

# ENERGY IN ONTARIO 2043

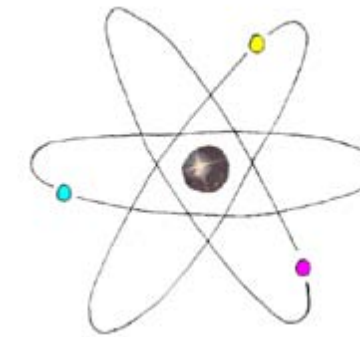


OCAD University,  
Strategic Foresight  
and Innovation, 2013

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Christine Keene  
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The release of atomic energy has not created a new problem. It has merely made more urgent the necessity of solving an existing one.

~ ALBERT EINSTEIN



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# THE TEAM



## IAN GRAY

Ian is a senior landscape architect, urban designer and project manager.

He has a proven ability to generate and link disparate design and environmental engineering ideas and technologies in innovative ways and has collaborated with a diverse range of internationally recognized talent including composer R. Murray Schafer, multi-media artist David Rokeby and Derrick de Kerckhove of the McLuhan Centre. He led the landscape design for the Bahen Centre at the University of Toronto, the recipient of a Toronto Urban Design Award of Excellence and led the team that won the Mississauga Living Arts Centre landscape architectural competition.

Ian has served as President of the Ontario Association of Landscape Architects, as an appointee to numerous boards including the Ontario Government, Ministry of Economic Development, and Design Sector Strategy Advisory Committee. He has taught Urban Ecology and other design courses at OCAD University and lectured widely, including in the Landscape Architecture Programs at University of Toronto, University of Guelph and Ryerson University.

His current work is focused on the design of sustainable systems for communities and sustainable site initiatives.  
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## CARL HASTRICH

Carl Hastrich is the founder of Bouncing Ideas, and a Biomimicry Fellow. He has worked directly with Janine Benyus and Dayna Baumeister on the development of the Biomimicry Guild, an innovation consultancy and the Biomimicry Institute, an educational non-profit.

Carl has been an Associate Professor at OCAD University, with research projects for Herman Miller and Autodesk. Driven to bring a designer's curiosity and playfulness into complex challenges, Carl is an independent consultant bringing systems thinking to strategic challenges ranging from urban ecology to healthcare.

Carl was trained at the Swinburne National School of Design in Melbourne and OCAD University, where he is currently a candidate for the Masters of Strategic Foresight and Innovation.

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## CHRISTINE KEENE

"Expressing that Christine has the energy of the "Energizer Bunny," is actually an understatement. Christine is an accomplished academic who was schooled in biochemistry at the University of Saskatchewan. She is a talented musician, an entrepreneur, a "week-end warrior" soccer star, and has previously sustained successful careers in some of the World's Top corporate entities. Christine's career passion is learning and development, and inspiring this enthusiasm for learning and discovery in others. In fact, her learning, experiences and interests, led her to launch Keene Innovations Consulting Inc. Always a progressive thinker and innovator, Christine identified a need in today's economy to establish a business that partners with organizations to support and potentially re-think their current vision, products and/or processes in an effort to take them to the next level of development and achievement. Competition in today's world is fierce and Keene Innovations Inc., with Christine as CEO, partners with organizations to achieve their goals. Her enthusiasm for learning and eloquent speaking abilities have lead her to be a sought out speaker in her field at both national and international conferences and engagements."

--LB, friend and colleague

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## NASEER ROOPANI

Naseer is a candidate for Masters of Design in Strategic Foresight & Innovation at OCAD University with a background in industrial design, project management, finance, visual arts and more. Naseer is an independent consultant with project management expertise for clients in the municipal and provincial government, financial institutions and telecommunication companies. He is also a member of the Board of Governors at OCAD University.

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## MEGHAN SAVIGNY

With an advertising career that spans three Canadian cities Meghan is committed to fresh and engaging creative. She graduated with honours from the Advertising and Design department at the Ontario College of Art and Design in Toronto, and holds a BA in Design in conjunction with Queen's University. Meghan has won several industry awards, from institutions such as The Advertising and Design Club of Canada, the Marketing Awards, The Lotus Awards and the London International Advertising Awards.

In addition, Meghan has long been involved in social justice issues; working with United Way agencies that provide camping opportunities for families at risk, and volunteering with several organizations in Vancouver's Downtown Eastside such as Pivot Legal Society and WISH Drop-In Centre.

It's the combination of these two pursuits that lead her to OCADU's Strategic Foresight and Innovation Master's program, where she is currently a candidate.

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Suzanne Stein and Stuart Candy -  
Thank you for helping us through the madness and for your guidance and support through the foresight process.

Katherine Moshonas-Cole -  
A special thank you for sharing your insights and expertise in both nuclear energy and the industry overall.

Electricity is really just organized lightning.

~ GEORGE CARLIN



[www.pimagazine-asia.com/wp-content/uploads/2013/09/shutterstock\\_137593487.jpg](http://www.pimagazine-asia.com/wp-content/uploads/2013/09/shutterstock_137593487.jpg)

# ELECTRICAL ENERGY IN ONTARIO PROCESS OVERVIEW

Energy is a vast and complex area. There is an abundance of information and misinformation in the public domain, presenting a difficult challenge to anyone looking to explore and understand this topic. Comparisons between energy sources are difficult, as factors involved in comparisons are subjected to biases.

This research project began using a broad lens to create a basic understanding of energy as a system, and was then focused to explore electrical energy in Ontario. Ontario Power Generation (OPG) was identified as a key stakeholder, with the ability to influence the future of electrical energy in Ontario. Strategic analysis and foresighting methods were applied from the OPG perspective to identify how OPG might thrive in the future and to provide a glimpse of the possible futures it could influence.

# HORIZON SCAN - STEEPV OF NUCLEAR

Our research initially focused on the future of nuclear as a source for electricity generation. To ensure our initial research integrated a wide array of insights we searched for signals in each of the following categories; Society, Technology, Environment, Economics, Politics and Values (STEEPV). During our initial stages of research, heated debates between supporters and critics of different energy sources were unearthed. Most sources of information had very transparent biases, highlighting significant tension and rivalry among the different energy sources. Within nuclear there was a clear divide between positive advocates who argued that societal concerns were overblown regarding health and environmental concerns over nuclear waste, while advocates against nuclear argued that inevitable disaster loomed around the corner. Signals and trends in nuclear were identified and investigated.

While most members of our research team held relatively negative antinuclear biases at the beginning of the process, these biases were clearly identified. General perception of nuclear was swayed as we began to systematically compare benefits and concerns amongst different energy sources. It became apparent that there were many arguable angles to each debate and that the highly combative winner-loser mentality was preventing positive systemic discussion.

**INSIGHT:** Energy sources cannot be researched in silos because of their comparative and synergistic relationships - an energy source is only better or worse when compared to another energy source across a broad set of criteria rather than simplistically comparing the cost of electricity production.

**INSIGHT:** There were few resources

focusing on informing audiences about the energy landscape in order to encourage individual informed conclusions. This gap was our opportunity to provide something unique and valuable.

Please see the initial horizon scan in more detail in the appendix, pages 104 to 124.

# COMPARATIVE SWOT ANALYSIS

It became clear that reviewing a single energy source in isolation would lead to limited insights. The next phase of our research was to develop a systematic analysis across the dominant and emerging energy sources through a comparative SWOT analysis (strengths, weaknesses, opportunities and threats). This became a broader, yet highly focused resource of data for the horizon scan, while contextualizing the current energy mix.

Through iterative experimentation with the comparative analysis, societal values was identified as a key driver of change. Broader adoption of renewable sources of electrical energy would require identifying key values, determining what will influence these values, and then implementing strategies to achieve these changes. These speculative experiments made it possible to highlight the plausibility of potential change, generating

hypotheses to be tested with further research.

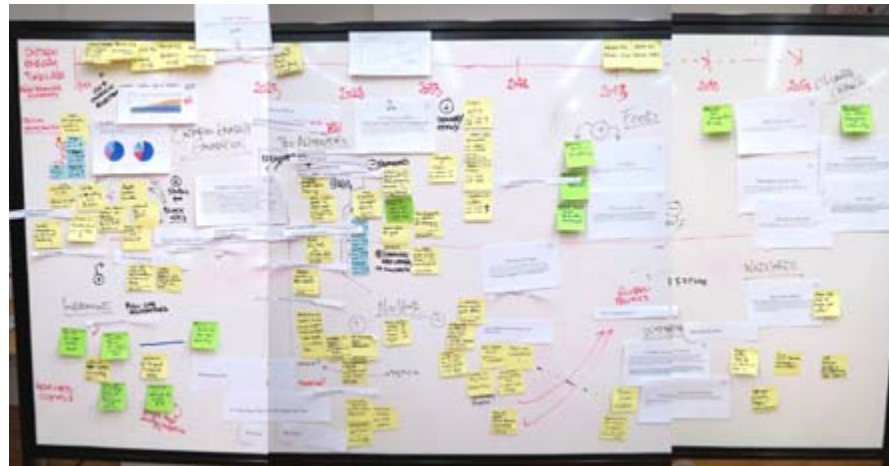
**INSIGHT:** Major shifts away from economic to environmental priorities would be required if any fundamental change was to be facilitated.

**INSIGHT:** A fundamental requirement to transition to renewable energy sources, like wind and solar, is the capacity for the grid to manage or store electricity from intermittent sources.

Please see the comparative SWOT analysis in the appendix, pages 125 to 141

# GENERAL SCENARIO DISCUSSION

As the scope of our project expanded beyond nuclear we integrated broader long term discussions for each potential energy source. What might the future look like? Our goal focused on using foresight methods to envision a variety of futures with different energy mixes. With initial research heavily focused on nuclear, the team revisited our horizon scan, identifying signals, trends and drivers in a variety of energy sources that may influence the future of energy in Ontario. The horizon scanning process produced 12 key drivers.



SCENARIO DISCUSSION, PROCESS OVERVIEW

A summary of the trend research table is available in the appendix, pages 142 to 151.

**INSIGHT:** Every community (city, province or country) approaches the challenge of energy from a unique perspective which is based on their economy, resource availability, politics, culture and values. For example, while Jordan is a country in a region rich in oil resources, they are adopting nuclear energy in order to be politically independent.

**INSIGHT:** Societal values will be more accurately reflected through informed public debate and discussion, rather than through fear and misinformation.

# SCENARIO GENERATION METHOD - 2X2

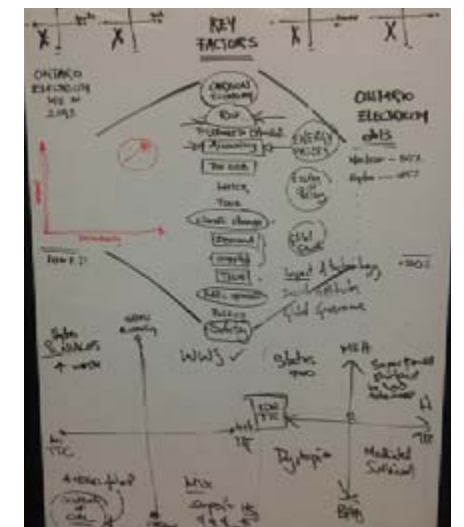
The 12 key drivers identified from horizon scanning were prioritized based on impact and certainty. The top two key drivers (Tolerance To Change and Accounting) were used to populate the 2x2 scenario matrix. To develop the four scenarios, the behaviors of the 12 key drivers were characterized in each scenario to determine outcomes.

**INSIGHT:** Even though energy is a complex area, it is advantageous to add a quantifiable aspect into the scenarios. We leveraged the electricity generation mix pie chart as a baseline in each scenario where we distributed the 100% respectively between the different energy sources. This also allowed us to work with the idea of electricity supply and demand.

As the project had moved beyond the scope of any one stakeholder, the idea of a foresight

toolkit - an interactive tool that an audience could engage with - emerged as a possible deliverable. A young audience was proposed, with the goal of engaging future decision makers in foresight discussions. For the purposes of this project we were unable to develop this proposed toolkit, although ideas for exploration exist for future discussion.

**COMMUNICATION OF SCENARIOS:** We chose to deliver the scenarios in a news format through headlines of future current events in order to give audiences a snapshot of potential worldviews that would exist as the context to the scenarios of energy mix. Humanizing the debates over energy mix was deeply insightful as it gave personal voices to what could easily have become cold discussions over economic and technical viability.



The scenarios are available to review from page 63 to page 80, with the full length scenarios available in the appendix, page 152 to 163.

# STRATEGIC IMPLICATIONS

From discussions during the previous scenario development phase, biases emerged within the group towards a preferred future scenario. Research into the increasingly strong certainty over human impact on climate change and the need for proactive commitment to change rose as concerns for each member of the group. While a generally positive outlook for nuclear remained, the long term buildup of radioactive waste was an ongoing concern. Nuclear continues to have enormous potential, with many long term research and innovation projects into the re-use of waste, smaller reactors and alternative fuel sources on the horizon, we believe that relying on only one potential technological breakthrough was too limiting.

As a group we saw a plausible future for Ontario to be a pioneer in Canada for the integration of renewables beyond hydro

and the gradual phase-out of nuclear. We also viewed this scenario as having high value for triggering strategic debate as it would place significant challenges on specific stakeholders, such as Ontario Power Generation (OPG) and the Ministry of Energy (MOE).

To reveal the tensions and challenges that could emerge in the transition towards our desired future scenario the 3 horizon technique was used to outline a potential pathway, summarizing key milestones and the drivers involved that might occur on the path to the future. Strategies were developed for stakeholders to successfully navigate and increase momentum towards our desired future.

**INSIGHT:** To reverse the negative, combative relationships between energy

providers, it was identified that businesses needed to be decoupled from a narrow selection of energy sources. For example, OPG makes 95% of its income from nuclear, making it overly reliant on the ongoing success of nuclear energy. Establishing strategies for OPG to remain financially successful in a future of declining nuclear became an intriguing challenge that was necessary if overall change in the system was possible without bankrupting current major contributors.

To review the three horizons summary and strategic implications see pages 81 to 96.

# TIME MACHINE

During the development of strategies for OPG, several ideas gained traction within the research group and were developed further. The strategies were conceived to allow OPG to navigate through disruptive changes that had the potential for a negative impact on OPG's core business. The intent of the strategies was to chart a course that could transition OPG away from the current reliance on nuclear power generation in the event of these kinds of disruptive change. It became possible for us to imagine a rebranded company that focused beyond nuclear, playing an active role in pioneering and integrating renewable energy sources, and even beyond energy, expanding into healthcare and transportation through leveraging internal capabilities, resources and infrastructure.

The outcomes of applying our foresight methodologies was the development of a press conference celebrating the successes of OPG - a repositioned company with a diversified portfolio of energy, healthcare and its latest venture into nuclear powered trains. Playfully the scenario is both hard to imagine, while very plausible. It is unique to Ontario's specific landscape where the public company is so closely aligned to the province's needs and long term success.

To review the final time machine presentation slides see the appendix, pages 166 to 175.





# HORIZON SCAN

Almost every way we make electricity today, except for the emerging renewables and nuclear, puts out CO2. And so, what we're going to have to do at a global scale, is create a new system. And so, we need energy miracles.

~ BILL GATES

Our research began as a deep dive into nuclear energy and evolved into a broader scan that included a wide spectrum of energy options. The following horizon scan summary includes specific trends within the nuclear industry and a broader selection of drivers affecting energy production, consumption and innovation, with local and international emphasis.

<http://enformable.com/wp-content/uploads/2013/02/Electric-Power-Grid.jpg>

# MICRO NUKES

## THE PATH TO HYDROGEN POWER

NUCLEAR POWER PLANTS WILL PRODUCE HYDROGEN TO FUEL A HYDROGEN BASED ECONOMY.



TECHNOLOGY

Production of hydrogen through low temperature electrolysis, high temperature electrolysis and room temperature laser technology is appearing increasingly feasible. Even as we speak current nuclear fuel high temperature electrolysis for production of hydrogen. Next-generation nuclear plants could use fuel for low temperature electrolysis or room temperature laser technology production of hydrogen.

## THE FISSION ENGINE THAT COULD

NATIONS ARE EXPLORING NUCLEAR AS A CLEANER, LESS EXPENSIVE WAY TO POWER THEIR RAILWAYS.



TECHNOLOGY

India has a problem - the railway system that is currently powered by diesel fuel is dirty and expensive. They are now seeking alternatives, the most prominent of these being a nuclear-powered train system. The UK & Russia are also exploring powering their railways using electricity generated through nuclear reactors. Reactors powering trains could be large traditional facilities which power the train via a third rail or potentially mobilized train units. As comfort with nuclear electricity increases in certain populations, so does the expansion of uses for nuclear energy, especially when looking to solve massive problems like poor air quality which continues to plague some of the world's most populated areas.

## HOPE FLOATS

RESEARCH IS CURRENTLY EXPLORING THE VIABILITY OF A FLOATING NUCLEAR REACTOR PLANT.



SOCIAL

TECHNOLOGY

Icebreakers and submarines are currently producing and operating on nuclear energy, so is a floating nuclear power plant a far stretch? An advance like this could potentially mitigate disagreements on where to locate plants, for lack of space or public resistance. Due to experience with other aquatic nuclear vehicles, the safety of a floating nuclear power plant could be high, and is currently proposed to be less costly than building a typical land reactor. Numerous applications exist for technology such as this, including: generating heat and electricity for remote areas, and providing electricity for oil rigs.

## SMALL BUT MIGHTY

NUCLEAR POWER IS GETTING A BIG, OR RATHER SMALL, MAKEOVER: THE NEW GENERATION OF REACTORS IS SMALL, SELF-CONTAINED, COST-EFFECTIVE AND TAMPER RESISTANT.



TECHNOLOGY

Globally, demand for nuclear power is growing, but concerns over the security and safety of nuclear energy is making way for a new fleet of reactors known as Small Modular Reactors (SMR). These reactors are factory built, can be shipped anywhere, operate autonomously and can run for 30 years without the need to refuel.

# PRO NUCLEAR

## STRANGE BEDFELLOWS

ENVIRONMENT SPOKESPEOPLE ARE LOBBYING FOR NUCLEAR TO SAVE THE PLANET AS BETTER TECHNOLOGIES ARE INTEGRATED OVER TIME.



.....  
New forming partnerships appear counter intuitive. Environmentalists and libertarians are finding common ground over a shared dislike of regulatory policies that limit free-markets and alternative energy sources. Anti-establishment voices are now praising nuclear as a "bridge" to alternative energy sources, claiming that nuclear will do the least harm as better solutions are developed.

## CARBON KILLS

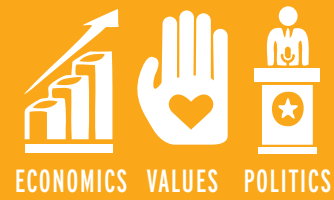
NUCLEAR POWER PRODUCTION IS PERCEIVED AS AN ENVIRONMENTALLY AND HEALTH FRIENDLY SOURCE OF ENERGY.



.....  
Carbon emissions are increasingly perceived as a greater threat than power production from nuclear

## RETHINKING GREEN

NUCLEAR ENERGY IS LOOKING MORE AND MORE FAVOURABLE WHEN COMPARED TO ALTERNATIVE GREEN ENERGY SOURCES THAT ARE PROVING EXPENSIVE, UNRELIABLE AND UNSUSTAINABLE.



.....  
Many of the "green" energy alternatives that were supposed to replace our reliance on "dirty" energy generation, like nuclear, are proving problematic once they're rolled out on a large scale. Contending with the footprint needed for wind power, the inconsistent flow of energy from solar, diverting food crops from feeding the population to the creation of biofuel, not to mention the hefty government subsidies need to make these alternatives possible, are forcing society to reconsider the role of nuclear power.

# NUCLEAR WASTE ISSUES

## LIKE BUILDING A HOUSE OVER AN OLD GRAVE YARD...

ONE OF THE BIGGEST CHALLENGES THAT ONTARIO FACES WHEN IT COMES TO NUCLEAR ENERGY IS PUBLIC PERCEPTION OF NUCLEAR WASTE DISPOSAL.



.....  
Ontario has a problem - it is called nuclear waste. When it comes to making decisions about how to manage this "hot" topic, many Ontarians have a "not in my backyard" mindset. Current disposal technologies are robust (Katherine Moshonas Cole, personal communication, Sept. 23, 2013) and Ontario has spaces that could be used as disposal sites, but public perception plagues the waste disposal and decommissioning process. A disposal site proposed in Kincardine has been met with ferocious opposition with is currently stored in warehouses at the site of the Pickering Nuclear Generating Station. Few realize that the waste they are concerned, a less than desirable containment method.

## KICKING THE CASK DOWN THE ROAD

DECISIONS BY THE OBAMA ADMINISTRATION HAVE CONTINUED A WORLDWIDE TREND OF DELAYING ACTION TO DISPOSE HIGH-LEVEL NUCLEAR WASTE, WITH NO ALTERNATIVES CLEARLY MOVING FORWARD.

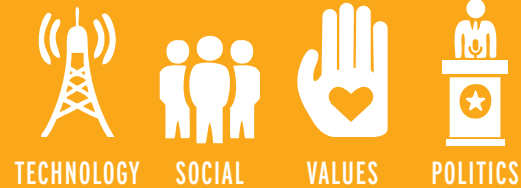


.....  
Nuclear waste is downplayed by an industry that celebrates its lack of carbon emissions. The small physical size of waste is celebrated, while glossing over the timescale of toxicity. No solution to nuclear waste has been generated despite over forty years of producing the hazard. The toxic life of nuclear waste, with high-level half lives up to 16 million years, is longer than human civilization and a time span where a comet hitting the earth or another ice age is inevitable. How to communicate danger across this time period, how to prevent all environmental disasters known to humans and how to prevent human error or misuse, are questions that need to be resolved when the timescale is fully extrapolated. The scale and scope of problems to be solved are beyond the capacity of most politicians and their short election cycles.

# WASTE FOR GOOD

## NINE LIVES OF URANIUM

PERMANENT STORAGE OF SPENT NUCLEAR FUEL IS NOT GOING TO HAPPEN SOON.



Spent nuclear fuel is not going to find a permanent repository quickly enough to solve issues. After spending \$12 billion researching the Yucca Mountain site the research team cannot confirm the feasibility of permanently storing waste fuel or, perhaps more importantly, contaminated wastewater at the site.

## REDUCE, REUSE, RECYCLE

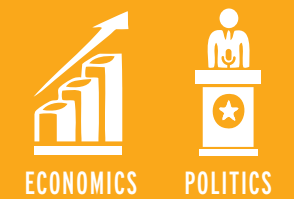
SCIENTIST HAVE DEVELOPED A METHOD TO RECYCLE SPENT NUCLEAR FUEL WASTE (SNF) TO YIELD MORE NUCLEAR ENERGY WHILST REDUCING THE VOLUME AND TOXICITY OF NUCLEAR WASTE.



Dealing with spent nuclear fuel waste (SNF) is one of, if not THE, leading concern with nuclear power generation. Currently only 5% of the uranium in a fuel rod gets fissioned for energy; after that, the rods are taken out of the reactor and put into storage. New technology called Pyroprocessing is demonstrating that nearly 93% of the energy in SNF can be reprocessed to yield more fuel for nuclear energy, while drastically reducing the length of time the remaining SNF poses a threat to humanity and the environment, down from hundreds of the thousands of years to mere hundreds.

## FRIENDS WITH BENEFITS

NUCLEAR RESEARCH AND DEVELOPMENT IS EXPENSIVE; NATIONS ARE QUICKLY REALIZING THE NEED FOR INTERNATIONAL COLLABORATIONS TO MAINTAIN A LEADING EDGE.



R&D in the nuclear field requires substantial investment and time. For nations to maintain a leadership edge in this field, they need to look beyond their own resources and capabilities. Some countries are exploring (or have implemented) private/public strategies where investment can be supported by private organizations. For example, the government of Canada is partnering with the private sector to manage and operate the AECL's Nuclear Laboratories. Other countries, like Iran and North Korea, are also partnering together (speculated partnership on nuclear warfare) - allowing collaboration and progression that would not necessarily have been attainable. We are also seeing these types of partnerships beyond nuclear - from a macro perspective the partnership between the US and Russia in a peaceful resolution to the Syrian conflict, to a micro perspective where in Toronto formerly owned and operated government organizations (such as the Light Rail Transit System) are finding ways to partner with private industry in order to strengthen the economic and intellectual resources.

# PUBLIC RELATIONS

## WHITE MALE EFFECT

INDIVIDUAL PERCEPTION OF NUCLEAR WASTE DISPOSAL IS ENHANCED IF THE NUCLEAR INDUSTRY IS ALREADY “WELL EMBEDDED” IN A COMMUNITY AND HAS DELIVERED ECONOMIC BENEFITS TO THE COMMUNITY.



There is a positive stance vis-à-vis nuclear waste disposal related to “industry awareness campaigns” as well as an “economic dependency effect” related to community acceptance of local nuclear waste disposal sites.

## THE APOCALYPSE SELLS TOYS

THE ENTERTAINMENT INDUSTRY IS A POWERFUL MOTIVATOR OF PUBLIC PERCEPTION AND AS LONG AS A NUCLEAR BOMB IS A STABLE PLOT DEVICE TO POWER INTERNATIONAL MOVIE HITS AND VIDEO GAMES, NUCLEAR FEAR WILL EXIST.



The pro-nuclear community claim that the fear of the general public is irrational, with many spokespeople citing robust scientific research to highlight the surprisingly few deaths that can be attributed to the nuclear power industry. But that doesn’t prevent this fear from being a core driver of stories that provoke fear and generate an audience for movies, games and books, that lead to the sales of action figures and more. Record sales of stories linked to end of earth apocalyptic scenarios are likely red rags to the industry bulls who are keen to cash in on public psyche.

## TYPE: B+

RETURNING TO THE DAYS WHEN THE ATOM WAS THE SOLUTION TO ALL OUR NIGHTMARES, NOT THE CREATION OF...



Recent emerging studies are highlighting the positive impacts of nuclear energy as an abundant, low-carbon source of base-load power that has made a large contribution to mitigation of global climate change and air pollution, and as a result has already saved millions of lives. While there have been countless antinuclear studies over the decades and this is a bold step in the opposite direction. It’s broad acceptance and support in the community has also encouraged other research to follow in the light. Revolutions such as nuclear energy never receive widespread support, even among the people who benefit from them. Among others is a strong irrational fear of nuclear power that’s been with us since the 1950’s. Studies show that Americans are significantly more likely to associate nuclear power with images of ‘disaster’ and ‘bad’. Ill-informed populations can often be whipped into hysteria over things they do not understand. It is the responsibility of the educated experts and the government to inform them.

# BIG BUSINESS

## PLACE YOUR BETS

FUTURE OF GLOBAL NUCLEAR INDUSTRY IS PROMISING AS COUNTRIES PLAN TO EXPAND THEIR NUCLEAR DRIVE AND OTHER COUNTRIES ENTER THE NUCLEAR SUPPLY BUSINESS TO TAKE ADVANTAGE OF THE OPPORTUNITY.



ECONOMICS



POLITICS

The global economic and socio-political conditions that promote nuclear energy are still standing - high oil prices, energy security, growing energy demand, low-carbon fuel search to mitigate climate change. While countries like Germany aim to be nuclear-energy free by 2022, new countries are adopting nuclear energy as a reliable energy source. Countries like India and China are not only creating nuclear energy reactors for themselves but are also taking advantage of this opportunity that is emerging from the intense nuclear power supply business and creating nuclear reactors for other countries. Innovation is slowly penetrating the market with technologies like the Small Modular Reactor which allow flexible, cost-effective energy alternatives.

## BIG BROTHER NEEDS HELP

NUCLEAR POWER PLANT CORPORATIONS IN ASIA ARE TURNING TOWARDS CAPITAL MARKETS THROUGH IPO TO FUND MULTI-BILLION DOLLAR NUCLEAR POWER PLANT PROJECTS.



POLITICS



ECONOMICS

State owned nuclear power plant corporations have started a trend of bypassing traditional funding models such as debt financing and are accessing the capital markets through IPO's which provide additional funding sources for the prospective. Capital markets are strong and IPO's are successful in the hundreds of millions but larger projects are in the planning which will require tens of billions. This trend is being encouraged by officials who think this will lead to the development of other innovative funding models.

# DECOMMISSIONING CONUNDRUM

## CASHING IN ON THE END GAME

THE MONEY GATHERED UP BY NUCLEAR UTILITIES FOR END OF LIFE DECOMMISSIONING IS BEING RELEASED INTO THE MARKETPLACE, CREATING OPPORTUNITY FOR PRIVATE COMPANIES WITH AN APPETITE FOR RISK.



TECHNOLOGY



ECONOMICS

Energy projects are beyond the scope of government, with timelines that stretch beyond political cycles and liability costs beyond the capacity of any government representative. In Canada this has led to an evolution of Public-Private-Partnerships, while in the USA this is leading to an increase in outsourcing private contractors. The money for these projects comes from business models developed decades ago and there is fear that there is not enough cash in the bank. In Germany there are calls for public funds to be created that ensure the flow of money is available at the time of need, while utilities companies are claiming that their economics is sound. The cash that has built up to cover costs and the possibility of projects that last at least a decade is fuelling a boom in business for companies capable of the highly specialized work required to decommission a nuclear plant. Governments are encouraging these private companies as they attempt to distance themselves from the liability risks and political fall out.

## THE PERFECT NUCLEAR FAMILY

THE FUTURE OF NUCLEAR DECOMMISSIONING WILL EVENTUALLY BE CONTROLLED BY ONE BODY THAT, ACCORDING TO INTERNATIONALLY SET DECOMMISSION STANDARDS, MANAGES THE COSTS AND OVERSEES THE DECOMMISSIONING PROCESS.



ECONOMICS

Nations around the world are dealing with the enormous task of decommissioning their nuclear power plants. Without an international body to regulate the process, countries are left to deal with the task on their own. The cost to decommission varies widely, depending on the country and each country has its own regulations and procedures. Currently, there are international organizations that share information, knowledge, and experiences related to nuclear decommissioning, but ultimately the process and funding of decommissioning is up to each individual nation. The future of nuclear power may be internationally regulated; funding will be provided to an overseeing body and that body will manage the decommissioning process.

# UNSHAKEABLE PROBLEM

## KILLING THEM SOFTLY

ACTIVISTS HAVE EVOLVED FROM A GROUP WANTING TO VOICE OPINIONS, INTO ANTI-NUCLEAR COMMUNITIES THAT KILL BIG ENERGY PROJECTS AND DISRUPT NATIONAL POLITICAL AGENDAS. BEFORE YOU KNOW IT, THEY WILL WANT A NEW GOVERNMENT OR NO GOVERNMENT AT ALL.














Public protests have been around for decades allowing the general public to voice their opinions, keeping matters local for the most part, and acting as a minor inconvenience while the nuclear sector goes about its business. Recently, the locally inconvenient anti-nuclear events have started to turn into national matters demanding disruptions in the country's political agenda. Anti-nuclear protesters are learning how to delay national projects and extending cost by hundreds of millions of dollars, and in the case of Guangdong, China, successfully preventing a nuclear plant from being built. Protesters can increase political risk of proposing nuclear projects that fail to come to fruition, thereby strengthening the anti-nuclear activities. Biggest risk for a communist country like China, is this anti-nuclear group turning into anti-government group. As they come across more of these events, the political risks will increase and become a threat. This may reach a pivotal point when the political security will begin to override the benefits of nuclear power as an energy source for their country.











<http://www.theatlanticcities.com/neighborhoods/2013/01/nasa-satellite-image-shows-beijing-drowning-lake-smog/4397/>

# CARBON TRENDS

<b>COAL</b>	<p>COAL IS BEING PHASED OUT IN ONTARIO BY THE GREEN ENERGY ACT. COAL WILL BE GONE BY 2013 IF CURRENT POLICY PLAYS OUT (ALREADY LESS THAN 3% OF TOTAL POWER)</p>	  POLITICS ENVIRONMENT
<b>CARBON</b>	<p>NET ZERO CARBON NEEDS TO INCLUDE EXPORTS AND IMPORTS.  <small>Canada has a lot of dirty hydrocarbons and there are a lot of hungry countries out there who want it. Preventing climate change needs to account for it all.</small></p>	  ECONOMICS ENVIRONMENT
<b>CARBON</b>	<p>CARBON CAPTURE SYSTEMS ARE MAKING HYDROCARBONS</p>	  TECHNOLOGY ENVIRONMENT
<b>CARBON</b>	<p>CARBON CAPTURE SYSTEMS ARE BEING DEVELOPED HEAVILY IN NORTH AMERICA.</p>	  TECHNOLOGY ENVIRONMENT
<b>OIL</b>	<p>IRAN AND OIL PRICES:  <small>Political upheaval in the Middle East is a boon to oil producers everywhere. The loss of Libya's 2.6 million barrels of daily production after the country's revolution in February sent crude prices sharply higher. The focus will be on Iran, as its the world's forth-largest oil producer .</small></p>	  POLITICS ECONOMICS
<b>COAL</b>	<p>DECLINING USE OF COAL:  <small>Declining role of coal used in power generation. Natural gas-fired plants are expected to replace retired coal-fired power plants.</small></p>	 ENVIRONMENT















<b>OIL</b>	BY 2035, CANADA ALMOST DOUBLES CRUDE OIL PRODUCTION RATES	 ENVIRONMENT
<b>OIL</b>	<b>OIL, DEMAND AND SUPPLY, DISCONNECT</b> WEO from IEA, predicts the demand for oil will rise from the 85 Million Barrels per Day (Mb/d) range to nearly 120 Mb/d around 2030. This is the fundamental disconnect: a projected demand by consumers of 120 Mb/d and a projected supply by the producers of only 1/3 of that amount. This means that in year 2030, 2/3 of the fossil fuel demand has to be covered by new fuels that we do not have today.	  ECONOMICS ENVIRONMENT
<b>COAL</b>	<b>THE FUTURE MIGHT NOT BE SO SMOGGY</b> Around the world, coal is being replaced by gas.	 ECONOMICS
<b>OIL &amp; GAS</b>	<b>ALBERTA CONTROLS CANADA</b> As long as the big industries dominate power, BIG change is difficult?	  ECONOMICS POLITICS
<b>OIL</b>	<b>BLACK GOLD, TEXAS TEA</b> The International Energy Agency (IEA) estimates that non-OPEC oil producers – led by the U.S., Canada and Kazakhstan, which has said it plans to raise oil production to over 2 million barrels a day by 2025 – will increase global supplies by a near record 1.7 million barrels a day to 56.4 million, reducing the amount of oil the world needs from OPEC.	  ECONOMICS ENVIRONMENT



[http://th01.deviantart.net/fs48/PRE/i/2009/i72/6/2/wind\\_turbine\\_by\\_TheBookofX.jpg](http://th01.deviantart.net/fs48/PRE/i/2009/i72/6/2/wind_turbine_by_TheBookofX.jpg)

# WIND, WATER & SOLAR TRENDS









<p><b>SOLAR</b></p>	<p><b>BIG SOLAR COMES TO USA</b>          Several megawatt projects are coming online in USA which are likely to be reference points for future discussions around solar. Ontario does not have similar sites for development, arid desert, but there are other opportunities.</p>	  <p>TECHNOLOGY ENVIRONMENT</p>
<p><b>WWS</b></p>	<p><b>A PATH TO CARBON FREE ENERGY IS POSSIBLE, AND IT IS BEING REFERRED TO AS WWS - THE NUMBERS ARE HUGE, THE BARRIERS ARE MATERIAL AVAILABILITY AND POLITICAL WILL.</b></p>	  <p>TECHNOLOGY ENVIRONMENT</p>
<p><b>WWS</b></p>	<p><b>A GREEN ENERGY PORTFOLIO COULD REPLACE THE PICKERING NUCLEAR STATION</b></p>	  <p>TECHNOLOGY ECONOMICS</p>
<p><b>GREEN</b></p>	<p><b>USE OF RENEWABLE RESOURCES TO GROW</b>          Canada has significant non-hydro renewable resources for electricity generation. Wind power has experienced strong growth in recent years.</p>	 <p>ENVIRONMENT</p>
<p><b>GREEN</b></p>	<p><b>GREEN ENERGY BONDS A HIT</b>          In February, the Korean export/import bank issued 500\$ Million in Green Bonds paying 5 basis points less than UST bills and is oversubscribed to the tune of 1.5 billion dollars</p>	 <p>ECONOMICS</p>

<p><b>WIND</b></p>	<p><b>CALL FOR COLLABORATION BETWEEN NUCLEAR AND WIND ENERGY PROVIDERS</b></p> <p>A tight discussion about the need for nuclear and wind to be close partners in the ongoing support for emissions free electricity generation.</p>	 <p>ECONOMICS</p>  <p>VALUES</p>
<p><b>WIND</b></p>	<p><b>JAPAN INVESTING IN BIG WIND:</b></p> <p>Japan has some huge floating turbines going on line very soon. They plan on rolling out a lot of these in order to replace Nuclear. This could be the first case study of such a large economy shifting to Wind.</p>	 <p>ENVIRONMENT</p>  <p>TECHNOLOGY</p>



<http://www.flickr.com/photos/gmcmullen/79062273/sizes/l/in/photostream/>





# DEMAND & GRID TRENDS

<b>DEMAND</b>	<p><b>ONTARIO ENERGY DEMAND IS DROPPING AS THE MANUFACTURING SECTOR IS WEAKENING</b></p> <p>Demand for energy is clearly the greatest driver of current and future decisions. Ontario's celebration of reduced greenhouse emissions and reduction of demand have little to do with efficiency gains, but rather losses to industry. If industry picks up again, will it reverse current wins? Will it push coal back into the equation?</p>	  <p>TECHNOLOGY ECONOMICS</p>
<b>GRID</b>	<p><b>THE DEMANDS ON THE GRID ARE CHANGING</b></p> <p>The electricity grid is looking like ancient infrastructure as new technologies become available. Solar and wind create unique demands - multi flow, micro locations and storage capacity - that are beyond the capability of a traditional grid.</p>	 <p>TECHNOLOGY</p>
<b>SUPPLY</b>	<p><b>BASELOAD POWER IS NOT GOING ANYWHERE</b></p> <p>Renewables (outside of hydro) struggle to be relevant in the discussion of providing baseload energy needs. The core discussion needs to evolve for them to have a greater impact at the table.</p>	 <p>TECHNOLOGY</p>
<b>DEMAND</b>	<p><b>CHANGING PATTERNS OF ELECTRICITY DEMAND IN ONTARIO:</b></p> <p>Toronto Consumption of electricity declined by 9% 2000-2009 while demand in Sudbury rose by 6%</p>	  <p>ECONOMICS POLITICS</p>
<b>DEMAND</b>	<p><b>DECLINING RESIDENTIAL AND AGRICULTURAL DEMAND FOR ELECTRICITY:</b></p> <p>Agricultural and residential demand for electricity dropped from 11000 KwH in 1996 to 9000 KwH in 2009</p>	  <p>ECONOMICS VALUES</p>



[http://www.haynesvillemovie.com/assets/media/2010/08/Natural\\_gas\\_rig.jpg](http://www.haynesvillemovie.com/assets/media/2010/08/Natural_gas_rig.jpg)








# NATURAL GAS TRENDS

<b>N.G.</b>	IS AN ENVIRONMENTAL FRACKING CATASTROPHE INEVITABLE?	 ENVIRONMENT
<b>N.G. &amp; OIL</b>	COSTS FOR EXTRACTING HYDROCARBONS ARE DROPPING, AND NEW BUSINESS MODELS EMERGING.	 TECHNOLOGY
<b>N.G.</b>	NATURAL GAS IS "GREEN"	 ENVIRONMENT
<b>N.G.</b>	NATURAL GAS - DRILLING AND PRODUCTION GRADUALLY CLIMB, AND THE FOCUS ON TIGHT AND SHALE GAS CONTINUES	 ENVIRONMENT






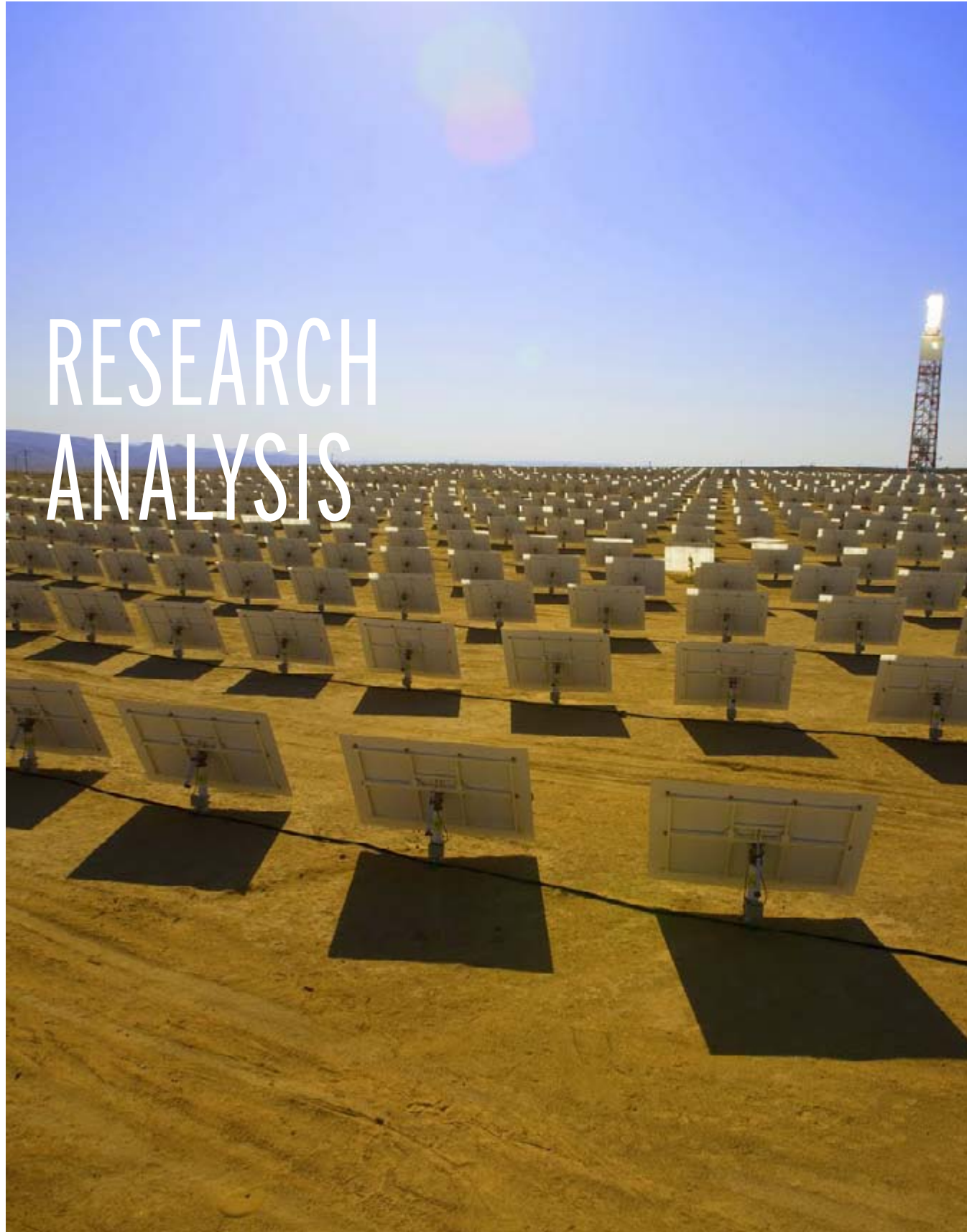
<http://www.futurehumanevolution.com/wp-content/uploads/renewable-energy-wind-and-ocean.jpg>

# GENERAL ENERGY TRENDS

<b>ALL</b>	CANADA'S TOTAL GENERATION CAPACITY TO INCREASE BY 27% BY 2035	 TECHNOLOGY
<b>ALL</b>	PREDICTIVE ANALYTICS IMPACTING ENERGY, UTILITY COMPANIES	 TECHNOLOGY
<b>ALL</b>	MOBILE AND LOCATION-AWARE TECHNOLOGY IMPACTING ENERGY, UTILITY COMPANIES	 TECHNOLOGY
<b>ALL</b>	CLOUD COMPUTING IMPACTING ENERGY, UTILITY COMPANIES	 TECHNOLOGY
<b>ALL</b>	SENSOR TECHNOLOGY IMPACTING ENERGY, UTILITY COMPANIES	 TECHNOLOGY
<b>ALL</b>	CHINA CALLS FOR VOLUNTARY CREDIT AND BOND GUIDELINES BASED ON ENVIRONMENTAL IMPACT ASSESSMENTS	 ECONOMICS  POLITICS

ALL	<p><b>ENERGY EFFICIENCY IN BUILDINGS</b></p> <p>All provinces and territories have voluntary programs encouraging greater energy efficiency in new homes and equipment. Many of these programs offer incentives to consumers such as rebates, low-interest loans, and education and awareness campaigns.</p>	  ECONOMICS VALUES
ALL	<p><b>ENERGY DEMAND GROWTH SLOWS FROM ITS HISTORICAL PACE</b></p> <ul style="list-style-type: none"> <li>• Residential sector - slowest-growing sector, drops to 11 per cent by 2035 from 14 per cent in 2009.</li> <li>• Commercial sector - By 2035, decreases to 13 per cent down from 14 per cent in 2009.</li> <li>• Industrial sector - Largest share of Canadian end-use energy demand. Increases to 51 per cent in 2035 from 47 per cent in 2009.</li> <li>• Transportation sector - 25% of total end-use demand in 2009, remains at 25% throughout the outlook period.</li> </ul>	  ECONOMICS VALUES
ALL	<p><b>BIG DATA IMPACTING ENERGY, UTILITY COMPANIES</b></p>	 TECHNOLOGY
ALL	<p><b>GLOBAL WARMING? WHAT GLOBAL WARMING?</b></p>	 ENVIRONMENT
ALL	<p><b>CHINA - PUPPET MASTER?</b></p>	  ECONOMICS VALUES

ALL	<p><b>WHAT NEEDS THE WATER?</b></p> <p>Nuclear and hydro-electric power facilities, agricultural and urban needs, are all placing growing demands on fresh water supplies.</p>	 ENVIRONMENT
ALL	<p><b>ULTERIOR MOTIVES</b></p> <p>But the oil giants' newfound zeal for green energy wasn't driven entirely by environmental altruism. Without investing in new sources of energy, they risk consuming an ever-growing amount of their fossil fuels, leaving less to be exported.</p>	 ECONOMICS
ALL	<p><b>RISE IN DISCUSSION OVER "TRUE COST" COMPARISONS BETWEEN ENERGY SOURCES.</b></p>	 ECONOMICS



# RESEARCH ANALYSIS

You could power America with renewables from a technical and economic standpoint. The biggest obstacles are social and political - what you need is the will to do it.

