

Bottled Water and Energy

By: Janna Dettmer

jdettmer@kentlaw.edu

Chicago–Kent College of Law

Energy Law

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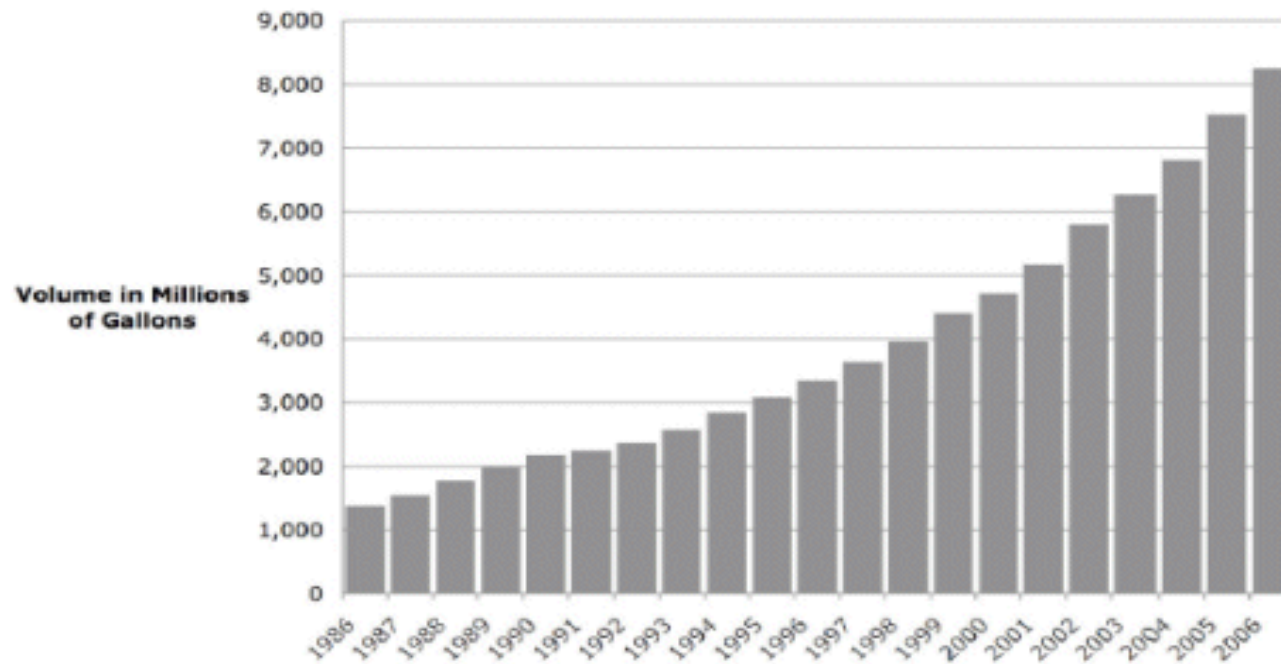


Presentation Summary

1. Boom of the Bottled Water Industry
2. Cost of Bottled Water
3. Why do People Drink Bottled Water?
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4. Environmental Impact
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The Boom of the Bottled Water Industry

Sales of Bottled Water (1986-2006)



Source: Beverage Marketing Corporation, as reported in Beverage World. 2007.

