Chapter 5 – The Real Estate, Energy, Food & Water Nexus

The Mystery of Forethought

"Sometimes people don't want to hear the truth because they don't want their illusions destroyed." – Friedrich Nietzsche

In retrospect, three previous American Crisis periods seem easy to predict, but one year prior to their onset…I doubt many could have imagined, let alone predicted the epic sacrifices and horrific casualties of war that were to follow. In 1772 there were few people expecting America to declare independence and fight an eight-year war for independence. In 1859 the election of Abraham Lincoln as president and an ensuing war was a major surprise that would kill 700,000 Americans. In 1928 no one imagined the stock market losing 89% of its value, an eleven-year depression, and a world war resulting in over 60 million deaths. History, all too often, is or seems 'inevitable' only in hindsight. But in many cases, it need not be. Certainly, many intelligent responses to global challenges are in the offing with some forethought. We need to think in such terms regarding the nexus of water, energy and the economy and finally start showing forethought and intelligent proactivity.

Water Demand for Energy to Double by 2035 (see https://www.truthdig.com/articles/water-demand-for-energy-to-double-by-2035/) – The International Energy Agency predicts the amount of fresh water needed to produce energy for the world is set to double.

Hydroelectricity is a nexus where water and energy collide. In drought conditions, municipalities may increasingly face decisions about whether to use the contents of their reservoir for water or electricity. Interestingly, according to Webber, each kWh of hydroelectric energy produced results in the loss of 18 gallons of water due to increased evaporation from manmade reservoirs—over-and-above what would have happened in the natural run of the river.

Hydro-electric production at dozens of dams along the Missouri River fell by nearly half in 2006 and we know it is problematic in many places in 2022.

https://www.theguardian.com/environment/2016/jan/08/hydro-dam-boom-threatens-third-of-worlds-freshwater-fish

96 million plastic balls prevent drought, water pollution
Black plastic balls have been dumped by the millions into L.A.'s reservoirs this summer—and with good reason. Known as shade balls, they play an essential role in protecting the city's water supply, which has been severely threatened by this year's brutal California drought. Among some of their benefits, the...
https://www.hortidaily.com/article/19668/96-million-plastic-balls-prevent-drought,-water-pollution/..

PERFORMANCE AT A GLANCE

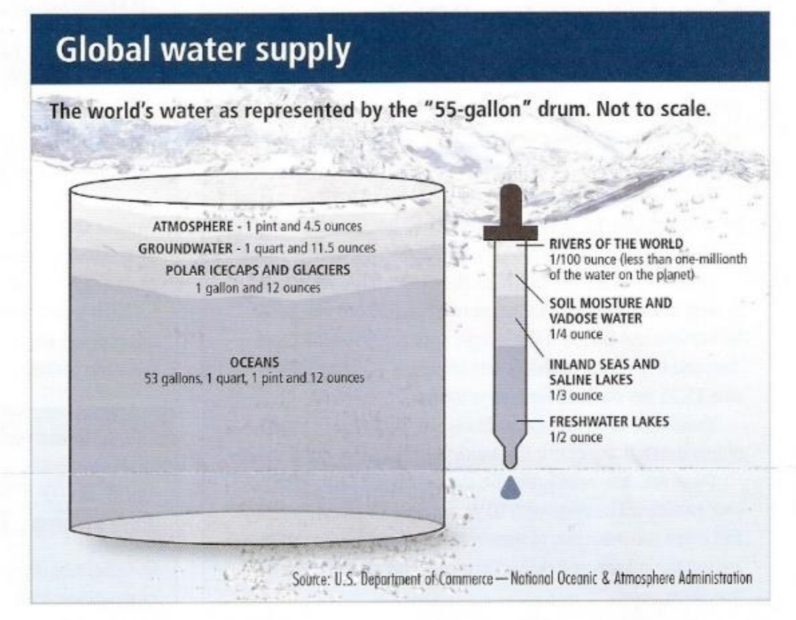
ELECTRICITY GENERATED

Net Generation by Fuel Type (gigawatt-hours)	2016	2017	2018	Annual Change
Coal	62,489	61,356	51,543	-16%
Diesel	659	526	544	+3%
Natural Gas	29,838	30,716	37,935	+24%
Oil	2,370	2,070	1,662	-20%
Total Fossil	**95,355**	**94,668**	**91,685**	**-3%**
Hydroelectric	297,244	303,459	295,014	-3%
Nuclear	72,316	70,175	69,257	-1%
Renewables (biomass, wind, solar, tidal, biofuel, other)	9,004	8,245	7,442	-9%
Total Non-Fossil	**378,564**	**381,879**	**371,712**	**-3%**
TOTAL Net Generation	**473,919**	**476,547**	**463,397**	**-3%**

The figures above are absolute measures (in contrast to intensity measures, expressed on a per-unit-of-production basis). They can therefore be impacted by CEA membership changes from one year to another, as well as by acquisitions or divestments on the part of members.