~MARK Z. JACOBSON

As preparation for developing scenarios, several workshops were held to identify critical uncertainties and key drivers from the previous horizon scan. In our proposed timeframe from 2013 to 2043 the following overview outlines what we identified would influence the Future of Energy in Ontario.

<http://4.bp.blogspot.com/-xYhetg7o4ZE/TaMypeoBe4I/AAAAAAAAH20/MVxaJVViPbM/s1600/BSE%25E2%2580%2599s+Solar+Energy+Development+Center.jpg>



# HOW THE ECONOMY AND CLIMATE, WHEN INTEGRATED, AFFECT WHAT IS VALUED:

## CARBON ACCOUNTING

Carbon emissions and the systemic impacts to health are rarely explored together, allowing economic focus to lead decision-making.

**COLD, HARD CAPITALISM.**

## GREEN ACCOUNTING

Companies must consider impacts beyond economics, such as health & safety, environmental, and social. Incentives or penalties are used to drive desired behaviours, for example carbon taxes or incentives.

**THE "GREENIES" RUN THE BOOKS.**



# OUR TOLERANCE TO CHANGE HAS IMPACTED HOW AGGRESSIVELY WE INNOVATE:

## HIGH INNOVATION

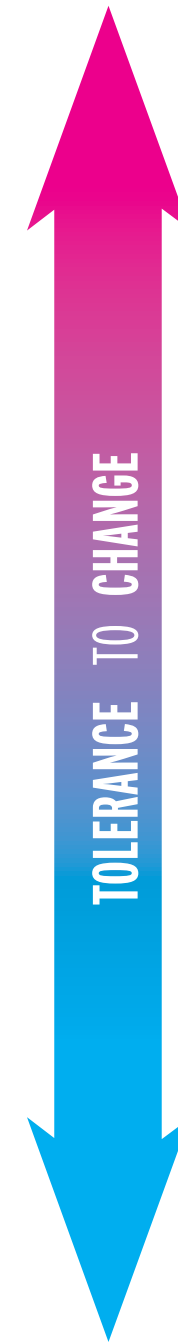
Trial and error are embraced in the hunger and urgency towards change. Research and development, innovation and technology investments are demanded by society.

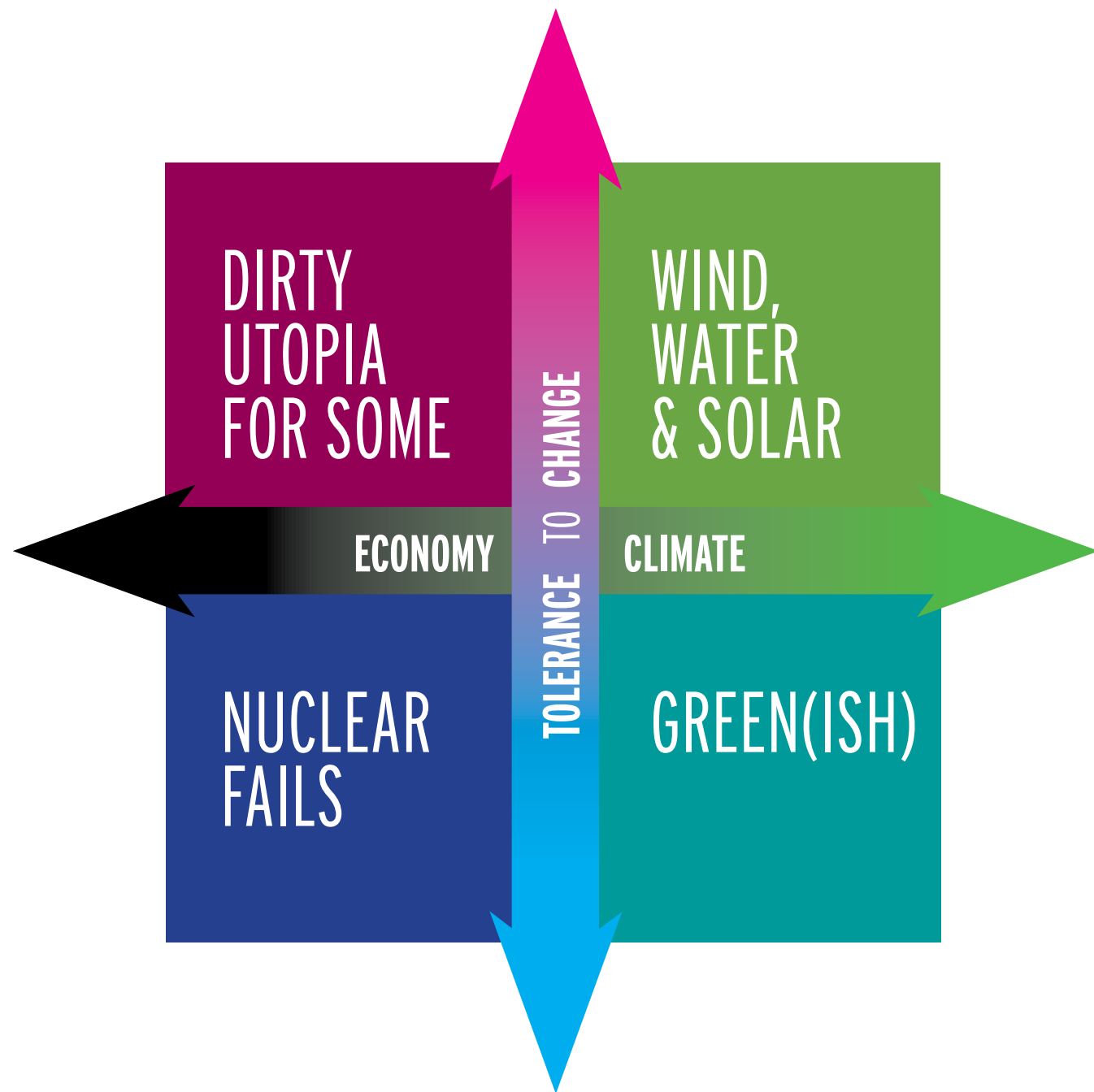
**THE TECHNOLOGY SPRINT.**

## LOW INNOVATION

With no desire to be the early adopter that fails, Ontario commits to existing infrastructure, allowing change to come slowly when proven elsewhere.

**THE TORTOISE STEERS THE SHIP.**

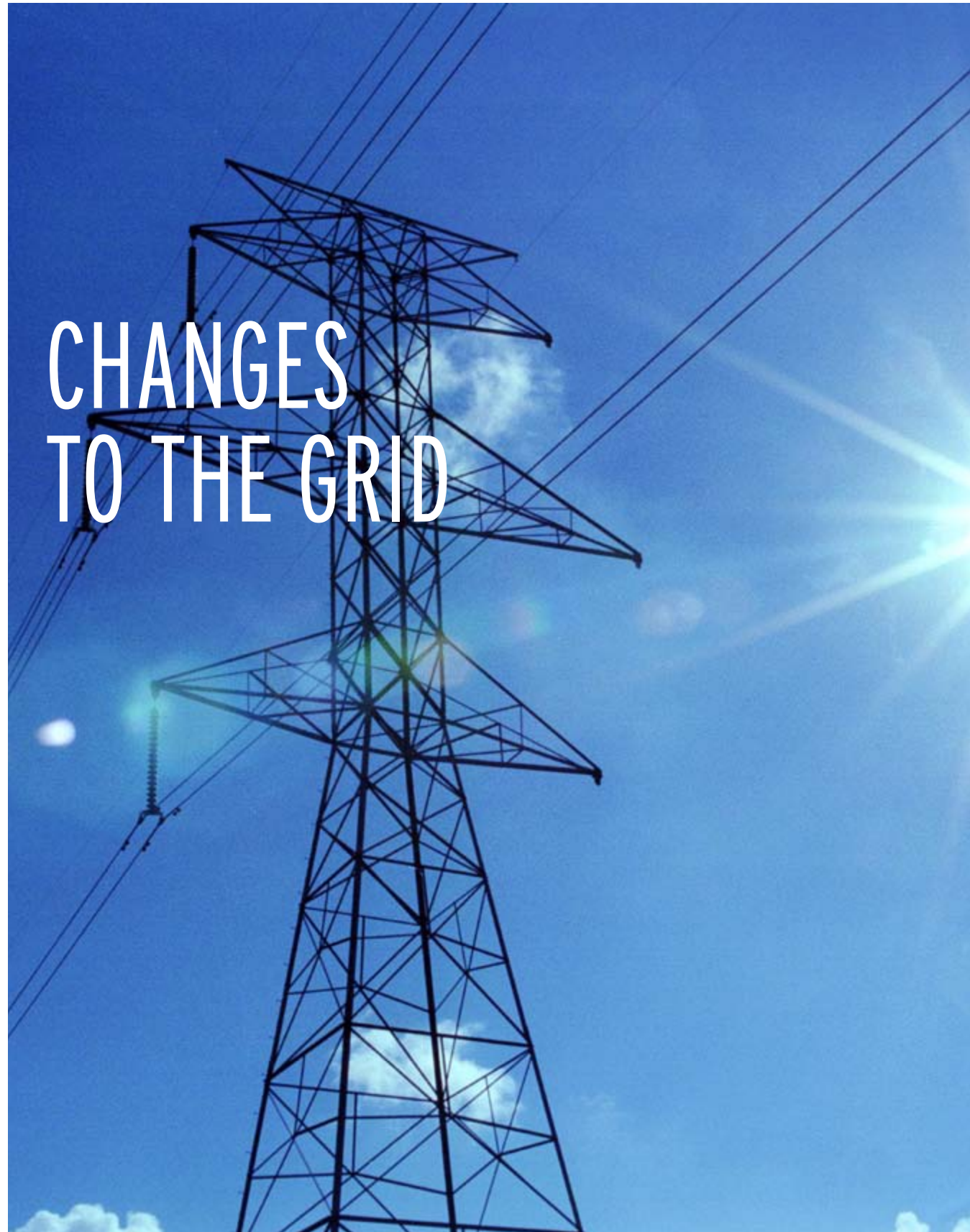




# WHAT MIGHT ONTARIO'S ENERGY MIX BE IN 2043? FOUR POSSIBLE FUTURES:

		SCENARIOS			
		GREEN(ISH)	WIND, WATER & SOLAR	NUCLEAR FAILs	DIRTY UTOPIA FOR SOME
KEY DRIVERS	APPETITE FOR INNOVATION	LOW	HIGH	LOW	HIGH
	ACCOUNTING	GREEN	GREEN	CARBON	CARBON
	GRID	STANDARD	SMART	STANDARD	SMART
	WATER TENSIONS	MEDIUM	HIGH	HIGH	MEDIUM
	ELECTRICIY DEMAND	MEDIATED & INSATIABLE	MEDIATED	INSATIABLE/ SHIFT TO MEDIATED	INSATIABLE
	DEMAND FOR INNOVATION	LOW	HIGH	LOW	HIGH

For each of the four generated future scenarios we outlined the characteristics of every key driver. Through synthesis of the many trends within the previous horizon scan, implications were generated that reveal potential challenges and opportunities that could emerge over the coming decades.



# CHANGES TO THE GRID

[http://www.alliantenergykids.com/wcm/groups/wcm\\_internet/@int/@aekids/documents/digitalmedia/mdaw/mdmx/-edisp/031206.jpg](http://www.alliantenergykids.com/wcm/groups/wcm_internet/@int/@aekids/documents/digitalmedia/mdaw/mdmx/-edisp/031206.jpg)

The infrastructure that facilitates the storage and distribution of power could be the key to the future of electricity, either preventing or facilitating the change.

## THE STANDARD GRID: NUCLEAR FAILS & GREEN(ISH)

A lack of innovation in the grid trickles into a lack of integration and viability of “alternative power sources”, due to an inability to manage localized, small scale energy and intermittent power sources.

### 5 YEARS

Incremental investments in the grid lead to little impact for integrating intermittent power sources. Wind and Solar is expensive due to complex transformers required to plug into the main grid.

### 15 YEARS

Infrastructure upgrades focus on increased efficiency and reduced loss of power at main transformer hubs. Miniscule investment is made in power storage, keeping wind, solar and hybrid production modes out of the main discussion.

### 30 YEARS

Alternative energy sources require alternative energy grids, leading to a fragmented power grid. Peripheral grids exist in small communities linked to wind and solar.

## THE SMART GRID: DIRTY UTOPIA FOR SOME & WIND, WATER AND SOLAR

The grid will accommodate innovation and distributed network functions. Alternative energy sources will be integrated into the power generation system.

### 5 YEARS

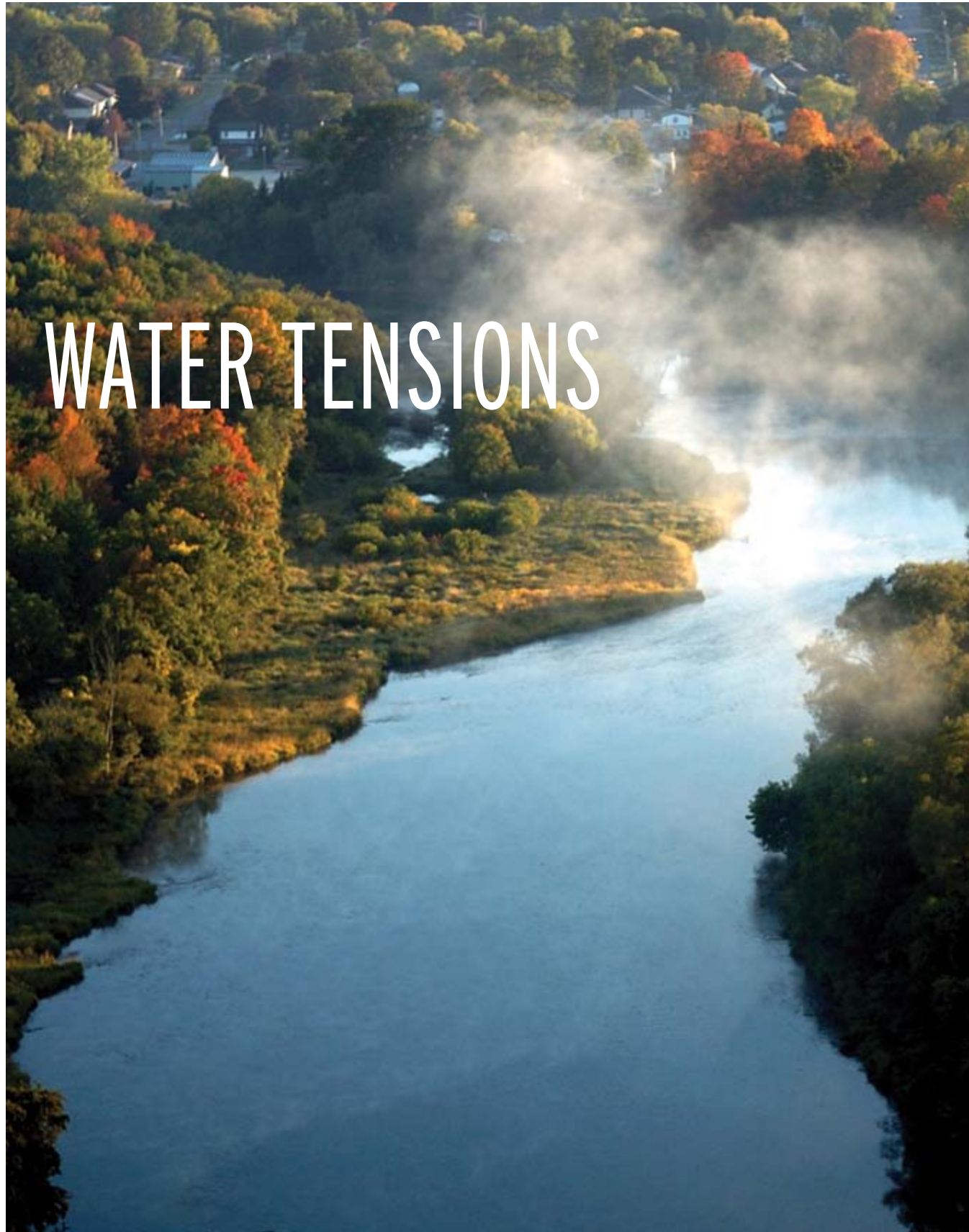
The current investments in smart grid technology are celebrated for their success and a positive public opinion leads to an aggressive near future strategic plan being developed and implementation for long term innovation within the grid.

### 15 YEARS

The emerging smart grid advances the capacity of wind to integrate, for solar to remove local need for the grid and deliver more precise power bills to consumers, rewarding those who reduce their consumption.

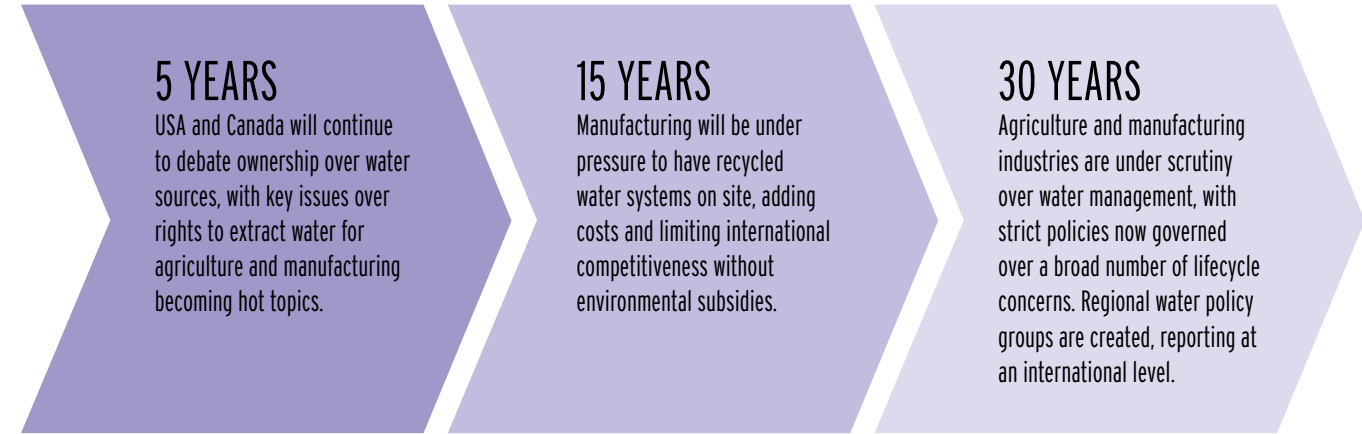
### 30 YEARS

The rise in storage technologies makes it possible for Wind, Water and Solar methods for producing power to dominate. The distributed grid network makes it possible for small scale power to emerge, with different communities competing to generate clean, cheap energy, attracting residents and businesses.



# WATER TENSIONS

Fresh water is increasingly being recognized as a vital resource with limited capacity to renew. Increasingly complex debates are emerging over water rights between USA and Canada over the Great Lakes. Fear of wars being triggered over access to clean drinking water are an international concern.



<http://b68389.medialib.glogster.com/media/a7643b423696163595c8d6e36299f3ed682972d927053ba22947d62de325ea58/the-great-lakes.jpg>

# ELECTRICITY DEMAND



<http://www.sevagc.com/wp-content/uploads/2011/02/sf-hdr-night-light-pollution-raw.jpg>

The decline in the manufacturing industry of Ontario has led to reduced demand of electricity. Although Ontario currently has a surplus of energy, steady population growth consistently influences potential increase in required capacity. Demand of a central energy provider will depend on technology and the behaviour of energy consumers.

## INSATIABLE DEMAND FOR ELECTRICITY:

### 5 YEARS

Individuals and businesses continue to make limited investments in technology that would reduce the need for power, such as insulation in buildings or localized micro-power generators.

### 15 YEARS

Increase in products and services that rely on electricity continue to rise. These include; transportation, consumer electronics and large scale computers, whose processors emerge as one of the largest drawers of power in the city.

### 30 YEARS

Most innovation is linked to computing. Constant population growth is driving general consumption. Global climate change requires a shift away from hydrocarbon fuels. This has caused electricity demand to double since 2013.

## MEDIATED DEMAND FOR ELECTRICITY:

### 5 YEARS

New policy in Ontario rewards consumers that reduce their electricity consumption.

### 15 YEARS

Early adopters who have integrated electricity reduction plans, such as condominium towers with green retrofits and companies who have developed computing technology that requires low amounts of power are reaping huge savings and large commercial success.

### 30 YEARS

Subsidies are at an all time high for residents and businesses capable of removing themselves from the central grid through distributed micro-production, as the core grid fails to cope with spikes in demand from record hot days and increased population.

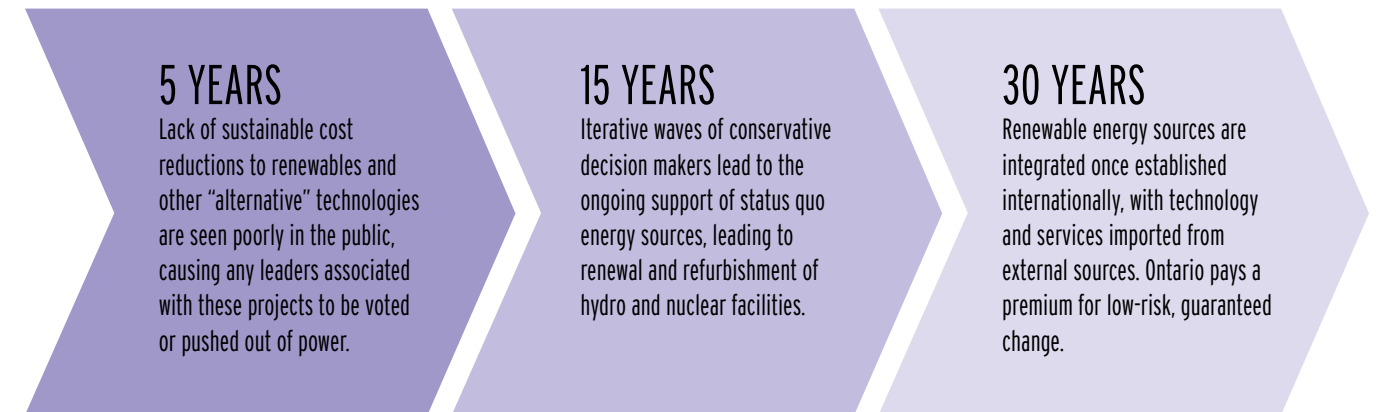


# TOLERANCE TO CHANGE

How Ontario embraces change will affect whether the province is recognized as a global pioneer of new technologies or a late adopter of established wins from elsewhere.

## LOW APPETITE FOR RISK: GREEN(ISH) & NUCLEAR FAILS:

A lack of drive for change makes decision makers conservative, as leaders do not want to be held responsible for failed actions, leading to an overall lack of innovation.



## HIGH APPETITE FOR RISK: WWS & DIRTY UTOPIA FOR SOME:

Public perception rewards politicians and leaders who take aggressive steps towards innovation, with incentives in place to encourage businesses to invest in change.



# ACCOUNTING/ DEFINING COST



<http://www.superwallpapers.com/photography/transmission-towers-15052/>

Moving beyond economics: how value is defined (i.e. environmental impact, health impact, etc.) will drive how true cost is integrated within overall accounting.

## CARBON ACCOUNTING: DIRTY UTOPIA FOR SOME & NUCLEAR FAILS

Carbon based energy remains cheap when costs such as health and environment are externalized from the business models that produce the energy.

### 5 YEARS

Continued business as normal, with countries most affected by climate change growing increasingly aggressive towards the more established countries that have made little attempt to reduce emissions.

### 15 YEARS

European Union is the only global body actively integrating externalities into their costs of production. USA, Asia and Russia continue to have high export business due to the price competitiveness of their goods and services.

### 30 YEARS

Environmental terrorism is now a tangible, global threat, with government support in some countries struggling to deal with climate change. Tensions over free-trade and environmental taxes are now UN discussions.

## GREEN ACCOUNTING: WIND, WATER AND SOLAR & GREEN(ISH):

True cost accounting is an emerging movement commonly referred to as "triple bottom line". Carbon based energy becomes expensive as taxes and duties are integrated regarding water use, carbon emissions and other natural resources. Healthcare impacts of energy generation become a major factor when comparing costs of electricity.

### 5 YEARS

Free-Trade agreements between North America and Europe focus on the integration externalized costs into exports. Countries that do not comply begin to feel financial pressure against their cost competitiveness.

### 15 YEARS

Resource intensive manufacturing returns to Europe and North America where environmental mitigation technologies work to reduce international eco-penalties.

### 30 YEARS

The bulk of energy produced by developed countries comes from renewables and non-carbon emitting fuel sources. Carbon capture technology is rapidly integrated by polluting sources.



# SCENARIOS

And God said, 'Let there be light' and there was light,  
but the Electricity Board said He would have to wait  
until Thursday to be connected.

~SPIKE MILLIGAN

Various combinations of energy sources were explored as a foundational tool for developing and communicating scenarios. News articles were used to reveal broader social and political contexts. The format of headlines and snippets of quotes, with long form articles available for a deep dive, allowed room for interpretation by audiences looking into potential opportunities or challenges that specific stakeholders might face.



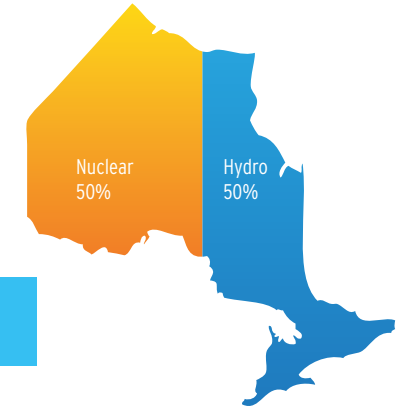


<http://www.ceati.com/Meetings/WM2011/Proceedings/images/Kerr%20dam.jpg>

# GREEN(ISH)

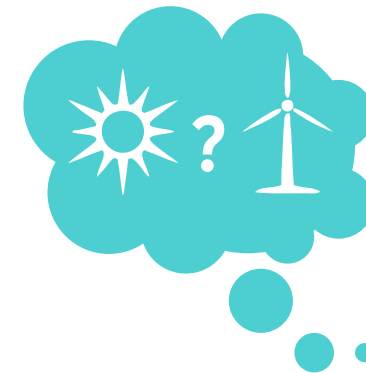
THE "GREENIES" RUN THE BOOKS

& THE TORTOISE STEERS THE SHIP



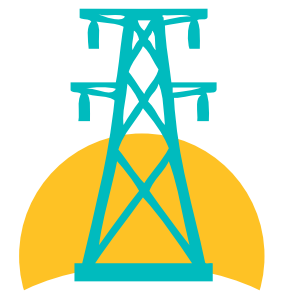
## MEGA INFRASTRUCTURE

Total reliance on hydro and nuclear means huge infrastructure, in both energy production and transmission.



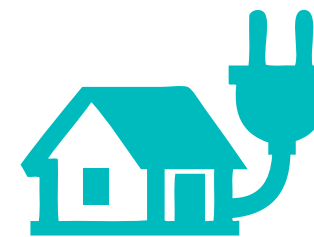
## BETTER SAFE

Wind and solar are too unproven, too risky. Better to invest in known technology.



## PLENTY OF POWER

Big Nuclear and Big Hydro means plenty of energy to go around.



## CONSERVATION IS SO YESTERDAY

A steady supplying of electricity with zero carbon emissions produced during generation means fewer pressures for the public to conserve energy.



## ZERO CARBON

Carbon emissions have been aggressively reduced.



## TAXED

Mega infrastructure is expensive and taxes are high.

# NEWS OF THE DAY

DECEMBER 12, 2043



<http://upload.wikimedia.org/wikipedia/commons/a/ab/ThreeGorgesDam-China2009.jpg>

## Talks resume on future of Canada/USA Trio Dam power sharing.

CANADA MULLS SELLING A PORTION OF ITS SHARE. CRITICS AND SUPPORTERS WEIGHT IN.

Absorbing citizens moving north to escape the heat and drought of the Sun Belt has put a strain on America's electricity supply and through these talks they're hoping to buy a greater share of the dams' output. Critics worry this step towards the US seizing greater control of the Trio dams is

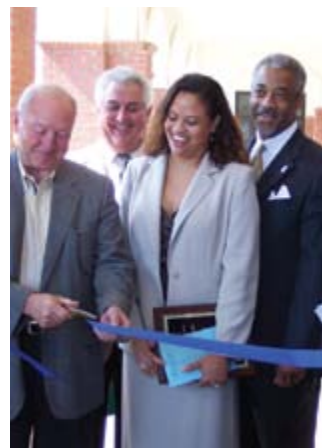
part of America's larger goal to control the Great Lakes. However, supporters argue the revenue generated by the sale will allow Ontario to fulfill its Fast Reactor mandate by 2060, possibly completing the construction and upgrades ahead of schedule.

## Ontario's second fast reactor about to come online.

ONTARIO'S SECOND FAST REACTOR, BRUCE 2, WILL BEGIN OPERATION IN FEBRUARY.

Says Uphar Dhanu, Ontario's Energy Minister, "Our government is incredibly proud of Bruce 2. All Ontarians should be. It's a world-class fast reactor that demonstrates Ontario's talent, innovation and contribution towards a carbon-free future."

Canada has become a world leader in the development and implementation of fast reactor technology.



<http://coasttransit.com/admin/wp-content/gallery/ribbon-cutting-center/Ribbon%20Cutting%20Ceremony%202-13-07.JPG>

## Toronto's last gas station to close.

FAREWELL TO A BYGONE ERA.

Since the introduction of the 25% provincial carbon tax in 2022, gas powered and hybrid vehicles were rapidly replaced with the electric vehicles of today. "It's a sad day for us, those of us who like to drive our old cars around. Gas isn't cheap,

that's for sure, but when you love to drive your 2013 Mini Cooper like I do, then you just accept the cost and the inconvenience. I guess I'll have to convert it to jet fuel now!" laughs car collector Harvey Trinh.



[http://upload.wikimedia.org/wikipedia/commons/1/14/Biglow\\_Canyon\\_Wind\\_Farm\\_under\\_construction.jpg](http://upload.wikimedia.org/wikipedia/commons/1/14/Biglow_Canyon_Wind_Farm_under_construction.jpg)

## Debate heats up over future of last wind farm site.

SITE SERVES AS A REMINDER OF ONTARIO'S FAILED WIND FARMS. COMMUNITY AND PROVINCE AT ODDS OVER ITS FUTURE.

Subsidy scandals forced the closure of all wind farms after it was revealed to the public that former Premier Neil Hastings and many of his most senior cabinet ministers held shares in TECH Energy Inc, the company with several multi-billion dollar contracts to build wind farms

across Ontario. "The province has had a bad experience, it's true. But the doesn't mean we shouldn't continue to look at ways to harness the wind." says Emma Illingsworth from WindFuture, an advocacy group for wind technology.

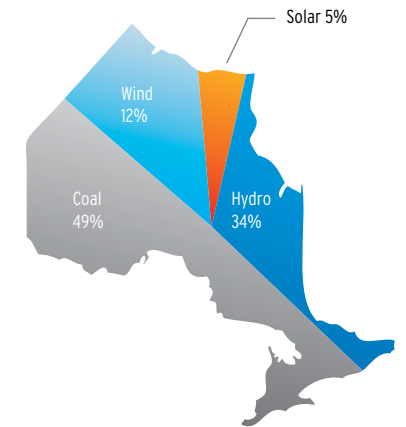
## Class-action lawsuit for displaced St. Lawrence communities set to proceed.

COMMUNITIES ALONG THE BANKS OF THE ST LAWRENCE RIVER THAT WERE MANDATED TO RELOCATE IN ORDER TO ACCOMMODATE THE MAMMOTH TRIO DAMS ARE LAUNCHING A CLASS-ACTION LAWSUIT AGAINST THE PROVINCIAL AND FEDERAL GOVERNMENTS.



[http://news.xinhuanet.com/english/photo/2011-12/08/c\\_131294486.htm](http://news.xinhuanet.com/english/photo/2011-12/08/c_131294486.htm)

# NUCLEAR FAILS



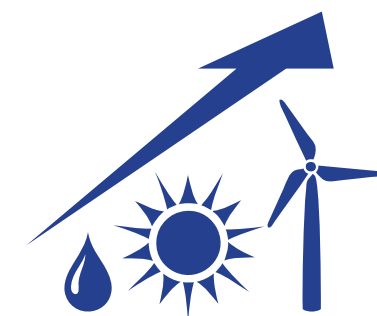
COLD, HARD CAPITALISM

& THE TORTOISE STEERS THE SHIP



**PUBLIC PERCEPTION TRUMPS ALL**

ONTARIO IS NUCLEAR-FREE AND SO IS CANADA (ALMOST).



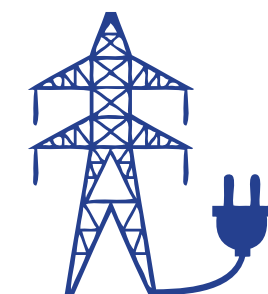
**RENEWABLES ARE GRADUALLY PROGRESSING**

The race is on for wind, water and solar.



**BIG BUCKS**

Coal - it's actually the most expensive source of electricity.



**GOING "OFF THE GRID"**

PEOPLE TAKE CONTROL.



**ONLY A MEANS TO AN END**

Coal is back (for now)



**TO IMPORT OR NOT TO IMPORT, THAT'S THE QUESTION.**

# NEWS OF THE DAY

DECEMBER 12, 2043

## The race is on for water, wind and solar

Progress for greener alternatives has been gradual and promising, but is still unable to generate the required electrical energy to replace the current base load supplied by coal. The race is on for innovation in the Water, Wind and Solar sectors to see which will thrive as a viable solution in Ontario's future.



[http://2.bp.blogspot.com/\\_b5GLWaJ5xMA/TDtltaCEETvI/AAAAAAAAAFQ/DgN5D4hu1WE/s1600/Coal\\_Plug\\_4C.jpg](http://2.bp.blogspot.com/_b5GLWaJ5xMA/TDtltaCEETvI/AAAAAAAAAFQ/DgN5D4hu1WE/s1600/Coal_Plug_4C.jpg)

## Coal (don't call it a comeback)

AS OF 2042, COAL IS PROVIDING ALMOST HALF OF ONTARIO'S BASELOAD ELECTRICITY.

The number of smog days spent billions of dollars over annually in the GTA has gone a decade, working on coal from 48 in 2005 (Coal at 29%), 12 in 2012 (Coal at 3%), 131 in 2043 (Coal at 48%). generated electricity; but this is only the means, not the end. The sulphur emissions have increased dramatically. Ontario Coal is not the solution, it's only an interim solution.

## People taking control - going 'Off the Grid'



THE MINISTRY OF ENERGY HAS LAUNCHED SEVERAL ATTRACTIVE ELECTRICITY CONSERVATION INITIATIVES AND PROGRAMS. MORE HOMES ARE NOW 'OFF THE GRID' THAN EVER BEFORE. HOMES ARE AIMING TO BECOME TOTALLY INDEPENDENT FOR THEIR ELECTRICITY AND THE GOVERNMENT IS ENCOURAGING THEM TO CONTINUE THROUGH INCENTIVES.

