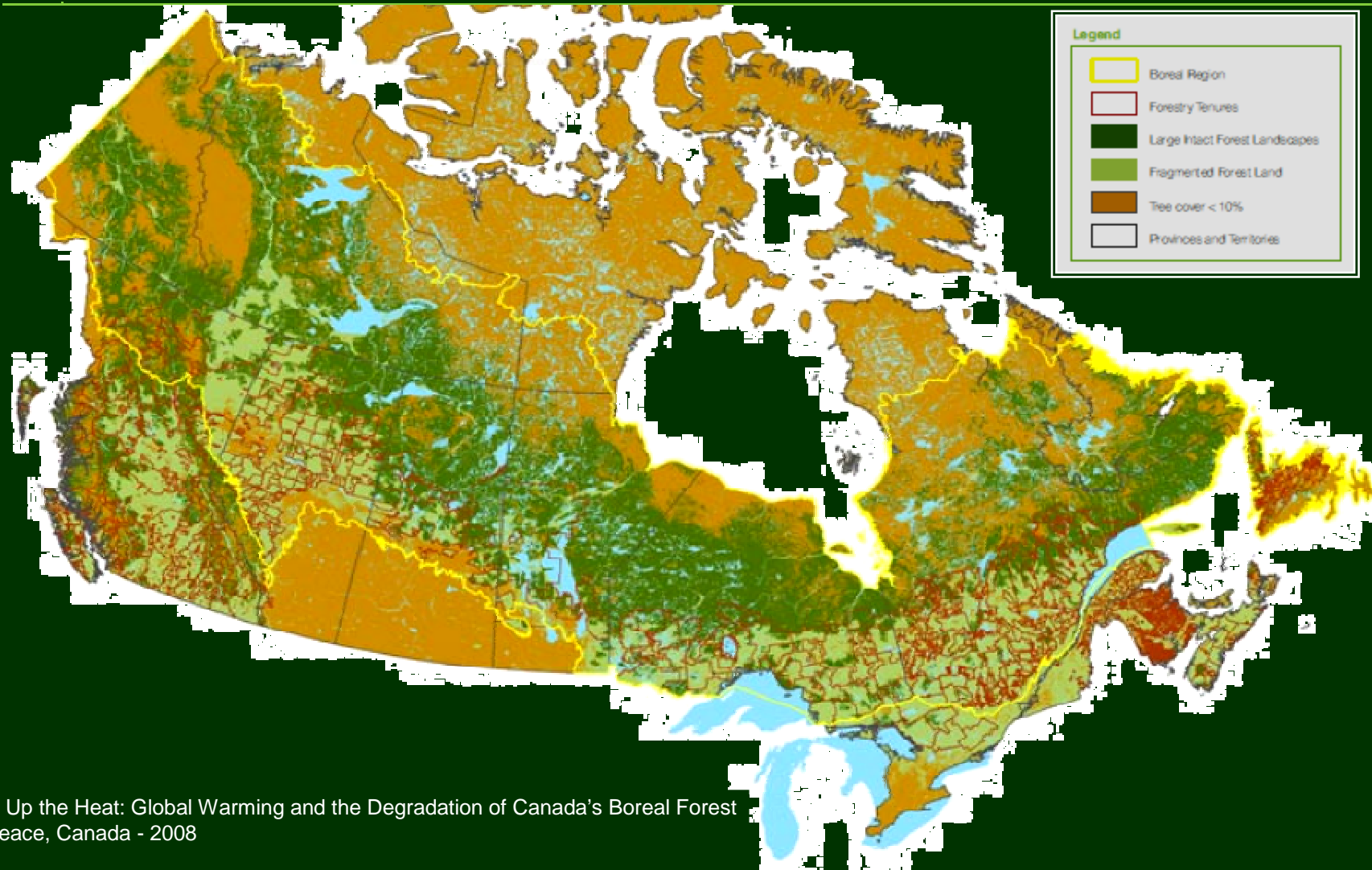
*ISBN: 978-0-9732337-6-6*

*Authors*

*Christy Ferguson, Greenpeace Canada*

*Elizabeth A. Nelson, University of Toronto*

*Geoff G. Sherman, University of Toronto*



Turning Up the Heat: Global Warming and the Degradation of Canada's Boreal Forest  
Greenpeace, Canada - 2008

Data Sources:  
Global Forest Watch Canada; Government of Canada,  
Natural Resources Canada / Earth Sciences Sector /  
Canada Centre for Remote Sensing; Global Land  
Cover Facility (2000), [www.landcover.org](http://www.landcover.org); Canadian  
Boreal Initiative (CBI), Canada's Boreal Region  
(2003) [www.borealcanada.ca](http://www.borealcanada.ca)

Note: Large Intact Boreal Forests Landscapes  
represents a contiguous mosaic of natural ecosystems  
greater than 50,000 hectares in the Boreal Forest  
landscape, essentially undisturbed by human  
influence. This map was generated through the use of  
Landsat imagery acquired during the approximate  
epochs of 1990 and 2000.