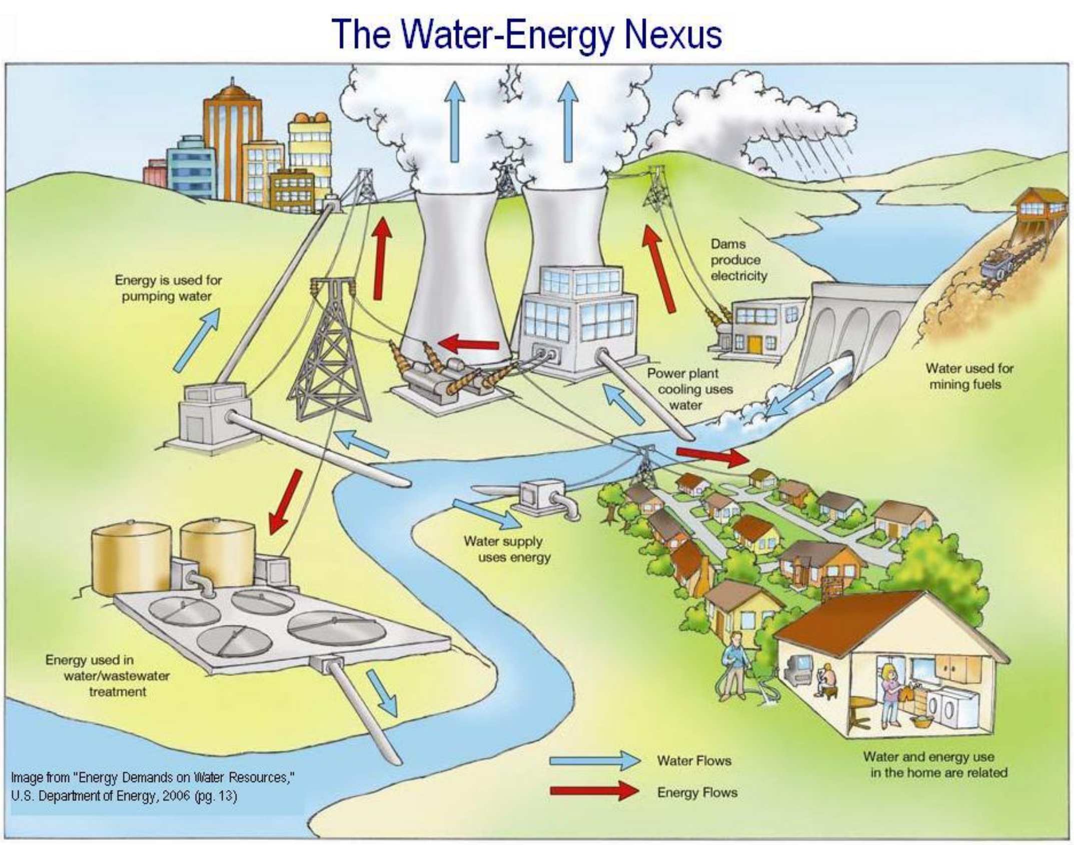
15 | RESILIENT ASSETS AND SUSTAINABLE OUTCOMES | 2019 SUSTAINABLE ELECTRICITY ANNUAL REPORT

Coal and Natural Gas Fired Power Plants Water Use



Power plants generally use water as a conveyance for waste heat and withdraw far more water than any other entity in North America. Canadian federal statistics indicate that one single industry alone, thermal power generation, extracts 63 percent of all the water removed from nature within our own borders. Total annual freshwater withdrawal is 50,812 mcm/year of which 63% is for thermal power generation, 15% for manufacturing, 11.5% for municipal use (urban and rural), 9.5% for agriculture, and 1% for mining.

Page 18 of the Energy Demands on Water Resources report explicitly states the water withdrawn is "lost to evaporation". Such evaporation is the worst contributor to global warming, ahead of methane and GHG in that order. One can attempt to argue the water is not lost due to evaporation but will return as rain, but then the question becomes when and where? Also, unfortunately this cooling process kills every living organism in the water used – larvae, eggs, microorganisms – all of it. If we run closed loop combined heat and power we dramatically increase our energy efficiency, avoid power plant water consumption, reduce GHG's and all with very little intermittency but north American policies do very little to support its adoption… more on that shortly.



According to the U.S. Geological Survey (USGS), thermoelectric power, which uses water for cooling steam turbines, accounts for the largest share of water withdrawal in the U.S., at 49 percent in 2005 (latest year data are available). Table 1-4 shows the water consumption (gal/MWh) by SHP technology and cooling technology.

Table 1-4: Water Consumption by SHP Technology, Cooling Technology[6]

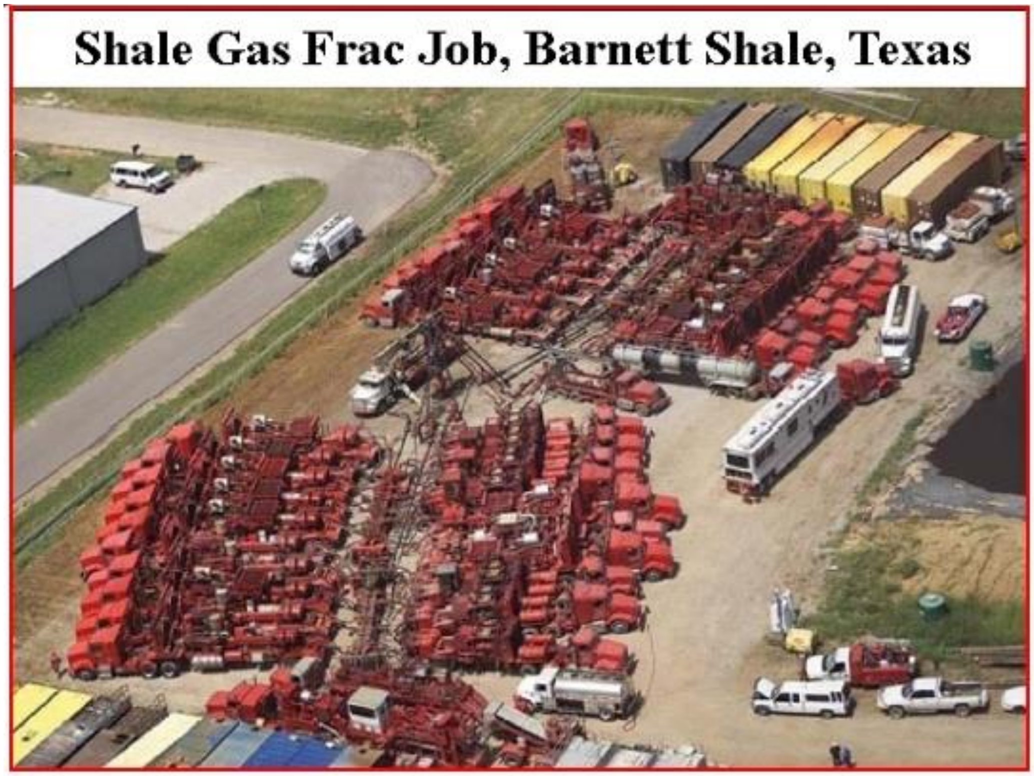
			Cooling Technologies – Water Consumption (gal/MWh)				
			Open-Loop	Closed-Loop Reservoir	Closed-Loop Cooling Tower	Hybrid Cooling	Air-Cooling
Fuel Technology	Thermal	Coal	300	385 (±115)	480	between	60 (±10)
		Nuclear	400	625 (±225)	720	between	60 (±10)
		Natural Gas Combustion Turbine	negligible	negligible	negligible	negligible	negligible
		Natural Gas Combined-Cycle	100	130† (±20)	180	between	60† (±10)
		Integrated Gasification Combined-Cycle	not used	not used	350† (±100)	between	60† (±10)
		Concentrated Solar Power	not used	not used	840 (±80)	between	80† (±10)
	Non-Thermal	Wind	none	none	none	none	none
		Photovoltaic Solar	none	none	none	none	none

