



Green



Laundry

A Small Change Leads to a Big Impact on Energy Savings

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Introduction

We have a tradition of hanging our laundry out to dry whenever the weather is suitable. We hardly use a laundry dryer, but only use our dryer when it is raining, snowing, or too cold. When I help my mom hang the clothes, I always wonder how much energy we save.

My idea of this was reinforced by my visits to China. Even on cloudy days, everybody there still hangs his/her clothes out to dry. So I thought, if they can do that on cloudy days, then here in New Mexico, where we have so much sunshine, why do not more households dry their clothes outside? We should save a lot of energy by not using dryer that much. To find out how much energy this drying method can save. I started this project.



don.sutton - March 19th, 2009;

[Www.bownet.org](http://www.bownet.org)

<http://www.flickr.com/photos/hizbrowneyez/1317439568/009>

Hypothesis

- ★ Cotton clothes absorb more water and take longer time to dry than other types of clothes.
- ★ Clothes will dry faster on sunny and warm days than on cold days.
- ★ Wind helps clothes dry faster.
- ★ A lot of energy could be saved if each household effectively uses the sun to dry its clothes.



Materials

- Washing Machine
- Dryer
- Clothes line
- Clothes
- Scale
- Thermometer
- Hygrometer
- Clothes Basket



Experimental Procedure

1. Identify the fabric of the majority clothes (e.g. towel, jeans, cotton, polyester, etc).
2. Wash clothes with different load settings (medium or large mode).
3. Determine the weight of wet clothes after washing
4. Dry them either outside or in the dryer.
5. When drying outside, record drying time, outside temperature, and humidity.
6. After they are dried, find the weight of dry clothes.
7. Based on the weight change, determine water content for each type of clothes.
8. From the evaporation heat of water, the energy saved by drying clothes outside can be estimated based on dryer efficiency.

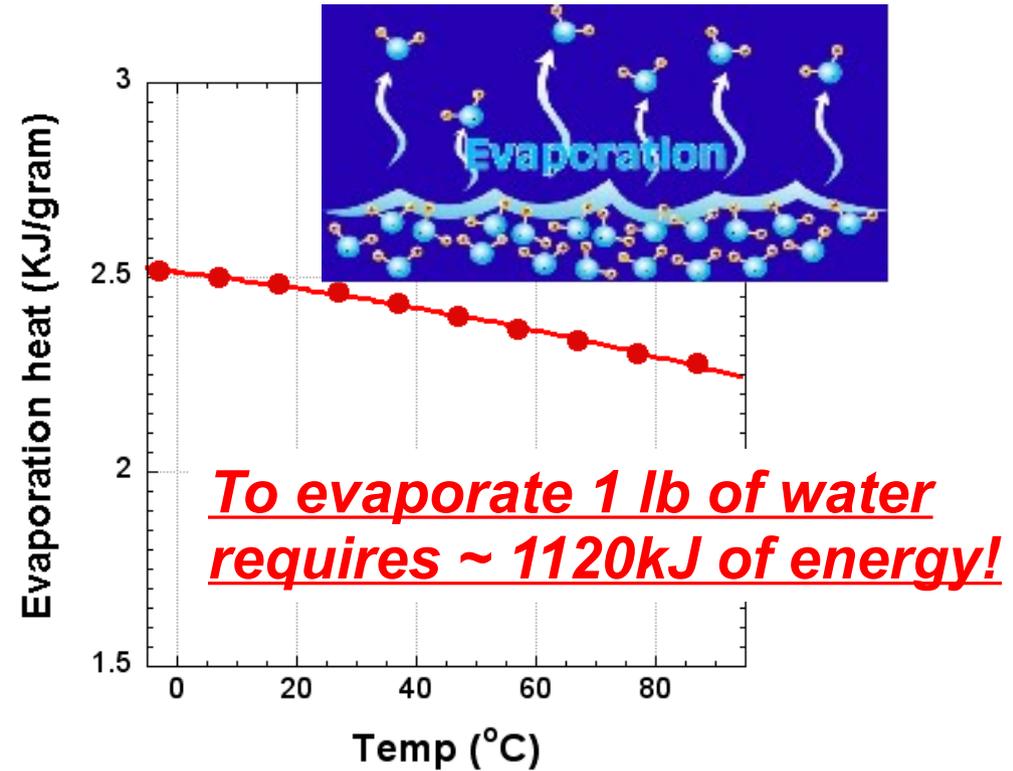
Drying Principle – Water Evaporation

What is evaporation?