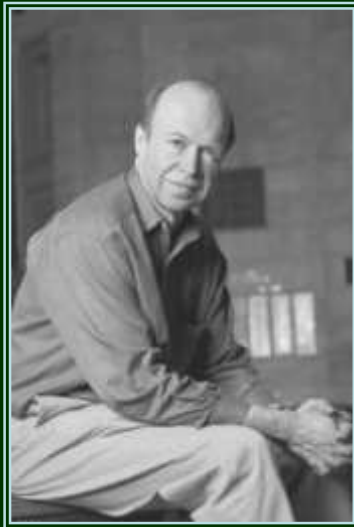
Produced by Global Forest Watch Canada, November, 2007.

Projection:  
Lambert Conformal Conic  
False Easting: 0.0  
False Northing: 0.0

Central Meridian: -95.0  
Standard Parallel 1: 49.0  
Standard Parallel 2: 77.0  
Latitude of Origin: 49.0



## ...climate change (“...this is serious.”)



“reduction of CO2 emissions is a top priority..”  
“..the world has a 10-year window of opportunity to take decisive action on global warming and avert a weather catastrophe.”

NASA scientist James Hansen - 2006

In Germany, the Potsdam Institute for Climate Impact Research says Arctic sea ice has “already tipped.” ...potential “tipping elements” that are still stable:

- a melt of Siberian permafrost,
- a slowdown of the Gulf Stream,
- disruptions to the Indian monsoon,
- Himalayan water flows (Water source for 600,000,000 Indian and Chinese)

*Milliken , Mary, “World has 10-Year Window to Act on Climate Warming – NASA Expert,” Reuters, September 14, 2006.*

*Arctic Thaw May Be at ‘Tipping Point’ by Alister Doyle <http://www.commondreams.org/archive/2007/09/28/4180/> 2007-09-28*

*Hansen Congressional Testimony [http://www.enn.com/top\\_stories/article/37478](http://www.enn.com/top_stories/article/37478) 2008-06-23*

“reduction of CO2 emissions is a top priority..”

...from science to mainstream  
...from scientific validation to societal validation

“The Revenge of Gaia”

James Lovelock – 2006

“The Creation”

Edward O. Wilson – 2006

“The Weather Makers”

Tim Flannery – 2006

“Field Notes from a Catastrophe”

Elizabeth Kolbert – 2006

“An Inconvenient Truth”

Al Gore – 2006

“Global Warming,  
What You Need to Know”

Tom Browkaw - 2006

# Global Warming Impact Like 'Nuclear War'

Climate change could have global security implications on a par with nuclear war unless urgent action is taken.

The International Institute for Strategic Studies (IISS) - London [September 12, 2007]



“... increase competition between haves and have-nots...”

“...heighten racial and ethnic tensions which ...produce fertile breeding grounds for more conflict.”

“...food, water and energy security ...climate change will magnify all three,”

Jeremy Lovell, Published on Wednesday, September 12, 2007

Reuters <http://www.commondreams.org/archive/2007/09/12/3791/2007-09-12>.

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water, water, everywhere, and nowhere

...climate change (resource disruption – water)

### **London to Get Desalination Plant in Climate Battle - UK: July 19, 2007**

LONDON - Britain gave the green light on Wednesday for a desalination plant on London's River Thames in an effort to cope with climate change and get clean water to the capital's booming population.

Watchdog Waterwise (has) said Londoners use on average 165 litres of water a day each against the national average of 150 litres.

This compares with averages of:

107 litres/day in Belgium,

131 litres/day in Denmark,

200 litres/day in Norway, and

360 litres/day in the US

<http://www.planetark.com/dailynewsstory.cfm/newsid/43170/story.htm> [2007-07-19]

water, water, everywhere, and nowhere

...climate change (resource disruption – water)

## New China Algae Outbreak Threatens Water Supplies

*July 18, 2007 — By Reuters*

BEIJING -- An outbreak of blue algae in a Chinese reservoir has left nearly 25,000 people without water and 100,000 others with reduced supplies, state media said on Wednesday of the latest in a series of water pollution scares.