†Estimated based on withdrawal and consumption ratios

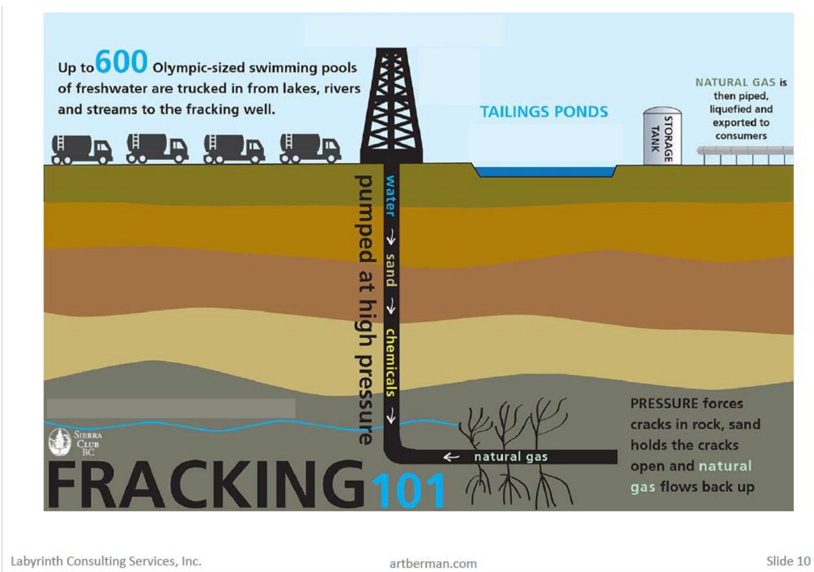
[6] Stillwell, Ashlynn S., et al, Energy-Water Nexus in Texas, The University of Texas at Austin and Environmental Defense Fund, April 2009.

Production and processing of our fossil energy commodities also requires the extensive use of water:

- On average it takes 4 barrels of water to produce one barrel of oil according to the Energy Water Nexus Commission. For tar sands, the ratio is about 5:1 water:oil-product, plus more for refining. A similar number accompanies oil shale extraction. The Canadian tar sands use more water than the entire population of Alberta but a lot of effort has been made to dramatically reduce this with material positive results.
- Gasoline consumes a few times its volume in water for production. But from an energy standpoint, at 36.6 kWh/gal on average including all power plant types in North America, every kWh of energy available in the gasoline takes a small fraction of a gallon of water to produce. Thus electric cars turn out to be more water-intensive than gasoline cars, for instance, if each kWh of electricity production gulps a few gallons of water.
- Hydraulic Fracturing ('fracking') for natural gas appears to require 10 L/GJ of water consumption. For the energy equivalent of one gallon of gasoline, this works out to just about one liter—so not as intensive as tar sands or oil shale or even gasoline but as the water is pumped deep it is out of circulation for the most part for a very long time and it may even cause tremors and more.
- Truck driving is the most common job being created in natural gas and shale oil. Hauling water is one of the primary reasons' drivers are needed, given shale oil and gases propensity to be located in arid regions. The following is a picture of a typical fracking site:



• Each mini-earth quake uses 1,500 – 3,000 cubic meters of water and 150 – 250 tonnes of sand driven in with compressors
•Shale gas uses 2-5 million gallon of water per well!! (source Oct 2009 Alberta Oil Magazine



- In the life of one well, 80% of what is injected is 2 million plus gallons of water, 4 million pounds of proppant (natural quartz sand and man-made ceramics), and 350+ barrels of chemicals.
- 80% of the water is disposed of by pumping it into wells at least 2,500 feet below potable water where it is lost for the foreseeable future. 20% is recycled. Source: Oil & Gas Fracking Facts from March 2013 National Geographic

Horn River, BC: The resource lies at a depth of 7800 -13,300 feet and the average first year decline rate is 50 percent. Current production is 0.2 BCFPD. Estimated reserves recoverable is 61-96 TCF

More Shale Gas Wells, More Water: One Calculation for British Columbia's Horn River Basin

Number of Shale Gas Wells	Water Needed for Hydraulic Fracturing
10	909,090 cubic metres
25	2,272,725 cubic metres
50	4,545,450 cubic metres
150	13,636,350 cubic metres

Source: Presentation to the Sixth Annual Shale Gas Conference in Calgary, Alberta in January 2010, by Ken Campbell, a professional geologist and senior hydrologist with Schlumberger Water Services

•To compare, the domestic and business water consumption in the Greater Victoria area - home to nearly 336,000 residents - is on average 134,282 cubic metres.

While the availability of energy and water for future generations largely depends on the relationship between the two, this relationship often remains missing from policy and industry conversations around both resources. Energy production requires the consumption of our finite water resources and the magnitude of that consumption will affect the amount of clean water available in future years. As business leaders, policy makers and researchers debate the future of energy, it is important to consider the impact on available water resources as part of the equation.