- ✓ Is a type of vaporization of a liquid
- ✓ Only occurs **on the surface of a liquid**
- ✓ Is different from boiling - occurring **on the entire mass of the liquid**
- ✓ Is type of phase transition - a process by which liquid molecules (e.g., water) spontaneously become gaseous (e.g., water vapor)
- ✓ Is also part of the water cycle

Factors affect evaporation rate

- ✓ Temperature - in hot temperature, water molecules have a higher potential to evaporate
- ✓ Humidity (water concentration in air) - dry weather dries faster
- ✓ Surface area - more water molecules can escape from the larger surface
- ✓ Flow rate of air - wind is moving over clothes all the time, the water content in the air is less, thus accelerating evaporation.
- ✓ Pressure – at low pressure, evaporation happens faster because less exertion on the surface keeps the molecules from escaping.



Effect of Drying Conditions on Drying Time

Temp (°F)	Humidity (%)	Wet Clothes Wt (lb)	Dry Clothes Wt (lb)	Clothes type	Water Wt (lb)	Water Content (%)	Drying Time (hr)
>61.2	13	11.2	6.8	Polyester & Cotton	4.4	39.2	4.2
>76.1	15	17.0	10.8	Polyester & Cotton	6.2	36.5	3.8
>69.1	31	10.8	7.6	Polyester	3.2	29.6	5.0
>70.0	15	13.6	9.2	Polyester	4.4	32.3	3.5
>85.7	10	12.6	8.4	Polyester	4.2	33.3	1.5
>53.0	25	10.8	7.0	Cotton	3.8	35.2	4.2
>59.0 (windy)	30	15.6	9.8	Cotton	5.8	37.8	5.2
>66.4	42	10.0	6.4	Cotton	3.6	36.0	6.0
>78.2	13	13.2	7.8	Cotton	5.4	40.9	2.5
>85.0	10	12.6	7.6	Cotton	5.0	39.6	1.5
>72.0	22	16.9	11.8	Jeans	5.1	30.2	5.0
>78.7	15	15.4	9.8	Cotton & Jeans	5.6	36.3	4.5
>70.0	38	9.4	5.2	Towels	4.2	44.9	6.0
>75.0	<10	13.4	7.6	Towels	5.8	43.3	3.2
>83.0	15	12.7	6.8	Towels	5.9	46.4	2.0
>92.2	<10	16.0	9.0	Towels	7.0	43.8	2.5

- ✓ High Temperature and low humidity result in faster drying
- ✓ Wind helps clothes dry faster
- ✓ Polyester and Jeans hold less water than cotton and towels
- ✓ Large surface area leads to a short drying time