The algae, in the northeastern city of Changchun, was likely caused by farm fertilizers and abnormally hot and dry weather, the official China Daily reported.

...a major outbreak in China's third biggest lake cut off water supplies to over 2 million residents of Wuxi city, in Jiangsu.

*Source: Reuters*

*FROM: <http://www.enn.com/today.html?id=13152> 2007-07-18*

## Estimates Of Potential Global Greenhouse Gas Emission Reductions 2010 And 2020

Sector		Historic emissions in 1990	Historic C <sub>eq</sub> annual growth rate in 1990-1995	Potential emission reductions in 2010	Potential emission reductions in 2020	Net direct costs per tonne of carbon avoided
		(MtC <sub>eq</sub> /yr)	(%)	(MtC <sub>eq</sub> /yr)	(MtC <sub>eq</sub> /yr)	
Buildings <sup>a</sup>	CO <sub>2</sub> only	1,650	1.0	700-750	1,000-1,100	Most reductions are available at negative net direct costs.
Transport	CO <sub>2</sub> only	1,080	2.4	100-300	300-700	Most studies indicate net direct costs less than US\$25/tC but two suggest net direct costs will exceed US\$50/tC.
Industry	CO <sub>2</sub> only	2,300	0.4			
-energy efficiency				300-500	700-900	More than half available at net negative direct costs.
-material efficiency				~200	~600	Costs are uncertain.
Industry	Non-CO <sub>2</sub> gases	170		~100	~100	N <sub>2</sub> O emissions reduction costs are US\$0-US\$10/tC <sub>eq</sub> .
Agriculture <sup>b</sup>	CO <sub>2</sub> only	210				Most reductions will cost between US\$0-100/tC <sub>eq</sub> with limited opportunities for negative net direct cost options.
	Non-CO <sub>2</sub> gases	1,250-2,800	n.a.	150-300	350-750	
Waste <sup>b</sup>	CH <sub>4</sub> only	240	1.0	~200	~200	About 75% of the savings as methane recovery from landfills at net negative direct cost; 25% at a cost of US\$20/tC <sub>eq</sub> .
Montreal Protocol	Non-CO <sub>2</sub> gases	0	n.a.	~100	n.a.	About half of reductions due to difference in study replacement applications baseline and SRES baseline values. Remaining half of the reductions available at net direct costs below US\$200/tC <sub>eq</sub> .
Energy supply and conversion <sup>c</sup>	CO <sub>2</sub> only	(1,620)	1.5	50-150	350-700	Limited net negative direct cost options exist; many options are available for less than US\$100/tC <sub>eq</sub> .
Total		6,900-8,400 <sup>d</sup>		1,900-2,600 <sup>e</sup>	3,600-5,050 <sup>e</sup>	<i>Source &amp; © : IPCC TAR SPM of WG III</i>

# A Confluence of Consciousness about Climate Change

...a growing demand for transparency about the economic, environmental and social costs related to products, the businesses that create them, and the systems in which they operate...

There are three kinds of people in this world...

Those that make things happen...

Those that watch things happen...

Those that wonder what happened...

“What’s your carbon footprint?”

...activity in business sectors (Kyoto Protocol):

Energy - energy production, manufacturing, (facilities that generate energy, extract and convert base materials, and manufacture products) and transport

Industrial Processes - mineral, chemical and metals production  
Solvent and Product Use

Agriculture

“What’s your carbon footprint?”

Carbon Dioxide (CO<sub>2</sub>) & five other greenhouse gases (GHGs) whose emission factors have been normalized to a CO<sub>2</sub> equivalent:

- Methane (CH<sub>4</sub>) = (23xCO<sub>2</sub>)
- Nitrous Oxide (NO)
- Hydrofluorocarbons (HFCS) (2500 x CO<sub>2</sub>)
- Perfluorocarbons (PFCS)
- Sulphur Hexafluoride (SF<sub>6</sub>)

and Water Vapor (H<sub>2</sub>O) (3 x CO<sub>2</sub> )

# Flat Screen (LCD) TVs Worse For Climate Than a Big Coal Plant

by [Lloyd Alter, Toronto](#) on 07. 3.08  
[Science & Technology](#)



And not just because of all the people sitting there using electricity and eating corn chips. 4,000 tons of [nitrogen trifluoride](#) is used each year in the production of flat screen TVs and monitors. Michael Prather of the Environment Institute of the University of California in Irvine claims that the stuff is 17,000 times as potent a greenhouse gas as carbon dioxide, and writes in *Geophysical Research Letters* that it has "a potential greenhouse impact larger than that of the industrialised nations' emissions of perfluorocarbons (PFCs) or sulfur hexafluoride (SF6), or even that of the world's largest coal-fired power plants". It survives in the atmosphere for 550 years, and if this year's supply got out, it would be equivalent to 67 million tonnes of CO2.