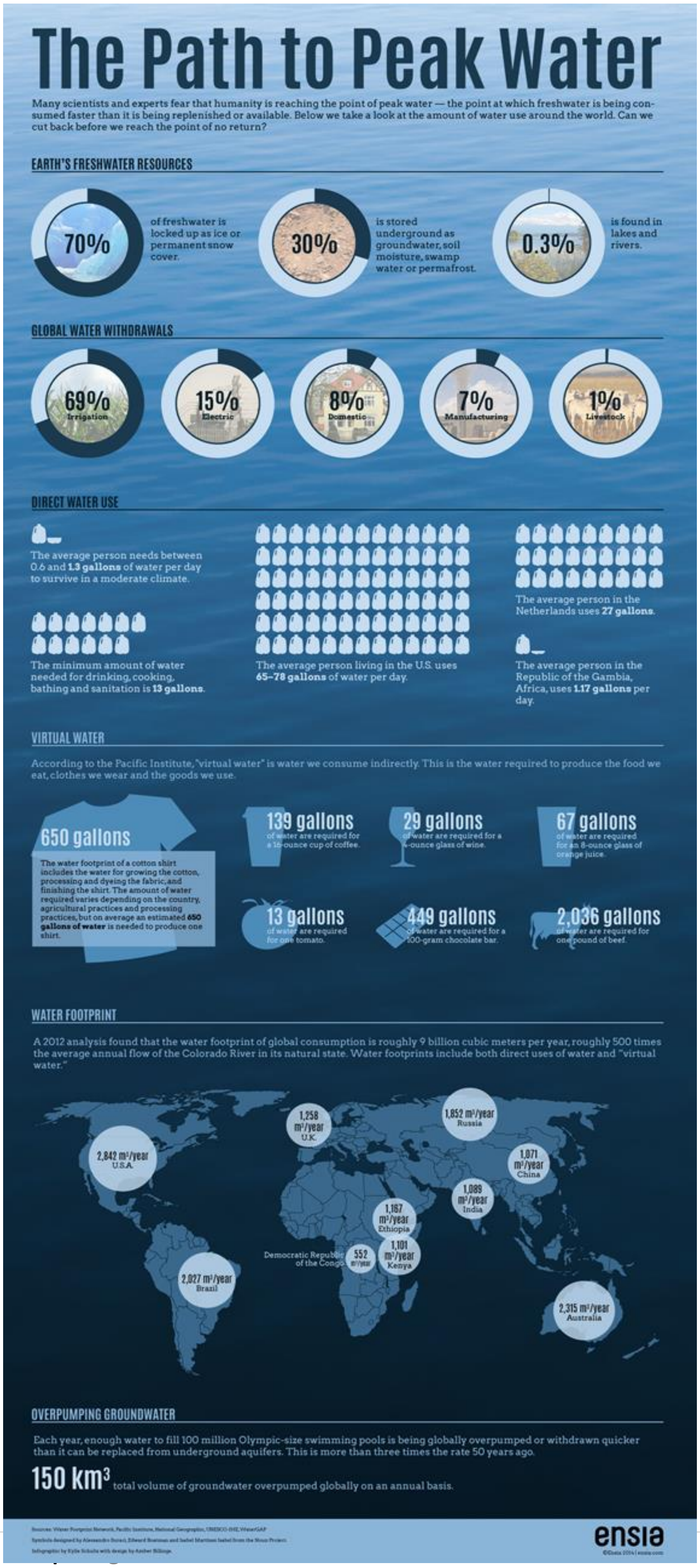
Not all energy alternatives make an equal splash. Energy production consumes vastly different amounts of water depending on the source.

According to the World Policy Institute, the volume of water used to produce the energy required to drive from New York City to Washington, D.C. is 32 gallons when the fuel source is traditional oil and 33 gallons when the fuel is unconventional natural gas. That volume is reduced to just 5 gallons when the fuel source is natural gas from conventional land extraction.

This may not paint a full picture of the impact of our energy resources on water availability (i.e., fracking may have a greater impact on the amount of available water after accounting for pollution from fracking fluids). Nevertheless, as we transition to a low-carbon future, energy alternatives that reduce carbon dioxide emissions may not minimize impact on water resources. Depending on the composition of our future energy mix there could be significantly varying impacts on already-decreasing water tables.

As water resources grow scarce and the global population increases, public scrutiny on available energy and water resources will only heighten. As we should have learned from our foray into forest management and fossil fuels, we cannot afford to sacrifice long term sustainability for short term accessibility. And if the food versus fuel debate (see https://www.reuters.com/article/us-usa-ethanol-support/analysis-in-food-vs-fuel-debate-u-s-resolute-on-ethanol-idUSTRE71D0UR20110214) (the global dispute regarding the diversion of crops from food to biofuels) is any indication, global stakeholders should not let energy demand easily compromise the sustainability of other vital resources. The contention surrounding these issues shows us that stakeholders are already paying more attention to this relationship than ever.

Transitioning to a low-carbon economy that has minimal impact on our water supply will not be easy. The considerations are many and the conversation is complex. Is it more important to reduce the associated water consumption or carbon dioxide emissions of our energy production? What fuel mix will minimize the impact on both? There is much debate for any "answers", but now is the time to recognize that these water considerations need to become an inextricable part of the energy conversation. Now is not the time for a lack of energy literacy that would suggest wind is the definitive answer, for example. Or that wind uses no water (it certainly does in its manufacturing and installation process) or has no environmental impact (tell that to the bats and birds) Wind is but part of the answer! We touched on this in Chapter Three as we discussed a cubic mile of oil and we will add detail on the myriad of reasons why.



The water crisis facing humans over the next number of years will ultimately have as great an impact on human activity as does energy scarcity, around the world, particularly as we have seen they are so very inter-related. Potable water is increasingly becoming more expensive to treat (although we are learning alternatives to deal with this) thus water scarcity is one of the most challenging issues facing the world. It has been estimated that the value of the global desalination market alone will reach $18.37bn.

We face water scarcity almost the globe over now. Yet as energy makes a 'demand call' to double its energy use by 2035 (according to the IEA), farmers too will need 19 percent more water by 2050 to meet increasing demands for food (much of it in regions already suffering from water scarcity.

A quarter of world farmland is "highly degraded" by intensive agriculture that has depleted water resources, reduced soil quality (including its ability to hold moisture) or increased erosion.

Mounting water shortages "are an unacceptable situation," said then French Prime Minister Francois Fillon adding that while means exist to resolve water issues, indicators "like gross domestic product don't reflect existing problems."

Farming is the biggest cause of water stress in the Middle East, and in Iraq, Oman, Syria and Yemen, it accounts for more than 90 percent of usage, the UN said. The region already imports as much as half its grain consumption and climate change could cut agricultural productivity by a quarter by 2080.

Saudi Arabia (SABIC) is reducing grain production to reduce unsustainable use of groundwater and encouraging companies to lease tracts of land in Africa for growing. India is growing maize, sugarcane, lentils and rice in Ethiopia, Kenya, Madagascar, Senegal and Mozambique to feed its domestic market.