Image: <http://www.flex-news-food.cm>

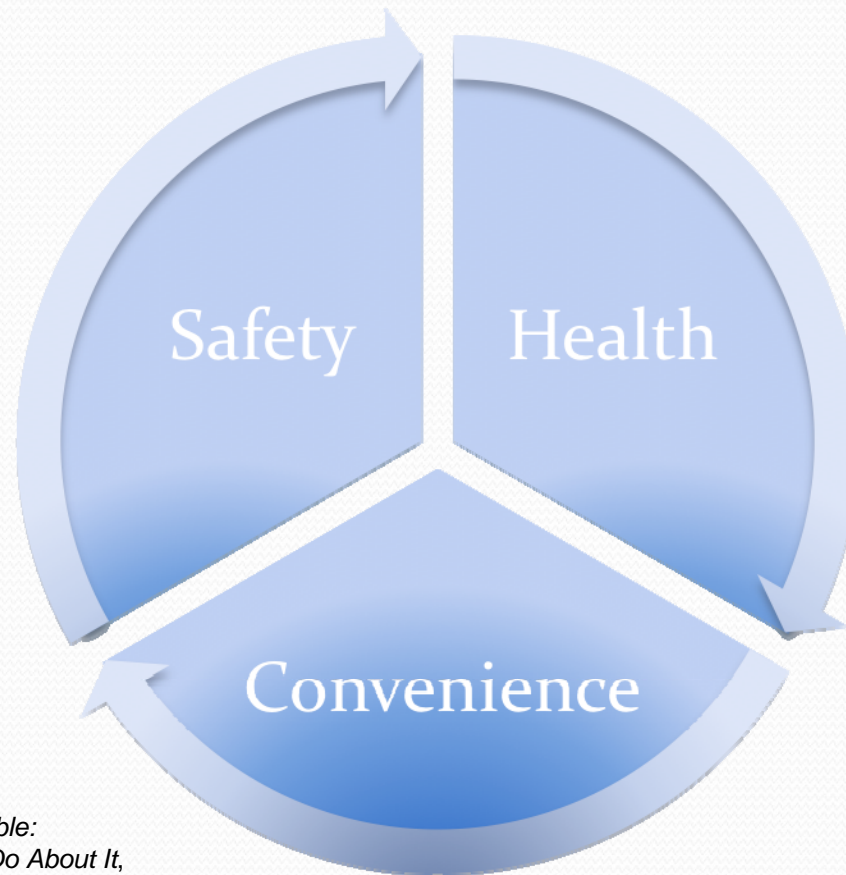
The Cost of Bottled Water

- Bottled water consumers spend 240 to over 10,000 times more per gallon purchasing bottled water than it does purchasing a gallon of average tap water

Source: National Resources Defense Council, *Bottled Water Pure Drink or Pure Hype?* (1999), available at <http://www.nrdc.org/water/drinking/bw/chap2.asp>
Image: <http://www.iowawaterquality.org/snapshots.htm>



Why Do People Drink Bottled Water?



Source: Robert Glennon, *Unquenchable: America's Water Crisis and What to Do About It*, 44 (2009).

Examples of Nestlé Waters Advertising



- **Did You Know?** As its name implies, Ice Mountain® Brand Natural Spring Water is crisp-tasting and “Pure As The Driven Snow!®.” It is the local favorite of Midwesterners

- Image and Source: <http://www.nestle-watersna.com/Menu/OurBrands/Ice+Mountain.htm>

Examples of Nestlé Waters Advertising



- **Pure water from a pure place[®]**
- **Zephyrhills[®] Brand Natural Spring Water was born of the ocean. Tens of thousands of years ago, Florida was under water. As sea levels lowered, its mineral-rich limestone bedrock remained, creating a natural filter for groundwater to flow through. The mineral content gives Zephyrhills[®] its natural purity and distinctive taste.**

Image/Source: <http://www.nestle-watersna.com/Menu/OurBrands/Zephyrhills.htm>

Bottled Water, a Safer Alternative to Tap Water?



- National Resources Defense Council's 1999 Study:
 - 1/3 of bottles tested contained significant contamination
 - Contaminants present:
 - Heterotrophic-plate-count bacteria
 - Coliform bacteria
 - Arsenic
 - Synthetic Organic Chemicals

Source: National Resources Defense Council, *Bottled Water Pure Drink or Pure Hype?* (1999), available at <http://www.nrdc.org/water/drinking/bw/chap2.asp>

Image: <http://www.newsli.com/2008/03/11/nyc-dep-released-a-statement-to-counter-water-contamination-claims/>

Environmental Impact of Bottled Water



- GAO believes that the environmental impact of bottled water is three-fold:
 1. Municipal landfill capacity of discarded water bottles;
 2. The effect of groundwater extraction for the purposes of bottling water
 3. The effects on U.S. energy demands from the manufacture and transport of plastic water bottles

Source: U.S. GOV'T ACCOUNTABILITY OFFICE, BOTTLED WATER: FDA SAFETY AND CONSUMER PROTECTIONS ARE OFTEN LESS STRINGENT THAN COMPARABLE EPA PROTECTIONS FOR TAP WATER 23 (2009).