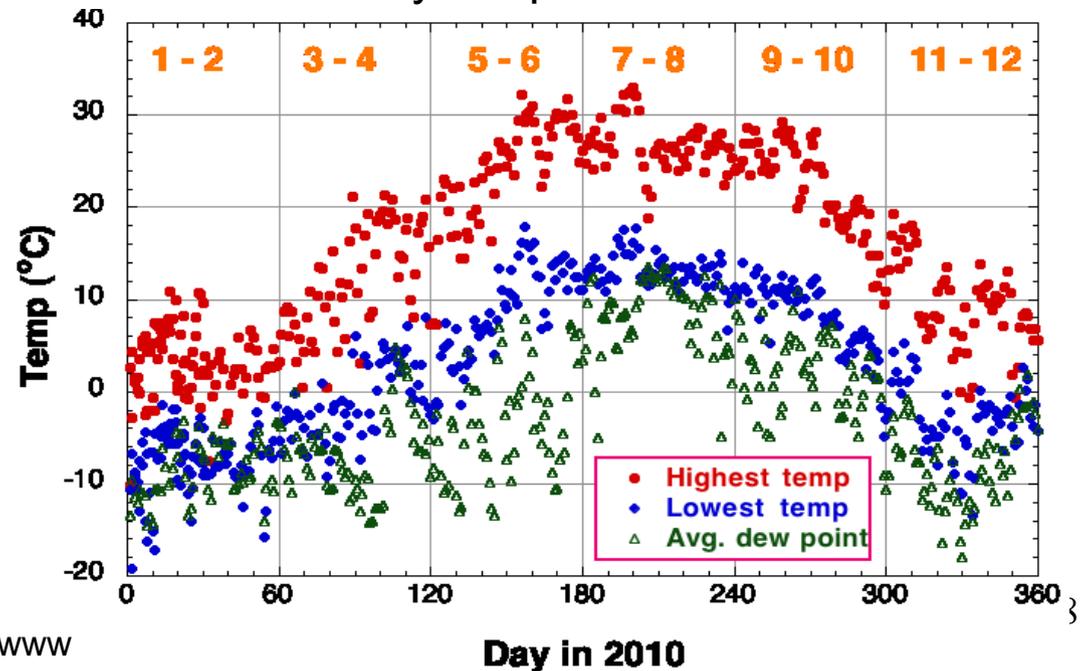
Can You Dry Clothes During the Cold Weather?

Test #	Date	Weather	Temp (°F)	Humidity(%)	Clothes Type	Drying Time (hr)
1	11/02/2010	Sunny	>41.0	<10	Towels & Bed Covers	3.5
2	11/02/2010	Sunny	>41.0	<10	Towels	3.5
3	11/02/2010	Sunny	>41.0	<10	Bed Covers	3.0
4	11/14/2010	Sunny & windy	>39.8	<10	Towels	3.25
5	12/04/2010	Sunny	>38.5	<12	Towels	5.4
6	12/04/2010	Sunny	>48.6	>12	Towels	5.0
7	12/05/2010	Partly cloudy	>44.0	>13	Towels	5.5
8	12/11/2010	Sunny	>59.0	>15	Towels	2.5

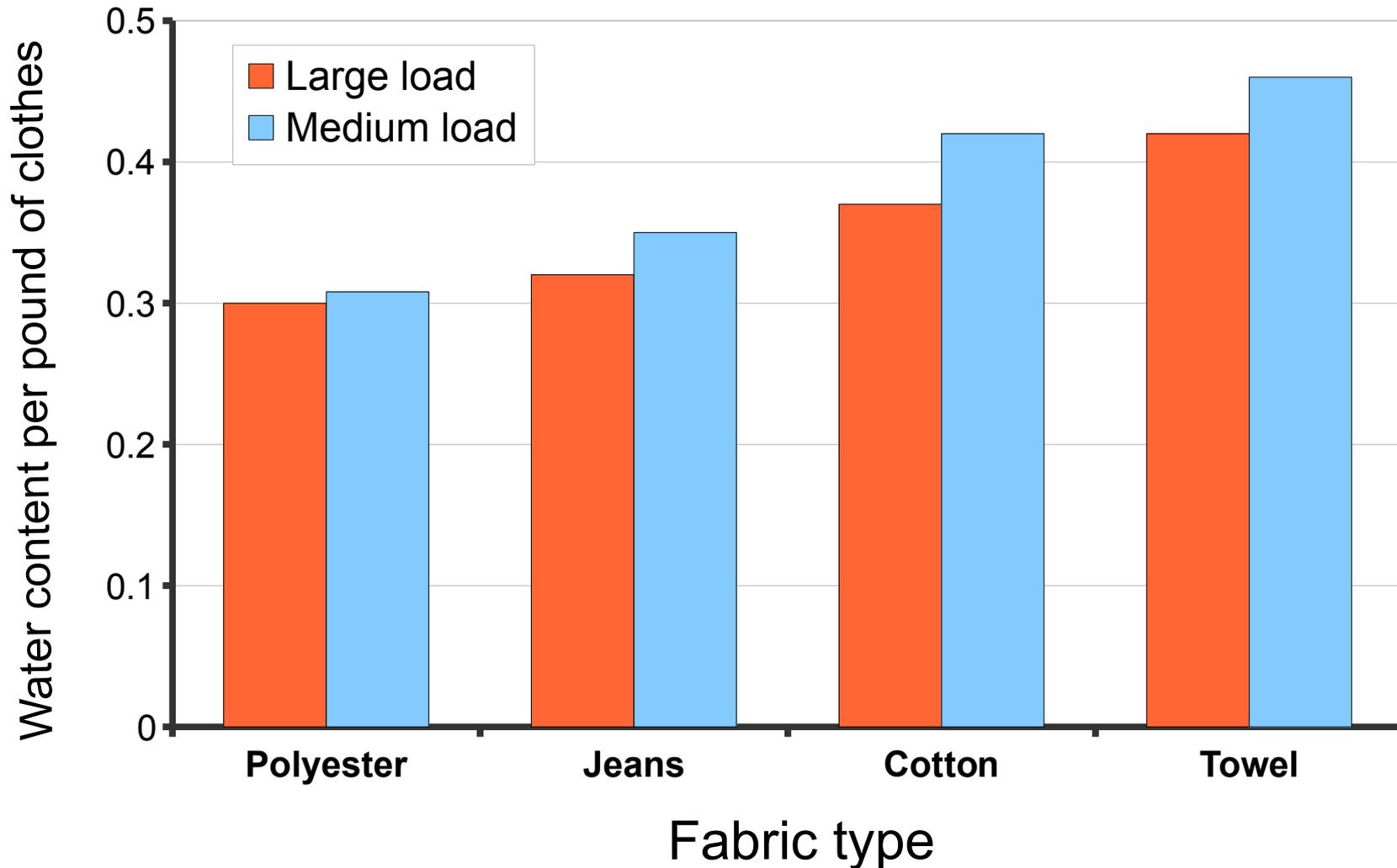
➤ Even in the cold weather, you still can dry your clothes outside as long as the humidity is relatively low and the temperature is above the dew point of water.