This interim solution to use coal as a source of electricity is expected to get us through the next few decades. While they work on possible long term solutions, they are simultaneously working on damage control - trying to mitigate the damages by attempting to lower the demand of electricity. Using coal as a source of electricity is bad but I guess if we used less, it's still better.

## Analysts claim, it's cheaper, healthier and environmentally responsible to import electricity

Studies repeatedly show, it is much cheaper, safer and environmental to import energy until we come up with a long term solution, rather than accruing more debt and causing harm for an interim solution.

## Coal - it's actually the most expensive source of electricity

IRONICALLY, AS LONG AS PEOPLE'S ELECTRICITY BILLS AREN'T GOING UP, THE EXPENSE IS CONSIDERED INDIRECT AND THEREFORE NOT CORRELATED TO THE USAGE OF COAL.

The general public just can't seem to make the connection between coal generated electricity and climate change. Coal is the cheapest source of electricity but that's true only if you consider just the direct electricity cost. The damages caused by coal are significant and when the systemic cost is taken into account to include things like healthcare, coal ends up being the most expensive and the most harmful to the people and planet.



<http://www.manageyourleads.com/wp-content/uploads/2012/04/80-20-Rule.jpg>

## Electricity is cheap, but not that cheap

RETIREMENT CHARGES COMPARED TO 4% IN 2012.

Even though we are using coal and heavy investment in one of the cheapest source of nuclear during the early parts of generation, electricity cost is still this century, the provincial debt very expensive because debt is began to skyrocket. More debt is accrued each time the Ministry of Energy replaces a source of in anticipated as Ontario moves towards a long term solution. energy. With the elimination of

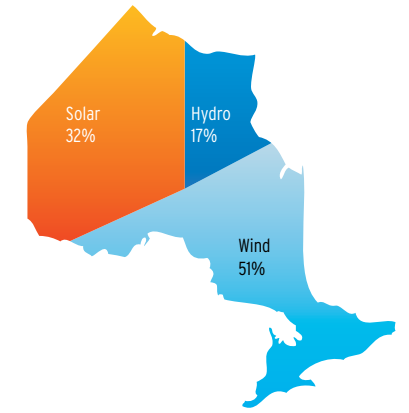
## As of today, Ontario is nuclear-free and so is Canada (almost)

12 years ago, a single local nuclear accident caused the public perception to flip overnight. Today, the last nuclear reactor - Bruce Power A4, was officially decommissioned. Public perception trumped all. In 2012, nuclear accounted for 15% of Canada's electricity (14% of which was from Ontario). Now, nuclear accounts for less than 1% of Canada's electricity.



<http://www.kreepa.org/images/slider/simple/1.jpg>

# WIND, WATER & SOLAR



THE "GREENIES" RUN THE BOOKS

& THE TECHNOLOGY SPRINT



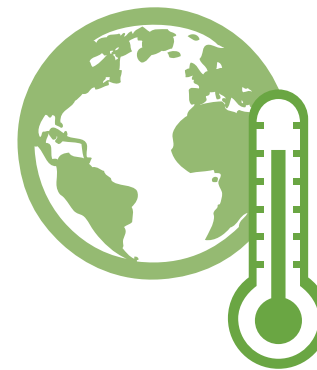
GO HYDRO!



DESPERATELY SEEKING SUSTAINABILITY



DIKTATOR IN DISGUISE?



GLOBAL WARMING CONTINUES TO CREEP



BIG WIND, BIG BUSINESS



## Conservation is big business

CORPORATIONS CONTINUE TO MEET AND EXCEED ELECTRICAL ENERGY CONSERVATION TARGETS.

“Sustainability is our number one priority. In the past 20 years, we have continued to implement successful strategies to decrease our electrical energy consumption. The government tax rebates are great, but our employees say they do this because it make sense for Ontario,” says James Grainer, CEO of Magentatech.

“Many of our partners in Calgary and Edmonton are struggling. Government rebates for businesses that comply with energy consumption guidelines are significant and we are now seeking partners that are in alignment with the NSGE standards.”

## Ontario is now poised to be self-reliant by January 2044

WITH THE INTRODUCTION OF THE INTEGRATED SMART GRID, GUESSING GAMES OF SUPPLY AND DEMAND ARE NO LONGER AN ISSUE.

Following energy leaders, like Japan, Ontario has decreased its energy use, transitioned to cleaner methods for producing electricity, and implemented smart grids to monitor and meet its energy needs. This all comes with significant challenges. Building the

integrated electricity grid cost taxpayers four times the estimated cost of building two new nuclear plants, and the estimated maintenance costs far exceeded the initial proposal budgets back in 2022. This leaves Ontario in significant debt.

## Food export restriction creating greater Government/Farmer tensions

HEATED DEBATES ON THE NEW FOOD EXPORTING RESTRICTION IMPOSED BY THE CANADIAN GOVERNMENT ARE RAGING.

“With the Great Global Food Crisis, there is a huge demand for our agricultural goods from large consumers like China. Now with export restrictions and price caps, we are losing significant bitcoin value.” “Where once upon a time we

believed manufacturing in Ontario was dead, restrictions like these are forcing agricultural sector workers and owners into the booming manufacturing sector.” - Joe Taylor, Ontario Agriculture Association

## Ontario works to develop a solution for long-standing nuclear waste dilemma

IT’S BEEN 11 YEARS SINCE THE FINAL NUCLEAR PLANT IN ONTARIO HAS BEEN SHUT DOWN, BUT DECOMMISSIONING AND WASTE MANAGEMENT HAS CONTINUED TO HAUNT OFFICIALS AND THE GENERAL PUBLIC. GAMES OF SUPPLY AND DEMAND ARE NO LONGER AN ISSUE.

“It is irresponsible of us to delay the management of this problem,” says the Minister of Environment, Susan Kane. The choice to refurbish X and Y years ago, rather than build new plans, was a turning point for Ontario’s commitment to wind and solar, “the strategy

of using nuclear energy as a bridge while Ontario developed stronger capacity for wind and solar energy has proven to be key: Public approval of our energy mix has strengthened and our manufacturing sector has regenerated.”



## Manufacturing boom continues for now

ONTARIO INNOVATIONS IN OFFSHORE WIND ARE PROPELLING THE ECONOMY.

Wind continues to be a dominant energy option for Canadians and the world. As export leaders in offshore wind manufacturing, Ontario is in an ideal position. The drastic decision decades ago to abandon all land locked wind farms in pursuit of offshore wind turbine research and development proved to be a wise move, stimulating jobs and the development of a new

manufacturing sector. The world demand for offshore, wind-based electricity products was grossly underestimated and Canada is now the largest exporter of wind turbine components. Germany and India continue to invest heavily in wind research and development, and are Canada’s biggest competitors in this export market.

## Shine on, Ontario!

THE MANDATED SOLAR PANEL (MSP) PROGRAM NOW SPANS 45% OF ONTARIO RESIDENCES AND 55% OF ONTARIO BUSINESSES.

Beginning in 2019, the agreement between developers and government for the installation of solar panels on all new builds in Ontario has been a success. Family dwellings (average panel installed is 3000W) are able to draw 45% of household electricity needs from their panels, and draw the remaining from the integrated smart grid (hydro and wind). Lisa Napper is a proponent of solar panel installations on residences.

Lisa says, “Panels have cut our electrical energy cost in half over the past 15 years.” Ontario was a leader, along with a number of other areas around the world (i.e. India, California) in creating legislation for the mandatory installation of panels on new builds. In the past 10 years, cost of panels has decreased and effectiveness has increased substantially. Some of the newest panels are esthetically enhanced to blend well into the home exterior.



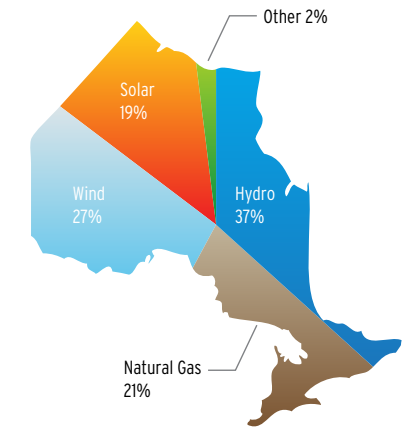
<http://www.dezeen.com/2011/04/07/competition-five-copies-of-utopia-forever-to-be-won/>

# DIRTY UTOPIA FOR SOME



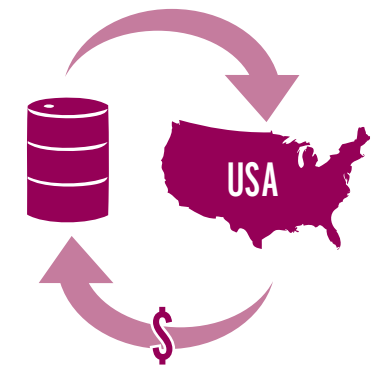
COLD, HARD CAPITALISM

& THE TECHNOLOGY SPRINT



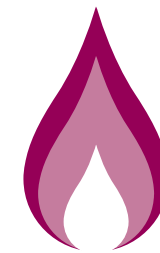
## BIG WIND! BIG SOLAR!

Ontario is a major industrial exporter overseas



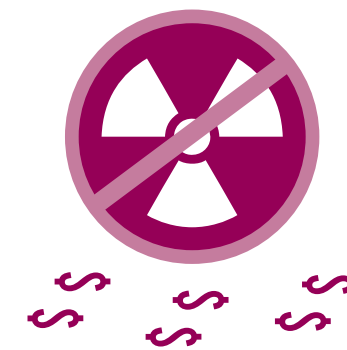
## EXPORT BUCKS!

North America is the Oil Baron of 2043.



## GOT GAS?

Local industry relies on natural gas to provide energy.



## NO NUCLEAR!

Too expensive to build the infrastructure, more money in selling minerals overseas.

# NEWS OF THE DAY

DECEMBER 12, 2043



## Snowbirds no longer fly south

A PERSON JOURNEY WITH THE EMERGING OUTSIDE CLASS OF ONTARIO.

"Everyone is forgetting the huge losses of crops to frost due to unpredictable starts to the growing season and the pests that come in the thick of the heat." Says Hamil Lectenour, author of *There are no Winners in Climate Change*. "Canadians are fortunate to be in an economic and ecological position to benefit from the gradual shift in temperatures," Says Conservative leader Suzanne Wainwright. "But the books of doom and gloom are the ones that sell."

## No Breathing Easy in Streets, No Satisfaction at Home

SMOG IS DRIVING PEOPLE INDOORS, BUT THOSE WHO CAN AFFORD UTOPIA ARE FINDING IT BORING.

While a few of the very wealthy have had their homes and businesses sealed inside translucent domes fitted with equally expensive air purification systems, the vast majority have seen their quality of life suffer. If it's hard to see your hand in front of your face, the income gap is clear.

## Wealth at What Cost?

ENVIRONMENTALISTS FURIOUS THAT BROAD IMPACTS ARE STILL BEING IGNORED, BUT ONTARIO IS FLUSH WITH CASH FROM THE GOVERNMENT.

"Globalization is much more than sharing economic resources," Says Damien Gould from the World Energy Outlook, "We share our atmosphere as well." Cash from the Energy Equalization Program, with Ontario now being a "Have-Not" drives innovation investment and manufacturing, making Ontario the highest energy consumer in Canada.

## Extended Growing Season a Boom for Ontario Farmers?

ONTARIO LEADERS NAME THEMSELVES WINNERS OF CLIMATE CHANGE - BEFORE THE RESULTS ARE IN.

Every summer they arrive, poor, octogenerian migrants fleeing the oppressive heat of the southern states and migrating north to Canada, congregating around the Great Lakes. There is a growing awareness that the impoverished communities clustered around thermal electric power plants, using low tech devices to take advantage of the waste heat to speed up crop production and provide the necessities of life, are a potential threat to the grid that powers the city-states of the Great Lakes Region.

## Healthcare Cuts Continue

ONTARIO RESIDENTS STILL WAITING FOR TRICKLE DOWN EFFECT AS GOV-BIZ PARTNERSHIPS RAKE RECORD PROFITS.

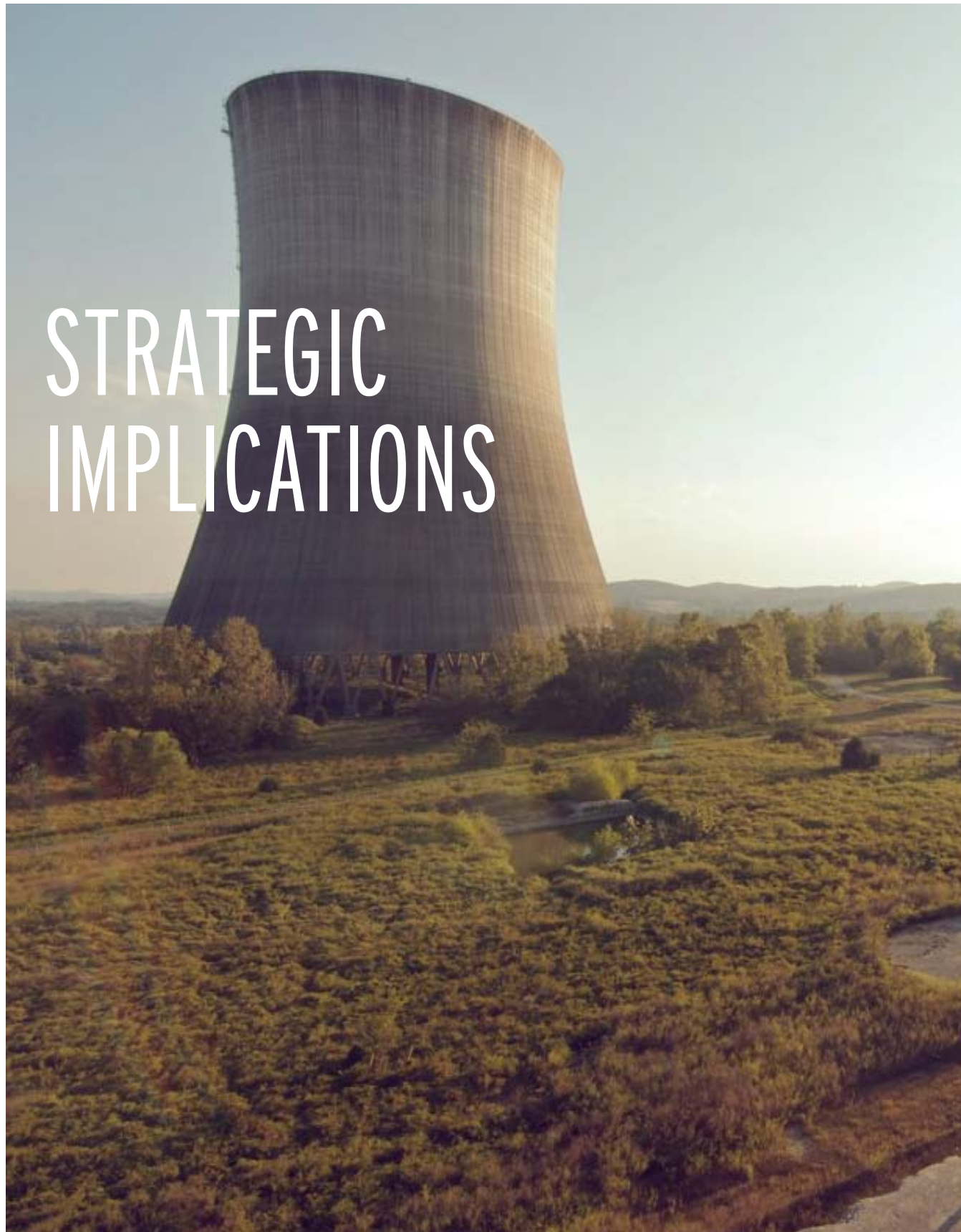
The early gains in social structure of the late 2030s, fuelled by the income of gas exports, has fallen behind as business sponsored services continue to be backed by government. Statistics show that employees of Big-Biz are declining thanks to the technology developed, making many inelligible for healthcare. "We worked hard to develop the technology that puts us out of work," Says Michael Rapooni, a robotics engineer, "Now business has cut my services and the government won't answer my calls."

## North American Oil Pushers

OPINION PIECE: NORTH AMERICA PUSHERS OF HIGH CARBON ENERGY STRUGGLE TO CAPITALIZE ON INTERNAL INNOVATION.

There now appears to be sound economic theory suggesting that without carbon based exports, North America would not be the juggernaut it is today, as the local economy has not found a way for reduced consumption to drive economic growth. Canada needs to be careful that the current confidence doesn't land it in hot water, melting ice opens shipping lanes full of gas, but that pristine lake system is looking more fragile than ever before...





# STRATEGIC IMPLICATIONS

Why is electricity so expensive these days? Why does it cost so much for something I can make with a balloon and my hair?

~DENNIS MILLER

Through the strategic implications development, a vision of the preferred future emerged for establishing Ontario to work towards an energy generation mix that was dominated by renewable sources and without carbon emissions. OPG (generates 70% of Ontario's energy) emerged as a key stakeholder with the most at risk, as their entire nuclear-dominant business would be threatened. The three horizons method identified strategies that could be used in the development of OPG's business strategies and provide recommendations to drive this change.

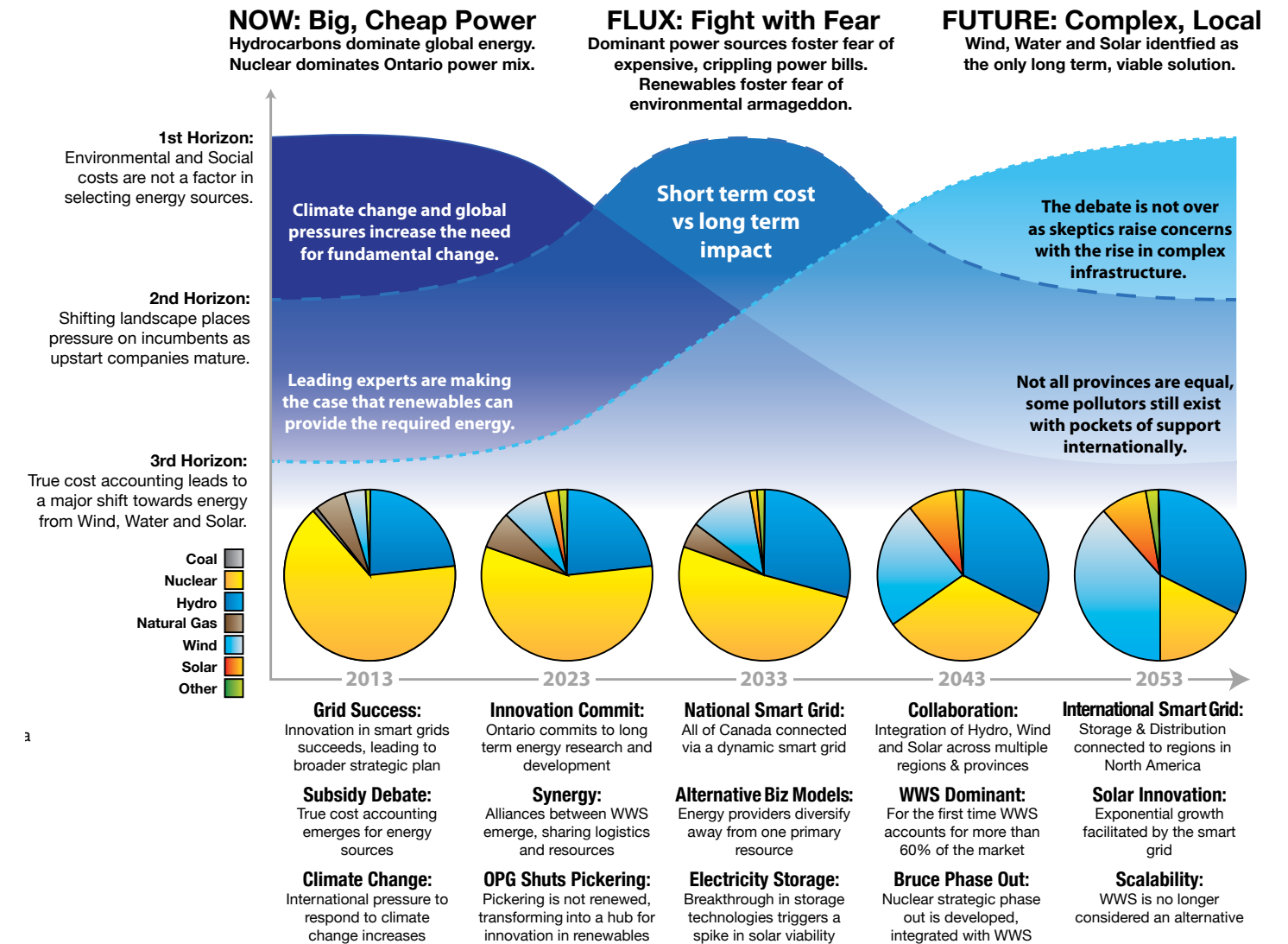
# Shifting The Energy Landscape of Ontario

## Introduction:

Domestic and international trends indicate a progressive movement toward renewable energy sources and away from higher CO2 emitting energy sources, although the rate of movement varies greatly between nations. Due to this shift, the development of implications and strategies focused on a future dominated by renewable sources. In Ontario, Ontario Power Generation (OPG) was identified as a key stakeholder as they generate 70% of Ontario's energy. With nuclear energy as their primary product, their business sustainability in the preferred future could be compromised unless they adopt change. This presents a unique opportunity for OPG to drive change in Ontario.

Another key stakeholder is the Ministry of Energy, because they drive choices and change in Ontario's future and impact consumer behaviour and industry partners. The third key stakeholder is the general public; by increasing engagement and aligning with values of Ontarians, the choices leading to Ontario's future energy mix will be embraced. Finally, changes in current infrastructure (the Grid) need to be made in order to support the proposed changes. Without integration of these key stakeholders, achieving the preferred future could be limited.

Horizon 1:	Horizon 2:	Horizon 3:
Global environmental crises trigger international discussion over energy	The case for WWS viability gaining traction and credibility	Public accepts the cost of environment integrated into electricity bills
Ontario investing in a smart grid	Japan investing in big wind - floating turbines - to replace nuclear	Technology for storing electrical energy is rapidly evolving
Kincardine deep geological repository triggering international debate	Environmental studies into the long term effects of fracking will be completed	Long term costs for refurbishments of nuclear facilities are a concern
Cheap gas revolution reducing carbon emissions in USA	Externalized costs are being incorporated into power costs	Management of nuclear waste causes negative high profile public debate
Hydrocarbons costs dropping due to fracking technologies	Climate change causes negative effects to Ontario crops due to flooding and inconsistent seasons	Offshore wind turbines proposed for the Great Lakes
Support for nuclear dropping in Germany and Japan	Call for collaboration between nuclear and wind energy providers	Nuclear decommissioning is a big business opportunity for companies willing to take on the challenge, driving acceptance for phasing out nuclear facilities
Nuclear capital costs increasing due to requirements for environmental proofing	Rise in discussion over "true cost" comparisons between energy sources	
North America investing heavily in carbon capture systems	Many Americans and their representatives in Congress still doubt climate change is a problem worth addressing	
Clean air, reliable generation and modernized transmission forecast to increase residential bills 3.5% per year		



## Implications:

<b>Energy Producers:</b> Producers of non-renewable energy sources will need to explore alternatives to remain successful in a future that actively calls for an end to their core business.	<b>Ministry of Energy:</b> Political leaders will need to strategically navigate complex changes where no solution comes without potential losers and conflict.	<b>Infrastructure Partnerships:</b> Large scale infrastructure changes required by wind and solar will require collaborative partnerships between producers and resellers of electricity.
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## Key Stakeholder Strategies and Implications:

The following section describes the short and long term strategies for each key stakeholder so they contribute towards change, stay relevant and succeed in this preferred future.

# MINISTRY OF ENERGY

Although **Ministry of Energy (MOE)** is successful today in meeting the electricity demand of Ontario, the challenges that lie ahead go beyond just meeting the electricity demand. They are about the quality and efficiency - of the technology, governance structures, business models, health and well-being of individuals and more. For MOE to continue to be successful in the preferred future of 'Wind, Water and Solar in 2043', they need to consider the true accounting cost, build relationships with other ministries and work towards shared outcomes, create a sense of community at large within the energy sector, and as a sector, assume responsibility beyond just energy.

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## STRATEGIES:

**Build A Strong United Community** - The energy sector is extremely hostile because each energy source believes they are the future - If you are not part of their energy source you are going to fail. Energy sources are competing with each other for the energy market share and even within each energy source, there are multiple companies competing. This creates a win-

lose environment because in order for one to win, another has to lose (i.e. if nuclear wins, wind loses). This is creating friction and hindering innovation because the goal of an energy company is not aligned with the larger purpose of MOE. If departments within a company are competing against one another, the company as a whole can never succeed.

MOE, as the governing/regulating body, needs to shift this paradigm because energy companies and MOE need to be aligned in their purpose, values and goals. MOE's goal is to meet Ontario's energy demand through accessibility and affordability, and they aim to continually innovate towards building a better future. The energy community needs to collaborate and innovate to build a better future that is economic and environmentally friendly. Rather than having individual communities within the sector that are based on energy sources, MOE needs to build a larger sense of community within the energy sector as a whole. This would change the nature of their business because you are changing the purpose for their existence.

**Let Companies Compete, Not Energy Sources** - Our current energy system forces all energy sources to compete. Every energy company uses only one source (i.e. wind) which means, the company has incentive to promote wind and its success, but also devalue other energy sources. However, if that same company was using multiple sources to generate energy (i.e. wind and hydro) then their incentive lies within the success of both energy sources. In the former scenario, energy loses, but in the latter scenario, energy benefits.

If, for reasons such as public perception or federal mandates, Ontario had to move towards a nuclear-free energy mix (nuclear power plants generate over 65% of Ontario's electricity) this would be very challenging. Not just from a financial standpoint but also the strong pushback from the nuclear industry - companies would do everything in their power to exist because essentially, you are challenging their survival. This challenge is wrong, and unhealthy. The challenge should not be about the survival of a company, the challenge should be about

energy - remove the company from the challenge so their survival is not threatened. Instead of defending an energy source because it threatens the company's survival, challenge the company to generate the most economic and environmentally friendly energy possible.

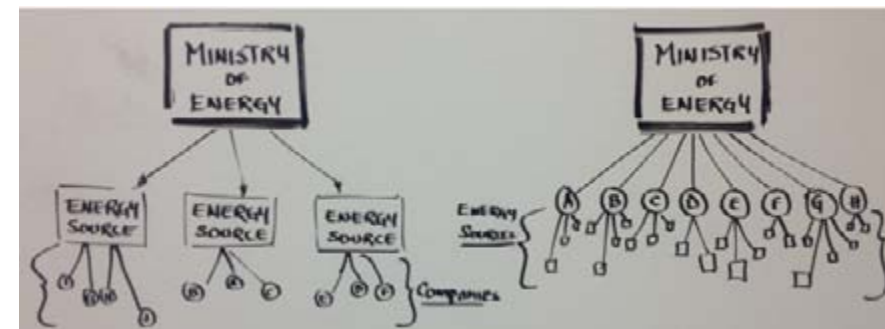
Energy sources should not be above the company, the company should be above the energy source. **Let companies compete, not energy sources.** This shift would minimize the unnecessary conflict and boost innovation and diversification in the energy sector.

**Consider True Cost Accounting** - Energy sources like coal have been polluting the environment and causing harm to the citizens of the land. Even though coal is viewed to be the cheapest source of electricity, if you take into consideration its impacts and consider the systemic cost (i.e. health and environmental costs), it proves to be the most expensive and the most harmful source of energy. Although coal is no longer part of Ontario's electricity mix, MOE has a

**Build Relationships with Other Ministries** - MOE needs to be more than just about energy generation and meeting energy demand. They need to link with Ministry of Environment (MOEv) and Ministry of Health (MOH) and build a plan for shared outcomes. This shared agency would allow MOE to have an open discussion with MOHLTC and MOEv to understand the impacts they have on one another and develop a relationship with shared accountability, allow them to reduce the negative impacts and foster shared outcomes.

**Risk Of Reducing Nuclear Energy in Ontario** - There is enormous governance at the federal level to regulate the nuclear industry in Canada. Although the decision to invest in electricity generation rests with the province (the province and the power utilities determine if nuclear power plants should be built), constitutionally, nuclear energy falls within federal jurisdiction. In 2012, nuclear accounted for 15% of Canada's

For example, If Ontario becomes nuclear-free, it means nuclear would account for less than 1% of Canada's electricity. If Ontario dramatically reduces nuclear energy, this may encourage the federal government to reevaluate the 'cost of nuclear' as a nation; they may reach a decision that the national infrastructure costs associated to maintain, govern and regulate, along with its risks, for less than 5% of energy mix, is just not economic. If so, the federal government could eliminate most of the regulating and governing bodies at all levels of government, eliminate the risk of any nuclear accidents or misuse and become a nuclear-free country.



huge impact on the health and well-being of its citizens. MOE needs to realize this impact, assume responsibility beyond just energy and take accountability for the health and well-being of its citizens.

electricity (14% of which was from Ontario). If Ontario is moving towards supporting a future with Wind, Water and Solar to replace nuclear, this raises many challenges, opportunities and also risks.

# ONTARIO POWER GENERATION

In the shift to an energy landscape dominated by wind, hydro and solar (WWS), OPG must work towards energy diversification and becoming a collaborator with the current “alternative” power sources of wind and solar. A critical success factor will be to develop and maintain public trust and support.

Change is happening. What does this mean for OPG?

International, national and local trends are showing a decrease in nuclear energy support, and in some cases an active move away from nuclear energy. Ontario currently has strong support for nuclear energy, however is showing early signals of a potential decline. This is validated by the latest MOE long-term energy plan that was released in December 2013, with a continued push towards renewables like wind and solar. A strategic analysis was conducted for OPG to identify and prioritize strategies that may successfully drive change resulting in long-term growth and sustainability in Ontario. The results are highlighted below.

*Strategic Opportunity: To transitioning Ontario Power Generation (OPG) to a future beyond Nuclear.*

## STAKEHOLDER

Ontario Power Generation is one of the largest energy suppliers in North America, with a generating capacity of 19,000[1] megawatts (MW) via:

- 2 nuclear power stations, Pickering and Darlington[2]
- 5 thermal power stations, four powered

by Coal[3] and one dual fuelled with Oil and Natural Gas

- 65 hydroelectric power stations on 24 river systems

- 2 wind power turbines

While the above sites are fully owned and operated by OPG, there are also two nuclear power stations leased to Bruce Power L.P. making OPG the sole provider of nuclear power to Ontario, and therefore 95% of Canada’s total nuclear generation and the largest supplier for North America.

Nuclear energy is valued highly due to the lack of carbon emissions, and the relatively low cost and stability of the source material due to its abundance in Canada[4]. There are several high profile environmental advocates, including Stuart Brand and Peter Schwartz[5], who very publicly support nuclear as the only source of power that can provide the energy required for electricity hungry developed societies without carbon emissions that contribute to climate change contributing. Advocates against nuclear, such as Ralph Cavanagh, agree on the same goal as many advocates for nuclear, with the debate focused solve on the speed in investment of renewables.

Pro-nuclear advocates call for nuclear

as a “transitional” source of energy as world economies shift reliance towards the alternatives of wind, solar and hydro-electricity. Concerns exist over the long term viability of nuclear due to several significant issues that remain open for debate internationally. These issues include; the ongoing generation of radioactive waste, the potential for large scale disasters such as Fukushima, international concerns over weapons proliferation caused by Iran, Syria and North Korea’s desire for nuclear energy and concerns over rising costs of refurbishment triggered domestically by OPG themselves[6].

During the foresight research into the Future of Energy in Ontario, it was identified that while there is immediate need and support for the nuclear industry, long term forecasts call for a reduction of nuclear with an emphasis on integrating renewables such as wind, solar and hydro-electricity. Ontario is in an excellent position to be active leaders of this shift, with hydro already contributing a large share of the energy mix.

## OPG’S STRATEGIC DRIVERS

*Fragile Dependence on Nuclear:*

While OPG owns and operates power generating sites from a number of sources, 95% of the energy produced comes from

nuclear power, making the business sustainability of OPG entirely dependent on the ongoing acceptance and reliance on nuclear technology in Ontario. Any shift away from nuclear will lead to a decline in profitability and long term viability for OPG, a major economic and employment contributor to Ontario.

\*Strategic Imperatives 1 and 2 (and the strategies that come out of these imperatives) address the Strategic Driver: *Fragile Dependence on Nuclear*

*Poor Public Perception:*

Nuclear struggles with a divided public opinion, with support ranging from 38% to 54% depending on the surveys. Several highly combative public showdowns over the transportation and disposal or storage of nuclear waste have divided local communities including; the transportation of turbines through the Great Lakes to Sweden, the proposed Kincardine waste burial site. Any cost overruns during the development of Darlington Nuclear Station will tip the debate dramatically.

\*Strategic Imperative 3 (and the strategies that come out of this imperative) address the Strategic Driver: *Poor Public Perception*

## STRATEGIC IMPERATIVE 1: DIVERSIFICATION OF OPG POWER PRODUCTION

OPG’s long term success has an inverted relationship to the long term integration of “alternative” renewables. In a future dominated by renewables (WWS), OPG with it’s current business model will become redundant. There is an opportunity for OPG to both reverse this relationship and facilitate a transition to WWS for Ontario, potentially

moving beyond total reliance on electrical power production as their core business.

*Strategy 1: Renegotiate the Memorandum of Agreement for Non-Competition with Renewables for a strategic phase out of Pickering Nuclear.*

The upcoming debate over the future of the Pickering Power Generation is a key opportunity for OPG to make a statement over its potential to be a major contributor to long term innovation in alternatives and its need to be a partner in this transition.

Currently OPG is limited by a Memorandum of Agreement (MOA) with the province of Ontario that controls the scale of investment in renewable energy. This agreement solidifies OPG in a combative position against renewables, as either too big to “play-friendly” with emerging energy providers, or at financial odds with the success of future competitors.

The transition to diverse power sources is complicated and requires a systemic approach that will require collaboration rather than competition and this MOA is shortsighted for Ontario’s long term management.

The Pickering Nuclear station will require refurbishment after 2020[7] if it is to continue to contribute safe energy to Ontario estimated at \$200 - \$300 million dollars[8]. So far OPG has focused on making the case for this refurbishment, with multiple investigations into the environmental and economic impact of this refurbishment.

Alternatively, proposals have been developed by current opponents to the plan for the power output of Pickering to be replaced

by a portfolio of strategies[9]. This is a key opportunity for OPG to reverse its competitive position and take on the role of collaborator and facilitator.

OPG has an opportunity to partner with pro-renewable advocates, such as “Renewable is Doable” to develop a joint alternative strategy for phasing out Pickering and replacing it with renewables in which OPG has joint investment.

OPG can use this to outline the need for renegotiating the MOA, while facilitating a less biased and more collaborative discussion over multiple plans for the future of the Pickering site. An increase in transparency at this level will have a positive impact on public perception, while making it possible for OPG to diversify its business model long term.

The Pickering site is perfect for this discussion with a plausible time frame for a strategic plan to be developed and the MOA to be renegotiated. OPG is capable, due to its thermal energy capacity, to guarantee support energy if required during the transition via temporary production of energy from non-renewable resources.

*Strategy 2: OPG as investor and advocate for the Smart Grid.*

Upgrading the grid to allow bi-directional flow of electricity is vital to integrating renewables such as wind and solar. The more modular the grid becomes the more flexibility is created. Individual sites, small and large, could be enabled to selectively draw from the grid depending on local energy production. This is especially valuable for energy sources that are reliant on external conditions, such as solar and wind.

OPG needs to be a participant on the Ontario Smart Grid Forum, advocating and pioneering technology where possible within its facilities. This work could align OPG with the Ontario Ministry of Energy, while potentially developing internal innovation and service capacity that could be marketed beyond Ontario's borders.

*Strategy 3: Invest and establish significant commitment to developing Wind and Solar alternatives, and further explore tidal, biomass and other alternatives.* The future is greener and relies on an energy mix, not a single energy source. The OPG is in an ideal position to demonstrate leadership in this market and to carve a "non-CO2" pathway for others to follow. With the virtual elimination of coal use for electricity production in Ontario, and nuclear and hydro providing the bulk of power, the OPG has space to broaden the scope of their offerings, increase market share, and expand into the manufacturing sector.

Tactics could include:

*Develop strategic partnerships or acquire wind corporations* to lead the development of offshore wind turbines in the Great Lakes. Significant research and analysis has been conducted to analyze the ecological impact of offshore wind turbines, yet there are still unknown factors. The development of offshore wind turbines could overcome some of the current weaknesses associated with wind energy in Ontario, including visual disturbances and low-grade noise pollution. Offshore, the turbines will generate more power as wind is stronger and there are fewer obstructions (buildings, terrain features) [10]. The Great Lakes offer an interesting alternative to typical offshore wind developments, as water salinity is low (vs.

oceanic conditions that can cause equipment erosion) and turbulent water conditions are less significant. 94% of Ontario's population is located in southwestern Ontario [11], where the proximity to the Great Lakes could be beneficial as it may reduce the need for lengthy transmission lines [10]. The capital cost of offshore wind developments are greater than onshore developments, creating a potential barrier.

*Lead manufacturing of offshore wind turbine components for both domestic use and international sale.* Importing wind turbine parts can be costly; development of provincial manufacturing capacity could provide numerous economic benefits, including job creation, generate a demand for export, and position Ontario as a leader in the clean energy space. There are numerous areas that could be explored, including turbine efficiency (design and materials), development of deep-sea turbines (currently most offshore turbines are designed for relatively shallow water usage), or floating wind turbine development. As countries around the world are challenged to find cleaner, more innovative ways to satisfy energy demands, Ontario has an opportunity to capitalize on experiences to date and lead development and manufacturing in the future. Competition for this leadership role may include Japan, which is currently planning to develop an offshore wind farm that is projected to produce 1 gigawatt of power [12]. The positive social impact of developing a manufacturing sector in Ontario and increasing jobs would likely translate into strong public support for the OPG. This, combined with increase profitability and a more positive environmental impact would likely position the OPG well in the coming years, and in a way that could withstand

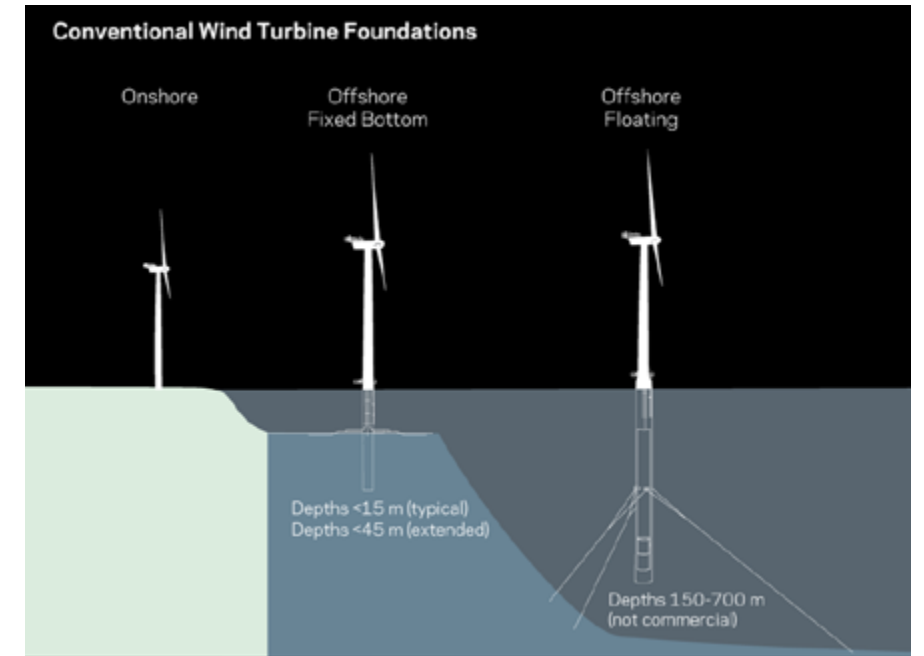
unexpected events in the future.

*Development of an Energy Centre of Excellence* to explore, develop and promote more efficient, economical, and environmentally viable innovations (ranging from strategic policy to technology advancement). For example:

- Further develop solar technologies;
- Champion legislation mandating solar installations on new residential, commercial and educational developments;
- Partnering with international researchers to develop energy storage techniques;
- Explore biomass use and links to "water use, food supply, biodiversity, job creation and market development" [14], and establish how biomass can be used to create carbon neutral or even carbon negative energy, vs. the potential to increase emissions which can occur [15];
- Lobby for equivalent regulatory environments for energy producers; or
- Explore expansion of tidal energy production, focusing on key targets like the Bay of Fundy.
- Monitor the potential for solar thermal power plants in Canada.

*Strategy 4: Analysis of assets and resources beyond power production.*

To identify opportunities for the very long term sustainability of OPG it is recommended that a full investigation into the assets and resources, both soft and hard, available within OPG that may have value inside and outside of the energy industry.