"Nitrogen trifluoride can be called the missing greenhouse gas. It is a synthetic chemical produced in industrial quantities, it is not included in the Kyoto basket of greenhouse gases, or in national reporting under the United Nations Framework Convention on Climate Change," Professor Prather said in the [Sentinel](#).

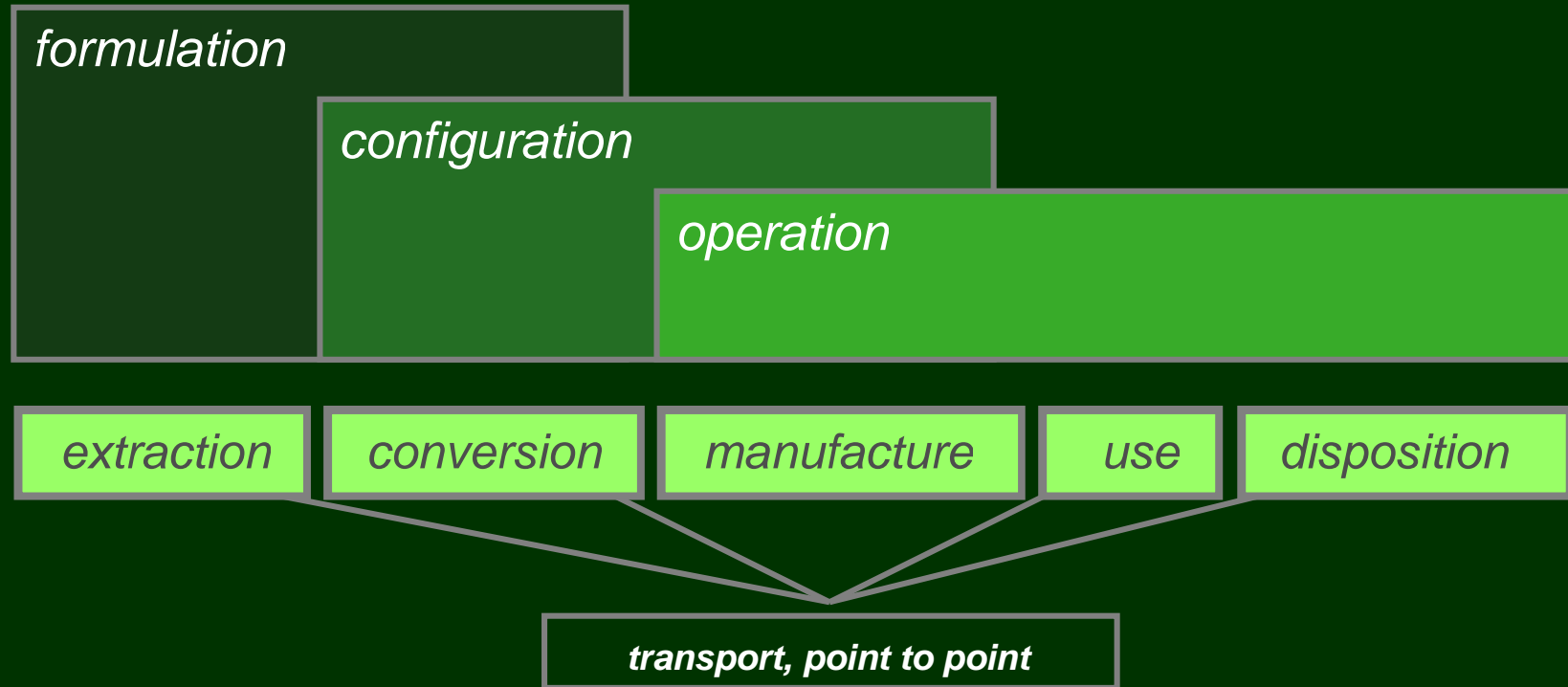
The industry says that only 2% of it gets out, but Prather doesn't believe them. The stuff isn't even indispensable; Toshiba avoids using it. Another good reason not to watch TV. [:Guardian](#) and [:Sentinel](#)

“What’s your carbon footprint?”