Collectively, the lands where two-thirds of humanity live – four billion people – get only about a quarter of the globe's precipitation. **By the 21st century, humanity had barred the natural flow of six of every 10 big rivers on earth**. Less than four-fifths of one percent of all water on earth is fresh and desalination is energy intensive by itself, let alone the energy required to pipe desalinated water any distance. The US EPA has estimated that the cost of piping water to a large-lot residential subdivision amounts to a subsidy of $130,000 for every mile a given house lies from the water supply with the cost generally hidden in city wide property taxes (Source: Growing Towards More Efficient Water Use). To extract from sea water the amount of fresh water a Canadian use in a year costs between $2,000 and $3,500, although some claim to be able to do it for about $940 Cdn.

The UN and OECD call for more efficient use of wastewater, of which 80 percent is not collected or treated, according to the UN. Biogas anaerobic digestion plants offer an intelligent response to not only water re-use at site, but renewable natural gas and nutrient capture. Europe and Asia are far ahead on this and North America has an opportunity to catch up. More on this later.

Irrigated fields aided mightily in the fossil fueled green revolution in producing the food surpluses that allowed early societies to increase in population and afforded the spare time and specialized manpower that lead to further inventions and civilization. Sanitization lets us live together in densities that otherwise would invite lethally epidemic infections and diseases.

Food From Wheat To Beef Requires Great Quantities Of Water

North Americans are making water work harder and go further than it did a quarter-century ago. Indeed, even as the United States population grew by 56 million and its economy by half in the two decades after 1985, its water consumption remained almost unchanged. Canada's per capita water consumption also dropped between 1980 and the start of the new century, but a doubling of our economy overrode improvements in water efficiency, with the result that our total water consumption went up by more than one-quarter over that time (Jevon's Paradox raises its head yet again). The Pacific Institutes comparison of countries domestic water consumption found Canadians near the top of the chart, at 767 litres a day each, about five and a half bathtubs full – all numbers that sound impossible to believe until one considers how much water our food requires. It takes about 1,300 litres of water to make a kilogram of wheat and 15,500 litres of water to make 1 kg of beef.

It is not at all unusual to farm by extracting ground water with diesel or electric pumps. In Texas doing so often requires a farmer to pull water straight up 110-120 metres, and that distance has increased by four and a half metres over recent years. By 2005, a farmer was paying 8 to 10 dollars US to pump 2.5 centimetres of water over an acre of fields. He needs 46-50 centimetres for each of his acres over a season, adding up to $320,000 poured into the dirt before he harvests a single bale of cotton. Running out of water maybe won't drive farmers out of business – but the economics of pumping it, likely will.

Alberta is estimated to have approximately 500,000 domestic wells and the most telling stat is about 7,000 are added per year (Source: Alberta Environment 2003).

All readers are likely aware that a great deal is happening in water conservation. The intention of the above has been to serve as a reminder of why it is so very critical. Below we only touched on several intelligent responses that do not get the profile they need, when in fact, an entire book of solutions could be or already has been thankfully written for our reference to aid with water conservation.

The picture to the left shows the beginnings of construction of a waste water catchment

The same catchment after planting:

Three years after planting (tropical 12 month growing season mind you)

The relationship between water efficiency and on site, small scale cogeneration energy is not well known – but it should be. According to the Energy-Water Nexus Committee electricity production from coal accounts for 52% of US electricity generation and each kWh generated from coal requires a withdrawal of 25 gallons of water. A 155 kWh cogeneration unit operating at its normal annual capacity will produce 1,071,535 kWh's of electricity – thereby saving approximately 26.8 million gallons of water annually. Cogeneration provides excellent economics, water conservation and environmental benefits such that it should be applied for renovations, upgrades and new buildings now.

A Special Mention on Water, Real Estate and Beavers Research Links:

- I've long been fascinated by the idea of using beavers for ecosystem repair. Dr Glynnis A. Hood from the University of Alberta has done extensive research on beavers and their positive impact on ecosystems. Here from a paper she wrote all about beavers are key points:
    - Wetlands with beavers had nine times the open water than similar ponds without beavers during times of drought (aka, **they drought proof**).
    - Farms that choose to keep active beaver lodges show almost twice the diversity over farms without active beavers (remember, **diversity equals stability**).
    - Beaver channels increase the pond perimeter tenfold which dramatically increases the biodiversity of the pond.
    - Here is a powerful story of an Alberta couple who after years of trying unsuccessfully to build a pond on their own, they sought out the help of the experts – beavers and succeeded fabulously see https://wildlife.org/monitoring-beaver-restoration-one-dam-at-a-time

Two excellent books on the water, food and energy topic are: *Dry Spring by Chris Wood and Why Your World Is About To Get A Whole Lot Smaller by Jeff Rubin*

Additional reading:

http://www.nytimes.com/2015/06/26/science/worlds-aquifers-losing-replenishment-race-researchers-say.html?_r=0

http://physics.ucsd.edu/do-the-math/2012/10/the-energy-water-nexus/

Eight Mighty Rivers Run Dry – National Geographic

http://www.caseyresearch.com/articles/coming-water-wars

To discuss the matter further we will address mini- case studies of several geographies:

The Middle East - Turning Oil Into Water

Saudi Arabia isn't just running out of oil – it's running out of water. So is the whole region. And the water depletion problem is far more pressing and urgent to the people on the ground than any oil depletion problem that they may face. Their inheritance of fresh water, like their oil, was laid down eons ago in underground aquifers. In countries like Saudi Arabia fresh water in aquifers is already down 50% from the levels of the mid-1990's.

Massive power subsidies in Saudi Arabia and elsewhere in the Middle East have long been in place. And just as underpriced gasoline is over consumed, so underpriced electricity is also over consumed. Saudi households pay about 1 cent per kilowatt-hour, roughly one-fifteenth of what a typical American or Canadian household would pay and about one-thirtieth of what you would pay in Germany. And that's pretty well par for the course for electricity rates among Saudi's OPEC neighbours. Not surprisingly, power demand across the Middle East is expanding at between three and four times the pace of power demand growth rates in North America or the rest of the OCED.