➤ **Can dry clothes most time of a year!**

2010 daily temp record in test area

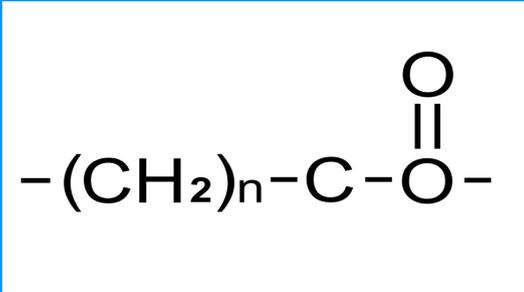
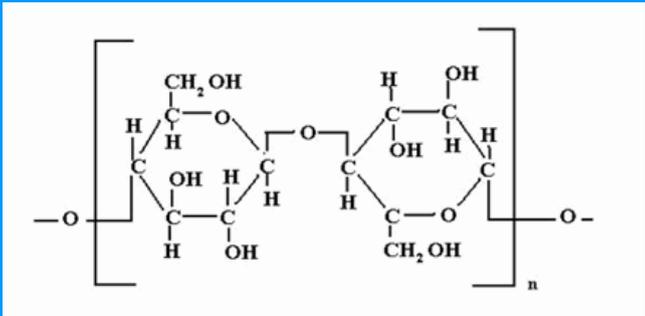


Water Content in Different Types of Clothes



- ✓ Polyester and Jeans hold less water than cotton and towels
- ✓ Towels can hold 0.45 lbs of water per pound of wet towel
- ✓ The spin dry at the large load setting seems to remove water more effectively than the medium load setting

Differences Between Polyester and Cotton

Polyester	Cotton
	
<ul style="list-style-type: none">★ Does not like water★ Wrinkle free and light weight★ Good durability and color retention★ Synthetically modifiable★ Not breathable ★ Good for jackets, shirts, pants, and etc.	<ul style="list-style-type: none">★ Likes water★ Soft, breathable, and comfortable★ Biodegradable★ Shrinks when washed, not durable★ Poor color retention ★ Good for towels, robes, and underwears

Chemical structures are cited from:

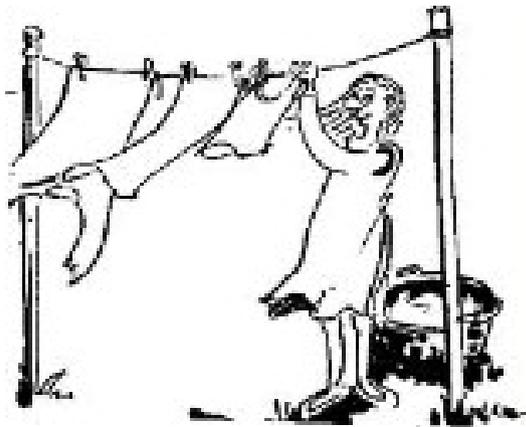
http://commons.wikimedia.org/wiki/Image:Polyester_chemical_structure.PNG?uselang=ja

<http://cotton.missouri.edu/Classroom-Chemical%20Composition.html>

Energy and Cost Estimation – Per Household

Assumptions:

- ✓ Drying outside for 40 weekends/year
- ✓ Dry 20 lbs of wet towels/week
- ✓ Dry 15 lbs of wet cotton clothes/week
- ✓ Dry 15 lbs of wet Jeans/week
- ✓ Dry 10 lbs of wet polyester/week
- ✓ Evaporate 22 lb water
- ✓ Dryer efficiency > 60%
- ✓ Electricity ~ \$0.18/Kwh



Savings

- ✓ Energy saved > **41,000 KJ/week**
- ✓ Energy saved > **1640,000 KJ/year**
- ✓ **Annual savings > \$85**

Environmental Impacts

- ✓ Electricity saved > **455 Kwh/year**
- ✓ CO2 emission reduction > **0.35 ton/year**
- ✓ Trees planted > **1.7/year**

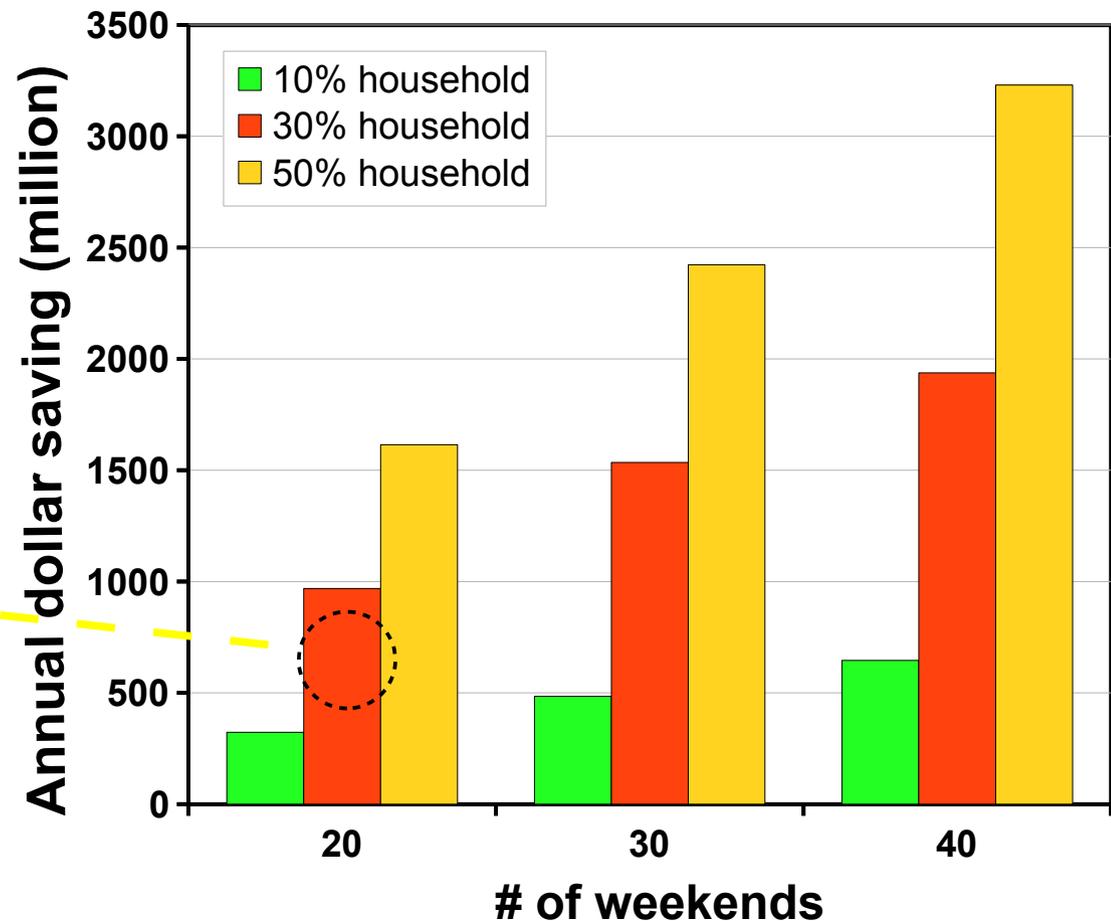
Energy Saving Estimation – United States