- Mandatory/Voluntary Trading (Cap & Trade)
  - European Union
  - Chicago Climate Exchange
  - Regional, State and Local (City) Initiatives
- Taxation Schemes (Product Focused)
- Allocation Schemes (Product Focused)



# A product' carbon footprint...



“What’s your carbon footprint?”

activity by individuals :

...a function of individual, or household activity, primarily related to *energy consumption* in the home and in transportation.

personal practice and public policy

What can a person do???

1. share the CO<sub>2</sub> story...  
(with colleagues, with children)



<http://www.kidsforfuture.net/ourfuture/000035.html>

2. know your CO<sub>2</sub> footprint...  
(dwelling, traveling, and consuming)

3. get (politically) active in the response...

4. be the change you want to see in the world...

Our Choices:

Avoidance

Mitigation

Adaptation

## Calculators

[Air conditioner sizing calculator](#)

[Carbon footprint calculators](#)

[Fuel economy calculator](#)

[Generator wattage calculator](#)

[Heating and cooling calculators](#)

[Refrigerator energy calculator](#)

[Washer dryer energy calculator](#)



# Greenest Host GreenGuide

<http://www.greenesthost.com/green-guide.php>

## Calculators

[U.S. Climate Technology Cooperation Gateway's Greenhouse Gas Equivalencies Calculator](#)

[The National Energy Foundation's CO2 Calculator](#)

[Eredux's Interactive United States Carbon Footprint Map](#)

[An Inconvenient Truth's Carbon Calculator](#)

[The Ecological Footprint Quiz](#)

[Score Your Diet](#)

[The Eating Green Calculator](#)

[The Energy Star@Home Tool](#)

[The Sierra Club's MPG Calculator](#)

[The Generic Electricity Energy Cost Calculator](#)

[EcoConsumer Waste Calculator](#)

[Real Cost's Travel Carbon Calculator](#)

[Environmental Defense's Paper Calculator](#)

## Scorecards

[Climate Counts Retailer Ratings](#)

[Green Peace's Guide to Greener Electronics](#)

[2007 World's Most Ethical Companies](#)

[The Sierra Club's Environmentalist's Guide to Gasoline](#)

## The Energy Star@Home Tool



# Low Carbon Diet

A 30 Day Program to Lose 5000 Pounds

WINNER 2007 INDEPENDENT PUBLISHER "MOST LIKELY TO SAVE THE PLANET" BOOK AWARD

## Low Carbon Diet

A 30 Day Program to Lose 5000 Pounds



...save money ...save energy ...save the planet

Be part of the global warming solution!

David Gershon

Winner of the 2007 Independent Publisher "Most Likely to Save the Planet" Book Award"

Scrub-A-Dub Tub  
Wear It Again Sam  
Drive Earth Smart

This book is fabulous! It couldn't be more timely. It's practical, accessible and effective. Getting people to take on global warming at a personal level is critical to tackling the issue. The Low Carbon Diet can make a huge difference."

Denis Hayes, co-founder, Earth Day

<http://www.empowermentinstitute.net/lcd/>



The climb to the top of Mount Sustainability is an arduous, but rewarding, journey. Every foothold gained begins with a self-questioning analysis of our processes and materials and the determination to achieve even better results with less, and ultimately, no impact on our environment.

At Interface, sustainability is built into our business decisions, from the raw materials we source to the way we reclaim our customers' used products.

We strive to make sure every new Interface product is conceived within The Sustainable Design Model created by David Oakey, the industry-leading designer who guides our global modular product development effort. This model dictates the use of renewable materials that can be easily reclaimed and recycled, or even composted, with an overall reduction in materials used.

Through our QUEST waste reduction program; the use of renewable energy such as solar and wind power; smarter design; and continuous reduction in harmful emissions, Interface continues its ascent to the top of Mount Sustainability. With the vision of becoming a restorative company by the year 2020, we have a long way to go, but we're well on our way.



...a car that runs on air?

[www.theaircar.com](http://www.theaircar.com)

