Water-Energy Nexus
A SWOT analysis

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Clean water flowing freely from a tap

- electricity available from a public outlet
- food at hand and relatively inexpensive
- places to go, people to meet
- **The very image of civilization**
- WEN plays a central but underappreciated role

From both Water and Energy, flexible use, low price, with use disconnected from obvious human effort and the natural world

- All have led to staggering use, and abuse!
Problems often look overwhelming at first.
The secret is to break problems into small, manageable chunks. If you deal with those, you're done before you know it.
For example, I'm supposed to read this entire history chapter. It looks impossible, so I break the problem down.
You focus on reading the first section?
I ask myself, "Do I even care?"
The Water-Energy Nexus

Water-energy connections are

Essential, ubiquitous and natural

Strategic | important to human activities NOW

Urgent | the need will only grow

Neglected | too often “been there done that”

Complex | need holistic approaches
Water-Energy Connections

- underlie almost all that is important to humans and the planet
- are the foundation of a strong economy
- must be well balanced to achieve health and fitness
- are key to our perceived quality of life
- the crucial component on planetary habitibility
- a key ingredient into much that is beautiful and inspirational
- at the heart of any evaluation of sustainability
Natural Cycles | WEN role is central

- Energy Balance
- Dynamic Atmosphere
- Carbon Cycle
- Nitrogen Cycle
- Ocean Movements
- Rock Cycles
- Water Cycle
Human Intervention and Ability

Water-energy connections are:

- Co-opted life and nature
- Paul Colinvaux – every niche exploited
- Ronald Wright – progress traps – extended ability to kill not one, but all
- E.O. Wilson – a summary of economic history: “people used every means they could devise to convert the resources of the Earth into wealth.”
- All our experience is with a habitably planet: yet only 1 part in X of solar system is habitable
  - $X = 100,000,000,000,000,000,000,000,000,000,000,000,000,000,000$
- Like finding one atom in a cubic kilometer
move to pg 9 after
WEN: Strength of the Concept

**Accuracy** | it reflects reality – water and energy ARE profoundly linked

**Learning** | sometimes insight into one domain transfer to the other

**Strategic** | sometimes one domain provides a key insight for the other

**Integrity** | can avoid a deceptive shell game, since sometimes victories in one domain can hide a loss on the other

**Stewardship** | because water and energy are genuinely linked in the natural system
Civilization

An image of our true existential position?

“The greater the rapidity of human-induced changes, the more likely they are to destabilize the complex systems of Nature.”

Leopold (1949)
Water is...

Fugitive | always going elsewhere
Bulky | needed in large quantities
Non-substitutable | Not easily traded
Overall role | Priceless
Water plays a crucial role in...

The generation of electricity:

- As a cooling agent, a transportation media, an component in manufacturing, a working agent, or a driving force

- 50% of installed Hydro-electricity plants have serious trouble in operation and in meeting their design capacity

The use of energy:

- Whether pumped for water supply or for irrigation and food production

- Treatment, desalinization, purification

- Role of heated water – warming, cooking, cleaning, reacting, treating...
Water use by Major Canadian Sectors, 2005

Weakness of the Concept

**Diffusion** | the very size of the concept can be overwhelming

**Distraction** | can take attention from other pressing and valid priorities

**Distortion** | deep emotional connections may prevent effective discussion and further complicate already tough questions
Opportunities

**Regional** | great possibility of regional benefits and synergies

**Conceptual** | finding, developing and benefiting from new connections

**Low hanging fruit** | our rediscovery of this concept has huge potential
The Cost of Water

- Order of magnitude costs for 25L of product:

  - Municipal Water (Delivered)
  - Bottled Water
  - Milk
  - Pop
  - Beer

  
<table>
<thead>
<tr>
<th>Product</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Municipal Water</td>
<td>$0.02</td>
</tr>
<tr>
<td>Bottled Water</td>
<td>$15.00</td>
</tr>
<tr>
<td>Milk</td>
<td>$25.00</td>
</tr>
<tr>
<td>Pop</td>
<td>$30.00</td>
</tr>
<tr>
<td>Beer</td>
<td>$85.00</td>
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</tbody>
</table>
Contend | We have not fully used nor benefitted from W-E connections

Our infrastructure failures are:

- A direct result of system properties and behaviour – not chance or conspiracy
- Inevitable, but a great chance to learn
- Usually wasted – discussion blocked, embarrassed silence, suppressed reporting
- Thus, often repeated
Pipe ruptures, loses more than 70 million gallons of water before being repaired.

Sources: ESRI, GDT, USGS, Chronicle reporting

Chronicle Graphic
Water Supply Connections

Water efficiency ratio can reflect what is needed rather than what is delivered

\[
\frac{Q_{D. \ to \ system}}{Q_{supplied}} \rightarrow \frac{Q_{D. \ to \ user}}{Q_{supplied}} \rightarrow \frac{Q_{required}}{Q_{supplied}}
\]

Perhaps a truer picture of water saving opportunities:

- Recognizes some losses at WTP, some during delivery, and wasteful practices by users
- Typical (good): 0.95-97 to 0.80-0.85 – to ?
Energy efficiency ratio can reflect what is needed, not only what is delivered.

\[
\frac{E_{D. \text{ to system}}}{E_{\text{supplied}}} \quad \frac{E_{D. \text{ to user}}}{E_{\text{supplied}}} \quad \frac{E_{\text{required}}}{E_{\text{supplied}}}
\]

- Moving from pump, to delivery system, to overall system performance, including user
- Perhaps a truer picture of energy opportunities
- You can’t waste water and keep the energy performance high energy drives water
Water Conservation + Demand Management

High-efficiency fixtures

Changes to daily habits
- Shower durations; closing tap when brushing teeth
- Maximizing use of household appliances (e.g., dishwasher)

Education & awareness programs

Appropriate pricing
- Full-cost pricing
- Water is generally priced below the cost to provide it
- Proper pricing will encourage more appropriate usage
Threats

**Priority** | tyranny of the urgent

**Power** | breaks traditional lines and thus a threat to some

**Price** | we can’t value what we don’t evaluate well
Parallels with Energy

Increasingly important where:

• Sources of energy are environmentally expensive (e.g., high carbon energy sources such as coal)

• Electrical supplies are priced according to market forces (e.g., variable rate structures)

Recall “Demand Management/Conservation” theme:

• Can we curtail consumption?

Similarly,

• Are we supplying too much pressure on average?
Implications of Higher Pressures

- Leak rates are higher
- Pipe bursts more frequent

Therefore...

- Water losses higher
- Energy losses higher
- Energy effectiveness much lower!
Closing Thoughts

Aging infrastructure:

• Degradation non-linear
• We can expect to see more breaks, leaks, etc.
• Energy costs are almost bound to increase!

*Things are moving so fast the inaction itself is one of the biggest mistakes. The 10,000-year experiment of the settled life will stand or fall by what we do, and don’t do, now. The reform that is needed is not anti-capitalist, anti-American or even deep environmentalist; it is simply the transition from short-term to long-term thinking.*

Ronald Wright, 2004