

Meeting Our Needs with Renewable Energy Data Sources and References February 2008

For use with the following CanREA materials:

- ⇒ Slide Presentation: Meeting Our Needs with Renewable Energy
- ⇒ Fact Sheet: Renewable Power for the 21st Century
- ⇒ Fact Sheet: Six ways of providing base load power with wind

The Transition to Renewable Energy

•Renewable Energy could supply 30% of the world's energy by 2030 - all global energy needs by 2090. European Renewable Energy Council (EREC):

<http://www.erec.org/documents/publications/energy-revolution.html>

•By 2050 Renewable energy could supply 85% of Canada's electricity and 65% of Canada's heating and cooling. Renewable Energy Network for 21st Century (REN 21).

http://www.ren21.net/pdf/REN21_RE_Potentials_Interim_Report.pdf

Global Investment in Renewable Energy

•Wind and solar are the world's fastest growing energy investments. Germany and Spain are the leaders. REN 21: <http://www.ren21.net/globalstatusreport/default.asp>. Ernst and Young Renewable Energy Attractiveness Index:

http://www.ey.com/global/content.nsf/International/Oil_Gas_Renewable_Energy

•United States catching up - \$26 billion in new spending under Obama administration. Pembina Institute. <http://www.pembina.org/pub/1786>

•Canada lagging far behind – **13 times** less investment per capita than the US. Pembina Institute. <http://www.pembina.org/pub/1786>

Energy Efficiency

The key to the Renewable Energy Transition is a new commitment to energy efficiency

•California has held energy demand constant with energy efficiency for over 20 years

http://www.washingtonpost.com/wp-dyn/content/article/2007/02/16/AR2007021602274_pf.html

•There is still a huge potential in Energy Efficiency

Rocky Mountain Institute. <http://ert.rmi.org/files/documents/CGU.RMI.pdf>

•US to spend \$25 billion over next 2 years. Canada lagging behind. Pembina Institute 2009. <http://www.pembina.org/pub/1786>

•The Canada Green Building Council says building energy use can be cut by 50% by 2015. Preliminary results from the Green Building Performance Initiative presented to the National Advisory Council on Energy Efficiency. November 2007

http://www.cagbc.org/initiatives/green_building_performance/index.php
http://www.cagbc.org/database/rte/080721_Initiatives_LCI_GBPI_ENG.pdf

- Buildings that use 90% less energy (Factor 9) and produce as much energy than they use (net zero) are already realities.

http://www.retscreen.net/ang/case_studies_house_energy_efficient_canada.php

- Top vehicle efficiency now down to 4 litres/100km. New Toyota Prius.

<http://oee.nrcan.gc.ca/transportation/personal/index.cfm?attr=8>

There is More than Enough Renewable Energy to Meet our Needs

- More than 100 times the world’s annual power consumption could be commercially produced from solar PV systems

- More than 20 times this amount could be commercially produced by wind farms

Based on extensive assessments of global potential by Mark Jacobson.

“Review of solutions to global warming, air pollution, and energy security.”

<http://www.rsc.org/delivery/ArticleLinking/DisplayArticleForFree.cfm?doi=b809990c&JournalCode=EE>

Renewable Energy is Reliable

	Wind	Nuclear	Coal
Percent unavailable because of breakdown or repair:	0-2 % on shore 0-5% off shore	10-25%	6%
Time to get back on line after shutdown:	0 – immediate start up	1 week or more	2-3 days
Flexibility during times of rapid changes in demand:	Easily controlled	Inflexible – must run	Somewhat flexible
Impact of one unit going off line:	Small – many units	Very high – unstable grid	High

Mark Jacobson.

“Review of solutions to global warming, air pollution, and energy security.”

<http://www.rsc.org/delivery/ArticleLinking/DisplayArticleForFree.cfm?doi=b809990c&JournalCode=EE>

Rocky Mountain Institute: <http://www.rmi.org/sitepages/pid257.php#E08-01>

Quickly Installed/Produces Immediately

- Nuclear experiences chronic overruns of time and cost –Finland reactor: 3 years behind and 50% over budget

<http://www.greenpeace.org/international/press/releases/confidential-documents-reveal>

http://en.wikipedia.org/wiki/Olkiluoto_Nuclear_Power_Plant

Renewable Energies have Lower Environmental Impacts

	Wind	Solar	Nuclear	Coal + CCS
Life-cycle GHG emissions gms CO ₂ /kWh	3-7	20-50	20-70	250-400*
Water consumption US gal/kWh	0.005		0.4 – 0.7	0.5
Waste production	Very small - only during manufacture	Minor - only during manufacture	High and low level radiation and waste	Mining tailings and toxic wastes removed during carbon capture
Land Use	High but allows multiple uses. Siting important	High but allows multiple uses. Siting important	Waste disposal issue unsolved	Mining aspects still an issue

Mark Jacobson.

“Review of solutions to global warming, air pollution, and energy security.”

http://www.rsc.org/delivery/_ArticleLinking/DisplayArticleForFree.cfm?doi=b809990c&JournalCode=EE

Rocky Mountain Institute: http://www.rmi.org/images/PDFs/Energy/E08-01_AmbioNucIllusion.pdf

Renewable Energy is the Cornerstone of a New Green Economy

•Germany employs [40,000 people](#) in the solar industry, and 140,000 jobs in renewable energy.