[10]

Opportunities could include:

Healthcare - rise in nuclear technology for the use in diagnostics, treatment and research. This will be increasingly valuable as Ontario's population ages.

Transportation - capitalize on emerging technology that utilizes nuclear energy to power passenger and commercial rail lines.

Waste Management - get at the forefront of extracting value from existing spent fuel, whether for reuse in the nuclear industry or for heat generation in northern climates

**STRATEGIC IMPERATIVE 2: BROADEN CUSTOMER BASE FOR NUCLEAR ENERGY**

*Strategy 1: Evaluate geographical nuclear expansion opportunities within Canada.* Currently, energy mixes are provincially determined. Decisions can be made

according to natural resource availability and provincial values (for example, Alberta's goal to achieve "sustained economic prosperity" [13]). The opportunity to expand nuclear and alternative offerings into other provinces is an option to grow OPG and to decrease national CO2 emissions.

- Use mini-reactors to mine Alberta and Saskatchewan oil-sands [16]; or
- Install nuclear capacity to replace more CO2 dependent sources.

**STRATEGIC IMPERATIVE 3: EVOLVE OPG PUBLIC PERCEPTION**

OPG's brand is limited for long term growth beyond the business of power production.

*Strategy 1: Rebrand Ontario Power Generation to OPG.*

Ontario Power Generation is already commonly referred to in the public and media as OPG, but there are benefits for completely transitioning to OPG as the primary name. When British Petroleum formally changed its name to BP in 2000 it allowed the company to reduce negative association to petroleum, allowing the company to diversify its product and service offerings.

OPG has the opportunity to develop highly visible urban Wind and Solar resources, connected to the rebrand and ongoing awareness campaign and informing the public that it is capable and willing to invest in renewables when given the chance. A partnership with a current provider that is seen as an "enemy" in order to develop micro-energy generation with high visibility in the urban cores of Toronto, Hamilton and Waterloo would increase brand exposure.

*Strategy 2: Collaborate with Government and Alternative Energy Advocates on a broad comparative energy analysis, becoming a key thought leader in true cost accounting for energy and a contributor to Ontario's long term energy strategy.*

It's critical to tackle the public perception over inequalities and biases across the energy landscape. Concerns that WWS requires substantial government subsidies are equal to fears that the nuclear is hiding the costs of waste management. Creating a true and clearly articulated accounting of the full cost of nuclear, wind, solar and water (materials, construction, maintenance, operation, waste management, site remediation, impact on human health, communities and the environment) allows Ontarians to easily compare all models of power generation and would make a better case for how transition should be managed in the short, medium and long term.

Currently OPG is an outsider to these discussions. As a thought leader in nuclear, while slowly investing in alternatives, OPG has the opportunity to contribute and be a keystone part of the future energy ecosystem.

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# PUBLIC RELATIONS, POLICY & ENGAGEMENT

The transition from nuclear to wind, water and solar (WWS) generation cannot happen without the support of the public. Public perception can be a slow-turning barge; requiring strategies from many angles to shift thinking. Ultimately a successful transition comes down to a combination of education, engagement, transparency and progressive policy, led by a government mandate and then promoted jointly by the government and by energy providers.

Public support could be developed using the following strategies.

#### AGGRESSIVELY ADDRESS WWS' CURRENT HURDLES

Including, but not limited to:

- Support research to address health concerns
- Develop policy strategies to address the perception that energy infrastructure on private property has a negative impact on property values
- Engage and educate the public to avoid "Not in my backyard" (NIMBY) resistance
- True cost accounting to establish economic, social and environmental benefits of each energy source.
- Satisfy supply and demand needs through integrated smart grid, effective energy mix and investment in storage technology

#### BRING IT DOWNTOWN

Bring WWS to urban centres. Resolve the contempt felt by rural communities for having

to shoulder the responsibility of generating power used by their urban neighbours. Make WWS present in all corners of the province - from farmland to downtown or offshore options. Daily familiarity with WWS will breed understanding and acceptance.

#### EDUCATION

Educating the public is the key to shoring up their support for, and ultimately demand of, wind, water and solar power generation. Education must take on several components:

- How the energy production process works for WWS.
- What its role is in Ontario, now and into the future.
- What are the benefits to all Ontarians (energy security, jobs, income generation, reduction in energy bills, increased health for the population and the environment)

#### PROVIDE TRANSPARENCY IN GOVERNMENT

#### FUNDING

It's critical to tackle the perception that WWS requires substantial government subsidies while nuclear is self sustaining. Creating a true and clearly articulated accounting of the full cost of nuclear, wind, solar and water from cradle to grave (manufacturing process and waste, sourcing and shipping materials, construction, maintenance, operation, waste management, site remediation, impact on human health, communities and the environment) allows Ontarians to easily compare all models of power generation and ultimately makes for a compelling economic argument for WWS.

#### RESEARCH, DOCUMENT AND PUBLISH IMPACTS ON HUMAN HEALTH

Perception that wind turbines are harmful to human health abound, with the industry and government failing to put concerns to rest or continuing to report that more research must be done. Non-biased (as possible) research on human health must be rigorously

performed for nuclear, wind, water and solar. Again, account for the entire life cycle for each method of generation.

#### COMMUNICATE INVESTMENTS IN R&D

Trumpet Ontario's role in future WWS innovation. If Ontario becomes a WWS innovation hub, subsequent job creation will shore up a sense of ownership and public support (ie: Bruce Nuclear Plant's support from the surrounding communities). Establishing research centres at Ontario universities and partnering with other progressive intellectual communities at the forefront of WWS from around the world will contribute to Ontario's identity as a global leader in the sector.

**OFFER FINANCIAL INCENTIVES** Build on current tax incentives by redesigning programs to be more attractive and more efficient than the current system. Solar panels and wind turbines on your property mean a substantial reduction in your property taxes.

Solar panels and wind turbines on private property produces energy that then feeds back into the grid, generating revenue for the property owner. Educate the population on this potential to boost income.

#### AMEND BUILDING CODES

Make WWS commonplace and urban so that it's not just something that's visible in rural places. For every square foot of new development, builders must accommodate a mandated number of solar panels.

- Bridges and handling of waterways must accommodate some form of power generation.
- All appropriate waterfronts must accommodate wind turbines wherever possible.

- Roofs of all residential and commercial buildings must accommodate the maximum number of panels for the building's footprint.

#### SMART GRID EDUCATION AND AWARENESS CAMPAIGN

WWS means users are also generators, the grid is decentralized, and energy production happens at its point of use. Ensuring Ontarians understand how a Smart Grid works and how individuals can benefit is of critical importance and that communication is the government's and the energy provider's responsibility.

There's huge opportunity for individual Ontarians to derive income from installing a form of WWS power generation on their property, and selling energy back into the grid. This is happening currently, but on a very small scale. Moving towards a greater provincial adoption of WWS means converting significant numbers of Ontarians onto a Smart Grid.

Government must be a leader by making the WWS component of each new facility prominent and celebrated - schools, hospitals, airports, transit infrastructure, courts, and other government buildings.

# SMART GRID

In the course of developing scenarios around the future of energy in Ontario a number of major or mega drivers were identified that exert pressure on the present and will continue to influence longer-term horizons in all of the scenarios. What Van derHeijden calls Big Unarticulated Issues, are according to him, examples of the business or socio-political environment shifting. These drivers included climate change, the price of energy and the supply and demand for energy. Climate change is predicted to result in an increase in the number and intensity of storm events and flooding as well as fluctuations in temperature and a significant externality in all of the scenarios. So too, the social factors of mobility and security as well as the economic factors such as growth, globalization and the emergence of a "sharing" economy will all form part of the contextual landscape. We developed a matrix with these drivers in mind with two axes of uncertainty. The horizontal axis expressed a range for generally accepted accounting that might exist in the scenarios. At one end of the axis costs related to carbon are completely internalized in the price of goods and services and at the other extreme those costs are externalized. On the vertical axis, we plotted societal resistance to change, ranging from high to low.

Among the signals that informed our selection of drivers, the trend toward the emergence of smart grid in Ontario was identified. Two key questions that need to be answered in our aspirational transition to a carbon free economy represented in the

scenario Wind, Water, Solar:

**"How might Ontario transition to a smart grid?"**

and

**"Who are some of the key stakeholders that would be involved in such a transition?"**

#### STAKEHOLDERS:

Many of Ontario's current major stakeholders in the Smart Grid today are members of the Ontario Smart Grid Forum. They are drawn from public agencies, industry associations, universities and the utility sector to this forum which was convened in 2008 by the Independent Electricity System Operator (IESO) which was founded in 1998. Members of the Ontario Smart Grid Forum include representatives from:

- IESO
- Toronto Hydro Electric System Limited
- Niagara-on-the-Lake Hydro
- Ontario Centers of Excellence, energy and environment sector
- University of Waterloo, public policy and sustainable energy management
- Ontario Power Authority
- Hydro One
- as well as observers and working group members from the Ontario Energy Board

the Ontario Ministry of Energy and Natural Resources Canada

#### WHAT IS A SMART GRID?

At the most basic level of smart grid can be understood as an electricity transmission network with the capability of bidirectional flow of power. The bidirectional aspect stems from the emerging patterns of renewable energy production and consumption that see residential, commercial, institutional and other users of power also being sources of renewable energy from solar, wind and other production modes that will feed power back into a grid when they produce more than they need for their own consumption. While currently smart grid is focused primarily on the distribution of electricity, in the future it will be better understood as infrastructure that gathers, stores, processes and delivers data. In this definition, the term data is used in more of a sense that ecologists might use the term and includes concepts of mass and energy as forms of data and the distribution of that data as information. It is the emergence of information in what was formerly purely a data or power focused grid that has resulted in notions of intelligent use and the term "smart grid."

"A national smart grid has been at the forefront of Barack Obama's energy administration, yet it is still struggling to get through the state level." (Perekov)

Here in Ontario, the transition to a smart grid has begun with smart meters in many homes and small businesses. The increases

in reliability, efficiency and benefits the user experience are numerous. They allow the consumer to manage their demand and take variations of supply into account in order to determine optimal times to use power and activate devices accordingly. Perhaps more significantly however, a smart grid provides technology for accommodating highly localized production of renewable energy and a mechanism for both feeding it into the grid and managing the distribution and storage of that energy. New perspectives on energy storage and new policy tools such as feed in tariffs need to be taken into account by Smart Grid stakeholders.

#### STORAGE:

The ability to store power by converting the power from one energy source into another energy source provides both spatial and temporal benefits. Storage management is another aspect of the smart grid. Power can be generated and stored at the same source transported to a customer for storage at that location or to intermediate points along the grid or in the case of hydrogen energy can be converted from a fuel source and stored in hybrid vehicles for use in the vehicles were transportation to other users. In addition to hydrogen as a storage medium, there are numerous types of batteries as well as compressed air storage and pumped Hydro. Less well known storage mediums are flywheels and super capacitors.

#### FEED IN TARIFFS (FIT) IN ONTARIO :

Feed in Tariffs are a government economic policy that provides producers of renewable energy guaranteed access to the grid at a guaranteed price for the power they provide. There are number of advantages to (FIT).

- Minimizes risk to the start-up and so

encourages more participation

- Spread the marginal increase costs of renewable energy production at start-up amongst consumers
- Establishing a broad base of small-scale producers provides both energy Independence and security to Ontario by speeding up the establishment of renewable energy supply base
- Provides a long-term purchase commitment from the province and hence security to the supplier
- encourages local job creation
- there are currently over 20 countries globally that have feed in tariff policies. Ontario's considered one of the more advanced in its first year of existence

**The strategy** for many of the identified stakeholders will be the same. They need to transform their Big Idea of who they are and what value proposition they deliver in order to respond to the shifting context that they will increasingly find themselves in. When they assess their core competencies and distinctive resources, there is an opportunity to transition from perceiving themselves as organizations that are solely involved in the distribution of power to organizations with broader capabilities and resources that include the storage of energy as well.

More significantly, as they move from the current horizon to the next they will need to transition to an understanding of themselves as facilitators and providers of information distribution and storage. Power and energy will be only components of that data and information distribution service.

Pursuing such a strategy for power distribution has the potential to create a win for the sector, the public and the government. Effectively, the smart grid will permit the distribution of power to be accomplished with less risk to the IEEE, more economic and supply security to the consumer and increased health and environmental benefits to the consumer.

These last benefits need to be monetized in order to recognize their value to the public and accrue value to the sector. This will more readily take place in a scenario that internalizes the cost of carbon and is open to change, a scenario that is represented by Wind, Water, Solar.

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You must skate to where the puck is going, not to where it is now.

~WAYNE GRETZKY

The future looks very bright if Ontario embraces an ambitious clean energy agenda. Using speculative design thinking to propose solutions to the strategic challenges outlined in the previous section, we developed a future vision of year 2043, where Ontario Power Generation has successfully repositioned and diversified energy sources beyond nuclear energy.

# REPOSITIONING OPG

OPG has evolved into OBE: Ontario Beyond Energy, a company that leverages its nuclear expertise to develop innovations in energy healthcare and transportation. OBE plays a major role in the development and integration of renewable energy sources, with nuclear innovation supporting this transition.

The following pages reveal glimpses of a future where old nuclear facilities have been transformed into hubs of innovation in renewables and healthcare. Nuclear has become a refined and optimized generator of highly specific power, using spent fuel as its primary feedstock.



ONTARIO POWER GENERATION (OPG) REBRANDS TO BECOME ONTARIO BEYOND ENERGY (OBE). OBE HAS SEVERAL DEPARTMENTS - ENERGY, HEALTH AND TRANSPORTATION.

**OBE Beyond Energy**

**OBE Energy**

**OBE Health**

**OBE Transportation**



A nuclear powered mass transit system is rolled out across the province, extensively serving the growing GTA.

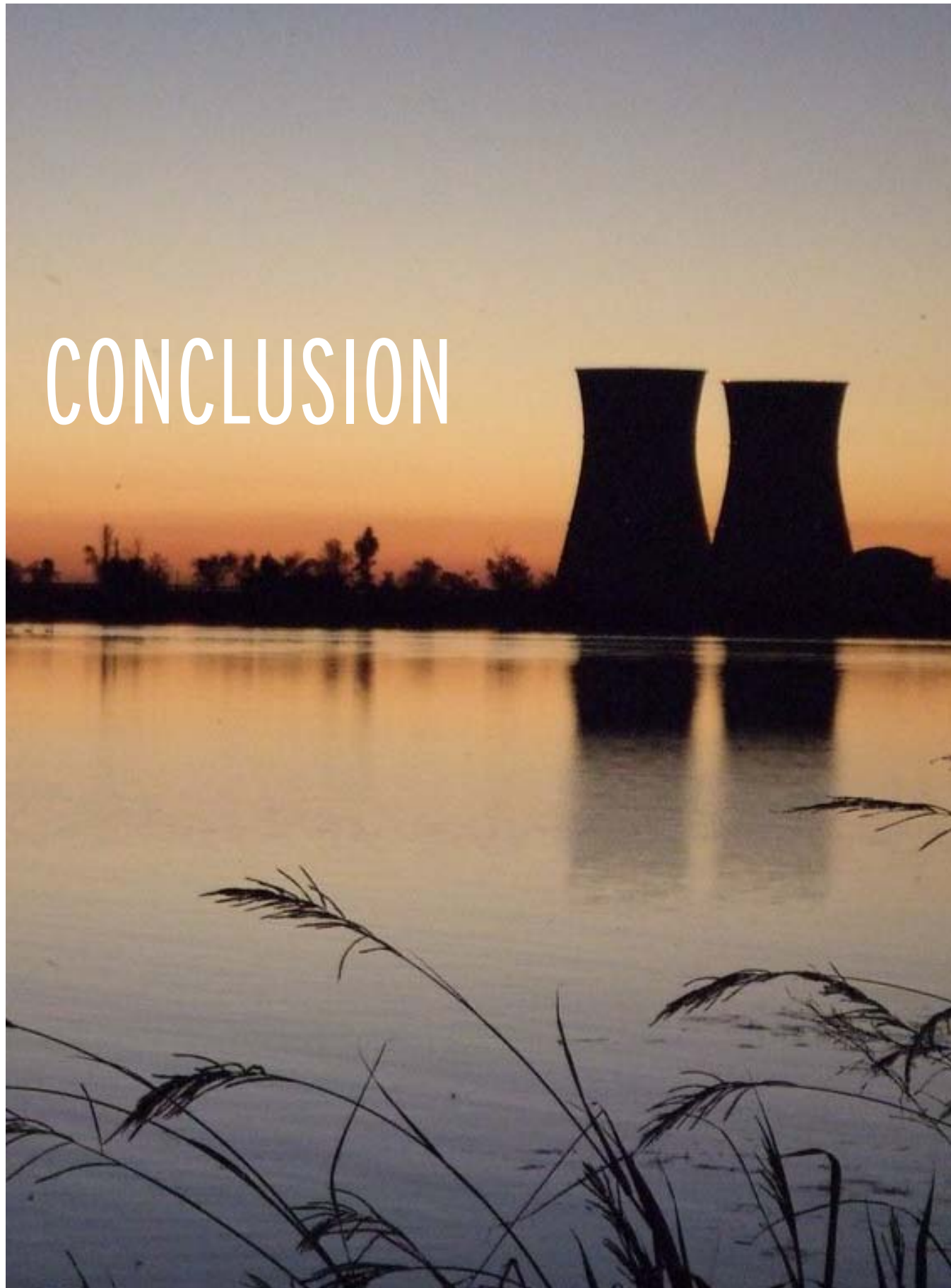


Wind and solar power generation is visible across the province.



The Bruce Wellness Centre in Kincardine, Ontario. Featuring the famous Wellness Walk along the waterfront.

# CONCLUSION



The future of energy in Ontario is a highly complex topic. International pressures for change in response to climate concerns are already clashing with domestic economic realities. Within Ontario, where energy is dominated by nuclear, this raises a very unique set of challenges. Our research highlights a future with doubts over long term nuclear viability due to waste issues, while urgently reducing energy sources that emit carbon emissions. Renewables are recognized as a must for a healthy future, but these technologies will require assistance as they take over with innovation in energy storage and support during fluctuating weather conditions.

Despite these complex and often conflicting challenges, there is ample optimism. Ontario has a strong relationship between government and industry, allowing possibilities of large scale collaboration. However, the challenges must be understood as part of a holistic system to address diverse and integrative solutions.

Foresight suggests many possible futures, but only few are truly desirable. Technology will make opportunities possible, but policy and business innovation are required to implement these technologies. Most

importantly, the focus needs to extend beyond energy, especially any one source, to integrate the cost incurred or value created between economy, health, environment and society.

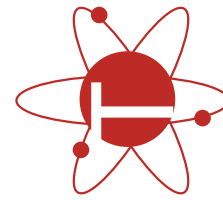
Key decisions in the near future will have a long term impact on Ontario. The future use of the Pickering Facility could be an example where decision makers failed, leaving problems unsolved. Or it could be a case study of transformation if the site is used for the next generation of technologies. Refurbishment and upgrades to Bruce

and Darlington could equally highlight opportunities for the future, as innovations to enhance flexibility could support sources of intermittent power such as wind and solar.

There is much to be optimistic about but with difficult decisions, some risk and uncertainty. This foresight process highlights that these decisions need to be taken into serious consideration and that risks could be mitigated with long term investments across multiple points within the system of energy production and infrastructure.

# APPENDIX

# NUCLEAR TRENDS INITIAL RESEARCH



## The Fission Engine That Could

Nations are exploring nuclear as a cleaner, less expensive way to power their railways.

India has a problem – the railway system that is currently powered by diesel fuel is dirty and expensive<sup>1</sup>. They are now seeking alternatives, the most prominent of these being a nuclear-powered train system. The UK & Russia are also exploring powering their railways using electricity generated through nuclear reactors. Reactors powering trains could be large traditional facilities which power the train via a third rail or potentially mobilized train units<sup>5</sup>. As comfort with nuclear electricity increases in certain populations, so does the expansion of uses for nuclear energy, especially when looking to solve massive problems like poor air quality which continues to plague some of the world's most populated areas<sup>6</sup>.

**SIGNALS**  
The UK has been electrifying its train lines (40% of lines), and has now signed a 10-year agreement to power these lines with nuclear energy<sup>4</sup>.

**IMPLICATIONS**  
Greener energy alternatives are on the rise. Some of the processes that consume large amounts of electricity, or other forms of energy that could potentially be powered by electricity, are being examined through a nuclear lens (i.e. electric cars<sup>7</sup>). As public acceptance of CO<sub>2</sub> emissions and the processes surrounding these methods for producing energy decreases, nuclear may encounter new opportunities.

**EXTRAPOLATION**  
After 10 years of successfully running trains via electricity generated from nuclear energy, public perception has

softened and Canada is now exploring options to expand their uses of nuclear energy.

**COUNTER TRENDS**  
Munich Maglev (Magnetic Levitation) Transrapid is another development in train transportation that shows great potential. A number of countries have experimented with this technology and are looking to expand this technology to a larger scale<sup>8</sup>.

**INDUSTRY**  
Manufacturing, Transportation

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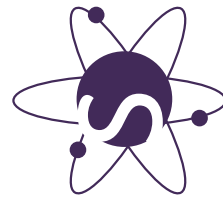
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# Like building a house over an old grave yard...

One of the biggest challenges that Ontario faces when it comes to nuclear energy is public perception regarding the disposal of nuclear waste.

Ontario has a problem – it is called nuclear waste. When it comes to making decisions about how to manage this “hot” topic, many Ontarians have a “not in my backyard” mindset. Current disposal technologies are robust (Katherine Moshonas Cole, personal communication, Sept. 23, 2013) and Ontario has spaces that could be used as disposal sites, but public perception plagues the waste disposal and decommissioning process. A disposal site proposed in Kincardine has been met with ferocious opposition<sup>4</sup>. Few realize that the waste they are concerned with is currently stored in warehouses at the site of the Pickering Nuclear Generating Station<sup>5</sup>, a less than desirable containment method.

**SIGNALS**

Currently, a tribunal is being held to listen to individual concerns with the proposed Kincardine disposal site<sup>4</sup>, which has delayed the commencement of site development.

**IMPLICATIONS**

A cradle to grave strategy is required for the future of nuclear energy to be part of the Ontario energy mix. Nuclear energy has been and will continue to be part of our energy plans for the near, if not long-term future. We need to facilitate the safe and proper disposal of the waste generated through this process, so that future generations are not burdened with our safety and economical issues.

**EXTRAPOLATION**

As CO2 emissions continue to rise, and the awareness and implications of the fracking process receive more media attention, the fear of nuclear energy will decrease as the public realizes the importance of this energy source. Ontario will implement a successful cradle to grave strategy, which will eventually be phased out as other renewable energy sources become viable.

**COUNTER TRENDS**

In some countries, citizens have a more positive view of nuclear energy, including nuclear disposal sites. France and Poland are among the more supportive nations, citing benefits like economic stimulation and job creation<sup>6</sup>.

**INDUSTRY**

Advertising

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# Friends with benefits

Nuclear research and development is expensive; nations are quickly realizing the need for international collaborations to maintain a leading edge.

R&D in the nuclear field requires substantial investment and time. For nations to maintain a leadership edge in this field, they need to look beyond their own resources and capabilities. Some countries are exploring (or have implemented) private/public strategies where investment can be supported by private organizations<sup>5</sup>. For example, the government of Canada is partnering with the private sector to manage and operate the AECI's Nuclear Laboratories<sup>5</sup>. Other countries, like Iran and North Korea, are also partnering together (speculated partnership on nuclear warfare)<sup>6</sup> – allowing collaboration and progression that would not necessarily have been attainable. We are also seeing these types of partnerships beyond nuclear – from a macro perspective the partnership between the US and Russia in a peaceful resolution to the Syrian conflict, to a micro perspective where in Toronto formerly owned and operated government organizations (such as the Light Rail Transit System<sup>3</sup>) are finding ways to partner with private industry in order to strengthen the economic and intellectual resources.

**SIGNALS**

Indication of strategic partnerships are appearing both within and outside the nuclear industry, for example: Syria resolution collaborations, 7 national party project (nuclear fusion)<sup>1</sup>, and more locally the Ontario Ministry of Health and Long-Term Care partnerships with the private sector to rebuild hospitals<sup>2</sup>.

**IMPLICATIONS**

Powerful and strategic collaborations could result in progress in the nuclear field that we otherwise would not experience, or might see in a much slower progression.

**EXTRAPOLATION**

International collaborations between the US, Russia and India have resulted in the pilot of nuclear fusion technology.

**COUNTER TRENDS**

Rather than form strategic partnerships, some countries may opt out of nuclear altogether, as demonstrated by German Chancellor Angela Merkel and her intentions with Germany to move away from nuclear energy.

**INDUSTRY**

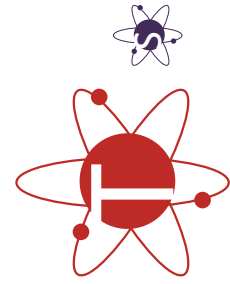
Politics/Strategic partnerships

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# Hope Floats

## Research is currently exploring the viability of a floating nuclear reactor plant.

Icebreakers and submarines are currently producing and operating on nuclear energy, so is a floating nuclear power plant a far stretch? An advance like this could potentially mitigate disagreements on where to locate plants, for lack of space or public resistance. Due to experience with other aquatic nuclear vehicles, the safety of a floating nuclear power plant could be high, and is currently proposed to be less costly than building a typical land reactor<sup>3</sup>. Numerous applications exist for technology such as this, including: generating heat and electricity for remote areas, and providing electricity for oil rigs<sup>4</sup>.

**SIGNALS**  
Russia is currently exploring this technology, and began construction in 2009<sup>5</sup>.

**IMPLICATIONS**  
A mobile and less costly electricity generating method could fulfill needs of underserved areas.

**EXTRAPOLATION**  
Russia becomes the first country to launch a floating nuclear power plant, providing heat and electricity to remote areas of the country. Private firms are securing funding to purchase floating nuclear power stations in order to resell the electricity in remote/underserved areas of the world.

**COUNTER TRENDS**  
Floating nuclear vessels become a target for terrorist groups seeking nuclear weapon capabilities<sup>6</sup>. Public is concerned over nuclear contamination of ocean waters after Fukushima and successfully lobbies against development as the risk is too high.

**INDUSTRY**  
Manufacturing, Transportation

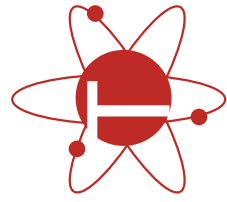
**RESOURCES AND REFERENCES**

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7



# Small but Mighty

## Nuclear power is getting a big, or rather small, makeover: the new generation of reactors is small, self-contained, cost-effective and tamper resistant.

Globally, demand for nuclear power is growing, but concerns over the security and safety of nuclear energy is making way for a new fleet of reactors known as Small Modular Reactors (SMR). These reactors are factory built, can be shipped anywhere, operate autonomously and can run for 30 years without the need to refuel.

**SIGNALS**  
A Livermore team is part of a Department of Energy (DOE) collaboration that is addressing both the growing need for nuclear energy and the concern over nuclear proliferation by pursuing a concept called SSTAR, a small, sealed, transportable, autonomous reactor. (Lawrence Livermore National Laboratory. Science & Technology. Nuclear energy to go: A self-contained, portable reactor. <https://www.llnl.gov/str/julaug04/bid-0208134.html>)

UK-based engineering company Rolls-Royce is adding its support to NuScale Power's submission for US federal funds to help build and commercialize its small modular reactor (SMR). (NuScale SMR. [http://www.nucscale.com/newsroom/nv-rollis\\_royce\\_backs\\_nucscale\\_smr\\_funding\\_bid-0208134.html](http://www.nucscale.com/newsroom/nv-rollis_royce_backs_nucscale_smr_funding_bid-0208134.html))

This interest in small and medium nuclear power reactors is driven both by a desire to reduce the impact of

capital costs and to provide power away from large grid systems.

(World Nuclear Association (2013). Small Nuclear Reactors: Fuel Cycle, Power Reactors (Small Nuclear Power Reactors) # UACG(WQ6V4)

**IMPLICATIONS**  
There are a lot of challenges with the current model of nuclear power generation. For the most part nuclear energy is generated in big plants that are incredibly expensive to build and maintain, take years to bring online, and getting the public's support for a new reactor requires very careful political maneuvering. SMRs mean shifting from this cumbersome "Big Energy" model to something more nimble.

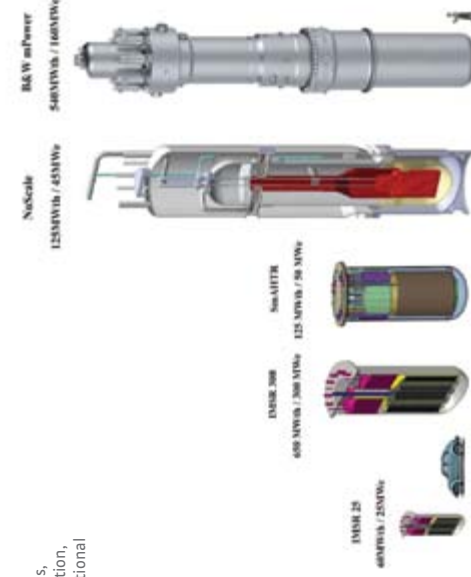
**EXTRAPOLATION**  
Small Modular Reactors will shift the way society funds, constructs, maintains and regards nuclear energy. Whether the SMRs are run by governments, private companies

or social trusts they'll make nuclear power a utility that exists in the community or at the source of use – such as locations off the grid, or in the case of industry.

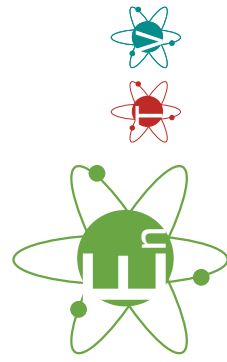
**OTHER RESOURCES**  
ENERGY.GOV, Office of Nuclear Energy <http://energy.gov/nuclear-reactor-technology/04-small-modular-nuclear-reactors>

NuScale Power <http://www.nucscalepower.com/ourtechnology.aspx>

**COUNTER TRENDS**  
Institute for Energy and Environmental Research (IEER) Report: Small Modular Reactors a "Poor Bet" in U.S. <http://www.pewresearch.com/news-releases/ieer-report-small-modular-reactors-a-poor-bet-to-revive-failed-nuclear-renaissance-in-us-218861621.html>







# Reduce, Reuse, Recycle

Scientists have developed a method to recycle spent nuclear fuel waste (SNF) to yield more nuclear energy whilst reducing the volume and toxicity of nuclear waste.

Dealing with spent nuclear fuel waste (SNF) is one of, if not THE, leading concern with nuclear power generation. Currently only 5% of the uranium in a fuel rod gets fissioned for energy; after that, the rods are taken out of the reactor and put into permanent storage. New technology called Pyroprocessing is demonstrating that nearly 93% of the energy in SNF can be reprocessed to yield more fuel for nuclear energy, while drastically reducing the length of time the remaining SNF poses a threat to humanity and the environment, down from hundreds of the thousands of years to mere hundreds.

**SIGNALS**  
Recycling used nuclear fuel could produce hundreds of years of energy from just the uranium we've already mined, all of it carbon-free.  
(Idaho National Laboratory (2012), Nuclear Fuel Recycling could offer plentiful energy to power the world's nuclear fuel-recycling could offer plentiful energy)

As a result of Pyroprocessing, the amount of difficult long half-life material is reduced by 98% and the 300,000 years waste storage problem is reduced to about 300 years -- a period that is clearly feasible with today's technology.  
(The Science Council (2010) Pyroprocessing Business Case, [www.the-science-council.com/pdfs/PyroprocessingBusinessCase.pdf](http://www.the-science-council.com/pdfs/PyroprocessingBusinessCase.pdf))

Pyroprocessing treatment can reduce the volume, radioactivity, and heat load of the light water reactor (LWR) spent fuels.  
(Hindawi Publishing Corporation (2013) Current

Status of Pyroprocessing Development at INEL, <http://www.hindawi.com/journal/idsn/2013/34349/>)

**IMPLICATIONS**  
Bringing Fast Reactors online and utilizing Pyroprocessing has the potential to address not just the nuclear energy industry's biggest challenges -- what to do with huge amounts of hazardous waste -- but challenges that our government and global society is facing with regards to producing enough energy for our growing population.

**EXTRAPOLATION**  
Recycling SNF waste means reducing the volume of hazardous waste, reducing the need to source new fuel, and providing enough fuel to power nuclear energy for many, many years to come.

**OTHER RESOURCES**  
Idaho National Laboratory (2007), National Laboratory Progress at Idaho National Laboratory  
<http://www.inel.gov/publications/Documents/393394.pdf>

**COUNTER TRENDS**  
The Nuclear Threat Initiative, U.S. Sees Pyroprocessing as Nuclear Fuel Reprocessing: Official.  
<http://www.nti.org/brief/article/also-sees-pyroprocessing-as-nuclear-fuel-reprocessing-official/>

**INDUSTRY**  
Government, power utilities, energy consumers



# The Perfect Nuclear Family

The future of nuclear decommissioning will eventually be controlled by one body that, according to internationally set decommission standards, manages the costs and oversees the decommissioning process.

Nations around the world are dealing with the enormous task of decommissioning their nuclear power plants. Without an international body to regulate the process, countries are left to deal with the task on their own. The cost to decommission varies widely, depending on the country and each country has its own regulations and procedures. Currently, there are international organizations that share information, knowledge, and experiences related to nuclear decommissioning, but ultimately the process and funding of decommissioning is up to each individual nation. In the future, I believe all nations with nuclear power will fall under international regulation, will provide funding to an overseeing body, and that body will eventually manage the decommissioning process.

**SIGNALS**  
The Nuclear Energy Agency seeks to assist its member countries in developing safe, sustainable and societally acceptable strategies for the management of all types of radioactive materials, with particular emphasis on the management of long-lived waste and spent fuel and on decommissioning of disused nuclear facilities. The program of work in these areas is carried out for the most part by the Radioactive Waste Management Committee (RWMC)  
(Nuclear Energy Agency, <http://www.oecd-nea.org/rwm/>)

The Deactivation and Decommissioning Knowledge Management Information Tool (D&D KM-IT) serves as a centralized repository providing a common interface for all D&D related activities. It assists users in gathering, analyzing, storing and sharing knowledge and information within the D&D community.  
(Office of Environmental Management, <http://envoy.government/downloads/deactivation-decommissioning-knowledge-management-information-tool-d&d-km-it/>)

Several factors directly affect decommissioning costs: the type of nuclear facility, the decommissioning option or stage chosen, project duration, waste disposal practices, the rate of inflation, discount rates, etc. Because of these variables, decommissioning costs will differ from country to country, as well as from plant to plant.  
(Pabitra L. De, (1990) Costs of decommissioning nuclear power plants, <http://www.iaea.org/Publications/Magazines/Bulletin/Bull39/3907/69342.pdf>)

**IMPLICATIONS**  
With so many nuclear plants reaching retirement age the entire global community has a stake in decommissioning (decom) procedures being carried out carefully and thoroughly. At present there's a spirit of knowledge and experience sharing within the nuclear community; however, it would only take one botched decom -- and the exorbitant costs to clean up such a mess -- for international standards to be established. Once international decom standards are set the question then becomes who

enforces the standards, and how are the standards enforced?

**EXTRAPOLATION**  
At present the European Commission and USA collect funds for the decommissioning process the day a nuclear plant begins operation. In many nations these funds do not exist, are insufficient or are used for other activities. An international body that oversees all nuclear plants' operations, collects funds during their time of operation and ultimately finances and conducts safe decommissioning and the safe storage of spent nuclear fuels is inevitable.

**OTHER RESOURCES**  
Radioactive Waste Management Committee, (2011) The NEA Co-operative Programme on Decommissioning: Twenty-five Years of Progress; The Last Five Years - 2006 through 2010  
(<http://www.oecd-nea.org/rwm/docs/2011/rwm-r2011-3.pdf>)

**COUNTER TRENDS**  
The closest entity that resembles an international body tasked with the responsibility of overseeing all matters of nuclear energy production is the International Atomic Energy Agency (IAEA), which is closely aligned with The United Nations. Membership to the IAEA states, "The Agency is based on the principle of the sovereign equality of all its members, and all members, in order to ensure to all of them the rights and benefits resulting from membership, shall fulfill in good faith the obligation assumed by them in accordance with this Statute."  
<http://www.iaea.org/About/Statute/tomif/AL4>

**INDUSTRY**  
Government



<http://www.iaea.org/About/Statute/tomif/AL4>



# Rethinking Green

Nuclear energy is looking more and more favourable when compared to alternative green energy sources that are proving expensive, unreliable and unsustainable.



Many of the “green” energy alternatives that were supposed to replace our reliance on “dirty” energy generation, like nuclear, are proving problematic once they’re rolled out on a large scale. Contending with the footprint needed for wind power, the inconsistent flow of energy from solar, diverting food crops from feeding the population to the creation of biofuel, not to mention the hefty government subsidies need to make these alternatives possible, are forcing society to reconsider the role of nuclear power.

### SIGNALS

A 20 year US government tax credit that’s offset 30% of the cost of building wind turbines is set to expire in 2013. (Heiman, C. (2013) Why It’s The End Of The Line For Wind Power. <http://www.forbes.com/sites/chrisopherheiman/2013/12/21/why-its-the-end-of-the-line-for-wind-power/>)

In North America, ethanol refiners consume roughly 40% of the corn crop. In Brazil, they use around half the country’s sugarcane crop, and in Europe the biodiesel industry consumes about 60% of the continent’s rapeseed crop. (Economists Intelligence Unit. (2013) Biofuels change direction. <http://www.eiu.com/lib/eu/content/biofuels-change-direction/erK548EA9gFF95905E2>)

The European Parliament has decided to back proposals which would limit the use of food crops in the production of biofuel products. (O’Sborne, C. (2013) Biofuel limited in Europe in the name of feeding the population. [www.smartplanet.com](http://www.smartplanet.com))

comblog/bulletin/biofuel-limits-in-europe-in-the-name-of-feeding-the-population/2952189#search=net)

Renewable energy sources like wind and solar generate power intermittently

(Curry, A. (2013) Can You Have Too Much Solar Energy?. [http://www.slate.com/articles/health\\_and\\_science/alternative\\_energy/2013/09/solar\\_power\\_in\\_germany\\_now\\_a\\_cloudy\\_country\\_became\\_the\\_world\\_leader\\_in\\_solar.html](http://www.slate.com/articles/health_and_science/alternative_energy/2013/09/solar_power_in_germany_now_a_cloudy_country_became_the_world_leader_in_solar.html))

### IMPLICATIONS

As the global population grows there will be less available land for wind and solar generation. A growing population, especially in the developing world, means an increase in energy demand. At the same time government budgets are stretched, meaning there will be fewer funds available to subsidize experimental energy sources.

### EXTRAPOLATION

Governments grappling with how to provide enough power for their citizens and industries with a finite budget will choose nuclear for its reliable energy production, small footprint and known costs.

### OTHER RESOURCES

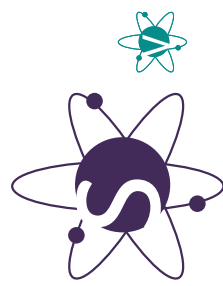
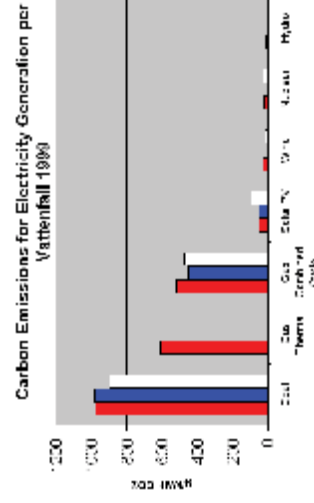
Clean and Safe Energy Coalition (<http://cseenergy.org/>)

### COUNTER TRENDS

There’s no shortage of information on how green energy is the way forward: <http://www.ieseenergy.com/ieo/green-energy-act/> <http://www.greenenergyuk.com/> <http://environmentaldefence.ca/issues/clean-energy-renewableenergy>

### INDUSTRY

Government, energy producers, public relations



# The Apocalypse Sells Toys

The entertainment industry is a powerful motivator of public perception and as long as a nuclear bomb is a stable plot device to power international movie hits and video games, nuclear fear will exist.

The pro-nuclear community claim that the fear of the general public is irrational, with many spokespeople citing robust scientific research to highlight the surprisingly few deaths that can be attributed to the nuclear power industry. But that doesn’t prevent this fear from being a core driver of stories that provoke fear and generate an audience for movies, games and books, that lead to the sales of action figures and more. Record sales of stories linked to end of earth apocalyptic scenarios are likely red flags to the industry bulls who are keen to cash in on public psyche.

### SIGNALS

Bruce Power’s plan to ship old steam generators had to be scrapped due to public outrage. In reality, the level of radiation was very low, the safety of the vessel extremely high and decontaminating and decommissioning in Sweden would have moved waste away from the sensitive sites that environmentalists wish to protect.