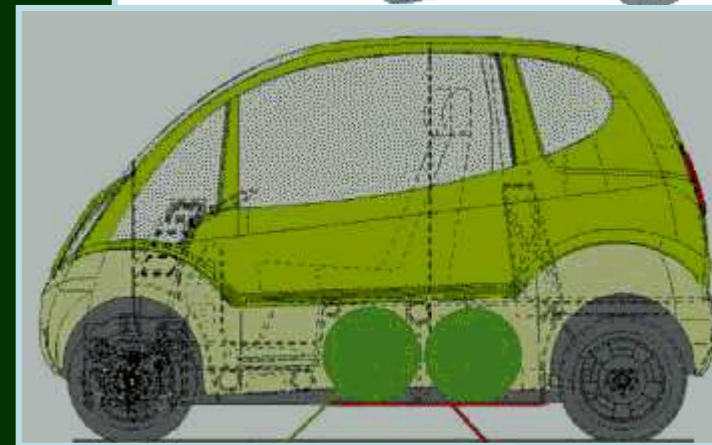
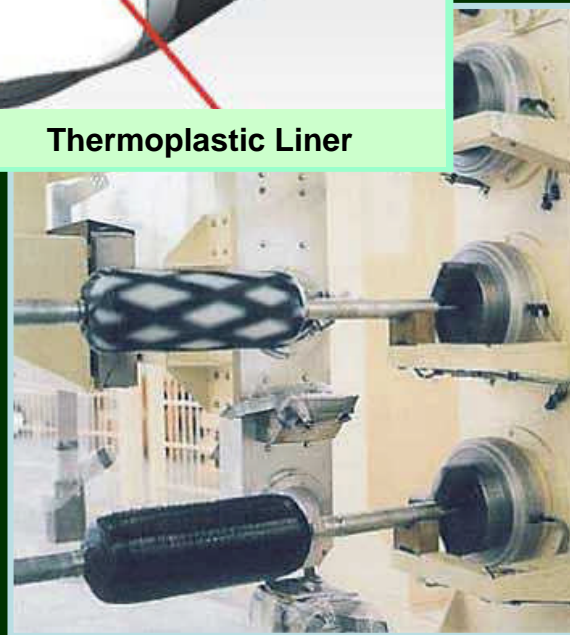
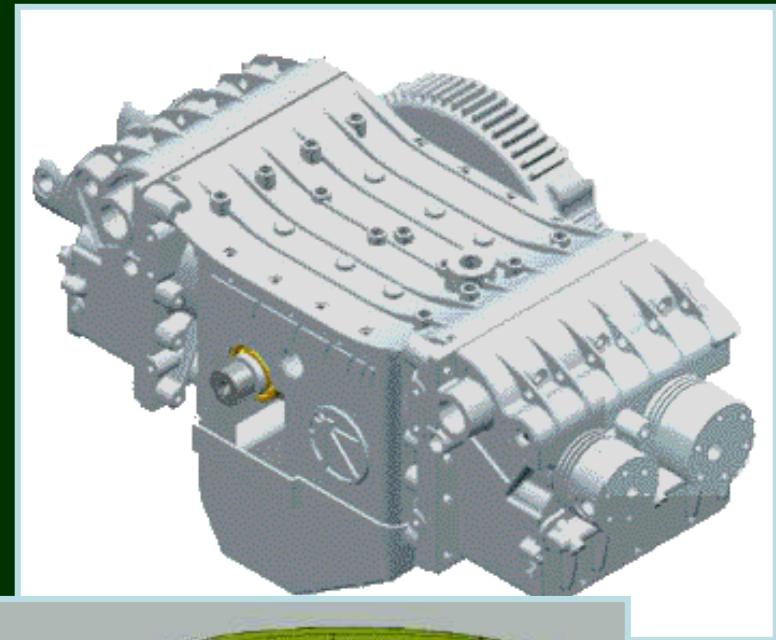
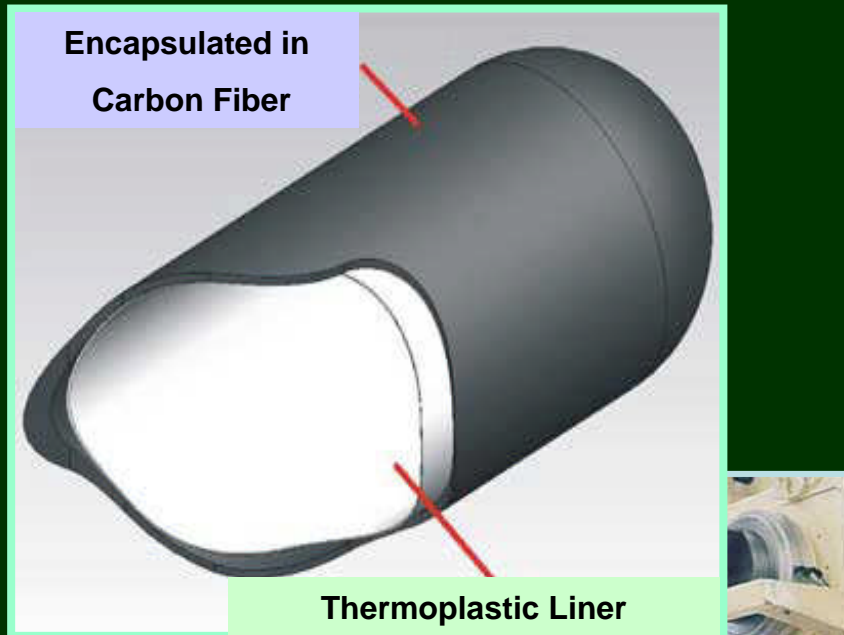
Motor Development International (MDI) is a privately held company, created by Guy Negre in 1993 to realize his vision of a zero pollution motor car.