Image: http://images.usatoday.com/news/_photos/2006/04/16/water.jpg

The Study: Energy Implications of Bottled Water

- Peter H. Gleick & Heather Cooley
 - Pacific Institute
- 2009 Published Paper
 - Energy Implications of Bottled Water
 - The Paper DOES NOT “develop a single comprehensive life-cycle energy estimate”
 - The Paper “estimates the energy footprint required for various phases of bottled water production, transportation and use”

Source: PH Gleick and HS Cooley, *Energy implications of bottled water*, Environ. Res. Lett. 4, 1 (2009).

Energy Requirements

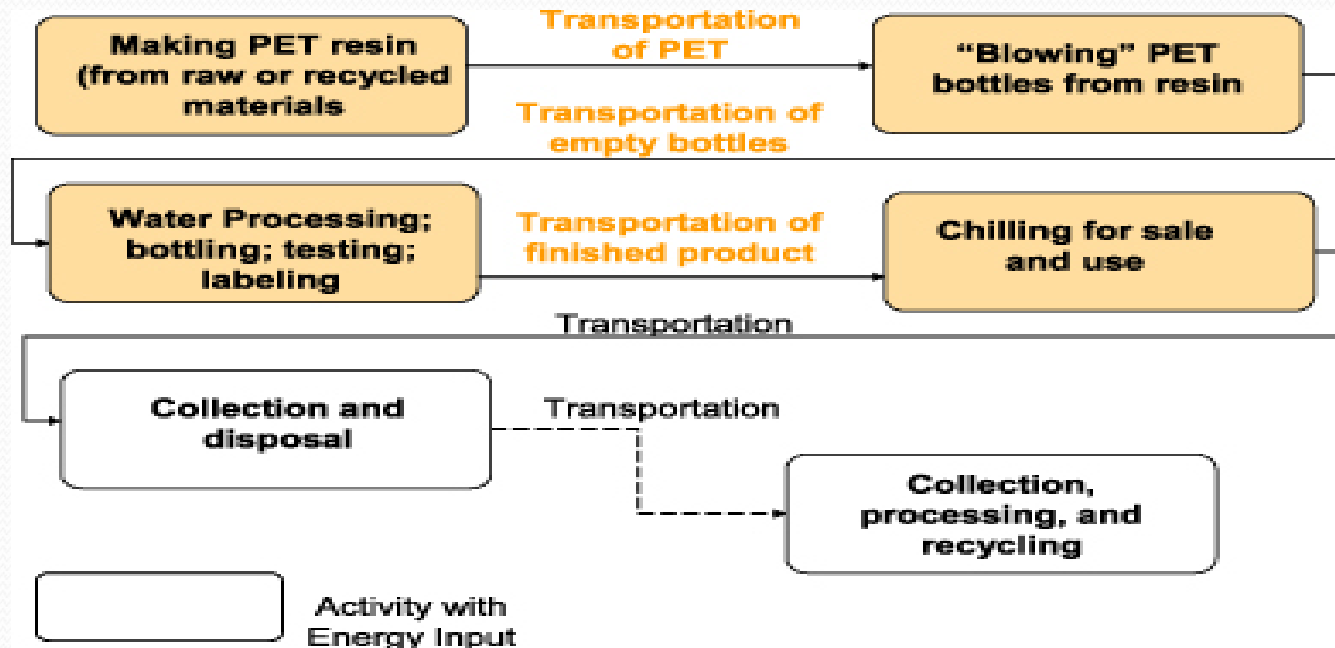


Chart: PH Gleick and HS Cooley, *Energy implications of bottled water*, Environ. Res. Lett. 4 (2009).