Current water use in Saudi Arabia is seven times sustainable levels. And some of Saudi Arabia's neighbours are running through their water supplies at an even more alarming rate. In Dubai and the rest of the Emirates, water use is running fifteen times higher than its natural replenishment, while in Kuwait it is running at over twenty times sustainable levels.

Take into account the fact that nearly two-thirds of all the water in the Middle East is used for agriculture, and it becomes clear that many Middle Eastern nations are facing the difficult choice between water, food and using their last fossil fuel reserves to get them..

Saudi Arabia already accounts for 60% of the regions desalination plants, including the world's largest facility, Shuaibah 3. When it reached full capacity in 2009, it began producing 31 million cubic feet of water per day. Shuaibah 3 is powered by one of the biggest generation plants in the world, sending a steady stream of oil that it is charged less than $3 a barrel for, up its smokestack. Every year Saudi Arabia depletes about 700 billion cubic feet of its natural water in aquifers. To desalinate a compensating amount of salt water, it will have to burn roughly 300,000 barrels of oil or the equivalent in natural gas.

The World Bank estimates that the Middle East will need roughly another 50-60 billion cubic feet of water annually over the next 10-15 years to meet the region's burgeoning water demand. Desalinating that immense volume of water could ultimately require the use of a million barrels of oil per day (about 1.2% of global daily output). To put that in perspective, the largest oil field discovered in the North Sea in the past 25 years, Buzzard, has a daily output of less than a fifth of that. All of the Alaskan oil fields together pump out considerably less than a million barrels a day. Peak water hastens peak energy. And as the Middle East sells the world less oil, oil prices have resumed rising coming off their brief reprieve from 2014 to 2019.

Water shortages in China potentially a perfect storm

In China, the Three Gorges Dam has come under immense scrutiny because of its impact on water availability in the midst of the worst drought in 50 years for China.

Water shortages could be China's own version of the perfect storm, potentially blowing a hole in its failed carefully laid socialist central plans.

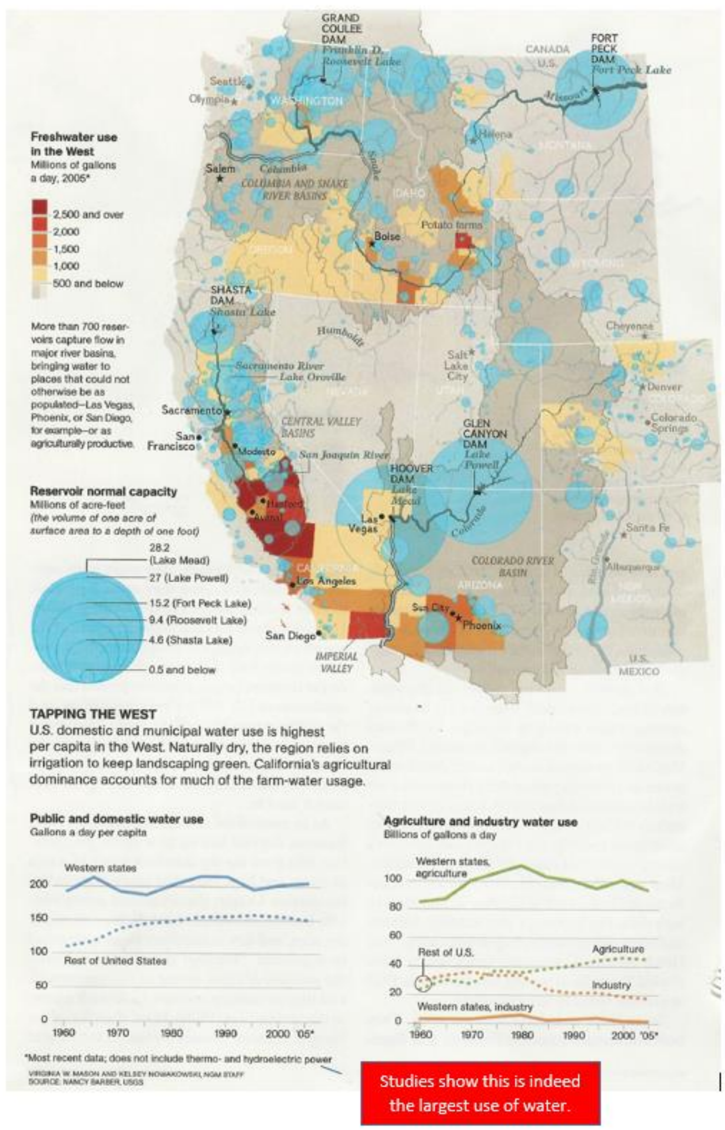
Targets for moderately fast economic development, seen as crucial for the Communist Party to maintain its grip on power, no longer seem so easy to achieve as China is running shy of the water needed to leverage up the electrical-power generation it requires to meet those targets.

Switching the energy mix between nuclear, hydro-power, coal or even the exploitation of promising shale-gas deposits, doesn't really add up because of a shrinking water supply. ... Click here to read more.

Colorado River and California:

Rising energy prices and climate-change regulations are threatening southern California's ability to keep pumping water long distances. In California, the water sector consumes 19% of the state's electricity and 31% of its natural gas. 50-80% of desalination costs are for energy.

Location destruction and North American Food Inflation Due To Overdrawn Colorado River



The Colorado River, whose flow is life to nine American and Mexican states – including parts of California, Arizona and Nevada and Mexico's Sonora and Baja California – fell to less than half its low level recorded during the Dust Bowl years. The Colorado irrigates pasture land in Wyoming, the cotton rows that stretch implausibly across Arizona's Sonora Desert and perhaps most notably California's Central Imperial Valley, the source of much of North America's mid-winter bounty of fresh vegetables

The Colorado has been transformed from a free river into one of the most intensely managed water courses on the planet. Its most famous restraint, the Hoover Dam just south of Las Vegas, has attained iconic status for its scale and bold engineering. Turbines in the powerhouses far below and elsewhere along the river spin out 12 billion kilowatt hours of electricity per year (about a third of what those on the Niagara River can produce). Since its inception though, it has been realized that Hoover and associates licensed at least 40% more water than really flows down the Colorado and that is at lager heads with the folks in Arizona, Colorado, Utah and Californians, who all want more of the water, which now arrives as a trickle of what used to arrive, in Mexico. Not to mention that the Colorado now loses more water to evaporation from its artificial lakes to the thirsty air, than is now delivered to Mexico. Lake Mead has now dropped more than 27 metres since 1999. The Bureau of Reclamation acknowledges that years of drawing more out of Lake Mead and Lake Powell, have left both giant reservoirs barely half full and the silt and sediment that no longer flows is collecting on the bottom – so they are far less than half full with water. It would take decades of above-average rain and snowfall to refill them. Mark Bird with the Bureau of Reclamation foresees water bills jumping by half, the same for electricity generated at Colorado dams as well as a 50% increase in the cost of food grown in Southern California.