<http://www.theaircar.com/> [2006-07-10]

...a car that runs on air?

The air car innovation is a result of the convergence of two technologies...



...a car that runs on air?

[www.theaircar.com](http://www.theaircar.com)

Both the driving range and speed of the air car make it ideal for urban transport without pollution of the urban space...

Motor:	CAT's 4 cylinder engine, 800 cm3, equipped with a "pause" system at Top Dead Centre and a top power of 25bhp at 4000rpm.		
Length:	2.65m	Width:	1.62m
Height:	1.64m	Weight:	550Kg
Seating:	3 front seats.	Maximum load:	270Kg
Refilling time:	3 hrs 30mins - 4 hrs from a 230V mains connection; 2 hrs 30 mins - 3 hrs from a 380V connection; and 2 minutes at a high-pressure air station..		
Mileage for city driving:	150Km		
Maximum speed:	110Km/h		



# Hybrid Car or Air-Car

Why Not This?



Toyota Concept...

in the spirit of the "beetle, the Mustang

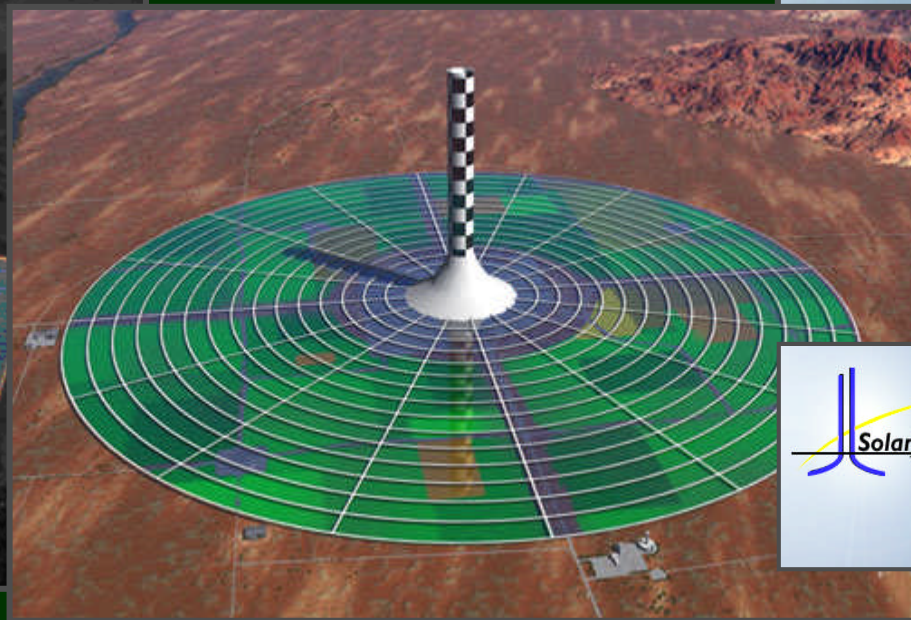
## ...a power plant that runs on air?

Enviro Mission's [Solar Tower Technology](#)

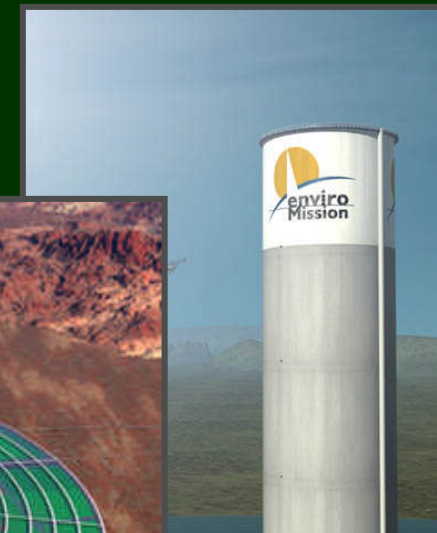
Solar Towers are like an inverted funnel, with a wide skirt to collect air to then turn a turbine in the tower. The company expects that this will be the first renewable energy source to achieve "primary provider" status, meeting the demand profile, at grid-competitive pricing.