Assumptions:

- ✓ Drying clothes during weekends
- ✓ Dry 15 lbs of each type of clothes/week
- ✓ 4 person/per household
- ✓ > 77.1 Million households
- ✓ \$85/yr/household cost of drying

of households and # of days to dry clothes outside directly impact the total saving in US

**Easily save
> \$500M**



Environmental Impacts – United States

Assumptions:

- ✓ Only 10% of US households dry clothes outside
- ✓ Only 20 weekends dry clothes outside

Annually Saving

Electricity: > 1.750 Billion Kwh
Trees: ~ 6.56 Million
CO2 emissions: ~ 1.3 Million ton reduction



Many Good Reasons to Dry Clothes Outside

1. Gentle on clothing - Clothes last much longer
2. Good Rays - The sun whitens clothes – for free and without toxic bleach
3. Sunlight kills bed bugs
4. Freshness and peacefulness – fresh smells
5. A breeze makes a good fabric softener.
6. Clothing doesn't shrink when hung outside versus forced to dry in the dryer
7. Winter humidity - Indoor racks can humidify the air in dry winter weather
8. Prevent fire risks - **account for about 15,600 structure fires, 15 deaths and 400 injuries annually. The yearly costs in US for fire loss due to the dryer fires ~ \$99 million.**



Useful Tips for Drying Clothes Outside

- ✓ Dry dark clothes inside – out or in the shade to preserve the color
- ✓ Let the backside of colored towels face the sun to preserve the color
- ✓ Add some softener during the washing stage to avoid the stiffness of dried clothes
- ✓ Expose blankets to sunlight during sunny winter days to kill germs and soften the blankets
- ✓ Fully extend clothes for the best drying effect



Conclusions

- ✓ Due to different molecular structures, cotton based clothes absorb much more water than polyester based clothes
- ✓ Higher temperature, lower humidity, windy condition and large surface area speed up the drying process
- ✓ One can dry clothes even in cool weather
- ✓ Large energy savings can be easily achieved
 - > 1.75 Billion Kwh electricity
 - > \$500 million annually
- ✓ The US can reduce its CO₂ emission by >1.3M ton annually
- ✓ Green laundry seems to be a small change in our daily routine, but will have a huge impact to save our planet - Earth



References

1. Woodford, Chris. Cool Stuff and How it Works. New York: DK Publishing, Inc. 2005.
2. Burnie, David. Science Encyclopedia. New York: DK Publishing Inc. (pockets edition, 2003).
3. Stockley, Corinne. The Usborne Illustrated Dictionary of Science. Oklahoma: EDC Publishing, 2007.
4. www.eia.doe.gov/energyexplained/index.cfm?page=electricity_factors_affecting_prices
5. en.wikipedia.org/wiki/Washing_machine
6. en.wikipedia.org/wiki/evaporation
7. www.carbonify.com/carbon-calculator.htm
8. www.census.gov
9. www.thegoodhuman.com/2010/01/11/10-reasons-you-should-line-dry-your-clothes-if-you-can
10. www.laundry.about.com/od/ecofriendlylaundry/tp/10reasonstolinedrylaundry.htm
11. en.wikipedia.org/wiki/cotton
12. en.wikipedia.org/wiki/polyester

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