Additional reading:

http://www.reuters.com/article/2013/03/13/us-usa-desalination-idUSBRE92C05720130313

http://www.popsci.com/lake-mead-just-hit-its-lowest-level-yet

http://www.utsandiego.com/news/2015/may/11/colorado-river-shortage-even-chance/

http://www.nytimes.com/interactive/2015/05/21/us/your-contribution-to-the-california-drought.html?_r=0

http://geab.eu/en/californias-water-crisis-is-coming-soon-to-the-rest-of-america/

Ontario:

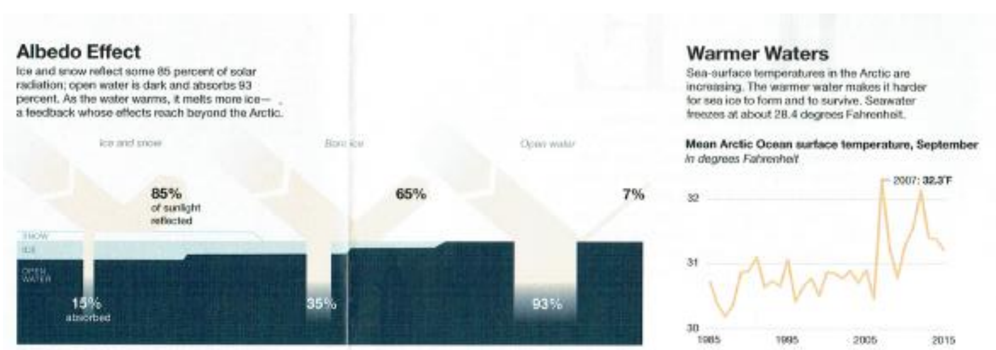
Reconciling The Great Lakes Vastness & Relation To Hydroelectricity

"It is important to remember that there is no 'surplus' water in the Great Lakes basin," the International Joint Commission report said. "From an ecosystem perspective, it is all in use, even in periods of high supply." Click here to continue reading

It is amazing how interrelated water, energy and economics are as the following points show:

- The Great Lakes after freezing over every winter between 1953 and 1998, the shallowest (and therefore most easily frozen) of the Great Lakes – Lake Erie failed to freeze fully across in three of the subsequent nine winters. By early January 2007, the water in the lake was a record 41F, seven degrees above historic norms for that date. Not freezing increases evaporation and heating significantly. Is this a worry for nuclear power plant cooling or the fact that district energy cools 150+ of downtown Toronto's largest buildings?
- Lake Ontario, on Toronto's shore used to freeze yearly, but like Lake Erie, Huron and Superior it no longer regularly does. Only about one percent of the Great Lakes' volume is replenished each year by rain and snow. The impact on shipping is been noted. Through most of the new century's first decade, three quarters of the Great Lakes shipping fleet ran with holds only partly full, sacrificing $6,000 to $12,000 in trip revenue for each inch of draft (their depth below the water-line) they gave up to avoid grounding (Source: Annin, The Great Lakes Water Wars, page 210).
- How sensitive is hydro-electricity to water flow? Note that nightly in some Great Lake locations the hydroelectric plants close some of their gates to back up water, in anticipation, to drive its turbine during the normal surge in demand for electricity the next morning.

Lakes encased in a sheet of ice don't lose much to evaporation, whereas when they remain ice free, water continues to escape into the air. That's particularly true late in the year, when the first winter blasts of dry Artic air push south and blow eastward across lakes that are still comparatively warm. The dry air as it warms up over the lakes increases its capacity to absorb. Under these conditions, water evaporates from open surfaces even faster than on a hot summer day when the muggy air is already saturated. Evapotranspiration (ET) already extracts more water from the Great Lakes than all our human diversifications combined. Scientists who monitored lakes in north western Ontario between 1970 and 1990 discovered that as temperatures rose by 1.6C, rainfall declined. But ET ballooned by 50%. Annual runoff into Lake Superior plummeted by almost two-thirds from 40 centimetres to only about 15 (Source: Great Lakes Water Quality Board). Less hydro power is the consequence. It would be a huge drain on natural gas resources to try and make up this hydro supply gap. People see how vast the great lakes are and mistake their vastness for invincibility.



Alberta:

A photo of Bow Lake in 1902. VAUX FAMILY/WHYTE MUSEUM OF THE CANADIAN ROCKIES

A photo of Bow Lake in 2002. HENRY VAUX JR. / WHYTE MUSEUM OF THE CANADIAN ROCKIES

Decline of glaciers in Western Canada chronicled in family photographs

Every August from 1997 to 2013, Henry Vaux Jr. visited the Canadian Rockies to retrace the steps of his ancestors who took a slew of black-and-white photographs a century earlier…We know what the comparison looks like don't we...Click here to continue reading.

Irrigation Is Very Important To Southern Alberta To Be A Bread Basket

North Americans and Canadians are great at sloughing such issues off as 'a problem over there but not here' and therefore we are blissfully ignorant of our own circumstances. For example, most Canadians think we have vast amounts of fresh water but are unaware if we subtract the great lakes and the water that flows north and is not heavily used by Canadian's, our water supply is very average when compared with the rest of the world on a per capita basis.

The Dust Bowl of the 1930's devastated many prairie communities. More recently in 2001-02, the arid triangle of south western Saskatchewan and south eastern Alberta, named for John Palliser, the early surveyor who declared it too dry to farm, saw moisture levels drop lower than any recorded in 110 years. The region's economy lost well over a billion dollars (Source: Crop Insurance To Pay Out Billions: Extreme Drought Resulted in Below Average Yield In The Southern Prairies, Ottawa Citizen, September 22, 2001).