<http://www.renewableenergyworld.com/rea/news/article/2008/04/renewable-energy-jobs-soar-in-germany-52089>

http://www.economist.com/business/displaystory.cfm?story_id=10961890

Wind and Solar Energy sources can provide Base Load Power

1. Geographic Distribution

When wind farms over a 850 km x 850 km area in US Mid-west are interconnected:

•33% of annual wind production could be counted on towards base load with the same reliability as a coal power plant.

•Because generation was also closer to demand, grid distribution losses cut from 7% to less than 2%.

Archer and Jacobson, Stanford University:

http://www.stanford.edu/group/efmh/winds/aj07_jamc.pdf

In Spain Interconnecting wind farms nearly eliminates variability

•On individual days in March 2008 and 2009, 40% of Spain’s power was coming from wind

http://www.worldproutassembly.org/archives/2008/03/new_record_wind.html

<http://www.guardian.co.uk/environment/2009/mar/06/spain-wind-power>

2. Coordinating with Hydro

At the Nine Canyon wind project in Washington State

- The output from a new 63 MW wind farm was successfully integrated with 65 MW of hydro to provide base load power.

- The additional cost of coordinating wind and hydro estimated to be only 0.09 cents/kWh.

RETSCREEN case study: www.etscreen.net/download.php/fi/841/3/WIND08-C.pdf

3. Lowering Demand to Match Supply

- Most utilities peak manage demand to match supply

- In California grid operators are planning to reduce demand when supply from solar or wind farms drops by:

 - Re-setting customer programmable thermostats to higher or lower temperatures

 - Getting customers to use hot and cold storage

- Customers feel no impact and are rewarded for participating

<http://www.allbusiness.com/energy-utilities/utilities-industry-electric-power/5319870-1.html>

California's ISO Launches Demand Response Lab; Author: Jennifer Delony; North American Wind Power: Feb., p. 68

4. Storing Renewable Power – pumped hydro, compressed air, advanced batteries, flywheels, capacitors, hydrogen

See Pembina Institute primer *Storing Renewable Power*

<http://pubs.pembina.org/reports/StoringRenewablePower-jun17.pdf>

5. Vehicle to Grid

- Austin, TX plans on using the local wind power that is generated at night to charge plug-in hybrid car batteries, and then tap into those same car batteries for extra power during the day time.

http://www.ci.austin.tx.us/council/downloads/texas_quest_wsj.pdf

Renewable Energies are Cost Competitive and Commercially Available

- For solar, wind and hydro energy there are no fuel costs

- The cost of using these technologies will decrease over time and will drop in price the more they are used

- The cost of firming up variable resources like wind and solar to provide base load power using storage and other means (see above) is likely to be less than nuclear or coal + CCS

- Current costs – world averages

 - Wind 6-9 cents/kWh**

 - Solar 20-30 cents/kWh**

 - Nuclear 10-22 cents/kWh (including overruns)**

 - Conventional Coal 4-7 cents /kWh**

- Estimated Future costs
 - Base load wind 8-12 cents/kWh**
 - Solar thermal base load 12-20 cents/kWh**
 - New Nuclear 15-22 cents/kWh**
 - Coal + Carbon Capture ~ 8-15 cents /kWh**

Review of all costs. Mark Jacobson. “Review of solutions to global warming, air pollution, and energy security.”

<http://www.rsc.org/delivery/ArticleLinking/DisplayArticleForFree.cfm?doi=b809990c&JournalCode=EE>

Cost of Nuclear: Craig A Severance <http://climateprogress.org/2009/01/05/study-cost-risks-new-nuclear-power-plants/>

Rocky Mountain Institute: http://www.rmi.org/images/PDFs/Energy/E08-01_AmbioNucIllusion.pdf

Nuclear Engineering International

<http://www.neimagazine.com/story.asp?storyCode=2051898>

Cost of Solar: RBC Capital Markets: <http://www.rbc.com/newsroom/20070509solar.html>

Industry predictions

<http://www.reuters.com/article/environmentNews/idUSL1878986220071019?pageNumber=1&virtualBrandChannel=0>

Cost of Solar + compressed air storage = 1.5 x solar alone:

US Solar Grand Plan <http://www.sciam.com/article.cfm?id=a-solar-grand-plan>

Cost of Wind + flow battery storage = 1.3 to 1.5 x wind alone – commercialization by 2015. VRB OEB IPSP hearings deposition <http://pubs.pembina.org/reports/oeb-storage-options.pdf>

Cost of Wind + compressed air storage = 1.3 x wind alone – already in use:

Princeton University: <http://www.princeton.edu/~ssuccar/caesReport.html>

Coal + Carbon Capture and Storage – price and commercialization prospects. Reuters;

<http://www.reuters.com/article/GCA-GreenBusiness/idUSTRE5244QJ20090305>

IPCC: http://arch.rivm.nl/env/int/ipcc/pages_media/SRCCS-final/IPCCSpecialReportonCarbondioxideCaptureandStorage.htm

Economist:

http://www.economist.com/opinion/displayStory.cfm?story_id=13226661&source=hptextfeature

Examples of Provincial Transitions to Renewable Power

Alberta – Greening the Grid

–<http://re.pembina.org>

Ontario – Renewable is Doable

<http://www.renewableisdoable.com>