The biggest failing of the project was communication and public consultation, but it is impossible to know whether the right process would ever have overcome the deep fears triggered by the word “radiation”. (Rob Ferguson. “Plan to ship nuclear waste through Great Lakes shelved”. Toronto Star. Accessed September 25, 2013. [http://www.thestar.com/news/queenspark/2013/07/25/plan\\_to\\_ship\\_nuclear\\_waste\\_through\\_great\\_lakes\\_shelved.html](http://www.thestar.com/news/queenspark/2013/07/25/plan_to_ship_nuclear_waste_through_great_lakes_shelved.html).)

In the 1950s the Atom was the utopian solution, which all changed when Soviet Russia beat the US into space offering the vision of bombs being dropped from above at any moment. “Ban the bomb” eventually became the first truly global protest movement, championed by Albert Einstein and Bertrand Russell, with the Cuban Missile crisis bringing the worst case scenario onto America’s front door step. At every stage the entertainment

industry has capitalized on the general psyche of the people. “The China Syndrome” in 1979 was a frightening success of the times, and “The Day After” received the largest audience to date in 1983-2012’s major blockbusters, Batman and The Avengers, were driven by MacGuffins that promised unlimited power or ultimate destruction if in the wrong hands. Both movies broke international records. (David Ropick. Scientific American Blog Network. “The Rise of the Nuclear Apocalypse”. Accessed September 25, 2013. <http://blogs.scientificamerican.com/guest-blog/2012/06/15/the-rise-of-nuclear-fear-how-we-learned-to-fear-the-bomb/>.)

Part of the big fear of nuclear is that the negative consequences are so far outside of an individual’s control, involving invisible radiation leaking into your home due to a failure in automated machinery, human error, a disgruntled worker or the ever looming climate catastrophe that hovers over everyone. Throw into the mix international warfare, the rise in terrorism and the image of mishandling of current weapon stockpiles and it is easy to see how the general public has negative connotations with nuclear. (David Ropick. “Why Are We Afraid of Nuclear Power? by David Ropick”. Accessed September 25, 2013. <http://www.comingofage.com/2013/09/25/why-are-we-afraid-of-nuclear-power/>.)

project-syndicate.org/commentary/why-are-we-afraid-of-nuclear-power/”

• Eric Schlosser. “Nuclear weapons: an accident waiting to happen”. World news | The Guardian. Accessed September 25, 2013. <http://www.theguardian.com/world/2013/sep/24/nuclear-weapons-accident-waiting-to-happen>.

The apocalypse sells video games, possibly how they would solve the worst possible challenges, rebuild the world from scratch, become hardcore survivalists and have fun doing things that would never be acceptable in current society. The Fallout Series was entirely built around nuclear apocalypse and sold over \$300 million US in the last game alone. (Andrew Hayward. IGN. “Why We Love the Apocalypse”. Accessed September 25, 2013. <http://www.ign.com/articles/2013/09/26/why-we-love-the-apocalypse>.)

### IMPLICATIONS

Will it ever be possible to have a truly rational dialogue about such a contentious issue as nuclear waste? Unconscious fears that are tickled by the entertainment industry will continue to affect decision making.

### EXTRAPOLATION

If the nuclear industry alters public perception it will need to produce a best selling book, movie and video game in the next decade that

features nuclear as a believable plot device for solving, rather than creating, a deep problem in society. If in a decade a nuclear apocalypse still sells a worldwide bestseller, expect that public perception of the nuclear industry is negative and government desire low.

### OTHER RESOURCES

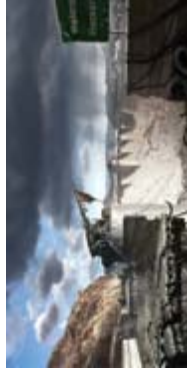
“The Rise of Nuclear Fear” by Spencer R. Weart

### COUNTER TRENDS

The knowledge industry, where conferences such as TED are celebrated as the pioneering lights, is actively making more “rational” and “robust” sources of information freely available. As this integrates into education at multiple levels, it is possible to see a trend of rational decision making emerge that is beyond the influence of mass media. (TED Talks. “Survivalism: The Rise of the TED Effect.” Accessed September 25, 2013. <http://www.ted.com/speakers/info/3278/The-TED-Effect.aspx>.)

### INDUSTRY

Entertainment industry



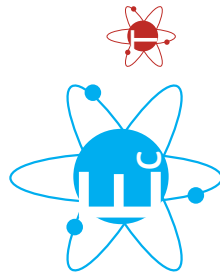
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<http://www.etsy.com/listing/1000000000/child-in-protective-suit-playing-with-a-ted-effect-figurine>



# Cashing in on the End Game

The money gathered up by nuclear utilities for end of life decommissioning is being released into the marketplace, creating opportunity for private companies with an appetite for risk.

Energy projects are beyond the scope of government, with timelines that stretch beyond political cycles and liability costs beyond the capacity of any government representative. In Canada this has led to an evolution of Public-Private-Partnerships, while in the USA this is leading to an increase in outsourcing private contractors. The money for these projects comes from business models developed decades ago and there is fear that there is not enough cash in the bank. In Germany there are calls for public funds to be created that ensure the flow of money is available at the time of need, while utilities companies are claiming that their economics is sound. The size of cash that has built up to cover costs and the possibility of projects that last at least a decade is fuelling a boom in business for companies capable of the highly specialized work required to decommission a nuclear plant. Governments are encouraging these private companies as they attempt to distance themselves from the liability risks and political fall out.

**SIGNALS**  
 Bruce Power is Canada's largest Public-Private Partnership and has been the largest private investor in Ontario's economy in the past 10 years. The innovation investment in restarting the generators in Bruce A and B was closely integrated with the community that exists to facilitate the site.  
 Getting off Coal | Nuclear Up Coal Down. "Renewal of Bruce | Nuclear Up Coal Down." Accessed September 25, 2013. <http://www.nuclearupcoal.com/renewal-of-bruce/>.

Decommissioning complex infrastructure is becoming big business for privately held contractors. EnergySolutions is the first company to take over full responsibility of a site in the US. Their work at the Zion facility will cost over \$1 billion across a decade. Taking on major liability is big business, and may be the only way to solve long term challenges that outlive any government body. The UK government has doubled their estimates for decommissioning work, and the biggest decommissioning project ever is occurring in Germany as 12 reactors are being taken down in the next 20 years.  
 Lisa Song, "Decommissioning a Nuclear Plant Can Cost \$1 Billion and Take Decades." Accessed September 25, 2013. <http://www.reuters.com/article/2013/06/13/idUS5788893682010613>.

**COUNTER TRENDS**  
 EnergySolutions, the contractor that is decommissioning the Zion facility, underestimated costs by \$100 million. The company has been bought by private investment firm Energy Capital. Long term projects come with long term variabilities, government regulators bring variability with the political cycles, all of which must be managed by the business entities.  
 Swetha Gopinath, Reuters. "UPDATE - Debt-laden EnergySolutions to be sold for \$38 mln." Accessed September 25, 2013. <http://www.reuters.com/idUSANACN6003007>.

**IMPLICATIONS**  
 Nuclear infrastructure is so large in scale that governments need industry partners with capacity to take on risk and long term management. Paying for these activities will test the economics established during the original business models developed over 30 years ago, any scenario where taxpayers foot the bill of unforeseen costs will trigger angry political backlash.  
 Kevin Gray, SmartPlanet. "Innovative Ideas That Impact Your World." For aging nuclear reactors, a coming surge of shutdowns | SmartPlanet." Accessed September 25, 2013. <http://www.smartplanet.com/blog/big-story/for-aging-nuclear-reactors-a-coming-surge-of-shutdowns/632>.

**INDUSTRY**  
 Energy Contractors  
 Nuclear decommissioning could be a growth industry, with private companies across the world generating ongoing business across decades due to the complexity of the undertaking. This could lead to a highly profitable industry emerging, one that may be linked to innovation in materials and nuclear management as companies compete for long-term contracts. Alternatively this could lead to disaster as governments stall projects that exceed predetermined budgets, cut corners, or change direction due to fast political cycles that leave companies and process in limbo.

**EXTRAPOLATION**  
 The fear of climate change, especially as it becomes more immediate and tangible, could outweigh the fear of the less immediate nuclear waste. The nuclear industry can capitalize on this fear as it presents itself as the clean alternative.  
 Todd W. Schultz, "The number of killer thunderstorms could jump 40% by 2070 - Quartz." Accessed September 25, 2013. <http://www.telegraph.co.uk/science/space/9943048/Nasas-advice-on-asteroid-hitting-Earth-planet.html>.

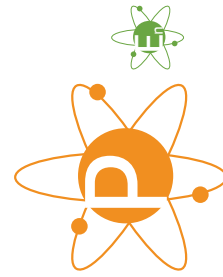
**IMPLICATIONS**  
 Making decisions to manage toxic waste is outside of the capacity of any local or provincial government, and for Canada it might even be out of the scope at the Federal level. International Regulatory bodies are going to be needed to bridge local barriers, and act as the "fall guy" to protect politicians looking to get re-elected.  
 NASA by all accounts is guaranteeing an asteroid will hit earth at some point. This is often used in the argument for space travel to other planets.  
 Telegraph.co.uk. "Nasa's advice on asteroid hitting Earth may - Telegraph." Accessed September 25, 2013. <http://www.telegraph.co.uk/science/space/9943048/Nasas-advice-on-asteroid-hitting-Earth-planet.html>.



<http://www.chicagojournal.com/midwest-report/09-16-13/09-16-13-01-building-construct-work/>



<http://www.dailystar.com.au/Treasure-from-the-Deep-8792515>



Decisions by the Obama Administration have continued a worldwide trend of delaying action to dispose high-level nuclear waste, with no alternatives clearly moving forward.

Nuclear waste is downplayed by an industry that celebrates its lack of carbon emissions. The small physical size of waste is celebrated, while glossing over the timescale of toxicity. No solution to nuclear waste has been generated despite over forty years of producing the hazard. The toxic life of nuclear waste, with high-level half lives up to 16 million years, is longer than human civilization and a time span where a comet hitting the earth or another ice age is inevitable. How to communicate danger across this time period, how to prevent all environmental disasters known to humans and how to prevent human error or misuse, are questions that need to be resolved when the timescale is fully extrapolated. The scale and scope of problems to be solved are beyond the capacity of most politicians and their short election cycles.

**SIGNALS**  
 The waste from the Zion decommissioning plant has been approved for storage in small (ish) casks for 20 years, with extension up to 300 years. That is only temporary as the waste is toxic for at least to million years, a concept outside our scope of understanding. There appears to be a perception that a technology will ultimately present a solution in the future, but the contingency plan in the meantime is quite thin.  
 Gray, Kevin. For aging nuclear reactors, a coming surge of shutdowns | SmartPlanet. (n.d.). Retrieved from <http://www.smartplanet.com/blog/big-story/for-aging-nuclear-reactors-a-coming-surge-of-shutdowns/632>  
 The most toxic sites in the world are in Russia and the USA and are directly linked to weapon enrichment programs of the cold war. A robust plan to remediate these sites or manage the waste has yet to emerge, with genuine fears that a serious accident is increasingly likely and leaking infrastructure already well documented.  
 Hanford Nuclear Waste Cleanup Plant May Be Too Dangerous, Scientific American. (n.d.). Retrieved from <http://www.scientificamerican.com/article/hanford-nuclear-waste-cleanup/>  
 Bechtel Corporation: Hanford Verification Plant. (n.d.). Retrieved from [http://www.bchtel.com/hanford\\_waste\\_treatment.html](http://www.bchtel.com/hanford_waste_treatment.html)

**COUNTER TRENDS**  
 Not a "trend", but as soon as there is any disaster or accident, the government of the day will be directly responsible for immediate action. Kicking the problem down the road is only a good policy while no major accident occurs. The moment a storage site leaks, even at minor levels, there will be enormous public backlash. The governments are clearly banking that their estimations around low risk of disaster are correct.  
 Politics, the industry of getting re-elected, waste management, nuclear contractors, environmental lobby groups

**IMPLICATIONS**  
 Making decisions to manage toxic waste is outside of the capacity of any local or provincial government, and for Canada it might even be out of the scope at the Federal level. International Regulatory bodies are going to be needed to bridge local barriers, and act as the "fall guy" to protect politicians looking to get re-elected.  
 In the coming decades nuclear waste could emerge as a hot political topic, with politicians being elected for their guarantee that nuclear waste will not be dumped in their region. This will only further stall the situation, preventing any difficult decisions from being enacted upon and place greater responsibility on regulatory bodies outside of election cycles.

**EXTRAPOLATION**  
 The fear of climate change, especially as it becomes more immediate and tangible, could outweigh the fear of the less immediate nuclear waste. The nuclear industry can capitalize on this fear as it presents itself as the clean alternative.  
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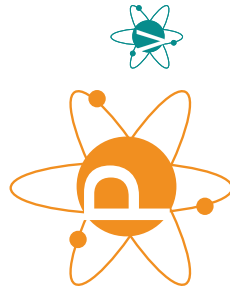
<http://www.dailystar.com/projects/feature/04>



<http://www.thehedgeer.com/corporate-responsibility/encouraging-long-term-nuclear-waste-storage-with-urgent-public-action>



<http://pymhistory2a.weebly.com/strategic-arms-limitation-treaty-salt-and-4-9375-938.html>



# Strange Bedfellows

Environment spokespeople are lobbying for nuclear to save the planet as better technologies are integrated over time.

New partnerships are forming that look contradictory on paper. Environmentalists and libertarians are finding common ground over a shared dislike of regulatory policies that limit free-markets and alternative energy sources. Anti-establishment voices are now praising nuclear as a “bridge” to alternative energy sources, claiming that nuclear will do the least harm as better solutions are developed.

**SIGNALS**  
 Hippies and libertarians are becoming allies against “big energy” due to a shared love of freedom of choice and open markets. The Green Tea Coalition, between Georgian Tea Party members and the Sierra Club, banded together to fight a campaign by the Koch brothers’ Americans for Prosperity (AFP), playing a pivotal role enforcing solar power to be integrated into the offerings of Georgia Power Co.  
 -Scott Smith, Quartz, “Hippies and libertarians have become unlikely allies in a war against solar power—Quartz,” Accessed September 25, 2013. <http://qz.com/12925/hippies-and-libertarians-have-become-unlikely-allies-in-a-war-against-solar-power/>.  
 - Seth Shulman, The Huffington Post, “Got Science? A Green Tea Party May Be Brewing,” Accessed September 25, 2013. [http://www.huffingtonpost.com/seth-shulman/got-science-a-green-tea-party\\_1\\_374049.html](http://www.huffingtonpost.com/seth-shulman/got-science-a-green-tea-party_1_374049.html).

There is a shift in the old guard of activists, with long standing environmental activists such as Patrick Moore, Peter Schwartz and most famously Stewart Brand becoming advocates of nuclear energy. This argument is usually framed with Nuclear being a “bridge” to alternative sources of energy.  
 -CASEnergy Coalition, “Why Nuclear? - CASEnergy Coalition,” Accessed September 25, 2013. <http://caseenergy.org/nuclear-energy/why-nuclear/>.  
 -TED: Ideas worth spreading, “Stewart Brand + Mark Z. Jacobson: Debate: Does the world need nuclear energy? |

[www.ted.com/talks/debate\\_does\\_the\\_world\\_need\\_nuclear\\_energy.html](http://www.ted.com/talks/debate_does_the_world_need_nuclear_energy.html).  
 - Pandora, Accessed September 25, 2013. <http://pandora.com/promisc.com/>.

Much of USA’s recent energy from nuclear actually came from decommissioned Soviet weapons, once a concept that sounded impossible, now a celebrated activity in the process of reducing a toxic weapons in the world. This supply has recently been fully used, with it being possible for a new partnership to be developed.

- Jeff McMahon, Forbes, “U.S. Runs Out Of Nuclear Fuel From Russian Warheads,” Accessed September 25, 2013. <http://www.forbes.com/sites/jeffmcmahon/2013/09/30/u-s-runs-out-of-nuclear-fuel-from-russian-warheads/>.  
 -NSA, “U.S. Purchases Russian Warheads,” Accessed September 25, 2013. <http://www.msa.energy.gov/media-room/pressreleases/thepurchaseofnuclearweapons0930>.

**IMPLICATIONS**

The debate in Ontario will increase in complications, as high profile spokespeople entering the discussion. Energy has been a kiss of death discussion in the past, as a topic too hard to get into public opinion, but national spokespeople with spectacular histories and public pull could turn this around.

**EXTRAPOLATION**

In the coming alternative political narrative



<http://firms.deviantart.com/art/Atomic-Thatz3167947>



may be more proactive at integrating environmental advocates within their campaigns. Environmentalists that would have previously shied away from this “dance with the devil” may have recognized that being part of the system will achieve their broader goals.

**COUNTER TRENDS**

Not all environmental activists have been swayed, Amory Lovins released a report in 2009 clearly arguing against adopting nuclear. Advocates for wind and solar call for an outright investment in the end solution, raising fear of nuclear proliferation and toxic waste. Amory is one of many voices actively rejecting the work of Stuart Brand and others.  
 - Home, “Nuclear Power: Climate Fix or Folly?” Accessed September 25, 2013. [http://www.rmi.org/knowledge-center/library/E09-01\\_NuclearPowerClimateFixOrFolly](http://www.rmi.org/knowledge-center/library/E09-01_NuclearPowerClimateFixOrFolly).  
 -TED: Ideas worth spreading, “Stewart Brand + Mark Z. Jacobson: Debate: Does the world need nuclear energy? | Video on TED.com,” Accessed September 25, 2013. [http://www.ted.com/talks/debate\\_does\\_the\\_world\\_need\\_nuclear\\_energy.html](http://www.ted.com/talks/debate_does_the_world_need_nuclear_energy.html).

**INDUSTRY**

Political Lobbying, Environmental Advocacy

Activists who began as a group wanting to voice their opinions, have turned into anti-nuclear communities by learning to kill big energy projects and disrupting the national political agenda, and before you know it they will want a new government or no government at all.

Public protests have been around for decades allowing the general public to voice their opinions, keep matters local for the most part and maybe act as a minor inconvenience as the nuclear sector goes about its business. Recently, the locally inconvenient anti-nuclear events have started to turn into national matters demanding disruptions in the country’s political agenda. Anti-nuclear protesters are learning how to delay national projects and extending costs by hundreds of millions of dollars, and in the case of Guangdong, China, successfully preventing a nuclear plant from being built.

**SIGNALS**

**Taiwan Anti-Nuclear Protests May Derail \$8.9 Billion Power Plant** - The island’s fourth nuclear power plant of \$8.9B has drawn new criticism and anti-nuclear protests which threaten its completion. The government says it would abandon it’s 30% source of nuclear energy provided that alternatives are available while keeping in mind, price and carbon reduction. If the fourth power plant cannot be completed, the alternative option will have to be natural gas plants as coal projects are facing severe challenges.

**Public Trust Crisis Threatens China’s Nuclear Power Ambitions** - Growing anti-nuclear skepticism in China highlighted outcry when a thousand people marched the streets demanding the project to be cancelled due to public health and environmental fears. Official assurances about safety failed as they were followed by an earlier series of food and pollution scandals. As a result, the plan to build a \$6 billion uranium processing plant in the southern province of Guangdong was cancelled. If communication and public education does not improve, more protests could spring up elsewhere, threatening the plans to build new reactors.

**China’s Government Fears That Anti-Nuclear Activism May Become A National**

**Movement** - “Not in my front yard” - While most anti-nuclear has remained local, the recent exception of the Jangmen’s successful protest against a \$6B uranium plant has raised concerns that this may encourage others. Similar protests are expected at the planned site for nuclear plants. This not only challenges China’s nuclear plans but such projects strike fear of something bigger - an anti-nuclear movement turning into an anti-government activity (similar to Taiwan in the 1980’s). China’s communist party has to debate this risk against the benefits of nuclear energy.

**Thousands Attend Unprecedented Anti-Nuclear Protests In Germany: Local Action Achieves Global Impact** - Local protests had been around for decades and received national attention met by success over the years. The Germans take full credit for the nuclear-energy free by 2022. This success therefore stands as their proof that there is a global problem with nuclear waste. The movements activities are directed not just against nuclear waste or its transport but against nuclear energy overall. While they are starting to see the fruits of their efforts on the world’s media with Germany becoming nuclear energy free and their anti-nuclear laws, they want to encourage others around the world by this example “one that tells them nothing prevents them from taking action on their own”.

**IMPLICATIONS**

It depends, if this is perceived to be a matter of practicing safe nuclear energy and public education regarding the safety of nuclear energy, there is something to be done. However, if it’s perceived to be a rebellion or movement the game changes drastically because it’s no longer about nuclear energy or energy sources. It will be a political insecurity challenge and the governments may decide to fight, fight harder or abandon nuclear energy in the hopes that the activist movement is not fueled further and slowly extinguished.

**EXTRAPOLATION**

**Next 5** - This challenge will play out mostly over the next few years as the activists continue to push. This will shrink governments appetite to put forward new large scale project and maybe reconsider the one in progress.

**Next 10** - As a result of the push back, all new nuclear energy projects were terminated. Mutual agreement was to let the existing nuclear plants will run their course and then decommission them safely, invest in alternative energy sources as large companies flood the emerging market.

**Next 20** - By now, the country will be totally nuclear-energy free, and celebrate alternative energy sources. However, governments have imposed harsh laws to sustain public protests within a control environment.

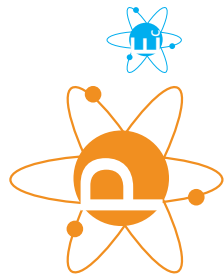
**COUNTER TRENDS**

**Thousands of Protesters Fail to Block India’s Nuclear Power Plant** - Despite the protests and hunger strikes by the anti-nuclear struggle support group over the last eight months, the government still gave their go ahead to the Russians, to complete the nuclear power plant build. Anti-nuclear protesters had stalled this construction of the Kudankulam nuclear power plant which is 98% complete. Nuclear power is the fourth-largest source of electricity in India with 20 nuclear reactors in operation in six nuclear power plants, while seven other reactors are under construction. Populations around proposed Indian nuclear power plant sites have mounted protests, warning that atomic energy is not a clean and safe alternative to fossil fuels.

**INDUSTRY**

Government, Law





# Place Your Bets

Future of global nuclear industry is promising as countries plan to expand their nuclear drive and other countries enter the nuclear supply business to take advantage of the opportunity.

The global economic and socio-political conditions that promote nuclear energy are still standing – high oil prices, energy security, growing energy demand, low-carbon fuel search to mitigate climate change. While countries like Germany aim to be nuclear-free by 2022, new countries are adopting nuclear energy as a reliant energy source. Countries like India and China are not only creating nuclear energy reactors for themselves but are also taking advantage of this opportunity that is emerging from the intense nuclear power supply business and creating nuclear reactors for other countries. Innovation is slowly penetrating the market with technologies like the Small Modular Reactor which allow flexible, cost-effective energy alternatives.

**SIGNALS**  
**World Nuclear Association** - World Nuclear Power Reactor Requirements - Operable reactors: 42; Under construction: 66; Planned (8-10 years): 175; Proposed (15 years): 314. Active nuclear reactors to double in the next 15 years.

**Global Trends in Nuclear Power Post Fukushima** - While parts of the developed world might now freeze or reduce their reliance on nuclear energy, countries like Germany is aiming to go 100% nuclear-energy free as early as 2022. On the other hand, emerging markets such as India, China, Middle East and Eastern Europe continue with their plans to expand their nuclear drive. Firms that sell reactors are mostly state-owned which means negotiations about nuclear deals are often done government to government.

**New Countries Are Adding Nuclear To Their Energy Mix** - United Arab Emirates, the first new country in 27 years, has started building a commercial nuclear power plant. A number of other countries have also taken the decision to introduce nuclear power, including Bangladesh, Egypt, Jordan, Nigeria, Poland, Turkey and Vietnam.

**Energy Choices Not So Obvious In The Middle East** - If asked to describe the likely

energy choices for countries in the Middle East, most would think of oil or natural gas. These are only enjoyed by Saudi Arabia and Iran, while most other regions still use subsidized oil for electricity while they can. Jordan spent 20% of their GDP importing energy supplies in 2007. Keeping cost in mind, how their strategy is to generate 30% of total energy through nuclear power by 2030.

**India's Nuclear Push** - While nuclear states are looking for alternatives to expensive reactors sold by the French, Russians, Japanese, Canadians and Americans, other countries such as India, China and South Korea are entering the nuclear supply business to take advantage of the opportunity that may emerge from intensified nuclear power. Korea received a \$20B agreement from UAE to build 4 nuclear power reactors, and a potential 6 more. China is building their own nuclear power reactors and also building for Pakistan, with interest from Turkish and Arab state plans. India is next in this export race.

**IMPLICATIONS**  
 This will have a positive impact on the adopting countries' economy and the global climate change and carbon emissions, and it will simultaneously raise concern with the general public about the safety and threats that come with nuclear energy.

**EXTRAPOLATION**  
**Next 5** - 68 new nuclear reactors under construction will be operable.

**Next 10** - Countries which are currently planning on building the 175 new nuclear reactors will now be operable.

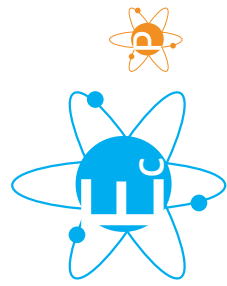
**Next 20** - Countries which have proposed the 314 new nuclear reactors, provided they are approved, will be built and operable. With the exceptions of the reactors which will retire, the number of global nuclear reactors will have doubled in capacity. Along with new reactors will be twice as much nuclear waste, pressuring the countries to find creative solutions. Will this growing demand entice other countries to re-enter the market?

**COUNTER TRENDS**  
**Germany to be 100% Nuclear Power-Free by 2022** - The Fukushima disaster paired with the support of public opinion, Germany turned against the nuclear industry by aiming to be nuclear-energy free. The government is making good on the promises and hopes to fill the gap with renewable energy sources. With high hopes for industrialized countries looking to phase out dirty, dangerous, or unpopular energy sources, the path forward is clear.



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- INDUSTRY**  
 Capital Markets, Financial Institutions
- OTHER RESOURCES AND REFERENCES**
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  3. IAEA Director General Yukiya Amano. (March 11, 2013). IAEA Perspectives on Future of Nuclear Energy. Indian Nuclear Society. <http://www.iaea.org/newscenter/statements/2013/iamsp030903.html>
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# Big Brother Needs Help

Nuclear power plant corporations in Asia are turning towards capital markets through IPO to fund multi-billion dollar nuclear power plant projects

State owned nuclear power plant corporations have started a trend of bypassing traditional funding models such as debt financing and are accessing the capital markets through IPO's which provide additional funding sources for the prospective. Capital markets are strong and IPO's are successful in the hundreds of millions but larger projects are in the planning which will require tens of billions. This trend is being encouraged by officials who think this will lead to the development of other innovative funding models.

**SIGNALS**  
**Romania is 'Satisfied' With Interest in Nuclear-Utility Sale** - Romania raised \$85.9M via IPO for a 10% stake in nuclear power plant operator - Nuclerelectrica. By the end of subscription period, they were oversubscribed. Nuclerelectrica is the first IPO of a state-owned company since 2007 (Gas Grid operator), Romania's economy ministry holds a 90.3% stake in Nuclerelectrica, the operator of the country's sole nuclear power plant - Cernavoda. This utility sale is anticipated to pave the path for the next listing of Romgaz this year for over \$750M.

**China Nuclear Company Plans IPO to Help Fund Projects** - Country's largest power developer, China National Nuclear Power, plans to raise \$27B for five projects through the biggest IPO in China and a first for a nuclear power company. If they are successful in raising the funds, CNNPC could surpass Agriculture and become the largest in China. CNNPC has already received ministry approval, as industries like as nuclear power, chemicals and mining must obtain approval prior to submission of IPO applications to the securities regulator.

**Financing Nuclear Power Projects: New Trends Emerging for Asia** - a new trend in emerging whereby Nuclear Steam System

Suppliers have started to include equity as part of the deals which provides an additional funding source for the prospective. Building comprehensive funding models for prospective projects allows the integration of new sources for financing through the different stages of constructing a new power plant. New nuclear construction projects are asked to get creative and look beyond traditional funding sources such as debt financing to cover large fixed costs for long construction periods. Accessing capital markets through IPO is one of many options while more innovative structures develop. Markets and banks will find a receptive and welcoming partner in the nuclear industry.

**Nuclear Power Corporation to Launch Dual IPO in Hong Kong and Shanghai** - Operated by the State, China Guangdong Nuclear Power Corporation (CGNPC) plans to launch dual IPO's in Hong Kong and Shanghai to target \$4.12B with split assets in both cities. CGNPC is the only nuclear power firm under the direct management of the State Council, or the cabinet.

**IMPLICATIONS**  
 This relieves the financial burden of the governments and allows them to incur the high costs of nuclear plant construction and the multi-ownership creates more shareholders for the nuclear industry.

**EXTRAPOLATION**  
**Next 5** - Nuclear power corporations have successfully funded small projects in capital markets through IPO's. The governments are relieved of the financial pressure and support and encourage the industry to continue being creative with innovative funding models.

**Next 10** - Other countries and industries are catching on while the Asian market is successfully closing multi-billion fundings through capital markets and other models.

**Next 20** - Other governments are applying this successful model and no longer invests capital in the nuclear energy sector. The nuclear power corporations are built and operable, the shareholders are content and as a result of positive returns, continue to invest in the nuclear energy sector.

**COUNTER TRENDS**  
**US Government Funds First New Nuclear Plant in Decades** - U.S. President Barack Obama guaranteed more than \$8 billion in loans to help build the first new American nuclear power plant in decades to support clean, safe nuclear power as it's vital to the nation's future. "To meet our growing energy needs and prevent the worst consequences of climate change, we will need to increase our supply of nuclear power. It is that simple," he said.

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## Type: B+

### Returning to the days when the atom was the solution to all our nightmares, not the creation of...

Recent emerging studies are highlighting the positive impacts of nuclear energy as an abundant, low-carbon source of base-load power that has made a large contribution to mitigation of global climate change and air pollution, and as a result has already saved millions of lives. While there have been countless anti-nuclear studies over the decades and this is a bold step in the opposite direction, it's broad acceptance and support in the community has also encouraged other research to follow in the light.

**SIGNALS** Prevented Mortality and Greenhouse Gas Emissions from Nuclear - NASA's Goddard Institute for Space Studies (James E. Hansen) - Using historical production data, they calculated that global nuclear power has prevented an average of 64 gigatonnes of CO<sub>2</sub>-equivalent (GtCO<sub>2</sub>-eq) greenhouse gas (GHG) emissions that would have resulted from fossil fuel burning. On the basis of global projection data that take into account the effects of the Fukushima accident, we find that nuclear power could additionally prevent an average of 80–240 GtCO<sub>2</sub>-eq emissions due to fossil fuels by 2050, depending on which fuel it replaces.

**Nuclear Power Prevents More Deaths Than It Causes** - Using nuclear power in place of fossil-fuel energy sources (coal), has prevented ~1.8 million deaths, globally, from 1972-2009. Replacing all forecasted nuclear power use until 2050 with natural gas would cause an additional ~420,000 deaths; replacing it with coal would add an additional ~7 million deaths.

**Deaths Per TWh By Energy Source** - World average for coal is about 100 deaths per TWh (96% of world energy, 50% of electricity). Oil is about 36/TWh (36% of world energy). Natural Gas is about 4/TWh (21% of world energy). Solar (rooftop) is about 0.44/TWh (0.2% of world energy for all solar). Wind is about 0.15/TWh (0.6% of world energy). Nuclear power is

about 0.04 deaths/TWh (5.9% of world energy). Nuclear, wind, solar and hydro are a lot safer than coal and oil. Natural gas is safer but not as much as nuclear and those others.

**The Triumph of Coal Marketing** - For every person killed by nuclear power generation, 4,000 people die due to coal, adjusted for the same amount of power produced. Forget which is better. The important question is, how does this reality resonate with you?

**Endangered Crocodile Finds New Life At Nuclear Power Plant** - Even after two sanctuaries were built in Florida to promote crocodile nesting, the American crocodile was going extinct due to lack of population restoration. But the American crocs are making a comeback in the 168 miles of cooling water canals surrounding the Turkey Point Nuclear Power Plant. The cooling canals provide solitude and allow them to mate - they have multiplied five folds. The American crocodiles is no longer considered an endangered specie.

**IMPLICATIONS** These studies and research provide a different and positive perspective for the users of nuclear energy and for the general public. While nuclear energy has it's challenges, so does every other energy source. The effects of this trend are spreading and more research is anticipated to emerge on benefits of nuclear energy.

Revolutions such as nuclear energy never receive widespread support, even among the people who benefit from them. Among others is this strong irrational fear of nuclear power that's been with us since the 1950's. Studies show that americans are significantly more likely to associate nuclear power with images of 'disaster' and 'bad'. These ill-informed populations can often be whipped into hysteria over things they do not understand. It is the responsibility of the educated experts and the government to inform them.

**EXTRAPOLATION** Next 5 - The world is slowly starting to spread and while most conversations amongst the general public around nuclear energy still equal to 'death' and 'bad', some have started to become about saving human lives and saving the planet.

**Next 10** - Research is being funded from within the industry to continue the positive effect. General public, especially the younger generations are beginning to understand that nuclear energy is not an outcast, all energy resources have challenges and are working on improving the results.

**Next 20** - Now the conversations around nuclear energy are much more balanced. People are well informed and hopeful about nuclear power as an energy source.

**COUNTER TRENDS** Reasons Why Nuclear Power is Bad For The Environment And The Nation - Nuclear industries push government officials for self-financial interest and sacrifice the country. They push marketing campaigns to claim that it's better for the economy and the environment. In fact, the truth is far from it. Nuclear is dangerous, expensive and it's bad for the environment, bad for our health and wrong for our country.

Nuclear Power in The American Mind - Using two separate nationally representative

7. Climate Change Communication. In a), Nuclear Power is the American Mind. Yale School for Forestry and Environmental Studies. <http://environment.yale.edu/climate-communication/> article/nuclear-power-in-the-american-mind is up for first how comment/Obama announces funding \$ help for first view nuclear-plant-in-decides-84490102/123599.html

1. Hansen, E. (March 22, 2013). Prevented Mortality and Greenhouse Gas Emissions from Historical and Projected Nuclear Power. Environmental Science & Technology. <http://pubs.acs.org/dolabs/10.1021/es30137>

2. Schriepel, M. (April 02, 2013). Nuclear Power Prevents More Deaths Than It Causes. Chemical & Engineering News. <http://cen.acs.org/Technology/2013/04/Nuclear-Power-Prevents-Deaths-Causes>.html

3. Wong, B. (March 13, 2013). Deaths Per TWh by Energy Source. Next Big Thing. <http://nextbigthing.com/2013/03/deaths-per-twh-by-energy-source.html>

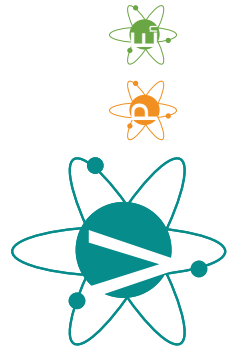
4. Godin, S. (March 22, 2013). The Triumph of Coal Marketing. Seth Godin. [http://sethgodin.com/seth\\_godin/2013/03/the-triumph-of-coal-marketing.html](http://sethgodin.com/seth_godin/2013/03/the-triumph-of-coal-marketing.html)

5. Pfeiffer, E. (December 06, 2013). Endangered Crocodile Finds New Life at Nuclear Power Plant. Yahoo! News. <http://news.yahoo.com/blogs/animals/endangered-crocodile-finds-life-nuclear-power-plant-12448153.html>

6. Ross, M. (December 11, 2013). Why are we why nuclear power is bad for the environment and the nation. Examiner. <http://examiner.com/article/why-nuclear-power-is-bad-for-the-environment-and-the-nation>



<http://transitionsnow.com/wp-content/uploads/2013/07/did-these-per-watts-jam-0001.jpg>



## Carbon Kills

### Nuclear power production is perceived as an environmentally and health friendly source of energy.

Carbon emissions are increasingly perceived as a greater threat than power production from nuclear

**SIGNALS** Evidence mounts of the health cost of carbon-based fuel compared to nuclear. <http://www.sciencedaily.com/releases/2013/05/13052913343.htm>

**Pressure grows to reduce carbon emissions** [http://switchboard.nrdc.org/blogs/lojinson/scc\\_electricity\\_costs.html](http://switchboard.nrdc.org/blogs/lojinson/scc_electricity_costs.html)

Increasing profile of the concept of the Social Cost of Carbon (SCC)

**IMPLICATIONS** Nuclear power emerges as an acceptable alternative solution to global carbon emissions based dilemma.

**EXTRAPOLATION** The Clean Air Act is toughened in U.S. and Canada vows to lead to reduction of carbon emissions.

**OTHER RESOURCES** Natural Resources Defense Council

**COUNTER TRENDS** No one believes that the human use of fossil fuels causes climate change or pollution.

**INDUSTRY** Nuclear power generation and waste disposal.



# Nine Lives Of Uranium

## Permanent storage of spent nuclear fuel is not going to happen soon.

Spent nuclear fuel is not going to find a permanent repository quickly enough to solve issues around temporary storage. After spending \$12 billion researching the Yucca Mountain site the research team cannot confirm the feasibility of permanently storing waste fuel or, perhaps more importantly, contaminated wastewater at the site.



**SIGNALS**  
US legislation and legal wrangling around the Yucca Mountain site.  
<http://www.forbes.com/sites/kensilverstein/2013/08/29/where-on-earth-do-we-put-spent-nuclear-fuel/print/>  
<http://www.forbes.com/sites/kensilverstein/2013/08/29/where-on-earth-do-we-put-spent-nuclear-fuel/print/>  
<http://www.forbes.com/sites/kensilverstein/2013/08/29/where-on-earth-do-we-put-spent-nuclear-fuel/print/>

New technology is emerging to reprocess nuclear waste.  
<http://www.sciencedaily.com/releases/2013/07/130710a083503.htm>

**IMPLICATIONS**  
This has implications for continued acceptance worldwide of the conventional wisdom that permanent storage of nuclear waste is the endgame with respect to waste fuel and associated storage materials that are currently involved in temporary storage. In addition, new technology that will provide economic feasibility for the production of energy from waste and at the same time address the issue of public perception of nuclear waste is emerging. Reprocessing may supplant a storage solution. The potential of energy production from waste becomes a driver in the search for solutions to current nuclear waste issues.

**EXTRAPOLATION**  
Legislation will prevent permanent storage of waste

The will be an increased investment in nuclear waste reuse technologies.

**OTHER RESOURCES**  
MIT, Forbes, Science daily

**COUNTER TRENDS**  
Solution found and accepted for permanent storage of waste

**INDUSTRY**  
Nuclear power generation and waste disposal.

# The Path to Hydrogen Power

## Nuclear power plants will produce hydrogen to fuel a hydrogen based economy

Production of hydrogen through low temperature electrolysis, high temperature electrolysis and room temperature laser technology is appearing increasingly feasible. Waste heat and spent fuel from current nuclear plants could fuel high temperature electrolysis for production of hydrogen. Next-generation nuclear plants could use spent fuel for low temperature electrolysis or room temperature laser technology production of hydrogen.

**SIGNALS**  
Public interest and technology breakthroughs are converging on hydrogen as a power source.  
<http://www.sciencedaily.com/releases/2012/09/120923a012500.htm>  
<http://www.sciencedaily.com/releases/2013/08/130818a144250.htm>

**IMPLICATIONS**  
New technology and other fuels may have crossover implications for the nuclear industry, both in terms of production, scale and waste.

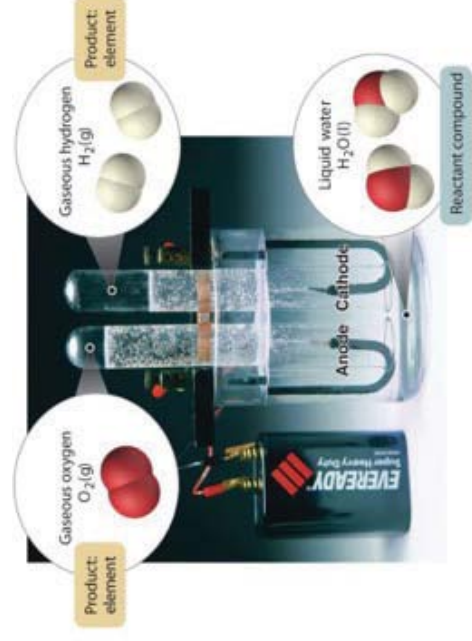
**EXTRAPOLATION**  
Cost-effective hydrogen production occurs.

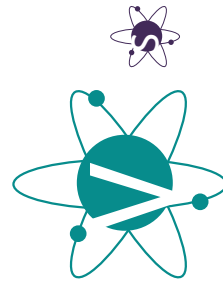
Demand for hydrogen fuel expands.