For the most part this area is farmed thanks to irrigation from the Bow River and at the source is the Bow Glacier which is rapidly receding. The Bow no longer runs all summer over its full natural course. Alberta irrigates some 1.6 million acres of land and as a result the irrigated 4% of Alberta's farmland supports nearly 20% of its agricultural employment. To give some perspective of the water required, the three billion cubic metres of water held in the Oldman Dam each spring is one-tenth of the volume of Lake Mead or twice what Mexico receives from the Colorado River. And the Oldman Dam is anything but the only source of irrigation water for the area.

"Provincial water use is predicted to increase by 21% by 2025, particularly by the petroleum industry, due to increased tar sands (from northern flows) and shale gas production and irrigation. For more details see the report "Fight To The Last Drop" at www.bowriverkeeper.org.

Brent Paterson oversees the Alberta Irrigation Branch which oversees the water supply for nearly three quarters of all irrigated acreage in Canada. He says, "We have long lists of farmers interested in investing the dollars to irrigate and we have lots of land to irrigate. Water is our limiting factor. We're telling them, there's no more."

Canada's driest province, Alberta, gets less than 25 millimetres of rain over much of its territory east of the foothills in an average year. In drier soils, less solar energy is used up in evaporating water, meaning more is available to raise the temperature of the soil and overlying air, leading to even more desiccating conditions. Not only can that self-amplifying cycle extend and intensify droughts, but dry soils release little moisture into the air that might fall back to earth as precipitation.

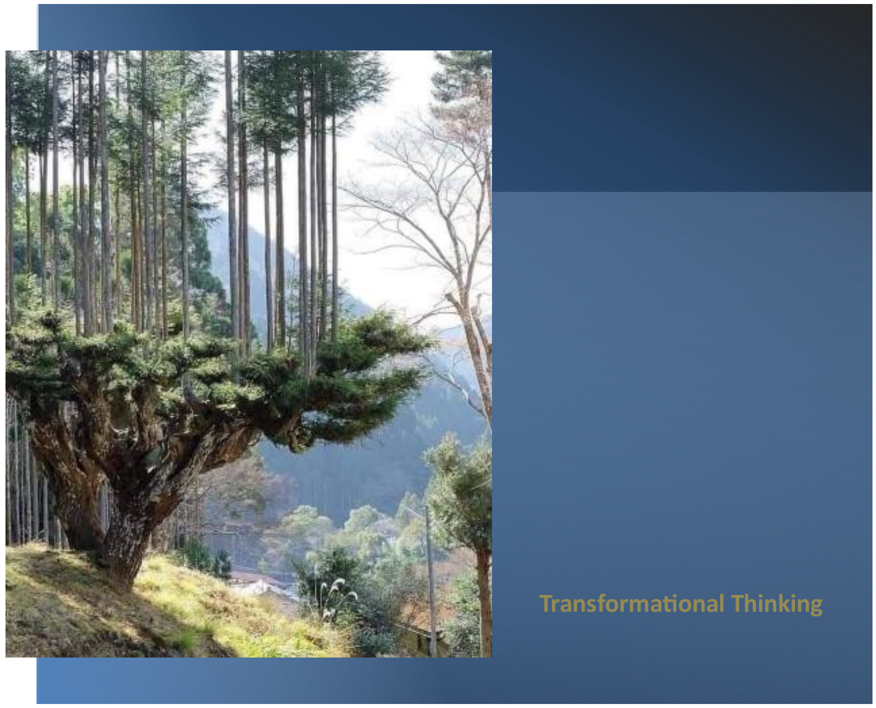
One of several groups attempting to sound an alarm has been the Alberta Institute of Agrologists whose members are specialists in farming science. "Alberta is at a major crossroads" the Institute reported after studying the state of the provinces water supply. "The limit of available water has been reached in a number of watersheds." The Bow Rivers average summer flow is estimated to have been halved and the water in the south Saskatchewan that reaches Saskatoon is now barely one-sixth of what used to arrive. The South Saskatchewan is a major contributor to Lake Winnipeg, larger today than Lake Ontario.

Eerily, extracted fossil algae and the rings of ancient trees, in which minute differences correspond to fluctuations in the weather pattern of the past, indicates that the 20th century may have been the wettest in the southern Canadian Prairies in more than 500 years.

The droughts that shrivel harvests in the world's breadbaskets are having an even more dangerous effect. They are shrinking the breadbaskets themselves, transforming what are now arid but arable landscapes into raw deserts. Since the 1970's, the area lost annually to desert has more than doubled as farms disappear in over 100 countries. (Source: United Nations Convention to Combat Desertification, June 2004). Climate scientists link rampant deforestation in parts of Africa and South America to the decline in rainfall there – pause for thought in some of our current wood biomass schemes and other causes for deforestation (more on this in Chapter 10).

Author and geographer Jared Diamond compared the histories of Japan and Easter Island, each a small island with limited resources supporting a growing population. Both peoples cut down increasingly large numbers of trees; in Japan as building materials and on Easter Island, at least in part, to erect enormous statues for which it is still famous. In both places the deforestation caused environmental harm; in particular water became scarcer. Yet whereas the Japanese faced facts and responded with rules to limit tree cutting, the Easter Island folks continued with abandon. Japan weathered an environmental crisis, continued to thrive and now has a population of 127 million. Its forests today occupy a proportion of its land that is one of the worlds' highest per acre per capita. Easter Island's population, by contrast crashed from tens of thousands of reasonably well-fed people to a few hundred thousand semi-starved souls who descendants have reintroduced trees to the island. The moral, Diamond points out, is that Japan recognized its danger and proactively executed an intelligent response.

The Japanese have been producing wood for 700 years without cutting down trees. In the 14th century, the extraordinary daisugi technique was born in Japan. Indeed, the daisugi provide that these trees will be planted for future generations and not be cut down but pruned/coppiced as if they were giant bonsai trees; by applying this technique to cedars, the wood that can be obtained is uniform, straight and without knots, practically perfect for construction. A pruning as a rule of art that allows the tree to grow and germinate while using its wood, without ever cutting it down. Extraordinary technique.



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