Megajoules for Dummies

$$1 \text{ J} = 1 \text{ N} \cdot \text{m} = \left(\frac{\text{kg} \cdot \text{m}}{\text{s}^2} \right) \cdot \text{m} = \frac{\text{kg} \cdot \text{m}^2}{\text{s}^2} = \text{Pa} \cdot \text{m}^3 = 1 \text{ W} \cdot \text{s}$$

- A Joule represents the “energy exerted by a force of one newton acting to move an object through a distance of one metre.”
 - “The megajoule (MJ) is equal to one million joules, or approximately the kinetic energy of a one ton vehicle moving at 160 km/h (100 mph).”
- Real Life examples:
 - One Joule =

Source: <http://en.wikipedia.org/wiki/Joule>

Manufacture of Plastic Bottles: Energy Needed

- Bottles are made out of Polyethylene Terephthalate
- Study found that:
 - Energy to produce PET resin is approximately $70\text{-}83 \text{ MJ kg}^{-1}$
 - Energy needed to produce preforms and turn into bottles requires 20 MJ kg^{-1}
 - Equals $100 \text{ MJ}_{(\text{th})} \text{ kg}^{-1}$ or $100,000 \text{ MJ}_{(\text{th})} / \text{ton}$ of PET
- The Study also found that:
 - Average 1 liter bottle weighs approximately 38g
- 1 liter PET bottle weighing 38g = 4 MJ

Source: PH Gleick and HS Cooley, *Energy implications of bottled water*, Environ. Res. Lett. 4, 2-3 (2009).

Image: www.earthodyssey.com



Manufacture of Plastic Bottles: Energy Needed

- 2007 100 billion liters of bottled water was sold
 - 100 billion liters x 38g = 3.8 million tons of PET
- 2007 approximately 3 millions tons of PET were produced globally
 - 3 million tons of PET x 100,000 MJ_(th)/ton
 - Equals 300 billion MJ_(th) of energy

Citation: PH Gleick and HS Cooley, *Energy implications of bottled water*, Environ. Res. Lett. 4, 2-3 (2009).

Image: <http://www.earth911.com/plastic/plastic-bottles/>



Manufacture of Plastic Bottles: Energy Needed

- One barrel of oil contains around 6,000 MJ
- If it takes 300 billion MJ_(th) to manufacture plastic bottles
- It is “the energy equivalent of approximately **50 million barrels of oil per year, worldwide.**”

• Source: PH Gleick and HS Cooley, *Energy implications of bottled water*, Environ. Res. Lett. 4, 3 (2009).

• Image:
<http://people.bu.edu/ragsdale/ImageWithEqualSigns/OilBarrels.jpg>



Energy to Process Bottled Water



- Water Treatments:
 - micro or ultra filtration → 1,800 kWh_e per million liters
 - Ozonation → 1,800 kWh_e per million liters
 - Ultraviolet radiation → 10 kWh_e per million liters
 - Reverse osmosis → 1,800 kWh_e per million liters
- Energy: between .0001 and 0.02 MJ_(th)l⁻¹

Source: PH Gleick and HS Cooley, *Energy implications of bottled water*, Environ. Res. Lett. 4, 3-4 (2009).
Image: <http://halmapr.com/news/aquionics/beverage-bottled-water-and-food-processing/>

Energy needed to clean, fill, seal, and label bottles



- Average to clean, fill, seal and label bottles
 - 0.014 MJ_(th) per bottle
 - .34% of the energy contained in the bottle itself.

Source: PH Gleick and HS Cooley, *Energy implications of bottled water*, Environ. Res. Lett. 4, 4 (2009).

Image:

http://http://nazret.com/blog/media/blogs/new/bottle_water.jpg

Transporting Bottled Water: Energy Requirements

- The energy required for transporting water is sizable as water is heavy.
- Dependent on two factors:
 - Distance between bottling facility and market
 - Type of Transportation
- Study looked at three scenarios of bottled water coming to Los Angeles, California:
 - “Processed municipal water that is distributed locally by truck;
 - Spring water produced in the South Pacific (such as Fiji spring water) transported by ship to LA and distributed locally by truck;
 - Spring water packaged in France (such as Evian) shipped to the eastern United States transported by freight railcars to LA and distributed locally by truck.”