**OTHER RESOURCES**  
Chemistry journals

**COUNTER TRENDS**  
Hydrogen fuel increasingly becomes socially or politically undesirable

**INDUSTRY**  
Nuclear power generation and waste disposal





## White Male Effect

Individual perception of nuclear waste disposal is enhanced if the nuclear industry is already “well embedded” in a community and has delivered economic benefits to the community.

There is a positive stance vis-à-vis nuclear waste disposal related to “industry awareness campaigns” as well as an “economic dependency effect” related to community acceptance of local nuclear waste disposal sites.

**SIGNALS**

Research suggests that there is a greater acceptance of nuclear waste storage in European communities that already have advanced nuclear industries than in communities that don't. <http://www.sciencedaily.com/releases/2012/06/120609103941.htm>

Wouter Poortinga, Midori Aoyagi, Public Perceptions of Climate Change and Energy Futures Before and After the Fukushima Accident: A Comparison between Britain and Japan, WSA Working Paper Series ISSN 2050-8522,2013

**IMPLICATIONS**

Community acceptance of nuclear waste disposal is linked to economic benefits and industry awareness campaigns. If nuclear facilities become more common, so will acceptance of waste disposal.

**EXTRAPOLATION**

There will be an increase in nuclear waste acceptance campaigns by the nuclear industry. There will be a corresponding increase in local support for waste disposal communities that currently have nuclear power facilities. A polarization in support for nuclear waste storage will emerge

that is dependent on the energy production modes of individual communities.

**OTHER RESOURCES**

Science daily, newspapers

**COUNTER TRENDS**

Local communities are adversely affected by events related to nuclear waste storage facilities; Fukushima is a possible example.

**INDUSTRY**

Nuclear power generation and waste disposal.



# ENERGY SWOT

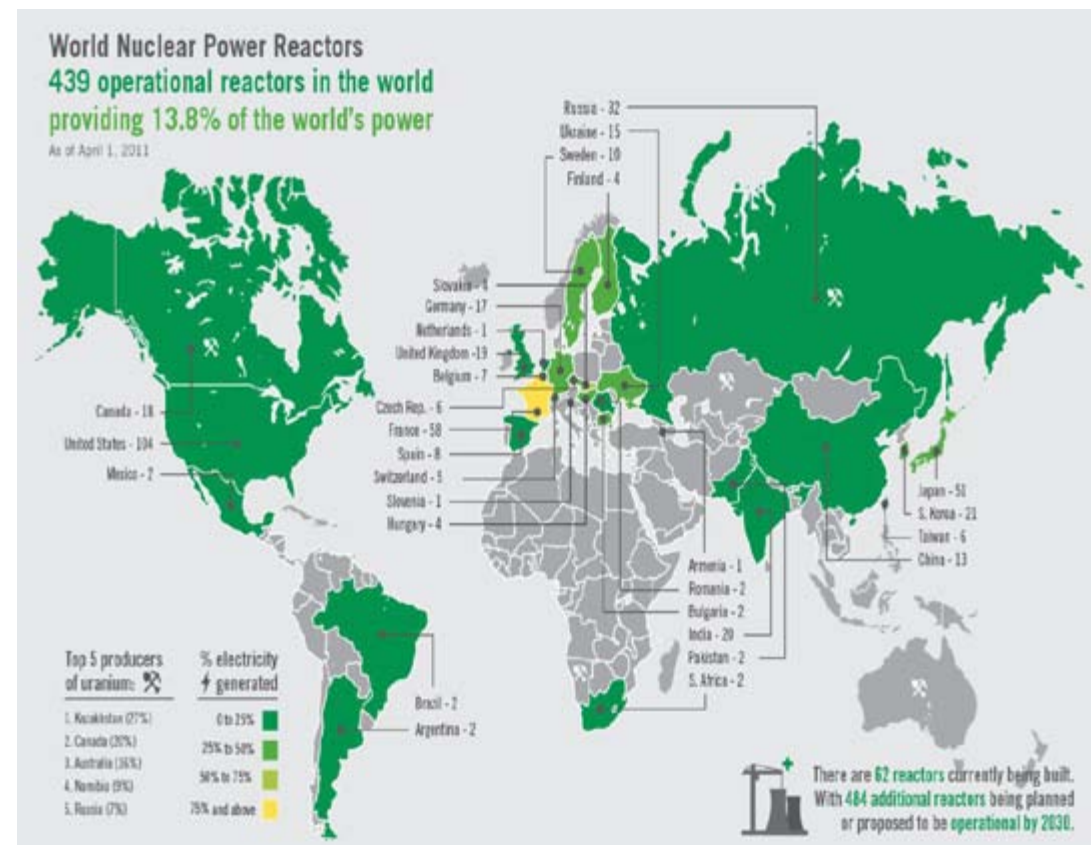


# Nuclear SWOT

Nuclear is the largest source of electricity in Ontario, meeting more than 50% of the demand, and with ongoing support from the federal and provincial government. The station at Bruce Peninsula is the largest fully operational facility in the world providing almost four thousand jobs in the region. This establishes a clear tension as waste management continues to be a problem, with the Kincardine deep geological repository struggling to get approval amid fear of pollution to Ontario's unique water system. Without any low hydrocarbon alternatives for base power load, Nuclear is currently a well-established contributor of energy for the next several decades in Ontario.

## ONTARIO OVERVIEW:

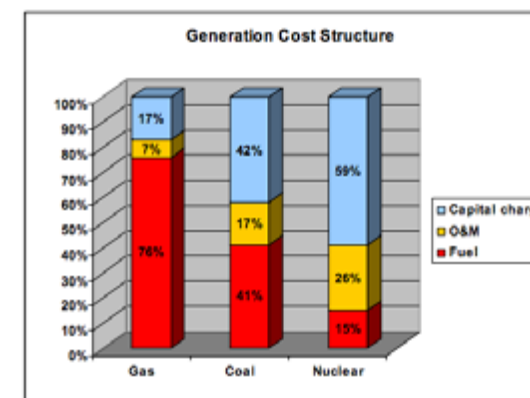
Current installed capacity: 12,998 MW - 36%  
 Average energy output (2012): 56.4%  
 Recent news: Bruce Units 1 & 2 +1,552 MW in 2012  
 Source: IESO



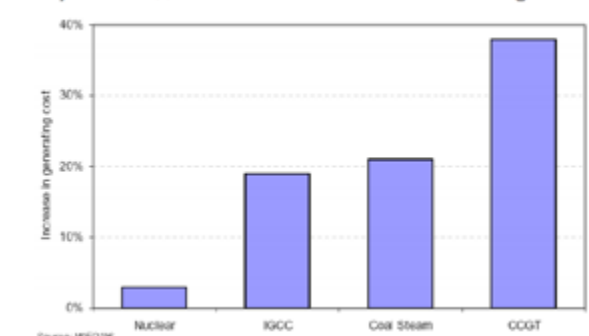
Source: Lawrence Livermore National Laboratory, 2008. Estimated U.S. Energy Use in 2008

Nuclear Strengths	Nuclear Weaknesses
<ul style="list-style-type: none"> <li>No carbon emissions</li> <li>Creates a high amount of long term, high skill employment</li> <li>Strong regulatory governance, with a strong safety record internationally</li> <li>Stable prices of raw fuel, especially due to local supply</li> <li>Canada is the world's largest uranium producer - with capacity increasing significantly in 2014 (Cigar Lake mine)</li> <li>Cost of waste disposal factored into revenue generation in advance</li> <li>Lowest cost option for generating base-load centralized electricity, with smallest physical footprint</li> <li>High profile supporters within green movement and environmental activists</li> </ul>	<ul style="list-style-type: none"> <li>The lack of any long-term solutions to high-level-waste increases negative public perception and generating political volatility</li> <li>Very poor public perception</li> <li>Impacts of an accident are high, with global awareness</li> <li>Requirement of highly trained staff, operators and researchers, and infrastructure for transferring knowledge to successors</li> <li>Uranium resources are not renewable outside of an asteroid hitting earth</li> <li>Radiation leaking into the Great Lakes is a concern for local people</li> <li>High capital costs</li> </ul>
Nuclear Opportunities	Nuclear Threats
<ul style="list-style-type: none"> <li>Increase flexibility in controlling power output in order to facilitate intermittent power sources and compete directly with natural gas</li> <li>Leverage low carbon emission benefits in global transition to alternative energy sources</li> <li>Leverage Canada as leader of nuclear industry</li> <li>Bring refurbishments on time and on budget</li> <li>Build further partnership with long-term energy and sustainability spokespeople to integrate with broader environmental movements</li> <li>Invest in advancements for nuclear waste processing as future fuel source</li> <li>Continue to use disarmament of nuclear weapons as fuel source</li> <li>Develop improved community engagement around employment benefits</li> </ul>	<ul style="list-style-type: none"> <li>Any accident is extremely high profile, causing long-term impacts on public perception</li> <li>Cost over runs of refurbishments will re-enforce public concerns of expensive infrastructure</li> <li>Lack of waste disposal facilities will reinforce concerns over waste management</li> <li>Public fear rising over weapon proliferations with increasing threats of Iran and North Korea</li> <li>A high-level waste storage accident will provoke further public fear</li> <li>High profile activists against nuclear energy</li> <li>Extremely long scope of challenges increases the likelihood of a potential disaster occurring</li> <li>Links between biodiversity and radiation waste within water cooling could create environmental concerns</li> </ul>

Generation Costs Structure



Impact of 50% Increase in Fuel Price on Generating Costs



Source: ENEF Working Group, 2011.

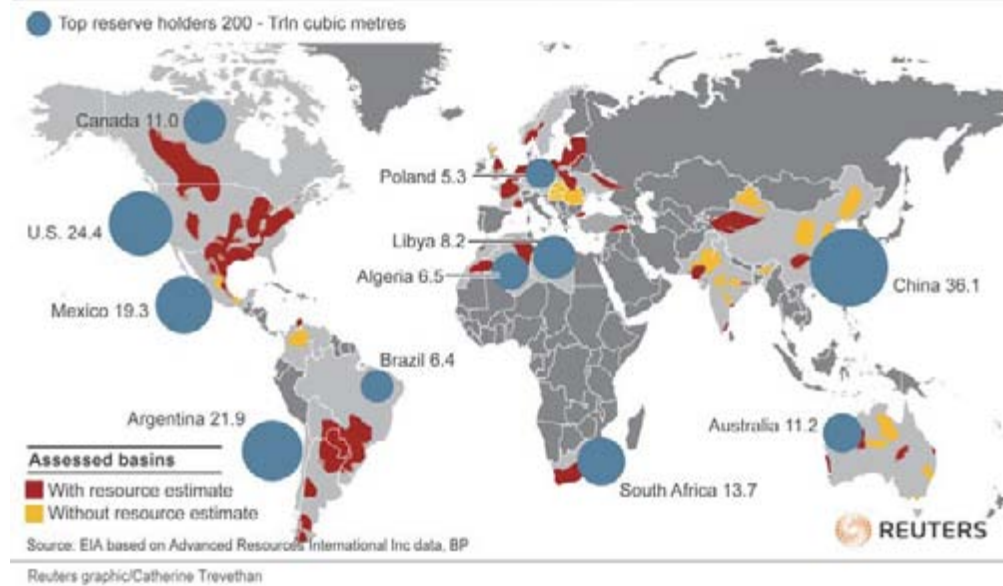
# Natural Gas SWOT

Where gas was once a poor substitute to oil, shifts in technology, concerns over peak oil and the successful positioning of lower emissions from production have caused a boom in popularity. Deep issues remain unanswered as environmental advocates question the fracking methodology used in extraction and general concern over climate change. This places pressure on hydrocarbon based power output. In Ontario two major natural gas plants were closed down as part of a lower emissions strategy for improving air quality, but concerns have been raised over potential increases in costs for consumers while replacement infrastructure is developed.

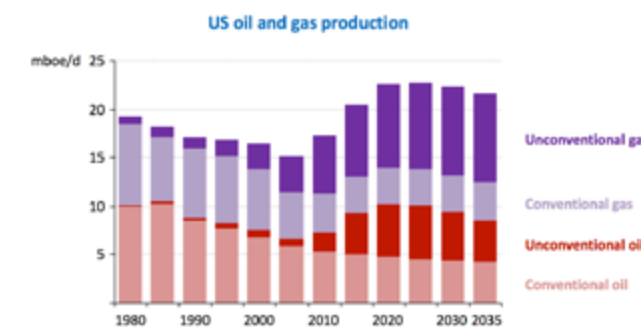
## ONTARIO OVERVIEW:

Current installed capacity: 9,987 MW - 27.9%  
 Average energy output (2012): 14.6%  
 Recent news: York Energy Centre +438 MW, 2012  
 Source: IESO

## Global shale gas basins, top reserve holders

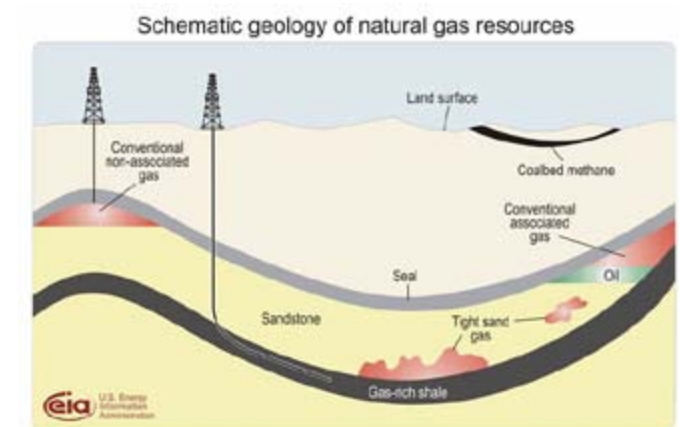


Natural Gas Strengths	Natural Gas Weaknesses
<ul style="list-style-type: none"> <li>• Low price of fuel</li> <li>• Established stable infrastructure</li> <li>• Lower emissions than competitive hydrocarbon fuels such as coal and oil</li> <li>• Flexible source for baseload power supply, highly manageable output</li> <li>• Huge reserves of fuel being discovered in geopolitically stable locations</li> <li>• Cost of gas extraction is coming down, especially within Canada</li> </ul>	<ul style="list-style-type: none"> <li>• High use of chemical laden water, with risks of groundwater contamination</li> <li>• Fracking processes have high potential for environmental damage</li> <li>• High carbon emissions</li> <li>• Questionable political support in current Ontario government</li> <li>• Limited regulatory control</li> <li>• Poor safety record</li> <li>• Politically sensitive due to air pollution, extraction methods and global warming</li> <li>• New business models required by gas companies due to variations in drilling and infrastructure methodologies</li> <li>• Lack of accepted environmental research highlights potential volatile findings that will affect the industry</li> </ul>
Natural Gas Opportunities	Natural Gas Threats
<ul style="list-style-type: none"> <li>• High oil prices to drive demand</li> <li>• Peak oil is likely to happen before peak gas, reinforcing viability of gas</li> <li>• Control over supply (extraction technologies) to match demand, ensures a balanced and stable price of the fuel</li> <li>• Continuing to compare carbon emissions to coal and oil reinforces gas as a greener alternative</li> <li>• Invest heavily in carbon capture technology at power plants</li> <li>• Global acceptance of hydraulic fracturing</li> <li>• Reduction in popularity of nuclear will increase gas demand</li> </ul>	<ul style="list-style-type: none"> <li>• Major environmental catastrophe during extraction could cause the introduction of new regulations and requirements that would add cost and curb current production</li> <li>• Global warming concerns challenge long-term viability of hydrocarbon based power, no matter what the price of the raw fuel</li> <li>• Drive to increased efficiency will challenge consumption</li> <li>• Perceived collusion between industry and government reinforces negative public sentiment</li> <li>• Environmental reviews of emerging extraction practices could reveal damaging findings that affects the industry</li> <li>• Increase in nuclear popularity will drive demand away from gas</li> </ul>



The surge in unconventional oil & gas production has implications well beyond the United States

Note: "unconventional" is the term used for oil and gas trapped in coals, shale and tight sands (BG Group, 2013)

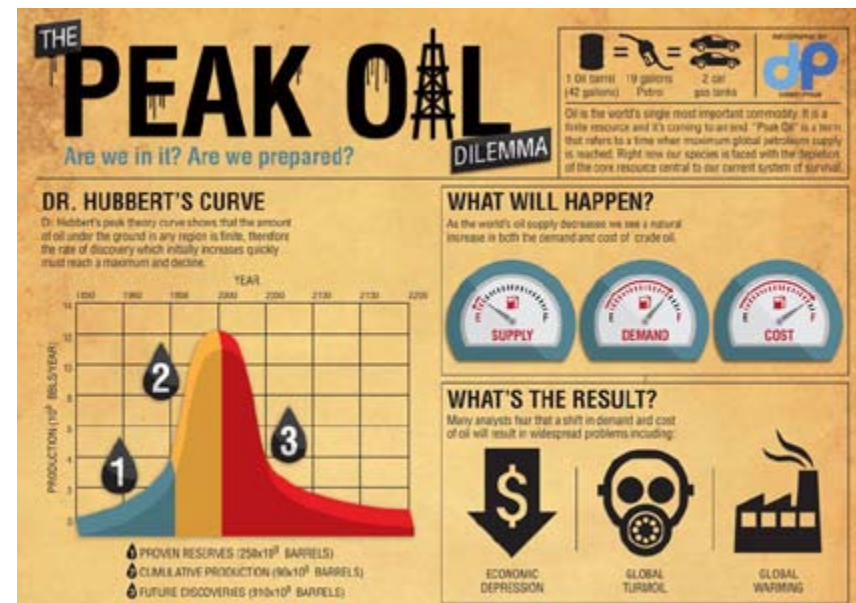


# Oil SWOT

Oil is a naturally occurring liquid consisting of a complex mixture of hydrocarbons that can be found in geologic formations beneath the earth's surface. A fossil fuel, recovered mostly through drilling, is refined and separated by boiling. It is used for consumer products such as gasoline. It releases pollutants and greenhouse gasses into the air and has a negative impact on the environment. Worldwide consumption is estimated around 89 million barrels a day (IEA) raises concern for this depleting resource.

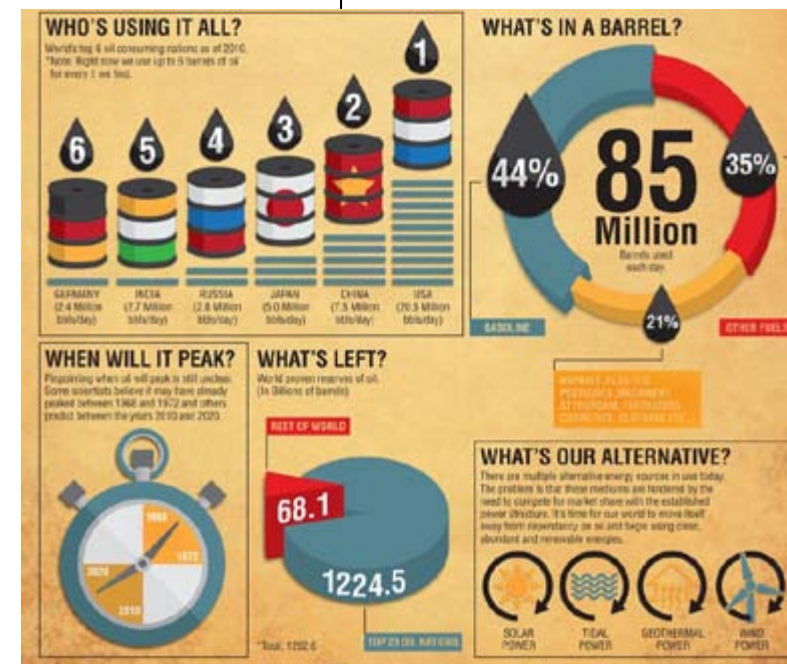
## ONTARIO OVERVIEW:

While oil is currently not a contributor to Ontario's electricity generation mix it has been included in this document as it is a major export to countries, such as the USA, where it can be used to produce electricity (Hughes, 2010).



Source: Fatcatwatch, 2011. Peak Oil Dilemma

Oil Strengths	Oil Weaknesses
<ul style="list-style-type: none"> <li>Abundant source of energy worldwide</li> <li>Easily combustible, and produces high energy upon combustion (high heating value)</li> <li>Established distribution system - widely and easily distributed all over the world</li> <li>Comparatively inexpensive due to large reserves and ease of accessibility</li> <li>Oil-fired power stations are very efficient - very large amounts of electricity is generated in one place using oil</li> <li>Burns cleaner compared to coal</li> <li>An oil-fuelled power station can be built almost anywhere, so long as you can get large quantities of fuel to it</li> <li>No new technology required for usage</li> </ul>	<ul style="list-style-type: none"> <li>Burning leads to carbon emissions</li> <li>Declining oil reserves (finite resource)</li> <li>Negative public perception</li> <li>The price of oil is rising, especially if the cost of carbon is included</li> <li>Oil drilling (and spills) endanger the environment and ecosystem</li> <li>Not a renewable source</li> <li>Expensive for generating energy</li> </ul>
Oil Opportunities	Oil Threats
<ul style="list-style-type: none"> <li>Development of carbon capture systems to reduce emissions</li> <li>Expansion of oil refineries</li> <li>Exploration of shale</li> <li>Produce higher quality oil</li> <li>Over 200 000 Canadians work in the oil and gas industry (COSSD, 2013)</li> </ul>	<ul style="list-style-type: none"> <li>Industry regulations related to greenhouse gas emissions</li> <li>Volatile industry</li> <li>Political risk - unstable governments</li> <li>Causes pollution upon combustion by leaving behind harmful by-products</li> <li>Intense competitors</li> <li>Alternative energies are increasing in viability</li> <li>Mining of oil leads to irreversible damage to the environment</li> <li>Oil spills as well as evaporation and fumes pollutes the environment</li> </ul>

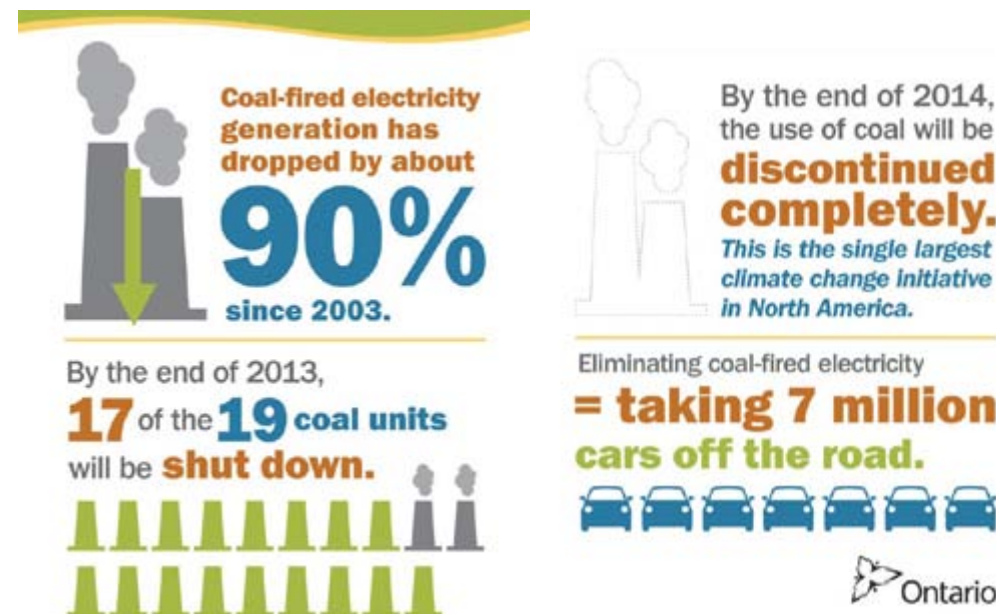


# Coal SWOT

Coal is a combustible black sedimentary rock, composed mainly of carbon and other elements such as hydrogen, sulfur, oxygen and nitrogen (Blander, n.d.). It is primarily used for production of electricity and or/heat, and for industrial purposes such as refining metals. It is extracted from underground or ground levels through different extraction methods. It's the largest source of energy used to generate electricity worldwide and also the largest source of carbon dioxide releases worldwide. Coal is widely recognized as the worst pollutant in the energy sector and in Ontario it is being phased out as early as 2014 (Ministry of Energy, n.d.). Having said that, coal will not disappear anytime soon as it's the largest fossil fuel source of energy available, low cost, existing infrastructure and innovation opportunities such as biomass, and therefore should be included when highlighting the challenges of transitioning to alternatives.

## ONTARIO OVERVIEW:

Current installed capacity: 9.987 MW - 9.1%  
 Bio-mass capacity: 122 MW - 0.3%  
 Average energy output (2012): 2.8%  
 Recent news: to be phased out 2014  
 Source: IESO



Source: Ministry of Energy, n.d. Building Our Clean Energy Future

Coal Strengths	Coal Weaknesses
<ul style="list-style-type: none"> <li>• Largest fossil fuel source of energy worldwide</li> <li>• Resources sufficient for the next 200 years (Martin, 2012)</li> <li>• 50% of the world's electricity comes from coal (OSPE, 2011)</li> <li>• Inexpensive - competitive price in comparison to other energy carriers</li> <li>• Versatile; can be burned directly, transformed into liquid, gas, or feedstock (JISIBHL Physics, n.d.)</li> <li>• Enables safe and faultless energy production</li> <li>• Reduces dependence on foreign oil</li> <li>• Not easy to substitute</li> <li>• Easily combustible; burns at low temp. (mining)</li> <li>• Easy in transportation, storage and energy production regardless of climate</li> <li>• By-product of burning (ash) can be used for concrete and roadways</li> </ul>	<ul style="list-style-type: none"> <li>• High source of pollution: emits waste, SO<sub>2</sub>, Nitrogen Oxide, ash</li> <li>• Highest contributor to green house gas emissions</li> <li>• High costs to health due to pollution (Ministry of Energy, n.d.)</li> <li>• High rate of accidents during mining</li> <li>• Moderate capital cost</li> <li>• Liquefaction, gasification require large amounts of water</li> <li>• Low innovation capabilities</li> <li>• Lowest energy density per unit volume</li> <li>• Physical transport is difficult</li> <li>• Coal dust is an extreme explosion hazard</li> </ul>
Coal Opportunities	Coal Threats
<ul style="list-style-type: none"> <li>• Carbon capture systems could reduce emissions</li> <li>• Significant potential of decreasing CO<sub>2</sub> emissions</li> <li>• Transition to alternate biomass fuel sources that can work with existing infrastructure</li> <li>• Improvement of energy production efficiency</li> <li>• Implementation of new technologies</li> <li>• Setting up manufacturing units</li> <li>• Could produce ultra-clean fuel</li> </ul>	<ul style="list-style-type: none"> <li>• Represents 20% of CO<sub>2</sub> emissions in Canada (Clean Coal Technologies)</li> <li>• Considered the #1 source of carbon emissions worldwide</li> <li>• Public desire with significant non-government advocates against coal production</li> <li>• Stringent government regulations - stricter environmental rules restricting coal mining activities</li> <li>• Ontario government program to remove coal from energy mix (Ministry of Energy, n.d.)</li> <li>• Poor infrastructure facilities</li> </ul>

# Hydro SWOT

Hydro is a dominant electricity producer in Ontario and in Canada. It converts the potential and kinetic energy of water into mechanical energy (International Hydropower Association, 2011 & Buijs et al 2007). This mechanical energy is converted into electrical power and transmitted immediately through a grid to the demand site. Potential energy of water can be stored in reservoirs by pumping water into the reservoirs at times of low demand for alternate energy sources.

Globally, hydro provides approximately 15-17% of power production capacity (International Hydropower Association, 2011 & Buijs et al 2007), in Ontario the percentage is a much higher 25% (Conserve Energy Future, n.d.).

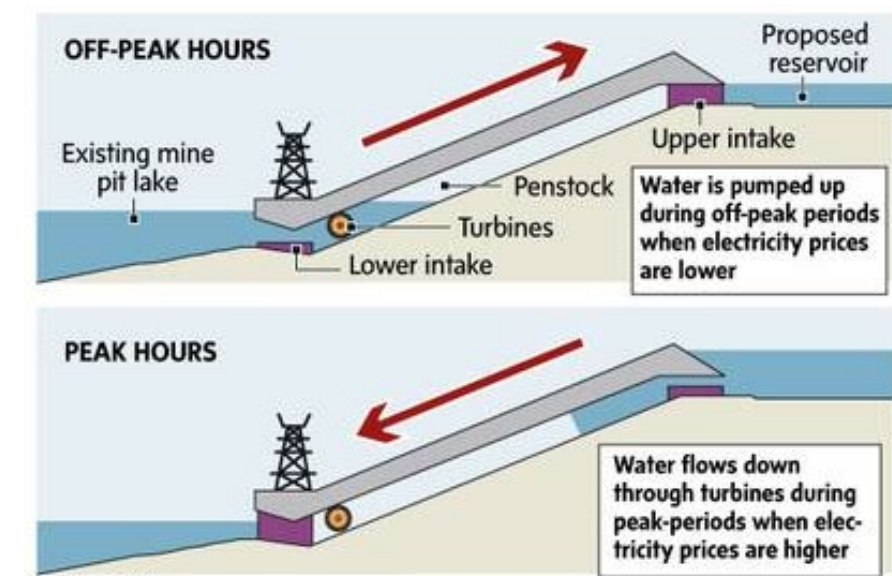
## ONTARIO OVERVIEW:

Current installed capacity: 7,939 MW - 22%  
 Average energy output (2012): 22.3%  
 Recent news: Beck Upgrades +137 MW in 2009  
 Source: IESO

“Hydroelectric power is a central pillar of the government’s renewable electricity portfolio...Clearly, the province’s hydroelectric generation sector has been in the renewable energy business since before the term ‘renewable’ was common currency.” Minister of Energy Bob Chiarelli, October 22, 2013.

	Power	Back-up time	Response time	Efficiency	Lifetime
Pumped hydro	200 MW → 2 GW	hours	~ 12 min	~ 75%	~ 50 y
CAES	25 MW → 2.7 GW	hours	~ 12 min	~ 70%	< 50 y
Batteries	KW's → 50 MW	hours	seconds	~ 80%	< 10 y
Flywheels	5 kW → 3 MW	mins	~ 12 min	< 95%	~ 20 y
EMES	10 kW → 3 MW	seconds	millisecs	~ 95%	~ 30 y
Supercapacitors	< 150 kW	seconds	millisecs	< 95%	> 10 y

Hydro Strengths	Hydro Weaknesses
<ul style="list-style-type: none"> <li>Extremely efficient method for generating electricity</li> <li>No greenhouse gas emissions</li> <li>Storable as latent energy in hydraulic set-ups</li> <li>Flexible due to ability to regulate flows</li> <li>Relatively quick demand response times and shut-down/start-up</li> <li>Easy to upgrade the technology</li> <li>Politically attractive</li> <li>High degree of public acceptance</li> <li>Reliable projected costs</li> </ul>	<ul style="list-style-type: none"> <li>Limited new hydro opportunity in Ontario</li> <li>Environmental impacts, especially to wildlife</li> <li>Location specific, must be near large bodies of water</li> <li>Habitat destruction</li> <li>Competes with other demands for water</li> </ul>
Hydro Opportunities	Hydro Threats
<ul style="list-style-type: none"> <li>Refurbishment of existing plant can increase capacity</li> <li>Using hydro to store energy in micro dams</li> <li>Increase efficiency through new technology the increases flexibility of power generation</li> <li>Increased geographic distribution due to high head pump development</li> </ul>	<ul style="list-style-type: none"> <li>Vulnerable to water shortages due to drought</li> <li>Vulnerable to water shortage due to competition for water</li> <li>Legislative threats due to environmental or resource concerns</li> <li>Public perception of environmental costs could rise</li> </ul>



Pumped Hydro Storage Infographic. Source: Globe and Mail, Northland Power Inc.; ESRI

# Wind Energy SWOT

Wind energy is not a new phenomenon: it has been used throughout the centuries as an energy source. What has developed in recent years is the mass harnessing of wind energy, and using it in electricity grids to power our homes and businesses. At first glance wind appears to be a cleaner alternative to energy sources like gas and coal, but upon closer inspection of the current status of wind in Ontario, a number of significant issues arise and the Ministry of Energy is working towards solutions to position wind so it benefits people, the environment and the economy.

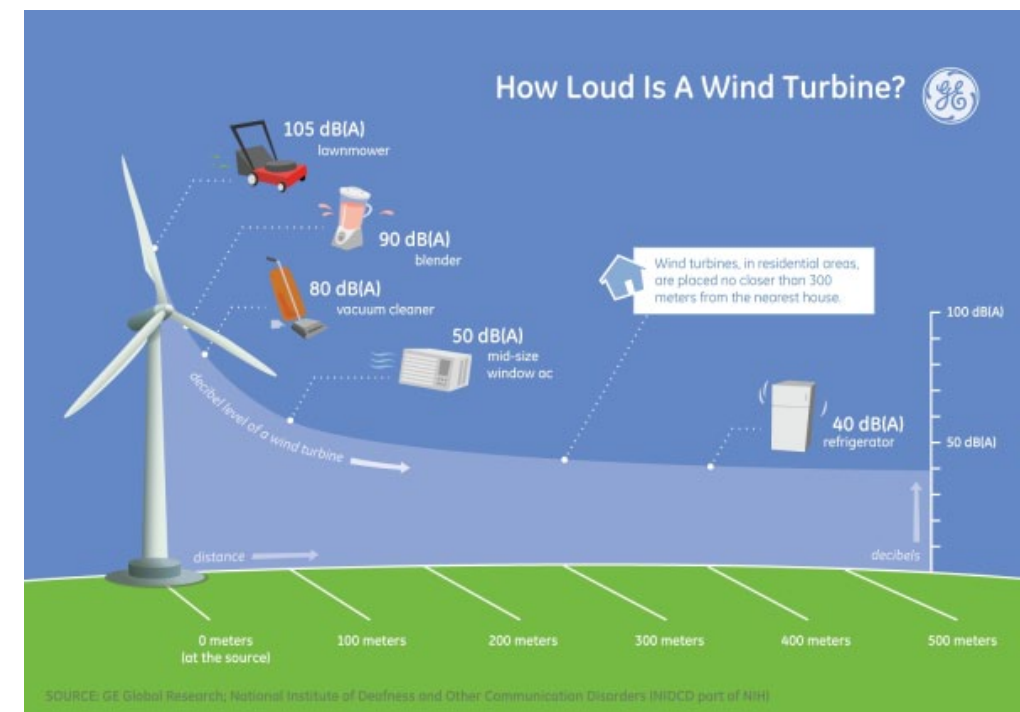
## ONTARIO OVERVIEW

Current installed capacity: 1,725 MW - 4.8%

Average energy output (2012): 3.0%

Recent news: Pointe Aux Roches and Comber Wind Farm +215 MW in 2013

Source: IESO



Source: General Electric, n.d. How Loud is a Wind Turbine?

Wind Strengths	Wind Weaknesses
<ul style="list-style-type: none"> <li>Per watt, theoretically more economical* in Ontario if no back up energy source is required (current high costs are due to natural gas support supply of energy)</li> <li>No fuel cost</li> <li>Renewable/sustainable, with abundant natural fuel source</li> <li>Ontario is at the forefront of wind energy in Canada, with more than 1,700 MW of wind generation capacity connected to the province's power grid (IESO, 2010)</li> <li>Fee-in Tariff Program (FIT) (incentive to build wind farms)</li> <li>Fastest growing energy source in the world (OSPE, 2012)</li> <li>Strong government support*** and long-term commitment</li> <li>Strong public support: "Ipsos Reid poll conducted in June 2010 found that 90% of Ontarians would support a wind farm in their region of the province (OSPE, 2012)</li> </ul>	<ul style="list-style-type: none"> <li>Remarkably inefficient in terms of producing at capacity when it is needed (Stinson, 2012): Provides more power off-peak times (evening/night) and power supply is intermittent</li> <li>**When wind cannot meet supply demands, Ontario currently uses natural gas to fill the gap creating greenhouse gas emissions. Environmental footprint is found in constructing wind farms and grid development (Kishewitsch, 2010)</li> <li>Infrastructure is location specific due to wind source, and therefore inherently inflexible to changing circumstances (Kishewitsch, 2010)</li> <li>Land use (usually land that could otherwise have been used for agriculture)</li> <li>Visual disturbance</li> <li>Like other electricity suppliers, wind needs subsidies to remain competitive</li> <li>Localized impact on night temperatures</li> <li>Canada is behind in wind development (Can WEA, n.d.)</li> <li>"Potential" health threat of exposure to low frequency noise (Stinson, 2012)</li> <li>FIT program: Ontario pays for wind energy generated, even when it is not used, causing significant price increases</li> </ul>
Wind Opportunities	Wind Threats
<ul style="list-style-type: none"> <li>Electricity \$ going up (projected to double in next 5 years) while wind technology forecasted with efficiency improvements</li> <li>Volatility of oil and gas prices</li> <li>Cost overruns for current nuclear projects creating increase in electricity prices or massive tax breaks</li> <li>Offshore, large scale production is increasing in viability internationally</li> <li>Public opinion to coal fired plants (CO2 emissions, mercury, and smog) and nuclear (fear, waste, decommissioning) is encouraging long term commitment to alternatives</li> <li>Potential tax on CO2 emissions</li> <li>Opportunity for Canadian supply chain development (Can WEA, n.d.)</li> <li>Low water levels could impact electricity generation during peak times (but could be beneficial off-peak) (Hamilton, 2010)</li> <li>Increase efficiency of energy production through technology innovation</li> <li>Development of energy storage will increase overall viability</li> </ul>	<ul style="list-style-type: none"> <li>Debate over land use (vs. solar, agriculture, etc.)</li> <li>Inability for technology to establish viability; grid, storage or efficiency in production</li> <li>Current limit of 2500MW on transmission grid (Can WEA, n.d.)</li> <li>Electricity market mostly insulated from high oil prices</li> <li>All energy is heavily subsidized</li> <li>AB/SK - abundant supply or relatively clean natural gas</li> <li>Hydro Power (ie. James Bay QC - 16000MW produced) has a dominant role in Canada (O'Donohue, 2006)</li> <li>Canada has one of world's largest uranium supplies</li> </ul>

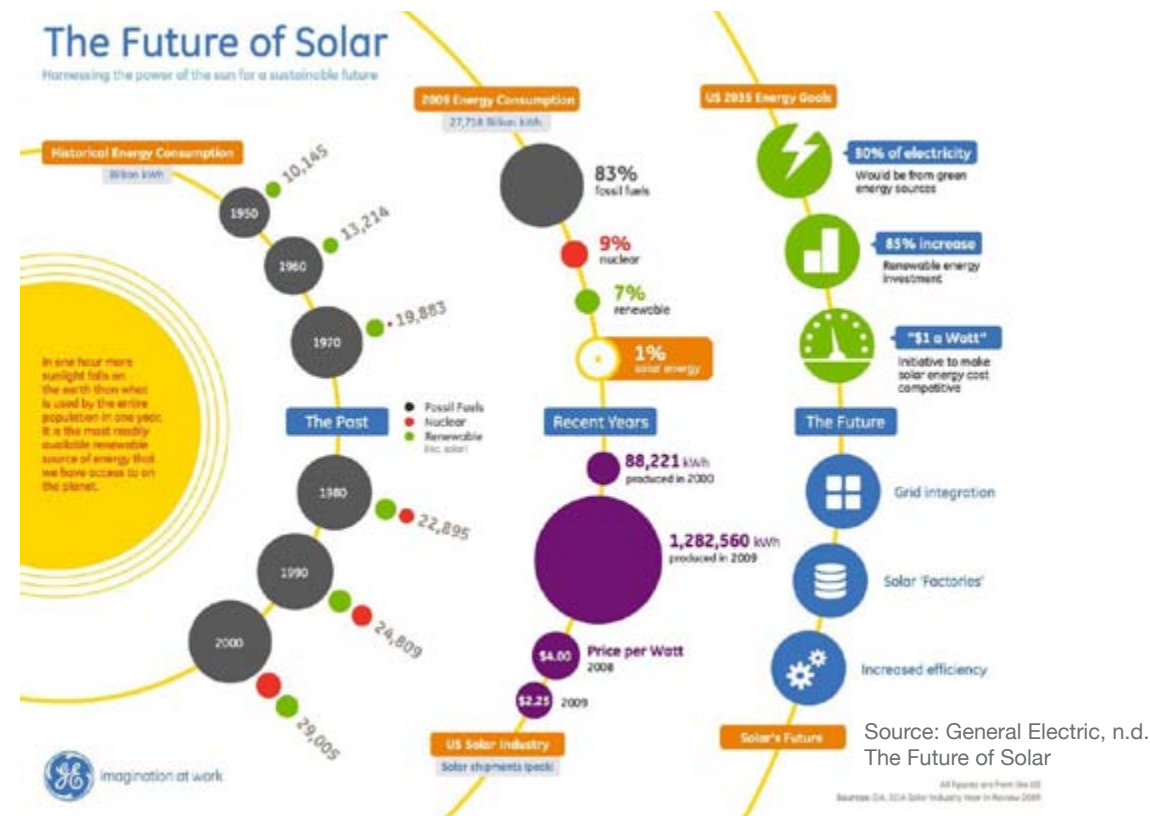
# Solar SWOT

Using photovoltaic cells, naturally occurring, self-generating light from the sun can be used as energy. Once converted using a generator, it can be used as an electricity source. Small and large scale solar energy projects are raising awareness in Ontario. This energy can be used in the electricity grid, but is currently only being used to alleviate a small fraction of the demand to the grid. FIT (Fee-in Tariff) and Micro-FIT programs have been leveraged by the Ontario government to encourage individuals and groups to invest in the capital costs associated with solar energy production, with the government promising to purchase extra kilowatts of energy for the grid.