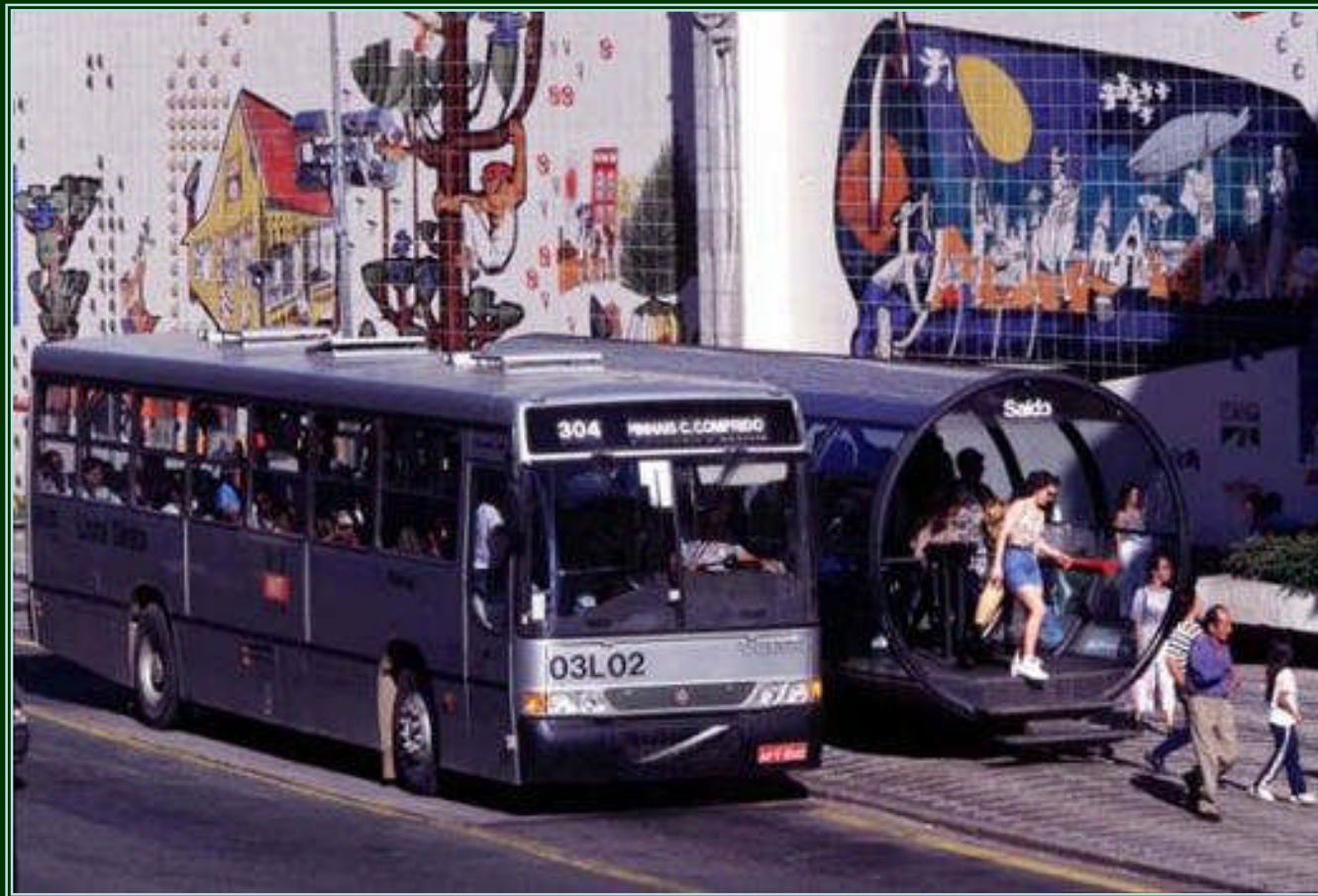


<http://www.solarmissiontechnologies.com>



[www.enviromission.com.au/images/artist-tower.jpg](http://www.enviromission.com.au/images/artist-tower.jpg)





Curitiba's eco-efficient, bus-only transportation system  
It is a model for cities around the world

“Never doubt that a small group of thoughtful, committed citizens can change the world; indeed, it's the only thing that ever has.”

*Margaret Mead*



Thank You...

JohnPaul Kusz, Associate Director  
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Illinois Institute of Technology  
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