Transporting Bottled Water

- locally produced and transported: 1.4 MJ l^{-1}
- Spring water shipped from Fiji: 4.0 MJ l^{-1}
- Spring water shipped from France: 5.8 MJ l^{-1}



Source: PH Gleick and HS Cooley, *Energy implications of bottled water*, Environ. Res. Lett. 4, 4-5 (2009).

Image: www.uslogistics.us/Trucking.html

Energy to Chill Bottled Water



- Two Considerations
 - Energy it takes to cool bottled water from room temperature to the temperature of the refrigerator or cooler
 - 0.2MJl^{-1}
 - How long the bottled water is cooled for
 - 0.2MJl^{-1}

Source : PH Gleick and HS Cooley, *Energy implications of bottled water*, Environ. Res. Lett. 4, 5 (2009).

Image:

http://www.vendorsequipment.com/FOUNDATIONS/STORE/products/true_gdm_49_generic.jpg

Energy Summary

- In comparison to tap water
 - **2000** times more in the amount of energy needed
- Study estimates that the US consumption of bottled water is equivalent to 32-54 million barrels of oil
 - 1/3 of a percent of total US primary energy consumption

Manufacture Plastic Bottle	4.0
Treatment at bottling plant	0.0001-0.02
Fill, label, and seal bottle	0.01
Transportation	1.4-5.8
Cooling	0.2-0.4
Total	5.6-10.2 MJ_(th)l⁻¹

Source: PH Gleick and HS Cooley, *Energy implications of bottled water*, Environ. Res. Lett. 4, 6 (2009).

Bottled Water Cost Calculator:

How much water do you drink?

Enter the total number of 16 oz bottled of water you drink in a year: **365**

Cost of Tap Water per Gallon: **0.002**

Cost of 16 oz Bottled Water (typical is \$1.50) **\$1.50**

Impact

Total Water Consumed: **57 gallons**

Extra Water Required for Production and Purification: **114 gallons**

Energy Required for Manufacturing; **37 megajoules**

Oil Required to Produce the Plastic Bottle(s): **9 gallons**

CO₂ to Manufacture Plastic Bottle(s): **68 pounds**

Your Extra Cost for Bottled Water: **\$546.77**

Available at :

[http://www.newdream.org/water/calculator.p](http://www.newdream.org/water/calculator.php)

[hp](http://www.newdream.org/water/calculator.php)

What You Can Do...

- Use Reusable Bottles
- Check Your Water Quality Report
- Encourage Others To Stop Using Bottled Water
 - Local government
 - Restaurants
 - Office
 - Friends and Family

Source: <http://www.newdream.org/water/ways.ph> ;

<http://www.foodandwaterwatch.org/water/bottled/SmartWaterCard.pdf>

Image: <http://www.foodandwaterwatch.org/support-us/shop>





List of Sources

- <http://www.foodandwaterwatch.org/water/bottled/SmartWaterCard.pdf>
- <http://www.nestle-watersna.com/Menu/OurBrands/Ice+Mountain.htm>
- <http://www.nestle-watersna.com/Menu/OurBrands/Zephyrhills.htm>
- <http://www.newdream.org/water/calculator.php>
- <http://www.newdream.org/water/ways.php>
- National Resources Defense Council, *Bottled Water Pure Drink or Pure Hype?* (1999), available at <http://www.nrdc.org/water/drinking/bw/chap2.asp>
- PH Gleick and HS Cooley, *Energy implications of bottled water*, Environ. Res. Lett. 4, (2009).
- Robert Glennon, *Unquenchable: America's Water Crisis and What to Do About It*, 44 (2009).
- U.S. GOV'T ACCOUNTABILITY OFFICE, BOTTLED WATER: FDA SAFETY AND CONSUMER PROTECTIONS ARE OFTEN LESS STRINGENT THAN COMPARABLE EPA PROTECTIONS FOR TAP WATER (2009).