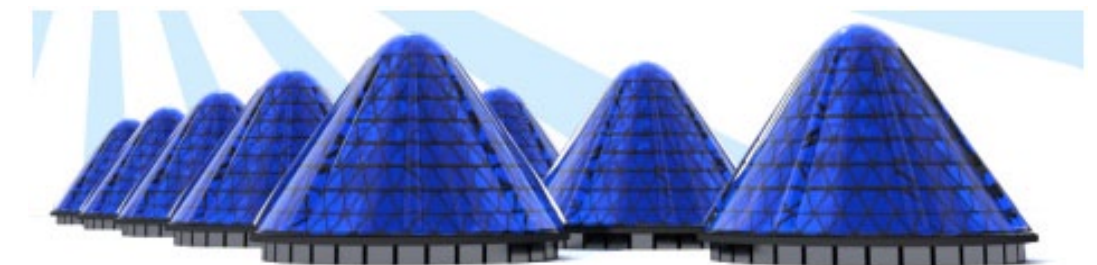
## ONTARIO OVERVIEW:

Not a major contributor to the energy mix.  
 Forecast energy output (2014): 280 MW  
 Recent news: 10 projects under progress  
 Source: IESO

"Ten grid-connected solar projects are expected to come in-service during the outlook period, adding a total of 280 MW to Ontario's supply mix."  
 - 18 month forecast IESO



Solar Strengths	Solar Weaknesses
<ul style="list-style-type: none"> <li>• Endless supply of free fuel</li> <li>• Low operating and maintenance costs</li> <li>• No known adverse events to health</li> <li>• Decreased need for transmission lines due to local production</li> <li>• No harm to animals</li> <li>• No emissions</li> <li>• Capital costs similar to water power and nuclear, and less than wind and gas</li> <li>• Less constructions delay risk or operation failure</li> <li>• Effective during peak time</li> <li>• Enables self sufficiency</li> <li>• Can contribute to a distributed system, ie coupled directly with a service such as air conditioning.</li> </ul>	<ul style="list-style-type: none"> <li>• Not capable of baseload supply</li> <li>• Investment required to ramp up production of existing technology</li> <li>• Highest cost of energy supply</li> <li>• "Levelized costs of electricity from solar plants are approximately 40.9 USD/kWh, and about 47.0 USD/kWh for residential systems."(OSPE, 2011)</li> <li>• Potential safety risks in circumstances where building fires occur (CBC News, 2013)</li> <li>• Toxicity of producing solar panels</li> </ul>
Solar Opportunities	Solar Threats
<ul style="list-style-type: none"> <li>• Worldwide support of renewable energy sources and technology should spur innovation, enhance current technologies and decrease costs (IEA, 2013 and Settle, 2013)</li> <li>• Oil price volatility - \$/barrel</li> <li>• Cost overruns for current nuc. projects + increase in electricity prices or massive tax breaks</li> <li>• Public opinion to coal fired plants (CO2 emissions, mercury, and smog)</li> <li>• Potential tax on CO2 emissions</li> <li>• Home owners have the option of selling energy created through their solar energy system to the grid</li> <li>• The International Energy Agency (IEA) predicts power generation from renewable sources will exceed natural gas and be twice the contribution from nuclear energy globally by 2016 – just three short years from now (Marcacci, 2013)</li> <li>• Major solar projects coming on line in the USA</li> </ul>	<ul style="list-style-type: none"> <li>• Low energy cost may slow solar development</li> <li>• Electricity market mostly insulated from high oil prices (this is likely temporary)</li> <li>• AB/SK - abundant supply or relatively clean natural gas</li> <li>• Hydro Power (ie. James Bay QC - 16000MW produced) has a dominant role in Canada (O'Donohue, 2006)</li> <li>• Canada has one of world's largest uranium supplies</li> </ul>



Spin cells: developments in technology quote lower costs and more efficient energy production

Source: Settle, 2013.

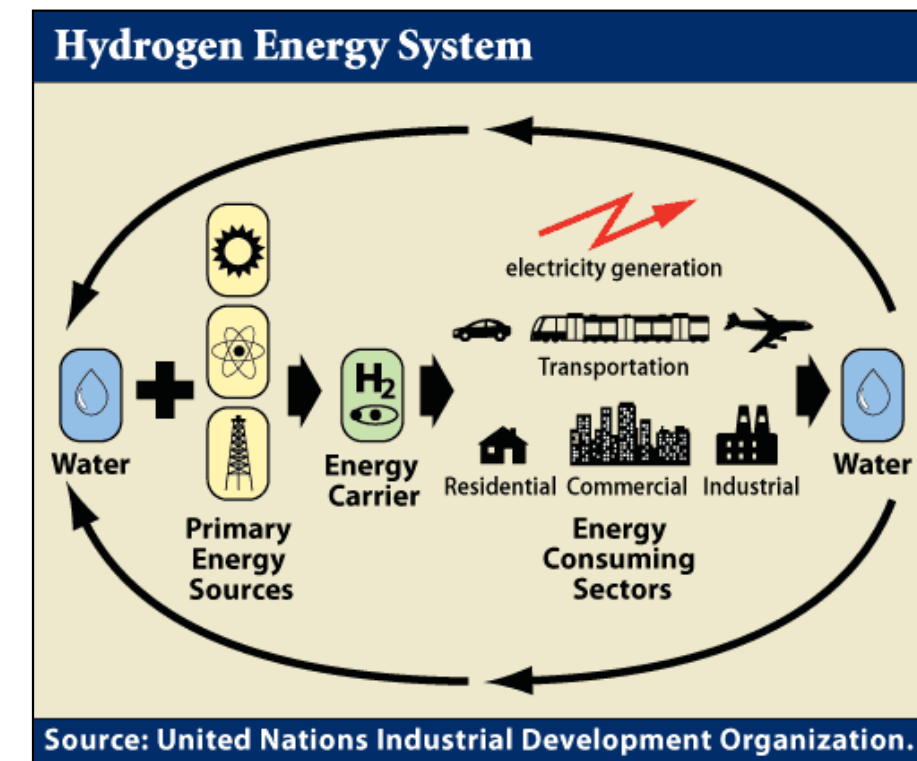
# Hydrogen SWOT

Hydrogen offers the most dramatic potential in disrupting the current energy landscape, not only for its abundance and lack of emissions during electricity generation, but for the fundamentally different method of production. Hydrogen is not a fuel to be burned in order to generate electricity, as the energy exists as chemical potential that is released when separating the molecules in fuel cells. In this sense, hydrogen is like a higher order component within the energy food web and can be used in partnership with other energy sources as a storage medium. In this scenario, of peak or intermittent power can be used to “charge” fuel cells that can be used when required; whether to power transportation or a home. While hydrogen is not currently a contributor to Ontario’s energy landscape, it is included in our research as it has commitment internationally, especially in Germany.

## ONTARIO OVERVIEW

Presently, hydrogen production in Ontario is largely focused on two aspects: its potential use as a storage medium for the unused energy available in electrical power systems and as a component of fuel cells for transportation based use. Much of our technological know how is exported to the EU (4), Germany has a recently increased interest in this technology due to internal political decisions about energy.

Hydrogen Strengths	Hydrogen Weaknesses
<ul style="list-style-type: none"> <li>• Is a non polluting element</li> <li>• Fundamentally change current centralized system</li> <li>• Flexible production (in off-peak hours)</li> <li>• Potential carrier for energy from multiples sources</li> <li>• Potential storage medium for energy from multiples sources</li> <li>• Most abundant element in the world</li> <li>• Positive, utopian, public image</li> </ul>	<ul style="list-style-type: none"> <li>• Technology is not currently feasible for mass application</li> <li>• Although abundant, not available in free form and must be created</li> <li>• Conversion of other energy sources into hydrogen is expensive</li> <li>• Conversion of other energy sources to hydrogen is low in efficiency (approximately 4%)</li> <li>• In its gaseous state it occupies a lot of space</li> <li>• Compression of gas to liquid or solid state is energy intensive</li> </ul>
Hydrogen Opportunities	Hydrogen Threats
<ul style="list-style-type: none"> <li>• A supplement and potential replacement to the electric grid</li> <li>• Legislative restrictions on other energy sources may prove beneficial</li> <li>• Public incentives available</li> <li>• Positive cumulative comparative emissions profile</li> </ul>	<ul style="list-style-type: none"> <li>• Lack of local R &amp; D</li> <li>• Limited public understanding of production processes</li> <li>• Resistance to change by established infrastructure</li> </ul>





# HORIZON SCAN MASTER LIST

YOUR INITIALS	TREND NAME	S. T. Ec. En. P. V.	ENERGY SOURCE (Nuclear, Coal, etc.)	SCALE (Macro/Micro)	RELATION (Direct/Indirect)	COMMENTS (brief)	REFERENCE (URL's)
CH	Coal being phased out in Ontario by the Green Energy Act	P.En	Coal	Micro	Direct	Coal will be gone by 2013 if current policy plays out (already less than 3% of total power)	
CH	Pro-Nuclear Activists lobby Nukes as transition to alternatives	S.P.V.	Nuclear	Macro	Direct	Stuart Brand and Peter Schwarz	<a href="http://news.ontario.ca/mci/en/2013/1/ontario-getting-out-of-coal-fired-generation.html">http://news.ontario.ca/mci/en/2013/1/ontario-getting-out-of-coal-fired-generation.html</a>
CH	When will wars be fought over water?		Wildcard?			How do we factor this into our scenarios? - this could be like our scenario pathways...	<a href="http://thejournal.wordpress.com/2013/04/25/global-trends-in-nuclear-power-post-fukushima/">http://thejournal.wordpress.com/2013/04/25/global-trends-in-nuclear-power-post-fukushima/</a>
CH	Hollywood reinforces public fear of dangerous power sources - like Nuclear	S. V.	Nuclear	Macro	Indirect	Rational energy discussions are hard to come by when terrorists are always hiding in the dark and an earthquake is a moment away from unleashing hell...	
CH	Decommissioning is big money	Ec.	Nuclear	Micro	Direct	As the nuclear stations reach the end of their life, huge pots of money will become available for the process of decommissioning. This could impact a wide range of possibilities - from an innovation boom to environmental fiascos.	
CH	Ontario energy demand is dropping as the manufacturing sector is weakening	Ec. T.	Demand	Macro	Direct	Demand for energy is clearly the greatest driver of current and future decisions. Ontario's celebration of reduced greenhouse emissions and reduction of demand have little to do with efficiency gains, but rather losses to industry. If industry picks up again, will it reverse current wins? Will it push coal back into the equation?	<a href="http://www.ieso.ca/imoweb/media/mcd_demand.asp">http://www.ieso.ca/imoweb/media/mcd_demand.asp</a> <a href="http://www.energy.gov.on.ca/en/kep/demand/#.Upljg_2RgYoA">http://www.energy.gov.on.ca/en/kep/demand/#.Upljg_2RgYoA</a>
CH	Big Solar comes to USA	T. Ec. En.	Solar	Micro	Direct	Several megawatt projects are coming online in USA which are likely to be reference points for future discussions around solar. Ontario does not have similar sites for development, arid desert, but there are other opportunities.	<a href="http://qz.com/137263/super-large-scale-solar-installations-are-surging-in-the-us/">http://qz.com/137263/super-large-scale-solar-installations-are-surging-in-the-us/</a>
CH	We must move towards zero carbon.	En		Macro	Direct	We could do a quick list of all the climate change thought leaders who are making this point, so that we clarify that this is a HUGE and IMPORTANT driver that needs to be integrated fully.	
CH	The demands on the grid are changing.	T.	Grids	Micro	Direct	The electricity grid is looking like ancient infrastructure as new technologies become available. Solar and wind great unique demands - multi flow, micro locations and storage capacity - that are beyond the current scope.	
CH	The human brain is not wired for long term decision making.	S. V.	People	Macro	Direct	Dan Gilbert is very provocative at describing the core factors that prevent humanity from truly treating climate change as an enemy to be battled against, while adding metal detectors and screening to every airport for protection against evil terrorists (that mostly don't exist) is accepted in public opinion.	
CH	Houses leaving the grid (and other efficiency improvements) may drive up the price for other consumers.	Ec. T. V.	Price	Micro	Direct	While celebrating a reduction in demand is good. A certain amount of demand is required to cover the costs of mega infrastructure such as Nuclear plants. If too many houses leave the grid, the electricity being produced will need to go somewhere, which can boost the cost. Advocates against alternatives, who use the poor homeowner as their core argument (I'm looking at you Hudak) can easily use this paradox to fight against alternatives and microproduction.	
CH	Net zero carbon needs to include exports AND imports	Ec. En.	Carbon	Macro	Direct	Canada has a lot of dirty hydrocarbons and there are a lot of hungry countries out there who want it. Preventing climate change needs to account for it all.	
CH	Iran and North Korea want Nuclear power	Ec. P. V.	Nuclear	Macro	Direct	Evil nations that are considered the enemy want nuclear. This brings back fears of weapons proliferation and more, hurting public perception and triggering national debates.	

YOUR INITIALS	TREND NAME	S. T. Ec. En. P. V.	ENERGY SOURCE (Nuclear, Coal, etc.)	SCALE (Macro/Micro)	RELATION (Direct/Indirect)	COMMENTS (brief)	REFERENCE (URL's)
CH	Is radiation poisoning going to kill the great lakes biodiversity?	En	Nuclear	Micro	Direct	Research is beginning to emerge that radiation is reducing biodiversity of crucial organisms in the great lakes. The debate is all "he says, she says" with no clear middle ground at the table, so public opinion can be forgiven for being confused.	
CH	Nuclear power stations are becoming environmental proof, but with a boost in capital costs.	T.	Nuclear	Micro	Direct	Finland's reactor is damn expensive and not even online yet. All around the world reactors are being inspected and upgraded thanks to Fukushima. This is great for pro-nuclear and should be used when making a case for nuclear safety, but it should also be on the table when comparing the costs of new initiatives such as wind, solar and hydrogen.	
CH	Is an environmental fracking catastrophe inevitable?	En.	Natural Gas	Macro	Direct	I don't have any research - but we know fracking has some questionable impacts on the local water tables, which has a lot of people upset, but it has never had much of an impact on the hydrocarbon industry. Is it possible to consider a "Fukushima-like" event inevitable for the Natural Gas extraction industry?	
CH	Costs for extracting hydrocarbons are dropping, and new business models emerging.	T. En. Ec.	Natural Gas, Oil	Macro	Direct	A major friction in the shift towards net zero carbon is the ongoing "affordability" of hydrocarbon fuel sources. Can countries make difficult decisions to avoid dirty energy while the price is still so attractive?	
CH	Natural Gas is "Green"	En. V.	Natural Gas	Micro	Direct	This is complete bullshit, but NG is touted as green because it is "less-bad" than oil and coal. USA is celebrating a huge reduction of emissions, but only because coal is switching to natural gas - genuine alternatives are not having as much an impact, yet. The NG industry is loving it, and fracking continues to be acceptable.	
CH	Baseload power is not going anywhere.	T.	Supply	Macro	Direct	Renewables (outside of hydro) struggle to be relevant in the discussion of providing baseload energy needs. The core discussion needs to evolve for them to have a greater impact at the table.	
CH	Carbon capture systems are making hydrocarbons a little less bad.	T. Ec. En	Carbon	Micro	Direct	Is there any data that shows how much an influence on emissions carbon capture is actually having? Could we compare the dollars being spent on this technology against other renewables? Could we use this to make an argument in Ontario about investing in different ways?	
CH	Carbon capture systems are being developed heavily in North America	T. Ec. En	Carbon	Macro	Direct	While mostly still in "early planning", North America is shaping up to be world leaders in this technology and infrastructure - does this improve or reinforce the stranglehold of carbon as an energy source.	
IG	Changing patterns of electricity demand in Ontario	Ec, P, V				Toronto Consumption of electricity declined by 9% 2000-2009 while demand in Sudbury rose by 6%	DeWees, D. 2012:
IG	Energy costs in Ontario rising	P, Ec, V				Green Energy Act will account for approximately 25% of overall energy costs by 2015	DeWees, D. 2012:
IG	Externalized costs incorporated into power costs	P, V				Externalized costs of coal based power production are internalized by Ontario policy resulting in estimated 5-10 cent/KwH externalized cost of harm increasing the cost of power generation	DeWees, D. 2012:
IG	Declining residential and agricultural demand for electricity	Ec, V				Agricultural and residential demand for electricity dropped from 11000 KwH in 1996 to 9000 KwH in 2009	DeWees, D. 2012:
IG	Rising global demand for Electric Vehicle technology	Ec, T	Electricity, Hydrogen			Estimated global market for EV charging technologies 1.9 Billion\$ by 2015	Ontario Ministry of Energy: 2011.Smart Grid in Ontario, Toronto, Ontario. Retrieved October 27, 2013 from http://isipcanada.ca/_files/file.php?fileid=fileEcCncSdnKr&filename=file_TO_PP__Usman_Syed.pdf

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IG	Increasing demand for Smart Grid	P. Ec, T, Env	Electricity			An integrated approach to reducing demand and adapting aging infrastructure leads to increasing demand and R&D into all aspects of smart grids.	ibid
CH	Japan investing in BIG WIND	En. T	Wind			Japan has some huge floating turbines going on line very soon. They plan on rolling out a lot of these in order to replace Nuclear. This could be the first case study of such a large economy shifting to Wind.	http://www.nytimes.com/2013/10/25/business/international/to-expand-offshore-power-japan-builds-floating-windmills.html?_r=0
CH	A path to carbon free energy is possible, and it is being referred to as WWS - the numbers are huge, the barriers are material availability and political will.	En. T. V	WWS (Wind, water, solar)	Macro	Direct	Mark Jacobson and Mark A. Delucchi have written a series of proposals for solving global energy needs without carbon. There should be a lot in here for us ... need to research more. Note: Hydrogen plays a role.	https://www.stanford.edu/group/efmh/jacobson/Articles/I/sad1109Jaco5p.indd.pdf
IG	Global industrial food production practices challenged	Env	Electricity			Energy distribution and storage patterns disrupted	Note: This is a fantastic resource with some great graphs and a LOT of further reading...
IG	Global industrial food production practices challenged	Env	Electricity (& transportation)			Increase in Urban food production entails shift in demand patterns for energy (Huge implications re fertilizer and the link of food to energy sources)	
CH	A Green Energy Portfolio could replace the Pickering Nuclear Station	T. Ec. En.	Nuclear and Alternates	Macro	Direct	This is the energy ontario plan for dealing with the end of Pickering Plant, which the reports claims will be too expensive to upgrade - and that money should be invested into long term alternates. Included are the numbers to argue for more jobs, boost to economy and more...	http://www.renewableisdoable.com/pub/2059
CH	Zero Carbon Ontario					A bunch of resources that I am yet to go through...	http://zerocarbonontario.ca/zero-carbon/mark-jacobson
NR	Iran and Oil Prices	P.Ec.	Oil	Macro	Direct	Political upheaval in the Middle East is a boon to oil producers everywhere. The loss of Libya's 2.6 million barrels of daily production after the country's revolution in February sent crude prices sharply higher. The focus will be on Iran, as its the world's forth-largest oil producer	
NR	Canadian electricity supply becomes cleaner	En.P.	X	Macro/Micro	Direct	Share of non-CO2-emitting generation sources (such as nuclear, renewable and plants with carbon capture and storage technology) increases from 76 per cent in 2010 to 79 per cent in 2035. The share of renewable-based generation increases from 62 per cent in 2010 to 68 per cent in 2035.	http://www.neb.gc.ca/qlf-nsi/mrgynfmr/nrgyprpt/nrgyftu/2011/fcsh1134mrgngfl-eng.html
NR	Use of renewable resources to grow	En.	Renewables	Micro	Direct	Canada has significant non-hydro renewable resources for electricity generation. Wind power has experienced strong growth in recent years.	
NR	Hydro Electricity	En.	Hydro	Micro	Direct	Canada is a world leader in hydroelectricity generation. Hydroelectricity will remain a dominant source of electricity supply in Canada.	http://www.neb.gc.ca/qlf-nsi/mrgynfmr/nrgyprpt/nrgyftu/2011/fcsh1134mrgngfl-eng.html
NR	Declining use of coal	En.	Coal	Micro	Direct	Declining role of coal used in power generation. Natural gas-fired plants are expected to replace retired coal-fired power plants.	
NR	Energy efficiency in buildings	V.Ec.	All	Micro	Direct	All provinces and territories have voluntary programs encouraging greater efficiency in new homes and equipment. Many of these programs offer incentives to consumers such as rebates, low-interest loans, and education and awareness campaigns.	http://www.neb.gc.ca/qlf-nsi/mrgynfmr/nrgyprpt/nrgyftu/2011/fcsh1134mrgngfl-eng.html
NR	Energy demand growth slows from its historical pace	Ec.V.	All	Micro	Direct	Residential sector - slowest-growing sector; drops to 11 per cent by 2035 from 14 per cent in 2009. Commercial sector - By 2035, decreases to 13 per cent down from 14 per cent in 2009. Industrial sector - Largest share of Canadian end-use energy demand. Increases to 51 per cent in 2035 from 47 per cent in 2009. Transportation sector - 25% of total end-use demand in 2009, remains at 25% throughout the outlook period.	http://www.neb.gc.ca/qlf-nsi/mrgynfmr/nrgyprpt/nrgyftu/2011/fcsh1134mrgngfl-eng.html

YOUR INITIALS	TREND NAME	S. T. Ec. En. P. V.	ENERGY SOURCE (Nuclear, Coal, etc.)	SCALE (Macro/Micro)	RELATION (Direct/Indirect)	COMMENTS (brief)	REFERENCE (URL's)
NR	Canada's total generation capacity to increase by 27% by 2035		All	Micro	Direct	Hydro - remains a dominant source, increases from 75 GW in 2010 to 87 GW. Nuclear - Declines to 12%, compared to 14% in 2010. Coal-fired - about two-thirds of the total coal-fired capacity in 2010, will be retired by 2035. Natural gas-fired - Increases from 9% in 2010 to 15%. Oil-fired - Accounts for 1% and is expected to maintain a very small share.	<a href="http://www.neb.gc.ca/cf-nsi/mrgymfntm/mrgyprpt/mrgyvr/2011/fctsh1134crtct-eng.html">http://www.neb.gc.ca/cf-nsi/mrgymfntm/mrgyprpt/mrgyvr/2011/fctsh1134crtct-eng.html</a>
NR	By 2035, Canada almost doubles crude oil production rates	Ev.	Oil	Micro	Direct	In 2035, oil sands account for nearly 85 per cent of production, compared to 54 per cent in 2010. Crude Oil Reserves - Canada has abundant reserves of crude oil, with remaining reserves of 27.5 billion cubic metres (173 billion barrels). Of this, oil sands bitumen accounts for 98% and conventional crude oil makes up 2%. According to the Oil & Gas Journal, Canada ranks third in the world in terms of oil reserves, behind Saudi Arabia and Venezuela. Canadian marketable natural gas production declines slightly until 2015, (from 388 million in 2011 to 372 million in 2015). Production then starts to increase, reaching 510 million in 2035. Ontario's population to grow by 28.6% (3.9M), by 2036 (from 13.5M in 2012 to 17.4M in 2036). 2013-2036: Net migration to account for 71% of all population growth in Ontario, with natural increase accounting for the remaining 29%. Seniors aged 65 and over is projected to more than double from about 2.0M, or 14.6% of population, in 2012 to almost 4.2M, or 24%, by 2036. After 2031, the growth in the number of seniors will slow significantly. Children aged 0-14 to increase gradually, from 2.2M in 2012 to over 2.7M by 2036. Ontarians aged 15-64 to grow from 9.3M in 2012 to almost 10.5M by 2036. GTA to be the fastest growing region of the province, with its population increasing by 2.5M, or 39%, to reach over 8.9M by 2036. Tons of moon jellyfish (Aurelia aurita) flooded into the intake pipes of the Oskarshamn plant, clogging it completely and forcing the shutdown while they were cleared out. New equipment monitoring technologies allow facilities to compile information about their systems and machines and improve the reliability of their equipment. The more information managers have about their plant operations, the better they can understand and make decisions about maintenance, staffing needs and productivity goals. Companies are using their data to draw insights about equipment and perform predictive maintenance, and to analyze other operational trends. Companies can focus on predicting future problems to prevent them from occurring, a method that can result in substantial cost and time savings. Any devices that allow companies to collect data wirelessly or communicate remotely will help operators streamline operations. This will also provide information that can be acted on in real time.	<a href="http://www.neb.gc.ca/cf-nsi/mrgymfntm/mrgyprpt/mrgyvr/2011/fctsh1134crtct-eng.html">http://www.neb.gc.ca/cf-nsi/mrgymfntm/mrgyprpt/mrgyvr/2011/fctsh1134crtct-eng.html</a> <a href="http://www.fin.gov.on.ca/en/economy/demographics/projections/">http://www.fin.gov.on.ca/en/economy/demographics/projections/</a> <a href="http://www.fin.gov.on.ca/en/economy/demographics/projections/">http://www.fin.gov.on.ca/en/economy/demographics/projections/</a> <a href="http://www.fin.gov.on.ca/en/economy/demographics/projections/">http://www.fin.gov.on.ca/en/economy/demographics/projections/</a> <a href="http://www.fin.gov.on.ca/en/economy/demographics/projections/">http://www.fin.gov.on.ca/en/economy/demographics/projections/</a> <a href="http://www.popsi.com/article/technology/jellyfish-shut-down-massive-nuclear-power-plant">http://www.popsi.com/article/technology/jellyfish-shut-down-massive-nuclear-power-plant</a> <a href="http://www.scanimetrix.com/condition-monitoring-news/16-methods-and-applications/481-5-technology-trends-impacting-energy-utility-companies">http://www.scanimetrix.com/condition-monitoring-news/16-methods-and-applications/481-5-technology-trends-impacting-energy-utility-companies</a> <a href="http://www.scanimetrix.com/condition-monitoring-news/16-methods-and-applications/481-5-technology-trends-impacting-energy-utility-companies">http://www.scanimetrix.com/condition-monitoring-news/16-methods-and-applications/481-5-technology-trends-impacting-energy-utility-companies</a> <a href="http://www.scanimetrix.com/condition-monitoring-news/16-methods-and-applications/481-5-technology-trends-impacting-energy-utility-companies">http://www.scanimetrix.com/condition-monitoring-news/16-methods-and-applications/481-5-technology-trends-impacting-energy-utility-companies</a>
NR	Natural Gas - Drilling and production gradually climb, and the focus on tight and shale gas continues	Ev.	Natural Gas	Micro	Direct		
NR	Ontario's population is growing. Duh!	S.	n/a	Micro	Indirect		
NR	Immigration in Ontario	.	n/a	Micro	Indirect		
NR	Baby Boomers of Ontario	.	n/a	Micro	Indirect		
NR	Children in Ontario	.	n/a	Micro	Indirect		
NR	Adults in Ontario	.	n/a	Micro	Indirect		
NR	GTA's growth	.	n/a	Micro	Indirect		
NR	Jellyfish Shut Down Massive Nuclear Power Plant	En.	Nuclear	-	Direct		
NR	Big Data impacting Energy, utility companies	T.	All	Macro	Direct		
NR	Predictive Analytics impacting Energy, utility companies	T.	All	Macro	Direct		
NR	Mobile and Location-Aware Technology impacting Energy, utility companies	T.	All	Macro	Direct		

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NR	Cloud Computing impacting Energy, utility companies	T.	All	Macro	Direct	As companies amass more data about their operations, they are relying on the cloud to analyze it and store it. This makes it easier for operators to share data with other workers and facilities. These devices allow companies to perform remote equipment monitoring and to track other conditions or systems within their facilities... Creating a network of devices that can monitor performance and collect information about individual machines or larger systems	<a href="http://www.scanimetrix.com/condition-monitoring-news/16-methods-and-applications/481-5-technology-trends-impacting-energy-utility-companies">http://www.scanimetrix.com/condition-monitoring-news/16-methods-and-applications/481-5-technology-trends-impacting-energy-utility-companies</a> <a href="http://www.scanimetrix.com/condition-monitoring-news/16-methods-and-applications/481-5-technology-trends-impacting-energy-utility-companies">http://www.scanimetrix.com/condition-monitoring-news/16-methods-and-applications/481-5-technology-trends-impacting-energy-utility-companies</a>
NR	Sensor Technology impacting Energy, utility companies	T.	All	Macro	Direct		
NR	Oil, Demand and Supply, disconnect	Ec.En.	Oil	Macro	Direct	WEO from IEA, predicts the demand for oil will rise from the 85 Million Barrels per Day (Mb/d) range to nearly 120 Mb/d around 2030. This is the fundamental disconnect: a projected demand by consumers of 120 Mb/d and a projected supply by the producers of only 1/3 of that amount. This means that in year 2030, 2/3 of the fossil fuel demand has to be covered by new fuels that we do not have today.	<a href="http://www.alpha-kataasia.co/index.php/information/energy-trends-html">http://www.alpha-kataasia.co/index.php/information/energy-trends-html</a>
IG	Green Energy Bonds a hit	Ec.	Green energy			In February, the Korean export/import bank issued 500\$ Million in Green Bonds paying 5 basis points less than UST bills and is oversubscribed to the tune of 1.5 billion dollars Green Credit Banking Guidelines issued October 25, 2013 from the Chinese Banking Regulatory Commission, a regulator calling for banks to screen all loans, new and ongoing, for environmental impact In Southern Ontario, the number of days over 30°C will likely more than double by 2050. although gas was clearly a greener option than coal, current prices for gas in China and developing Asia relative to coal would see coal remain the predominant feedstock of choice for power generation. ALSO US emissions of CO2, the gas that scientists say is mainly responsible for climate change, have been in decline since 2007, and last year hit their lowest level since 1994, according to the government's Energy Information Administration. However Fatih Birol, chief economist at the International Energy Agency, a Paris-based think-tank backed by 28 governments, said last week the decline was principally a result of US power generators switching away from coal and towards gas, which typically creates about half as much CO2 when burnt for an equivalent output of electricity. [...] The reason that America began to use a lot of shale gas was because it was cheaper," Mr Birol said. "My main worry is that if gas prices continue to climb, we may see coal coming back, and then this emissions reduction may well be reversed."	Korean Exp-Imp Bonds: Way Oversubscribed 95 bsp over UST. February 22, 2013 Climate Bonds Initiative blog retrieved from <a href="http://www.climatebonds.net/2013/02/kexim-green-bond/">http://www.climatebonds.net/2013/02/kexim-green-bond/</a> <a href="http://www.climatebonds.net/category/greenbonds/#sthash.5PX3pVzv.dpuf">http://www.climatebonds.net/category/greenbonds/#sthash.5PX3pVzv.dpuf</a> <a href="http://www.ene.gov.on.ca/stdprodconsume/groups/lr/@ene/@resources/documents/tes">http://www.ene.gov.on.ca/stdprodconsume/groups/lr/@ene/@resources/documents/tes</a>
IG	China calls for voluntary credit and bond guidelines based on environmental impact assessments	P, Ec	All				
MS	HOT, HOT, HOT	En.	Ontario				<a href="http://www.worldenergyoutlook.org">http://www.worldenergyoutlook.org</a>
CK	COAL - the future might not be so smoggy	Ec	Coal	Macro	Indirect		
MS	No more white stuff	En.	Ontario			Less snow but more freezing rain - which can down transmission lines and presents safety risks to road and air traffic.	<a href="http://www.ene.gov.on.ca/environment/en/category/climate_change/index.htm#change">http://www.ene.gov.on.ca/environment/en/category/climate_change/index.htm#change</a>
MS	They used to be great	En.	Ontario			A drop in Great Lakes water levels by as much as one metre by 2050, jeopardizing shipping, fisheries, water quality and supply.	<a href="http://www.ene.gov.on.ca/environment/en/category/climate_change/index.htm#change">http://www.ene.gov.on.ca/environment/en/category/climate_change/index.htm#change</a>
MS	The tropics come to us	S, En	Ontario			Increased risk of warm-climate diseases such as Lyme and West Nile diseases and malaria which can spread through insects taking advantage of warmer winters.	<a href="http://www.ene.gov.on.ca/environment/en/category/climate_change/index.htm#change">http://www.ene.gov.on.ca/environment/en/category/climate_change/index.htm#change</a>
MS	Let it grow	En.	Ontario			Longer growing seasons, which can affect crop selection and yields.	<a href="http://www.ene.gov.on.ca/environment/en/category/climate_change/index.htm#change">http://www.ene.gov.on.ca/environment/en/category/climate_change/index.htm#change</a>

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MS	Exhausting the grid	Ec, En	Ontario		Direct	In order to cope with temperature extremes, there's a greater demand on energy to heat and cool homes.	<a href="http://www.ene.gov.on.ca/environment/en/category/climate_change/index.htm#change">http://www.ene.gov.on.ca/environment/en/category/climate_change/index.htm#change</a>
CK	Black gold, Texas Tea	Ec, En	Oil	Macro	Indirect	The International Energy Agency (IEA) estimates that non-OPEC oil producers – led by the U.S., Canada and Kazakhstan, which has said it plans to raise oil production to over 2 million barrels a day by 2025 – will increase global supplies by a near record 1.7 million barrels a day to 56.4 million, reducing the amount of oil the world needs from OPEC.	<a href="http://www.worldenergyoutlook.org">http://www.worldenergyoutlook.org</a>
CK	Global warming? What Global warming?	En	All	Macro	Direct	The International Energy Agency (IEA) last week warned that global carbon dioxide emissions in 2012 were the highest ever. Yet international climate negotiations have floundered. Many Americans and their representatives in Congress still doubt climate change is a problem worth addressing. And as the developing world advances, its peoples are polluting more to obtain higher standards of living. Forget for a moment the ideal or rational response; what's the bare minimum global leaders could do?	<a href="http://www.worldenergyoutlook.org">http://www.worldenergyoutlook.org</a>
CK	China - Puppet master?	Ec, V, S	All	Macro	Direct	China is set to become a major producing country outside of its borders, Fath Birol, chief economist at the IEA, told the Financial Times on the sidelines of IP Week, an annual gathering of the oil industry in London. "A significant part of the increased foreign production comes from [merger and acquisition] transactions last year."	<a href="http://www.worldenergyoutlook.org">http://www.worldenergyoutlook.org</a>
CK	What needs the water?	En	All	Macro	Direct	The amount of fresh water consumed for world energy production is on track to double within the next 25 years, the International Energy Agency (IEA) projects. And even though fracking—high-pressure hydraulic fracturing of underground rock formations for natural gas and oil—might grab headlines, IEA sees its future impact as relatively small. By far the largest strain on future water resources from the energy system, according to IEA's forecast, would be due to two lesser noted, but profound trends in the energy world: soaring coal-fired electricity, and the ramping up of biofuel production.	<a href="http://www.worldenergyoutlook.org">http://www.worldenergyoutlook.org</a>
CK	Ultior Motives	Ec	All	Macro	Direct	But the oil giants' newfound zeal for green energy wasn't driven entirely by environmental altruism. Without investing in new sources of energy, they risk consuming an ever-growing amount of their fossil fuels, leaving less to be exported. "Many countries in the region have to look at oil alternatives," said Fath Birol, chief economist at the International Energy Agency. If they don't, their oil exports will suffer, he said.	<a href="http://www.worldenergyoutlook.org">http://www.worldenergyoutlook.org</a>
CK	The Fission Engine That Could	T.	Nuclear	Micro	Direct	India has a problem – the railway system that is currently powered by diesel fuel is dirty and expensive. They are now seeking alternatives, the most prominent of these being a nuclear-powered train system. The UK & Russia are also exploring powering their railways using electricity generated through nuclear reactors. Reactors powering trains could be large traditional facilities which power the train via a third rail or potentially mobilized train units <sup>5</sup> . As comfort with nuclear electricity increases in certain populations, so does the expansion of uses for nuclear energy, especially when looking to solve massive problems like poor air quality which continues to plague some of the world's most populated areas <sup>9</sup> .	

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CK	Like building a house over an old grave yard...	S, En	Nuclear	Micro	Direct	Ontario has a problem – it is called nuclear waste. When it comes to making decisions about how to manage this "hot" topic, many Ontarians have a "not in my backyard" mindset. Current disposal technologies are robust (Katherine Moshonas Cole, personal communication, Sept. 23, 2013) and Ontario has spaces that could be used as disposal sites, but public perception plagues the waste disposal and decommissioning process. A disposal site proposed in Kincaidine has been met with ferocious opposition <sup>4</sup> . Few realize that the waste they are concerned with is currently stored in warehouses at the site of the Pickering Nuclear Generating Station <sup>5</sup> , a less than desirable containment method.	
CK	Friends with benefits	P	All	Macro	Direct	R&D in the nuclear field requires substantial investment and time. For nations to maintain a leadership edge in this field, they need to look beyond their own resources and capabilities. Some countries are exploring (or have implemented) private/public strategies where investment can be supported by private organizations <sup>3</sup> . For example, the government of Canada is partnering with the private sector to manage and operate the AECL's Nuclear Laboratories <sup>5</sup> . Other countries, like Iran and North Korea, are also partnering together (speculated partnership on nuclear warfare) <sup>6</sup> – allowing collaboration and progression that would not necessarily have been attainable. We are also seeing these types of partnerships beyond nuclear – from a macro perspective the partnership between the US and Russia in a peaceful resolution to the Syrian conflict, to a micro perspective where in Toronto formerly owned and operated government organizations (such as the Light Rail Transit System <sup>5</sup> ) are finding ways to partner with private industry in order to strengthen the economic and intellectual resources.	
MS	It's gonna cost ya	Ec	Ontario			An increase in severe and intense storms mean costly damage. For example, the Vaughan tornadoes were one of the costliest extreme weather events of 2009. The Insurance Bureau of Canada estimated costs of more than \$76 million for this single day event.	<a href="http://www.ene.gov.on.ca/stdprodconsume/groups/lr/@enc/@resources/documents/res">http://www.ene.gov.on.ca/stdprodconsume/groups/lr/@enc/@resources/documents/res</a>
MS	The toll on our food	S, Ec, En	Ontario			Ontario's changing climate affects farms: Extreme weather damages crops through drought, hail and flooding. While milder winters can reduce heating bills for livestock barns, they help some pests and diseases survive the winter, while others spread further across Ontario.	<a href="http://www.ene.gov.on.ca/stdprodconsume/groups/lr/@enc/@resources/documents/res">http://www.ene.gov.on.ca/stdprodconsume/groups/lr/@enc/@resources/documents/res</a>
MS	Rate hikes	S, Ec, P	Ontario		Indirect	In order to have clean air, reliable generation and modernized transmission, residential bills are expected to rise by 3.5 per cent per year over the next 20 years. Industrial prices are expected to rise by 2.7 per cent per year over the next 20 years.	<a href="http://www.energy.gov.on.ca/docs/en/MEI_LTEP_en.pdf">http://www.energy.gov.on.ca/docs/en/MEI_LTEP_en.pdf</a>
MS	Electric Avenue	S, Ec, En, V	Ontario			Ontario's goal is that by 2020, about one in every 20 vehicles on the road will be electric.	<a href="http://www.energy.gov.on.ca/docs/en/MEI_LTEP_en.pdf">http://www.energy.gov.on.ca/docs/en/MEI_LTEP_en.pdf</a>

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CK	Hope Floats	T	Nuclear	Macro	Direct	Icbreakers and submarines are currently producing and operating on nuclear energy, so is a floating nuclear power plant a far stretch? An advance like this could potentially mitigate disagreements on where to locate plants, for lack of space or public resistance. Due to experience with other aquatic nuclear vehicles, the safety of a floating nuclear power plant could be high, and is currently proposed to be less costly than building a typical land reactor. Numerous applications exist for technology such as this, including: generating heat and electricity for remote areas, and providing electricity for oil rigs.	<a href="http://www.energy.gov.on.ca/docs/en/MEI_LTEP_en.pdf">http://www.energy.gov.on.ca/docs/en/MEI_LTEP_en.pdf</a>
MS	Growing population	S	Ontario		Direct	By 2030, Ontario's population is expected to rise about 28 per cent — a gain of almost 3.7 million people. Ontario's population will become more urbanized with population growth taking place in primarily urban areas. The Greater Toronto Area (GTA) population will increase by almost 38 per cent over the same period.	<a href="http://www.energy.gov.on.ca/docs/en/MEI_LTEP_en.pdf">http://www.energy.gov.on.ca/docs/en/MEI_LTEP_en.pdf</a>
MS	New(fish) Energy Plan		Ontario			Nuclear power will continue to reliably supply about 50 per cent of the province's electricity needs. It does not emit air pollutants or emissions during production. Hydroelectric power is expanding to include increased capacity from the Niagara Tunnel project and the Lower Mattagami project — producing clean energy by tapping into a renewable and free fuel source. Natural gas-fired plants have the flexibility to respond when demand is high — acting as peak source or cushion for the electricity system. Natural gas is the cleanest of the fossil fuels, emitting less than half of the carbon dioxide emitted by coal.	<a href="http://www.energy.gov.on.ca/docs/en/MEI_LTEP_en.pdf">http://www.energy.gov.on.ca/docs/en/MEI_LTEP_en.pdf</a>
MS	Future Demand: Low Growth		Ontario			Low growth assumes that Ontario's manufacturing and industrial sectors continue to grow modestly in accordance with the current trend. Some of the recent decline in consumption is due to conservation, some to restructuring in the various industrial sectors, and some due to the recession. This forecast assumes a lower rate of population growth than in the other two scenarios. It further assumes that only 13 per cent of people use electricity for heating and that small appliance use accounts for 30 per cent of growth.	<a href="http://www.energy.gov.on.ca/docs/en/MEI_LTEP_en.pdf">http://www.energy.gov.on.ca/docs/en/MEI_LTEP_en.pdf</a>
MS	Future Demand: Medium Growth		Ontario			Medium growth (brown) represents moderate growth in the industrial sector and in population. This scenario assumes continued growth in the residential, commercial and transportation sectors. This forecast assumes that there is a consistent move towards high-tech and service industries and somewhat higher provincial population growth than the low growth scenario. This scenario is consistent with the current government goal for electric vehicles: five per cent by 2020.	<a href="http://www.energy.gov.on.ca/docs/en/MEI_LTEP_en.pdf">http://www.energy.gov.on.ca/docs/en/MEI_LTEP_en.pdf</a>

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MS	Future Demand: High Growth					High growth, or aggressive electrification, assumes that there is a significant increase in electric transportation — both public and private. It assumes that there is aggressive North American greenhouse gas regulation, faster population growth than the low growth scenario, significant industrial change and that by 2030 about 12 per cent of vehicles on the road are electric.	<a href="http://www.energy.gov.on.ca/docs/en/MEI_LTEP_en.pdf">http://www.energy.gov.on.ca/docs/en/MEI_LTEP_en.pdf</a>
MS	Dreams of storage		Ontario		Direct	Energy Storage can help to balance the electricity grid by storing off-peak generation and using it during peak hours. This helps to reliably incorporate more renewable generation into the grid. Energy storage is an important part of the move to a Smart Grid. Ontario will continue to investigate the potential for new storage technologies. There are a number of issues that impact the development of energy storage: <ul style="list-style-type: none"> <li>• The capital costs for large-scale electricity storage are high largely due to high engineering and construction costs.</li> <li>• Research is underway on flywheel storage, plug-in vehicle storage, various forms of thermal storage as well as other storage options.</li> <li>• There are growing opportunities for small storage projects, particularly as battery technology improves.</li> <li>• Ontario has a pumped storage facility in the Sir Adam Beck Pumping Generating Station at Niagara Falls. OPG is currently studying the possible expansion of the reservoir to allow for further storage at the station.</li> </ul> <p>Though the lakes are so vast they hold one-fifth of all the fresh water on the Earth's surface, the states with rights to it have always guarded them jealously — and they aren't in a generous mood after more than a decade of abnormally low levels. Their permission is required to tap in from outside the watershed. The ban on piping Great Lakes water beyond the boundary was established five years ago to keep the drought-stricken Sun Belt from siphoning off the region's greatest resource.</p> <p>Who owns the Great Lakes? Who gets access when we know the world is running out of fresh water? Currently, the International Joint Commission mediates issues that arise between USA and Canada regarding the Great Lakes, but what happens if there's a serious conflict, or other nations want access? If the conservatives stick to cost of energy as a core platform, Ontario could be spinning backwards...</p> <p>As long as the big industries dominate power, BIG change is difficult?</p>	<a href="http://www.energy.gov.on.ca/docs/en/MEI_LTEP_en.pdf">http://www.energy.gov.on.ca/docs/en/MEI_LTEP_en.pdf</a>
MS	World War Water	All	Ontario				
CH	Hudak Campaigning on Cost of Electricity	Ec. P.	Electricity	Micro	Direct		<a href="http://www.timesdispatch.com/news/national-world/near-lake-michigan-city-years-for-water/article_44660cac-2fbc-5a11-bd1d-5dd8df74fe6.html">http://www.timesdispatch.com/news/national-world/near-lake-michigan-city-years-for-water/article_44660cac-2fbc-5a11-bd1d-5dd8df74fe6.html</a>
CH	Alberta Controls Canada It will take the world stock of rare minerals to scale up current "renewable" technologies.	Ec. P.	Oil & Gas	Macro	Indirect		<a href="https://www.stamford.edu/group/cfmh/jacobson/Articles/1/sad1109Jaco5p.indd.pdf">https://www.stamford.edu/group/cfmh/jacobson/Articles/1/sad1109Jaco5p.indd.pdf</a>
CH	Bruce A - Retires in 2043					Will have been in service for over 70 years.	<a href="http://en.wikipedia.org/wiki/Bruce_Nuclear_Generating_Station">http://en.wikipedia.org/wiki/Bruce_Nuclear_Generating_Station</a>
CH	BRUCE B - Shutsdown 2015-2019					Is not clear when it will be retired...	
CH	Concerns over Kincardine are international more than local.	V	Nuclear	Macro	Direct	Citizens in Michigan are more concerned over leaking radiation than locals in Kincardine.	<a href="http://kitchener.ctvnews.ca/kincardine-residents-back-plan-to-bury-nuclear-waste-near-lake-huron-1.1561064">http://kitchener.ctvnews.ca/kincardine-residents-back-plan-to-bury-nuclear-waste-near-lake-huron-1.1561064</a>

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CH	Call for collaboration between nuclear and wind energy providers	Ec. V	Nuclear Wind	Macro	Direct	A light discussion about the need for nuclear and wind to be close partners in the ongoing support for emissions free electricity generation.	<a href="http://www.power-eng.com/articles/npi/print/volume-6/issue-6/departments/enrichment/why-can-t-we-be-friends.html">http://www.power-eng.com/articles/npi/print/volume-6/issue-6/departments/enrichment/why-can-t-we-be-friends.html</a>
CH	Rise in discussion over "true cost" comparisons between energy sources.	Ec.	All	Macro	Direct	Resource for comparing costs between power sources.	<a href="http://www.eia.gov/forecasts/aeo/electricity_generation.cfm">http://www.eia.gov/forecasts/aeo/electricity_generation.cfm</a>

# SCENARIOS FULL LENGTH

# DIRTY UTOPIA FOR SOME

## WEALTH AT WHAT COST?

As Canada continues to cash in on its hydrocarbon crops, concerns continue to be raised that our local commitment to alternatives is not enough in the battle against climate change. While the local emissions of Ontario continue a steady decline, mostly thanks to high risk, high reward investments in wind and solar initiatives that continue to reap benefits, Ontarians still face the impacts of climate change as global emissions continue steady growth.

“Globalization is much more than sharing economic resources,” Says Damien Gould from the World Energy Outlook, “We share our atmosphere as well.”

The record of extremely hot days last summer and the spike of elderly deaths caused questions over the long term safety of high density cities and their heat island effect. Only a few months ago the highly urbanized Toronto-Hamilton region was receiving global sustainability awards for the smart grid technologies responsible for a tremendous boost in energy alternatives. But this now seems like an awkward punch-line as Toronto-Hamilton residents use more energy in Summer than any city in Canada.

The core debate continues to be the

addiction to the federal Energy Equalization Program, that has seen a reversal of fortunes, as Ontario has now been on the receiving end of equalization payments for the past eight years. Critics of the program say these payments are still not enough to balance the growing costs of climate change.

“People of Ontario need to ask whether fast cash is better than slow cooking.” Says Mary-Anne Pulowski of the David Suzuki foundation. “Despite all the warnings, and all the rising costs, why can’t people see the big picture.”

## EXTENDED GROWING SEASON A BOOM FOR ONTARIO FARMERS?

The urbanization of Ontario, with the Toronto-Hamilton region internationally recognized as the gold standard of public infrastructure, is even more facilitated by the improved production of agriculture as the growing belt of Canada. Climate change has brought forward an increase in local temperatures, reducing the length and severity of winter. This has meant a reduced demand for hay, as grazing animals can self-sustain longer in the year, which has allowed more focus on crops such as Soybeans and Corn. Exports continue to grow, especially to drought torn Australia

that continues to be heavily affected by water shortages. But critics say that there is a limit to how much growth can be sustained. “Everyone is forgetting the huge losses of crops to frost due to unpredictable starts to the growing season and the pests that come in the thick of the heat.” Says Hamil Lectenour, author of *There are no Winners in Climate Change*. His controversial book, currently an international best seller in every non-scandinavian country in the world, outlines that small gains come with long term pains, but it is a message that continues to be in the background as the bulk of the focus is on opportunity.

“Canadians are fortunate to be in an economic and ecological position to benefit from the gradual shift in temperatures,” Says Conservative leader Suzanne Wainwright. “But the books of doom and gloom are the ones that sell.”

## NO BREATHING EASY ON STREETS, NO SATISFACTION AT HOME

Recent record breaking heat combined with some of the highest air pollution counts in memory have left residents of the Great Lakes City States with stinging eyes and difficulty breathing. The technological

advances of the past several decades have powered a literally breathtaking rise in the GDP but for most residents the health costs have not been offset by the rise in incomes. While a few of the very wealthy have had their homes and businesses sealed inside translucent domes fitted with equally expensive air purification systems, the vast majority have seen their quality of life suffer. Modern healthcare keeps them alive, but they need ever-increasing medical interventions to offset the effects of high pollution. If it’s hard to see your hand in front of your face, the income gap is clear.

There is a heart ailment that both rich and poor suffer however and it’s evidenced by increasing signs of unhappiness - much of it rooted in the lack of opportunity for community that is the result of such high rates of pollution and the forced indoor confinement that comes with it.

As one resident put it, before heading back inside their air-tight dome, “my money just means I can afford to be miserable in comfort and solitude.”

## NORTH AMERICAN OIL PUSHERS

*Opinion Piece*

Winners write the history books. They also tend to write the rules. And no one is writing more rules at the moment than North America. Full of cash from selling Gas and Oil from stocks that never seem to disappear, the cheeky Canadians and brash Americans are shipping the liquid gold back to the countries that once held sway over them. They aren’t even pretending to hide their smirks as they continue to reduce internal demand

through rapid technological innovation in infrastructure. The Canadian smirk grows wider as royalty cash flows through the open market thanks to some well timed intellectual property leadership.

As international drug pushers, North America bullies those countries who continue to struggle with addiction, all the while not admitting who is truly stuck flailing in barrels of the black stuff. Because, while North America has rapidly cut demand, it still hasn’t worked out how to economically capitalize on the concept of less consumption.

Hydrocarbons is a game of winners and losers. You have it or you don’t. Everyone needs it, or used to, and so control over the supply wins the game. The cascade effect of technological and behavioural change has led consumers to need less and focus their efforts elsewhere. Removing customers from the circus has confused the ringleaders, which is why you see North America at battle with China and Europe over global carbon taxing structures. There now appears to be sound economic theory suggesting that without carbon based exports, North America would not be the juggernaut it is today, as the local economy has not found a way for reduced consumption to drive growth.

Canada needs to be careful that the current confidence doesn’t land it in hot water, melting ice opens shipping lanes full of gas, but that pristine lake system is looking more fragile than ever before as the Prince Edward Island fishing collapse continues to trigger ripples across the country.

If Canada can invest in future facing policy as well as it has on technical innovation, there may be a way to wean itself from the black

stuff and learn to play with children other than America in the playground.

## HEALTHCARE CUTS CONTINUE

Ontario residents still waiting for trickle down effect as Gov-Biz partnerships rake record profits. The early gains in social structure of the late 2030s, fuelled by the income of gas exports, has fallen behind as business sponsored services continue to be backed by government. Statistics show that employees of Big-Biz are declining thanks to the technology developed, making many inelligible for healthcare.

“We worked hard to develop the technology that puts us out of work,” Says Michael Rapooni, a robotics engineer, “Now business has cut my services and the government won’t answer my calls.”

## SNOWBIRDS NO LONGER FLY SOUTH

The combined Canada-Independence Week Holiday that most citizens of the Great Lakes Nation State Cities celebrate marks the beginning of the busiest cross border shopping and immigration challenges of the year. Every summer they arrive; poor, octogenarian migrants fleeing the oppressive heat of the southern states, heading north to Canada and congregating around the Great Lakes. They arrive with their cups, ready to take advantage of the abundance of excess heat flowing from thermo-electric generating plants dotted on the shores of the abundant freshwater lakes and rivers around which have sprung the wealthiest city-states in the

world.

While winter heating costs have dropped dramatically as global temperatures rose over the past three decades, the need to keep cool in the ever-increasing summer heat drives those who are most vulnerable north. The lengthened lifespans and decreased mortality courtesy of high tech, state provided health care, means that these migrants are increasingly aged and a significant number of them are unemployed and without pensions. Combinations of these environmental and economic factors are driving increasing numbers of illegal migrants north.

While the Smart grid and other technological advances have resulted in ever increasing efficiencies of production for power, the benefits have increasingly accrued to corporations with the deep pockets required to take advantage of rapid innovations in technology or to those highly skilled workers that can demand pay packages that allow them to purchase “pharmaceutical grade” water purification and cooling technologies. For the rest of the population, including the aging 99%, the best they can hope for is to take advantage of discarded and outdated, personal-scaled heat recovery technology. In the early years of the 2030’s, the “dirtier thirties” as they have come to be known because of increasing levels of pollution, the commercialization of personal technology that produced power from excess heat sources was seen as a possible solution to the demand for efficient power. However, it quickly became apparent that big-city governments were not going to permit this kind of technology to gain a foothold and get in the way of the superior surveillance and big-data collection that the Smart Grid

provided along with its cheap, abundant power. As a result, the portable cups that could cool increasingly warm tap water, simply by converting the waste heat from the water and an individual’s body heat into electrical power to run the cooling coils built into the cups, became collectors items for the nostalgic and practical ways for the masses of unemployed to cool water for personal use. Increasingly, these cups had been showing up on t-shirts and were carried openly as a way of demonstrating sympathy for, or membership in, the Occupy Movement by increasingly politically active members of the older generation. There is a real concern that the baby boom population, one that didn’t expect to see their expected lifespan increase to 120 years and that looks with increasing regret on their ineffective political activism of the 1960’s could turn violent and take action against the powerful city elites. With little to lose in terms of quality of life, these “coppers” as they have become known, are a wild card and politically difficult faction to quell.

The growing chasm that separates the dependence on the grid by the elites for everything from power, to water and food provides a vivid contrast with the low-tech self-reliance of the other 99 percent and their cups. There is a growing awareness that the impoverished communities clustered around thermal electric power plants, using low tech devices to take advantage of the waste heat to speed up crop production and provide the necessities of life, are a potential threat to the grid that powers the city-states of the Great Lakes Region.

There are rumours surfacing today that the cups have an emergent property when clustered in large numbers, that allows the

power to be harnessed by means of the old Apple iPhones that are the other constant device found in the hands of these “coppers”.

# GREEN(ISH)

## TALKS RESUME ON FUTURE OF CANADA/USA TRIO DAM POWER SHARING.

Talks resume today at the Power Summit in Ottawa as Canada and the USA meet to renegotiate the sharing of energy from the Trio Hydro Dams. The three dams, built jointly by the two nations between 2020 and 2030 along the St Lawrence River, supply equal electricity to both Canada and the US. However, the Americans have long been lobbying for a greater share of the dams’ power due to their rapidly increasing population. Absorbing citizens moving north to escape the heat and drought of the Sun Belt has put a strain on America’s electricity supply. Through these talks they’re hoping to acquire a greater share of the dams’ output. A share that currently belongs to Canada.

Arthur Chan, a professor of Energy Policy and Political Science at the MARS University in Toronto provides perspective on the talks, “This is a critical time for the two countries and these talks must be handled delicately. America doesn’t have the water resources that Canada has and desperately needs the electricity generated by these three dams. The two nations have friendly relations but are facing very different futures with regards to water, the ability to generate hydro

electricity and power demand.”

Critics worry this step towards the US seizing greater control of the Trio dams is part of America’s larger goal to control the Great Lakes. However, supporters argue the revenue generated by the sale will allow Ontario to fulfill its Fast Reactor mandate by 2060, possibly completing the construction and upgrades ahead of schedule.

## ONTARIO’S SECOND FAST REACTOR ABOUT TO COME ONLINE.

The Bruce 2 Generating Station is nearing completion. It replaces the Bruce Nuclear Generating Station, which is slated for decommissioning next year. Bruce 2 will be Ontario’s second fast reactor, the first being Pickering’s P2.

Says Uphar Dhanu, Ontario’s Energy Minister, “Our government is incredibly proud of Bruce 2. All Ontarians should be. It’s a world-class fast reactor that demonstrates Ontario’s talent, innovation and contribution towards a carbon-free future.”

Canada has become a world leader in the development and implementation of fast reactor technology. Fast reactors use a

technology called pyroprocessing that subjects fuel to extremely high temperatures, allowing 93% of the energy in the fuel rods to be accessed, in contrast to the 5% accessed by the old generation of nuclear reactors. Ontario’s old reactors left great amounts of spent fuel to manage; spent fuel the fast reactors have been and will continue to use to produce Ontario’s energy for the next century. In addition, the amount of half-life material rendered by the new fleet of reactors is reduced by 98% - 300 years, down from the previous 300,000 years.

Bruce 2 will begin operation in February and will employ a workforce of 1,500 people. Two more fast reactors are under development along the shores of Lake Huron, in what’s now being referred to as Nuke Alley. Ontario plans to have four reactors up and running by 2060.

## DEBATE HEATS UP ON FUTURE OF LAST WIND FARM SITE.

Contention over what to do with the final site of Ontario’s long abandoned wind farms is heating up outside of Kingston. Many residents would like the site to become a provincial park, while rumours swirl that the province is ready to sell the land to Harvest Corp, Canada’s largest producer of



greenhouse grown produce.

However, amid the conflict, environmental advocates are calling for renewed investment in wind technology. “The province has had a bad experience, it’s true. But the doesn’t mean we shouldn’t continue to look at ways to harness the wind.” says Emma Illingsworth from WindFuture, an advocacy group for wind technology.

Subsidy scandals forced the closure of all wind farms after it was revealed to the public that former Premier Neil Hastings and many of his most senior cabinet ministers held shares in TECH Energy Inc, the company with several multi-billion dollar contracts to build wind farms across Ontario.

## CLASS-ACTION LAWSUIT FOR DISPLACED ST. LAWRENCE COMMUNITIES SET TO PROCEED.

Communities along the banks of the St Lawrence River that were mandated to relocate in order to accommodate the mammoth Trio Dams are launching a class-action lawsuit against the provincial and federal governments.

## TORONTO’S LAST GAS STATION TO CLOSE.

The last consumer vehicle gas station in Toronto is slated to close next month. The station has been in operation since 2003 and for the last 15 years has become something of a relic, mostly serving the needs of auto collectors. Since the introduction of the 25% provincial carbon tax in 2022, gas powered and hybrid vehicles were rapidly replaced

with the electric vehicles of today.

“It’s a sad day for us, those of us who like to drive our old cars around. Gas isn’t cheap, that’s for sure, but when you love to drive your 2013 Mini Cooper like I do, then you just accept the cost and the inconvenience. I guess I’ll have to convert it to jet fuel now!” laughs car collector Harvey Trinh.

# WIND, WATER & SOLAR

## FOOD EXPORT RESTRICTION CREATING GREATER GOVERNMENT/FARMER TENSIONS

Heated debates on the new food exporting restriction imposed by the Canadian Government are raging. This week leaders representing Ontario farmers met with the Ministry of Agriculture to voice concerns over the imposed restrictions. According to the Minister, “All Ontarians must be active participants in our self-sustaining culture. People in all sectors have had to make lifestyle adjustments so Ontario can continue to grow and thrive.” The Minister referred to the conservation efforts being made across all business and community sectors as another example.

Farmers are outraged, according to Joe Taylor, “at the deceptive and forceful tactics by the Ontario government.” Wind farms built decades ago are being referred to as “wind graveyards” - built on the promise of selling additional energy to the Ontario grid. Dispatching legislation and then off-shore builds have made these wind farms all but obsolete. “With the Great Global Food Crisis, there is a huge demand for our agricultural

goods from large consumers like China. Now with export restrictions and price caps, we are losing significant bitcoin value.” Taylor and other representatives proposed government remove wind farms from prime agricultural land arguing, “the land could be better used for crops, and the energy it is providing to our individual farms could be acquired inexpensively from the integrated smart grid.”

Taylor also warns, “Where once upon a time we believed manufacturing in Ontario was dead, restrictions like these are forcing agricultural sector workers and owners into the booming manufacturing sector.”

## CONSERVATION IS BIG BUSINESS

Corporations continue to meet and exceed electrical energy conservation targets. Cooperative ownership and accountability for Ontario’s energy sector drives organizations to seek ways to improve electrical energy efficiency. “Sustainability is our number one priority,” says James Grainer, CEO of Magentatech, “In the past 20 years, we have continued to implement successful strategies to decrease our electrical energy consumption. The government tax rebates

are great, but our employees say they do this because it make sense for Ontario.”

The strive and desire for economical greener energy has created a significant movement in Ontario, who took the lead from Germany at the turn of the century. While Ontario leads the way as the powerful “Green Machine”, laggards like Alberta and Newfoundland continue to struggle to meet the National Standards for Green Electricity (NSGE). Grainer says, “Many of our partners in Calgary and Edmonton are struggling. Government rebates for businesses that comply with energy consumption guidelines are significant and we are now seeking partners that are in alignment with the NSGE standards.”

Social accountability by over 75% of the world’s nations has led to a significant decrease in CO2 emissions and has slowed the trajectory of global warming. A few significant outliers still exist, including the mega-power China.

Although China is a significant exporter of wind and solar manufacturing components and is a leader in innovation, the population explosion that continues to occur presents significant challenges with the move to green energy. Scarred with rampant weather

catastrophes, poor air quality and trading restrictions, China may soon be forced to comply and shift towards a more solid green commitment.

## ONTARIO IS NOW POISED TO BE SELF-RELIANT BY JANUARY 2044

Gone are the days of selling excess electricity at a loss. With the introduction of the integrated smart grid, guessing games of supply and demand are no longer an issue. Following energy leaders, like Japan, Ontario has decreased its energy use, transitioned to cleaner methods for producing electricity, and implemented smart grids to monitor and meet its energy needs.

This all comes with significant challenges.

Building the integrated electricity grid cost taxpayers four times the estimated cost of building two new nuclear plants, and the estimated maintenance costs far exceeded the initial proposal budgets back in 2022. This leaves Ontario in significant debt.

Innovations in solar power are decreasing our reliance on oil to power our family cars, but outlooks for decreased dependence for air travel, trains and even trucking are still “light years” away. Decreased oil availability has driven prices up so significantly, that nations all over the world are struggling to decrease their dependence. Forward-thinking and progressive Ontario is not panicking, but continues to look for ways to minimize its appetite for oil.

Finally, the Great Global Food Crisis has had a significant impact on Ontarians. The latest food export restrictions have created

significant tensions between farmers and governments, and long-term strategic plans to address this major problem are yet to be seen.

## MANUFACTURING BOOM CONTINUES FOR NOW

Ontario Innovations in offshore wind are propelling the economy.

Wind continues to be a dominant energy option for Canadians and the world. As export leaders in offshore wind manufacturing, Ontario is in an ideal position. The drastic decision decades ago to abandon all land locked wind farms in pursuit of offshore wind turbine research and development proved to be a wise move. Benefits included job stimulation and the development of a new manufacturing sector. The world demand for offshore, wind-based electricity products was grossly underestimated and Canada is now the largest exporter of wind turbine components. Germany and India continue to invest heavily in wind research and development, and are Canada’s biggest competitors in this export market.

## SHINE ON, ONTARIO!

The Mandated Solar Panel (MSP) Program now spans 45% of Ontario residences and 55% of Ontario businesses. Beginning in 2019, the agreement between developers and government for the installation of solar panels on all new builds in Ontario has been a success. Family dwellings (average panel installed is 3000W) are able to draw 45% of household electricity needs from their panels, and draw the remaining from the integrated smart grid (hydro and wind). Lisa Napper is a proponent of solar panel installations on residences. Lisa says, “Panels have cut our

electrical energy cost in half over the past 15 years.”

Ontario was a leader, along with a number of other areas around the world (i.e. India, California) in creating legislation for the mandatory installation of panels on new builds. In the past 10 years, cost of panels has decreased and effectiveness has increased substantially. Some of the newest panels are esthetically enhanced to blend well into the home exterior.

## ONTARIO WORKS TO DEVELOP A SOLUTION FOR LONG-STANDING NUCLEAR WASTE DILEMMA

It’s been 11 years since the final nuclear plant in Ontario has been shut down, but decommissioning and waste management has continued to haunt officials and the general public. “It is irresponsible of us to delay the management of this problem,” says the Minister of Environment, Susan Kane.

The choice to refurbish years ago, rather than build new plans, was a turning point for Ontario’s commitment to wind and solar, “the strategy of using nuclear energy as a bridge while Ontario developed stronger capacity for wind and solar energy has proven to be key: Public approval of our energy mix has strengthened and our manufacturing sector has regenerated.”

Yet even with this transition to electricity alternatives, the problems of the past continue.

Most recent advancements in nuclear “recycling” allows a large portion of waste

to be processed and reused. The remaining waste requires a permanent disposal solution. A tentative agreement has been reached with the US to process our nuclear waste and store it in the newest deep borehole disposal system, located in Wisconsin, and could commence as early as 2045.

# NUCLEAR FAILS FULL LENGTH SCENARIOS

## AS OF TODAY, ONTARIO IS NUCLEAR-FREE AND SO IS CANADA (ALMOST)

12 years ago, a single nuclear accident in Ontario, changed the course of Ontario's power generation for the decades to come. In 2017, Canadian Nuclear Safety Commission (CNSC), approved the Kincardine project as the official holding facility for Ontario's nuclear waste management. When the Pickering, ON nuclear power plants reached end of life, one by one they were decommissioned and all the nuclear waste from these power plants was transferred to Kincardine.

In 2031, Ontario's Power Generation (OPG) was transferring nuclear waste from one of Bruce Power plants to Kincardine. The transfer was thoroughly planned, approved by the Ontario Energy Board, Transport Canada and the federal regulatory CNSC. OPG had been making approximately 800 shipments of radioactive materials per year, and had done so safely for the past 60 years. A few citizens maintained peaceful protests near the Kincardine facility, leading up to the event. All necessary safety policies and procedures were in place as per the International Atomic Energy Agency (IAEA). The convoy transferring radioactive waste by road was

escorted by Pickering Police and Ontario Provincial Police (OPP). KABOOOOM!!!

The container holding highly radioactive material leaked, causing an explosion and instantly claiming the lives of 35 individuals. The emergency response plan was immediately authorized and all available resources were dispatched to mitigate the situation. Even though the crack the size of a credit card, it engulfed in flames and the high-temperature fuel fire lofted particles of irradiated fuel. The event can be compared to Chernobyl, but on a much smaller scale. Nonetheless, the effects are much the same, impacting thousands of people, water, soil, food, animals. Due to its concentration, it caused a lethal exposure around the immediate accident area. This included the workers involved in the transfer, emergency response crews and other motorists.

After 70 years of using nuclear energy, the public perception flipped overnight. Although there was much controversy around the cause of the accident, it did not matter if nuclear was at fault, or not. The truth did not matter. What matter was public perception, and people clung to the fact that there was an accident with nuclear waste involved. The media was relentless in exploding this

further into the public view. We had seen many similar events around the globe, but this was in our neighbourhood, the lives lost were of our family member. The impacts were direct and devastating. This resulted in an anti-nuclear movement. Without much thought, people reacted, and wanted nothing to do with nuclear. Period. Despite the truth, the perception was strong and it was here to stay. The NIMBY attitude was back.

People did not have solutions; they weren't concerned about how the electricity demand should be met, they just wanted nuclear gone. Just earlier this century, we had invested billions into nuclear as an electricity source for Ontario. When the experts tried to make them realize that we rely heavily on nuclear - for more than half of the electricity generation in Ontario - people were outraged. This only fueled the fire and confirmed their insecurities. Public perception trumped politics, economics and pretty much any other argument. As a result, nuclear had to go.

Today, over 12 years since the nuclear accident and \$billions later, the last nuclear reactor - Bruce Power A4, was officially decommissioned. Ontario is nuclear-free. The people won. In 2012, nuclear accounted for

15% of Canada's electricity (14% of which was from Ontario). Now, nuclear accounts for less than 1% of Canada's electricity.

## COAL (DON'T CALL IT A COMEBACK)

Coal provides almost half of Ontario's electricity but it's only a means, not an end. In 2002, coal provided almost 30% of Ontario's electricity generation. Ontario spent over a decade and billions of dollars to be coal-free since 2014. Now, without nuclear, just over half the current demand was being met. With the existing provincial debt, the only economically viable solution was to temporarily re-open our long retired coal plants. The 20+ coal-fired plants that were converted to natural gas plants earlier in the century, were converted back to coal-fired plants. New coal-fired plants were also built because coal was expected to generate almost half of Ontario's electricity mix. It was around this time that Ontario realized, its reliance on nuclear was unhealthy, and they didn't have a plan B. Renewables like wind and solar were making great progress, but that was not nearly fast enough. At best, Hydro and other renewables combined, would provide just shy of 50% of Ontario's electricity.

As of 2042, Coal is providing almost half of Ontario's baseload electricity. The number of smog days annually in the GTA has gone from 48 in 2005 (Coal at 29%), 12 in 2012 (Coal at 3%), 131 in 2043 (Coal at 48%). The sulphur emissions have increased dramatically. Ontario spent billions of dollars and over a decade working on coal-fired plants to replace nuclear generated electricity; but this is only the means, not the end. Coal is not the solution, it's only an interim solution.

## COAL - IT'S ACTUALLY THE MOST EXPENSIVE SOURCE OF ELECTRICITY

For one reason or another, the general public can't seem to make the connection between coal generated electricity and climate change. Maybe they don't want to. Even though coal causes 4,000 times more deaths when compared to nuclear, we still use it to generate half of the world's electricity. This is partly a result of the public perception for coal. Coal is extremely harmful to the environment, related accidents cause many deaths.

Ironically, people don't react as strongly to indirect consequences such as climate change, compared to direct consequences like local accidents and the death of family/friend. Similarly, they do not comprehend a systemic overview of coal. Coal is considered to be the cheapest source of electricity but that's true only if you consider just the direct electricity cost. The damages caused by coal are significant, i.e. health costs, environmental costs. When the systemic cost is taken into account, coal is the most expensive and the most harmful to the people and planet. However, as long as people's electricity bills aren't going up, the expense is indirect and therefore not correlated to the usage of coal. Our health-care system is already starting to see the effects of coal-fired plants.

## PEOPLE TAKING CONTROL - GOING 'OFF THE GRID'

This interim solution to use coal as a source of electricity is expected to get us through the next few decades. While they work on possible long term solutions, they are simultaneously working on damage control -

trying to mitigate the damages by attempting to lower the demand of electricity. Using coal as a source of electricity is bad but I guess if we used less, it's still better. The Ministry of Energy has launched several attractive electricity conservation initiatives and programs for better equipment, buildings, home appliances etc. More homes are now 'off the grid' than ever before. Homes are aiming to become totally independent for their electricity and the government is encouraging them to continue through incentives.

## ELECTRICITY IS CHEAP, BUT NOT THAT CHEAP

Debt is accrued each time the Ministry of Energy replaces a source of energy. With the elimination of coal and heavy investment in nuclear during the early parts of this century, the provincial debt began to skyrocket. Nuclear projects grossly exceeded initial proposed budgets, and with the implementation of new nuclear safety standards the costs increased further. Once Ontario committed to shutting down these facilities, the debt hit a new, all-time high. Electricity cost is still very expensive, even though we are using one of the cheapest source of generation. Today, around 19% of our electricity cost are debt retirement charges compared to 4% in 2012. More debt is anticipated as Ontario moves towards a long term solution.

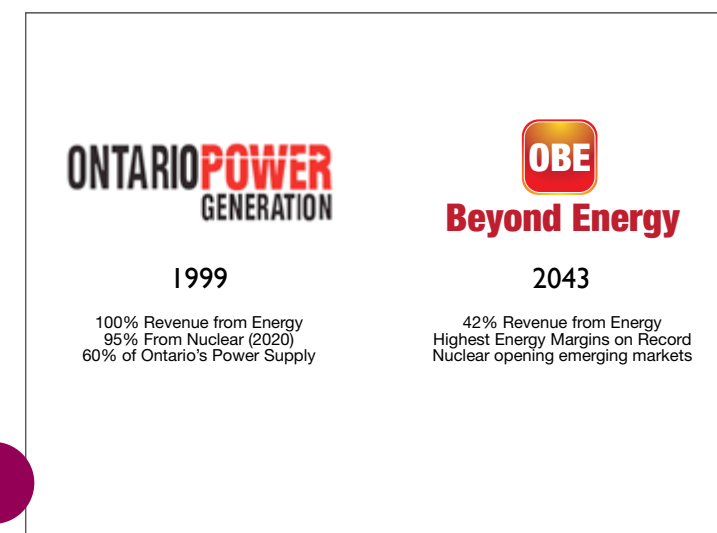
## ANALYSTS CLAIM, IT'S CHEAPER, HEALTHIER AND ENVIRONMENTALLY RESPONSIBLE TO IMPORT ELECTRICITY

Studies repeatedly show, it is much cheaper, safer and environmentally friendly to import energy until we come up with a long term solution, rather than accruing more debt and causing harm for an interim solution.

## THE RACE IS ON FOR WATER, WIND AND SOLAR

Progress for greener alternatives has been gradual and promising, but is still unable to generate the required electrical energy to replace the current base load supplied by coal. The race is on for innovation in the Water, Wind and Solar sectors to see which will thrive as a viable solution in Ontario's future.

# TIME MACHINE PRESENTATION SLIDES





4

**OBE Energy**

**Industry Review**  
Christine Keene  
Director of Power



7

**OBE Energy**

**Pioneering Technologies**



5

**OBE Health**

**Innovation Review**  
Ian Gray  
Director of Health



8

**OBE Energy**

**Paving the way**



6

**OBE Transportation**

**Industry Review**  
Meghan Savigny  
Director of Transportation



9

**OBE Energy**

**Full spectrum solar**



10

**OBE Energy**

Pickering Solar Hub



11

**OBE Health**



12

**OBE Health**

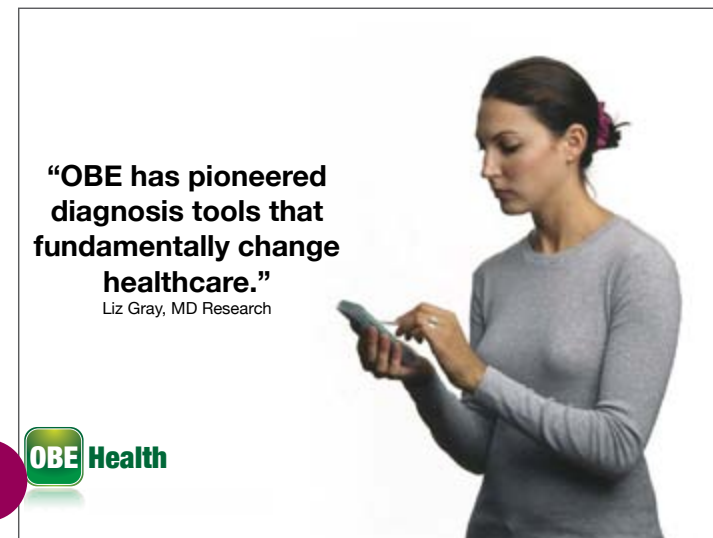
Chalk River Laboratories



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**OBE Health**

Cyclotron Technology



14

**OBE Health**



15

**OBE Health**

Bruce Wellness Centre



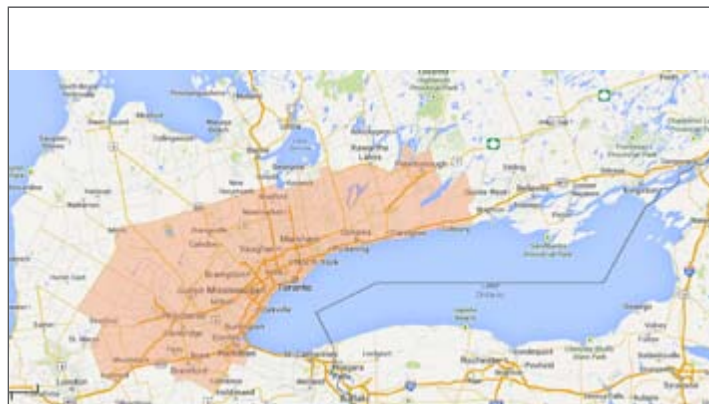
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**OBE Transportation**



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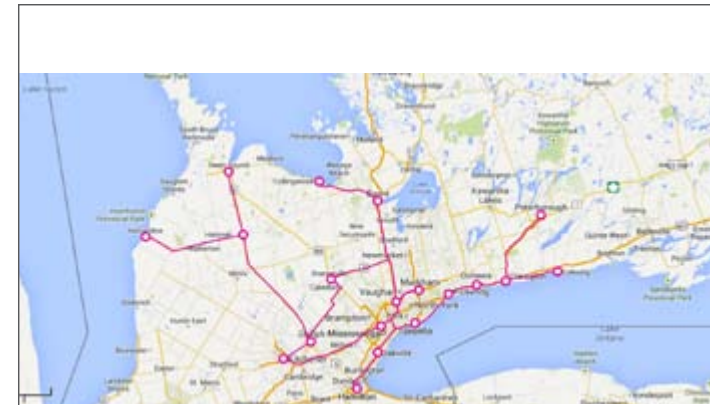
**OBE Transportation**



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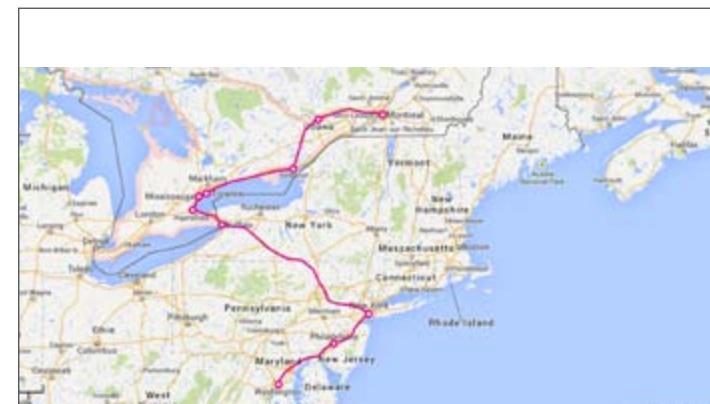
**OBE Transportation**

Connects the entire GTA



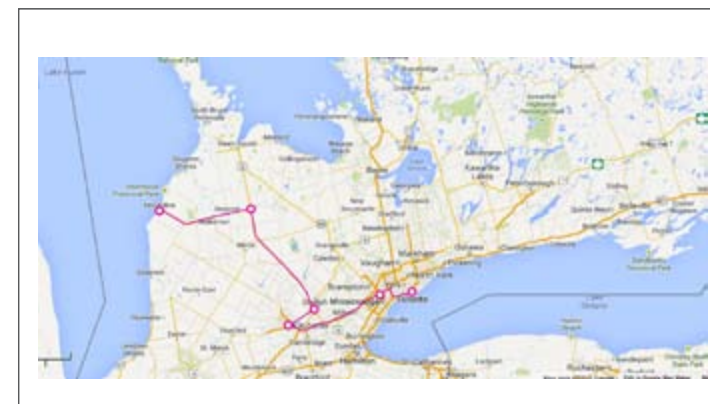
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**OBE Transportation**



20

**OBE Transportation**




21

**OBE Transportation**

Today's route:  
Toronto – Kincardine






**22** **OBE Transportation**



**Closing Remarks**  
**45th Annual General Meeting**

**25** **OBE Beyond Energy**



**23** **OBE Transportation**

Electric rail network is powered by small, dedicated fast reactors.



**24** **OBE Transportation**

OBE Research & Innovation Facility, Hamilton

